Total Maximum Daily Load for Total Nitrogen to the Neuse River Estuary, North Carolina

June 1999

Neuse River Basin

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I. Background And Purpose

I-A. Section 303(d) Requirements

Section 303(d) of the Clean Water Act (CWA) requires states to develop a list of waters not meeting water quality standards or waters which have impaired uses. Waters may be excluded from the list if existing control strategies for point and nonpoint source pollution will achieve standards and uses. Listed waterbodies must be prioritized, and a management strategy or total maximum daily load (TMDL) must subsequently be developed for all listed waters. The 303(d) process is presented in Figure 1.

I-B. Neuse Basin Description

The Neuse River originates northwest of Durham and flows southeasterly for over 150 miles past Raleigh, Smithfield, Goldsboro and Kinston before it reaches its estuary around New Bern (Figure 2). The Neuse River's watershed encompasses nearly 6200 square miles over 19 counties. A few miles above New Bern, the river takes on estuarine characteristics as it widens but remains shallow (< 5 m), frequently resulting in minimal discharge and long hydraulic residence times. The Neuse River estuary stretches to the southeast for 25 miles until it reaches Cherry Point (Minnesott Beach on the north side), where it turns to the northeast and continues for another 20 miles before meeting Pamlico Sound. Estuarine salinity varies vertically and horizontally with saltwater inflow from the sound, meteorological conditions (wind and precipitation), and river discharge (Pinckney et al., 1997). Up-estuary advancement of saline water along the bottom occurs in the growing season during low to moderate discharge and prevailing southwest winds. Saltwater advance typically persists until heavy winter rains result in high river discharge that drives the salt wedge back into the sound.

I-C. History of Nutrient Issues in the Neuse Basin

Eutrophication became a water quality concern in the lower Neuse River Basin in the late 1970s and early 1980s through the proliferation of nuisance algal blooms (Paerl 1983, 1987; Stanley 1983; Christian et al. 1986). A prevalence of algal blooms in the freshwater portion of the basin prompted a special Division of Water Quality (DWQ) investigation of the Neuse River beginning in 1979 (Tedder et al., 1980). This study found that phytoplankton growth in the Neuse was not limited by the major nutrients of nitrogen or phosphorus. Similar conclusions derived from other studies led to a ban on phosphate detergent and classification of the lower basin as nutrient sensitive water (NSW); both actions were instituted in January, 1988. One requirement of the NSW strategy was that all new and expanding NPDES dischargers, as well as existing ones with design flows greater than 0.05 MGD, must meet a quarterly average phosphorus limit of 2 mg/l.

In 1993, DWQ completed the Neuse River Basinwide Water Quality Management Plan, which recognized the reductions in total phosphorus loading that had been achieved through the phosphate detergent ban and the NSW strategy. Furthermore, the reduction

Figure 1. The 303(D) Process

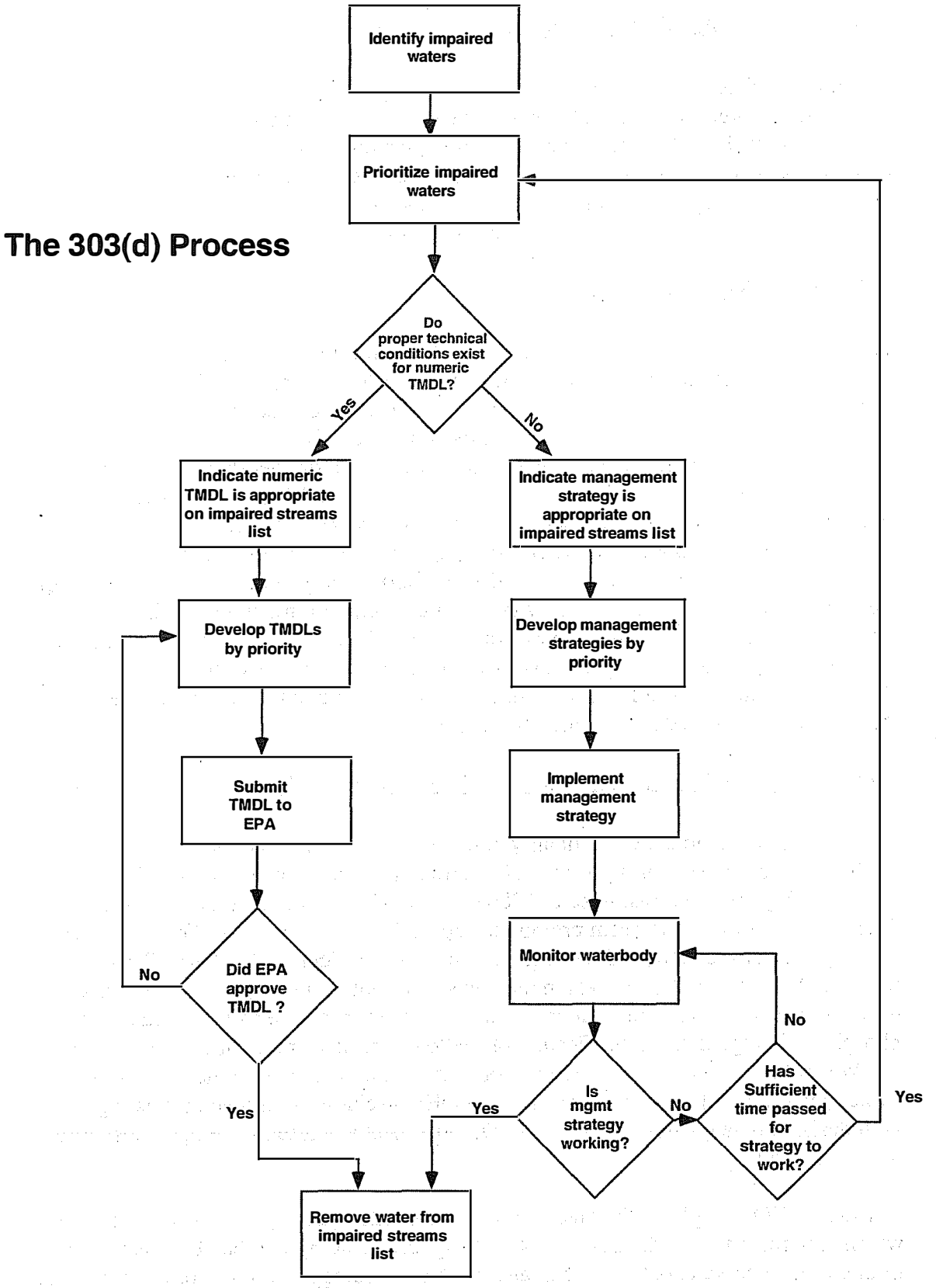
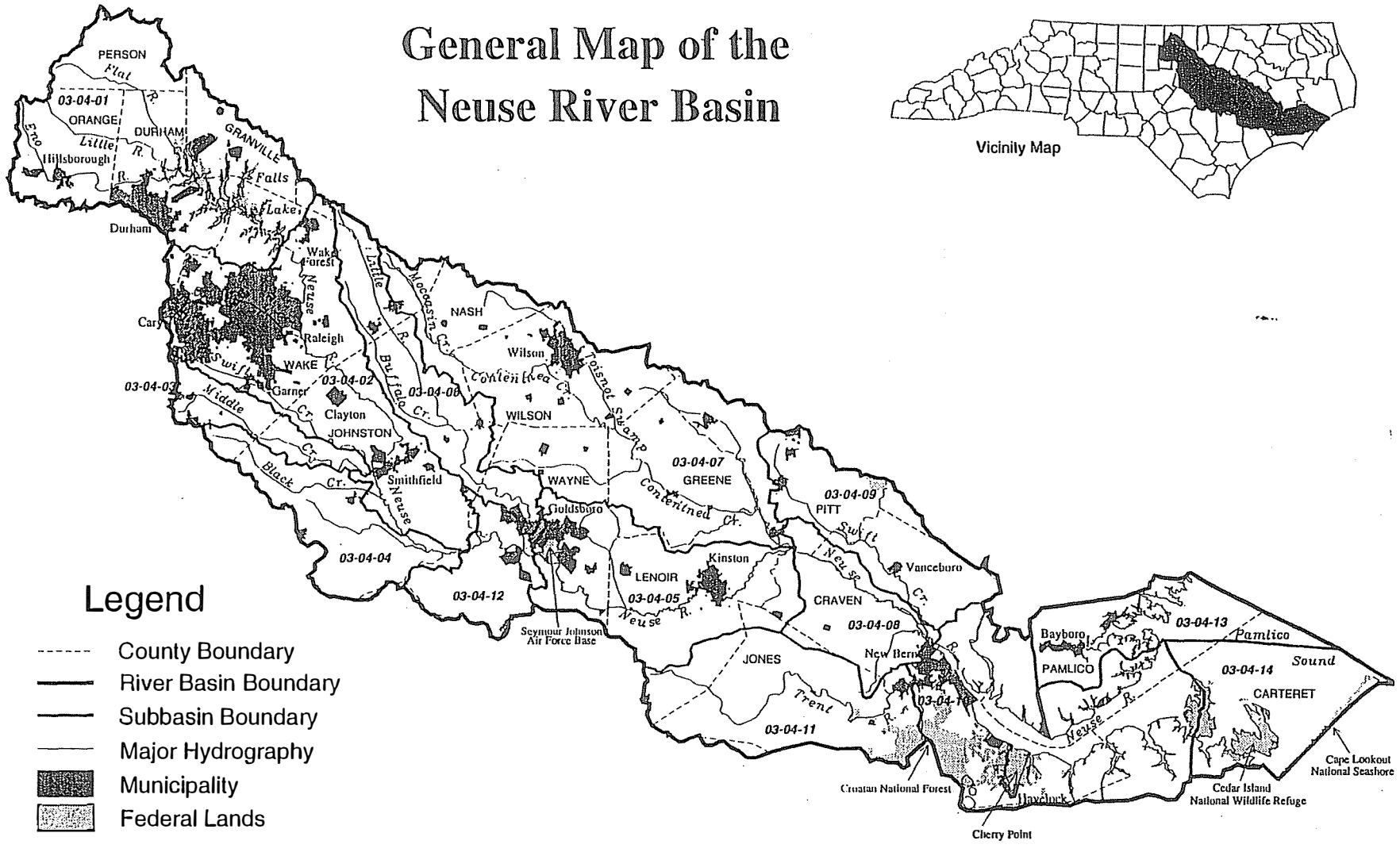


Figure 2.


General Map of the Neuse River Basin
Vicinity Map
PERSON
ORANGE
DURHAM
GRANVILLE
Hillsborough
Falls
Lake
Durham
Wake Forest
Cary
Raleigh
WAKE
Garner
Clayton
JOHNSTON
Smithfield
NASH
Wilson
WILSON
WAYNE
Goldsboro
GREENE
PITT
Kinston
LENOIR
Vanceboro
CRAVEN
JONES
New Bern
PAMLICO
Bayboro
CARTERET
Pamlico Sound
Cape Lookout National Seashore
Cedar Island National Wildlife Refuge
Havelock
Cherry Point
Croatan National Forest
Seymour Johnson Air Force Base
03-04-01
03-04-02
03-04-03
03-04-04
03-04-05
03-04-06
03-04-07
03-04-08
03-04-09
03-04-10
03-04-11
03-04-12
03-04-13
03-04-14
Neuse R.
Little R.
Flat R.
Eno R.
Swift Cr.
Middle Cr.
Black Cr.
Buffalo Cr.
Moccasin Cr.
Contentnea Cr.
Toisnot Swamp
Trent R.
Legend
County Boundary
River Basin Boundary
Subbasin Boundary
Major Hydrography
Municipality
Federal Lands
1:1,300,000
0 10 20 30 Miles
DEHNR
Produced by: State Center for Health Statistics
May 1997

in phosphorus loading greatly reduced algal blooms in the river and freshwater, uppermost portion of the estuary. However, the plan recognized that eutrophication was still a problem in much of the estuary. The plan indicated that a water quality model of the estuary would be developed, and that addressing eutrophication in the estuary was a priority (NCDEM, 1993).

During July, September, and October 1995, extensive fish kills occurred in the Neuse estuary, primarily from New Bern to Minnesott Beach. Millions of menhaden, as well as flounder, croaker and rock fish were killed. DWQ conducted extensive water quality sampling in the areas of the fish kills. The sampling showed the water was often hypoxic only 1 to 2 meters below the surface. The results also showed a prevalence of algal blooms. Though not directly linked to these fish kills through published data, a toxic dinoflagellate, *Pfiesteria piscida*, has been found in the water where many of the fish kills occurred (Burkholder and Glasgow, 1997). Researchers have suggested that *Pfiesteria* may have been responsible for 30 to 50 percent of the fish kills in the estuary. Furthermore, its presence is thought to be stimulated by eutrophic conditions (Burkholder et al. 1995). In sum, the 1995 fish kills and threat of *Pfiesteria* led to a review of water quality and management actions to expedite nutrient loading reductions in the system.

I-D. Pollutant Addressed by TMDL

The Neuse River was listed as one of the 20 most threatened rivers in the United States because of the frequency, magnitude and areal extent of phytoplankton blooms (American Rivers, Washington, D.C. 1996). As a result of these phytoplankton blooms and chlorophyll *a* levels, North Carolina placed the Neuse River estuary on its 1994, 1996 and 1998 303(d) impaired waters lists. Controlling nutrients is the most direct way to reduce chlorophyll *a* concentrations, and the science indicates nitrogen is the main nutrient of concern in the estuary. Early nutrient addition bioassays (Paerl 1987, Rudek et al. 1991, Paerl et al. 1995) and nutrient uptake kinetics studies (Boyer et al. 1994) showed that phytoplankton growth was nitrogen limited throughout the estuary. Other bioassay studies found that nitrogen enrichment yielded similar phytoplankton growth as with nitrogen and phosphorus enrichment (Paerl et al. 1995, Pinckney et al. 1997). Some parties suggest that quasi-quantitative management of phosphorus is needed as well. This does not appear to be necessary as colimitation by nitrogen and phosphorus only appears to occur during high spring loading events when it is not likely that any management strategy would reduce productivity due to the presence of abundant nitrogen and phosphorus (Paerl et al. 1990, Rudek et al. 1991, Paerl et al. 1995). In a letter to Dr. Tim Spruill of USGS on December 22, 1998, Dr. Hans Paerl noted that much of the present watershed phosphorus loading is naturally occurring, and originally derived from soil weathering, mineralization, and solubilization processes. Such sources would be extremely difficult to manage, and the Clean Water Act does not require that natural sources be reduced. Furthermore, nitrogen and anthropogenically derived phosphorus have similar sources, and many of the nonpoint source management strategies aimed at nitrogen will obtain parallel phosphorus reductions.

Tetra Tech (Butcher 1999 - see TMDL Reduction Target Section) considered the nitrogen to phosphorus (N:P) ratio to determine which was the limiting nutrient, and found that gross N:P ratios, based on annual load estimates at Fort Barnwell, show an increase coincident with the phosphate detergent ban, though the ratio is generally less than 10. The individual observations show that temporary high N:P ratios, often above 15, have occurred since 1989. Tetra Tech states that a ratio between 10 and 15 is generally regarded as a dividing line between nitrogen and phosphorus limitation, which would indicate occasional limitation by phosphorus. This analysis was conducted at Fort Barnwell, well upstream from the impaired segments, in strictly freshwater. Somewhere between Streets Ferry Bridge and Cherry Point would be the preferred site(s) for this analysis. Furthermore, as Dr. Martin Lebo of Weyerhaeuser notes (letter to Dr. Tim Spruill, USGS on December 18, 1998), typically half of the total nitrogen pool is comprised of organic nitrogen, which is "largely resistant to microbial degradation over typical residence times for water in the estuary and, thus, only partially available to stimulate algal growth. The impact of organic nitrogen fractions on the appropriate N:P ratio for calculations...is that a realistic number is 15-20." This would certainly decrease the frequency of apparent phosphorus limitation. Additionally, it appears by the individual observation plots (Butcher, 1999) that the high N:P ratios occur in the late-winter and spring, and as previously stated, nutrient limitation is particularly challenging under those conditions. Finally, trend analyses indicate that phosphorus loads have been decreasing over much of the basin, which suggests that reducing phophorus loads will not impact the estuary as much as reducing nitrogen loads. These analyses are highlighted in the Riverine Loading subsection.

The remainder of this document describes the TMDL that has been developed for total nitrogen across the entire Neuse basin.

II. TMDL DEVELOPMENT

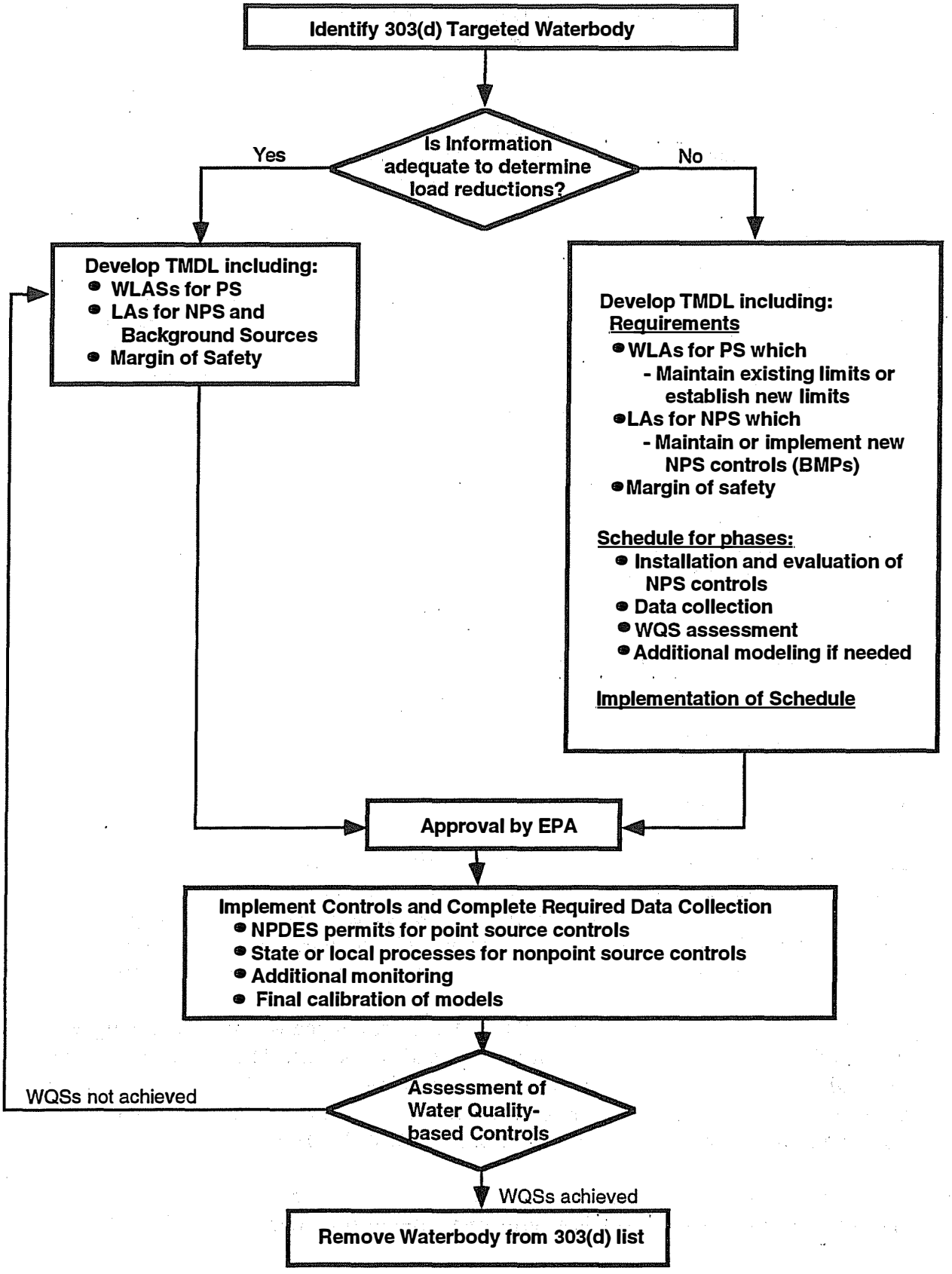
II-A. TMDL Approach

In 1991, the Environmental Protection Agency (EPA) published guidance for states to follow when developing TMDLs (USEPA, 1991). This guidance document outlined two potential approaches, one to follow when available data are adequate to develop the TMDL and the allocations between point and nonpoint sources, and one to follow when there is greater uncertainty in the data. These approaches are illustrated in Figure 3.

EPA has used the term "phased TMDL" for TMDLs developed where there is a higher degree of uncertainty in the TMDL calculations and allocations. The narrative portion of the guidance states that the "phased approach is required when the TMDL involves both point and nonpoint sources and the point source WLA is based on a LA for which nonpoint source controls need to be implemented" (USEPA, 1991).

North Carolina has opted to develop a phased TMDL for nitrogen in the Neuse River Basin for several reasons: there is no estuarine water quality model at this time, the fate

Figure 3 Development of TMDLs for Targeted Waterbodies



Source: EPA, Guidance for Water Quality - based Decisions: The TMDL Process, April 1991.

and transport of nitrogen is not clearly understood, there is uncertainty in the magnitude of the various nonpoint sources, and nutrient studies are ongoing in the basin.

Due to the lack of a fully calibrated estuarine response model, there is no good tool to determine the allowable nutrient loads to the Neuse River estuary. Therefore, the first phase of this TMDL is based on the best professional judgment of scientists who have done much research in the Neuse River and other analyses. There is much ongoing work in the Neuse River estuary including the development of an estuarine response model that will provide DWQ with more information. The TMDL process is iterative, and DWQ will continue to evaluate available data, assess use support, and the TMDL (subsection on Future Phases of TMDL, Figure 14 for phased schedule). If data indicate that there are more effective methods to address the eutrophication issues in the estuary, DWQ will modify the management strategies that have been developed to implement the first phase of the TMDL. If an acceptable estuarine response model and other pertinent research indicate that the TMDL itself must be modified, this will occur as well. Further information on this on-going monitoring, future work, and schedules is provided in the Subsection entitled "Ongoing and Future Studies in the Neuse River", beginning on p. 29.

The remainder of this section of the report will describe the science that is available to further examine the nitrogen loading reduction target, the TMDL calculation, and the allocation among the sources. The Clean Water Act also requires that all TMDLs account for seasonality and a margin of safety. Due to the lack of an estuarine response model, these issues are difficult to quantify, but they are addressed qualitatively in this section as well.

II-B. TMDL Reduction Target

There is broad consensus among the water quality experts, both within and outside DWQ, that a thirty percent reduction in total nitrogen is a good initial step to restore water quality in the Neuse River estuary. At a January 1996 workshop sponsored by the NC Senate Select Committee on River Water Quality and Fish Kills, a consensus was reached by the numerous scientists familiar with the Neuse River that a 30 percent reduction in total nitrogen was a good goal. A summary of this meeting is included in Appendix I. This goal was codified by the NC General Assembly during its 1996 session in Session Laws 1995, Section 572 (Appendix II). While comments have been received that indicate a 50% reduction in total nitrogen is needed in the Neuse River, insufficient evidence was submitted to support this conclusion.

Presently, phytoplankton growth dynamics, nutrient pathways and sediment diagenesis in the Neuse River estuary are only partially understood. The scientific community has an idea of how basic processes operate but cannot quantify, or reduce uncertainty about many of the processes that lead to nuisance algal blooms, anoxia, and fish kills. However, this state of gross uncertainty is likely to improve in the near future as there are numerous State-funded Neuse River MODeling and MONitoring (MODMON) projects underway. One of their main purposes is to quantitatively assess interaction and the pathways between nutrients, phytoplankton, and dissolved oxygen. Once this research is

completed, the Neuse stakeholders will have a greatly enhanced ability to assess an appropriate load reduction target.

Currently, there is no estuarine water quality model available that can be used to predict the effects of this proposed nitrogen reduction on water quality standards in the estuary, although significant progress has been made on a model that will ultimately be used to refine the TMDL presented in this report. There are other tools that were examined to determine if there is sufficient evidence at this time to refine the scientists' recommendation. The following sections briefly outline available tools, their limitations, and how they were used to examine the reduction target.

Estuarine Response Model

The 1996 General Assembly allocated money to monitor and model the Neuse River estuary. DWQ contracted with a team of university researchers to collect monitoring data throughout the estuary and develop a two dimensional estuarine water quality model to determine allowable nutrient loads. This effort is part of MODMON.

At this time, the model has been calibrated using data collected between May and September 1991. An uncertainty analysis has also been developed for this calibration period. Data collected from June through December 1997 have been used for model verification.

Dr. James Bowen, the principal investigator developing the estuary model, has stated that the model should ultimately be able to be used to determine nutrient TMDLs for the Neuse River estuary, however, Dr. Bowen has stated, also, that the model is not yet ready to be used in that manner (personal communication on January 12, 1999, letter from Dr. Bowen to EPA on February 19, 1999). The following reasons have been cited: (1) difficulty establishing initial conditions without a full calendar year of data; (2) inadequate data to develop downstream boundary condition; (3) need for sediment model that will do multi-year simulations; and (4) 1991 and 1997 were fairly average hydrologic years to simulate with a model. Further information on each of these reasons is provided below.

Data were available from May through September 1991 and June through December 1997 for model development. In each of these years, the high winter and spring discharge and loads that occur prior to the summer conditions have not been monitored. Therefore, it is difficult to quantify the initial conditions that occur prior to the growing season, when hypoxia is prevalent. Work is currently underway to use data collected from January through December, 1998 to refine the model. These data do capture the winter and spring discharge/load needed to quantify initial conditions.

The model is very sensitive to the downstream boundary conditions as this is used to calibrate its hydrodynamic component. For the runs completed to date there were no good data available at the downstream boundary. Current velocity data collected near Cherry Point were used to set the downstream boundary, but there is quite a bit of

uncertainty associated with this indirect method. A water level monitor is necessary further downstream, and that was installed in January, 1998.

The current model contains a single constituent sediment model. The model predicts sediment organic carbon and then calculates sediment oxygen demand and nutrient fluxes for ammonium and phosphate. Data are available that indicate the sediments are a major source of nutrients and oxygen demand, and it will be critical to develop a sediment model that is capable of doing multi-year simulations (DWQ 1998, Bowen and Hieronymus 1999, Christian & Thomas 1999). Without the capability of doing multiyear simulations, the model is only designed to predict what the change in water quality would be in the year that nitrogen reductions occur. This will not provide accurate predictions of long term water quality improvement, while there is consensus among research scientists that improvement will likely take a number of years following achievement of reduced loading. The 1998 General Assembly allocated additional money to extend the MODMON project. A proposal has been submitted by Dr. Bowen to obtain funds to include a multi-year simulation sediment model within the estuary water quality model.

Finally, 1991 and 1997 were similar and average hydrologic years. There were no high discharge, winter/spring loading events, or periods of hot and dry weather in the summer. The model in its current state could only predict water quality conditions for years with similar flow regimes. 1998 was different hydrologically and will enable us to predict water quality under a wider array of conditions. High flows were experienced in early 1998, and there was one period of anoxia and fish kills.

DWQ intends to use the 1998-calibrated version of the estuary water quality model to refine its estimates of the TMDL. The estuary model should be delivered to DWQ in April, 2000 and DWQ will work with stakeholders to use the model to refine the total nitrogen loading target. The enhanced sediment component of the model will be included in the version DWQ uses for developing management scenarios. Further information is provided in section VI titled "Future TMDL Initiatives", beginning on p. 41.

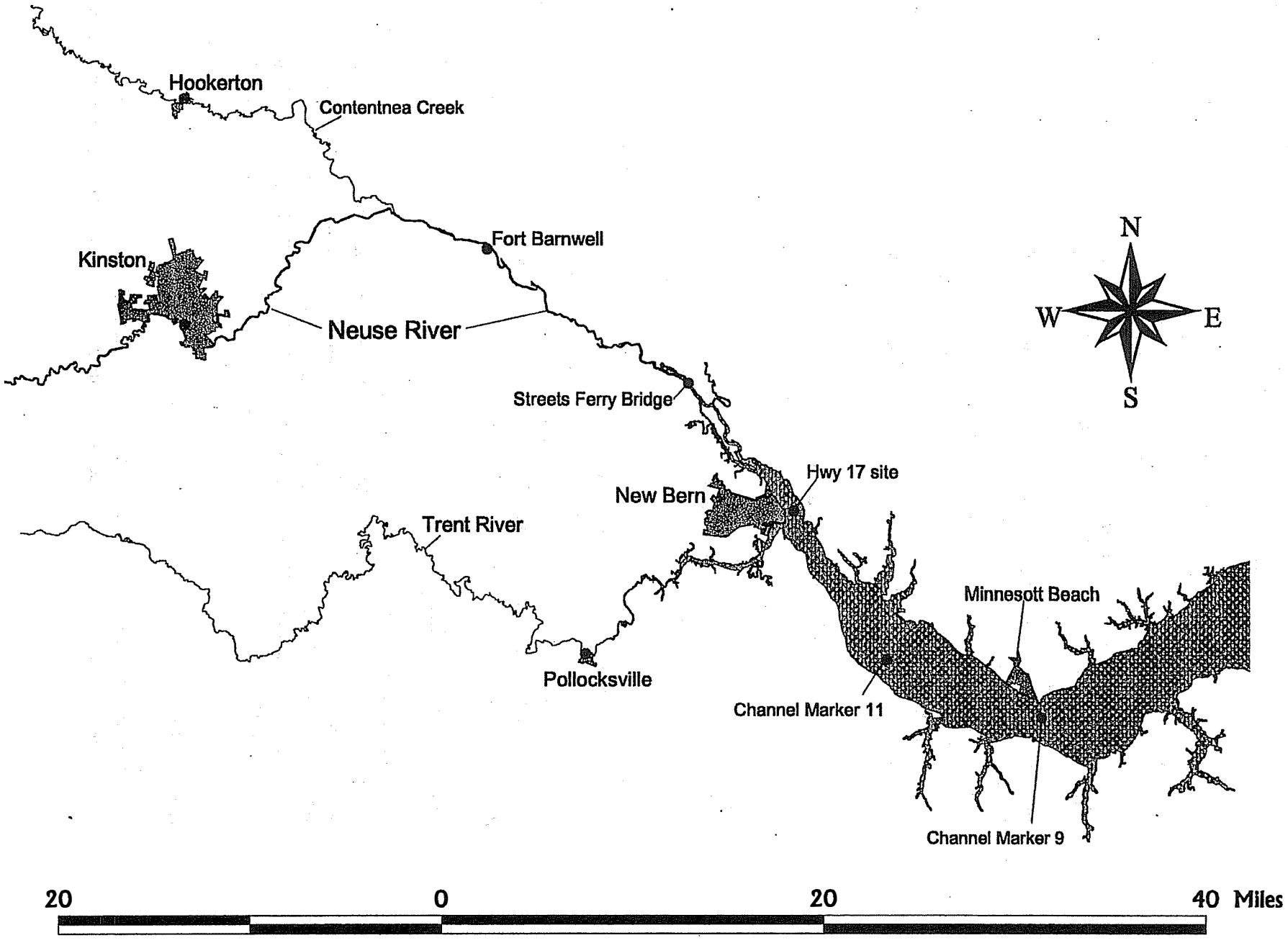
Statistical Approaches

This subsection considers several analyses to assess the present validity of the scientists' best professional judgement that a 30% nitrogen reduction represents a reasonable initial target. These analyses include: (1) DWQ's trend analysis of riverine loading and a hindcast estimate of loading in 1975, (2) Stow and Borsuk's "An Examination of Long Term Nutrient Data in the Neuse River Watershed", (3) Tetra Tech's analysis of the TMDL. Refer to Figure 4 for a map of the estuary and relevant sites to the following analyses.

Riverine Loading

This portion of the TMDL addresses the issue of historical riverine nutrient loading through monotonic trend analysis. Because we lack the tools to make a linkage between

Figure 4. Map of Neuse River Estuary and Sites Relevant to the TMDL



riverine nutrient loading and algal response in the estuary, some efforts to determine a reduction target have been shifted to examine changes in riverine loading over time. If loading has increased as estuary water quality has declined, nutrient load targets similar to those that occurred when estuary water quality was acceptable could be determined. Acceptable water quality is defined by DWQ as when a water body supports its designated uses. North Carolina's 305(b) report, as well as research in 1975 reported that the Neuse estuary was meeting its uses (Hobbie and Smith, 1975), so 1975 has been used as the beginning year for this nutrient loading trend analysis. As will be shown in Section III, DWQ uses 1991-1995 to determine baseline loads so 1995 was chosen as the end of the trend analysis period.

Kinston is the farthest downstream site on the main stem of the Neuse that records both flow and nutrient concentration. However, Kinston does not include loading from Contentnea Creek, the Neuse River's largest tributary. To address Contentnea Creek, DWQ assessed nutrient loading trends at Hookerton, NC, the most downstream monitoring site in the Contentnea Creek watershed to provide both discharge and nutrient concentration data. DWQ chose this approach because flow was not measured at Ft. Barnwell (on Neuse, includes Contentnea Creek discharge) until recently; it must be estimated during the period of interest with a regression equation that uses flow at Kinston, and this introduces error. Additionally, one of the MODMON projects that is near publication, Stow and Borsuk's "An Examination of Long Term Nutrient Data in the Neuse River Watershed", addresses loading at Kinston and is presented as another approach to trend analysis.

Scientists studying the Neuse River estuary have identified nitrogen as the limiting nutrient in phytoplankton growth on a year-round basis (Boyer et al 1994, Paerl 1987, Paerl et al 1998, Pinckney et al. 1998, Rudek et al 1991,). Probably because of the phosphorus ban in 1988, DWQ found an overall decreasing trend in total phosphorus load at Kinston and Hookerton between 1975 and 1995. For these reasons, the trend analyses focus on nitrogen but will also provide less detailed phosphorus information.

Seasonal Kendall Tests

To determine if a trend in loading was present at Kinston and Hookerton between 1975 and 1995, DWQ employed the seasonal Kendall (SK) test on log normalized, flow-corrected, nitrogen and phosphorus loads. The SK is a nonparametric method that is considered the standard for water quality trend analyses (Reckhow 1999, Aroner 1995). The limitations of the SK are that it only considers monotonic (unidirectional) trends, and that it provides limited insight on the cause of trends compared to other methods. DWQ is primarily interested in detecting a monotonic change since 1975, so that limitation is acceptable. Also, the SK does not provide an efficient hindcast estimate of earlier data. A hindcast estimate in trend analysis is a linear slope which allows estimation of loads at a desired period in the record given a known load at some other date. In this instance, total nitrogen load between 1991 and 1995 has been quantified (Section on TMDL Calculation), so with a robust slope, estimates of loading in the mid 1970s may be obtained. The Sen slope estimator, typically used with the SK, is not considered an

efficient estimator of slope as it considers median values in the trend. A more robust hindcast estimate of the slope of nitrogen loads at Kinston was therefore developed using ordinary least squares regression (accounting for correlation) and autoregression, which are techniques professed by a recognized time series statistician, Dr. David Dickey, at N.C. State University (personal communication January 22, 1999). These techniques are also useful in explaining the cause of the trend. To estimate if real delivery has changed, DWQ also examined the results of the SK test on unadjusted load.

The goal of the trend analysis is to make some statement about changes in watershed activity over the period of record. There are numerous factors that explain the variability in load, but after correcting for the deterministic factors of flow and seasonality, one of the primary remaining factors must be watershed activity, or more explicitly, anthropogenic loading. Anthropogenic loading is what we can manage to meet a load reduction target so it is logical that we focus our trend analysis on this. DWQ chose to look at flow adjusted load as the basis for trend detection. DWQ is interested in load because it captures some signal of the important nonpoint source events. Concentration would lose the nonpoint source signals because higher flows often mean dilution of the carried constituents. Also, load is preferred to concentration because it is the standard by which progress in implementation will be measured. It seems reasonable to adjust for flow since it tends to represent recent weather patterns that have no reflection on changes in watershed activity; however, there may be hydrologic alterations in the watershed which do reflect changes in land use and will affect flow. Flow adjusted load is not an ideal measurement of anthropogenic loading but it seems to be as close as one can get in this context.

The calculation of nutrient loads that were subjected to trend analysis began with concentration data that were gathered between 1975 and 1995. Samples were not collected on a monthly basis until 1985, so there is more uncertainty associated with pre-1985 concentrations. USGS provided an estimate of average daily flow, in cubic feet per second (cfs), for each day. DWQ only used the flow values for those days when concentration samples were collected. To determine load in pounds per day, the following formula was used (variables in italics, conversion factors in plain text):

(*flow in cfs*)*(.646 MGD/cfs)*(*conc. in mg/l*)*(8.34 (lbs/day)/(MGD*mg/l))

The next step was to adjust for the deterministic, or exogenous, factors of flow and seasonality. The goal of removing these exogenous factors is to consider the factors which explain variability in load that cannot be accounted for; principally, this includes anthropogenic loading, or the changes in load that may be attributed to human management actions. The load data were then log normalized to ease the flow adjustment process. Flow adjustment is accomplished using a LOWESS technique on a load versus flow plot. The LOWESS technique is a smoothing approach that uses moving averages to estimate the variability in load that may be explained by flow. The LOWESS line is subtracted from the load (by individual observation) leaving a flow adjusted set of residual values.

The second deterministic effect that DWQ addressed is seasonality. The SK test adjusts for seasonality by removing the variability in load that may be explained by the time of year when the data were collected. For instance, we might expect the highest load to occur in January, when winter rains deliver nonpoint source nutrients that have been stored on land during drier periods. Some of this effect may be removed when the data are flow adjusted, but that which remains may be accounted for by subtracting the monthly load means for the period of record from the residuals.

There are two versions of the SK test in WQHYDRO, the statistical package for water quality trend analysis that DWQ used for this study. The first does not have a correction for serial correlation (assumes that has been eliminated) and the second includes a correction for serial correlation. The software manual recommends that the latter be selected when dealing with data sets that span 10 years or longer, and where serial correlation exists after adjusting for exogenous factors (Aroner, 1995). In all cases serial correlation was evident, and since our period of record exceeds 10 years, the SK with correction was employed. The test with correction comprises power, which is the ability to detect a trend when one is present. A priori, the α significance level for accepting the presence of a trend was 0.10 for all SK time series analysis. For borderline cases, DWQ looks at alternate means of analyzing the trend.

Trend analyses of flow adjusted nitrogen and phosphorus loads from Contentnea Creek at Hookerton using the SK test reveal significant decreasing trends in both nitrogen load and phosphorus load. Table 1 shows the results of each SK test. For nitrogen, the Z statistic was -4.04; this signifies that a decreasing trend exists (Figure 5). Also, a 2P value of .00005 indicates that, with the available data, there is a 5 in one hundred thousand chance of concluding that there is a trend when one does not exist. The test on flow adjusted phosphorus load yielded a Z statistic of -3.44 and that a decreasing trend exists (Figure 6). Considering the phosphate detergent ban in 1988, one might expect a decreasing trend in total phosphorus load, but a decreasing trend in nitrogen load may come to many as a surprise. However, it is clear by visual inspection that a decreasing trend exists in both nitrogen and phosphorus loads since 1985.

