TAR-PAMLICO RIVER BASINWIDE WATER QUALITY MANAGEMENT PLAN

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This document was approved and endorsed by the North Carolina Environmental Management Commission on December 7, 1994 to be used as a guide by the NC Division of Environmental Management in carrying out it Water Quality Program duties and responsibilities in the Tar-Pamlico River Basin. It will be updated in 1999.

FORWARD

The Tar-Pamlico River system is a major tributary to Pamlico Sound. Together, Pamlico Sound and neighboring Albemarle Sound constitute one of the most productive estuarine systems in the country and are a part of the US Environmental Protection Agency's National Estuary Program.

The Tar-Pamlico Basin encompasses the relatively undeveloped 5440-square mile watershed of the Tar-Pamlico River system and a large part of Pamlico Sound. It extends from the north central Piedmont region of the state to the Atlantic Ocean. It includes portions of 16 counties and has a population of approximately 365,000 people. It also provides habitat for at least nine state or federally listed threatened or endangered freshwater mussel species and includes all or part of three national wildlife refuges.

Despite the rural character of the basin, there are a number of water quality problems that need to be addressed. Almost one third of the freshwater streams in the basin are considered impaired. Major causes are sediment, low pH and fecal coliform bacteria. Several lakes are impaired due to excessive nutrients. In the estuarine waters, over 50,000 acres do not fully support their uses. Problems in the estuary include occurrences of algae blooms, fish kills, toxic dinoflagellates, diseased crabs and fish and closed shellfish waters.

A large portion of the estuarine problems have been linked to an overabundance of nutrients from agricultural and urban runoff, wastewater treatment plant discharges and atmospheric deposition. Nutrients, which occur in fertilizers, human and animal wastes and air pollution, can promote excessive algal growth, called blooms. These blooms, in turn, can deplete the water column of oxygen thereby causing fish kills. In addition, nutrient overenrichment has been linked with the occurrence of blooms of toxic dinoflagellates that have recently been implicated in fish kills.

The nutrient problem in the basin has been known for a number of years and significant actions have been taken to address it. The entire basin was supplementally classified as nutrient sensitive waters (NSW) by the North Carolina Environmental Management Commission in 1989. As a result, nutrient reduction goals were established for wastewater treatment plant discharges, and an innovative nutrient trading approach was developed in an agreement between major dischargers, environmental groups and the state. In addition, Texas Gulf, a company which mines phosphate rock at a site near the southern shore of the Pamlico River has reduced its discharge of phosphorus by 93% since 1988. Despite the fact that the dischargers have been able to meet their nutrient reduction goals through Phase I of this agreement, intensive modeling of the Pamlico River estuary indicates that a significant reduction in nitrogen from both point and nonpoint sources will be needed if water quality standards are to be restored. An interim goal of a 30% reduction in nitrogen loading at Washington has been recommended.

This plan addresses the major water quality issues of the basin. It draws on extensive data compiled by university and private researchers, the North Carolina Division of Environmental Management and the Albemarle-Pamlico Estuarine Study. It includes recommendations for meeting nutrient reduction goals, for protecting dissolved oxygen standards and for reducing sedimentation. It stresses the need to protect and reopen shellfish waters, to preserve habitat for endangered species and to control nonpoint sources of pollution. Finally, in addressing the control of nutrients from nonpoint sources, it emphasizes the importance of further research, public education, identification of cost-effective solutions, cooperation and innovation.

DEM is doing its best to address these issues through its basinwide approach and has considered these and other issues identified by workshop participants in developing its basin plan. A more complete summary of the workshops is provided in Appendix V.

TAR-PAMLICO BASIN OVERVIEW

The Tar-Pamlico River Basin stretches 180 miles from its headwaters in the north central Piedmont portion of North Carolina to the Atlantic Ocean (Figure 1). The basin, encompassing 5440 square miles, is the fourth largest river basin in North Carolina and is one of only four of the 17 major river basins in North Carolina whose boundaries are located entirely within the state. There are 2,355 miles of freshwater streams in the basin, 634,400 acres classified as salt waters and thousands of acres of impoundments including Lake Mattamuskeet, the largest natural lake in the state. Part or all of three national wildlife refuges are located in the basin (Lake Mattamuskeet, Swanquarter and Pocosin Lakes National Wildlife Refuges).

The Tar-Pamlico River basin originates in Person and Granville Counties west of Interstate 85. The upper portion of the river from its headwaters downstream to US Highway 17 in the Town of Washington is called the Tar River. From Washington to Pamlico Sound it is called the Pamlico River. Major tributaries include Swift Creek, Fishing Creek, Cokey Swamp, Tranters Creek and the Pungo River. Most of the Tar River is fresh and free-flowing. Tidal influence begins near Greenville. The Pamlico River is entirely estuarine.

The population of the basin, based on 1990 census data, is approximately 365,000. The basin encompasses all or part of the following 16 counties: Beaufort, Dare, Edgecombe, Franklin, Granville, Halifax, Hyde, Martin, Nash, Pamlico (<5%), Person, Pitt, Vance, Warren, Washington and Wilson. Municipalities with a population of 5,000 or more include Washington, Rocky Mount, Tarboro, Oxford, Greenville and Henderson. The overall population density of the basin is 80 persons per square mile versus a state average of 127 persons per square mile. The percent population growth over the past ten years (1980 to 1990) was 7.9 % versus a statewide percentage increase of 13.1%. However, cities such as Greenville and Rocky Mount have experienced 10-year percentage increases in population of 26% and 18%, respectively.

Average rainfall in the basin ranges from less than 44 inches per year in the Piedmont area to more than 50 inches per year near Pamlico Sound. The average July temperature is just under 80°F while the average January temperature ranges from 46°F near Pamlico Sound to 42°F in the upper basin. The evapotranspiration rate for the basin is about 40 inches per year.

Land cover, based on 1987 Landsat satellite imagery, is dominated by agriculture (33.6%) and forests (29.6%) which jointly comprise a little less than two-thirds of the land/water surface area in the entire basin. Open water (19.7%) and wetlands (11.4%) comprise slightly less than one third of the total area. The remaining land is made up of scrub growth (3.4%), urban area (1.8%) and barren land.

The upper one-fifth of the basin, or that area generally encompassed by Franklin, Warren, Vance, Granville and Person Counties, is located in the Piedmont physiographic region. That portion of the basin east of this area is located in the Coastal Plain region. The Piedmont is typified by highly-erodible clay soils; rolling topography with broad ridges and sharply indented stream valleys; and low gradient streams composed of a series of sluggish pools separated by riffles and occasional small rapids. Stream floodplains are relatively narrow and mostly forested. There are no natural lakes in the Piedmont region. Soils in the region are underlain by a fractured rock formation with little water storage capacity which offers only a limited supply of groundwater.