Kinston trend analyses for flow adjusted nitrogen and phosphorus loads reveal a significant increasing and decreasing trend, respectively (Figures 7 and 8). For nitrogen, the Z statistic was 1.71, and a 2P value of 0.087. Because of the low significance value, the nitrogen load trend analysis at Kinston is open to question. Further analysis by an academic statistician confirmed the trend, and that analysis is provided in the following subsection. For phosphorus, the Z statistic was -3.6333.

To determine if real delivery at Kinston and Hookerton has changed, DWQ performed supplemental analyses using the SK test on unadjusted load (load not corrected for flow). Interestingly, two of the trends seen in flow adjusted load no longer appear in this version; nitrogen load at Kinston and Hookerton do not show a significant trend (Figures 9 and 10). Decreasing phosphorus load trends remain at Kinston and Hookerton, however, with reduced 2P values of 0.013 and 0.086, respectively (Figures 11 and 12).

Figure 5.

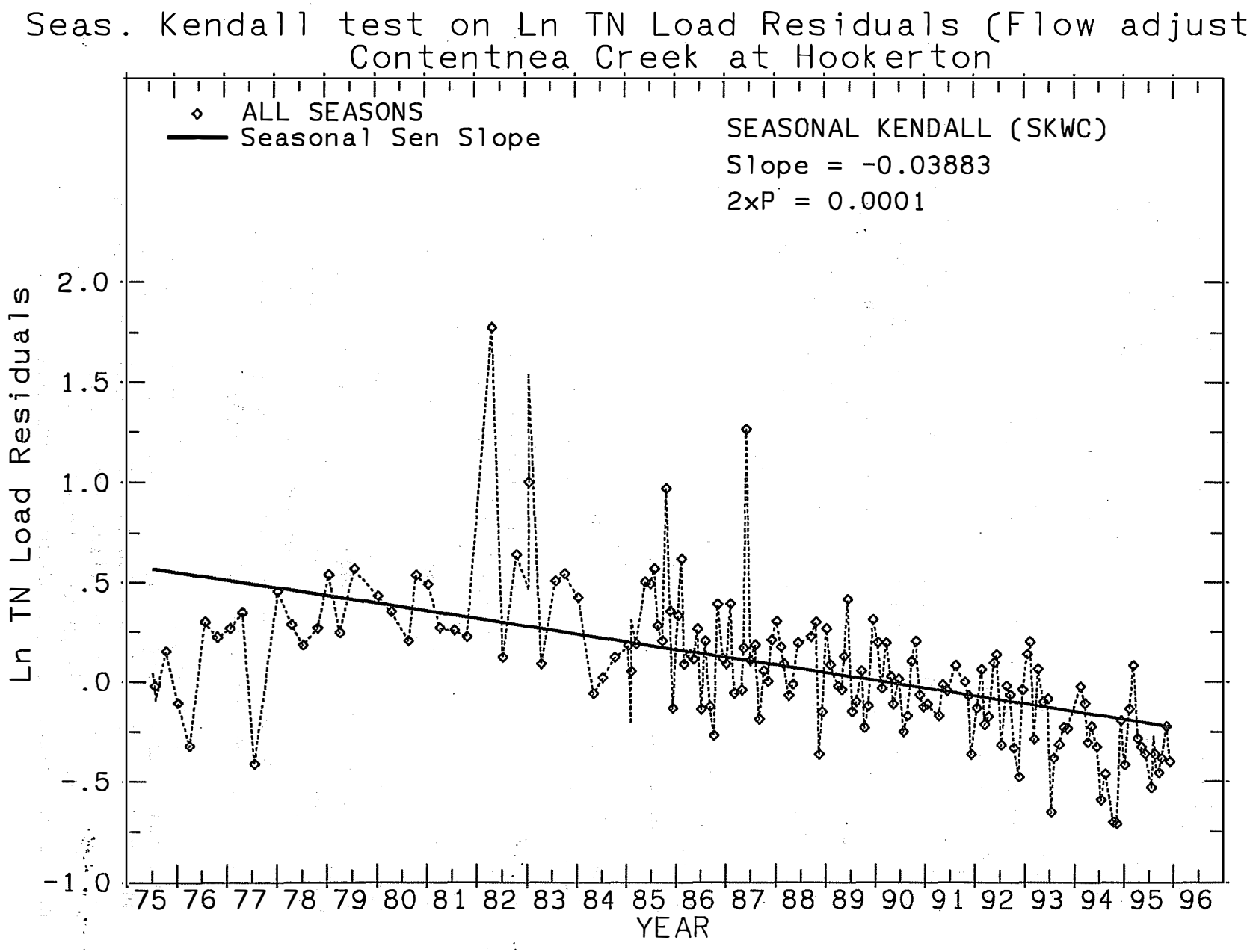

Seas. Kendall test on Ln TN Load Residuals (Flow adjusted)
Contentnea Creek at Hookerton
ALL SEASONS
Seasonal Sen Slope
SEASONAL KENDALL (SKWC)
Slope = -0.03883
2xP = 0.0001
Ln TN Load Residuals
2.0
1.5
1.0
.5
.0
-.5
-1.0
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
YEAR

Figure 6.

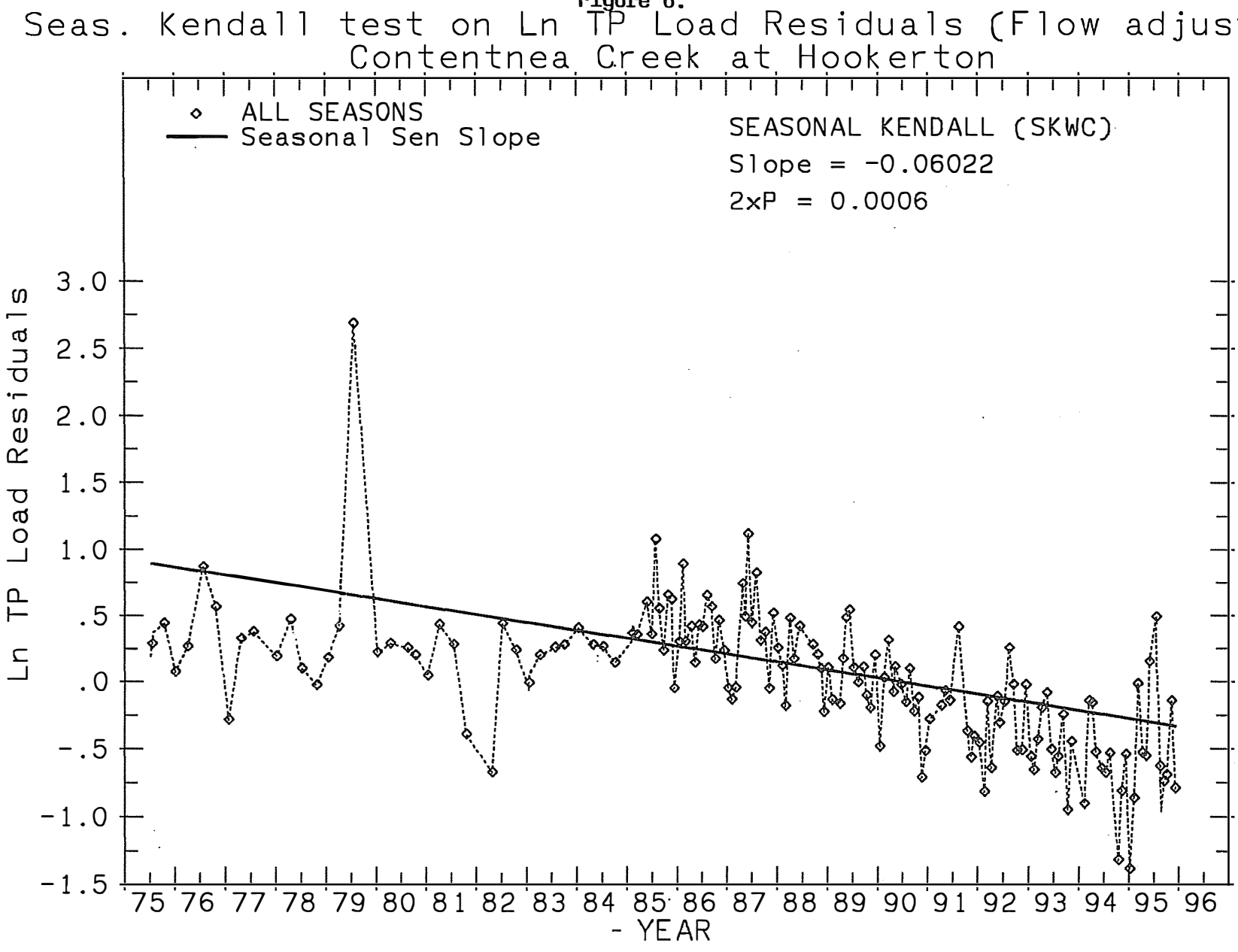

Seas. Kendall test on Ln TP Load Residuals (Flow adjusted)
Contentnea Creek at Hookerton
ALL SEASONS
Seasonal Sen Slope
SEASONAL KENDALL (SKWC)
Slope = -0.06022
2xP = 0.0006
Ln TP Load Residuals
3.0
2.5
2.0
1.5
1.0
.5
.0
-.5
-1.0
-1.5
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
- YEAR

Figure 7.

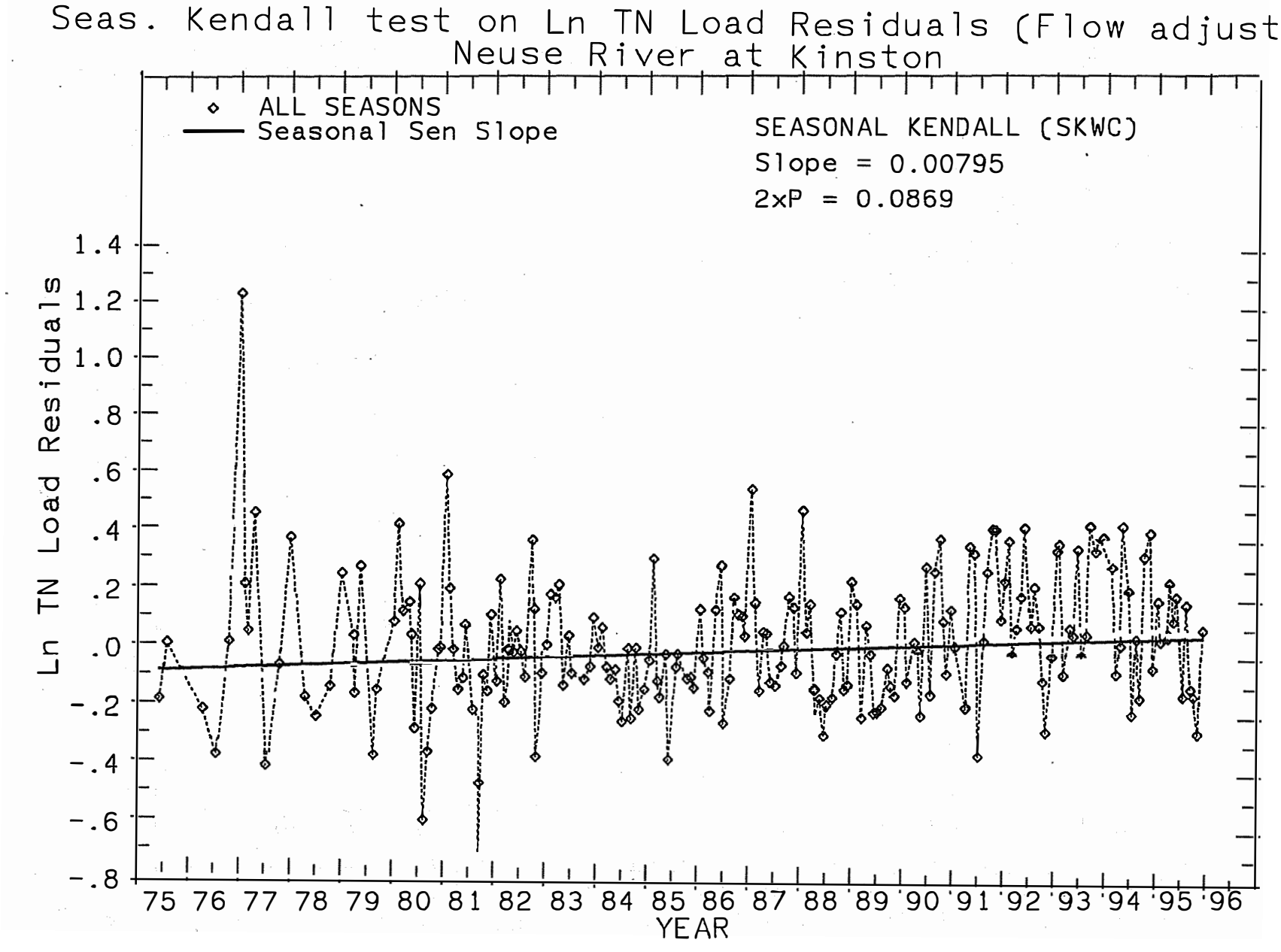

Seas. Kendall test on Ln TN Load Residuals (Flow adjusted)
Neuse River at Kinston
ALL SEASONS
Seasonal Sen Slope
SEASONAL KENDALL (SKWC)
Slope = 0.00795
2xP = 0.0869
Ln TN Load Residuals
1.4
1.2
1.0
.8
.6
.4
.2
.0
-.2
-.4
-.6
-.8
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
YEAR

Figure 8.

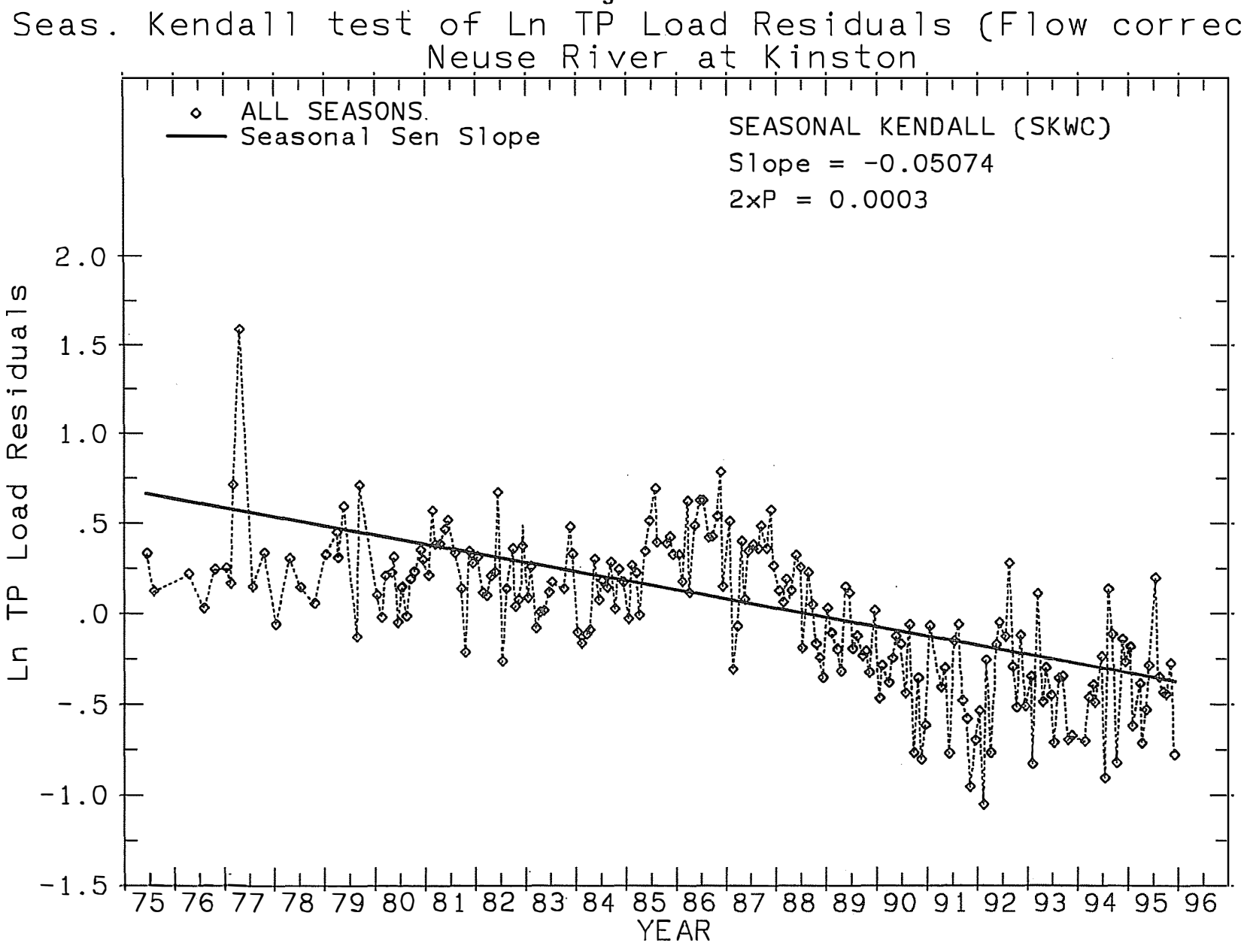

Seas. Kendall test of Ln TP Load Residuals (Flow corrected)
Neuse River at Kinston
ALL SEASONS
Seasonal Sen Slope
SEASONAL KENDALL (SKWC)
Slope = -0.05074
2xP = 0.0003
Ln TP Load Residuals
2.0
1.5
1.0
.5
.0
-.5
-1.0
-1.5
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
YEAR

Figure 9.

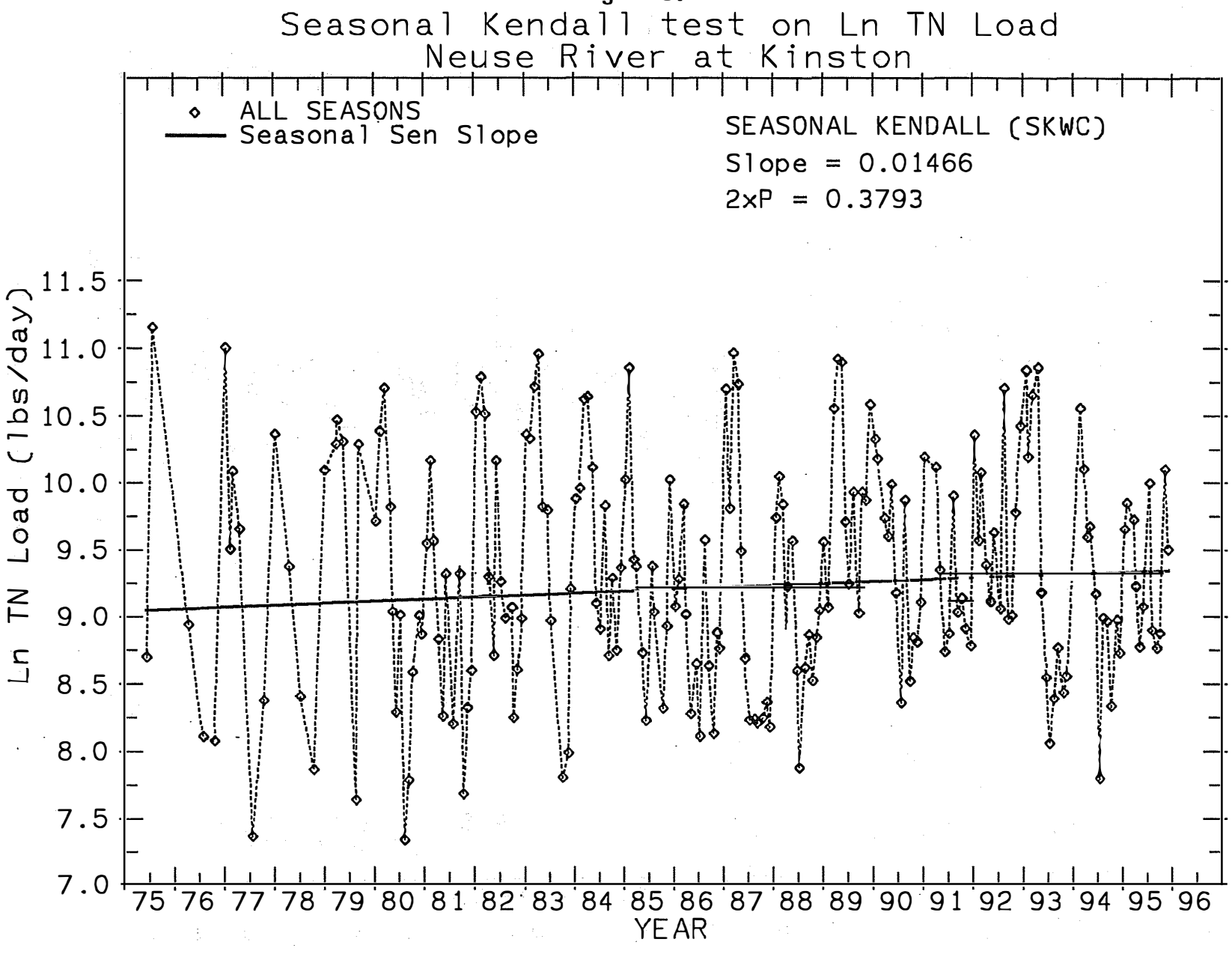

Seasonal Kendall test on Ln TN Load
Neuse River at Kinston
ALL SEASONS
Seasonal Sen Slope
SEASONAL KENDALL (SKWC)
Slope = 0.01466
2xP = 0.3793
Ln TN Load (lbs/day)
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
YEAR

Figure 10.

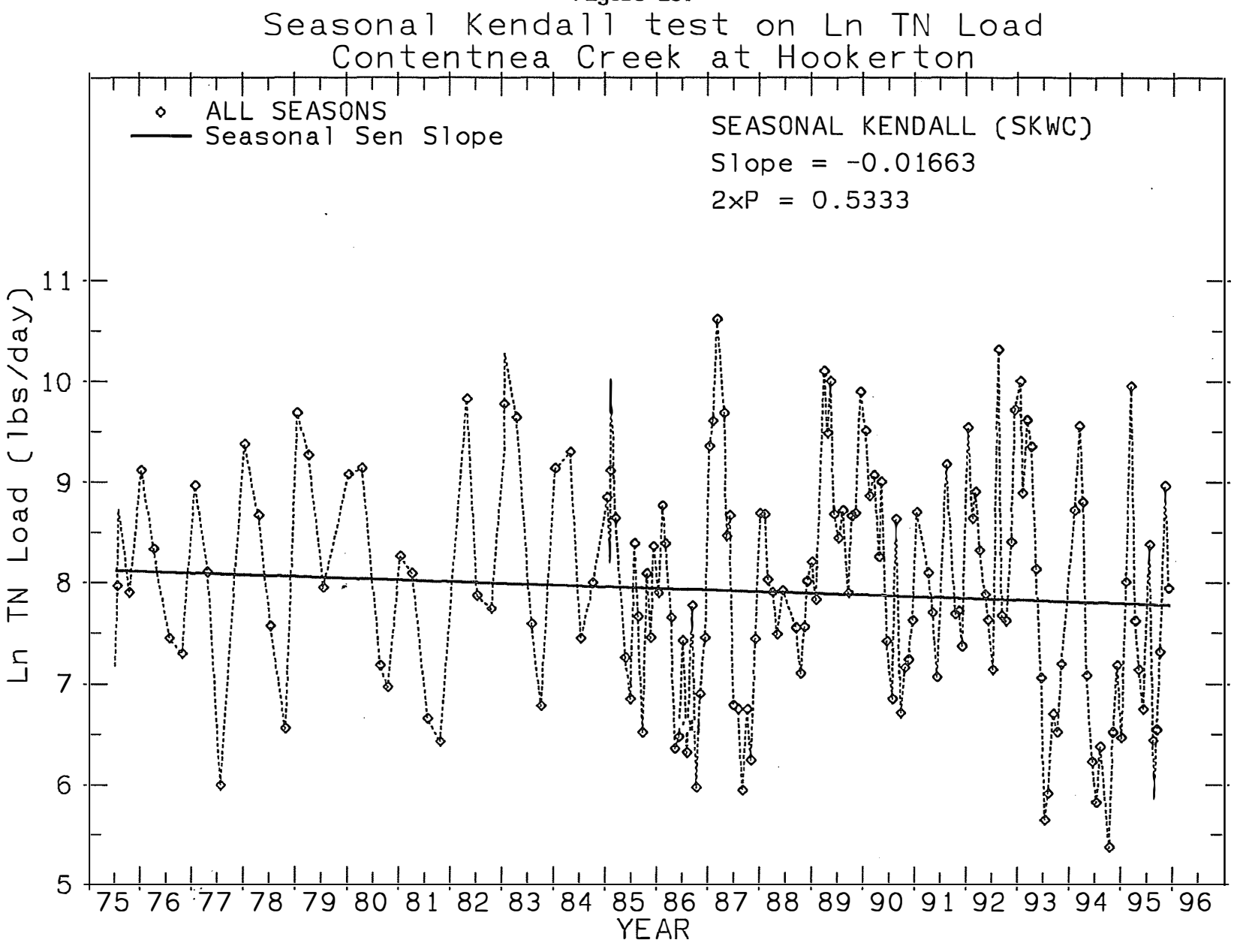

Seasonal Kendall test on Ln TN Load
Contentnea Creek at Hookerton
ALL SEASONS
Seasonal Sen Slope
SEASONAL KENDALL (SKWC)
Slope = -0.01663
2xP = 0.5333
Ln TN Load (lbs/day)
11
10
9
8
7
6
5
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
YEAR

Figure 11.

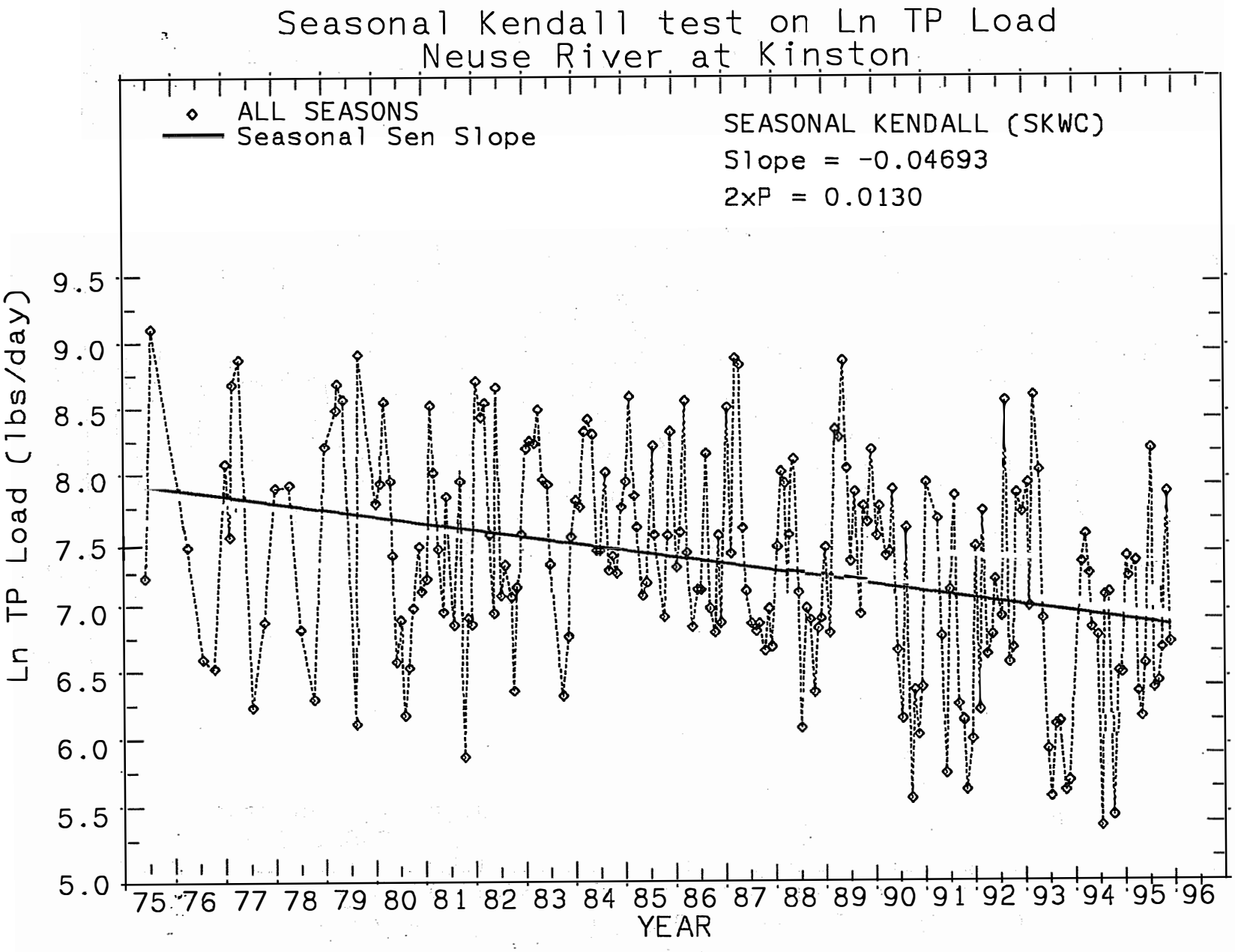
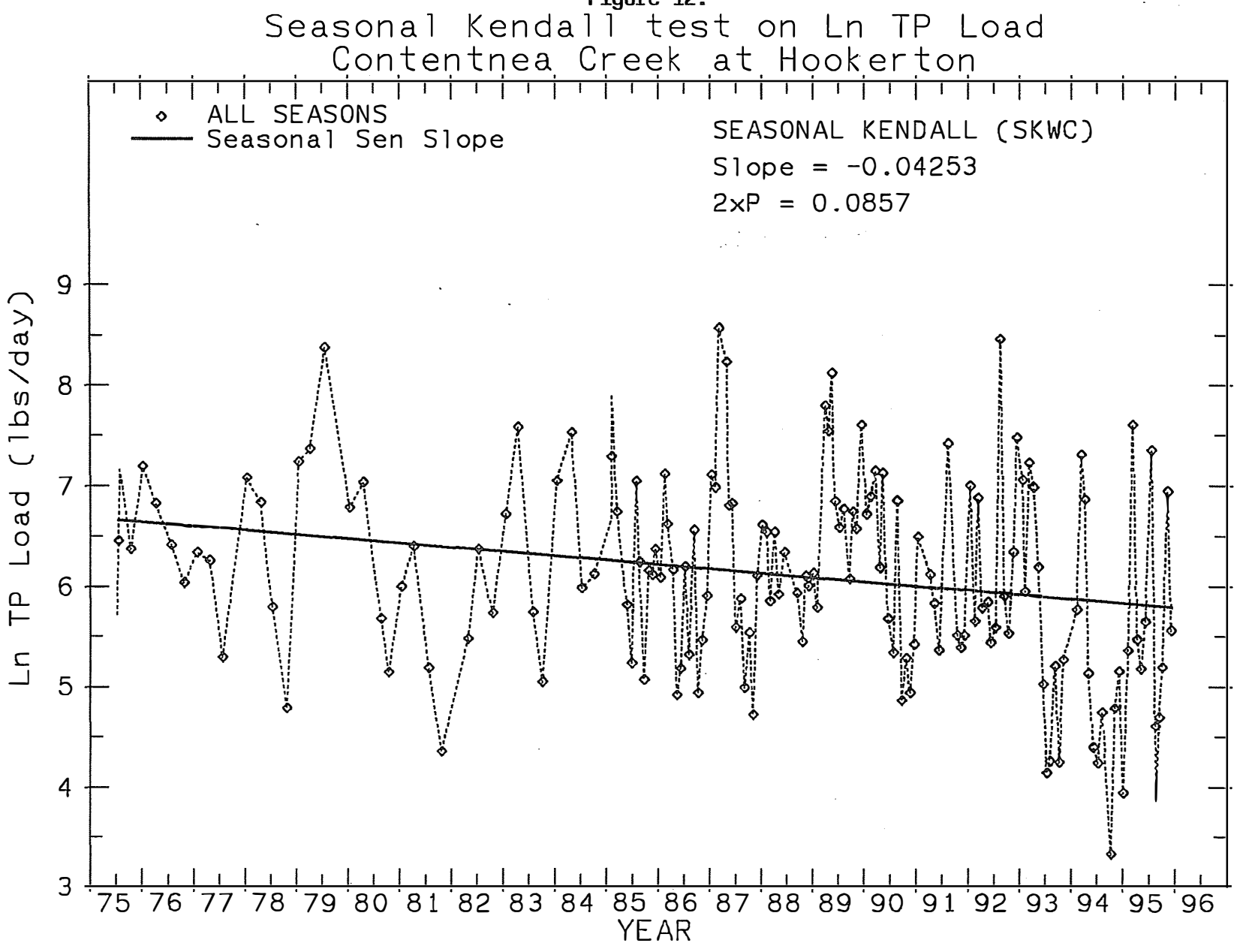

Seasonal Kendall test on Ln TP Load
Neuse River at Kinston
ALL SEASONS
Seasonal Sen Slope
SEASONAL KENDALL (SKWC)
Slope = -0.04693
2xP = 0.0130
Ln TP Load (lbs/day)
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
YEAR

Figure 12.


Seasonal Kendall test on Ln TP Load
Contentnea Creek at Hookerton
ALL SEASONS
Seasonal Sen Slope
SEASONAL KENDALL (SKWC)
Slope = -0.04253
2xP = 0.0857
Ln TP Load (lbs/day)
9
8
7
6
5
4
3
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
YEAR

Considering the differing trend analyses of flow adjusted load and load it appears that process changes such as land use management and wastewater treatment in the Kinston watershed have been somewhat offset by meteorological differences over the period of record. This amounts to seemingly no significant change in real delivery to the estuary.

Table 1. Seasonal Kendall test results.

SK test subject	**Location**	**Significance**	**2P-value**
Ln TN Load (flow adj.)	Hookerton	sig. decreasing	0.00005
Ln TP Load (flow adj.)	Hookerton	sig. decreasing	0.00058
Ln TN Load (flow adj.)	Kinston	sig. increasing	0.0869
Ln TP Load (flow adj.)	Kinston	sig. decreasing	0.00028
Ln TN Load (unadj.)	Hookerton	not significant	0.5333
Ln TP Load (unadj.)	Hookerton	sig. decreasing	0.0857
Ln TN Load (unadj.)	Kinston	not significant	0.3830
Ln TP Load (unadj.)	Kinston	sig. decreasing	0.0130

Autoregression on Kinston Nitrogen Load

In order to make hindcast estimates of what loads were like in the mid 1970s at Kinston, DWQ consulted Dr. David Dickey, a Professor of Statistics at N.C. State University. The Sen slope estimate is rather inefficient for this purpose since it focuses on median values and does not consider outliers. Dr. Dickey used autoregression and ordinary least squares regression (accounting for correlation) to determine if the DATE variable (trend) was a statistically significant variable after accounting for variability due to flow and seasonality. Moreover, if that variable was significant, its coefficient provides an efficient hindcast estimate of the slope of the loading trend. This analysis was only performed on nitrogen loads at Kinston. Variability in log of load, the dependent variable, was explained by several variables: the log of flow, sine and cosine waves used to explain seasonal variation, and date. The sine and cosine waves capture periodic highs and lows at certain frequencies that may be attributed to seasonal variation. The results show that variability due to date was significant at 99%, and that the estimated increase in load was less than 1 percent (0.84%) per year (Table 2). The annual increase in load amounts to less than 17 percent from 1975-1995. So, from a riverine loading perspective, this result indicates that a 30% reduction in total nitrogen would bring loading in the watershed at Kinston to levels that are below those that occurred when water quality was acceptable.

Table 2. Autoregression results:

Variable	B Value (Coeff.)	Std. Error	t Ratio	Approx. Prob.	Slope in %
Intercept	3.232510	0.1603	20.164	0.0001	
LOG OF FLOW	0.796791	0.0187	42.704	0.0001	
SIN	0.094248	0.0263	3.577	0.0004	
COS	0.120952	0.0245	4.938	0.0001	
DATE	0.000023	8.723E-6	2.615	0.0096	0.84

Duke University Trend Analyses

Another study that has high relevance to this TMDL is that of Duke University reseachers Stow and Borsuk. They examined trends in nutrient data from 1979 to 1997 in the Neuse River watershed at Falls Lake outlet, Clayton and Kinston (1999, in draft). The portion of this study that is relevant to the TMDL focuses on loads and adjusted concentrations for total nitrogen and total phosphorus. The authors determined the presence of a trend by visual inspection as they question the validity of assuming linearity in a trend. Also, they make the point that it is possible to show a trend in either direction in the same data set by selecting optimal beginning and end points. The problem of selection of beginning and ending dates may be avoided by using visual inspection for determination of a trend. Stow and Borsuk report that no distinct nitrogen trends are discernable at Kinston. The report adds that the lack of trend at Kinston is reflected in the lack of obvious nitrogen concentration trends in the estuary. The authors suggest that this absence of downstream nutrient increases indicate "that the current water quality impairment in the lower river and estuary may result from chronic nutrient overloading rather than recent changes in the watershed."

By considering all of the evidence in this TMDL on trends in nutrient loading at Kinston and Hookerton, DWQ's (with NCSU) analysis on flow adjusted nitrogen loading at Kinston is the only case of an increasing trend, and based on Stow and Borsuk's work, this is open to question. The differences between the two approaches include: the beginning and ending dates for the period of record, the base parameter by which a trend is evaluated (flow adjusted load versus flow adjusted concentration), the use of flow data without concentration on the same day (Stow and Borsuk used regression type methods to fill in concentration for missing days), and the means to detect trend (test versus visual inspection). It is not clear how to resolve these differences except to say that a 30% reduction appears conservative with respect to riverine loading.

Tetra Tech analysis of River Nutrient Loads and Nutrient Reduction Targets

Through a contractual arrangement with EPA to support the review of the Neuse TN TMDL, Dr. Jonathan Butcher of Tetra Tech (Butcher, 1999) conducted analyses of river nutrient loads and nutrient reduction targets. Tetra Tech used somewhat different methods than either DWQ, or Stow and Borsuk, to analyze trends at Kinston and Ft. Barnwell, and concluded that no increasing trends in nitrogen loading exist between the mid-1970s and the present. As with DWQ's analysis, phosphorus loading showed decreasing trends due to the phosphate detergent ban in 1988. Tetra Tech also examined the relationship between chlorophyll *a* in the estuary and nutrient loading, and found no simple and clear relationship. It seems that an estuary nutrient response model will be necessary to form a quantitative TMDL, as existing point measurements of chlorophyll *a* do not "appear to provide a sufficiently sensitive indicator." Citing Hobbie and Smith (1975), Tetra Tech notes that 1970-1973 may "arguably represent pre-impairment conditions" in the estuary. By comparing nitrogen concentrations at New Bern during

that time period and the 1991-1995 DWQ baseline loading period, Tetra Tech suggests that a 30% reduction in nitrogen loading is an appropriate target.

To examine river nutrient loading trends, Tetra Tech used annual average estimates of total nitrogen and total phosphorus loads. In contrast to DWQ, which analyzed trends based on point estimates of load on days when concentration data were collected, Tetra Tech employed a ratio method of flow weighted concentration to estimate loads on a daily basis (USGS provides daily flow data) before calculating an annual average. Tetra Tech's method is analogous to using regression of concentration against flow to estimate load at all flow levels. There seems to be benefits and drawbacks to both methods. By estimating daily load based on a few concentration data points per year, Tetra Tech is introducing error that is not present in DWQ's trend analysis. On the other hand, DWQ does not consider the full flow regime for a given year, and relies on the sampling frequency to capture representative flows. DWQ adjusted its load estimates for flow so that the omission of the complete flow record is less critical. Another difference between methods is that DWQ ran its trend tests through 1995 (end of baseline), while Tetra Tech included data through 1997. Tetra Tech began its trend analysis in 1975 at Fort Barnwell and in 1974 at Kinston. DWQ did not receive data prior to 1975 from a STORET download request.

Tetra Tech and DWQ came to the same conclusion about a decreasing trend in phosphorus loading at Kinston since the mid-1970s, but differed in that DWQ found a slightly increasing nitrogen trend there, while Tetra Tech found none. Tetra Tech used a flow regression equation developed by Weyerhaeuser to estimate flows at Fort Barnwell and perform trend analyses there. Because it found inhomogeneity in a test of seasonal trend, Tetra Tech examined nitrogen loading trends by quarter at Fort Barnwell and found only one significant trend (decreasing) in the first quarter, the rest were not significant. In addition to examining nutrient loading trends at Kinston and Fort Barnwell, Tetra Tech addressed concentration data at New Bern from 1974-1997. In this case, there was little evidence of a trend, although a gradual decline is possible.

If it can be shown that there is a trend in chlorophyll *a* concentration, or correlation between chlorophyll *a* and nitrogen load, then the case for the proposed TMDL would be strengthened. These issues were addressed by considering four groups of sampling stations in the estuary. Summer average chlorophyll *a* concentrations do appear to be higher in 1979-1997 than 1970-1974, though the data were analyzed using different methods, and the earlier period represents only monthly sampling. Tetra Tech notes that there have been frequent exceedances of the chlorophyll *a* standard of 40 µg/l. "It may well be that the standard is not realistically attainable in the Neuse estuary." Also, Tetra Tech found a weak relationship between summer chlorophyll *a* and annual total nitrogen load. "The results suggest that high nitrogen loads have potentially bad implications but do not identify a target load. To a large extent, the weak relationship likely highlights the inadequacy of point chlorophyll *a* measurements as an index of primary productivity. A better comparison to nitrogen loading could likely be obtained if estimates of annual primary productivity integrated over both space and time were available. High feedback rates from nitrogen from the sediment may, however, further obscure this effect, as

blooms may be supported in part by nitrogen accumulated from previous years' loading." This is a succinct reiteration of what DWQ has said about the need for an estuary response model and one of the difficulties (internal load from sediment organic matter) its developer is currently experiencing.

Next, Tetra Tech closely evaluated the Sea Grant study by Hobbie and Smith (1975) which contained estuary chlorophyll *a* and nutrient data between 1970-1973. That period appears to be the closest match to pre-impairment conditions in the estuary, and thus a good case for an empirical target. Comparison of chlorophyll *a* results above the water quality standard show an increase in such events at the estuary sites of Broad Creek and Minnesott Beach, between 1989-1997 relative to 1970-1973. Though there have been relatively small increases in the median values, the 90^{th} percentile at Broad Creek has doubled and the 95^{th} percentile at Minnesott Beach has tripled. Again, bias due to analytical methods is certainly possible. River nutrient loads between these two periods cannot be compared as there was sparse monitoring in the river for the 1970-1973 period. Average total nitrogen concentrations at New Bern are available, and show an increase from 0.67 mg/l for the "pre-impairment baseline" to 0.97 mg/l for the 1991-1995 DWQ baseline. Tetra Tech attempted to verify the accuracy of Hobbie and Smith's total nitrogen data by comparing Hobbie and Smith's ratio of nitrate-plus-nitrite to total nitrogen to that of later periods and reported that they are nearly constant, and thus, sufficient to use. Based on this comparison of nitrogen data, Tetra Tech suggests that a 31% reduction in total nitrogen concentration, and a 25% reduction in nitrate-plus-nitrite concentration, are needed to return to conditions of the early 1970s.

Finally, Tetra Tech, based on its analyses, supports DWQ's 30% reduction in nitrogen with a few warnings. One, their analysis supports a reduction in concentration at New Bern instead of loads at Fort Barnwell. The relationship between the two may not be linear, depending on the rate of uptake between the two locations, and the rate of downstream mixing in the estuary. Secondly, another analysis for the mid estuary may be needed as increased algal blooms there may be attributable to direct deposition of atmospheric nitrogen (Paerl et al., 1995) beyond increases in watershed load. Third, the conclusions in the analysis depend on the interpretation of 1970-1973 conditions as representing pre-impairment. Finally, the analysis of temporal reference conditions suggests that a reduction slightly greater than 30% may be required. Presumably, Tetra Tech is referring to the 31% that was cited earlier. If so, this assumes that the difference between DWQ's 30% and Tetra Tech's 31% is significant.

The second point regarding the possible need for another mid estuary analysis may be addressed by pointing to the recent mid estuary dilution assay results of Piehler and Paerl (See following subsection, Algal Assays). Also, it seems somewhat difficult to reconcile Tetra Tech's observation that nitrogen concentrations at New Bern between 1974 and 1997 showed "little evidence of a trend, although a gradual decline is possible" yet median 1991-1995 total nitrogen concentration showed a 31% increase over that of 1970-1973.

Algal Assays

A nutrient dilution bioassay is being conducted by Piehler and Paerl of UNC's Institute of Marine Science at a riverine and an estuarine site in the Neuse River estuary (Piehler and Paerl 1999, preliminary results). This study gives us a look at what effect a 30% nitrogen reduction would have on estuary productivity.

Some of the early dilution bioassay work on the river portion of the Neuse system was considered by the Senate Select Committee to arrive at the original 30% nitrogen reduction target (Paerl and Bowles 1987, Paerl 1987). The current project is designed to move the focus from the river to the estuary. There is one site at the head of the estuary, Streets Ferry Bridge, and a second between New Bern and Cherry Point at Marker 15. To accomplish the simulation, 3 liters are removed from a 10 liter container of estuarine water, and replaced with 3 liters of major ion solution that lacks nitrogen. The bioassays were performed 7 times between August 1997 and August 1998. The standard used to evaluate differences is assimilation number, or productivity/Chl a per hour. By dividing by Chl a, the biomass that is removed in the dilution process is corrected for. Mean assimilation numbers in the dilutions were lower than the control in 11 out of 14 observations. In the experiments thus far, there is a significant reduction in the productivity (assimilation number) at the Marker 15 site with a 30% reduction in nitrogen concentration ($p<0.05$, ANOVA). There is not a significant difference between the dilutions and the controls at Streets Ferry Bridge.

One limitation of this experiment with respect to the TMDL is that the bioassays examine changes in nutrient concentration and not nutrient loads. The next year of the project will further explore the necessary reduction in nutrients during highest loading conditions, typically spring, to test for an observed decline in assimilation number. Also, the project will attempt to reduce uncertainty by examining the potential effects of the quantity and type of light received by the phytoplankton.

This research lends credence to the TMDL because it shows that a 30% reduction in nitrogen has a noticeable effect on productivity in the estuary. While productivity may be implicitly related to Chl a, they may not correlate well in space and time because of downstream gradients in algal growth rates (Pinckney et al, 1997). In other words, as growth rate decreases downstream, chl a per unit productivity may increase. It is problematic that a statistically significant difference was not detected at Streets Ferry Bridge. This lack of a difference appears to be attributable to the fact that 3 of the 7 dilutions at this site were roughly equal to or greater than the control. This seems unlikely to occur in a "real world" scenario since only nitrogen inputs are being managed; however, the researchers will investigate potential causes of this unexpected result in the coming year. The factors that could cause a diluted sample to be higher than its control include: the toxic constituents are diluted; color is diluted and hence light availability is increased to detrimental levels; and finally, some unknown constituent(s) is (are) diluted.

In the second phase of the TMDL, this research will serve as one of several tools to guide the decision making process on the appropriate reduction target.

From the studies by Piehler and Paerl, DWQ understands that the 30% nitrogen load reduction should have a noticeable effect on Neuse River estuary water quality, but that given the complexity of the system, a direct correlation between loading and Chl a response is impossible at present.

Reduction Target Conclusion

The available data and research are not yet adequate and linked sufficiently to be used for a final TMDL, however, they do support the best professional judgement of scientists that 30 percent represents a reasonable initial target. Statistical analyses indicate that a 17 to 31 percent reduction in nitrogen is needed. Dilution assays indicate that a 30 percent reduction will result in decreased productivity in the estuary.

The work that has been presented in the past year is very encouraging and gives DWQ a clearer picture of where we stand in the phased TMDL schedule. There is every indication that once the MODMON research is completed in a couple years, it would provide the stakeholders and DWQ with the tools necessary to better evaluate a TMDL. Building consensus does not seem so daunting when there are numerous projects that have a common goal, yet provide different and mutually beneficial perspectives on the task. Interest has been expressed by many of the major scientists working in the Neuse arena to participate in the stakeholder process by presenting their findings for all to consider. Furthermore, DWQ completed a rule-making process for the TMDL's implementation strategy in August, 1998. Not only is the momentum not in favor of an adjusted target, neither are the data nor research consensus.

II-C. Margin of Safety

The Clean Water Act requires that TMDLs include a margin of safety. Since the first phase of the TMDL is based on a review of available information and the best professional judgment of scientific experts, a margin of safety cannot be quantified at this time. An inherent margin of safety in the phased approach to developing a TMDL is that the TMDL will be revisited. DWQ will review all available data and tools and commits to public notice a revised TMDL by March, 31 2001 in accordance with the schedule below. Also, please refer to Figure 14 on p. 44 for a more detailed schedule.

April 1, 2000	A CE-QUAL-W2 model (estuary response model) of the Neuse estuary will be completed to the extent that it will be ready to use as a tool for the completion of the second phase of the TMDL.
July 1, 2000	The nitrogen reduction goal (i.e. the total percent reduction necessary to support the estuary's uses) will be completed using the CE-QUALW2 model and other data and tools

	available. The state will provide EPA with the appropriate information to review by this date. If the model and other tools are not ready or capable of predicting the nitrogen reduction goal, the State will be prepared to revise the TMDL to include an explicit margin of safety (i.e. an additional reduction will be added to the proposed 30% reduction). The State will provide EPA Region IV with the documentation that includes: (1) the explicit margin of safety that the State intends to use: and (2) the rationale for the value of this margin of safety.
August 1, 2000	EPA Region IV will approve/disapprove the State's nitrogen reduction goal submitted on July 1, 2000.
March 31, 2001	The State will public notice for comment the 2nd phase of the TMDL.
July 31, 2001	The State will submit the 2nd phase of the TMDL to EPA for approval/disapproval.
August 30, 2001	EPA Region IV will make an approval/disapproval decision on the 2nd phase of the TMDL.

II-D. Seasonality

Studies have shown that high spring total nitrogen loading followed by low flow, warm weather conditions in the summer and early fall determine, in part, the magnitude and frequency of algal blooms and fish kills during the warmer months (Paerl, 1987). In addition, studies have shown that algal activity in the estuary increases following storm events in the basin (Mallin et al. 1993). Thus, in order to control the eutrophication problem in the estuary, it will likely be necessary to control nutrient loading from storm events. In general, nitrogen loading during the late winter and early spring as well as during summer storm events will be important to control. Paerl et al. (1998) examined the Neuse estuary's response to nutrient loads under three scenarios: an average hydrologic year; a year with high summer loads; and a year in which two hurricanes hit the North Carolina coast. The researchers determined that an annual reduction in total nitrogen will likely improve water quality in average flow years, but in years with high summer loading and hurricanes, additional controls may be needed. However, it is likely that no nutrient control strategy would protect the Neuse River estuary from algal blooms and fish kills following hurricanes.

Network Analysis

Christian and Thomas (in draft, 1999) have been developing a network analysis of the Neuse River. This project uses a group of algorithms to evaluate networks of material flows within a structured system. The purpose of this ecological network analysis is to

provide understanding of the relationship between nitrogen loading and recycling, the fates of loaded nitrogen, and exported interseasonal variation of both model inputs and outputs. The study used data collected between Spring 1985 and Winter 1989. There are two conclusions in this analysis that have relevance to the seasonality in this first phase TMDL: (1) seasonal phytoplankton response in the estuary is more coupled to seasonal loads in the winter than summer, and (2) there is a high degree of recycling of nutrients within the estuary.

By examining correlation between loading by season and phytoplankton uptake, the authors detected a trend where winter and spring primary productivities are more closely related to loading than summer and fall primary productivities. The correlation coefficients for winter, spring, summer and fall were 0.90, 0.95, -0.59, and 0.42, respectively. This result might be expected as winter flows are typically higher and can transport more nutrients farther into the estuary for uptake. The authors were interested in testing this hypothesis more rigorously, but due to a lack of standardization for primary productivity estimates and incomplete loading estimates from all sources of the estuary, it was considered not within the scope of this study. This points to the need for more research on seasonal phytoplankton response to nitrogen loading before the TMDL can be divided into smaller time increments.

Another seasonal observation from the Christian and Thomas research was the dependance of phytoplankton on nitrogen that once resided in the sediment. For winter that rate was 5-32 % and in summer it was 71-85%. Other studies have shown that the sediments can be a significant source of nitrogen to the water column under summer/fall conditions (Fisher et al, 1982, NCDWQ, 1998). Again, this result is not surprising since warm temperatures promote microbial breakdown of organic matter and enhance ammonium flux from the sediment to the water column. Similarly, it makes sense that primary productivity is more closely correlated to winter riverine loading because internal recycling is suppressed in winter.

The implications for the TMDL are that, in terms of phytoplankton response, winter is the more sensitive period to riverine loading. Phytoplankton growth in the summer is more linked to nitrogen which moves through the sediments. This point may be less applicable than it appears, however, if most of the nutrients, during either season, remain in the estuary for reuse during subsequent seasons. Christian and Thomas note that two of their work's weaknesses are nitrogen export to Pamlico Sound and denitrification. Without a good understanding of estuarine nitrogen export, it is difficult to tell what the net effect is of the seasonal link between loading and uptake.

The long hydraulic residence times, high productivity, and microbial recycling result in multiple uses of nitrogen during its stay within the estuary. The Finn Cycling Index, which measures percent of total nitrogen flux involved in cycling, was generally 90% or greater throughout the study. Christian and Thomas' work also showed that phytoplankton can take up a given atom of nitrogen up to 35 times before exiting the system. This indicates that nitrogen is cycling through the Neuse estuary, and each nitrogen atom can remain in the system for a while. While nutrient loads may be higher

during the winter and spring, these winter and spring loads may be stored in the sediments and used as a source by algae during summer months. Therefore, an annual loading target is appropriate during the first phase of the TMDL given that nitrogen is reused after initial seasonal riverine loading.

Seasonality Conclusion

DWQ acknowledges that, based on work by Christian and Thomas and others, the late winter and early spring loads are important to control. Therefore, seasonality will be addressed in more detail in the second phase of the TMDL. The estuary model that is being developed and other information being collected should provide further insight into the importance of controlling nitrogen on a seasonal basis, and DWQ will incorporate this information in the next phase of the TMDL.

Although the TMDL loading targets are annual for the first phase of this TMDL, the implementation plans to achieve the loads will address the seasonality issue to an extent. The nonpoint source BMPs are designed to reduce nitrogen loading during storm events and, therefore, will reduce nitrogen loads during the winter and spring period, as well as summer storm events that the literature indicates are important to control. Point sources will be limited for nitrogen on an annual basis with a goal to achieve at least half the necessary reductions during the summer months. Biological activity in treatment plants is a function of temperature. As temperature increases, nutrient removal increases. Thus, wastewater treatment plants will achieve the greatest portion of their reductions during the warmer summer months when point sources contribute a greater portion of the nitrogen load to the estuary. A review of the effluent data for the facilities in the Neuse River Basin generally indicates that nitrogen load does not increase in the summer months. A review of data collected on facilities in the Tar-Pamlico River Basin that are achieving nitrogen removal also indicates that that nitrogen load does not increase in the summer. If the data and modeling tools developed in the next couple years indicate that the point sources need to be controlled on shorter time frames, these limits will be included in the NPDES permits when they are renewed in 2003.

III. Total Nitrogen TMDL Calculation

III-A. Baseline Loading for Total Nitrogen

The 1991-1995 period was used to calculate baseline nutrient loads at New Bern. Since load is a function of concentration and flow, it is important to understand that an increase or decrease in load may be a function of rainfall rather than activities occurring in the watershed. Thus, it is important to choose a range of years that covers different rainfall events. The period 1991-1995 represented high and low flow spring and summer periods. Average annual total nitrogen load at New Bern was estimated to be 9.4 million pounds per year based on this time frame. To obtain these loading estimates the following steps were performed:

- The daily flows measured at a USGS gaging station at Kinston were used to predict daily flows at Streets Ferry using a flow correlation developed by Weyerhaeuser Corporation (DiPeiro et al. 1994):

  $$\text{Flow near New Bern} = 1.242*(\text{Flow at Kinston})^{1.024}$$

- The FLUX model developed by the U.S. Army Corps of Engineer's (Walker, 1985) was used to estimate total loading at Fort Barnwell based on estimated daily flows and the observed relationship between nitrogen concentration and flow. Total nitrogen load on the Trent River near Pollocksville was estimated using data collected during a special study from June 1995 to August 1996 and the FLUX model.

- Effluent monitoring data from Weyerhaeuser, Cherry Point, and other WWTPs below the sampling point were used to determine the additional point source load below Fort Barnwell.

- Direct atmospheric deposition to the impaired portion of the estuary was estimated using an atmospheric deposition coefficient of 8.75 lb/acre-year and 28,950 acres, the impaired area in the estuary. The result was 253,000 pounds of nitrogen directly deposited on the estuary. It should be noted that atmospheric deposition above the estuary was taken into account through the instream loading measurements which reflect all source contributions.

- The load at New Bern from the Neuse was assumed to be the load at Fort Barnwell plus the load from the Trent River at Pollocksville plus 100 percent of the load from dischargers downstream of Fort Barnwell plus 100 percent of the direct atmospheric deposition to the estuary.

The average TN load of 9.65 million pounds per year at New Bern is the baseline from which the TMDL, described later in this report, is calculated.

III-B. TN TMDL

The TMDL for total nitrogen is a 30% reduction from the baseline load. This equates to 70% of the baseline load of 9.65 million pounds per year for a TMDL of 6.76 million pounds per year at New Bern.

Allocation of Allowable Nitrogen Load

In order to meet the 30% reduction target at New Bern, it was decided to reduce the loads from point sources and nonpoint sources by 30%. Within a given source category, some individual sources (for example, an individual farm or NPDES facility) could reduce by loads greater or less than 30% provided that the overall reduction for that category of sources was 30%. Much of the following sections are devoted to assessing the baseline load, but conclude with the allowable loads, following reduction, for each source.

Point Sources

For point sources, the 1995 load was estimated by first calculating the end-of-pipe nitrogen load based on actual flow and concentration data submitted by the wastewater treatment plants. For the minor facilities where total nitrogen data were not available or the data provided were inconsistent (that is, ammonia concentrations in excess of total nitrogen concentrations), the concentration was assumed to be equal to 21 mg/l, the average concentration of other minor facilities in the basin. The annual nitrogen load at the end-of-pipe for each facility was calculated as the sum of the loads calculated from monthly average flows and concentrations. If monthly concentration data were not available, available data were averaged over quarterly periods.

The next step was to determine the percentage of total nitrogen from each facility that was transported to the estuary. This was done using a general nutrient transport model. A certain percentage of the nutrients deposited in the upper portion of the basin is lost to various processes such as conversion to nitrogen gas, an inert form of the nutrient, and subsequently released to the atmosphere. Fate and transport models are therefore used to estimate nutrient delivery to the estuary.

DWQ has developed a GIS-based nutrient fate and transport model for the Neuse River Basin to New Bern. Within the model, the delivered load is assumed to be a function of the location of a source within the basin, the stream velocities between the source and the estuary, and the rate at which the pollutant load decays along the route.

The nitrogen transport model is a refinement of the modeling framework previously provided by the Research Triangle Institute, and relies on the Reach File 3.0 (RF3) hydrography database developed by the US EPA. A first order decay equation is used to simulate the loss of nitrogen down the network as described by the following equation:

$$\text{Percent TN delivered} = e^{(-k*t)} * 100$$

where: k = "decay" coefficient that represents the loss of total nitrogen from the system in /day

t = time of travel from a stream reach to the estuary in days.

For this model application, it was assumed that the decay rate was equivalent to 0.2 /day and velocity was equivalent to 18 mi/day throughout the basin. At this time, the decay rate is based on literature values. It should be noted that the literature values vary greatly, and studies should be performed in the Neuse River Basin to further refine this value. The MODMON project described in the subsection entitled "Ongoing and Future Studies in the Neuse Basin" may address the decay rate. The velocity assumption is based on data collected at U.S. Geological Survey gaging stations.

Due to the uncertainty in the decay rate and velocity rates, it was decided to break the basin into four zones rather than assigning each NPDES facility an individual transport

percentage. The model was linked into a GIS system, and the results are displayed in Figure 13. This method estimates that approximately 2.34 million pounds per year of total nitrogen that originates from point sources arrives at New Bern.

Allowable Point Source Load

Thus, the point source total nitrogen allocation at New Bern is 1.64 million pounds per year, a 30% reduction from the estimated 1995 delivered load to the estuary.

Nonpoint Sources

Baseline NPS Loading

Since point sources contribute approximately 2.34 million pounds of total nitrogen per year, nonpoint sources were calculated by difference to contribute the remainder of the baseline load or 7.31 million pounds per year (9.65 – 2.34 million pounds per year).

In order to partition the baseline nonpoint source load into the various categories such as agriculture, forestry, and urban areas, the export coefficient method was used to estimate the amount of nitrogen that enters surface waters from the various landuses/landcovers. Numerous studies have been conducted to determine the amount of nitrogen that leaves a watershed and enters surface waters on an annual basis. The export coefficient approach can be used to describe the amount of nutrients leaving a given land use type. The export coefficient itself is derived from an examination of actual field measurements taken over a period of time and is usually a single number expressed as mass/area/time.

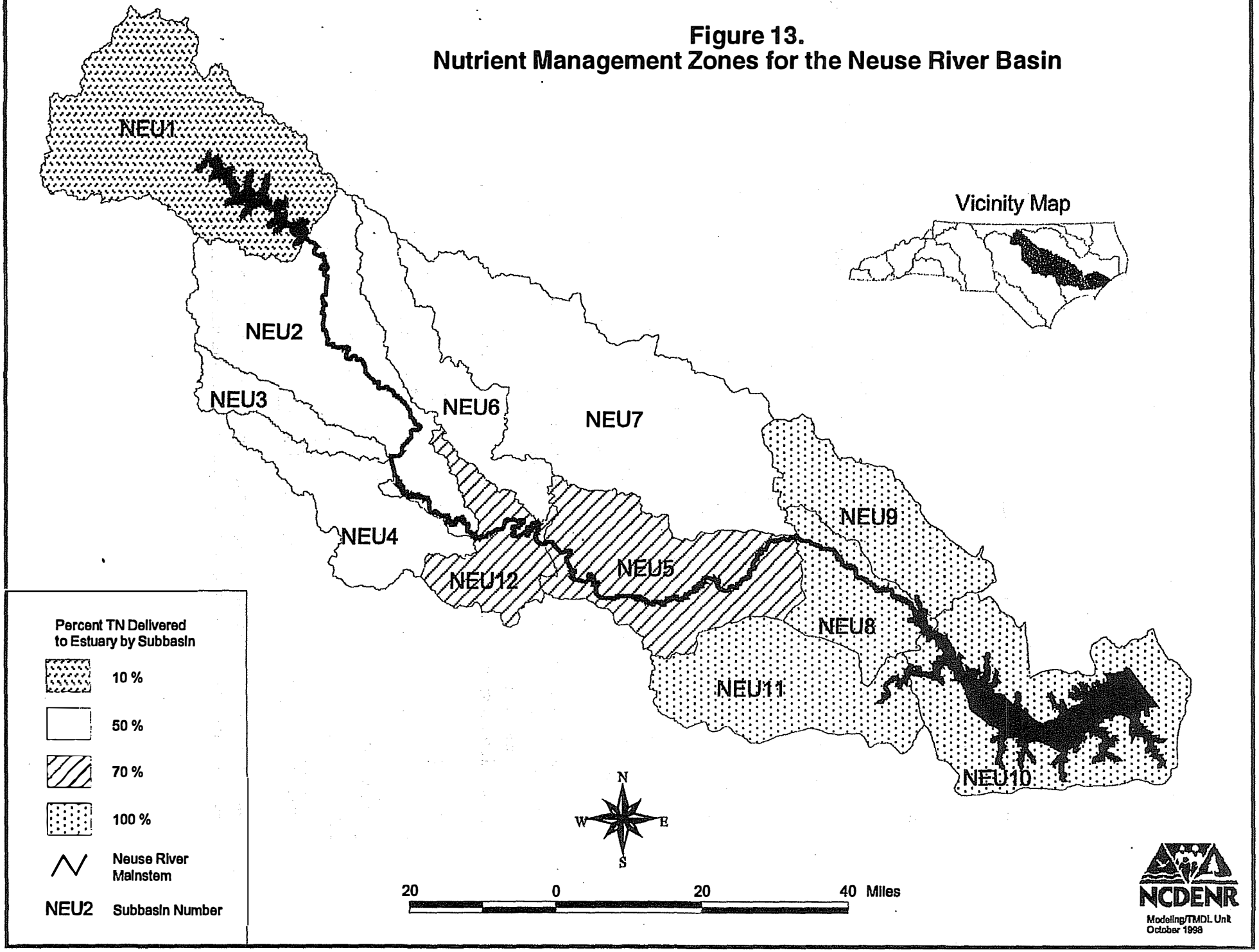
The export coefficients developed by Research Triangle Institute (Dodd and McMahon, 1992) were used as a basis for determining export. The export coefficient for atmospheric deposition was updated using data available from the National Atmospheric Deposition Program (NCEMC, 1997a). Table 3 contains the nitrogen export coefficients.

Table 3: Export Coefficients Used in TN Loading Calculations in Neuse River Basin

Land Use	Export Coefficient (lb/acre-year)
Urban	8.06
Cultivated	13.56
Managed Herbaceous	4.37
Forest	1.72
Open Water (direct atmospheric depostion)	8.75

The 1993-95 infrared satellite imagery data was used to estimate acreages of various land use within the basin. Since the land cover did not have municipal area interpreted, DWQ

Figure 13.
Nutrient Management Zones for the Neuse River Basin



surveyed municipalities in the basin with populations greater than 5000 to determine an estimate of average land use within municipal areas. Total nitrogen load was estimated using these export coefficients for cultivated land, managed herbaceous land, forests, urban land, and direct atmospheric deposition on open water. The following estimates of nitrogen load resulted:

Table 4: Estimated TN Load by Land Cover for Neuse River Basin

Land Use	Acres in Trent	TN in Trent (lb/yr)	Acres above New Bern	TN above New Bern (lb/yr)	TN in Basin (lb/yr)	Percent Load from Land Use
Urban	1,635	13,178	192,407	1,550,800	1,563,979	8%
Cultivated	75,437	1,022,926	850,279	11,529,783	12,552,709	67%
Mngd Herb	6,425	28,077	137,158	599,380	627,458	3%
Forest	200,073	344,126	1,932,297	3,323,551	3,667,676	20%
Open Water	1,076	9,415	36,810	322,088	331,503	2%

The direct deposition to the estuary was also estimated. There are 28,950 impaired acres in the estuary below New Bern. Using the same export coefficient of 8.75 lb/acre-year results in an estimated load of 0.25 million pounds directly deposited on the estuary below New Bern.

The managed herbaceous land use was then partitioned into agricultural and urban land uses based on Department of Agriculture Survey results. The survey indicated that approximately 25% of turf grass is in non-agricultural use such as golf courses, lawns and commercial lands and the remaining 75% was in agricultural land. Based on these numbers, the managed herbaceous land use was split into urban and forested land, and a general agricultural class was created.

The final step in calculating the baseline nonpoint source loads was to estimate the total nitrogen loading that is actually transported to the estuary for each land use type. Export coefficients are a measure of the nitrogen load leaving a given land use type. Some of this nitrogen is lost as it travels to a nearby stream and eventually to the estuary. DWQ assumed that the nitrogen load to the estuary for each land use was proportionate to the loads estimated at the edge of field. The atmospheric deposition directly to the estuary below New Bern was added to the load estimated to be directly deposited on open water above New Bern (i.e. 100% of this load was assumed to be transported to the estuary). Table 5 shows the final baseline total nitrogen loads by category for the Neuse River Basin:

Table 5: Baseline TN Loads by Land Use Category

Land Use	Baseline TN Load (million lb/yr)
Urban	0.65
Agriculture	4.90
Forest	1.38
Open Water (Atmospheric Deposition)	0.38
Total Baseline NPS Load	7.31

Allowable NPS Loads

DWQ initially set 30% reduction targets from the baseline calculation for each nonpoint source category. Commentors indicated that reductions could not be made from forested land. Therefore, the nitrogen from this land use was considered as background in the final allocation. The 30% reduction that would be needed from forested land was allocated among agriculture and urban land in proportion to their respective land areas within the basin. The allocation targets for each nonpoint source category are included in Table 6.

Table 6: Allocation Targets by Land Use Category

Land Use	TN Allocation (lb/yr)
Agriculture	3,090,000
Urban	390,000
Open Water (Atmospheric Deposition)	260,000
Forest (Background)	1,380,000
Total	5,120,000

(Note: The numbers in the above table differ from those that would be calculated from the table reported in the 1997 Report of Proceedings for three reasons. First, based on comments from EPA, the Trent River nonpoint source loads were included in the calculations. Second, based on comments from EPA, atmospheric deposition below New Bern was accounted for. Third, the point source numbers were checked by obtaining the lab sheets from each facility with permitted flows of 0.5 MGD or greater. The numbers for the smaller dischargers were also quality assured with hard copies of the discharge monitoring reports to ensure the numbers were entered correctly into the computer compliance system. Thus, the allocation to point sources has changed slightly since the 1997 Report of Proceedings was drafted, and this affected the nonpoint source allocations slightly).

It should also be noted that this TMDL accounts for only the nitrogen entering the estuary via freshwater. Because nitrogen is soluble, it is transported through groundwater. At this time, the amount of nitrogen entering the Neuse River from groundwater sources is unknown and cannot be quantified. Groundwater is accounted for in the nonpoint source allocation, since the baseline load at Fort Barnwell and Pollocksville (Trent watershed) includes all sources, even those that cannot be quantified for allocation purposes with current data. Some of the control measures to reduce nitrogen loading in the basin such as buffers, do reduce the nitrogen load from groundwater.

IV. Implementation of the Nitrogen TMDL

DWQ developed rules to require nitrogen reductions from both point and nonpoint sources within the Neuse River Basin. A copy of the adopted rules is included in Appendix III. A brief summary of the various rules along with other implementation plans to achieve the 30% reduction is provided below:

IV-A. Point Source Implementation

Rules were drafted that require all dischargers below the Falls Dam that have a design flow of 0.5 MGD or greater (major dischargers) to meet annual nitrogen loads based on their permitted flow and a concentration of approximately 3.7 mg/l TN. The current point source rule contains limits of 5.5 mg/l TN for major dischargers above Falls Dam. A mechanism was also established that allowed the point sources to meet the nitrogen reduction goal collectively. The intent of this rule was to achieve a 30% reduction in point source loading at the estuary. However, a mistake was made in the calculations that were done to evaluate different management scenarios, and the rules as currently drafted will not likely achieve the 30% reduction for point sources at the estuary. Therefore, DWQ is holding the NPDES permits in the Neuse River until guidance is received from the Environmental Management Commission on potential rule changes. We expect to receive this guidance in the next few months, and the point source community is prepared to meet a 30% reduction in nitrogen loading. In the meantime, EPA has requested that DWQ delay issuing NPDES permits until April 30, 1999 pending review of this TMDL.

IV-B. Nonpoint Source Implementation

Four main rules were drafted requiring mandatory nonpoint source controls for nitrogen in the Neuse River Basin. These were rules concerning: (1) stormwater, (2) agriculture, (3) nutrient management planning, and (4) buffer requirements. Each of these rules with the exception of the buffer rule was adopted as permanent rules by the 1998 General Assembly and became effective on August 1, 1998. A temporary buffer rule has been in effect since July 22, 1997. Further information on each of the rules and the status of the buffer requirements, as well as other initiatives is provided below:

Stormwater Rule

The stormwater rules apply to the 10 largest municipalities and 5 counties within the Neuse River Basin. The rules require DWQ and the local governments to develop a model stormwater management plan that addresses new development, public education, illegal discharges, and identifying existing sites by August 1, 1999 that could, potentially, be retrofitted with stormwater controls. Local governments then have an additional 18 months to develop a local plan that includes the same components as the model plan.

Agriculture Rule

The rule provides each farmer with two options to achieve the nitrogen reduction goals:

- Participate in a local nitrogen reduction strategy that would include specific plans that would enable farmers to collectively meet the nitrogen reduction goal, or
- Implement standard best management practices such as buffers, water control structures, and nutrient management plans.

Under the first option, two main committees have been formed: a Basin Oversight Committee and a Local Advisory Committee for each county in the Basin. The Basin Oversight Committee is charged with the following responsibilities:

- Develop method to track nitrogen loads and reductions from farms
- Refine calculations on agriculture nitrogen loads to the Neuse River
- Allocate nitrogen goals to each county/watershed in the basin based on strategies developed by the Local Advisory Committees.
- Review and approve county/watershed nitrogen reduction strategies

While the rules specify that the agricultural community achieve a 30% reduction in total nitrogen, the Basin Oversight Committee is urging the agricultural community to achieve a 35-40% reduction in total nitrogen loading in the basin which is in agreement with the TMDL allocation for agriculture.

The Local Advisory Committee is charged with the following responsibilities:

- Sign up farmers for this option
- Develop local strategies to meet county/watershed nitrogen reduction goal
- Submit annual progress reports to Basin Oversight Committee

Farmers who choose to implement standard best management practices under the second option will have to comply with the BMPs outlined in Table 7.

Table 7: Standard BMPs Required for Farmers Selecting Option 2

BMP(s) Implemented	Required Riparian Area Zones and Vegetation
Nutrient Management *and* Controlled Drainage	No Riparian Area Requirement
Nutrient Management *or* Controlled Drainage	20' Forested Riparian Area *or* 30' Vegetated Filter Strip
Loss of Cropland Required for Receipt of Federal Tobacco Allotments (no Nutrient Management or Controlled Drainage)	20' Forested Riparian Area *and* 30' Vegetated Filter Strip
None of the above BMPs	30' Forested Riparian Area *and* 20' Vegetated Filter Strip

Nutrient Management Rule

Persons who apply fertilizer to or manage 50 or more acres per year of cropland, golf courses, recreational lands, rights-of-way, lawns and gardens in commercial and

residential areas, and other turfgrass areas have two options to comply with the Neuse rules. They may complete training and continuing education in nutrient management or develop a written nutrient management plan for all property where nutrients are applied. If they choose to complete nutrient management training, they must do so within 5 years of the effective date of the rule. If they choose to develop nutrient management plans, the plans for cropland must meet the standards and specifications of the USDA National Resources Conservation Service or the standards and specification adopted by the NC Soil and Water Conservation Commission. The nutrient management plans for other lands must meet recommended guidelines from land-grant universities. It should be noted that the nutrient management planning requirements are above and beyond the reduction requirements for agriculture and urban lands. Therefore, a greater than 30% reduction should be achieved from these land uses which is in accordance with the TMDL allocations for these land uses.

Buffer Rule

The Neuse River Riparian Area Protection and Maintenance rule was first put into effect as a temporary rule on July 22, 1997 by the NC Environmental Management Commission. Since that date, this temporary rule has provided protection for riparian areas with existing forest vegetation along all perennial and intermittent streams, lakes, ponds and estuaries in the Neuse River Basin. The protected riparian area consists of two zones. Zone 1 is the first 30 feet directly adjacent to the waterbody, which is required to be essentially undisturbed forest vegetation. Zone 2 is an additional 20 feet adjacent to Zone 1, which is required to be dense vegetation which may be managed. The temporary rule includes allowances for activities such as road and utility crossings, water-dependent activities and limited tree harvest within the riparian area.

In 1998, the General Assembly considered adoption of the Neuse River Riparian Area rule as a permanent rule. Rather than approving the permanent rule, the General Assembly approved House Bill 1402. House Bill 1402 allows DWQ to continue implementing the temporary Riparian Area rule for one more year with some modifications in the definitions of streams, forest vegetation and vested rights. In addition to the changes to the temporary rule, House Bill 1402 calls for the formation of a Stakeholder Advisory Committee. The Committee, which has been meeting frequently, is responsible for making recommendations to the EMC by April, 1999 on some of the technical issues associated with the Riparian Area Rule. These issues include: defining a stream, creating a riparian area mitigation program, and delegating the riparian area program to local governments. Based on the Committee's recommendations, the EMC will recommend revised language for the temporary Riparian Area rule and will begin the permanent rule-making process for the revised rule.

Other Expected Agricultural Reductions

North Carolina was awarded $256 million in Comprehensive Reserve Enhancement Program (CREP) funds for use in establishing best management practices (BMPs) in its nutrient sensitive waters basins including the Neuse River. The agricultural agencies are

expecting the farming community to use this funding to implement the Neuse River agricultural rules as well as to implement additional BMPs. Therefore, we expect the agricultural community to surpass its loading target for total nitrogen. When the TMDL is updated, the programs funded with CREP money will be reviewed in order to estimate the loading reductions that have been achieved to date. It is important to note that full compliance with the TMDL requirements has been established for 2003, and the TMDL will be reviewed in 2001.

IV-C. Atmospheric Nitrogen Implementation

Although there is no rule specific to the Neuse River Basin to control atmospheric sources of nitrogen, there are measures which are being enacted that should reduce atmospheric emission of nitrogen. First, last month, EPA finalized a landmark Clean Air Act rule requiring utilities and large industrial sources throughout 22 Eastern states to reduce by 85% their emissions of nitrogen oxides (NOx) by 2003 (U.S. E.P.A., 1998b). This translates to a best estimate of reduced nitrogen load of 4.1 million lbs/yr to the Albemarle/Pamlico Sound (U.S. E.P.A., 1998a), of which the Neuse estuary is a section. This estimate assumes that 10% of nitrogen deposited on land surfaces in a given watershed is exported to the estuary.

Secondly, the NC Environmental Management Commission passed a temporary rule in February, 1999 that requires all animal operations to implement BMPs to control odor being emitted from the facilities. The effective date of this rule was March 1, 1999. If odor complaints persist, further measures will be required. The rule-making process to develop a permanent rule will begin in Fall 1999. The scientific literature suggests that reducing odor may help reduce ammonia emissions (personal communication with Dr. Viney Aneja, February 19, 1999).