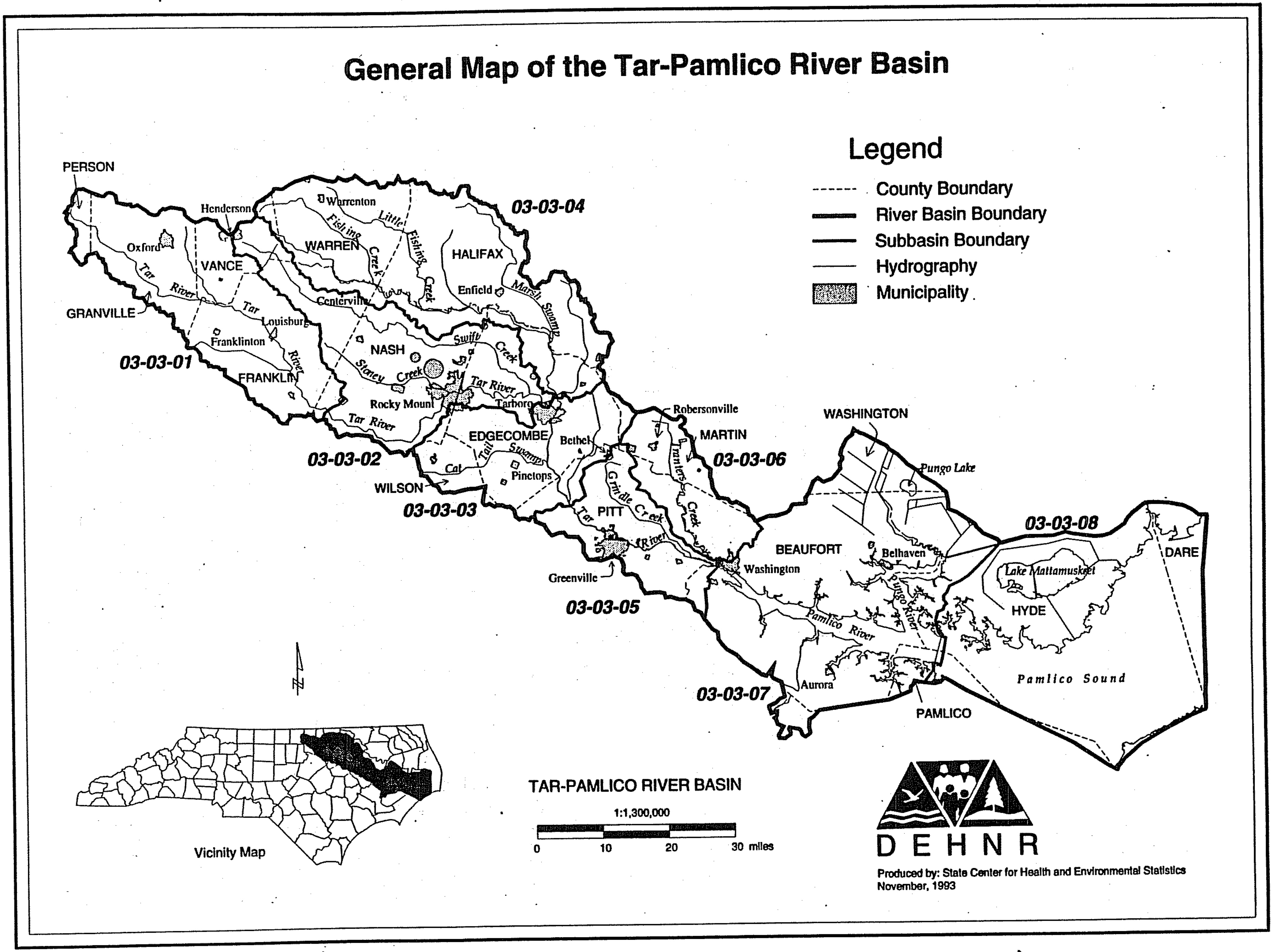

Figure 1 General Map of the Tar-Pamlico River Basin

interpret because of the possible influence of saline water. Several euryhaline benthic taxa are often collected at this location.

Very few biological investigations have been conducted on the tributary streams of the Pamlico River, due to the swampy nature of the streams. The only fisheries data are from Horse Creek, which had a Fair-Good rating. Some benthos data have been collected from estuarine sites, but no water quality ratings are associated with these data. Lakes data note that Pungo Lake is a dystrophic lake. Lake Mattamuskeet, the largest natural lake in North Carolina, is classified as fully supporting its designated uses.

The estuarine portion of the basin has been the focus of a variety of research efforts since the early 1970's, and especially since 1988 in conjunction with the Albemarle-Pamlico Estuary Study (APES). The APES program is one of the US Environmental Protection Agency's nationwide estuary programs, and it has generated a number of research projects. Highlights of some of that research can be found in the Phytoplankton and Water Quality part of Chapter 4 of this report. Much of this research has been aimed at describing nutrient and phytoplankton interactions, documenting water column stratification and occurrences of hypoxia and anoxia, determining the distribution and behavior of a toxic dinoflagellate (to be named Pfiesteria piscimorte), and investigating nitrogen and phosphorus cycling.

Numerous phytoplankton samples have been collected by DEM from the Pamlico River and Pamlico Sound. Where the Pamlico River typically becomes brackish near Washington, phytoplankton populations were comprised of a diversity of algal classes. This station supports both fresh and brackish water species of algae since the fresh-brackish water interface migrates depending on flow and winds. Downstream, phytoplankton communities at mainstem stations were comprised of typical estuarine phytoplanktors including bacillariophytes, dinoflagellates and cryptophytes. Small filamentous cyanophytes and bacillariophytes were also common by density estimates. Mainstem stations often exhibited algae blooms during the summer. In addition, these stations exhibited winter blooms of cool weather dinoflagellates, Heterocapsa triquetra and Prorocentrum minimum. These dinoflagellate blooms cause little concern during winter months because sufficient oxygen is present in the water column even with high levels of algal respiration. Data from phytoplankton samples are almost always below bloom thresholds from the ambient station in the lower Pamlico River estuary. Ambient water quality data show low nutrient values for this area.

There is one major Outstanding Resource Water (ORW) area in the lower Pamlico River estuary. It is located in the Swanquarter National Wildlife Refuge, which includes Swanquarter Bay, Juniper Bay, Shell Bay and most of their tributaries. Some creeks in this subbasin, including Far Creek, Kitty Creek, Waupopin Creek and Cumberland Creek, have received a High Quality Waters classification because of their designation as primary nursery areas.

WATER QUALITY USE-SUPPORT RATINGS / CAUSES AND SOURCES OF POLLUTION

Another important method for assessing surface water quality is to determine whether the quality is sufficient to support the uses for which the waterbody has been classified by the state. The word *uses*, depending on the classification of the waters, refers to activities such as swimming, fishing, water supply and shellfishing. DEM has collected extensive chemical and biological water quality monitoring data throughout the Tar-Pamlico basin as summarized above. All data for a particular stream segment have been assessed to determine the overall *use support* rating; that is, whether the waters are *fully supporting*, *partially supporting* or *not supporting* their uses. A fourth rating, support-*threatened*, applies where all uses are currently being supported but that water quality conditions are marginal. Streams referred to as *impaired* are those rated as either partially supporting or not supporting. Use support ratings in the Tar-Pamlico basin, described more fully in Chapter 4, are summarized below for freshwater streams, saltwaters (estuarine areas) and lakes.

Freshwater Streams and Rivers

Of the 2355 miles of freshwater streams and rivers in the Tar-Pamlico basin, use support ratings were determined for 89% or 2088 miles with the following breakdown: 21% were rated fully supporting, 43% support-threatened (for a total of 64% of freshwaters currently supporting uses), 20% partially supporting, five percent not supporting and 11% nonevaluated. In general, subbasins 01, 02, 03, 04, 06 and 07 had a majority of their streams which were either supporting or support-threatened, while subbasins 05 and 08 had a larger percentage of streams which were considered impaired (partially supporting or not supporting their uses).

Probable causes and sources of freshwater impairment were determined for about 87% of the impaired streams. Sediment was the most widespread cause of impairment, followed by low pH and fecal coliform bacteria.

Information on sources of impairment indicated that 520 stream miles (or 92% of stream impaired stream miles) were impaired by nonpoint sources, and 43.5 stream miles (or 8% of impaired stream miles) were impaired by point sources. Agriculture was the most widespread nonpoint source, followed by hydrologic/habitat modification (e.g., stream channelization, drainage ditching, wetlands drainage, etc.), and unknown sources (e.g., general erosion). Forestry and urban activities also contributed substantially to the nonpoint source pollution in this basin. Subbasins 04 and 05 had the highest number of streams thought to be impaired by agriculture and subbasin 05 had the highest number attributed to hydrologic modification.

Salt (Estuarine) Waters

Use support determinations were made for all 634,400 acres of saltwater in the Tar-Pamlico Basin which includes 120,000 acres in the Pamlico River (subbasin 03-03-06) and 514,400 acres in Pamlico Sound and its tributaries (03-03-07). Use support data for all saltwaters are presented in Table 4.7. Data are presented for each of 12 shellfish management areas used by the NC Division of Environmental Health's Shellfish Sanitation Branch (Figure 4.27). In evaluating all 634,400 saltwaters in the basin, approximately eighty-four percent of the saltwaters were rated as fully supporting, 7.1 percent were rated support- threatened and 8.6 percent were rated partially supporting. However, all of the support-threatened and most of the partially supporting waters are located in the Pamlico River. Therefore, while 99.5% of the waters in Pamlico Sound are considered supporting (with only 0.5% partially supporting), just 19% of the Pamlico River's saltwaters are fully supporting with 38% being fully supporting but threatened and 43% being partially supporting.