Finally, the local plans called for in the Neuse Rules may address some of the atmospheric load originating on urban and agricultural land in the basin. As part of their strategy to reduce nitrogen loading it may be deemed appropriate to target atmospheric sources.

IV-D. Conclusions on Implementation Issues

DWQ believes there is reasonable assurance that an overall 30% reduction in total nitrogen will be achieved. The rules assure that a 30% reduction in total nitrogen will be achieved from point sources, urban areas, and agricultural lands. In addition, the nutrient management rule requires reductions above and beyond the reductions required for agriculture and urban lands; therefore, greater than a 30% reduction will be achieved from these sources through the rules.

Further reductions are expected from agricultural lands based on two sources: (1) the Basin Oversight Committee established by the Neuse agricultural rules is urging counties to implement BMPS that will achieve a 35-40% reduction in total nitrogen and (2) the agricultural agencies are expecting farmers to implement BMPs above and beyond those

required by the Neuse agricultural rule with the CREP money that has been awarded to North Carolina.

Finally, reductions in atmospheric nitrogen will be achieved through new federal and state rules. The EPA has estimated that nitrogen oxide deposition in the Albemarle Pamlico Estuary system will be reduced by 4.1 million pounds per year. EPA could not provide DWQ with specific information on the reductions that would be expected in the Neuse, but the Neuse is a major estuary within this system. The odor control rule adopted by the EMC will result in reduced ammonia emissions to the watershed. At this time, the reductions cannot be quantified, but DWQ will review any new information concerning the effectiveness of this rule when the TMDL is reviewed in 2001.

V. Public Participation

40 CFR 130.7 requires that TMDLs go through a public participation process. The public had multiple opportunities to comment on and participate in public discussion of the 30% reduction target, as well as the point and nonpoint source rules that DWQ has developed in order to implement the TMDL (described above). At the public meetings, the reduction target was justified based on the Senate Select Committee's recommendation. Specifically, the DWQ held six public workshops in New Bern and Smithfield in May 1996 in order to obtain input from the public early in the process. Four public hearings were then held in November 1996 in Raleigh, New Bern, Goldsboro, and Kinston to obtain public input on the proposed TMDL and the rules that were drafted to implement the TMDL. Based on the comments received at this hearing, substantial changes were made to the rule, and a second set of public hearings was held in October 1997 in New Bern and Raleigh. A copy of the announcements for the public hearings is included in Appendix IV. The comments from each hearing are summarized in the Report of Proceedings that was written following each hearing (NCEMC, 1997a; NCEMC, 1997b), and the workshop comments were summarized in a report prepared by the Division (NCDEM, 1996).

In general, most commentors supported the 30% reduction in total nitrogen. Although no one stated that they believed a 30% reduction would indeed restore water quality given the complexity of estuarine systems, people believed that it was a good goal until more information including modeling analyses were available to modify that goal. The Neuse River Foundation commented during each public meeting that a fifty percent reduction in total nitrogen was needed. DWQ did not believe there was sufficient evidence to change the TMDL, and the target has not been modified. More detail on this comment and other comments specific to the TMDL are provided in Appendix V.

VI. Future TMDL Initiatives

VI-A. Tracking Progress With the TMDL

The DWQ installed a continuous gage and began collecting daily nutrient concentration data at Fort Barnwell in 1996. As long as funding of this gage and daily monitoring

continue, the DWQ will continue to collect the data. These data will be used to calculate nitrogen loading at Fort Barnwell. To be consistent with the method in which the TMDL was calculated, the flows may need to be scaled up to flows at Streets Ferry. Weekly ambient data collected at the gaged site on the Trent River at Pollocksville will be used to calculate Trent River loads. Point source loading will then be added in to estimate the loads at New Bern. Direct atmospheric deposition to the estuary based on an estimate from the export coefficient method will be added to the load. Better methods may be available to estimate this load, but the export coefficients will be used to be consistent with the manner in which the TMDL was calculated. Future updates of the TMDL will further address this issue. Since flow and concentration determine load, compliance with the TMDL will be done over a five year period using the FLUX model to offset annual flow variability. This is consistent with the manner in which the baseline load and TMDL were calculated. The updated loading analysis will be performed on the basin planning cycle, and the information will be provided in the basin plan that is scheduled for mid 2002.

DWQ will determine if loads appear to be decreasing. It is important to note that there is greater uncertainty in trends based on short time periods, but DWQ will attempt to statistically analyze the data during each basin cycle. It is also important to note that many of the point and nonpoint source controls are not required to be fully implemented until 2003. Thus, total nitrogen load reductions that do not achieve the loading target during the upcoming basin cycle may not be indicative of an ineffective management strategy, but rather the result of management practices still being installed throughout the basin. In the next phase of the TMDL, DWQ will review available information to determine if it appears that the implementation strategies need to be revised in order to meet the TMDL goal. Ultimately, the goal of DWQ and the Clean Water Act is to restore the uses of the estuary. DWQ has established a Rapid Response Team in the Neuse estuary to collect data during fish kills and algal blooms and assist in monitoring the estuary. DWQ will report on the frequency and extent of algal blooms and fish kills that have occurred within the estuary in future updates of the Neuse River Basinwide Water Quality Management Plan.

VI-B. Future Phases of the TMDL

DWQ will use all available studies to re-evaluate the TMDL and management strategies (See following section entitled "Ongoing and Future Studies in the Neuse River") following the schedule in Figure 14 and Table 8. DWQ will use the results of all MODMON data collection and modeling to revise the TMDL and management strategy. The extension of the MODMON project indicates that all work should be completed by January, 2001. DWQ will use this information and any other new data and models that result from the projects described below to revise the TMDL and implementation plan. Specifically, seasonality and phosphorus loading will be addressed using the estuary model and any other means possible. DWQ will involve stakeholders in the TMDL review process. North Carolina's Administrative Procedures Act (APA) requires a minimum of two years to complete a new rule. Therefore, if rule making proceeds without any hold-ups, new rules could be completed by the end of 2001 with an effective

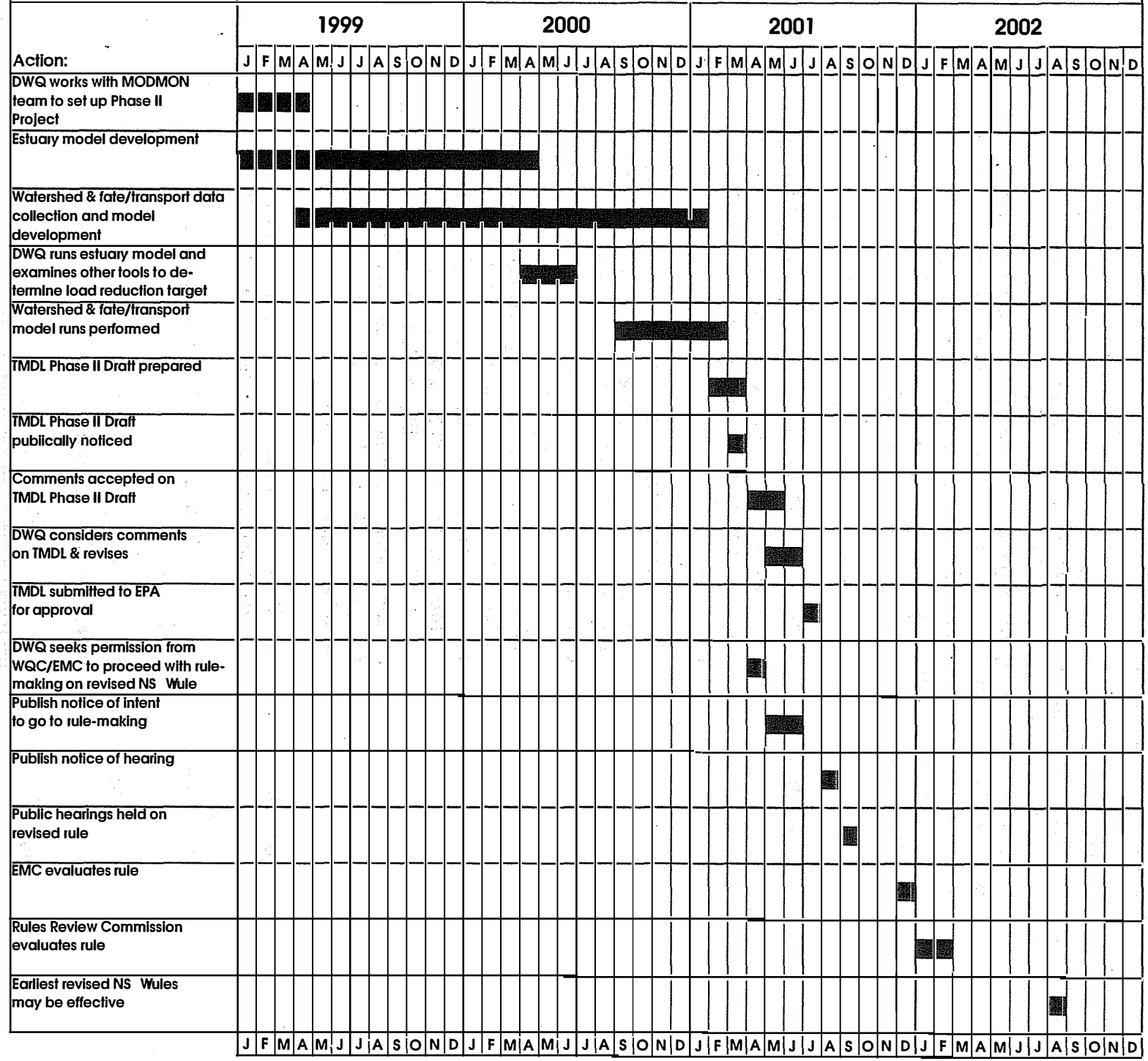
date of August 2002. This would just meet the schedule to include the revised TMDL and implementation strategies in the next update of the Neuse Basinwide Plan which is scheduled for completion in late 2002 or early 2003.

The potential exists that new information will indicate that the current TMDL is not adequate, but the new information may not be adequate to determine the exact nutrient reductions that are needed in order to achieve water quality standards. If the model and other tools are not ready or capable of predicting the nitrogen reduction goal, the State will be prepared to revise the TMDL to include an explicit margin of safety. A revised phased TMDL will be developed based on the new data, modeling tools and expert opinion of the scientists. Extensive public involvement would be built into the process as required by the federal regulations and North Carolina statutes.

Table 8: Milestone Dates to Review and Revise the Neuse TN TMDL

April 1, 2000	A CE-QUAL-W2 model (estuary response model) of the Neuse estuary will be completed to the extent that it will be ready to use as a tool for the completion of the second phase of the TMDL.
July 1, 2000	The nitrogen reduction goal (i.e. the total percent reduction necessary to support the estuary's uses) will be completed using the CE-QUALW2 model and other data and tools available. The state will provide EPA with the appropriate information to review by this date. If the model and other tools are not ready or capable of predicting the nitrogen reduction goal, the State will be prepared to revise the TMDL to include an explicit margin of safety (i.e. an additional reduction will be added to the proposed 30% reduction). The State will provide EPA Region IV with the documentation that includes: (1) the explicit margin of safety that the State intends to use: and (2) the rationale for the value of this margin of safety.
August 1, 2000	EPA Region IV will approve/disapprove the State's nitrogen reduction goal submitted on July 1, 2000.
March 31, 2001	The State will public notice for comment the 2nd phase of the TMDL.
July 31, 2001	The State will submit the 2nd phase of the TMDL to EPA for approval/disapproval.
August 30, 2001	EPA Region IV will make an approval/disapproval decision on the 2nd phase of the TMDL.

Figure 14. NEUSE PHASED TN TMDL SCHEDULE 1999 TO 2002



VI-C. Ongoing And Future Studies In The Neuse River

There are many studies that are ongoing in the Neuse River Basin that are pertinent to the nitrogen TMDL discussion, and these efforts are described in this section. Further information on Neuse River studies can be found at the North Carolina Water Resources Research Institute website at www2.ncsu.edu/ncsu/CIL/WRRI.

MODMON

Using money allocated by the 1996 North Carolina General Assembly, DWQ contracted work with a team of university researchers to collect monitoring data in the estuary and develop a two dimensional estuarine response model (MODMON). The initial version of the model is being verified using seven months of data that was collected beginning in June 1997. This model is being updated with data collected from January-December, 1998 and will include a sediment model. DWQ should receive the model in June, 2000; this tool will be valuable in evaluating the nitrogen loading targets.

The General Assembly approved in October, 1998 a budget that includes an item to extend the MODMON work. The General Assembly's budget package includes developing a model of the Neuse watershed that includes examining instream fate and transport issues and linking it to the estuarine response model. The additional work is projected to be completed in January 2001.

Groundwater Studies

The General Assembly provided funds for researchers at North Carolina State University (NCSU) to determine the extent to which animal waste lagoons may impact groundwater in the state. Preliminary research has shown that groundwater may account for a significant portion of the nitrogen load in the Neuse River Basin, and data collected from this study will help determine the magnitude of the impact from agricultural lagoons on nitrogen loading in the basin. A final document will be completed in 1999.

The U.S. Geological Survey is doing a study on the effects of buffers on groundwater and the subsequent impact on surface water quality. As part of this study, they are also trying to quantify the amount of nitrogen that is discharged to surface water from shallow and deep aquifers.

There is also a 319 project that has been funded in which maps of the basin will be developed that show areas where controls should be targeted in terms of groundwater vulnerability and potential for subsurface pollutant transport to streams.

Nitrogen Isotope Study

Different sources of nitrogen have their own isotopes, and studying these isotopes will help identify the relative magnitude of different nitrogen sources within the Neuse River Basin. This study, funded by the General Assembly, will provide valuable information

on the sources of nitrogen in the basin for inclusion in the modeling framework. This work will enable DENR to develop more effective nitrogen management plans. The study will be completed by 2000.

Atmospheric Deposition of Nitrogen

The General Assembly allocated funds to identify the amount of atmospheric nitrogen reaching the Neuse River estuary. Data collected under this study are being used in the atmospheric module of the estuary response model. In addition, data on atmospheric loading on the landscape will be needed to develop a linked watershed and estuary modeling framework. Furthermore, UNC Chapel Hill scientists are being funded to examine management practices that promote conversion of nitrogen compounds in animal waste to benign nitrogen gas.

Dr. Viney Aneja of NCSU and others are being contracted by the NC Division of Air Quality (DAQ) to study how much wet and dry deposition is occurring in various regions of North Carolina, as well as to gain a better understanding of the extent of atmospheric ammonium enhancement from animal operations.

The deposition study is just beginning and expected to last 3-4 years. It is primarily aimed at understanding dry deposition as our knowledge of that is presently very minimal compared to to that of wet deposition. It will progressively measure deposition on a grassy field, a crop field and an aquatic ecosystem. In the meantime, the group will model the transport and transformation of atmospheric nitrogen (primary NH_3/NH_4^+ with some NOx) to develop concentration fields that will predict deposition. DAQ will make ground measurements of deposition at a few ground locations including swine operations to calibrate this modeling exercise.

The emissions study will measure emissions from numerous sources within swine operation (house, lagoon, spray field) and combine those results with those from similar studies (USDA, USEPA) to make statistical estimates of emissions on a larger scale. In the future, this type of study will be expanded to include other animals such as turkeys and chickens.

Buffers

WRRI is funding NCSU scientists to refine design criteria for vegetative buffers along streams to control nitrogen loading.

RIMDESS

DENR obtained funds from the Environmental Protection Agency (EPA) to develop a shell to facilitate a modeling system that links the estuary model to a watershed model, groundwater model and atmospheric model. DENR contracted with the Research Triangle Institute (RTI) to develop this tool which is called the River Management Decision Support System (RIMDESS). RIMDESS is intended to provide DENR with the

ability to review various nitrogen management options in the basin, and assess the cost-effectiveness of these options. The framework to do this has been established, but the RIMDESS frame needs to be filled with the different model components, such as the estuarine model, and updated information.

MIMS

The U.S. Environmental Protection Agency is developing a multi-media integrated modeling system (MIMS) that will be an object-oriented modeling approach to holistically review environmental problems. The MIMS project will be using the Neuse River as a prototype and will include nitrogen in the surface waters, atmosphere, groundwater and watershed. They are planning on being able to use the project for TMDL issues, but the modeling system will not be available until 2008. Efforts are underway to coordinate this project such that it builds on the MODMON work and hopefully reduces the time frame for completion.

Other EPA Initiatives

EPA's Research Triangle Park office has much ongoing research in the Neuse River. At a meeting of the MIMS team in September 1998, DWQ was informed of these efforts. There is one part of this effort directly related to the nitrogen TMDL. EPA is developing a land use database that will be used to develop nonpoint source nutrient models of the basin. EPA is planning to complete these models by the end of 2000, and they can be used to allocate the allowable nitrogen load among various sources.

DWQ will use this ongoing research as it reviews data for inclusion in future updates of the TMDL and Neuse Basinwide Water Quality Management Plan. These data will be used to assess water quality in the estuary, determine use support ratings, and review the effectiveness of the proposed TMDL and the strategies to implement it.

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APPENDICES

Appendix I

Senate Select Committee on River Water Quality and Fish Kills
January 1996 Workshop on Neuse River

SENATE SELECT COMMITTEE ON
RIVER WATER QUALITY AND FISH KILLS

Summary of Scientific Forum, January 30, 1996

Issues and Recommendations

In response to requests made by the Senate Select Committee on River Water Quality and Fish Kills to provide scientific expertise to advise the committee, small groups of scientists from our State's universities were assembled to "focus" on issues related to water quality. First, "Focus Groups" considered 1) physical circulation and hydrography, 2) fisheries, 3) water quality and nutrient impacts, 4) land/water relationships, 5) sediments, 6) socio-economic concerns, and 7) wetlands. Results of all these focus group discussions were reported to the Senate Select Committee during December and January. Summary reports became part of the record of the committee's deliberations.

Questions raised during the focus group discussions as well as during the Senate Select Committee were the subject of a workshop held on January 30, 1996. Examples of questions include: 1) whether the evidence shows an increase in nutrients over the past 10 years; 2) what kinds of data is needed to manage the Neuse River Basin restoration effort; 3) factor to include in a model of the basin; and 4) what kind of measures are necessary to reduce nutrients and improve water quality. Participants included university scientists representing all focus groups, agency scientists from the Divisions of Environmental Management, Marine Fisheries, Coastal Management, and Soil and Water, and industry scientists. This report summarizes suggestions, from consensus conclusions, for immediate action. In addition, the forum served as an opportunity to open up lines of communication between the academic community, agencies and industry experts.

While not a specific question for the scientific workshop, it should be noted that a strong environmental education and communications program will be needed to undergird whatever technical and managerial actions may be implemented. All segments of society and user interests of coastal resources will need a better understanding of the environment and the effects of human activities in order to bring about the changes that will be required to improve the current environmental situation. Several modes of communication should be developed to deliver timely information at all levels of society. Resource user groups, such as fishermen, farmers, developers, etc., will need specially prepared education materials to enhance understanding of cause and effects of coastal water quality. Plans that are already underway to develop a focused environmental education program need to be expanded, accelerated and supported. All management agencies will need to increase their communications programs. An estimated cost of $25,000/yr is needed to produce special materials for education.

ISSUES AND RECOMMENDATIONS

1. Restoration of Water Quality in the Neuse River

Rationale: Coastal ecological systems like the Neuse suffer when the rate of nitrogen loading (pounds entering the estuary per year) exceeds that needed to sustain appropriate levels of estuarine productivity. Unfortunately, overnourishment sets off a chain reaction leading to increased frequency of algal blooms, oxygen depletion and associated fish kills (sublethal effects are pervasive). It is estimated that loading in the Neuse has substantially increased over the past century due to human sewage, industrial wastewaters, agricultural runoff, atmospheric inputs resulting from fossil fuel use and volatilization of ammonia, domestic animal waste systems, and urban runoff. Technology and best management practices have ameliorated the loading, but loading still exceeds the ability of the estuary to assimilate the nutrients. There is no known technology (nor is there any forthcoming) that will increase the estuary's capacity to handle excess nitrogen once it reaches the estuary. Therefore, we are left with the simple choice of reducing the loading or pay the price of diminishing water quality.

Recommendation: Adopt a minimum goal to create a detectable improvement in Neuse River water quality by capping loading at 70 % of the 1990-1995 average load. Based on current knowledge, we believe that this reduction will produce a detectable improvement within five years after loading reduction to that level has been achieved. The General Assembly should move as quickly as possible to impose the cap and achieve the desired reduction within three years. Cost: Unknown. Note: Capping the nutrient loading should serve as the "keystone" of a plan leading to the goal of better water quality and sustainable estuarine resources. Subsequent studies may create the scientific basis requiring further action. Since nutrients derive from a variety of sources, the action should be equitably distributed to include all sources.

Recommendation: Establish a partnership among university and agency scientists to coordinate, integrate and expedite water quality modeling efforts that encompasses the Neuse River basin. Cost: $75,000. Note: This funding would enable an effort to coordinate modeling efforts and foster communication among modelers.

2. Identification and Characterization of Nutrient Sources

Rationale: Nutrients entering the estuary derive from a variety of sources (e.g., sewage, animal wastes, fertilizers, atmosphere, runoff, etc). Current means to discern the origin of nitrogen entering the Neuse River are only approximations;

thus, assignment of relative loading to specific sources is controversial. New technology (stable isotope analyses) is now available to assess the sources of nitrogen in water and sediment.

Recommendation: Move quickly to improve nutrient source categorization, including determining isotope ratios to identify nitrogen sources. A study has been designed and partial funding is available. Cost: $100,000.

3. Data System

Rationale: A good, available data base is crucial and basic to the responsible management and assessment of all aspects of coastal water quality. Data currently exist in various agency, research and monitoring files, but have not been organized and catalogued in a central data file readily available to managers, researchers and user interests. It is critical that all existing (and future) data pertaining to coastal water quality and fisheries be organized, catalogued and quality checked--and continually, in real time, updated to accommodate new information.

Recommendation: Establish a centralized data bank that includes all historical water quality and fisheries data properly catalogued and retrievable (perhaps on internet). This data set must be continually updated. Cost: $100,000/yr. Note: Such a center could be established in the new Center for Marine Science and Technology (CMAST) planned in Morehead City.

4. Wetlands

Rationale: Wetlands can have a direct effect on river water quality by removing sediment, oxygen consuming organic matter and plant nutrient chemicals from runoff water before it gets into the rivers. Wetlands most effective at reducing sediment and nutrient input to rivers are the streamside riparian wetlands hydrologically contiguous to small water courses.

Recommendation: Move immediately to establish mandatory buffers of at least 50 feet for riparian wetlands. Conduct a highly targeted (capability exists) working group to develop site specific, quantitative guidelines for buffers, hydrologic reconstructions and best management practices. Cost: $50,000. Note: While we also endorse the notion of an integrated wetland enhancement, preservation and restoration program currently being developed by the Division of Coastal Management, it is imperative that efforts be devoted to the ones that matter the most for protecting river water quality.

5. Nutrient Reduction Cost/Benefit Identification

Rationale: The costs and benefits (both social and economic) of achieving water quality improvements are thought to be substantial, but are currently unknown. Socio-economic impact assessment must go beyond the simple changes in the flow of dollars. While some communities of people will affect resources by their behavior, others will be affected by changes in resource quality. All of these are measurable by various assessment processes.

Done 4) April 1997

Recommendation: Conduct a survey to ascertain public and stakeholder perceptions concerning the condition of water quality related resources, and their willingness to pay for and participate in changes and improvements in the management of the resources. Cost: $75,000. Convene a workshop to identify the state of knowledge regarding social and economic costs and benefits of pollution reduction alternatives, including modeling efforts and short and long term actions needed to estimate social and economic costs and benefits. Cost: $75,000.

6. Improved Water Quality Monitoring Program

Rationale: A more comprehensive monitoring program is necessary to keep track of the water quality in estuaries on a continuing basis. Events leading to fish kills and onset of diseases will also need to be monitored, including three-dimensional water quality parameters to estimate the health of the system for fishes. Monitoring is also needed to assess the efficacy of various management decisions and implementation. A network of volunteers, committed to monitoring their local waters, can be a tremendous addition to ongoing state monitoring programs. Besides, a volunteer monitoring network is an effective means of educating the public about the quality of their environment.

Recommendation: Design a comprehensive monitoring program, under the oversight of a scientific advisory board, to increase the likelihood that monitoring information is effective and will be used. Expand the DEM monitoring arrays to include flow measurements.

A well-organized volunteer monitoring network will enhance that possibility. Cost: $100,000/yr.

7. Need for a Scientific Advisory Board

Rationale: There is a need for continuing dialogue among university, government and industry based scientists. If we are to collectively improve water quality to maintain healthy, productive coastal ecological systems, we must formalize the capability for that dialogue and testing to occur.

Recommendation: Establish a formal Scientific Advisory Board, of five to seven members, to oversee planning for implementation of effective water quality management. Cost: $25,000/ yr. Note: A number of additional issues require continuing dialogue, analyses, interactions and workshops. Some areas of communication include:

- River basin process-oriented modeling oversight to coordinate modeling
- Integration of linkages and interaction of monitoring
- Evaluation of land application patterns to minimize net flux to surface water
- Design and implement BMP's to target topographic variations
- Enhance monitoring programs to include events leading up to fish kills and onset of diseases
- Summarize knowledge about costs of pollution reduction

The Scientific Advisory Board would need the authority to appoint Task Groups to consider specific, technical issues such as those listed above.

The State's waters and aquatic resources are public trust resources belonging to all citizens of North Carolina. Therefore, the State has a stewardship responsibility for managing those resources for the benefit of all. The Environmental Management Commission, the Coastal Resources Commission and the Marine Fisheries Commission has the obligation to work together in order to comprehensively address water quality issues. While efforts are underway to achieve coordinated and cooperative mechanisms, this notion needs to be enhanced and encouraged.

The issue of river water quality and fish kills is very complex and long term solutions will be needed to restore the quality desired for the Neuse River Estuary. The recommendations outlined above are a good beginning, but continuing dialogue and scientific oversight are required to achieve improvements in water quality.

Phone numbers for Neuse River Scientists

Hans Paerl, UNC-CH Institute of Marine Sciences.	(919) 726-6841
Jerad Bales, Chief Hydrologist, USGS	571-4000.
Don Stanley, ECU Institute for Coastal and Marine Resources.	(919) 757-6220
Tom Galagher , HydroQual, Inc.	(201) 529-5151
Alan Blumberg, HydroQual, Inc.	(201) 529-5151
Winston Lung UVA, Department of Civil Engineering	(804) 924-3722
Mike McCarthy, Water Department Manager, RTI	541-6796.
Randy Dodd, Environmental Supervisor, RTI	541-6491.
Bob Ambrose, EPA	(706) 546-3323.
Curtis Richardson, Duke University Wetlands Center.	613-8009
Martin Lebo, Aquatic Scientist at Weyerhaeuser	(919) 633-7511.
John Butcher, Cadmus Group	544-6639

We have invited members of the scientific focus groups that provided input into the process from the viewpoint of academia, representatives of user groups (industry, development, environmental and resource interests), and staff from the Department of Environment, Health and Natural Resources involved in management of coastal waters. We hope that this mixture of input will contribute to the kind and priority of recommendations leading to improvement of water quality in our coastal waters.

We will follow this memo (in a few days) with a list of questions that will need to be addressed at the workshop--along with some background materials. While our discussions will not necessarily be limited to these questions, they should focus our thinking about the kinds of recommendations and conclusions the General Assembly needs to deal with this Legislative Session.

Thank you. We believe that your participation will be rewarding to you professionally as well as a great service to the welfare of our coastal resources. If you have questions, please feel free to call B. J. at (919) 515-2454 or FAX 515-7095 or Sherri at (919) 733-2578 or FAX 715-5460.

List of Invitees to Workshop on Coastal Water Quality

Dr. JoAnn Burkholder
Mr. Walter Clark
Dr. John Costlow
Dr. James Easley
Dr. Wendell Gilliam
Dr. John Miller
Dr. Edward Noga
Dr. Hans Paerl
Dr. Norman Christensen
Dr. William Cleary
Dr. Larry Crowder
Dr. Dirk Frankenberg
Dr. Richard Leuttich
Dr. John Morrison
Dr. Michael Orbach
Dr. Leonard Pietrafesa
Dr. Stanley Riggs
Dr. Wayne Skaggs
Dr. Donald Stanley
Dr. Francisco Werner
Dr. Thomas Hopkins
Dr. David DeMaster
Dr. Dean Hesterberg
Dr. Roger Rulifson
Dr. Kerry Smith
Dr. John Wells
Dr. Lian Xie
Dr. Michael Stoskopf
Dr. Robert Evans
Dr. William Showers
Dr. Mark Brinson
Mr. Preston Howard
Mr. Steve Tedder
Mr. Greg Thorpe
Mr. Ken Eagleson
Mr. Jimmy Overton
Mr. Steve Bevington
Mr. John Dorney
Mr. David Harding
Ms. Lisa Huff
Mr. Jim Wuenscher
Mr. Dewey Botts
Mr. Bruce Freeman

FOCUS GROUPS

SENATE SELECT COMMITTEE ON RIVER WATER QUALITY AND FISH KILLS
N. C. Science Experts

We have prioritized "Focus" areas to reflect scientific expertise directed toward coastal water quality and fisheries resources in North Carolina. Each focus group includes scientists currently engaged in research relevant to the issues. Focus groups are:

I. PHYSICAL CIRCULATION AND HYDROGRAPHY

Leonard J. Pietrafesa, Professor, NCSU Department of Marine, Earth and Atmospheric Sciences. Coastal circulation, physics and water movement modeling.

Lian Xie, Assistant Professor, NCSU Department of Marine, Earth and Atmospheric Sciences. Physical modeling and air/water interface.

John Morrison, Associate Professor, NCSU Department of Marine, Earth and Atmospheric Sciences. Satellite data translation, physical modeling and mixing patterns.

Thomas Hopkins, Professor, NCSU Department of Marine, Earth and Atmospheric Sciences. Estuarine circulation and mixing patterns.

Richard Luettich, Associate Professor, UNC-CH Institute of Marine Sciences. Estuarine circulation, mixing patterns and hydrography.

Francisco Werner, Associate Professor, UNC-CH Marine Sciences. Coastal circulation, water movement modeling, and hydrography.

II. FISHERIES

John M. Miller, Professor, NCSU Department of Zoology. Population dynamics, fisheries recruitment and movement, and data handling.

Larry B. Crowder, Professor, Duke Marine Lab. Fisheries mortalities, population dynamics and population modeling.

Roger Rulifson, Professor, ECU Institute for Coastal and Marine Resources. Anadromous fish movements and survival, and fisheries recruitment and movement.

Edward Noga, Professor, NCSU College of Veterinary Medicine. Fish diseases and immunological response.

Michael Stoskopf, Professor, NCSU College of Veterinary Medicine. Fish health diagnostics.

John Costlow, Professor Emeritus, Duke Marine Lab. Coastal fisheries populations and ecology.

Dirk Frankenberg, Professor, UNC-CH Marine Sciences. Coastal processes, anoxia and fisheries models.

III. COASTAL WATER QUALITY AND NUTRIENT IMPACTS

Hans W. Paerl, Kenon Professor, UNC-CH Institute of Marine Sciences. Nutrient impacts, atmospheric deposition and algal blooms.

JoAnn M. Burkholder, Associate Professor, NCSU Department of Botany. Nutrient impacts, toxic dinoflagellates and eutrophication.

Donald Stanley, Professor, ECU Institute for Coastal and Marine Resources. Nutrient loading, sources and impacts, and anoxia.

Richard Barber, Professor, Duke Marine Lab. Coastal nutrient interactions and impacts.

David J. DeMaster, Professor, NCSU Department of Marine, Earth and Atmospheric Sciences. Bio-geochemical cycling.

IV. LAND/WATER RELATIONSHIPS

J. Wendel Gilliam, Professor, NCSU Department of Soil Science. Soil chemistry, loss of nutrients from land activities, and best management practices.

R. Wayne Skaggs, Distinguished Professor, NCSU Department of Biological and Agricultural Engineering. Ground-water dynamics and movement from land activities.

Robert O. Evans, Assistant Professor, NCSU Department of Biological and Agricultural Engineering. Land run-off and best management practices.

Dean L. Hesterberg, Assistant Professor, NCSU Department of Soil Science. Non-point source nutrient modeling.

V. SEDIMENTS

Orrin Pilkey, Professor, Duke College of the Environment. Coastal sedimentation rates and erosion effects.

John Wells, Professor, UNC-CH Institute of Marine Sciences. Loading rates in sediments, deposition patterns, movement.

Stanley Riggs, Professor, ECU Department of Geology. Sediment movement, metal accumulations and movement, and sediment/water interactions.

William Showers, Associate Professor, NCSU Department of Marine, Earth and Atmospheric Sciences. Stable isotope chemistry, organic nutrient identification.

William Cleary, Professor, UNC-W Department of Geology. Sedimentation rates and erosion.

VI. SOCIO-ECONOMIC CONCERNS

V. Kerry Smith, Distinguished Professor, Duke College of the Environment. Economics of environmental quality, water quality costs and returns, and opportunity/risk costs.

James E. Easley, Professor, NCSU Department of Resource Economics. Fisheries economics and catch statistics.

David Brower, Professor, UNC-CH Department of Regional Planning. Land-use management, coastal management and public trust resources.

Walter F. Clark, Legal Specialist, N.C. Sea Grant College. Public trust resources, conflict resolution and land/water use management.

Michael Orbach, Professor, Duke Marine Lab. Fisheries management, conflict resolution, and coastal management.

VII. WETLANDS

Norman Christianson, Professor, Duke College of the Environment. Wetlands management, wetlands ecology and function.

Mark Brinson, Professor, ECU Department of Biology. Wetlands ecology and function, wetlands evaluation and management.

Curtis Richardson, Professor, Duke College of the Environment. Wetlands management, non-point source management.

R. Wayne Skaggs, Distinguished Professor, NCSU Department of Biological and Agricultural Engineering. Ground-water dynamics and movement from land activities.

CIRCULATION AND MIXING

The Neuse River system receives materials from upstream point sources, watershed non-point sources, exchange with Pamlico Sound and the ocean through barrier inlets, rainfall on the watershed and estuary, and from activities on and around the estuary. Identification and characterization of issues are complicated by the fact that Pamlico Sound is a large, slowly moving, wind-mixed, shallow bowl where the water (and anything in it) sloshes back and forth driven more by the wind than by tidal influence, and flushes very slowly out to sea through narrow inlets between long barrier islands.

If we are to accomplish the overall goal of reducing nutrient inputs into the estuary so that some better level of water quality will be recovered, we must determine <u>how much</u> reduction is necessary to reverse the current trend in water quality and <u>what type</u> of reduction (e.g., point sources, agricultural, sewage treatment, etc) will be most effective (both cost and impact). We have so little idea about either of these that formulating a basis for instituting specific nutrient reduction strategy can not be effectively done.

Ideally, a model (or system of models) can provide guidance in assessing/designing/justifying/instituting a nutrient reduction strategy. However, models mean many different things to different people and we must be very careful about how modeling will be approached. Because the Neuse system (and Pamlico Sound) is such a complex system, the most realistic way to approach this problem is to identify the critical processes that control water quality, develop individual models of these processes and ultimately link the individual models together into a system of models that describes the whole picture. This approach would have the advantage of being able to adapt individual and existing models from previous work and/or other systems, recoding for the Neuse and linking them with the overall system approach.

Enough observational data exists for the Neuse River system to know the primary mechanisms causing and controlling water circulation and mixing. Water movement is principally in response to winds blowing across surface waters of the Neuse and connected bodies of water. Tempered by freshwater inputs from tributaries and salt, momentum and volumetric exchange with Pamlico Sound, the information exists to formulate a basic physical model. From a physical modeling perspective, to characterize the circulation physics, a model of the Neuse must: 1) represent processes in all three-dimensions in space as well as variability in time; 2) include inputs, movement and mixing of fresh and salt water; 3) account for winds blowing on the surface of the entire sound system, in general, and the Neuse, specifically; 4) include Pamlico Sound to account for the tight coupling between it and the Neuse; 5) realistically represent the complex geometry and bottom features in the system; 6) have as accurate description as possible of

turbulent mixing, to account for formation and destruction of stratification; and 7) have some connection to the coastal ocean for water exchange.

It should be noted that circulation models that take into account all of these processes are currently in use in the North Carolina academic community. Thus, it should be possible to get a good model for the Neuse up and running in a reasonable time period and at reasonable costs. While the amount of field data that has been collected in the Neuse is not large, it provides insights to set up and initially assess the validity of a circulation model. We need to establish a working model to assess the need and area of additional sampling. While further field research can be used to further adapt existing numerical models, lack of consolidated data sets will limit the results of whatever model may be used.

Individual models to reflect the processes affecting the Neuse and its assimilation of inputs, need to be decided upon with considerable care and input from managers and researchers concerned about the Neuse. It should be recognized that there is much more uncertainty in models of biological, chemical and geological processes than there is in physical process models. Therefore, we should not overestimate what a system of models of the important nonphysical processes can accomplish for the Neuse. Based on current knowledge and data availability, it is unlikely that a system of models will be able to definitively predict the effects of nutrient load reduction in the Neuse. Therefore, it is urgent that we provide a quantitative framework for synthesizing and expressing everything that is known about the system and identify the missing links to achieve a significant level of success.

Recommended Actions

1) Identify and assess all sources of nutrient and freshwater inputs into the Neuse River Estuary and place the information into a GIS database (this is equally critical for other issues as well).

2) Catalogue all available data for the Neuse system (include all physical, biological, chemical and geological data bases).

3) Organize and conduct a "workshop" on the needs and efficacy of developing a system of models to characterize the processes governing the Neuse River Estuary. The workshop would be organized around carefully structured management questions.

4) Identify, based on the workshop results, data needs and formulate mechanisms for their availability.

5) Assess previous modeling attempts for other shallow water systems to lay the groundwork for developing a system of models for the Neuse. Successful models have been developed for other states and other countries.

A Protocol for Estuarine Health - Fish Kills are a Symptom

Fish kills in our estuaries are frustrating for two reasons: they reveal a lack of understanding and an inability to solve problems in our estuaries. In truth, fish kills are commonplace in estuaries. But frequent kills are symptoms of an unhealthy environment, and our estuaries are no exception: any effort to either understand or reduce kills must be multi-faceted. But a comprehensive approach will, in the words of Jim Valvano, position us to deal with other, even unforseen, problems. So I am going to suggest solutions that will help us deal with other problems as well. An important benefit will come in the times ahead when tough management decisions must be made to restore our estuaries' health. We can provide a scientifically credible basis for these decisions. In doing so, we make the decisions defensible.

The questions surrounding fish kills are the same as when a patient dies. What was the cause of death? But the more important question is: What made the patient vulnerable to the cause of death? We must resist the temptation to treat only the symptoms. Fish kills are known to be caused by the following: disease, toxics, suffocation, starvation, and others. To date, most of the attention has been paid to disease (red sore and *Pfiesteria*). However, *Pfiesteria* is now known to be common in many parts of Pamlico Sound. So the important question is what conditions cause *Pfiesteria* to become virulent? - IF *Pfiesteria* is the cause. We must consider *Pfiesteria* a symptom of a more general environmental deterioration. In fact, there is evidence that Pamlico Sound has become increasingly prone to low oxygen levels owing to nutrient loading, and besides killing fish, low oxygen is apparently one factor that causes *Pfiesteria* to become a problem. So the situation is more complicated than we would like to think. It will require more than a *Pfiesteria* prescription to restore our estuaries to health. The good news is if we adopt a strategic, instead of a tactical, approach to the problem of fish kills, we can position ourselves to understand and prevent other problems before they arise.

The components of a comprehensive program to understand fish kills, as well as insuring the long-term health of our estuaries, must include changes in both research and management. The research community must become more involved and management must be professionalized to a level never before required. This latter must

consist of new research input from the universities, increased numbers of fisheries professionals, and increased political immunity. Each of these is necessary; none is sufficient.

The first step in solving the fish kill problem is to review what we, and others, already know. Data on fish kills exist as a result of DMF investigations, but they have never been analyzed. What fish of what size were killed in relation to fish present at kill sites? With such information, one could begin to hypothesize about causes, and design investigations to follow such leads. Along with summaries of what we know about the hydrodynamics, thus distribution of toxins, oxygen-demanding nutrients, and other inputs to our estuaries, one could begin to design a research program to support estuarine management decisions. But these data must be linked from the outset; for example, hydrodynamics and water quality data collection should be linked to what we know about fish. We know low levels of dissolved oxygen typically occur just before dawn, yet we rarely collect data at that time. Knowing the oxygen at noon, or the average oxygen concentration, is not adequate. Fish suffocate in a few minutes with insufficient oxygen, so we need to monitor oxygen. In sum, we need to summarize and analyze the data we already have, identify data gaps, proceed to systematically collect needed data.

Although many of the pieces are already there, the infrastructure to link them needs to be improved. Not the least of the necessary changes is to charge the agencies with the responsibility to improve the scientific basis for management and then to let them manage with a minimum of political interference - much in the same way a private company investigates and solves a problem. In sum, a revitalized DMF must be given the freedom to manage without interference until this proves insufficient. The only states with agencies who are currently managing resources successfully have entrusted their agencies with the job. In the present era of political expediency, this will require a new level of trust by the political powers and a new level of sophistication by the management agencies - but it is the ONLY way to success. The future will be managing inputs and outputs with a scientifically-defensible management plan. Universities have much of the critical expertise, but a new infrastructure is needed to use it to help protect our resources, through participation in a professionally-crafted management strategy. The new CMAST facility in Cartaret County is an important start.

As in human health, fisheries depend upon a healthy environment. A healthy estuary for fish has minimal constraints on productive capacity and minimal maintenance costs. The difference between capacity and maintenance costs defines both health and resistance to stress. In a fish kill, either the capacity is lowered or the maintenance costs are raised to the point where resistance is zero. For example, sub-optimal salinity or high temperature raises the maintenance costs for a fish, low oxygen constrains capacity. When oxygen falls below that necessary to meet maintenance costs, the fish dies. But before resistance to stress falls to this level, fish are vulnerable to diseases, perhaps *Pfiesteria*. This, more ecophysiological, view of health is precisely what is needed for estuaries, but it will require some new information and a new perspective of our estuaries' health. For fisheries and fish kills, there are three main research needs.

- First, we need to know the physiologically-relevant distributions of water quality factors.
- Second, we need a better understanding of effects of water quality on fish health.
- Third, we need to know the impacts of these effects at the population level.

It is time for a new era of fisheries management by a revitalized DMF, with significantly improved environmental input, significantly improved data handling, and significantly more input from our universities. We at the university are ready to help. Given an improved infrastructure and a new level of trust and cooperation, together we can craft, and implement, the necessary management strategy to restore and insure the long-term health and productivity of our estuaries.

My suggestions for a Forum as a start and some of the component tactics of the long-term strategy are appended.

Forum on Fish and Environment (March 1997)

- summarize existing information on fish kills
    1) esp DMF data in 88-89

- identify critical information on environmental requirements of fishes
    1) red drum model

- assess adequacy of present environmental data
    1) inputs
    2) hydrodynamics of Sounds, weather-forced systems
    3) short- and long-term variability

Based on the above, begin to craft the strategy, components of which would include:

- improving access to environmental and fisheries data
    1) upgrade data retrieval and analytical capability at DMF
    2) data warehousing at NCSU/CMAST

- developing a plan to obtain missing data
    1) strengthen research branch of DMF, not to do research, but to guide and contract it
    2) fish ecophysiology
    3) disease ecology
    4) eco-toxicology

- crafting a comprehensive plan for monitoring estuarine health
    1) instrumentation
    2) contract displaced commercial fishermen

- taking steps to stabilize and professionalize management agencies
    1) hire new professionals
    2) give them necessary political immunity

- creating a new infrastructure to capitalize on university, and other, expertise
    1) CMAST cooperative fisheries investigations
    2) co-funded graduate student stipends

SENATE SELECT COMMITTEE ON RIVER WATER QUALITY & FISH KILLS
FOCUS GROUPS

COASTAL WATER QUALITY

There has been considerable attention directed at the issues surrounding the level of water quality in the Neuse River estuary and subsequent fish kills. The public has demanded that attention be directed toward solutions aimed at reversing the trend toward deterioration of coastal water quality. It should be noted that progress toward that goal is limited by:

1) North Carolina's coastal ecological systems are extremely complex. Process interactions and linkages between cause and effect are exceptually complex and the situation is not well understood.

2) Nutrient loading is steadily increasing. The population of North Carolina is growing--we are among one of the faster growing populations in the country. Moreover, much of that growth is occurring near the coast and in the Neuse/Pamlico Sound basin, which brings more loading downstream.

3) Coastal North Carolina is a unique environment. Pamlico Sound is a large, slowly moving, wind-mixed, shallow bowl where the water (and anything in it) sloshes back and forth driven more by the wind than by tidal influence, and flushes very slowly out to sea through narrow inlets.

In order to bring university academic scientists' attention to the issues, we have developed seven focus areas (in order of priority):

1) Circulation and Mixing--the coastal ecological system receives input from upstream point sources, watershed non-point sources, rainfall, exchange with Pamlico Sound and the ocean through barrier inlets, etc. It is fundamentally important to understand how and when circulation and mixing occurs.

2) Fisheries--the secondary productivity is the connection to public and private user groups and serves as a base for large economic returns. Fish kills, diseases and reductions in fishery yields all need to be understood in the context of the entire ecosystem.

3) Nutrient Inputs--the neuse is receiving nutrient inputs exceeding the assimilative capacity, leading to nuisance algal blooms and fish kills. We need to understand the linkages between nutrient loading and water quality impacts.

4) Land/Water Interactions--a large portion of loading in the Neuse has been attributed to non-point sources. We must be able to identify those sources and relate the inputs to land use activities.

5) Socio-Economic Impacts--a large portion of the economy of the central coastal area involves the natural resources provided by Pamlico Sound and related coastal waters. Whatever changes

may be exacted to improve water quality will need to be evaluated in the socio-economic context, and we need know the relative costs (both economically and socially) of those changes.

6) Sediments--the great storehouse of material inputs to the estuary lies in and attached to the sediments. Sediment movement, distribution and interaction with the water needs to be understood to evaluate the estuarine response to changes in loading.

7) Wetlands--the natural function of wetlands offers natural buffers to non-point source loading. We need to understand the variability and use of wetlands to reduce loading and to protect estuarine water quality.

LAND/WATER INTERACTIONS

Use of the land in the watersheds of coastal water bodies is closely related to the quality of waters receiving runoff from and percolation through the watershed. While several contaminants can result from land-use activities, those most implicated in coastal water quality are nitrogen and phosphorus. In much of coastal North Carolina, nutrient runoff derives from agricultural activities and urbanization.

Currently, there is considerable controversy about the relative sources of nutrients in coastal waters. Point sources are generally well identified, while non-point sources are much more elusive. Because nutrients are used, recycled and stored in various biological systems, it is not a simple totaling up the sources to determine the relative impact and level of nutrients when they are incorporated in coastal systems. Runoff and percolation of nutrients from coastal soils depends a great deal on seasonal differences, weather variability and land-use patterns. A better method of quantifying the sources of nutrients is needed to provide the base upon which better management can be developed. Watershed-wide assessments (perhaps a watershed nutrient model) are needed to determine impacts and interactions of land-use activities on coastal ecological systems.

There are a variety of "Best Management Practices" that, if used properly, can significantly reduce the downstream impacts of land-derived nutrient impacts. Many of these are soil-specific and/or geographically useable--making it impossible to implement statewide (or even basin-wide), simplified solutions. Nutrient management plans should be utilized for all land activities, with site-specific implementation plans. Some kind of auditing process is needed to evaluate the effectiveness of best management practices before and after implementation.

Recommendations:

1. Develop a workable watershed model to evaluate nutrient impact in coastal waters. Field edge models are currently available, but the connections to watersheds and coastal waters are not yet available.

2. Develop distribution of Best Management Practices in relation to land use, soil type and ecological variations. Practices should be fitted to use activities on a regional basis.

3. Workshop on types of land management useful to interaction with river basin changes and identify gaps in knowledge on reaching degrees of assessment of BMP's.

SEDIMENT AND GEOCHEMISTRY ISSUES

Estuarine sediments are integrally involved in coastal water quality. They are known to serve as a significant storage facility for nutrients and toxins and, during suspension, can impact water quality. In fact, several characteristics of sediments make them a pollutant:

1) Sediments alter bottom habitats through deposition and can smother benthic communities;

2) When suspended, sediments attenuate light, and increased turbidity levels affect primary productivity;

3) Sediments store toxins which are adsorbed onto the surfaces and absorbed within the particles;

4) Organic-rich sediments, which are common in estuaries, exert a biological oxygen demand (BOD) that can lead to anoxia; and

5) Sediments may serve as a bank for nutrients, releasing them into the water under certain biochemical conditions.

Many of the details of the role of sediments in coastal water quality are not well understood. For example, the exchange processes between water and sediment with appropriate time and spatial scales are relatively unknown--yet muddy sediments are known to be highly mobile. Storage and transport mechanisms are known to occur, but the rates and time scales are not known at the quantitative levels necessary for accurate predictions. It is thought that sediments act as a net storage for nutrients in the lower estuarine areas and act as an exchange medium upstream.

Technology is now available to assess the sources of nutrients in water and sediments, and to examine basic exchange processes. For example, isotope ratios of nitrogen in combination with other elements can be used to identify sources of nitrogenous compounds, and electronic sensors can detect major resuspension events.

Recommendations

1. Conduct an isotope analysis to determine the relative sources of nitrogen compounds in estuarine sediments and water. The ultimate study to make the necessary assessments will require at least 3 years, but useful preliminary information can be obtained in 6 months.

2. Develop a workshop to summarize the state of knowledge on sediment transport, storage and exchange functions and rates, and the interaction between water and sediments on coastal water quality. The result would be a report on synthesis of existing data and understanding.

3. Establish an information system to support data needs, storage and retrieval.

4. Establish a scientific advisory committee to evaluate various management schemes and recommend critical areas of research that should receive immediate support.

SOCIO-ECONOMIC ISSUES

Significant portions of the coastal (and, by extension, that of the state) economy and community well-being involves natural resources of the coastal zone. Tourism, for example, is over a $3 billion annual industry in the state; much of which is due to the quality of North Carolina's environmental resources, especially its coast. Activities that degrade, or otherwise affect the capacity of these resources to sustain continuing use, impose costs on the citizens of this state directly and indirectly. Since most coastal natural resources (e.g., water, fish, bottom, wetlands, etc) are public trust resources, their protection is the responsibility of all citizens.

Economic impacts are not confined to market transactions that directly involve products (e.g., fish) supported by these resources or the complementary resources like hotel and motel rental by tourists. They arise because coastal rivers, thriving estuarine resources and clean beaches are important to people. This importance translates into a willingness to allocate time and money to be sure they have access to resources that have these characteristics. Each of these decisions involves economic tradeoff. Changes in the resources can affect people in multiple ways, transforming their recreational choices, altering their livelihoods, even affecting their perceptions of the quality of seafood products from North Carolina. In these cases, all too frequently, perception is reality and decisions to purchase or visit rely on what people think will happen.

Because there are economic consequences attributable to all uses and to the results of all uses that affect water quality we must take them into account in considering the costs of controlling the nutrients that contribute to reducing water quality. Avoiding these losses is an economic benefit. It has monetary consequence in precisely the same terms as the costs imposed on farms and waste water treatment facilities required to control effluents more stringently. Since some level of water quality is related to all uses of coastal natural resources, we should be able to obtain reasonable estimates of relative costs of various policy and management alternatives and to attach estimates of the benefits based on what people are "willing to pay" for the actions they provide. The difficulty lies in relating, in a quantitative way, the relationships between water quality and subsequent resource use and the consequences of alternative ways to reduce water quality impacts.

Socio-economic impact assessment must go beyond estimation of changes in the flow of dollars resulting from different policy and management alternatives. Impact assessment can recognize the existence of different dependent communities of people, communities

which have social, cultural and economic characteristics that are amenable to description and inclusion in impact assessment models. Some are communities of people whose behavior affect resources, while others are communities of people whose perceptions and behaviors are affected by changes in the resources. All of these perceptions and behaviors are measurable by various assessment processes.

Recommendations:

1. Determine the costs of alternative ways to reduce nutrient inputs to coastal waters; including impact assessment for the activities dependent on the affected resources.

2. Evaluate benefits of water quality improvements, including use (e.g., commercial or recreational fishing) and non-use (e.g., aesthetics) benefits as well as the values due to marginal changes in health (or the perception of well-being). While these values are not amenable to exact monetization, they are nonetheless subject to estimation in qualitative terms. A scientific panel could be established to oversee the exercise.

3. Establish the total economic and social importance of direct resource uses, such as tourism, fisheries, etc., to the North Carolina economy.

4. Evaluate the economic and social benefits of policy and management implementation, including the public perception that policy and management listens to the people.

Senate Select Committee

River Water Quality and Fish Kills

Background and Recommendations of the Wetlands Focus Group

Background

1. Can wetlands improve River Water Quality and reduce the likelihood of Fish Kills?

Yes, wetlands can have a direct effect on river water quality by removing sediment, oxygen consuming organic matter and plant nutrient chemicals (i.e., compounds containing nitrogen and phosphorous) from runoff water before it gets into the rivers.

Wetlands can have an indirect effect on fish kills by reducing the amount of oxygen consuming matter in runoff, thereby reducing the frequency and intensity of fish-killing low oxygen conditions in rivers. Wetlands can also reduce the load of plant nutrients entering rivers, thereby limiting the extent and intensity of fish-killing algal growth.

2. Are all wetlands equally important in reducing the input of water quality degrading materials from rivers?

No. The wetlands that are most effective at reducing sediment and nutrient input to rivers are those closest to streams and creeks, i.e., streamside riparian wetlands that are hydrologically contiguous to small water courses. These wetlands are known to be capable of removing over 90% of the sediment and sediment-related pollutants that would otherwise reach streams in runoff. They also can reduce nitrates by over 90%. The sediments removed from surface runoff are incorporated into the wetland soils, the nitrate is largely converted to nitrogen gas by bacteria that flourish in the moist, organic-rich wetland soil. This nitrogen gas is lost into the air which is already 80% nitrogen gas. It is the opinion of the wetlands focus group that streamside riparian wetlands are the single most important type of wetland in controlling nonpoint source pollution in North Carolina.

3. Do streamside riparian wetlands offer the only means to improve water quality and reduce fish kills?

No. While streamside riparian wetlands are the most effective wetland type in reducing nonpoint sources of pollution, there are additional ways to improve the overall situation:

a) The best way would be to reduce the sources of nitrogen and phosphorus at their source. Reductions in nonpoint sources using best management practices in farming and forestry are helpful. Reductions in point sources would also help. Both of these can reduce the chance that river water quality conditions will fall below acceptable thresholds for public use.

b) Once degraded water quality arrives in estuaries, it may still be possible to remove some important pollutants. Oyster reefs have the capacity to do so. A single adult oyster can filter almost all of the sediment and algae suspended in up to 2.5 gallons of water during each hour of feeding. Oyster reefs commonly have 15,000 oysters per square yard. Functioning oyster reefs have an observable effect on reducing suspended sediment concentrations in estuaries. Oysters are also among the estuarine organisms least susceptable to being killed by the toxic algae (*Pfisteria*) that was responsible for fish kills in the Neuse River in 1995.

Recommendations

1. North Carolina should find a way to protect, preserve, and restore streamside riparian wetlands.

Supplemental information:

The Wetlands Focus Group estimates that these wetlands comprise less than 10% of those east of I-95. Several wetland types, especially salt marshes, are already protected by coastal area management and wetland statutes. Those that may need further protection to preserve their role in maintaining river water quality include: 1, riparian zones of headwater streams; 2, coastal plain levee forest; 3, streamside coastal plain bottomland hardwoods; and 4, coastal plain streamside swamp and swamp forest (Cypress-Gum, small stream types). State supported projects to map these, and other, wetland types are currently underway in the N.C. Center for Geographic Information and Analysis (GCIA) and the Division of Coastal Management (DCM). Efforts to develop a wetlands rating system, wetland water quality standards, wetland permit tracking system, identification of outstanding resource wetlands, and a wetland restoration and enhancement program are underway in the Division of Environmental Management (DEM). Thus, the technologies already exist to identify riparian wetland resources and administrative structures are available to manage them.

2. North Carolina should fund a wetland workshop comparable to that that resulted in the report entitled "Water Quality Functions of the Riparian Forest Buffer Systems in the Chesapeake Bay Watershed." This workshop should bring together state agency staff from DCM, DEM, GCIA, Natural Heritage Program, and academic scientists. This group should discuss and identify specific wetlands of unusual value in maintaining riverine water quality and develop criteria for their identification as part of a Riparian Forest Buffer System for North Carolina.

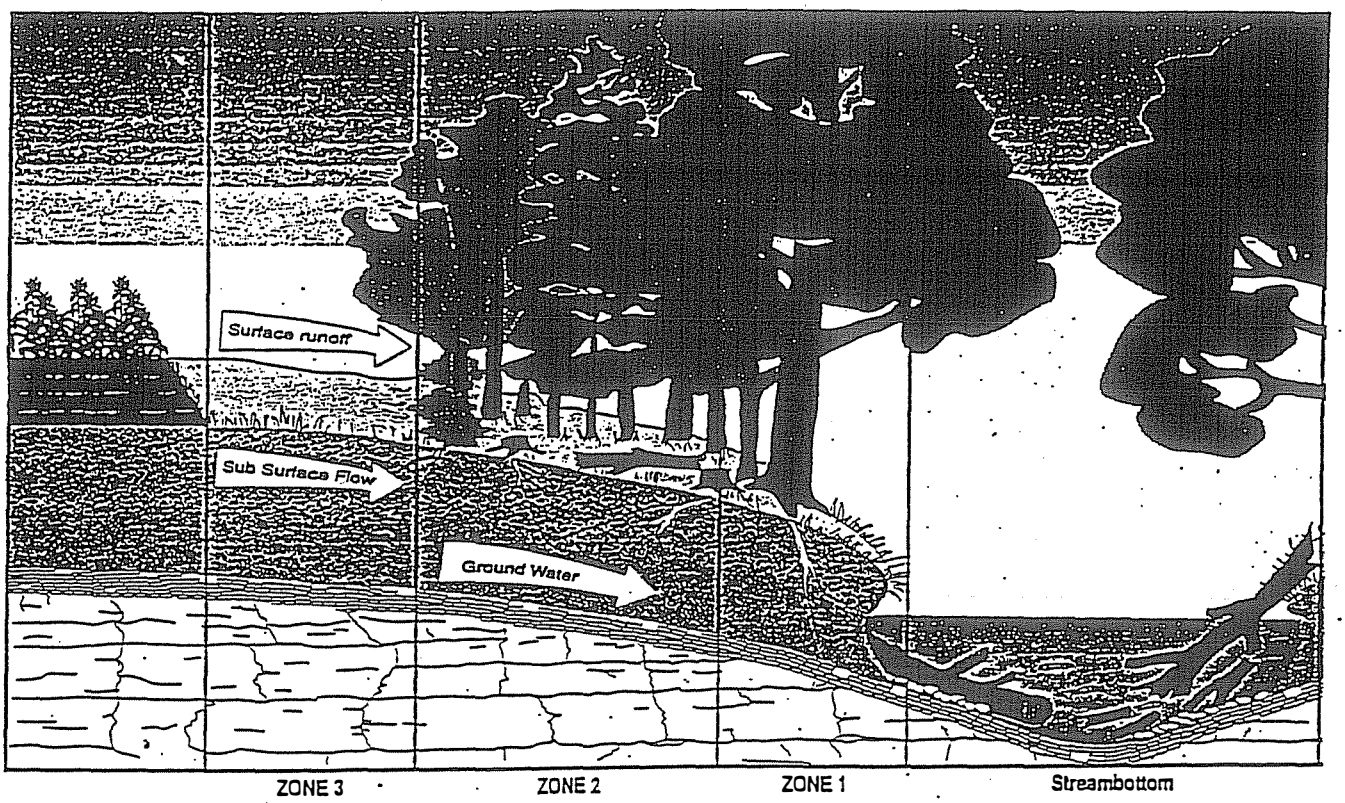
Supplemental information:

The Wetlands Focus Group estimates that the recommended workshop could be held at a cost of about $75,000 for travel, per diem, consultants and report preparation. We estimate the report could be available 6 to 9 months after funding is available for it. The workshop is needed to thoroughly review existing data on water quality preservation of specific riparian forest types in North Carolina, determine the extent of such systems that should be included in any Riparian Forest Buffer System, and develop a program for identifying and mapping these areas.

3. North Carolina should arrange for the DMF oyster habitat enhancement program to direct part of its effort towards building oyster reefs in the upper Neuse River estuary. The purpose of these reefs would be to enhance riverine water quality by providing natural filtration and algae reduction systems within the section of river most adversely impacted by toxic algal blooms in 1995.

Wetlands Focus Group Members:

Norman Christenson, Professor of Ecology, Duke University
Mark Brinson, Professor of Biology, East Carolina University
Dirk Frankenberg, Professor of Marine Sciences, UNC at Chapel Hill
R. Wayne Skaggs, Professor of Biological and Agricultural Engineering, North Carolina State University



Schematic Drawing of a Riparian Forest Buffer System (RFBS)
(from "Water Quality Functions of a Riparian Forest Buffer System in the Chesapeake Bay Watershed, EPA 903-R-95-004, pg. 6)

Zone 3: A grassy or herbaceous strip of land between field and forest. It functions to remove coarse sediment (sand) and sediment-related pollution and to spread funoff flows into shallow sheets before they enter Zone 2.

Zone 2: A forest strip that can be managed to enhance runoff water quality. It functions to remove fine sediment (silts and clays) and store and/or transform nutrients and pollutants that could harm the undisturbed forest of Zone 1 and the quality of water in the stream beyond. Research shows that forested strips in which most subsurface water flows through or near the root zone store excess nitrate in tree wood or convert it, through microbial action, into gaseous Nitrogen. Zone 2 forests can be managed to maximize the removal of materials that would otherwise degrade water quality in streams and rivers.

Zone 1: An undisturbed streamside forest. It functions to stabilize the stream bank from erosion, as well as to remove and convert the sediments, nutrients and pollutants that may move through Zone 2. Zone 1 vegetation also controls the stream environment by altering light quality, reducing water temperature variations, increasing habitat diversity, and providing food through leaves and litter.

Coastal Water Quality and Nutrient Impacts

A Summary of the Issues, Current State of Knowledge, Informational and Management Needs

Presented by the Focus Group on Nutrients and Water Quality

30 January, 1996

The Problem: The Neuse River Estuary, A Microcosm of North Carolina Estuarine and Coastal Nutrient-Driven Eutrophication

The Neuse River typifies hydrologically and nutrient sensitive estuaries of North Carolina. This system, a tributary of the Albemarle-Pamlico Estuarine Complex, is ringed by the Outer Banks and water exchange with the Atlantic Ocean is constrained by narrow inlets. Compared to other estuaries, the lower Neuse has a lengthy water residence time and nutrients entering the system remain there for relatively long periods. In this shallow system, nutrients are effectively cycled between the water column and sediments, making them readily available for plant growth. The combination of hydrological and nutrient cycling characteristics make the Neuse estuary highly responsive to nutrient inputs and (under excessive nutrient loading) susceptible to the detrimental consequences of excessive nutrient loading such as nuisance algal blooms, hypoxia, and anoxia.

Nutrients are delivered to the estuary by water discharge from the Neuse River and it's tributaries, streams, rainfall, and groundwater. Annually, about 70% of nutrient input is from diffuse, non-point sources such as surface runoff, rainfall, and groundwater. Point sources, attributed to wastewater treatment plants, industrial, and municipal discharges, account for the remaining 30%. Seasonal changes in this ratio arise from variability in discharge rates and rainfall. The rate of Nitrogen (N) supply (loading) controls plant growth because N is the nutrient in shortest supply. Therefore, high N-loading rates promote high rates of plant production. When production exceeds consumption by animal grazers, plant matter (biomass) accumulates in the estuary. This imbalance has led to massive accumulations (blooms) of free-floating microscopic algal communities (phytoplankton) that result in green, yellow, or red water discolorations. Blooms are considered undesirable because they are malodorous, release toxins, foul waters and shorelines, and, perhaps most problematic, lead to oxygen depletion of affected waters.

Environmental constraints (temperature, nutrient depletion, light, etc.) eventually cause blooms to die. In poorly-flushed systems such as the Neuse, dying blooms sink to the bottom where bacterial decomposition consumes large amounts of oxygen. If

decaying blooms are large enough and bottom water oxygen cannot be replenished by downward mixing of oxygenated surface waters, bottom waters and sediments can exhibit dangerously low (to both animal and plant life) oxygen levels (hypoxia) or a complete loss of oxygen (anoxia). Hypoxia and anoxia events have been linked to fish kills in reservoirs, golf course lagoons, small ponds, etc. Persistent periods of calm winds and large amounts of low density freshwater "sandwiched" over a denser, deeper saltwater layer (i.e., "salt wedge") are impediments to effective vertical mixing. If persistent (weeks to months), these stagnant conditions enhance the likelihood of hypoxia/anoxia.

In moderate to highly productive estuaries like the Neuse, hypoxia and (to a lesser extent) anoxia are natural occurrences. Historical accounts of "bad water," or anoxic water with a "rotten egg" sulfide smell, are common for the Neuse. This situation can, however, be aggravated by excessive N-loading that leads to enhanced algal growth, bloom formation, and increased potential for hypoxia/anoxia development and persistence. In this regard, there is ample evidence that accelerated manmade nutrient (including N) loading has exacerbated this unwanted condition. A "worst case" scenario for systems like the Neuse is an unusually large amount of N-enriched freshwater discharge into the broad, slow-flowing lower estuary that coincides with optimal algal growth and bloom periods (spring - summer). These conditions promote the maximum potentials for hypoxia/anoxia and subsequent extensive fish kills. This describes the chain of events during the summer and early fall of 1995, and forms the basis for addressing the problem of nutrient (specifically N) overenrichment of this and other North Carolina estuaries.

Nutrient Impacts on Water Quality in the Neuse River estuary: What do We Know?

✓ **Algal production is primarily controlled (limited) by nitrogen (N) availability. Phosphorus (P) plays a secondary role. Increased watershed N and P loading over the past 3 decades have led to enhanced primary production, or eutrophication. Excessive eutrophication, as expanding algal blooms, can promote oxygen depletion (hypoxia/anoxia), cause toxicity and negatively impact fish food supply and habitats**

✓ **Frequencies and areal extent of harmful freshwater blue-green algal and brackish "red tide" dinoflagellate blooms have increased in the past 20 years**

✓ **N loading reductions will slow eutrophication. In the river > 30% reduction will be needed. In the estuary at least a 30% cutback is needed, but more research is needed to establish effective, long-term reduction levels. Approximately 70% of annual N inputs are non-point, with the remainder point sources. P input constraints are also needed; some of these will be achieved once we target N (similar sources)**

✓ Nutrient loading, hydrology and water clarity interact to determine eutrophication. Since hydrology (e.g. rainfall/runoff) is not controllable, nutrient input control is the ONLY management option

✓ The system has stored (in sediments) at least 3 decades of elevated nutrient loading. It must be purged of excess nutrients. Nutrient input constraints may take from 5-10 years to achieve significant, long-term improvement of water quality. This underscores the urgency of implementing a nutrient management strategy

Research and Management Recommendations

✓ Seasonally, annually and interannually, identify sources and fates of dominant nutrient inputs critical to the eutrophication process

✓ Spatial distribution and timing (seasonality) of nutrient inputs govern algal production and blooms. Management strategies must address annual nutrient inputs, seasonality, interannual hydrological and nutrient discharge variability

✓ Determine nutrient loading trends during the past 3 decades in relation to eutrophication

✓ Initiate synoptic assessments of responses by the ecosystem to nutrient loading events

✓ Clarify seasonal interactions of nutrients with other environmental factors (e.g. light, temperature) known to mediate algal production and blooms

✓ Understand the role sediment-water column interactions play in mediating nutrient availability and the role the bottom plays in storing and cycling nutrients

✓ Based on the above information, determine effective and attainable nutrient loading reductions among key sources, capable of slowing eutrophication and reducing harmul blooms to levels deemed acceptable

✓ Develop a predictive, process-oriented water quality model, based on the interactions of hydrology, nutrient and algal production dynamics. The model should incorporate historical trends and relationships of these parameters, continued intensive monitoring and experimental verification

The Roles of Nutrient Concentrations vs. Loadings in Assessing and Managing Estuarine Water Quality

Nutrient *concentrations* (amount of a nutrient per unit volume of water) and *loading* (rate at which nutrients are supplied to a water body) are commonly used to assess water quality of lakes rivers and estuaries. Both measurements merit consideration; however, they cannot be used synonymously and should not be confused. Nutrient *concentrations* are instantaneous measurements and can vary in time and space in the estuary, depending on nutrient input and output rates, river flow, biological utilization and cycling. Nutrient loading rate is the actual amount of that nutrient entering a system in a given period of time. When nutrient loading rate is multiplied by a specific period of time (weeks to years), then this value is referred to as nutrient *loading*, representing the total amount of a nutrient added over a given time interval.

Nitrogen (N), the nutrient controlling algal production in the Neuse estuary, provides a useful illustration. If we consider N as the "currency" of estuarine productivity, monthly measurements of *concentration* are like examining what is left of one's paycheck at the end of the month to determine N income. It has little bearing on events that may have taken place in the interim (over- or underspending N). In terms of the estuary's ability to respond to N inputs with algal blooms and associated water quality degradation, monthly (or sometimes even weekly) measures of N *concentration* yield little useful information. This is because, during its transit through an estuary, N is biologically and chemically exchanged and cycled between the water column, suspended and bottoms sediments. The "net" N *concentration* that results from these interacting processes represents the "residual" portion of available N, rather than that portion of the load which was used to support algal growth (Fig. 1)

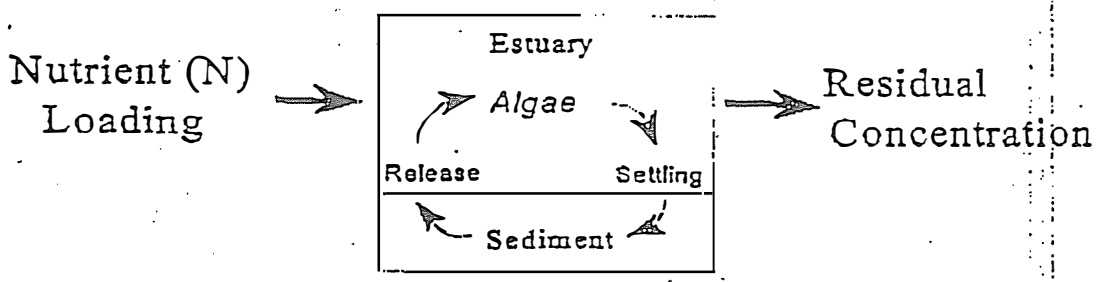


Figure 1. Nutrient (N) processing in estuaries

Consider:

- During the catastrophic hypoxia/anoxia-driven fish kills of 1995, the system did not reveal unusually-elevated N *concentrations*, even though algal production was 2-3 times "normal". On the other hand, N *loading* during the same time period was clearly above "normal", and proved to be a more useful predictor of the summer algal blooms which plagued the river, following periods of high rainfall and runoff.

- In contrast, the summer of 1994 proved to be relatively dry, resulting in lower (than 1995) levels of N discharge in the river during the bloom-sensitive summer months. Spring and summer N *concentrations* at estuarine locations known to support blooms, however, were not strikingly different between the two years.

- The N that is used in algal blooms does not disappear from the estuary when the algae die. Some N may be "lost" as atmospheric nitrogen gas via denitrification, a process requiring quantification, but a large portion can be stored in the sediments as decaying organic material, and later recycled. Sediment can thus serve as a nutrient "bank", thereby providing a built-in memory of past loading events.

- Unfortunately we do not know the time and spatial scales of nutrient exchange between the water column and bottom (contributions and withdrawals from the "bank"), but we do know that when organic matter decays it consumes oxygen and contributes to hypoxia and anoxia.

- The use of *loading* criteria provides a constant reminder that there is a limit to the estuary's capacity to assimilate our waste, and therefre a limit to the density of humans, animals, or other nutrient sources that can be placed in the watershed. The temptation to invoke dilution as a solution to pollution, and to waste freshwater, will be avoided.

Appendix II

North Carolina General Assembly Session Laws 1995, Section 572

GENERAL ASSEMBLY OF NORTH CAROLINA
1995 SESSION
RATIFIED BILL

CHAPTER 572
HOUSE BILL 1339

AN ACT TO IMPROVE WATER QUALITY BY ESTABLISHING A GOAL TO REDUCE THE AVERAGE LOAD OF NITROGEN DELIVERED TO THE NEUSE RIVER ESTUARY FROM POINT AND NONPOINT SOURCES BY A MINIMUM OF THIRTY PERCENT OF THE AVERAGE ANNUAL LOAD FOR THE PERIOD 1991 THROUGH 1995 BY THE YEAR 2001 AND TO REQUIRE THE ENVIRONMENTAL MANAGEMENT COMMISSION TO DEVELOP A PLAN TO ACHIEVE THIS GOAL, AS RECOMMENDED BY THE ENVIRONMENTAL REVIEW COMMISSION.

The General Assembly of North Carolina enacts:

Section 1. The General Assembly hereby determines that it should be the goal of this State to reduce the average annual load of nitrogen delivered to the Neuse River Estuary from point and nonpoint sources by a minimum of thirty percent (30%) of the average annual load for the period 1991 through 1995 by the year 2001 and any further reductions that may be achieved to protect water quality, with incremental progress demonstrated each year. The Environmental Management Commission shall develop and adopt a plan to achieve this goal. In developing this plan, the Commission shall determine and allow appropriate credit toward achieving this goal for reductions of water pollution by point and nonpoint sources through voluntary measures.

Sec. 2. The Commission shall publish a proposed plan to achieve the goal established by this act in the North Carolina Register by 1 November 1996. The Commission shall adopt the plan as provided in Article 2A of Chapter 150B of the General Statutes.

Sec. 3. The Environmental Management Commission shall annually report to the Environmental Review Commission as to its progress in developing and adopting the plan required by this act and as to progress in implementing the plan and achieving the goal established by this act. The Environmental Management Commission shall make its initial report to the Environmental Review Commission on or before 1 November 1996.

Sec. 4. The Commission may adopt temporary rules to implement the provisions of this act.

Sec. 5. This act is effective upon ratification.

In the General Assembly read three times and ratified this the 19th day of June, 1996.

Appendix III

NSW Rules Adopted by the EMC to Control Total Nitrogen Loading in the Neuse River Basin

On December 11, 1997, the North Carolina Environmental Management Commission adopted changes to the following rule to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. This rule was approved by the Rules Review Commission on January 15, 1998 and became effective August 1, 1998. The Rules Review Commission retained the objection on the definition for "wetlands," (#71).

15A NCAC 2B.0202 has been amended with changes as published in 12:6 NCR 462-479 as follows:

.0202 DEFINITIONS

The definition of any word or phrase used in this Section shall be the same as given in Article 21, Chapter 143 of the General Statutes of North Carolina. The following words and phrases, which are not defined in this article, shall be interpreted as follows:

(1) Acute toxicity to aquatic life means lethality or other harmful effects sustained by either resident aquatic populations or indicator species used as test organisms in a controlled toxicity test due to a short-term exposure (relative to the life cycle of the organism) to a specific chemical or mixture of chemicals (as in an effluent). Short-term exposure for acute tests is generally 96 hours or less. Acute toxicity shall be determined using the following procedures:
   (a) for specific chemical constituents or compounds, acceptable levels shall be equivalent to a concentration of one-half or less of the Final Acute Value (FAV) as determined according to "Guidelines for Deriving Numerical Water Quality Criteria for the Protection of Aquatic Life and its Uses" published by the Environmental Protection Agency and referenced in the Federal Register (50 FR 30784, July 29, 1985) which is hereby incorporated by reference including any subsequent amendments.
   (b) for specific chemical constituents or compounds for which values described under Subparagraph (1)(a) of this Rule can not be determined, acceptable levels shall be equivalent to a concentration of one-third or less of the lowest available LC50 value.
   (c) for effluents, acceptable levels are defined as no statistically measurable lethality (99 percent confidence level using Students t test) during a specified exposure period. Concentrations of exposure shall be determined on a case-by-case basis.
   (d) in instances where detailed dose response data indicate that levels of acute toxicity are significantly different from those defined in this Rule, the Director may determine on a case-by-case basis an alternate acceptable level through statistical analyses of the dose response curve.

(2) Acute to Chronic Ratio (ACR) means the ratio of acute toxicity expressed as an LC50 for a specific toxicant or an effluent to the chronic value for the same toxicant or effluent.

(3) Agricultural uses include the use of waters for stock watering, irrigation, and other farm purposes.

(4) Applicator means any person, firm, corporation, wholesaler, retailer, distributor, any local, state, or federal governmental agency, or any other person who applies fertilizer to the land of a consumer or client or to land they own or to land which they lease or otherwise hold rights.

(5) Approved treatment, as applied to water supplies, means treatment accepted as satisfactory by the Division of Environmental Health or Division of Water Quality.

(6) Average (except bacterial) means arithmetical average and includes the analytical results of all samples taken during the specified period; all sampling shall be done as to obtain the most representative sample under prevailing conditions:
   (a) Daily Average for dissolved oxygen, shall be of at least four samples;
   (b) Weekly Average means the average of all daily composite samples obtained during the calendar week. If only one grab sample is taken each day, the weekly average is the average of all daily grab samples. A minimum of three daily grab samples is needed to calculate a weekly average.
   (c) Monthly Average means the average of all daily composites (or grab samples if only one per day) obtained during the calendar month.