Chlorophyll *a* was the most widespread probable cause of impairment followed by low dissolved oxygen, and fecal coliform bacteria. Elevated levels of Chlorophyll *a* and fecal coliform bacteria are both indicators of water quality degradation, with the first related to nutrient overenrichment and the second to elevated bacterial levels that require the closure of shellfishing areas. The majority of partially supporting waters were in the upper part of the Pamlico River estuary where these waters were mainly impacted by nutrient overenrichment

Nonpoint source pollution is estimated to be the primary pollution source in 85% of the impaired waters, while point source impacts were identified in 15%. Waters were impacted primarily by multiple nonpoint sources including agriculture, urban runoff, septic tanks and marinas.

Lakes

Four lakes in the Tar-Pamlico Basin, totaling 46,985 acres, were monitored and assigned use support ratings. Of these four, one fully supported its uses, and three were support-threatened. Lake Mattamuskeet is the largest natural lake in North Carolina and at 42,000 acres fully supports its designated uses. It is shallow with no natural outlets and has a maximum depth of only 1.2 meters. Lake Devin and Tar River Reservoir are water supply reservoirs. Both lakes are eutrophic and rated support-threatened due to elevated nutrient levels. Pungo Lake is dystrophic, which means it has humic, tea colored water, that is rich in natural organic matter. It overlies a peat deposit, has no overland tributaries, and is recharged from precipitation and groundwater. Pungo Lake was rated support-threatened due to elevated nutrient levels.

MAJOR WATER QUALITY ISSUES

Several water quality issues emerge as being of particular importance in light of factors such as the degree of water quality degradation, the value of the resources being impacted, the number of users affected or the sensitivity of the resources involved. Those issues considered most significant on a basinwide scale are presented below.

A. **The Tar-Pamlico River basin has exceeded its assimilative capacity for nutrients.**

Due to a combination of hydraulic conditions and nutrient inputs from upstream, the estuary from Washington downstream to the Pungo River is experiencing degradation from excessive nutrient loadings, especially nitrogen. Algal blooms are common in the middle reaches of the estuary, and winter blooms regularly occur. Lack of dissolved oxygen near the bottom of the sound has been responsible for the die-off of bottom dwelling (benthic) organisms. This condition occurs during periods of water layer stratification (no mixing of waters between the top and bottom layers) and warm temperatures. To address this problem, and based on the results of extensive computer modeling of nutrient loadings and their impacts on the estuary, an interim of reduction goal of 30% for total nitrogen (TN) and maintenance of existing total phosphorus (TP) loading at Washington are recommended for the Tar-Pamlico River Basin. With a 30% overall reduction in nitrogen loading, the targeted annual nitrogen loading at Washington would be 1,361,000 kg/yr. The annual TN reduction goal from all sources, at Washington, is 583,000 kg/yr (1,800,000 kg/yr - 1,361,000 kg/yr = 583,000 kg/yr). The targeted annual loading of phosphorus would be maintained at 180,000 kg/yr at Washington.

Nonpoint source nutrient reductions needed to achieve nutrient reduction goals. The nutrient loading described in Chapter 3, based on the export coefficient model, indicates that point sources contribute only 5% of the total nitrogen in the entire basin and approximately 8% of the total nitrogen in the basin upstream from the estuary (subbasins 01 through 06). Nonpoint sources therefore account for 92% of the TN loading from subbasins 01 through 06. Based on the overall annual TN reduction goal of 583,000 kg/yr at Washington from all sources, annual point and nonpoint source reduction goals at Washington are as follows:

Point Sources = 46,640 kg/yr (583,000 kg/yr x .08)
Nonpoint Sources = 536,350 kg/yr (583,000 kg/yr x .92)

Therefore, in order to meet the nitrogen loading targets, nonpoint source controls will need to be implemented along with continued efforts by point sources dischargers to reduce their nutrient loadings.

Recommendations established for point and nonpoint sources under Phase II of the NSW strategy with the Tar-Pamlico Basin Association. The Division has negotiated a Phase II NSW Agreement which outlines loading targets for both point and nonpoint nutrient sources. Parties to the agreement include the Association, DEM and the NC Division of Soil and Water Conservation. It also outlines other actions Association dischargers have agreed to take to reduce nutrient loading in the basin. The fact that the majority of the nutrient loading in the basin is from nonpoint sources has been addressed in the Agreement. The Agreement contains a commitment by the Division of Environmental Management to convene and coordinate meetings with appropriate groups and agencies to establish a coordinated and focused plan to achieve the required nonpoint source nutrient reductions. This additional strategy that will provide further details of how such reductions are to achieved by nonpoint sources and the accounting of such actions is to be established by September, 1995.

Priority management areas for nonpoint source nutrient reductions are recommended. Agencies other than DEM have jurisdiction over many of the nonpoint source programs. In order to provide guidance in prioritizing areas in need of BMPs, a list of streams with high areal loadings is given here. This list should also be used by DEM to prioritize waterbodies for 319 project moneys as they become available to the state. This prioritized list is as follows: Swift Creek, Conetoe Creek, Cokey Swamp Creek, Tranters Creek and the Tar River Estuary

Nutrient management plans are recommended for agricultural lands. In addition to the strategies listed above, the mass balance model described in chapter 3 indicated that on average, 40% of the nitrogen applied as fertilizer is lost to the environment. Research should be done to see if this number can be reduced. Information assimilated through the Chesapeake Bay program indicates that nutrient management is one of the least costly methods to reduce nutrient loading and, when combined with other BMP practices, is very effective at reducing nutrients.

A nonpoint source BMP database needs to be developed. During the next five years, DEM should continue to work with the nonpoint source agencies to develop a good database on the type, location and effectiveness of BMPs.

Voluntary implementation of nutrient BMPs is preferred over mandatory controls. To make this happen, there needs to be a concerted effort to educate the nonpoint source contributors on the importance of reducing nutrient loading, to encourage further voluntary participation in the BMP programs, and to provide them with cost-effective options. Education may be conducted through the NC Cooperative Extension Service, Soil and Water Conservation Districts, Farm Bureau, NC Department of Agriculture and others. Cost share opportunities are offered through the USDA Agricultural Stabilization and Conservation Service and the NC Agricultural Cost Share Program. DEM will need assess the need for mandatory nonpoint source control measures during updating of the basin plan in 1999.

Development of cost effective measures and new technologies needs support. DEM should also work with the appropriate agricultural agencies to obtain better information on best management practice (BMP) cost/effectiveness to supplement research such as that being done by Research Triangle Institute. A portion of federal 319 nonpoint source funds and cost share moneys should be used to perform site specific monitoring before and after BMPs are implemented. These studies will provide data specific to the North Carolina coastal plain to help develop cost effective nutrient management strategies.

Performance monitoring is needed to evaluate the effectiveness of recommended nutrient reduction strategies. An instream monitoring plan should be developed during the next year which will allow DEM to evaluate these recommended management strategies. As part of this monitoring network, a USGS gaging station should be located between Grimesland and Tarboro, and monthly ambient data including the nutrient series should be measured there. This will give the Division accurate loading estimates at Greenville. The Division should also consider setting up gages to obtain better flow information in the estuary as this will allow the model hydrodynamics to be recalibrated so the model can be used to evaluate nutrient control strategies in the lower portion of the basin. In addition, extensive monitoring should continue throughout the estuary.

Further studies on the fate and transport of nutrients are recommended. Finally, a long term goal should be to develop methods to perform fate and transport modeling to examine how nutrients are assimilated instream. Current models available in the Tar-Pamlico Basin do not allow one to determine what percentage of nutrients which run off into a stream in the upper portion of the watershed actually is transported to the estuary. If estuary data indicate that problems are still prevalent in the estuary after loading targets are met, it may be prudent to develop a more sophisticated modeling tool.

B. Lack of assimilative capacity for oxygen-consuming wastes

Maintaining adequate dissolved oxygen in surface waters is critical to the survival of aquatic life in the Tar-Pamlico Basin. Over the past twenty years, tremendous progress has been made in reducing the amount of oxygen-consuming wastes discharged into surface waters from wastewater treatment plants (WWTPs). While the total daily effluent flow from these facilities has increased by 67% over the past 20 years, the actual daily loading of oxygen-consuming wastes has decreased by 63%. Despite these overall improvements, point source control strategies are being recommended for several areas of the basin in order to prevent violations of dissolved oxygen standards in the receiving waters associated with new or expanding WWTPs.