   The definitions in this Paragraph do not affect the monitoring requirements for NPDES permits but rather shall be used by the Division along with other methodologies in determining violations of water quality standards. Arithmetical averages as defined by this Section, and not confidence

limits nor other statistical descriptions, shall be used in all calculations of limitations which require the use of averages pursuant to this Section and 40 CFR 122.41(l)(4)(iii).

(7) Best Management Practice (BMP) means a structural or nonstructural management-based practice used singularly or in combination to reduce nonpoint source inputs to receiving waters in order to achieve water quality protection goals.

(8) Best usage of waters as specified for each class means those uses as determined by the Environmental Management Commission in accordance with the provisions of G.S. 143-214.1.

(9) Bioaccumulation factor (BAF) is a unitless value that describes the degree to which substances are taken up or accumulated into tissues of aquatic organisms from water directly and from food or other ingested materials containing the accumulated substances, and is usually measured as a ratio of a substance's concentration in tissue versus its concentration in water in situations where exposure to the substance is occurring from both water and the food chain.

(10) Bioconcentration factor (BCF) is a unitless value that describes the degree to which substances are absorbed or concentrated into tissues of aquatic organisms from water directly and is usually measured as a ratio of substance's concentration in tissue versus its concentration in water in situations where exposure to the substance is occurring from water only.

(11) Biological integrity means the ability of an aquatic ecosystem to support and maintain a balanced and indigenous community of organisms having species composition, diversity, population densities and functional organization similar to that of reference conditions.

(12) Buffer means a natural or vegetated area through which stormwater runoff flows in a diffuse manner so that the runoff does not become channelized and which provides for infiltration of the runoff and filtering of pollutants. The buffer shall be measured landward from the normal pool elevation of impounded structures and from the bank of each side of streams or rivers.

(13) Built-upon area means that portion of a development project that is covered by impervious or partially impervious cover including buildings, pavement, gravel areas (e.g. roads, parking lots, paths), recreation facilities (e.g. tennis courts), etc. (Note: Wooden slatted decks and the water area of a swimming pool are considered pervious.)

(14) Chronic toxicity to aquatic life means any harmful effect sustained by either resident aquatic populations or indicator species used as test organisms in a controlled toxicity test due to long-term exposure (relative to the life cycle of the organism) or exposure during a substantial portion of the duration of a sensitive period of the life cycle to a specific chemical substance or mixture of chemicals (as in an effluent). In absence of extended periods of exposure, early life stage or reproductive toxicity tests may be used to define chronic impacts.

(15) Chronic value for aquatic life means the geometric mean of two concentrations identified in a controlled toxicity test as the No Observable Effect Concentration (NOEC) and the Lowest Observable Effect Concentration (LOEC).

(16) Cluster development means the grouping of buildings in order to conserve land resources and provide for innovation in the design of the project including minimizing stormwater runoff impacts. This term includes nonresidential development as well as single-family residential and multi-family developments. For the purpose of Sections .0100, .0200 and .0300 of this Subchapter, planned unit developments and mixed use development shall be considered as cluster development.

(17) Commercial applicator means any person, firm, corporation, wholesaler, retailer, distributor or any other person who for hire or compensation applies fertilizer to the land of a consumer or client.

(18) Concentrations are the mass of a substance per volume of water and for the purposes of this Section shall be expressed as milligrams per liter (mg/l), micrograms per liter (ug/l), or nanograms per liter (ng/l).

(19) Contiguous refers to those wetlands landward of the mean high water line or normal water level and within 575 feet of classified surface waters which appear as solid blue lines on the most recently published versions of U.S.G.S. 1:24,000 (7.5 minute) scale topographic maps.

(20) Critical area means the area adjacent to a water supply intake or reservoir where risk associated with pollution is greater than from the remaining portions of the watershed. The critical area is defined as extending either ½ mile from the normal pool elevation of the reservoir in which the intake is located or to the ridge line of the watershed (whichever comes first); or ½ mile upstream

from and draining to the intake (or other appropriate downstream location associated with the water supply) located directly in the stream or river (run-of-the-river), or to the ridge line of the watershed (whichever comes first). Since WS-I watersheds are essentially undeveloped, establishment of a critical area is not required. Local governments may extend the critical area as needed. Major landmarks such as highways or property lines may be used to delineate the outer boundary of the critical area if these landmarks are immediately adjacent to the appropriate outer boundary of ½ mile. The Commission may adopt a different critical area size during the reclassification process.

(21) Cropland means agricultural land that is not covered by a certified animal waste management plan and is used for growing corn, grains, oilseed crops, cotton, forages, tobacco, beans, or other vegetables or fruits.

(22) Designated Nonpoint Source Agency means those agencies specified by the Governor in the North Carolina Nonpoint Source Management Program, as approved by the Environmental Protection Agency.

(23) Development means any land disturbing activity which adds to or changes the amount of impervious or partially impervious cover on a land area or which otherwise decreases the infiltration of precipitation into the soil.

(24) Director means the Director of the Division of Water Quality.

(25) Discharge is the addition of any man-induced waste effluent either directly or indirectly to state surface waters.

(26) Division means the Division of Water Quality or its successors.

(27) Domestic wastewater discharge means the discharge of sewage, non-process industrial wastewater, other domestic wastewater or any combination of these items. Domestic wastewater includes, but is not limited to, liquid waste generated by domestic water using fixtures and appliances, from any residence, place of business, or place of public assembly even if it contains no sewage. Examples of domestic wastewater include once-through non-contact cooling water, seafood packing facility discharges and wastewater from restaurants.

(28) Effluent channel means a discernable confined and discrete conveyance which is used for transporting treated wastewater to a receiving stream or other body of water as provided in Rule .0215 of this Section.

(29) Existing development, for projects that do not require a state permit, shall be defined as those projects that are built or those projects that at a minimum have established a vested right under North Carolina zoning law as of the effective date of the local government water supply ordinance, or such earlier time that an affected local government's ordinances shall specify, based on at least one of the following criteria:

(a) substantial expenditures of resources (time, labor, money) based on a good faith reliance upon having received a valid local government approval to proceed with the project, or

(b) having an outstanding valid building permit in compliance with G.S. 153A-344.1 or G.S. 160A-385.1, or

(c) having an approved site specific or phased development plan in compliance with G.S. 153A-344.1 or G.S. 160A-385.1.

For projects that require a state permit, such as landfills, NPDES wastewater discharges, land application of residuals and road construction activities, existing development shall be defined as those projects that are built or those projects for which a state permit was issued prior to August 3, 1992.

(30) Existing uses mean uses actually attained in the water body, in a significant and not incidental manner, on or after November 28, 1975, whether or not they are included in the water quality standards, which either have been actually available to the public or are uses deemed attainable by the Environmental Management Commission. At a minimum, uses shall be deemed attainable if they can be achieved by the imposition of effluent limits and cost-effective and reasonable best management practices (BMPs) for nonpoint source control.

(31) Family subdivision means a division of a tract of land:

(a) to convey the resulting parcels, with the exception of parcels retained by the grantor, to a relative or relatives as a gift or for nominal consideration, but only if no more than one parcel is conveyed by the grantor from the tract to any one relative; or

(b) to divide land from a common ancestor among tenants in common, all of whom inherited by intestacy or by will.

(32) Fertilizer means any substance containing nitrogen or phosphorus which is used primarily for its plant food content.

(33) Fishing means the taking of fish by sport or commercial methods as well as the consumption of fish or shellfish or the propagation of fish and such other aquatic life as is necessary to provide a suitable environment for fish.

(34) Forest vegetation means the plants of an area which grow together in disturbed or undisturbed conditions in various wooded plant communities in any combination of trees, saplings, shrubs, vines and herbaceous plants. This includes mature and successional forests as well as cutover stands.

(35) Freshwater means all waters that under natural conditions would have a chloride ion content of 500 mg/l or less.

(36) Industrial discharge means the discharge of industrial process treated wastewater or wastewater other than sewage. Stormwater shall not be considered to be an industrial wastewater unless it is contaminated with industrial wastewater. Industrial discharge includes:

(a) wastewater resulting from any process of industry or manufacture, or from the development of any natural resource;

(b) wastewater resulting from processes of trade or business, including wastewater from laundromats and car washes, but not wastewater from restaurants; or

(c) wastewater discharged from a municipal wastewater treatment plant requiring a pretreatment program.

(37) Land-disturbing activity means any use of the land that results in a change in the natural cover or topography that may cause or contribute to sedimentation.

(38) LC50 means that concentration of a toxic substance which is lethal (or immobilizing, if appropriate) to 50 percent of the organisms tested during a specified exposure period. The LC50 concentration for toxic materials shall be determined for sensitive species as defined by Subparagraph (43) of this Rule under aquatic conditions characteristic of the receiving waters.

(39) Local government means a city or county in singular or plural as defined in G.S. 160A-1(2) and G.S. 158A-10.

(40) Lower piedmont and coastal plain waters mean those waters of the Catawba River Basin below Lookout Shoals Dam; the Yadkin River Basin below the junction of the Forsyth, Yadkin, and Davie County lines; and all of the waters of Cape Fear, Lumber, Roanoke, Neuse, Tar-Pamlico, Chowan, Pasquotank, and White Oak River Basins; except tidal salt waters which are assigned S classifications.

(41) MF is an abbreviation for the membrane filter procedure for bacteriological analysis.

(42) Major variance means a variance from the minimum statewide watershed protection rules that results in the relaxation, by a factor greater than five percent of any buffer, density or built-upon area requirement under the high density option; any variation in the design, maintenance or operation requirements of a wet detention pond or other approved stormwater management system; or relaxation by a factor greater than 10 percent, of any management requirement under the low density option.

(43) Minor variance means a variance from the minimum statewide watershed protection rules that results in a relaxation, by a factor of up to five percent of any buffer, density or built-upon area requirement under the high density option; or that results in a relaxation by a factor up to 10 percent, of any management requirement under the low density option.

(44) Mixing zone means a region of the receiving water in the vicinity of a discharge within which dispersion and dilution of constituents in the discharge occurs and such zones shall be subject to conditions established in accordance with 15A NCAC 2B .0204(b).

(45) Mountain and upper piedmont waters mean all of the waters of the Hiwassee; Little Tennessee, including the Savannah River drainage area; French Broad; Broad; New; and Watauga River Basins; and those portions of the Catawba River Basin above Lookout Shoals Dam and the Yadkin River Basin above the junction of the Forsyth, Yadkin, and Davie County lines.

(46) Nonconforming lot of record means a lot described by a plat or a deed that was recorded prior to the effective date of local watershed regulations (or their amendments) that does not meet the minimum lot-size or other development requirements of Rule .0211 of this Subchapter.

(47) Nonpoint source pollution means pollution which enters waters mainly as a result of precipitation and subsequent runoff from lands which have been disturbed by man's activities and includes all sources of water pollution which are not required to have a permit in accordance with G.S. 143-215.1(c).

(48) Non-process discharge means industrial effluent not directly resulting from the manufacturing process. An example would be non-contact cooling water from a compressor.

(49) Nutrient sensitive waters mean those waters which are so designated in the classification schedule in order to limit the discharge of nutrients (usually nitrogen and phosphorus). They are designated by "NSW" following the water classification.

(50) Offensive condition means any condition or conditions resulting from the presence of sewage, industrial wastes or other wastes within the waters of the state or along the shorelines thereof which shall either directly or indirectly cause foul or noxious odors, unsightly conditions, or breeding of abnormally large quantities of mosquitoes or other insect pests, or shall damage private or public water supplies or other structures, result in the development of gases which destroy or damage surrounding property, herbage or grasses, or which may cause the impairment of taste, such as from fish flesh tainting, or affect the health of any person residing or working in the area.

(51) Primary Nursery Areas (PNAs) are tidal saltwaters which provide essential habitat for the early development of commercially important fish and shellfish and are so designated by the Marine Fisheries Commission.

(52) Primary recreation includes swimming, skin diving, skiing, and similar uses involving human body contact with water where such activities take place in an organized or on a frequent basis.

(53) Protected area means the area adjoining and upstream of the critical area in a WS-IV water supply in which protection measures are required. The boundaries of the protected areas are defined as within five miles of the normal pool elevation of the reservoir and draining to water supply reservoirs (measured from the normal pool elevation) or to the ridge line of the watershed (whichever comes first); or 10 miles upstream and draining to the intake located directly in the stream or river (run-of-the-river), or to the ridge line of the watershed (whichever comes first). Local governments may extend the protected area. Major landmarks such as highways or property lines may be used to delineate the outer boundary of the protected area if these landmarks are immediately adjacent to the appropriate outer boundary of five or 10 miles. In some cases the protected area shall encompass the entire watershed. The Commission may adopt a different protected area size during the reclassification process.

(54) Residential development means buildings for residence such as attached and detached single family dwellings, apartment complexes, condominiums, townhouses, cottages, and their associated outbuildings such as garages, storage buildings, and gazebos.

(55) Residuals means any solid or demisolid waste generated from a wastewater treatment plant, water treatment plant or air pollution control facility permitted under the authority of the Environmental Management Commission.

(56) Riparian area means an area that is adjacent to a body of water.

(57) Secondary recreation includes wading, boating, other uses not involving human body contact with water, and activities involving human body contact with water where such activities take place on an infrequent, unorganized, or incidental basis.

(58) Sensitive species for aquatic toxicity testing is any species utilized in procedures accepted by the Commission or its designee in accordance with Rule .0103 of this Subchapter, or the following genera:

(a) Daphnia;
(b) Ceriodaphnia;
(c) Salmo;
(d) Pimephales;
(e) Mysidopsis;
(f) Champia;

(g) Cyprinodon;
(h) Arbacia;
(i) Penaeus;
(j) Menidia;
(k) Notropis;
(l) Salvelinus;
(m) Oncorhynchus;
(n) Selenastrum;
(o) Chironomus;
(p) Hyalella;
(q) Lumbriculus.

(59) Shellfish culture includes the use of waters for the propagation, storage and gathering of oysters, clams, and other shellfish for market purposes.

(60) Stormwater collection system means any conduit, pipe, channel, curb or gutter for the primary purpose of transporting (not treating) runoff. A stormwater collection system does not include vegetated swales, swales stabilized with armoring or alternative methods where natural topography prevents the use of vegetated swales (subject to case-by-case review), curb outlet systems or pipes used to carry drainage underneath built-upon surfaces that are associated with development controlled by the provisions of 15A NCAC 2H .1003(c)(1).

(61) Source of water supply for drinking, culinary or food-processing purposes means any source, either public or private, the waters from which are used for human consumption, or used in connection with the processing of milk, beverages, food, or other purpose which requires water suitable for human consumption.

(62) Swamp waters mean those waters which are classified by the Environmental Management Commission and which are topographically located so as to generally have very low velocities and other characteristics which are different from adjacent streams draining steeper topography. They are designated by "Sw" following the water classification.

(63) Tidal salt waters mean all tidal waters which are classified by the Environmental Management Commission which generally have a natural chloride ion content in excess of 500 parts per million and include all waters assigned S classifications.

(64) Toxic substance or toxicant means any substance or combination of substances (including disease-causing agents), which after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, has the potential to cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions or suppression in reproduction or growth) or physical deformities in such organisms or their offspring.

(65) Trout waters are those waters which have conditions which shall sustain and allow for trout propagation and survival of stocked trout on a year-round basis. These waters shall be classified by the Commission after considering the requirements of Rule .0101(b) and (c) of this Subchapter and include all waters designated by "Tr" in the water classification.

(66) Waste disposal includes the use of waters for disposal of sewage, industrial waste or other waste after approved treatment.

(67) Water dependent structures are those structures for which the use requires access or proximity to or siting within surface waters to fulfill its basic purpose, such as boat ramps, boat houses, docks and bulkheads. Ancillary facilities such as restaurants, outlets for boat supplies, parking lots and commercial boat storage areas are not water dependent structures.

(68) Water quality based effluent limits and best management practices are limitations or best management practices developed by the Division for the purpose of protecting water quality standards and best usage of surface waters consistent with the requirements of G.S. 143-214.1 and the Federal Water Pollution Control Act as amended.

(69) Waters with quality higher than the standards means all waters for which the determination of waste load allocations (pursuant to Rule .0206 of this Section) indicates that water quality is sufficiently greater than that defined by the standards such that significant pollutant loading capacity still exists in those waters.

(70) Watershed means the entire land area contributing surface drainage to a specific point. For the purpose of the water supply protection rules in 15A NCAC 2B .0104 and .0211 local governments may use major landmarks such as highways or property lines to delineate the outer boundary of the drainage area if these landmarks are immediately adjacent to the ridgeline.

(71) Wetlands are "waters" as defined by G.S. 143-212(6) and are areas that are inundated or saturated by an accumulation of surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. Wetlands classified as waters of the state are restricted to waters of the United States as defined by 33 CFR 328.3 and 40 CFR 230.3.

History Note: *Authority G. S. 143-214.1; 143-215.3(a)(1);*
Eff. February 1, 1996;
Amended Eff. August 1, 1995; February 1, 1993; August 3, 1992; August 1, 1990;
RRC objection Eff. July 18, 1996 due to lack of statutory authority and ambiguity;
Amended Eff. August 1, 1998; October 1, 1996.

On December 11, 1997, the North Carolina Environmental Management Commission adopted the following rule to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. The Rules Review Commission approved the rule at their February 19, 1998 meeting and it became effective August 1, 1998.

15A NCAC 2B .0232 has been adopted with changes as published 12:6 NCR 462-479 as follows:

.0232 NEUSE RIVER BASIN- NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: BASIN NUTRIENT REDUCTION GOAL

(a) Pursuant to 1995 (Reg. Sess., 1996) N.C. Session Laws, c. 572, the Environmental Management Commission hereby establishes the goal of reducing the average annual load of nitrogen delivered to the Neuse River Estuary from point and nonpoint sources by a minimum of 30 percent of the average annual load for the period 1991 through 1995 by the year 2001. All waters of the Neuse River Basin have been supplementally classified as Nutrient Sensitive Waters (NSW) pursuant to 15A NCAC 2B .0223. The following Rules are to be implemented in accordance with 15A NCAC 2B .0223 in all waters of the Neuse River Basin:

(1)Rule .0233 for protection and maintenance of riparian areas,
(2)Rule .0234 for wastewater discharges,
(3)Rule .0235 for urban stormwater management,
(4)Rules .0236 and .0238 for agricultural nitrogen reduction,
(5)Rule .0239 for nutrient management, and
(6)Rule .0240 for nitrogen offset fees.

(b) Failure to meet requirements of Rules .0233, .0234, .0235, .0236, .0238, .0239, and .0240 of this Section may result in imposition of enforcement measures as authorized by N.C.G.S. 143-215.6A (civil penalties), N.C.G.S. 143-215.6B (criminal penalties), and N.C.G.S. 143-215.6C (injunctive relief).

History Note: Authority G. S. 143-214.1; 143-214.7; 143-215.1; 143-215.3(a)(1); 143-215.6A; 143-215.6B; 143-215.6C.
Eff. August 1, 1998.

On December 11, 1997, the North Carolina Environmental Management Commission adopted the following permanent rule to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. The Rules Review Commission approved the rule at their February 19, 1998 meeting and it will become effective as a permanent rule, pending approval by the North Carolina General Assembly. This rule is currently effective as a temporary rule and will remain effective until the North Carolina General Assembly acts on the rule.

15A NCAC 2B .0233 has been adopted with changes as published 12:6 NCR 462-479 as follows:

SUBCHAPTER 2B - SURFACE WATER AND WETLANDS STANDARDS, MONITORING
SECTION .0200 - CLASSIFICATIONS AND WATER QUALITY STANDARDS APPLICABLE TO SURFACE WATERS AND WETLANDS OR NORTH CAROLINA
.0233 NEUSE RIVER BASIN: NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: PROTECTION AND MAINTENANCE OF RIPARIAN AREAS WITH EXISTING FOREST VEGETATION

The following is the management strategy for maintaining and protecting riparian areas in the Neuse River Basin:

(1) Riparian areas shall be protected and maintained in accordance with this Rule on all sides of surface waters in the Neuse River Basin (intermittent streams, perennial streams, lakes, ponds, and estuaries) as indicated on the most recent versions of United States Geological Survey 1:24,000 scale (7.5 minute quadrangle) topographic maps or other site-specific evidence. This Rule only applies to riparian areas where forest vegetation is established in Zone 1 (as described in Sub-Item 3(a)) as of July 22, 1997. Forest vegetation, as defined in 15A NCAC 2B .0202, of any width in Zone 1 must be protected and maintained in accordance with this Rule. This Rule does not establish new buffers in riparian areas. Exceptions to the requirements of this Rule for riparian areas are described in Sub-Items (2) (a-h). Maintenance of the riparian areas should be such that, to the maximum extent possible, sheet flow of surface water is achieved. This Rule specifies requirements that shall be implemented in riparian areas to ensure that the pollutant removal functions of the riparian area are protected and maintained.

(2) The following waterbodies and land uses are exempt from the riparian area protection requirements:

(a) Ditches and manmade conveyances other than modified natural streams;

(b) Areas mapped as intermittent streams, perennial streams, lakes, ponds, or estuaries on the most recent versions of United States Geological Survey 1:24,000 scale (7.5 minute quadrangle) topographic maps where no perennial waterbody, intermittent waterbody, lake, pond or estuary actually exists on the ground;

(c) Ponds and lakes created for animal watering, irrigation, or other agricultural uses that are not part of a natural drainage way that is classified in accordance with 15A NCAC 2B .0100;

(d) Water dependent structures as defined in 15A NCAC 2B .0202, provided that they are located, designed, constructed and maintained to provide maximum nutrient removal, to have the least adverse effects on aquatic life and habitat and to protect water quality;

(e)The following uses may be allowed where no practical alternative exists. A lack of practical alternatives may be shown by demonstrating that, considering the potential for a reduction in size, configuration or density of the proposed activity and all alternative designs, the basic project purpose cannot be practically accomplished in a manner which would avoid or result in less adverse impact to surface waters. Also, these structures shall be located, designed, constructed, and maintained to have minimal disturbance, to provide maximum nutrient removal and erosion protection, to have the least adverse effects on aquatic life and habitat, and to protect water quality to the maximum extent practical through the use of best management practices.

(i) Road crossings, railroad crossings, bridges, airport facilities, and utility crossings may be allowed if conditions specified in 2(e) of this Rule are met.

(ii) Stormwater management facilities and ponds, and utility construction and maintenance corridors for utilities such as water, sewer or gas, may be allowed in Zone 2 of the riparian area as long as the conditions specified in 2(e) of this Rule are met and they are located at least 30 feet from the top of bank or mean high water line. Additional requirements for utility construction and maintenance corridors are listed in 2(f) of this Rule.

(f) A corridor for the construction and maintenance of utility lines, such as water, sewer or gas, (including access roads and stockpiling of materials) may run parallel to the stream and may be located within Zone 2 of the riparian area, as long as no practical alternative exists and they are located at least 30 feet from the top of bank or mean high water line and best management practices are installed to minimize runoff and maximize water quality protection to the maximum extent practicable. Permanent, maintained access corridors shall be restricted to the minimum width practicable and shall not exceed 10 feet in width except at manhole locations. A 10 feet by 10 feet perpendicular vehicle turnaround is allowed provided they are spaced at least 500 feet apart along the riparian area.

(g) Stream restoration projects, scientific studies, stream gauging, water wells, passive recreation facilities such as boardwalks, trails, pathways, historic preservation and archaeological activities are allowed provided that they are located in Zone 2 and are at least 30 feet from the top of bank or mean high water line and are designed, constructed and maintained to provide the maximum nutrient removal and erosion protection, to have the least adverse effects on aquatic life and habitat, and to protect water quality to the maximum extent practical through the use of best management practices. Activities that must cross the stream or be located within Zone 1 are allowed as long as all other requirements of this Item are met.

(h) Stream crossings associated with timber harvesting are allowed if performed in accordance with the Forest Practices Guidelines Related to Water Quality (15A NCAC 1J .0201-.0209).

(3) The protected riparian area shall have two zones as follows:

(a) Zone 1 is intended to be an undisturbed area of forest vegetation. Any forest vegetation, as defined in Rule .0202 of the Section, in Zone 1 as of July 22, 1997 shall be maintained and protected in accordance with this Rule.

(i) Location of Zone 1: Zone 1 begins at the top of bank for intermittent streams and perennial streams and extends landward a distance of 30 feet on all sides of the waterbody, measured horizontally on a line perpendicular to the waterbody. For all other waterbodies, Zone 1 begins at the top of bank or mean high water line and extends landward a distance of 30 feet, measured horizontally on a line perpendicular to the waterbody.

(ii) The following practices and activities are allowed in Zone 1:

(A) Natural regeneration of forest vegetation and planting vegetation to enhance the riparian area if disturbance is minimized, provided that any plantings should primarily consist of locally native trees and shrubs;

(B)Selective cutting of individual trees of high value in the outer 20 feet of Zone 1, provided that the basal area of this outer 20-foot wide area remains at or above 75 square feet per acre and is computed according to the following method. Basal area of this outer 20-foot wide area shall be computed every 100 feet along the stream to ensure even distribution of forest vegetation and shall be based on all trees measured at 4.5 feet from ground level. No tracked or wheeled equipment is allowed in Zone 1 except at stream crossings which are designed, constructed and maintained in accordance with Forest Practice Guidelines Related to Water Quality (15A NCAC 1J .0201 - .0209).

(C)Horticulture or silvicultural practices to maintain the health of individual trees;

(D) Removal of individual trees which are in danger of causing damage to dwellings, other structures or the stream channel;

(E)Removal of dead trees and other timber cutting techniques necessary to prevent extensive pest or disease infestation if recommended by the Director, Division of Forest Resources and approved by the Director, Division of Water Ouality; and

(F)Ongoing agricultural operations provided that existing forest vegetation is protected and requirements in Rules .0236 and .0238 of this Section are followed.

(iii) The following practices are not allowed in Zone 1:

(A) Land-disturbing activities and placement of fill and other materials, other than those allowed in Items 2 and 3(a)(ii) of this Rule, that would disturb forest vegetation, as defined in Rule .0200 of this Section;

(B)New development, except as provided in Sub-Items 2(d), 2(e) and 2(f) of this Rule;

(C)New on-site sanitary sewage systems which use ground adsorption;

(D) The application of fertilizer; and

(E) Any activity that threatens the health and function of the vegetation including, but not limited to, application of chemicals in amounts exceeding the manufacturer's recommended rate, uncontrolled sediment sources on adjacent lands, and the creation of any areas with bare soil.

(b) Vegetation in Zone 2 shall consist of a dense ground cover composed of herbaceous or woody species which provides for diffusion and infiltration of runoff and filtering of pollutants.

(i) Location of Zone 2: Zone 2 begins at the outer edge of Zone 1 and extends landward a minimum of 20 feet as measured horizontally on a line perpendicular to the waterbody. The combined minimum width of Zones 1 and 2 shall be 50 feet on all sides of the waterbody.

(ii) The following practices and activities are allowed in Zone 2 in addition to those allowed in Zone 1:

(A) Periodic mowing and removal of plant products such as timber, nuts, and fruit is allowed on a periodic basis provided the intended purpose of the riparian area is not compromised by harvesting, disturbance, or loss of forest or herbaceous ground cover.

(B) Forest vegetation in Zone 2 may be managed to minimize shading on adjacent land outside the riparian area if the water quality function of the riparian area is not compromised.

(C) On-going agricultural operations provided that requirements of Rules .0236 and .0238 of this Section are followed.

(iii) The following practices and activities are not allowed in Zone 2:

(A) Land disturbing activities and placement of fill and other materials, other than those allowed in Items 2 and 3(b)(ii) of this Rule;

(B) New development, except as provided in Sub-Items 2(e) and 2(f) of this Rule;

(C) New on-site sanitary sewage systems which use ground adsorption;

(D) The application of fertilizer; and

(E) Any activity that threatens the health and function of the vegetation including, but not limited to, application of chemicals in amounts exceeding the manufacturer's recommended rate, uncontrolled sediment sources on adjacent lands, and the creation of any areas with bare soil.

(c) Timber removal and skidding of trees shall be directed away from the water course or water body. Skidding shall be done in a manner to prevent the creation of ephemeral channels perpendicular to the water body. Any tree removal must be performed in a manner that does not compromise the intended purpose of the riparian area and is in accordance with the Forest Practices Guidelines Related to Water Quality (15A NCAC 1J .0201-.0209).

(d) Maintenance of sheet flow in Zones 1 and 2 is required in accordance with this Item.

(i) Sheet flow must be maintained to the maximum extent practical through dispersing concentrated flow and/or re-establishment of vegetation to maintain the effectiveness of the riparian area.

(ii) Concentrated runoff from new ditches or manmade conveyances must be dispersed into sheet flow before the runoff enters Zone 2 of the riparian area. Existing ditches and manmade convayances, as specified in Sub-Item 2(a) of this Rule, are exempt from this requirement; however, care should be taken to minimize pollutant loading through these existing ditches and manmade conveyances from fertilizer application or erosion.

(iii) Periodic corrective action to restore sheet flow should be taken by the landowner if necessary to impede the formation of erosion gullies which allow concentrated flow to bypass treatment in the riparian area.

(e) Periodic maintenance of modified natural streams such as canals is allowed provided that disturbance is minimized and the structure and function of the riparian area is not compromised. A grassed travelway is allowed on one side of the waterbody when alternative forms of maintenance access are not practical. The width and specifications of the travelway shall be only that needed for equipment access and operation. The travelway shall be located to maximize stream shading.

(4) If a local government has been issued a Municipal Separate Stormwater Sewer System permit or has been delegated to implement a local stormwater program, then the local government shall ensure that the riparian areas to be protected are, as a standard practice, recorded on new or modified plats.

(5) Where the standards and management requirements for riparian areas are in conflict with other laws, regulations, and permits regarding streams, steep slopes, erodible soils, wetlands, floodplains, forest harvesting, surface mining, land disturbance activities, development in Coastal Area Management Act Areas of Environmental Concern, or other environmental protection areas, the more protective shall apply.

(6) Where application of this Rule would prevent all reasonable uses of a lot platted and recorded prior to the effective date of this Rule, a variance may be granted by the Environmental Management Commission if it finds that:

(a) practical difficulties or unnecessary hardships would result in strict application of the Rule;

(b) such difficulties or hardships result from conditions which are peculiar to the property involved; and

(c) the general purpose and intent of the Rule would be preserved, water quality would be protected and substantial justice would be done if the variance were granted.

History Note: *Authority G. S. 143-214.1; 143-214.7; 143-215.3(a)(1); Chapter 572, 1995 Session Laws.*
Temporary Adoption Eff .July 22, 1997;
Temporary Amendment Eff. April 22, 1998; January 22, 1998.
Proposed Eff. As Permanent Rule August 1, 1998.

On December 11, 1997, the North Carolina Environmental Management Commission adopted the following rule to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. A portion of the rule became effective as a temporary rule on January 22, 1998 (see italics text following end of this rule, page 15). The Rules Review Commission approved the rule at their February 19, 1998 meeting and it became effective August 1, 1998.

15A NCAC 2B .0234 has been adopted with changes as published 12:6 NCR 462-479 as follows:

.0234 NEUSE RIVER BASIN - NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: WASTEWATER DISCHARGE REQUIREMENTS

The following is the National Pollutant Discharge Elimination System (NPDES) wastewater discharge management strategy for the Neuse River Basin:

(1) All new and expanding dischargers will be required to document that all practical alternatives to surface water discharge were evaluated pursuant to 15A NCAC 2H .0105(c)(2), prior to a submittal of an application for a discharge. For purposes of this rule, permitted discharges means those individually permitted and not those covered under general permits.

(2) All wastewater dischargers greater than or equal to 0.5 million gallons per day (MGD) permitted flow regardless of current loading levels are required to evaluate and optimize the operation of their facilities in order to reduce nutrient loadings. One year after the effective date of this rule, a report shall be submitted to the division by each wastewater discharger or collectively by an Association, documenting the efforts/level of reductions achieved.

(3) The collective total nitrogen load for all individually permitted wastewater discharges shall, on an annual mass basis, be no more than 2.8 million pounds per year, unless individual wastewater discharges separately or collectively purchase a portion of the nonpoint source allocation in accordance with the formula for offset payments set forth in 15A NCAC 2B .0240. Paragraphs (5), (6) and (7) of this Rule indicate how this load is allocated in the basin. Compliance with the 2.8 million pounds annual average mass load of total nitrogen shall be required within five years of the effective date of this rule. If dischargers individually choose to make nutrient offset payments per rule .0240 of this Section, those offset payments shall be required prior to permit issuance and reissuance. Nutrient offset payments made to purchase nitrogen load reductions from nonpoint sources shall not be credited to the existing nonpoint source's load allocation.

(4) Any existing individual discharger or collective group of wastewater dischargers that accepts wastewater

from another wastewater treatment facility in the Neuse River Basin and that results in the elimination of the discharge from that wastewater treatment facility shall be allowed to increase the annual mass load of total nitrogen discharged by the annual mass load of total nitrogen allocated to the wastewater treatment facility that is eliminated. If the wastewater treatment system that is to be eliminated has a permitted flow of less than 0.5 MGD, the annual mass load of total nitrogen shall be calculated from the most recent available data on that facility. (5) The individually permitted wastewater discharges to the Neuse River basin with permitted flows of less than 0.5 MGD in 1995 shall be allocated an annual average mass load of 280,000 pounds of total nitrogen. All existing facilities above Falls Lake Dam with permitted flows greater than or equal to 0.05 MGD will be required to meet a quarterly average total phosphorus limit of 2 mg/l. More stringent limits may apply to protect water quality standards in localized areas.

(6) The following Item specifies the nutrient allocations for discharges above Falls Lake with permitted flows

greater than or equal to 0.5 MGD in 1995.

(a) The individually permitted discharges above Falls Lake Dam with permitted flows of greater than or equal to 0.5 MGD in 1995 shall be allocated an annual average mass load of 444,000 pounds of total nitrogen. The estimate of the total nitrogen load discharged through the Falls Lake Dam to the lower Neuse River shall be fifteen (15) percent, or 66,600 pounds annual average total nitrogen discharged to the lower Neuse River. The load shall be allocated to the individual facilities based upon the ratio of their 1995 permitted flow to the total permitted flow of those dischargers greater than or equal to 0.5 MGD above the Falls Lake Dam.

(b) All existing facilities above Falls Lake Dam with permitted flows greater than or equal to 0.05 MGD will be required to meet a quarterly average total phosphorus limit of 2 mg/l. More stringent limits may apply to protect water quality standards in localized areas.

(7) The following Item specifies the nutrient allocations for discharges below Falls Lake with permitted flows greater than or equal to 0.5 MGD in 1995.

(a) Wastewater treatment plants below Falls Lake Dam that have a permitted flow greater than or equal to 0.5 MGD shall be assigned an annual mass loading limit for total nitrogen based upon the ratio of their flow to the sum of the individual flows as set forth in Paragraph (7)(b) of this rule multiplied by 2.45 million pounds within five years of the effective date of this rule.

(b) For purposes of the above calculation the flows shall be: Central Johnston County 4.99 MGD, Raleigh 60 MGD, Clayton 1. 9 MGD, Burlington Industries 5 MGD, Cary-Northside 12 MGD, Wake Forest 6 MGD, Cary-Southside 16 MGD, Apex 3.6 MGD, Fuquay-Varina 6 MGD, Benson 3 MGD, Goldsboro 16.8 MGD, Kinston-Peachtree 6.75 MGD, LaGrange 0.75 MGD, Kinston-Northside 4.5 MGD, Dupont-Kinston 3.6 MGD, Kenly 0.63 MGD, Wilson 14 MGD, Contentnea Sewerage District 2.85, Farmville 3.5 MGD, Zebulon 1.85 MGD, Weyerhaeuser 32 MGD, New Bern 4.7 MGD, Havelock 1.9 MGD, US Marine Corps Cherry Point 3.5 MGD, CWS Inc. NE Craven Utilities 1 MGD, and Snow Hill 0.5 MGD.

(c) All existing facilities below Falls Lake Dam with permitted flows greater than or equal to 0.5 MGD will be required to meet a quarterly average total phosphorus limit of 2 mg/l. Upon expansion, these facilities must meet a monthly average total phosphorous limit of 1 mg/l. More stringent limits may apply to protect water quality standards in localized areas.

(8)All new wastewater discharge flows, flows not permitted prior to December 31, 1995, shall document efforts to obtain allocation from the load established in paragraph (3) of this section from existing wastewater discharges. If allocation can not be obtained from the existing dischargers, new dischargers may purchase a portion of the nonpoint source load allocation at a rate of 200 percent of the cost as set in 15A NCAC 2B .0240 of this Section to implement practices designed to reduce that same loading created by the new discharge. Payment for the portion of the nonpoint source load allocation purchased shall be made prior to permit issuance and reissuance. The new discharge shall at a minimum comply with an annual mass load of total nitrogen based on a concentration of 3.5 mg/l and their permitted flow. These facilities must meet a monthly average total phosphorous limit of 1 mg/l. More stringent limits may be given to protect water quality standards in localized areas.

(9) The following Item describes the option for dischargers to join an Association to collectively meet nutrient load allocations.

(a) All dischargers within the basin will have the option of forming an Association to meet their allocated total nitrogen load collectively. For dischargers that join the Association, an agreement will be drafted between the Division and the Association that includes annual loading targets. The total nitrogen load allocated to the Association shall be calculated by the sum of the individual allocated loads developed in Paragraphs (5), (6) and (7) of this rule. The membership of the Association shall be established no later than March 1, 1998. All facilities who apply for membership in the Association prior to March 1, 1998 shall be accepted. Thereafter, the Division shall accept new members in the Association on every five-year anniversary March 1, 1998 based on applications for membership received before that date from facilities existing as the effective date of this Rule.

(b) This annual total nitrogen loading target shall be met within five years of the effective date of this rule. The agreement may also require stepwise decreases in total nitrogen loads for the 5 years following the effective date of this rule. When developing a final agreement, the Commission shall acknowledge the differences in transport percentages between dischargers above and below Falls Lake Dam. The Association shall also be required to document reduction in total nitrogen loadings for any member facilities located in Craven, Jones, Pamlico and Carteret Counties as a result of their immediate proximity to the estuary. If the Association does not meet its annual total nitrogen loading target in any given year, the Association shall make payments for nonpoint source controls at a rate as set in 15A NCAC 2B .0240 of this section. No Association exists, for the purposes of this Rule, until the Agreement is formally approved by the Commission.

(c) All existing Association dischargers below Falls Lake Dam that have a permitted flow greater than or equal to 0.5 MGD will receive a quarterly average total phosphorus limit of 2 mg/l in their NPDES permits. All existing Association dischargers above Falls Lake Dam that have a permitted flow greater than or equal to 0.05 MGD will receive a quarterly average total phosphorus limit of 2 mg/l in their NPDES permits. New and expanding Association dischargers will receive a quarterly average total phosphorus limit of 2 mg/l in their NPDES permits. More stringent phosphorous limits may apply to protect water quality standards in localized areas.

History Note: Authority G. S. 143-214.1; 143-215; 143-215.1; 143-215.3(a)(1); Chapter 572, 1995 Session Laws.
Eff. August 1, 1998.

Temporary rule effective January 22, 1998.

.0234 NEUSE RIVER BASIN - NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: APPLICATION DEADLINE FOR MEMBERSHIP IN THE ASSOCIATION OPTION FOR WASTEWATER DISCHARGERS

The membership of the Association shall be established no later than March 1, 1998. All facilities who apply to the Division of Water Quality for membership in the Association prior to March 1, 1998 shall be accepted. Thereafter, additions of facilities existing as of the effective date of this Rule, to the membership in the Association may be considered every five years.

History Note: Authority G. S. 143-214.1; 143-215; 143-215.1; 143-215.3(a)(1); Chapter 572, 1995 Session Laws.
Temporary Adoption Eff. January 22, 1998.

On December 11, 1997, the North Carolina Environmental Management Commission adopted the following rule to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. The Rules Review Commission approved the rule at their February 19, 1998 meeting and it became effective August 1, 1998.

15A NCAC 2B .0235 is proposed for adoption with changes as published in 12:6 NCR 462-479 as follows:

.0235 NEUSE RIVER BASIN- NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: BASINWIDE STORMWATER REQUIREMENTS

The following is the urban stormwater management strategy for the Neuse River Basin:

(1) The following local governments shall be designated, based on population and other factors, for stormwater management requirements as part of the Neuse River Nutrient Sensitive Waters stormwater management strategy:

(a) Cary,
(b) Durham,
(c) Garner,
(d) Goldsboro,
(e) Havelock,
(f) Kinston,
(g) New Bern,
(h) Raleigh,
(i) Smithfield,
(j) Wilson
(k) Durham County,
(l) Johnston County,
(m) Orange County,
(n) Wake County, and
(o) Wayne County.

(2) Other incorporated areas and other counties, not listed under Item (1), may seek to implement their own local stormwater management plan by complying with the requirements specified in Items (5), (6) and (7) of this rule.

(3) The Environmental Management Commission may designate additional local governments by amending this Rule based on their potential to contribute significant nutrient loads to the Neuse River. At a minimum, the Commission shall review the need for additional designations to the stormwater management program as part of the basinwide planning process for the Neuse River Basin. Any local governments that are designated at a later date under the Neuse Nutrient Sensitive Waters Stormwater Program shall meet the requirements under Items (5), (6) and (7) of this rule.

(4) Within 12 months of the effective date of this rule, the Division of Water Quality shall submit a model local stormwater management program plan to control nutrients to the Commission for approval. The Division will work in cooperation with subject local governments in developing this model plan. The model plan shall address nitrogen reductions for both existing and new development and include, but not be limited to, the following elements:

(a) Review and approval of stormwater management plans for new developments to ensure that:
    (i) the nitrogen load contributed by new development activities is held at 70% of the average nitrogen load contributed by the 1995 land uses of the non-urban areas of the Neuse River Basin. The local governments shall use a nitrogen export standard of 3.6 pounds/acre/year, determined by the Environmental Management Commission as 70% of the average collective nitrogen load for the 1995 non-urban land uses in the basin above New Bern. The EMC may periodically update the design standard based on the availability of new scientific information. Developers shall have the option of partially offsetting their nitrogen loads by funding wetland or riparian area restoration through the North Carolina Wetland Restoration Fund at the rate specified in Rule .0240 of this Section. However, before using offset payments, the development must attain, at a

minimum, a nitrogen export that does not exceed 6 pounds/acre/year for residential development and 10 pounds/acre/year for commercial or industrial development.

(ii) there is no net increase in peak flow leaving the site from the predevelopment conditions for the 1-year, 24-hour storm.

(b) Review of new development plans for compliance with requirements for protecting and maintaining existing riparian areas as specified in Rule 15A NCAC 2B .0233;

(c) Implementation of public education programs;

(d) Identification and removal of illegal discharges;

(e) Identification of suitable locations for potential stormwater retrofits (such as riparian areas) that could be funded by various sources; and

(f) Submittal of an annual report on October 30 to the Division documenting progress and net changes to nitrogen load from the local government's planning jurisdiction.

(5) Within 12 months of the EMC's approval of the model local government stormwater program or later designation (as described in Item (3)), subject local governments shall submit their local stormwater management program plans to the Commission for review and approval. These local plans shall equal or exceed the requirements in Item (4) of this Rule. Local governments may submit a more stringent local stormwater management program plan. Local stormwater management programs and modifications to these programs shall be kept on file by the Division of Water Quality.

(6) Within 18 months of the EMC's approval of the model local government stormwater program or designation, subject local governments are required to adopt and implement a local stormwater management program according to their approved plan. Local governments administering a stormwater management program are required to submit annual reports to the Division documenting their progress and net changes to nitrogen load by October 30 of each year.

(7) If a local government fails to submit an acceptable local stormwater management program plan within the time frames established in this Rule or fails to properly implement an approved plan, then stormwater management requirements for existing and new urban areas within its jurisdiction will be administered through the NPDES municipal stormwater permitting program per 15A NCAC 2H .0126.

(a) Subject local governments will be required to develop and implement comprehensive stormwater management programs, tailored toward nitrogen reduction, for both existing and new development.

(b) These stormwater management programs shall provide all components that are required of local government stormwater programs in Item (4)(a)-(f) above.

(c) Local governments that are subject to an NPDES permit shall be covered by the permit for at least one permitting cycle (five years) before they are eligible to submit a local stormwater management program for consideration and approval by the EMC.

History Note: *Authority G. S. 143-214.1; 143-214.7; 143-215.1; 143-215.3(a)(1); Chapter 572, 1995 Session Laws; 143-282(d).*
Eff. August 1, 1998.

On December 11, 1997, the North Carolina Environmental Management Commission adopted the following rule to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. This rule was approved by the Rules Review Commission on January 15, 1998 and became effective August 1, 1998.

15A NCAC 2B .0236 has been adopted with changes as published 12:6 NCR 462-479 as follows:

.0236 NEUSE RIVER BASIN- NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: AGRICULTURAL NITROGEN LOADING REDUCTION

All persons engaging in agricultural operations in the Neuse River Basin, including those related to crops, livestock, and poultry, shall collectively achieve and maintain a 30% net total nitrogen loading reduction from the cumulative average 1991-1995 nitrogen loadings. In addition to requirements set forth in general permits for animal operations issued pursuant to N.C.G.S. 143-215.10C, these rules apply to all livestock and poultry operations, regardless of size, in the Neuse River Basin. A management strategy to achieve this reduction is specified in Rule .0238 of this Section.

History Note: *Authority G. S. 143.214.1; 143.214.7; 143.215.3(a)(1).*
Eff. August 1, 1998.

On December 11, 1997, the North Carolina Environmental Management Commission adopted the following rule to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. The Rules Review Commission approved the rule at their February 19, 1998 meeting and it became effective August 1, 1998.

15A NCAC 2B .0238 is proposed for adoption as follows:

.0238 NEUSE RIVER BASIN- NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: AGRICULTURAL NITROGEN REDUCTION STRATEGY

The following requirements apply to all persons in the Neuse River Basin who engage in agricultural operations. Agricultural operations are activities which relate to the production of crops, livestock, and poultry.

(1) All persons engaging in agricultural operations in the Neuse River Basin shall collectively achieve and maintain a 30% net total nitrogen loading reduction from the cumulative average 1991-1995 nitrogen loadings within five years from the effective date of this Rule. Persons subject to this Rule are provided with two options for meeting the requirements of this Rule. The first option is to sign-up for and participate in implementing a collective local strategy for agricultural nitrogen reduction as described in Item (7) of this Rule. This option allows site-specific plans to be developed for those operations where further nitrogen reduction practices are necessary to achieve the collective reduction goal. The second option requires the implementation of standard Best Management Practices as specified in Item (8) of this Rule. Failure to meet requirements of this Rule may result in imposition of enforcement measures as authorized by N.C.G.S. 143-215.6A (civil penalties), N.C.G.S. 143-215.6B (criminal penalties), and N.C.G.S. 143-215.6C (injunctive relief).

(2) Formation and membership of the Basin Oversight Committee. The Environmental Management Commission shall delegate to the Secretary of the Department of Environment and Natural Resources the responsibility of forming a Basin Oversight Committee.

(a) The Secretary shall solicit one nomination for membership on this Committee from each of the following agencies:
  (i) Division of Soil and Water Conservation,
  (ii) United States Department of Agriculture- Natural Resources Conservation Service,
  (iii) North Carolina Department of Agriculture,
  (iv) North Carolina Cooperative Extension Service, and
  (v) Division of Water Quality.

(b) The Secretary shall also solicit one nomination that represents environmental interests, one nomination that represents agricultural interests, and one from the scientific community with experience related to water quality problems in the Neuse River Basin.

(c) Nominations for Basin Oversight Committee shall be approved by the Secretary, Department of Environment and Natural Resources. Members shall be appointed for a term not to exceed five years and shall serve at the pleasure of the Secretary. The United States Department of Agriculture-Natural Resources Conservation Service member will serve in an "ex-officio" non-voting capacity and will function as a technical program advisor to the committee.

(3) Role of the Basin Oversight Committee. The Environmental Management Commission shall delegate the following responsibilities to the Basin Oversight Committee.

(a) Develop a tracking and accounting methodology, as described below, for evaluating total nitrogen loading from agricultural operations and progress toward reaching the total nitrogen net loading reduction from the implementation BMPs within the Neuse River Basin. The accountability methodology must demonstrate how the nitrogen loading reduction can be met collectively by implementing best management practices approved by the Soil and Water Conservation Commission that include, but are not limited to, water control structures, riparian area establishment, and nutrient management.

(b) Submit a draft accountability process in accordance with the requirements in (3)(a) and (3)(c) of this Rule to the Environmental Management Commission for review within six months after the effective date of the Rule and the final accountability process to the Environmental Management Commission for approval within one year after the effective date of the Rule. The Environmental Management Commission shall approve the accountability process if it meets requirements in

(3)(a) and (3)(c) of this Rule. If the Basin Oversight Committee fails to submit an approvable accountability process to the Environmental Management Commission, then the Environmental Management Commission may accept alternative accountability process proposals within fifteen months of the effective date of the Rule. If the Environmental Management Commission fails to receive an approvable accountability process, then the Environmental Management Commission may require all agricultural operations to follow the standard Best Management Practices option as specified in Item (8) of this Rule.

(c) Include in the accountability process a method to accurately track implementation of BMPs, including location and type of BMPs; to estimate nitrogen reductions from BMP implementation; to quantify increases or decreases in nitrogen loading due to changes in land use, modified agricultural activity, or atmospheric nitrogen loading, based on the best available scientific information; to ensure operation and maintenance of BMPs, including year round management for water control structures; to address life expectancy of BMPs; and a method to ensure maintenance of the nitrogen net loading reduction after the initial five years of this Rule, including substitute BMPs to replace expired practices and additional BMPs to offset new sources of nitrogen.

(d) Calculate a separate total nitrogen loading for agricultural lands in the Neuse River Basin above and below New Bern based on the average of 1991-1995 conditions. Based on this loading, calculate a separate 30% net reduction. Loading calculations must include atmospheric emissions and deposition of nitrogen from agricultural lands based on the best available scientific information. Allocate to counties or watersheds, as allowed in 4(a), within the Neuse River Basin their portion of the calculated nitrogen loading reduction from agricultural operations, including any division of the reduction between specific categories of agricultural operations. Each county or watershed may not have to reduce individually its nitrogen loading by 30%; however, the nitrogen loading reduction from all counties or watershed above New Bern should collectively meet their total nitrogen reduction and all counties or watersheds below New Bern should collectively meet their total nitrogen reduction. If the Basin Oversight Committee fails to allocate the nitrogen loading reductions from agricultural operations to counties or watersheds within the Neuse River Basin, the Environmental Management Commission may assign the agricultural nitrogen reductions based on the approved accountability process as described in (3)(a) and (3)(c) of this Rule.

(e) Review, approve and summarize county nitrogen reduction strategies and present these strategies to the Environmental Management Commission for approval within two years from the effective date of this Rule.

(f) Review, approve and summarize local nitrogen reduction annual reports and present these reports to the Environmental Management Commission each October. Information to be included in the Annual Report is described in Item (5)(d) of this Rule.

(4) Formation and membership of the Local Advisory Committees. The Environmental Management Commission shall delegate to the Directors of the Division of Water Quality and Division of Soil and Water Conservation the responsibility of forming Local Advisory Committees.

(a) The Directors shall form Local Advisory Committees in each county (or watershed specified by the Basin Oversight Committee) within the Neuse River Basin. The Directors shall solicit nominations for membership on the Local Advisory Committee from each of the following local agencies:

(i) Soil and Water Conservation District,
(ii) United States Department of Agriculture- Natural Resources Conservation Service,
(iii) North Carolina Department of Agriculture,
(iv) North Carolina Cooperative Extension Service, and
(v) North Carolina Division of Soil and Water Conservation.
(vi) The Directors shall also solicit at least two nominations that represents a local farmer in the county watershed.

The Soil and Water Conservation District may be designated by the Basin Oversight Committee as the lead agency on the Local Advisory Committee.

(b) Nominations for the Local Advisory Committees shall be approved by the Environmental Management Commission and Soil and Water Conservation Commission and shall be appointed for a term not to exceed five years and shall serve at the pleasure of the Commissions.

(5) Role of the Local Advisory Committees. The Environmental Management Commission shall delegate the following responsibilities to employees of the Department who are members of the Local Advisory Committees and employees of the Division of Soil and Water Conservation or its designee. These employees shall act with advice from the Local Advisory Committees.

(a) Conduct a sign-up process for persons wishing to voluntarily implement the local nitrogen reduction strategy as specified in Item (7) of this Rule. This sign-up process shall be completed within one year following the effective date of this Rule.

(b) Develop local nitrogen reduction strategies that meet the nitrogen loading reduction goal for agricultural operations assigned by the the Basin Oversight Committee. The local strategies shall be designed to achieve the required nitrogen loading reduction within five years from the effective date of this Rule. A matrix of best management practice options, which account for stream order, floodplain width, and regional variations in soil types and topography, may be used in developing the local nitrogen reduction strategies. Local nitrogen reduction strategies must specify the name and location of participant agricultural farming operations, BMPs which will be required as part of the plan, estimated nitrogen reduction, schedule for BMP implementation, and operation and maintenance requirements. If the Local Advisory Committee fails to develop the local nitrogen reduction strategy, the Environmental Management Commission may develop the strategy based on the tracking and accounting method approved by the Environmental Management Commission.

(c) Submit an annual report to the Basin Oversight Committee each May on net total nitrogen loading reductions from agricultural operations, the implementation of BMPs for nitrogen control, and progress towards the total nitrogen loading reduction requirements in the Neuse River Basin above and below New Bern.

(d) Include in the annual report, at a minimum, documentation on the BMPs implemented (including type and location), their costs, documentation of any expired contracts for BMPs, estimated nitrogen net loading reductions achieved as a result of those BMPs, any increases or decreases in nitrogen loading resulting from changes in land use or modified agricultural-related activity, discussion of operation and maintenance of BMPs, and a summary of the estimated load from agricultural operations for the previous year, and any modifications to the accounting methodology. Information shall be provided in the annual report on the status of BMP implementation and estimated total nitrogen reduction by all agricultural operations within the Neuse River Basin in each county or watershed. The annual report shall also be summarized separately for cropland, livestock and poultry activities.

(6) Options for meeting the collective total nitrogen net loading reduction requirement. Each agricultural operation in the Neuse River Basin shall have two options for meeting the requirements of this Rule. The options are to either implement a local nitrogen reduction strategy, specified by Item (7) of this Rule, or implement standard Best Management Practices specified by Item (8) of this Rule.

(7) Local nitrogen reduction strategy option. All persons subject to this Rule that choose to implement the county nitrogen reduction plan must complete the sign-up process that will be conducted per the requirements of Item (5)(a) of this Rule. This sign-up process will be completed within one year from the effective date of this Rule. If a person subject to this Rule does not complete the sign-up process, he shall be subject to implementation of Best Management Practices as specified in Item (8) of this Rule. Persons who choose to participate in the local nitrogen reduction strategy must commit and implement their portion of the plan within 5 years of the effective date of this Rule. A person may withdraw from the local nutrient reduction strategy up until the time that the local strategy is finalized by the Local Advisory Committee and the person signs the specific plan for his property, which represents his commitment to implement the plan within 5 years of the effective date of the Rules. After a person has made the commitment to implement the local strategy by signing the plan for his property, then such persons may not withdraw from the local nitrogen reduction strategy during the initial five-year period. The local nitrogen reduction strategy is not required to be more stringent than the standard best management practice option provided that the net nitrogen reduction goals are met collectively; however, the Local Advisory Committes may develop strategies that achieve reductions of greater than 30%.

(8) Standard best management practice option. If a person subject to this Rule does not complete the sign-up process for implementation of the local nitrogen reduction strategy, then he shall implement the following best management practices within four years following the effective date of this Rule.

(a) A forested riparian area, as described in Sub-Item (8)(a)(i)-(ii) of this Rule, is required on all sides of surface waters in the Neuse River Basin (intermittent streams, perennial streams, lakes, ponds and estuaries) as indicated on the most recent versions of U.S.G.S. 1:24,000 scale (7.5 minute quadrangle) topographic maps or other site-specific evidence. Design and installation of the forested riparian area should be such that, to the maximum extent possible, sheet flow of surface water is achieved. Any activities that would result in water quality standard violations or disrupt the structural or functional integrity of the forested riparian area are prohibited. The protected riparian area shall have two zones as follows:

(i) Zone 1 is intended to be undisturbed forest. Zone 1 begins at the top of bank for intermittent streams and perennial streams without tributaries and extends landward a distance of 30 feet on each side of the waterbody, measured horizontally on a line perpendicular to the waterbody. For all other waterbodies, Zone 1 begins at the top of bank or the mean high water line and extends landward a distance of 30 feet, measured horizontally on a line perpendicular to the waterbody. Forest vegetation of any width that exists in Zone 1 as of July 22, 1997 must be preserved and maintained in accordance with Sub-Items 8(a)(i)(A-E). The application of fertilizer in Zone 1 is prohibited. The following practices and activities are allowed in Zone 1:

(A) Natural regeneration of forest vegetation and planting vegetation to enhance the riparian area if disturbance is minimized, provided that any plantings should primarily consist of locally native trees and shrubs;

(B) Selective cutting of individual trees of high value in the outer 20 feet of Zone 1, provided that the basal area of this outer 20-foot wide area remains at or above 75 square feet per acre and is computed according to the following method. Basal area of this outer 20-foot wide area shall be computed every 100 feet along the stream to ensure even distribution of forest vegetation and shall be based on all trees measured at 4.5 feet from ground level. No tracked or wheeled equipment is allowed in Zone 1 except at stream crossings which are designed, constructed and maintained in accordance with Forest Practice Guidelines Related to Water Quality (15A NCAC 1J .0201 - .0209).

(C) Horticulture or silvicultural practices to maintain the health of individual trees;

(D) Removal of individual trees which are in danger of causing damage to dwellings, other structures, or the stream channel; and

(E) Removal of dead trees and other timber cutting techniques necessary to prevent extensive pest or disease infestation if recommended by the Director, Division of Forest Resources and approved by the Director, Division of Water Quality

(ii) Zone 2: begins at the outer edge of Zone 1 and extends landward a minimum of 20 feet as measured horizontally on a line perpendicular to the waterbody. The combined minimum width of Zones 1 and 2 shall be 50 feet on all sides of the waterbody.. Vegetation in Zone 2 shall consist of a dense ground cover composed of herbaceous or woody species which provides for diffusion and infiltration of runoff and filtering of pollutants. The following practices and activities are allowed in Zone 2 in addition to those allowed in Zone 1: Periodic mowing and removal plant products such as timber, nuts, and fruit is allowed on a periodic basis provided the intended purpose of the riparian area is not compromised by harvesting, disturbance, or loss of forest or herbaceous ground cover. Forest vegetation in Zone 2 may be managed to minimize shading on adjacent land outside the riparian area if the water quality function of the riparian area is not compromised.

(iii) The following practices and activities are not allowed in Zone 1 and Zone 2:

(A) Land disturbing activities and placement of fill and other materials, other than those allowed in Items 8(a)(i) and 8(b) of this Rule;

(B) New development ;

(C) New on-site sanitary sewage systems which use ground absorptions;

(D) Any activity that threatens the health and function of the vegetation including, but not limited to, application of fertilizer or chemicals in amounts exceeding the manufacturer's recommended rate, uncontrolled sediment sources on adjacent lands, and the creation of any areas with bare soil.

(iv) Timber removal and skidding of trees in the riparian area shall be directed away from the water course or water body. Skidding shall be done in a manner to prevent creation of ephemeral channels perpendicular to the water body. Any tree removal must be performed in a manner that does not compromise the intended purpose of the riparian area and is in accordance with the Forest Practices Guidelines Related to Water Quality (15A NCAC 1J .0201-.0209).

(b) The following waterbodies and land uses are exempt from the riparian area requirement:

(i) Ditches and manmade conveyances, other than modified natural streams, which under normal conditions do not receive drainage waters from any tributary ditches, canals, or streams, unless the ditch or manmade conveyance delivers runoff directly to waters classified in accordance with 15A NCAC 2B .0100;

(ii) Ditches and manmade conveyances other than modified natural streams which are used exclusively for drainage of silvicultural land or naturally forested areas. All forest harvesting operations shall be in compliance with North Carolina s Forest Practices Guidelines Related to Water Quality;

(iii) Areas mapped as perennial streams, intermittent streams, lakes, ponds or estuaries on the most recent versions of United States Geological Survey 1:24,000 scale (7.5 minute quadrangle) topographic maps where no perennial, intermittent waterbody, or lakes, ponds or estuaries exists on the ground;

(iv) Ponds and lakes created for animal watering, irrigation, or other agricultural uses that are not part of a natural drainage way that is classified in accordance with 15A NCAC 2B .0100.

(v) Water dependent structures as defined in 15A NCAC 2B .0202 provided that they are located, designed, constructed and maintained to provide maximum nutrient removal, to have the least adverse effects on aquatic life habitat and to protect water quality.

(vi) The following uses may be allowed where no pratical alternative exists. A lack of practical alternatives may be shown by demonstrating that, considering the potential for a reduction in size, configuration or density of the proposed activity and all alternative designs, the basic project purpose cannot be practically accomplished in a manner which would avoid or result in less adverse impact to surface waters. Also, these structures shall be located, designed, constructed, and maintained to have minimal disturbance, to provide maximum nutrient removal and erosion protection, to have the least adverse effects on aquatic life and habitat, and to protect water quality to the maximum extent practical through the use of best management practices.

(A) Road crossings, railroad crossings, bridges, airport facilities, and utility crossings may be allowed if conditions specified in 8(b)(vi) of this Rule are met.

(B) Stormwater management facilities and ponds, and utility construction and maintenance corridors for utilities such as water, sewer or gas, may be allowed in Zone 2 of the riparian area as long as the conditions specified in 8(b)(vi) of this Rule are met and they are located at least 30 feet from the top of bank or mean high water line. Additional requirements for utility construction and maintenance corridors are listed in 8(b)(vi) of this Rule.

(vii) A corridor for the construction and maintenance of utility lines, such as water, sewer or gas, (including access roads and stockpiling of materials) may run parallel to the stream and may be located within Zone 2 of the riparian area, as long as no practical alternative exists and they are located at least 30 feet from the top of bank or mean high water line and best management practices are installed to minimize runoff and maximize water quality protection to the maximum extent practicable. Permanent, maintained access corridors shall be restricted to the minimum width practicable and shall not exceed 10 feet in width except at manhole locations. A 10 feet by 10 feet perpendicular vehicle turnaround is allowed provided they are spaced at least 500 feet apart along the riparian area.

(viii) Stream restoration projects, scientific studies, stream gauging, water wells, passive recreation facilities such as boardwalks, trails, pathways, historic preservation and archaeological activities are allowed; provided that they are located in Zone 2 and are at least 30 feet from the top of bank or mean high water line and are designed, constructed and maintained to provide the maximum nutrient removal and erosion protection, to have the least adverse effects on aquatic life and habitat, and to protect water quality to maximum extent practical through the use of best management practices. Activities that must cross the stream or be located within Zone 1 are allowed as long as all other requirements of this Item are met.

(ix) Stream crossings associated with timber harvesting are allowed if performed in accordance with the Forest Practices Guidelines Related to Water Quality (15A NCAC 1J .0201-.0209; and

(x) In addition to exceptions included in 8(b)(i)-(ix), canals, ditches, and other drainage conveyances are exempt from the riparian area requirement if both water control structures with a water control structure management plan and a nutrient management plan, are implemented on the adjacent agricultural land according to the standards and specifications of the USDA - Natural Resources Conservation Service or the standards and specifications adopted by the NC Soil and Water Conservation Commission. The water control structures and nutrient management practices must provide equivalent protection and directly affect the land and waterbodies draining into the waterbody exempted from the riparian area requirement. To the maximum extent practical, water control structures should be managed to maximize nitrogen removal throughout the year. A technical specialist designated pursuant to rules adopted by the Soil and Water Conservation Commission must provide written approval that the nutrient management and water management plans meet the standards and specifications of the USDA - Natural Resources Conservation Service or the standards and specifications adopted by the NC Soil and Water Conservation Commission. If the nutrient management plans and water management plans are not implemented, then a riparian area pursuant to this Section is required.

(c) The following are modifications to the riparian area requirements.

(i) On agricultural land where either water control structures with a water control structure management plan, or a nutrient management plan is implemented according to the standards and specifications of the USDA - Natural Resources Conservation Service or the standards and specifications adopted by the NC Soil and Water Conservation Commission, then a 20-ft forested or a 30-ft vegetated buffer is required. The water control structures or nutrient management practices must provide equivalent protection and directly affect the land and waterbodies draining into the waterbody with a modified buffer requirement. To the maximum extent practical, water control structures should be managed to maximize nitrogen removal throughout the year. A technical specialist designated pursuant to rules adopted by the Soil and Water Conservation Commission must provide written approval that the nutrient management plan meets the standards and specifications of the USDA - Natural Resources Conservation Service or the standards and specifications adopted by the NC Soil and Water Conservation Commission.

(ii) A vegetated riparian area may be substituted for an equivalent width of forested riparian area within 100 feet of tile drainage.

(iii) Where the riparian area requirements would result in an unavoidable loss of tobacco allotments [(7 CFR 723.220(c)] and the BMPs of controlled drainage or nutrient management are not in place, forest cover is required only in the first 20 feet of the riparian area.

(d) Maintenance of Zones 1 and 2 is required in accordance with this Rule.

(i) Sheet flow must be maintained to the maximum extent practical through dispersing concentrated flow and/or re-establishment of vegetation to maintain the effectiveness of the riparian area.

(ii) Concentrated runoff from new ditches or manmade conveyances must be dispersed into sheetflow before the runoff enters Zone 2 of the riparian area. Existing ditches and

manmade conveyances, as specified in Sub-Item 8(b)(ii) of this Rule, are exempt from this requirement; however, care should be taken to minimize pollutant loading through these existing ditches and manmade conveyances from fertilizer application or erosion.

(iii) Periodic corrective action to restore sheet flow should be taken by the landowner if necessary to impede the formation of erosion gullies which allow concentrated flow to bypass treatment in the riparian area.

(e) Periodic maintenance of modified natural streams such as canals is allowed provided that disturbance is minimized and the structure and function of the riparian area is not compromised. A grassed travelway is allowed on one side of the waterbody when alternative forms of maintenance access are not practical. The width and specifications of the travelway shall be only that needed for equipment access and operation. The travelway should be located to maximize stream shading.

(f) Where the standards and management requirements for riparian areas are in conflict with other laws, regulations, and permits regarding streams, steep slopes, erodible soils, wetlands, floodplains, forest harvesting, surface mining, land disturbance activities, development in Coastal Area Management Act Areas of Environmental Concern, or other environmental protection areas, the more protective shall apply.

(g) The Environmental Management Commission acknowledges that best management practices under the standard management practice option of this Rule do not fully address nitrogen loading, including atmospheric emissions and deposition, from animal operations. As information becomes available on nitrogen loadings from animal operations and best management practices to control these loadings, other best management practices from animal operations may be required by the Commission as necessary to achieve equivalent reduction in nitrogen loadings therefrom. These additional best management practices shall be required if deemed necessary to achieve a net total nitrogen loading reduction from the animal operations based on average 1991-1995 conditions.

History Note: *Authority G. S. 143-214.1; 143-214.7; 143-215.3(a)(1).*
Eff. August 1, 1998.

On December 11, 1997, the North Carolina Environmental Management Commission adopted the following rule to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. The Rules Review Commission approved the rule at their February 19, 1998 meeting and it became effective August 1, 1998.

15A NCAC 2B .0239 has been adopted with changes as published 12:6 NCR 462-479 as follows:

.0239 NEUSE RIVER BASIN: NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: NUTRIENT MANAGEMENT

The following is the management strategy for nutrient management in the Neuse River Basin:

(1) The following persons are required to obtain a certificate, issued within five years of the effective date of this Rule by the Cooperative Extension Service or the Division of Water Quality, verifying completion of training and continuing education in nutrient management. Within one year from the effective date of this Rule, the Division of Water Quality, in cooperation with the Cooperative Extension Service, shall conduct a sign-up process for persons wishing to take the nutrient management training. If these persons fail to obtain the nutrient management certificate, they are required to develop and properly implement nutrient management plans for the lands where they apply fertilizer within five years of the effective date of this Rule:

(a) Applicators who in a calendar year apply fertilizer to cropland areas, including row and vegetable crops, floraculture areas, ornamental areas and greenhouse production areas, that together comprise at least 50 acres and persons responsible for managing cropland areas, as described in this Sub-Item, that together comprise at least 50 acres;

(b) Applicators who in a calendar year apply fertilizer to a golf course, recreational land areas, right-of -way, or other turfgrass areas that together comprise at least 50 acres, and persons responsible for managing the turfgrass aspects of lands, as described in this Sub-Item, that together comprise at least 50 acres; and

(c) Commercial applicators who apply fertilizer to at least 50 total acres per year of lawn and garden areas in residential, commercial, or industrial developments, and persons responsible for managing the lawn and garden aspects of lands, as described in this Sub-Item, that together comprise at least 50 acres.

(2) If the persons listed in Subitems (1)(a-c) of this Rule do not attend and complete within 5 years of the effective date of this Rule a nutrient management training program administered by the Cooperative Extension Service, their nutrient management plans shall meet the following requirements:

(a) Nutrient management plans for cropland shall meet the standards and specifications of the USDA - Natural Resources Conservation Service or the standards and specifications adopted by the NC Soil and Water Conservation Commission. Written approval from a technical specialist designated pursuant to rules adopted by the Soil and Water Conservation Commission must be obtained by the applicator certifying that a nutrient management plan meeting these standards has been developed for the lands where they apply fertilizer.

(b) Nutrient management plans for turfgrass, floriculture, ornamental and greenhouse production application of nutrients shall meet recommendations based on guidelines in the following documents or other recommendations from land-grant universities to minimize nutrient loss to waters in the Neuse River Basin. Nutrient management plans for turfgrass shall follow the North Carolina Cooperative Extension Service (NCCES) guidelines in "Water Quality And Professional Lawn Care"; NCCES publication number WQMM-155 or "Water Quality And Home Lawn Care"; NCCES publication number WQMM-151. Copies may be obtained from the Division of Water Quality, 512 North Salisbury Street, Raleigh, North Carolina 27626 at no cost. Nutrient management plans for nursery crops and greenhouse production shall follow the Southern Nurserymen's Association guidelines promulgated in "Best Management Practices Guide For Producing Container-Grown Plants". Copies may be otained from the Southern Nurserymen's Association, 1000 Johnson Ferry Road, Suite E-130, Marietta, GA 30068-2100 at a cost of thirty-five dollars ($35.00). There materials related to nutrient management plans for turfgrass, nursery crops and greenhouse production are hereby incorporated by reference including any subsequent amendments and editions and are available for inspection at the Department of Environment and Natural Resources Library, 512 North Salisbury Street, Raleigh, North Carolina. The Division

of Water Quality shall develop model plans in consultation with the Cooperative Extension Service, the Natural Resources Conservation Service, the Division of Soil and Water Conservation, and the North Carolina Department of Agriculture and approved by the Director of the Division of Water Quality within 1 year of the effective date of this Rule. The model plans shall provide a description of the type of information to be included in the plans for source of nutrients, the amount of nutrient applied, the placement of nutrients, and the timing of nutrient applications. Written approval from a technical specialist designated pursuant to rules adopted by the the Environmental Management Commission must be obtained by the applicator certifying that a nutrient management plan meeting these standards has been developed for the lands where they apply fertilizer.

(c) For nutrient management plans developed under (2)(a) and (2)(b) using dry poultry litter from animal waste management systems involving 30,000 or more birds, dry poultry litter shall be applied at agronomic rates for nitrogen based on realistic yield expectations derived from waste nutrient content, crop and soil type or yield records.

(d) Nutrient management plans and supporting documents must be kept on-site or be producible within 24 hours of a request by the Division of Water Quality.

(e) Nutrient management plans may be written by the applicator or a consultant to the applicator.

(3) Applicators and commercial applicators subject to Item (2) of this Rule who do not develop a nutrient management plan or do not apply nutrients in accordance with a nutrient management plan meeting the specifications in Item (2) are in violation of this Rule and are subject to enforcement measures authorized in N.C.G.S. 143-215.6A (civil penalties), N.C.G.S. 143-215.6B (criminal penalties), and N.C.G.S. 143-215.6C (injunctive relief).

(4) Residential landowners and other individuals applying fertilizer to less than 50 acres per year should to the maximum extent practical apply fertilizer to residential, commercial, industrial, turfgrass, and cropland areas at rates recommended by the Cooperative Extension Service.

History Note: *Authority G. S. 143-214.1; 143-214.7; 143-215.3(a)(1).*
Eff. August 1, 1998.

On December 11, 1997, the North Carolina Environmental Management Commission adopted the following rule to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. This rule was approved by the Rules Review Commission on January 15, 1998 and became effective August 1, 1998.

15A NCAC 2B .0240 has been adopted with changes as published 12:6 NCR 462-479 as follows:

.0240 NEUSE RIVER BASIN- NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: NUTRIENT OFFSET PAYMENTS

(a) Nutrient offset payments made as part of fulfilling requirements of the Neuse River Nutrient Sensitive Waters Management Strategy shall be paid to the North Carolina Wetland Restoration Fund. Monies paid to this fund pursuant to this Rule shall be targeted toward restoration of wetlands and riparian areas within the Neuse River Basin.

(b) A cost effectiveness rate shall be established by the Division that represents the cost to achieve a reduction of one kilogram (1 kg) or one pound (1 lb) of total nitrogen per year through the use of nitrogen reduction measures. The rate shall be periodically updated by the Division based on the availability of new cost or effectiveness data. The rate shall be: twenty-three dollars per kilogram per year ($23/kg/year) or eleven dollars per pound per year ($11/lb/year).

(c) The offset payment shall be an amount sufficient to fund 30 years of nitrogen reduction. For loading offset in the wastewater discharge Rule (15A NCAC 2B .0234), payment shall be made prior to permit issuance. For loading offset in the stormwater Rule (15A NCAC 2B .0235), payment shall be made prior to approval of the development plan.

(d) The nitrogen reduction credit associated with restored wetlands and riparian areas funded under this Rule will be awarded exclusively to the person, municipality, discharger or group of dischargers who paid the offset fee.

History Note: *Authority G. S. 143-214.1.*
Eff. August 1, 1998.

Appendix IV

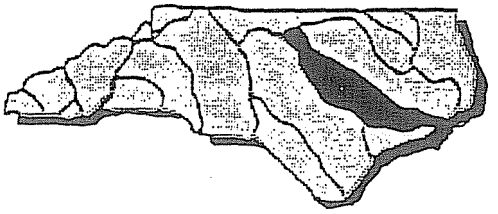
Public Hearing Announcements

ANNOUNCEMENT OF PUBLIC HEARINGS ON THE PROPOSED NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY FOR THE NEUSE RIVER

NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION

When and where will the hearings be held?

Date: September 9, 1996 (Monday), 7:00 P.M.
Location: Raleigh, State Highway Building Auditorium
Address: 11 S. Wilmington Street, Raleigh, North Carolina
Directions: Across from the east side of the Capitol in downtown Raleigh.



Date: September 10, 1996 (Tuesday), 7:00 P.M.
Location: Goldsboro, Wayne Community College, Learning Center Auditorium
Address: 3000 Wayne Memorial Drive, Goldsboro, North Carolina
Directions: From Highway 70 East, take the Wayne Memorial Drive exit to the left, pass a hospital on the right and the college will be on your right.

Date: September 11, 1996, (Wednesday), 7:00 P.M.
Location: New Bern, Craven County Courthouse
Address: 302 Broad St., New Bern, North Carolina
Directions: From Highway 70 East Bypass, take the East Front St., cross the Trent River toward downtown New Bern, make a left at Broad Street, then a right at Craven St. The Courthouse will be on your right.

Date: September 12, 1996, (Thursday), 7:00 P.M.
Location: Kinston, Lenoir Community College Auditorium
Address: 231 Highway 58 South, Kinston, North Carolina
Directions: From Highway 70 East Bypass, take the Highway 58 South exit (toward Trenton). Enter the college from Highway 58 South and the Auditorium will be the first building on the left.

Why are public hearings being held?

In 1988, the Environmental Management Commission (EMC) classified the entire Neuse River Basin as Nutrient Sensitive Waters (NSW). They adopted this classification due to nutrient-related water quality problems in the freshwater sections between Kinston and New Bern. At that time, the EMC adopted a Nutrient Management Strategy to improve water quality in the river. This initial NSW strategy addressed phosphorus reductions through point source controls and nitrogen from the voluntary implementation of agricultural best management practices (BMPs). The strategy was successful and phosphorus loading has declined due to these point source controls and the phosphate detergent ban.

Even with the management measures adopted in the initial NSW strategy, water quality problems in the lower Neuse River continue, especially below New Bern. For example, during July, September, and October 1995, widespread fish kills occurred in the Neuse River, mainly from New Bern to Minnesott Beach. Millions of fish were killed. The water was lacking oxygen near the surface and algal blooms were common.

Because of these continued water quality problems, the EMC intends to revise the NSW strategy and to focus on nitrogen loading to the estuary. The Division of Water Quality (DWQ) is holding public hearings on behalf of the EMC to share the

proposed NSW rules with interested people and to receive public comments. We will accept any comments and suggestions that you have on the proposed rules. We will share your comments and suggestions with the EMC before they make their final decision on what to adopt as rules. Your comments and suggestions can help to make the final set of rules and overall strategy a better solution for all parties involved.

What does the proposed strategy require?

The goal of the proposed strategy is to reduce by 30% the 1991-1995 average annual load of nitrogen from point and nonpoint sources to the river by the year 2001. This decrease in nutrient loading should lessen the water quality problems in the future. The proposed rules would require additional management actions for the following components.