Fishing Creek and its tributaries in and around Oxford - Although few DO violations have been observed by the City in recent years, the City of Oxford's existing NPDES permit limits were based on the Division's old empirical model, and the new model indicates that more stringent limits are needed to protect water quality during critical low flow conditions. If the City expands or modifies its treatment plant, more stringent limits would be recommended for the facility. Any proposed and expanding dischargers in the basin should examine the feasibility of connecting to Oxford before they receive a permit.

Tar River mainstem between Rocky Mount and Greenville - Substandard DO concentrations have been measured in the Tar River between Rocky Mount and Greenville. In order to evaluate the effects of point source dischargers on the instream dissolved oxygen concentration in the freshwater portion of the river, a QUAL2E model was developed from Rocky Mount to Greenville, a distance of approximately 60 miles. Two major NPDES dischargers, Rocky Mount and Tarboro, were included in the model. In light of the modeling results, it is recommended that Rocky Mount receive advanced tertiary limits (5 mg/l BOD5, 2 mg/l ammonia, 6 mg/l DO) for its expansion request to 21 MGD. These stringent limits are necessary to protect the Tar River mainstem below the City's discharge.

For other dischargers in this segment of the river, since the Tar River has already been overallocated, and DO violations have been observed, no new or expanded discharge should receive limits less stringent than 15 mg/l BOD5, 4 mg/l ammonia, and 5 mg/l DO.

Tranters Creek and several of its tributaries - The Town of Robersonville and Eagle Snacks Company discharge into Flat Swamp which drains into Tranters Creek. A QUAL2E model was calibrated for this section of stream which indicated that assimilative capacity is limited. Each of the above dischargers was assigned advanced tertiary limits based on the modeling analysis. In addition to the modeling results, substandard DO concentrations have been observed at an ambient site in Tranters Creek. Due to the limited assimilative capacity, it is recommended that no new dischargers should be allowed into Flat Swamp and the upper portion of Tranters Creek (to Turkey Swamp Creek).

Kennedy Creek at Washington - Dissolved oxygen standard violations have occurred in Kennedy Creek. The City of Washington discharges into the creek. Due to poor natural flow, the effluent remains in the creek contributing to the water quality standard violations. The City of Washington has not been allowed to expand its discharge and is in the process of planning the removal of its discharge from the creek. If the City does not relocate, no flow expansion will be permitted and limits of 5 mg/l BOD_5 and 2 mg/l NH_3 will be included in its NPDES permit. No new discharges shall be allowed to Kennedy Creek.

Outstanding Resource Waters (ORW) at Swanquarter National Wildlife Refuge - The Swanquarter Bay and Juniper Bay area have been designated as outstanding resource waters (ORW). No new or expanded NPDES discharges are allowed in this area.

Discharges to Swamp Waters - Many of the streams in the Tar-Pamlico River Basin are classified as swamp waters. DEM does not have a good tool to evaluate the ability of these streams to assimilate oxygen-consuming wastes as our desktop dissolved oxygen model assumes a steady-state, one-dimensional flow, and these conditions may not exist in a swamp water. In addition, data analysis on the previously-studied Lumber River basin indicated that critical flow conditions in a swamp system do not necessarily occur during low flow conditions. Inadequate flow and water quality data prevent verification of the relationship between flow and dissolved oxygen in many of the tributaries which are classified as swamp waters. Given the difficulty of determing the assimilative capacity of swamp waters, DEM has identified the need to develop a better tool to evaluate the ability of a swamp system to assimilate waste flow. Since the large influx of flow from a pipe may have a larger impact on these systems than actual treatment levels, DEM will be investigating the potential for innovative outfall designs which will allow a slower release of effluent to the system. Until these studies are completed, new discharges will not be permitted at limits greater than 15 mg/l BOD_5 and 4 mg/l NH_3-N (NH_3-N may be lower if dilution is low). More stringent limits may be given if, in the opinion of the Director, they are needed to protect water quality standards. For existing non-expanding facilities, existing limits will be recommended unless site specific information is available which indicates more stringent limits are needed. For expanding facilities, it will be recommended that existing loading (mass basis) be maintained although flow increases may be allowed.

C. Shellfish Water Closures due to fecal coliform bacteria

Approximately 10,000 acres of shellfish waters in the Tar-Pamlico River Basin have been closed to harvesting by the NC Division of Environmental Health's Sanitation Branch due to elevated levels of bacteria. Nonpoint source pollution is reported to be the pollution source for 85% of the impaired estuarine waters with point sources accounting for the remaining 15%. Probable sources of the fecal coliform contamination include urban runoff, septic tanks, agriculture, marinas, commercial forestry and wastewater treatment plants.

There are four new efforts underway that may provide additional protection of shellfish waters. The first is a new coastal nonpoint pollution control program being developed by the NC Division of Coastal Management under requirements of the Coastal Zone Act Reauthorization Amendments (CZARA). It is unclear to what extent these rules would reduce bacterial loadings from existing land uses, particularly developed areas, however, they may be able to strengthen requirements aimed at controlling pollution from new development through more effective density controls and/or use of BMPs. These rules are in the process of being drafted and are to be completed in 1995. The second approach is the Governor's Coastal Futures Committee initiative. This initiative is taking a close look at coastal problems, including the closure of shellfish waters. Third, the Comprehensive Conservation Management Plan (CCMP) prepared under the Albemarle - Pamlico Estuarine Study includes recommendations for addressing closed shellfish waters. Finally, DEM is working on development of a new supplemental water classification, called use restoration waters (URW), that would be assigned to the watersheds of waters that are not supporting their uses. If adopted, reclassification of waters to URW would follow the same formal procedures as for other surface waters reclassifications. The reclassification would include preparation of a watershed plan that would stipulate specific BMPs that would need to be implemented to restore uses to the subject waters.

D. Sediment-related stream impairment

Sediment is the most widespread cause of water quality use support impairment in the Tar-Pamlico River Basin. Significant sources include agricultural activities, road construction, urban development, timber harvesting and mining. There are 19 programs administered by various local, state and federal agencies which have been developed to control sediment from these activities (Table 6.3 of Chapter 6). Without these programs, sediment-related water quality impacts would undoubtedly be much worse. However, despite the combined efforts of all of the above programs there were still 387 miles of streams in the Tar-Pamlico Basin estimated to be impaired by sediment, thus pointing to the need for continued overall improvements in erosion and sediment control. Most of the programs referenced above and listed in Chapter 6 are the responsibility of agencies other than DEM. DEM is using the basinwide approach to draw attention to this issue to work more closely with the responsible agencies to find ways of improving erosion and sediment control.

Recommendations for Improving Erosion and Sediment Control

- Promote more effective implementation and especially maintenance of erosion and sediment control measures by contractors, farmers and other land owners.
- Evaluate effectiveness of enforcement of existing sediment control programs. Implement improvements that can be made with existing resources and/or identify additional resource needs.
- Encourage more widespread adoption of erosion and sediment control programs by local governments in rapidly developing areas.
- Promote public education at the state and local level on the impacts of sedimentation and the need for improved sediment control.
- Evaluate existing sedimentation and erosion control rules and statutes for possible strengthening. Consideration should be given to strengthening erosion control requirements. Examples include limiting the area of disturbed land on a given site and reducing the time period for reestablishing vegetation on denuded areas than currently required.
- Evaluate loopholes in interagency efforts to enforce sediment control measures, particularly as they relate to forestry and agricultural activities.

E. Toxic dinoflagellate

A small dinoflagellate that commonly occurs in the Tar-Pamlico River estuary has proven to be toxic and may account for many previously unexplained fish kills. The dinoflagellate, to be named Pfiesteria piscimortuis, represents a new family, genus and species. Although present since phytoplankton monitoring by DEM began in the Pamlico estuary in 1984, it was not recognized as a toxic species since it often comprises a small percentage of the algal biomass and is generally found with several other species of dinoflagellates. In addition, many fish kills occurred in conjunction with salt wedges and resultant hypoxia making it difficult to determine the causative agent of the kills. This organism is apparently not always toxic as it has also been found in high numbers without causing fish kills, but recent unpublished data has implicated it in nearly 50% of fish kills in the estuary. It is stimulated by substances excreted by fish, feeds on fish flesh and encysts in the sediments once the fish have died. There is also an apparent stimulatory effect of nutrients (particularly phosphorus) on some growth stages of this organism. The extent to which this growth is the result of direct nutrient stimulation versus preying on smaller algal flagellates whose populations may be increased by nutrient availability will be the subject of further study. Species involved in fish kills in the Tar-Pamlico estuary as a result of this dinoflagellate include menhaden, croaker, spot, eel, flounder, mullet, blue, hogchoker and crab. Other species of fish involved in fish kills associated with Pfiesteria in other North Carolina coastal waters include sheepshead, perch and catfish.

G. Toxic Substances

Research funded by the Albemarle Pamlico Estuarine Study has revealed relatively few toxicity-related water quality problems in the Tar-Pamlico basin. There are a number of toxic sediment hotspots in the Pamlico River estuary, most notably in and around Kennedy Creek. Much of the toxic sediment problem in Kennedy Creek is attributed to discharges that have been removed from creek. Fish tissue data collected by DEM from Pungo Lake and lower Tranters Lake have revealed elevated mercury levels. DEM's Environmental Sciences Branch is conducting a major study throughout much of the state's Coastal Plain to identify the extent of elevated mercury levels in fish tissues.

The general strategy for addressing toxic substances in the Tar-Pamlico Basin and elsewhere across the state involves a combination of prevention, detection and control. Clean up of past abuses is in many cases prohibitively expensive so an effective proactive approach is mandatory. The basin plan describes several point and nonpoint source programs aimed at preventing toxicity problems in surface waters. These include establishment of NPDES permit limits and pretreatment programs for dischargers, requiring of NPDES permits for urban and industrial runoff, in certain circumstances, and implementing nonpoint source control programs such as the NC Pesticide Law.

These programs are then supported by monitoring efforts that are intended to both provide information on the effectiveness of the control programs and to detect problems at an early stage. As examples, aquatic toxicity testing of effluent is required for thirty dischargers in the basin; fish tissue analyses are done to determine bioaccumulation of toxicants in fish; and ambient water quality sampling at strategic locations throughout the basin. Finally, when a problem is detected through monitoring, followup action is taken to address the source.

PRIORITIES FOR STRENGTHENING FUTURE UPDATES OF THE TAR-PAMLICO BASINWIDE MANAGEMENT PLAN

In addition to the recommendations presented above under Major Issues, the following topics have been identified as priorities to be addressed during the upcoming basin cycle. A number of them have been identified through public comment on the plan.

A. Increasing Public Participation and Stakeholder Involvement in the Basinwide Planning Process

Protection and enhancement of water quality is a shared need and a responsibility of all those who work, reside or recreate in the basin. Communication of ideas, conducting research, sharing information, solving problems cost-effectively with minimal regulation, and balancing the needs of various stakeholder groups are all necessary for long-term success. Basinwide planning can assist in meeting these needs but the planning process and products will need to be improved. Below are several recommended improvements to be undertaken during the next basinwide planning cycle for the Tar-Pamlico basin.

- More clearly define the role for citizen participation in basinwide planning
- Ensure active interaction between DEM staff and proposed regional volunteer implementation groups being considered for establishment for this and the other river basins in the Albemarle-Pamlico Estuarine Program area (see item E, below)
- Increase state staff involved in public outreach so as to provide better opportunities for communication between stakeholders and the state
- Produce more user-friendly basin plans and associated reports in order to enhance public interest and understanding in water quality protection.

B. Integration of Water Resources Planning with Water Quality Protection

Population increases and expanding industrial needs will place greater demands on the basin's limited surface water supplies. Reduced instream flows can adversely affect both aquatic habitat and waste assimilative capacity for municipal and industrial dischargers. At the present time, surface water supply needs in the basin are being met, but without adequate planning, towns, agriculture and industry could be faced with crippling water shortages. Consequently, conservation and reuse of water will need to be a priority for all water users in the basin. In this regard, it is recommended that future updates of the Tar-Pamlico basin plan be developed in consonance with long-range water supply planning needs. DEM will rely heavily on input from the NC Division of Water Resources (DWR), as well as from the US Geological Survey and other appropriate sources. DWR is responsible for administering several water supply statutes including the Water Supply Planning law (G.S. 143-355 (l) and (m)), the Registration of Water Withdrawals and Transfers law (G.S. 143-215.22H), the Regulation of Surface Water Transfers Act (G.S. 143-215.221 et seq.) and the Capacity Use Act (G.S. 143-215.11 et seq.). Local water supply plans under the Water Supply Planning Law are to be approved and submitted to DWR by January 1, 1995.

C. Discussion of Groundwater and Wetlands as they Relate to Water Quality

There are currently programs in place aimed at protecting ground water quality and preserving wetlands. However, the link between protection of these resources and surface water quality needs to explored and strengthened in future updates of the plan.

D. Costs Associated with Water Pollution and Control Measures

One of the potential benefits of the basinwide planning process is to utilize predictive modeling and other tools to show the consequences of growth and development activities on water quality, and to develop long-range protection strategies that allow for sustained growth. With sufficient lead time and involvement in the planning process, local governments, industry and others can plan their activities to work in consonance with these strategies.

This first plan for the Tar-Pamlico basin has begun this process through the nutrient modeling effort and identification of the need to reduce nitrogen loading from all sources upstream from the estuary. It has also begun to address the costs of pollution control through the nutrient trading agreements (Phases I and II) and discussion of costs for implementation of various agricultural best management practices. Future updates to the plan will be strengthened by inclusion of social costs of pollution (fish kills, higher water treatment costs, diminished recreational value, etc.) and a comprehensive discussion of other pollution control costs for both point and nonpoint sources of pollution.

E. APES CCMP and the Tar-Pamlico Basin Plan.

Preparation of the Tar-Pamlico Basin Plan has benefited significantly from the availability of research and data collection funded under the Albemarle-Pamlico Estuarine Study (APES) Program. For example, research describing nutrient and phytoplankton interactions, water column stratification, occurrences of hypoxia and anoxia, and nitrogen and phosphorus cycling have been instrumental in allowing the development of the nutrient model for basin. In addition, the APES program has resulted in preparation of a Comprehensive Conservation and Management Plan (CCMP) for the Tar-Pamlico and neighboring basins. Recommendations contained in the CCMP, which was signed by Governor Hunt and the US Environmental Protection Agency in November 1994, can be used to help shape and strengthen the next updated version of the Tar-Pamlico Plan due out in 1999. Finally, the Division is exploring the idea of establishing voluntary regional groups for each river basin in the APES region. These groups would include local government representation as well as positions for a wide array of user groups and state and federal agencies. The groups would have the potential to help target and implement the issues of greatest concern to stakeholders in the basin and to forge the link between the APES program, the CCMP and basinwide planning.

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CHAPTER 1
INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

The purpose of the Tar-Pamlico River Basinwide Water Quality Management Plan (Tar-Pamlico River Plan) is to report to citizens, policy makers and the regulated community on

- the current status of surface water quality in the basin,
- major water quality concerns and issues,
- projected trends in development and water quality,
- the long-range water quality goals for the basin, and
- recommended point and nonpoint source management options.

The Tar-Pamlico River Plan presents strategies for management of point sources and nonpoint sources of pollution. Section 1.2 provides an overview of the plan format to assist in use and understanding of the document. The Tar-Pamlico River Plan is the third in a series of basinwide water quality management plans that are being prepared by the Water Quality Section of the North Carolina Division of Environmental Management (DEM). Plans will be prepared for all seventeen of the state's major river basins over the next five years as shown in Figure 1.1. An introduction to the basinwide management approach and a statewide basinwide permitting schedule are presented in Section 1.3.