Nutrient reductions for ***point source dischargers*** would reduce the nitrogen load that is directly discharged to the Neuse River and associated streams. The proposed wastewater discharge requirements include:

- Proposed prohibition on new small domestic discharges less than ~~or equal~~ to 0.5 million gallons per day (MGD),
- Proposed total nitrogen and total phosphorus limits for some dischargers in the basin based on type, new or existing status, size, and location within the river basin. Proposed total phosphorus limits for nonindustrial facilities range from 1 to 2 milligrams per liter (mg/l). Proposed total nitrogen limits for nonindustrial facilities would be 6 mg/l. Nutrient limits for existing industrial facilities would be based on a case-by-case determination and best available technology.
- Proposed option for formation of a nutrient trading association below Falls Lake Dam. Members of the Association would receive individual total phosphorus limits and collective total nitrogen loading targets. Nitrogen loading above the nitrogen loading target would require payment for the implementation of best management practices to reduce nutrient loading from other sources in the basin.
- Proposed permit limits and requirement to pay for best management practices to offset their nutrient loading contribution for new dischargers not in the Association.

A program to remove and prevent ***illegal discharges*** would be required for municipal governments having a population greater than 5,000. There are 13 local governments which would need to develop this program.

Two alternatives are proposed for ***stormwater management*** as follows:

- One proposed alternative would be implemented by the state and reduce nitrogen from new development through low and high density development options.
- The second proposed alternative would allow local governments to work with the state to develop a collective stormwater management plan for those portions of the basin not currently covered by an existing stormwater management program (for example, coastal counties, water supply watersheds, outstanding resource waters). If the local government chose not to implement the collective plan for their jurisdiction, then DWQ would implement stormwater management controls for new development through a low and high density development option. The collective plan would address nitrogen reduction from both new and existing development.

Two alternatives are being proposed for ***animal waste management.*** The EMC approved these two alternatives for public hearing before the 1996 North Carolina General Assembly adjourned. During the 1996 session, a bill (Senate Bill 1217) was ratified that establishes a permitting and inspection program for animal operations. The requirements of SB 1217 will render the proposed rule alternatives for animal operations unnecessary. Any animal waste management rules that the EMC adopts as part of the NSW strategy for the Neuse River will reflect the requirements of Senate Bill

1217. Briefly, SB 1217 will require a permitting program using general and individual permits for animal operations based on size of operation. The bill also contains a permit fee schedule, a requirement for yearly inspections by DWQ, and an annual review of animal operations by technical specialists.

Two alternatives are being proposed for ***riparian buffers***. Forested buffers are very effective in reducing nitrogen loading to surface waters, especially from subsurface water flow. They also prevent erosion and stabilize streambanks. Both proposed alternatives would:

- Require a 50-foot buffer along certain streams and other waterbodies. The first proposed alternative would require a forested buffer, while the second proposed alternative would require a vegetated buffer.
- Provide a matrix of width options to account for regional variations in soil type and topography.
- Provide for the formation of an interagency review committee to make site-specific buffer determinations based on providing equivalent protection.
- Allow *exemptions* for streams and ditches not shown on USGS topo maps, existing development, first order ditches (for example, most field ditches), agricultural lands on which both nutrient management and water control structures (with a water management plan) are used, silvicultural ditches and new water dependent structures.
- Allow ***modifications*** to the buffer requirement for agricultural lands on which either nutrient management or water control structures are used, tobacco allotments, maintenance of drainage canals and ditches, and tile drainage.
- Provide an option for voluntary local government assumption of the buffer program.

Two alternatives are being proposed for ***nutrient management***. Nutrient management reduces losses of nitrogen from lands, while increasing the efficiency of nutrient use and improving application timing. It can maintain high crop yields while saving money.

- The first proposed alternative applies to contiguous areas of agricultural land greater than or equal to 250 acres which are under individual or multiple ownership and receiving nutrients.
- The second proposed alternative applies to these same agricultural lands but also to recreational land where nutrients are applied to greater than or equal to 10 acres and land receiving nutrients from commercial applicators.
- Both proposed alternatives require the landowner to be responsible for the nutrient management plan (unless there is a commercial applicator or the responsibility is transferred to a leasee through a written agreement). Commercial applicators would develop generic plans for various types of turfgrass and horticultural settings.

What is the format of hearings?

Five hearing officers have been designated to conduct the public hearings and make recommendations to the EMC for their consideration. After an introduction by the Lead Hearing Officer designated for each hearing, DWQ staff will describe the requirements of the proposed rules. Then the hearing will be opened for public comment on a first-come, first-serve basis, in the order of registration. The Hearing Officer may limit the length of time that you may speak so that all those who wish to speak have the opportunity to do so. In addition to making verbal comments at the hearing, we encourage you to submit written comments. The written comment period will remain open through October 14, 1996.

How can I get more information about the proposed rules and the hearings?

DWQ has prepared several documents to help you understand what the EMC is proposing for the Neuse River NSW Management Strategy. The documents are of varying length and detail, and may be focused on specific aspects of the proposed rules. The following documents are available:

1) Executive Summary of the Concept Paper on the Draft Plan- a nine page summary of the proposed rules.
2) Concept Paper on the Draft Plan- a comprehensive discussion of the proposed rules and overall strategy. Includes a full copy of the proposed rules. (Approx. 260 pages)
3) General Summary of the Draft Plan- a descriptive summary of the proposed rules. Includes a full copy of the proposed rules. (Approx. 100 pages)
4) Executive Summary of the Draft Fiscal Analysis- a 36-page summary of the estimated fiscal impact.
5) Draft Fiscal Analysis- a comprehensive discussion of the estimated fiscal impacts of the proposed rules to local governments, other affected parties and the implementing agencies. (Approx. 300 pages)
6) Accountability Issues- a description of the process that will be used to estimate and measure the progress towards nutrient reduction goals. (Approx. 45 pages)
7) Subject Notice Comments- a summary of verbal comments received at the public workshops held in May 1996 and a copy of written comments received. (Approx. 120 pages)

You may request these documents by calling Marsha Byrd at (919)733-5083, ext 558. If possible, please refer to the document number listed above (for example, #1-#7) when making your request.

How can I submit comments on the proposed strategy?

We will accept your verbal and written comments during the hearings. We will also accept your written comments before or after the hearings, but no later than October 14, 1996. You may submit your comments to :

David Harding
DEHNR/Div of Water Quality
Water Quality Section
Planning Branch
P.O. Box 29535
Raleigh, NC 27626-0535

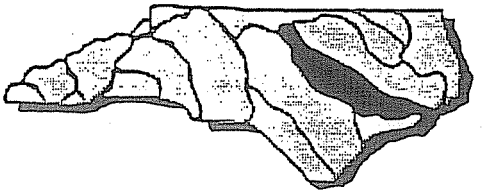
What happens after the hearings?

All interested and potentially affected persons are strongly encouraged to read this entire announcement and supporting information and make comments on the proposed rules. The EMC may not adopt a rule that differs substantially from the text of the proposed rule published in the North Carolina Register unless the EMC publishes the text of the proposed different rule and accepts comments on the new text. (See 150B 21.2(g)) The proposed effective date of the final rules is July 1, 1997.

NUTRIENTS AND THE NEUSE: PUBLIC HEARINGS SET FOR NOVEMBER

Public hearings will be held next month on proposals that could help to improve the health of the Neuse River Basin by the year 2001.

These proposals by the state's Environmental Management Commission (EMC), are designed to achieve a goal of 30 percent reduction in nitrogen loading to the Neuse River estuary by the year 2001. The strategy will center on the use of point source discharge requirements, stream buffers or equivalent Best Management Practices (BMPs), stormwater management, nutrient management, and animal waste management along the 200-mile stretch of the Neuse River and its tributaries.



The public hearings will be held in Raleigh on November 12, New Bern on November 14, Goldsboro on November 19, and Kinston on November 21. Details on the hearing locations and dates are included at the end of this announcement.

The hearings will enable all persons to voice their concerns or support before the EMC makes a decision on the proposals.

BACKGROUND

In 1988, the EMC classified the entire Neuse River Basin as Nutrient Sensitive Waters (NSW). That action, which allows state government to control nutrient pollution that enters the river, was in response to deteriorating water quality of the freshwater sections between Kinston and New Bern.

With this new nutrient management strategy, the EMC dealt with the control of phosphorus and nitrogen in the Neuse River. The phosphorus detergent ban and controls on point sources were successful-- phosphorus loading to the Neuse decreased.

However, the water quality problems persisted, especially below New Bern. Fish were killed by the millions from New Bern to Minnesott Beach in the summer and fall of 1995. Low oxygen concentrations near the surface and algal blooms were common occurrences along that stretch of the Neuse River.

Even with progress made on controlling levels of phosphorus into the river, depleted oxygen levels caused by excessive amounts of nitrogen continue to plague the river, which led the EMC to take a new set of proposals to the public for comment next month.

The core of the proposals will focus on major sources of nitrogen to the Neuse and the best methods of control.

POINT SOURCE DISCHARGERS

The EMC is proposing nitrogen and phosphorus limits for some dischargers in the basin based on type, new or existing status, size, and location within the river basin. Also, it is proposing that no new small domestic discharges less than 0.5 million gallons per day (MGD) be allowed, because these "package treatment" plants have difficulty meeting strict nitrogen and phosphorus limits.

A proposal is included for formation of a nutrient trading association below Falls Lake Dam. Members of the Association would receive individual phosphorus limits and collective nitrogen loading targets. Nitrogen loading above the nitrogen loading target would require payment for the implementation of BMPs to reduce nutrient loading from other sources in the basin.

New dischargers would receive permit limits for nitrogen and phosphorus and would have to pay for BMPs to offset their nutrient loading contribution.

BUFFERS

All land uses contribute nitrogen to the Neuse River. Many landowners are already using BMPs to protect water quality-- but often the BMPs were designed to control erosion and phosphorus and are not very effective in controlling nitrogen, since nitrogen is very soluble and flows into creeks and streams through subsurface flow.

Stream buffers, especially forested ones, have proven to be extremely effective in removing nitrogen from surface and subsurface runoff. Buffers are capable of removing as much as 80 - 90 percent of the nitrogen not captured by other BMPs. More than one million pounds of nitrogen each year could be kept out of streams in the river basin by use of buffers or more efficient BMPs.

Landowners WOULD NOT need a buffer if:

- ⊗ their streams, canals or ditches do not show up on the 1:24,000 scale USGS topographic map; or
- ⊗ both water control structures (with a water management plan) and a nutrient management plan are in effect; or
- ⊗ they have a site-specific combination of existing BMPs that effectively control nitrogen runoff; or
- ⊗ their ditch is small (including hoe drains and field ditches) where drainage waters first enter the drainage system; or
- ⊗ their land is being used for urban development and
  1) does not require an approved Sedimentation/Erosion Control Plan, but is platted and recorded by the effective date of the rules, or
  2) has an approved Sedimentation/Erosion Control Plan by the effective date of the rules.

Reductions to the buffer width will be allowed if either water control structures or nutrient management is used. Modifications are also allowed for site-specific plans that consider regional differences in soil types and topography. In addition, modifications to the buffer width are available for tobacco allotments, maintenance of drainage canals and ditches, or tile drainage. A matrix of alternative buffer widths and BMPs will be provided by the EMC.

If a landowner has difficulty determining which waterbodies may be subject to the buffer requirement, then he (or she) would be able to receive help from a team of advisors who are familiar with the requirements.

The proposal also allows for voluntary local government assumption of the buffer program.

If the conditions for an exemption or reduction of the buffer requirements were not met, then the EMC is proposing two alternatives for a 50-foot buffer along certain streams and other waterbodies, except on agricultural land with equivalent BMPs. The first proposal would require a forested buffer and the second a vegetated (nonforested) buffer.

Please refer to the enclosures for additional information on the buffer proposals.

STORMWATER MANAGEMENT

Two alternatives are proposed for areas in the Neuse River Basin not already covered by existing stormwater management programs. Coastal counties, water supply watersheds and outstanding resource waters already have stormwater management requirements. The first alternative is state-implemented and controls nitrogen from new development through low and high density development options.

The second proposal allows cooperative arrangements with local governments to control nitrogen from both new and existing development.

NUTRIENT MANAGEMENT

Two alternatives are proposed for nutrient management. Both proposals require the landowner to be responsible for a nutrient management plan (unless there is a commercial applicator or the responsibility is

transferred to a leasee through a written agreement). Commercial applicators would develop generic plans for various types of turfgrass and horticultural settings.

One proposal covers nutrient management for agricultural lands based on size of the area. The second proposal applies to these same agricultural areas, as well as recreational land, such as golf courses and parks that are fertilized.

ILLEGAL DISCHARGES

Municipalities with populations greater than 5,000 would develop a program to remove and prevent illegal wastewater discharges. This proposal would address the removal of illegal point sources of pollutants, such as leaking or overflowing sanitary sewers, car washes, household washers and floor drains, to storm drainage systems.

ANIMAL WASTE MANAGEMENT

Two alternatives were approved by the EMC for public hearing before the 1996 North Carolina General Assembly adjourned. During the 1996 session, a bill (Senate Bill 1217) was ratified that establishes a permitting and inspection program for animal operations. The requirements of Senate Bill 1217 will render the proposed rule alternatives for animal operation permitting unnecessary. Any animal waste management rules the EMC adopts as part of the NSW strategy for the Neuse River will reflect the requirements of Senate Bill 1217.

Both alternatives also propose a required 25-foot setback from ditches for spraying and land application of waste. Setbacks from ditches for land application of waste are not addressed in Senate Bill 1217.

ADDITIONAL MATERIAL

Staff of the Division of Water Quality (DWQ) can provide additional material on the proposals and hearings. DWQ has prepared several documents to help you understand what the EMC is proposing for the Neuse River NSW Management Strategy. The documents are of varying length and detail, and may be focused on specific aspects of the proposed rules. The following documents are available:

1) Executive Summary of the Concept Paper on the Draft Plan- a nine page summary of the proposed rules.
2) Concept Paper on the Draft Plan- a comprehensive discussion of the proposed rules and overall strategy. Includes a full copy of the proposed rules. (Approx. 260 pages)
3) General Summary of the Draft Plan- a descriptive summary of the proposed rules. Includes a full copy of the proposed rules. (Approx. 100 pages)
4) Executive Summary of the Draft Fiscal Analysis- a 36-page summary of the estimated fiscal impact.
5) Draft Fiscal Analysis- a comprehensive discussion of the estimated fiscal impacts of the proposed rules to local governments, other affected parties and the implementing agencies. (Approx. 300 pages)
6) Accountability Issues- a description of the process that will be used to estimate and measure the progress towards nutrient reduction goals. (Approx. 45 pages)
7) Subject Notice Comments- a summary of verbal comments received at the public workshops held in May 1996 and a copy of written comments received. (Approx. 120 pages)

You may request these documents by calling Marsha Byrd at (919)733-5083, ext 558. Please refer to the document number listed above (for example, #1-#7) when making your request.

QUESTIONS

Questions concerning the point source discharge requirements can be directed to Coleen Sullins at (919) 733-5083, ext. 550. You may direct other questions to David Harding at (919) 733-5083, ext. 569.

SUBMITTING COMMENTS

We will accept your verbal and written comments during the hearings. We will also accept your written comments before or after the hearings, but no later than December 16, 1996. You may submit your comments to :

David Harding
DEHNR/Div of Water Quality
Water Quality Section
Planning Branch
P.O. Box 29535
Raleigh, NC 27626-0535

All persons interested and potentially affected by the proposals are strongly encouraged to read this entire announcement and supporting information and make comments on the proposed rules. (The EMC may not adopt a rule that differs substantially from the text of the proposed rule published in the North Carolina Register unless the EMC publishes the text of the proposed different rule and accepts comments on the new text. (See General Statute 150B 21.2(g))

PUBLIC HEARING DATES AND LOCATIONS
NEUSE NSW MANAGEMENT STRATEGY

Date: November 12, 1996 (Tuesday), 7:00 P.M.
Location: Raleigh, State Highway Building Auditorium
Address: 11 South Wilmington Street
Directions: The State Highway Building is across from the east side of the Capitol, on the corner of Wilmington and Morgan Streets.

Date: November 14, 1996 (Thursday), 7:00 P.M.
Location: New Bern, Craven County Courthouse
Address: 302 Broad Street
Directions: From Highway 70 East Bypass, take the East Front St., cross the Trent River toward downtown New Bern, make a left at Broad Street, then a right at Craven St. The Courthouse will be on your right.

Date: November 19, 1996, (Tuesday), 7:00 P.M.
Location: Goldsboro, Goldsboro High School Auditorium
Address: Corner of Herman and Beach Streets
Directions: From Highway 70 East, take the Goldsboro High School exit off of Highway 70. Take a right at the top of the exit onto Wayne Memorial Drive. Cross railroad tracks (Wayne Memorial Drive turns into Herman Street), go two blocks and the school is on the left at the corner of Herman and Beach Streets. .

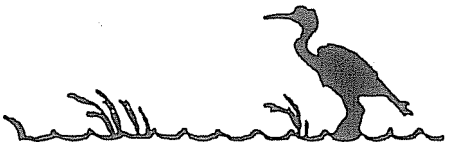
Date: November 21, 1996, (Thursday), 7:00 P.M.
Location: Kinston, J.H. Sampson Elementary School Auditorium
Address: 606 Tower Hill Road
Directions: From Highway 70 East, take Highway 70 Bypass exit toward downtown Kinston. Make a right at Tiffany Street. The School is on the corner of Tiffany Street and Tower Hill Road.

10/8/96

Announcement of Public Hearing on the Proposed Nutrient Sensitive Waters Management Strategy for the Neuse River

North Carolina Environmental Management Commission

Background



Environmental conditions in the Neuse River are driven by complex interactions between rainfall, flows, temperatures, biological factors and chemistry. Each year brings its own variations. However, the long history of problems with nutrient pollution and algal blooms provides solid evidence that immediate control measures are necessary.

In response to these concerns, the Environmental Management Commission (EMC) adopted a draft conceptual Neuse River Nutrient Sensitive Waters (NSW) Management Strategy in February 1996. This proposed draft strategy included a proposed management strategy for point and nonpoint sources of nutrients. In accordance with North Carolina general statutes, four public hearings were held in November 1996. Nine hundred and sixteen people attended the public hearings, with 201 of them making comments at the hearings. In addition to the speakers' comments, DWQ received over 300 written comments on the proposed strategy.

The Neuse River NSW Management Strategy have been revised on the basis of the Hearing Officers' review and analysis of public input from concerned citizens, interested groups and other organizations. The revised strategy was approved by the EMC in June 1997. In accordance with the Administrative Procedure Act, the revised rules will have to be re-noticed and public comment received for a period of 60 days following publication of the final notice due to substantial differences from the originally proposed rules. The public comment period will extend from September 15, 1997 to November 14, 1997. The public hearings will be held in Raleigh and New Bern on October 7. Details on the hearing locations are included at the end of this announcement.

The Revised Rules

The goal of the Neuse River NSW Management Strategy is to reduce by 30 percent the 1991-1995 average annual load of nitrogen from point and nonpoint sources to the Neuse River. To achieve this goal, a number of voluntary and mandatory strategies have been proposed. Below is a list of the revised rules.

Protection and Maintenance of Existing Riparian Buffers

The rule to protect and maintain existing riparian areas was approved and became effective as a temporary rule by the EMC on July 22, 1997. This rule requires that existing riparian (streamside) areas be protected and maintained on both sides of intermittent and perennial

surface waters. **This rule does not establish new buffers.** A total of 50 feet of riparian area is required on each side of certain waterbodies in the basin. This 50 foot riparian area consists of 30 feet of virtually undisturbed forest and 20 feet of grassed/vegetated area or trees that could be harvested. In the basin's larger urban areas, protection of existing riparian areas would be a component of the urban stormwater programs discussed below.

Wastewater Discharges

The purpose of the wastewater discharge requirements for the Neuse River Basin is to establish an equitable strategy that will mandate a cumulative 30 percent reduction in point source total nitrogen loading to the Neuse River Estuary. The strategy provides for several management options from which dischargers may select to comply with the proposed rules. This allows for flexibility in the management approach while maintaining a firm commitment to the 30 percent total nitrogen reduction goal. Dischargers in the Neuse River basin have two options: to meet the new requirements individually, or to join together as an association to meet the 30 percent N reduction collectively. Within each of the two options, dischargers have the flexibility to meet 30 percent reduction goal by optimizing their facility's operation, implementing plant improvements, reducing flows through water conservation and repairing leaky sewers, and paying nitrogen offset fees.

Urban Stormwater Requirements

The basinwide stormwater program requires that 10 cities and five counties (Cary, Durham, Garner, Goldsboro, Havelock, Kinston, New Bern, Raleigh, Smithfield, Wilson, Durham County, Johnston County, Orange County, Wake County and Wayne County) develop a stormwater management plan to address nutrients. The stormwater management plan requires these local governments to review and approve stormwater management plans for new development, implement a public education program, identify and remove illegal discharges to the storm sewer system, identify suitable locations for installing stormwater management practices in areas of existing development, and provide annual nitrogen load reporting. The affected local governments would administer the review and approval of development plans. New developments will be required to maintain a nitrogen loading of 70 percent or less of the 1995 loading and provide no net increase in the pre-development peak flow from the 1-year, 24-hour storm.

Agricultural Best Management Practices for Nitrogen Reduction

Under the revised proposal, persons engaging in agricultural operations in the Neuse River Basin have **two options** for meeting the nitrogen net loading reduction. The options are to either participate in a county nitrogen reduction plan or implement standard Best Management Practices. The two options are as follows:

Option 1 - County Nitrogen Reduction Plan

Farmers may choose to participate in the development and implementation of a countywide plan to reduce nitrogen loading. County Advisory Committees would develop, review and approve site-specific plans for nitrogen, based on the overall County Nitrogen Reduction goal. These committees will be comprised of representatives from the Natural Resources Conservation Service (NRCS), N.C. Cooperative Extension Service (CES), Division of Soil and

Water Conservation (DSWC), N.C. Department of Agriculture (NCDA), local Soil and Water Conservation Districts (SWCD), and a county farmer. The committees would be formed by the Directors of the DSWC and the DWQ.

Option 2 - Standard Best Management Practices (BMPs)
If option 1 is not selected, then the agricultural operation must implement standard BMPs. The standard BMPs include riparian vegetative areas, controlled drainage and nutrient management. These would be required to be established within 4 years of the effective date of the rule.

In addition to the County Advisory Committees, a Basin Oversight Committee will be formed by DSWC and DWQ. This group will have the responsibility of reviewing each county's nitrogen reduction plan. The Basin Oversight Committee would include one representative each from NRCS, DSWC, NCDA, CES, DWQ, an environmental interest group, the scientific community, and a farmer. Additional responsibilities of the Basin Oversight Committee would be to:

- Develop a tracking and accounting method for evaluating nitrogen loading from agricultural sources.
- Review, approve and summarize County Nitrogen Reduction Plans and report findings to the EMC.
- Allocate to counties their individual portion of the nitrogen loading reduction from agricultural operations. Each county may not have to reduce their individual nitrogen loading by 30 percent. However, the nitrogen loading reduction should collectively meet the total nitrogen reduction goal.

Nutrient Management Requirements

What this proposed rule would mean to applicators who apply nutrients to 50 or more acres per calendar year of cropland, golf course, recreational lands, residential, commercial, industrial, right-of-way or other turfgrass areas is:

- Persons must successfully complete nutrient management training and certification delivered by the CES or DWQ within 5 years of the effective date of the rule, -OR-
- Persons will be required to develop and implement nutrient management plans for the lands where nutrients are applied.
- Nutrient management plans must be approved by a technical specialist designated by the Soil and Water Conservation Commission (SWCC).

Additional Material

Staff of the DWQ can provide additional material on the proposals and hearings. DWQ has prepared several documents to help you understand what the EMC is proposing for the Neuse River NSW Management Strategy. The documents are of varying length and detail, and may be focused on specific aspects of the proposed rules. The following documents are available:

1) Report of Proceedings on the Proposed Neuse River Basin Nutrient Sensitive Waters (NSW) Management Strategy (88 pages)

2) Draft Fiscal Analysis - a comprehensive discussion of the estimated fiscal impacts of the proposed rules to local governments, other affected parties and the implementing agencies. (Approx. 170 pages)

You may request these documents by calling Marsha Byrd at (919)733-5083, ext 558. If possible, please refer to the document number listed above (for example, #1 or #2) when making your request.

Questions

Questions concerning the point source discharge requirements can be directed to Coleen Sullins at (919)733-5083, ext. 550. You may direct other questions to Annette Lucas at (919)733-5083, ext. 587.

Submitting Comments

We will accept your verbal and written comments during the hearings. We will also accept your written comments before or after the hearing, but no later than November 14, 1997. You may submit your comments to:

Lin Xu
DEHNR/Division of Water Quality
Planning Branch
P.O. Box 29535
Raleigh, NC 27626-0535

All persons interested and potentially affected by the proposals are strongly encouraged to read this entire announcement and supporting information and make comments on the revised rules. The proposed effective date of the final rules is August 1, 1998.

Public Hearing Dates And Locations

Date:	October 7, 1997 (Tuesday), 7:00 P.M.
Location:	Raleigh, State Highway Building Auditorium
Address:	11 S. Wilmington Street, Raleigh, North Carolina
Directions:	Across from the east side of the Capitol in downtown Raleigh

Date:	October 7, 1997 (Tuesday), 7:00 P.M.
Location:	New Bern, Craven County Courthouse
Address:	302 Broad St., New Bern, North Carolina
Directions:	From Highway 70 East Bypass, take the East Front St., cross the Trent River toward downtown New Bern, make a left at Broad Street, then a right at Craven St. The Courthouse will be on your left.

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Appendix V

Summary of TMDLComments

Most commenters supported the 30 percent reduction in total nitrogen. Although no one stated that they believed a 30 percent reduction would indeed restore water quality given the complexity of estuarine systems, in general, people believed that it was a good goal until more information including modeling analyses were available to modify that goal. One group, the Neuse River Foundation (NRF), commented during each public meeting that a fifty percent reduction was needed to restore water quality in the Neuse River Basin.

To support their findings, the NRF submitted numerous statistical analyses of water quality data on the Neuse River, but none of them indicated that a 50% reduction in nitrogen loading was needed to restore water quality. Early statistical analyses submitted were an attempt to show that nitrogen loading has increased substantially in the past few years in the Neuse River Basin. Our analyses have shown no short term trend in total nitrogen. In any trend analysis, the period of record selected affects the results of the analysis. The period of record analyzed by the NRF showed that nitrogen has increased. If different time periods are chosen, some of them more recently than those anlayzed by the NRF, a significant downward trend is predicted in total nitrogen loading.

The most recent NRF analysis compared current nitrogen loading in the Neuse River to nitrogen loading in pristine watersheds. These watersheds were described as being forested with no urban development, agriculture or roads, and very different from the Neuse River estuary. This NRF report contained other conclusions contested by DWQ that are summarized in memos.

In addition to reviewing the NRF reports, DWQ reviewed other literature to determine if there was other evidence concluded a 50% reduction in total nitrogen loading was warranted in the Neuse River Basin. Two were reviewed that indicated that load reductions higher than 30% may be needed. The first was a study performed by Paerl (1987) that involved dilution assay work in the Neuse River. This study indicated that a 30% reduction in inorganic nitrogen loading was needed to reduce algal blooms. The second was a study by the US Geological Survey that indicated that a 50% reduction in total nitrogen concentration is needed in the Neuse estuary.

Various groups and researchers have indicated that if a 30% reduction in nitrogen was needed in 1987, a greater reduction is needed now since nitrogen load has likely increased in the basin since the late 1980s (Paerl and Pinckney, Undated). DWQ has performed a seasonal kendall statistical test on nitrogen loads at Kinston over two short time frames. The first was done on the time frame the NRF submitted from 1988 to 1993, and this time frame does show a significant upward trend in nitrogen loading at Kinston (Figure 1). Alternatively, selecting 1990-1995 results in a statistically insignficant downward trend in nitrogen load at Kinston (Figure 2). Draft trend analyses by Stow and Borsuk (1998) indicate that nitrogen has not increased in the Neuse River at Kinston. Ratios of median nitrate concentration for the period 1988-97 to the median nitrate concentration from 1979-1987 is approximately 1 which indicates that nitrate has not increased in the last ten years. Ratios of the median total kjeldahl nitrogen (TKN) for 1988-97 to 1979-1987 are actually less than one showing a decrease in TKN

Figure I TN Trend at Kinston for Short period (Wagner match) Residuals of log - log flow model

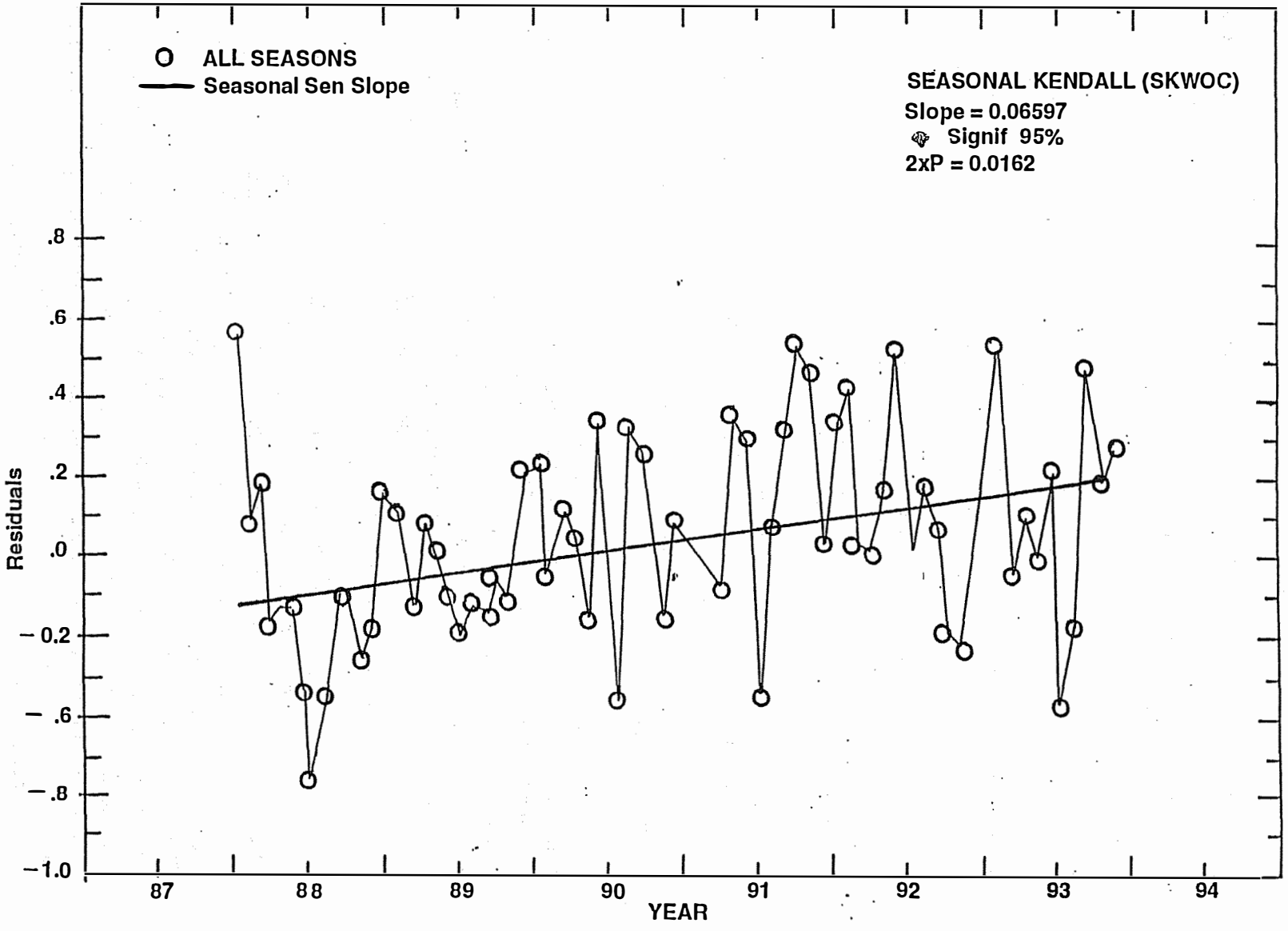
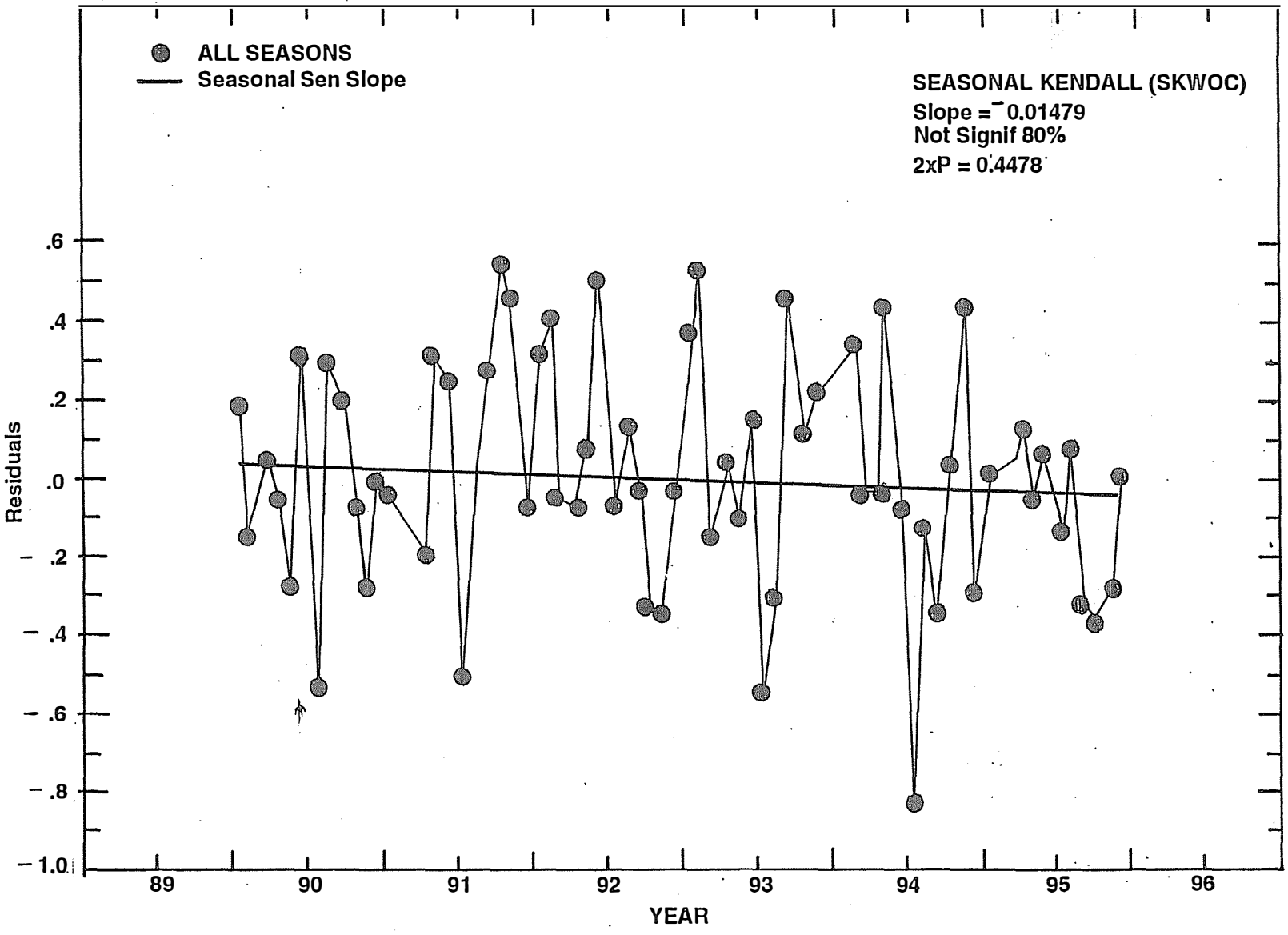


Figure 2. TN Analysis at Kinston for Short period Residuals of log - log flow model



concentrations in the past ten years. Total nitrogen, the sum of nitrate-nitrite and TKD, must also be around 1 or less, indicating no increase in the past 10 years.

Since the information using actual statistical tests does not show an increase in total nitrogen in the past ten years except for periods when there was a substantial increase in flow, it was determined that nitrogen loading in the Neuse Basin at Kinston has not substantially increased. Therefore stating that Paerl's dilution assay work now supports a higher reduction in load is not valid based on the trends observed in the data. Loads from individual sources may have increased, but most of it is lost or decayed by the time it reaches Kinston.

Recent dilution assays by Piehler and Paerl in the estuarine portion of the basin support a 30% reduction in total nitrogen for this phase of the TMDL. This work is summarized in the body of the TMDL report.

The other source that indicated that a 50% reduction in total nitrogen may be warranted was a report written as part of the National Water-Quality Assessment (NAWQA). The U.S. Geological Survey (Spruill et al. 1998) indicated that a 50% decrease in total nitrogen concentration was needed in the Neuse River. This conclusion was based on an optimum nitrogen to phosphorus (N:P) ratio of 7:1. This approach does not consider that species differ in their optimum nutrient ratios for growth. Further, the USGS assumed that a N:P ratio of 7:1 was representative of algae communities in the Neuse River system. There is no evidence or documentation to support this assumption. Hecky and Killiam (1988) indicates that optimum N:P ratios for marine species are higher than 7:1. Higher N:P ratios result in a higher demand for nitrogen for growth and thus the nitrogen reduction target would potentially be lower than 50% for optimum growth using the procedure employed by USGS.

Since no literature was found that determined that a 50% reduction in total nitrogen was needed to restore water quality in the Neuse River, the DWQ did not modify the loading target.

Other comments were received on the increase in animal operations in the basin and the potential subsequent increase in nitrogen loads from the atmosphere and groundwater. Since the TMDL is written as a 30% reduction in total nitrogen from all sources, regardless of whether they are controllable or not, this comment is moot. The baseline load calculation was based on measured instream values for flow and concentration and thus included all sources including groundwater and the atmosphere. Increases from atmospheric or groundwater sources will have to be offset by decreases in nitrogen load from other sources by amounts greater than 30% in order to meet the loading targets. As growth continues in the basin, it will become more difficult to meet the 30% reduction targets, but nitrogen removal technology from point and nonpoint sources may also improve with time.

Direct atmospheric deposition on the open water will be a much greater percentage than the deposition on open water above New Bern since the open water surface area is much

greater. To protect water quality in the lower basin, loading from atmospheric sources will need to be curtailed or reduced. There are several state and federal initiatives underway that should reduce atmospheric nitrogen loads that are highlighted in the body of the report. Much research is ongoing in atmospheric loading, and this data will be used to update the TMDL in the future.

As a result of public comments, the nonpoint source nitrogen allocation was recalculated. Initially, nonpoint source nitrogen loads were determined from the 1987 LANDSAT information. Commentors indicated that more recent land use information was available with the 1993-95 satellite imagery. DWQ used this information to modify the partitioning of the nonpoint source baseline loads. In addition, nitrogen reductions were to be made from forested areas as well as other nonpoint sources. Many commentors indicated that further reductions could not be made on forested land, and the reductions needed from these lands was allocated to the urban and agricultural sources.

All other comments on the TMDL related to the implementation plans outlined in the rules. Significant changes were made to the implementation rules, and the rules were subsequently taken to a second public hearing.