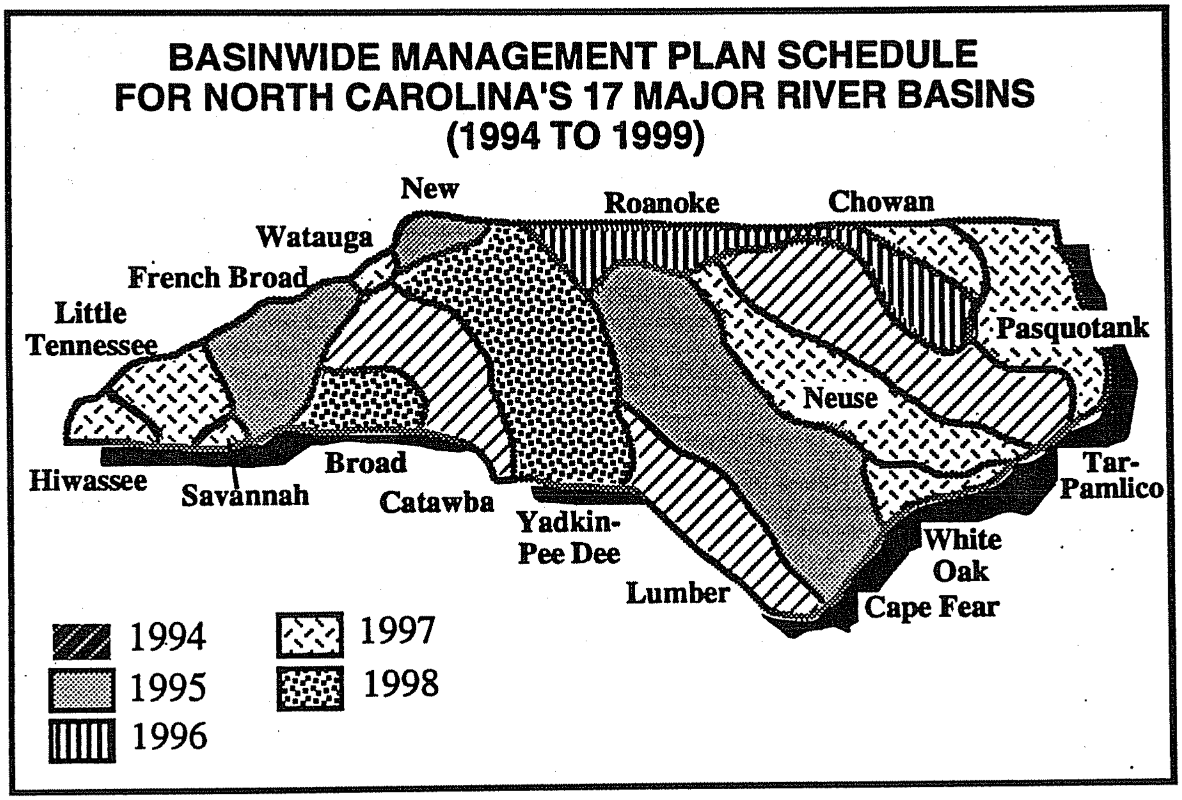

Figure 1.1 Basinwide Management Plan Schedule (1994 to 1999)

1.2 GUIDE TO USE OF THIS DOCUMENT

CHAPTER 1: Introduction - Provides a non-technical description of the purpose of this plan, the basinwide water quality management approach and how this approach will be administered through DEM's Water Quality Section. The description of the basinwide management approach is based largely on a 54-page document entitled *North Carolina's Basinwide Approach to Water Quality Management: Program Description - Final Report/August 1991* (Creager and Baker, 1991).

CHAPTER 2: General Basin Description - Physical features, population densities, land cover and water uses in the Tar-Pamlico River basin are summarized in five sections. Section 2.1 provides an overview of the major features of the Tar-Pamlico River basin such as location, rainfall, population, physiography and so on. Section 2.2 describes the hydrology of the basin and its eight subbasins. Section 2.3 presents a summary of land cover within the basin based on interpretation of 1987 Landsat satellite imagery. Section 2.4 describes population growth trends and densities by subbasin using 1970, 1980 and 1990 census data. The information is presented through a series of maps and tables. Section 2.5 discusses major water uses in the basin and introduces DEM's program of water quality classifications and standards.

CHAPTER 3: Causes and Sources of Water Pollution in the Tar-Pamlico River Basin - Chapter 3 discusses the causes and probable sources of surface water degradation in the Tar-Pamlico River basin. It describes both point and nonpoint sources of pollution as well as a number of important causes of water quality impacts including fecal coliform bacteria, sediment, biochemical oxygen demand (BOD), toxic substances, nutrients and others. It also discusses pollutant loading in the basin and generally discusses water quality problem areas.

CHAPTER 4: Water Quality Status in the Tar-Pamlico River Basin - Data generated by DEM on water quality and biological communities are reviewed and interpreted in this chapter in order to assess current conditions and the status of surface waters within the Tar-Pamlico River basin. Section 4.2 describes the various types of water quality monitoring conducted by DEM. Section 4.3 presents ambient water quality data for ambient stations on the mainstem of the river and for a number of its major tributaries. Section 4.4 summarizes water quality in each of the eight subbasins in the basin based on the biological indicators and sampling methods described in Section 4.2. This information is then used to generate a summary of use support ratings for those surface waters that have been monitored or evaluated (Sections 4.5 and 4.6).

CHAPTER 5: Existing Point and Nonpoint Source Pollution Control Programs - Chapter 5 summarizes the existing point and nonpoint source control programs available to address water quality problems. These programs represent the management tools available for addressing the priority water quality concerns and issues that are identified in Chapter 6. Chapter 5 also describes the concept of Total Maximum Daily Loads (TMDLs). TMDLs represent management strategies aimed at controlling point and nonpoint source pollutants on various water bodies within the basin.

CHAPTER 6: Basinwide Goals, Major Water Quality Concerns and Recommended Management Strategies - Water quality issues identified in chapters 2, 3 and 4 are evaluated and prioritized based on use-support ratings, degree of impairment, and the sensitivity of the aquatic resources being affected. Recommended management strategies, or TMDLs, are then presented that describe how the available water quality management tools and strategies described in Chapter 5 will be applied in the Tar-Pamlico River basin. This includes generalized wasteload allocations for dischargers (for nutrients and BOD) and recommended programs and best management practices for controlling nonpoint sources.

1.3 NORTH CAROLINA'S BASINWIDE MANAGEMENT APPROACH

Introduction - Basinwide water quality management is a watershed-based management approach being implemented by DEM which features basinwide permitting, integrating of existing point and nonpoint source control programs, and preparing basinwide management plan reports.

DEM is applying this approach to each of the seventeen major river basins in the state as a means of better identifying water quality problems, developing appropriate management strategies, maintaining and protecting water quality and aquatic habitat, and assuring equitable distribution of waste assimilative capacity for dischargers. Other important benefits of the basinwide approach include improved efficiency, increased cost-effectiveness, better consistency and equitability, and improved public awareness and involvement in management of the state's surface waters.

A basinwide management plan document is prepared for each basin. The plans are circulated for public review and are presented at public meetings in each river basin. The management plan for a given basin is completed and approved preceding the scheduled date for basinwide permit renewals in that basin. The plans are then to be evaluated, based on followup water quality monitoring, and updated at five year intervals thereafter.

DEM began formulating the idea of basinwide management in the late 1980s, established a basin permitting schedule and began basinwide monitoring activities in 1990, and published a basinwide program description in August 1991. Basinwide management entails coordinating and integrating, by major river basin, DEM's Water quality program activities. These activities, which are discussed further in Section 1.4, include permitting, monitoring, modeling, nonpoint source assessments, and planning.

Water Quality Program Benefits - Several benefits of basinwide planning and management to North Carolina's Water quality program include: (1) *improved program efficiency*, (2) *increased effectiveness*, (3) better *consistency and equitability* and (4) *increased public awareness of the state's water quality protection programs*. First, by reducing the area of the state covered each year, monitoring, modeling, and permitting efforts can be focused. As a result, *efficiency increases* and more can be achieved for a given level of funding and resource allocation. Second, the basinwide approach is in consonance with basic ecological principles of watershed management, leading to *more effective* water quality assessment and management. Linkages between aquatic and terrestrial systems are addressed (e.g., contributions from nonpoint sources) and all inputs to aquatic systems, and potential interactive, synergistic and cumulative effects, are considered. Third, the basinwide plans will provide a focus for management decisions. By clearly defining the program's long-term goals and approaches, these plans will encourage *consistent* decision-making on permits and water quality improvement strategies. Consistency, together with greater attention to long-range planning, in turn will promote a *more equitable* distribution of assimilative capacity, explicitly addressing the trade-offs among pollutant sources (point and nonpoint) and allowances for economic growth.

Basinwide management will also promote integrating point and nonpoint source pollution assessment and controls. Once waste loadings from both point and nonpoint sources are established, management strategies can be developed to prevent overloading of the receiving waters and to allow for a reasonable margin of safety to ensure compliance with water quality standards.

Basinwide Planning Schedule - The following table presents the overall basin schedule for all 17 major river basins in the state. Included are the dates for permit reissuance and the dates by which management plans are to be completed for each basin. Draft plans are due for completion a year in advance for public review.

Table 1.1 Basinwide Permitting and Planning Schedule for North Carolina's 17 Major River Basins (1993 through 1999).

Basin	Discharge Permits to be Issued	Target Date for Basin Plan Approval	Basin	Discharge Permits to be Issued	Target Date for Basin Plan Approval
Neuse	4/93	2/93 (approved)	Roanoke	1/97	7/96
			White Oak	6/97	1/97
Lumber	11/94	5/94 (approved)	Savannah	8/97	4/97
			Watauga	9/97	4/97
Tar-Pamlico	**1/95**	12/94 (Approved)	Little Tennessee	10/97	5/97
Catawba	4/95	2/95	Hiwassee	12/97	5/97
French Broad	8/95	5/95			
New	11/95	7/95	Chowan	1/98	8/97
			Pasquotank	1/98	8/97
Cape Fear	1/96	9/95	Neuse (2nd cycle)	4/98	11/97
			Yadkin-Pee Dee	7/98	1/98
			Broad	11/98	6/98

The number of plans to be developed each year varies from one to six and is based on the total number of permits to be issued each year. For example, the Cape Fear basin, the state's largest, has about as many dischargers as all six of the small basins in 1997. This has been done in order to balance the permit processing workload from year to year. In years where more than one basin is scheduled to be evaluated, an effort has been made to group at least some of the basins geographically in order to minimize travel time and cost for field studies and public meetings.

The earliest basin plans may not achieve all of the long-term objectives for basinwide management outlined above. However, subsequent updates of the plans, every 5 years, will incorporate additional data and new assessment tools (e.g., basinwide water quality modeling) and management strategies (e.g., for reducing nonpoint source contributions) as they become available.

Basinwide Plan Preparation, Review and Public Involvement - Preparation of an individual basinwide management plan is a five year process which is broken down into 15 steps in Figure 1.2 and is broadly described below.

Year	Activity
1 to 3	Water Quality Data Collection/Identification of Goals and Issues (steps 1 through 7): Year 1 entails identifying sampling needs and canvassing for information. It also entails coordinating with other agencies, the academic community and local interest groups to begin establishing goals and objectives and identifying and prioritizing problems and issues. Biomonitoring, fish community and tissue analyses, special studies and other water quality sampling activities are conducted in Years 2 and 3 by DEM's Environmental Sciences Branch (ESB). These studies provide information for assessing water quality status and trends throughout the basin and provide data for computer modeling.
3 to 4	Data Assessment and Model Preparation (steps 7 to 9): Modeling priorities are identified early in this phase and are refined through assessment of water quality data from the ESB. Data from special studies are then used by DEM's Technical Support Branch (TSB) to prepare models for estimating potential impacts of waste loading from point and nonpoint sources using the TMDL approach. Preliminary water quality control strategies are developed, based on modeling, with input from local governments, the regulated community and citizens groups during this period.

STEPS IN PREPARING A BASINWIDE MANAGEMENT PLAN

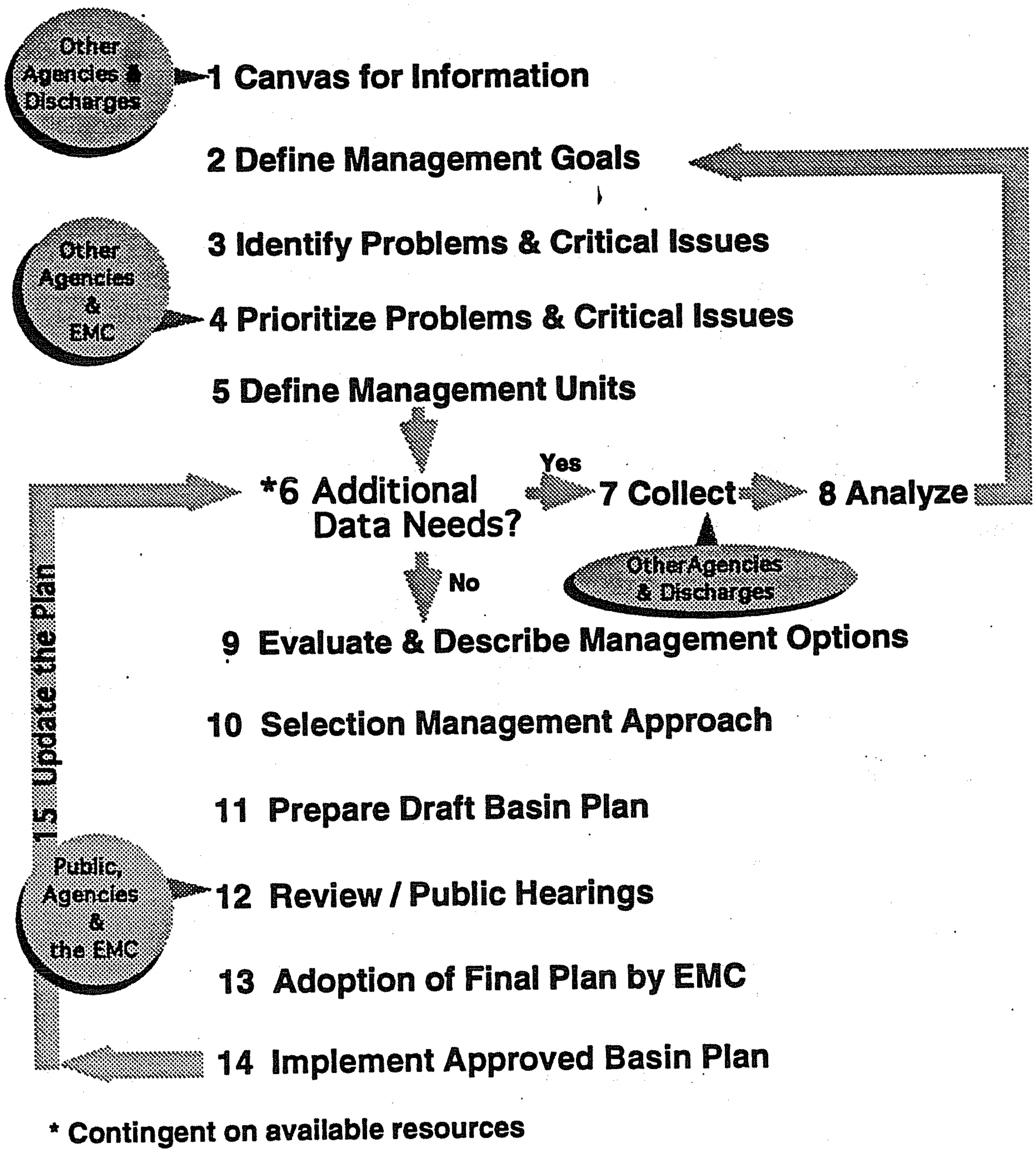

Figure 1.2 Major steps and information transfers involved in the development of a basinwide management plan.

4 Preparation of Draft Basinwide Plan (Steps 9, 10 and 11): The draft plan, which is prepared by DEM's Planning Branch, is due for completion by the end of year 4. It is based on support documents prepared by ESB (water quality data) and TSB (modeling data and recommended pollution control strategies). Preliminary findings are presented at informal meetings through the year with local governments and interested groups, and comments are incorporated into the draft.

5 Public Review and Approval of Plan (Steps 12, 13 and 14): During the beginning of year 5, the draft plan, after approval of the Environmental Management Commission (EMC), is circulated for review, and public meetings are held. Revisions are made to the document, based on public comments, and the final document is submitted to the EMC for approval midway through year 5. Basinwide permitting begins at the end of year 5.

Each basinwide management plan includes six chapters: (1) An introduction describing the purpose and format of the plan, Water Quality Section responsibilities and enabling legislation; (2) a general basin description including land use, population trends, physiographic regions, and classifications and standards; (3) an overview of existing pollutant sources and loads within a basin and a more generic description of causes and sources of point and nonpoint source pollution for the lay person; (4) an assessment of the status of water quality and biological communities in the basin including use-support rating and 305(b) information (see Section 1.5); (5) a description of the TMDL approach and the state's NPDES and nonpoint source control programs; and (6) priority water quality issues and recommended control strategies, including TMDLs. This process is discussed in more detail in the basinwide program description document.

Implementation - The implementation of basinwide planning and management will occur in phases. Permitting activities and associated routine support activities (field sampling, modeling, wasteload allocation calculations, etc.) have already been rescheduled by major river basin. All National Pollutant Discharge Elimination System (NPDES) permit renewals within a basin occur within a prescribed time period after completion of the final basin plan, and will be repeated at five year intervals. The NPDES permit renewal schedule drives the schedule for developing and updating the basinwide management plans. In each river basin, permits are to be issued by subbasin. Permitting in the Tar-Pamlico basin begins in January 1995 and ends in March 1995 (Table 1.2).

TABLE 1.2 Subbasin NPDES Permit Schedule for Tar-Pamlico Basin

Subbasin No.	Month/Year	Subbasin No.	Month/Year
03-03-01	January, 1995	**03-03-05**	February, 1995
03-03-02	January, 1995	**03-03-06**	March, 1995
03-03-03	February, 1995	**03-03-07**	March, 1995
03-03-04	February, 1995	**03-03-08**	March, 1995

Plans to be updated every five years - The earliest basin plans may not achieve all of the long-term objectives for basinwide management outlined above. However, subsequent updates of the plans, every 5 years, will incorporate additional data and new assessment tools (e.g., basinwide water quality modeling) and management strategies (e.g., for reducing nonpoint source contributions) as they become available.

1.4 BASINWIDE RESPONSIBILITIES WITHIN THE DEM WATER QUALITY SECTION

The Water Quality Section is the lead state agency for the regulation and protection of the state's surface waters. It is one of five sections located within the Division of Environmental

Management. The other sections are Groundwater, Air Quality, Construction Loans and Grants and the Laboratory.

The primary responsibilities of the Water Quality Section are to maintain or restore an aquatic environment of sufficient quality to protect the existing and best intended uses of North Carolina's surface waters and to ensure compliance with state and federal water quality standards. The Section receives both state and federal allocations and also receives funding through the collection of permit fees. Policy guidance is provided by the Environmental Management Commission. The Water Quality Section is comprised of over 200 staff members in the central and seven regional offices (Figure 1.3). The major areas of responsibility are water quality monitoring, permitting, planning, modeling (wasteload allocations) and compliance oversight.

The Central office is divided into four branches, with each branch being subdivided into two units. The Planning Branch is responsible for developing water quality standards and classifications, program planning and evaluation, and implementation of new water quality protection programs. The *Water Quality Planning and Assessment Unit* handles surface water reclassifications, development of water quality standards, coordination of the state's nonpoint source program and development of the stormwater runoff program. The *Basinwide Assessment Unit* administers implementation of the water supply watershed and basinwide management programs. It also coordinates EPA water quality planning grants, state environmental policy act responsibilities and development of wetlands rules and regulations.

The Operations Branch is responsible for permit compliance tracking, the pretreatment program and the operator training and certification program. The *Facility Assessment Unit* includes both the permit compliance and pretreatment programs. The *Operator Training and Certification Unit* rates the complexity of operation of wastewater treatment plants and provides formal training for operators commensurate with the plant operating needs.

The Technical Support Branch is responsible for processing of discharge and nondischarge permits as well for preparing TMDLs and wasteload allocations for dischargers. The *Instream Assessment Unit* provides primary computer modeling support and is responsible for coordinating development of TMDLs and individual NPDES wasteload allocations. The *Permits and Engineering Unit* handles reviews and processing of permit applications for both discharging and nondischarging wastewater treatment systems.

The Environmental Sciences Branch is responsible for water quality monitoring, toxicity testing, biological laboratory certifications and the wetlands 401 Water Quality Certification program. The branch is divided into the Ecosystems Analysis Unit and the Aquatic Survey and Toxicology Unit Some of the major functions of the *Ecosystems Analysis Unit* include biological and chemical water quality monitoring and evaluation, evaluating reclassification requests, algal analyses, benthic macroinvertebrate monitoring (biomonitoring), fish tissue and fish communities studies and wetlands assessment and certification. Major functions of the *Aquatic Survey and Toxicology Unit* include effluent toxicity testing, chemical toxicity evaluations, toxicity reduction evaluations (TRE), biological lab certification, biocide evaluations and related special studies, intensive surveys, special studies, dye studies, time-of-travel studies, long term biochemical and sediment oxygen demand, chemical water quality monitoring and lakes assessments.

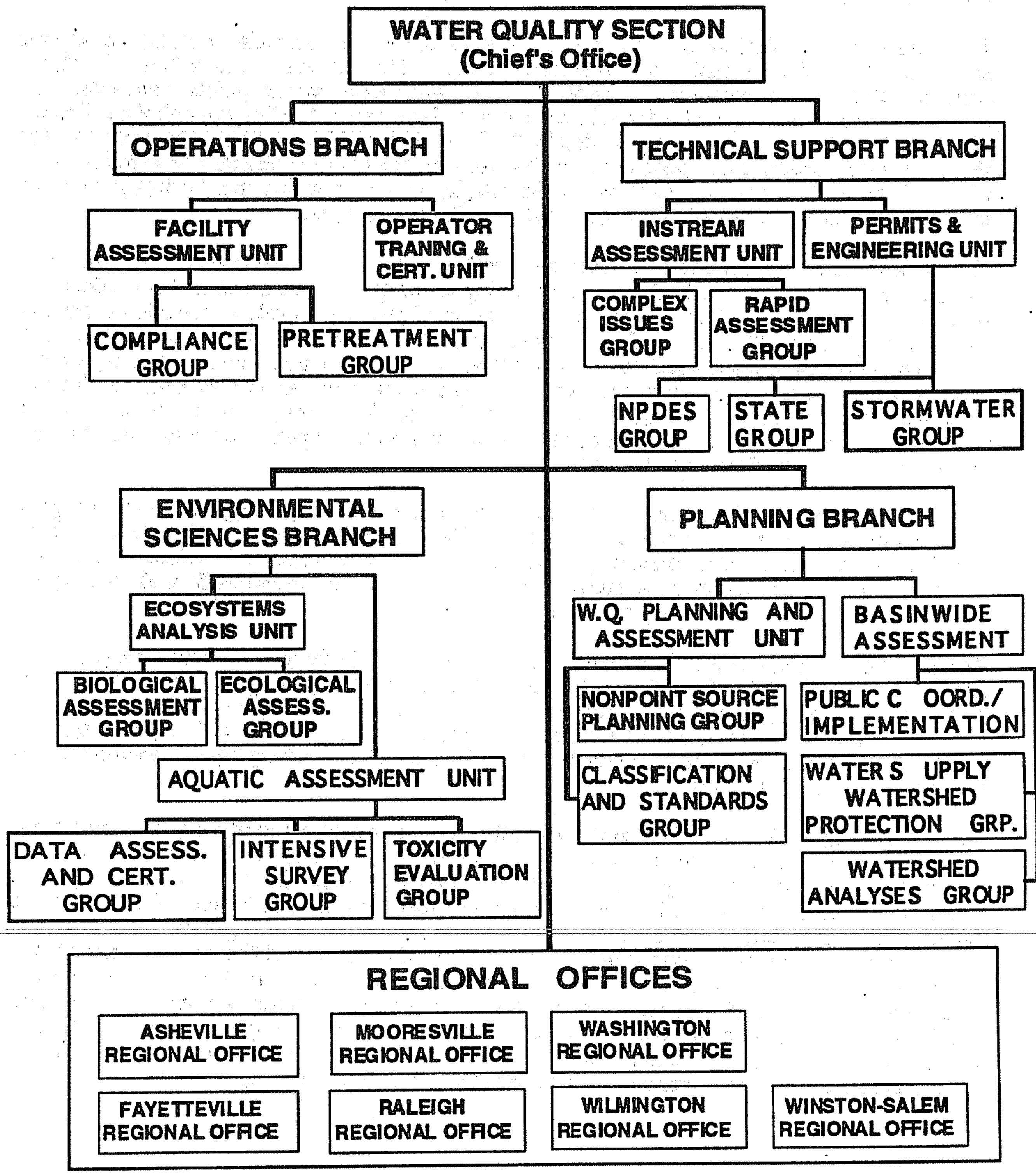

Figure 1.3 Organizational Structure of the DEM Water Quality Section

The seven Regional Offices carry out activities such as wetland reviews, compliance evaluations, permit reviews and facility inspections for both discharging and nondischarging systems, ambient water quality monitoring, state environmental policy act reviews, stream reclassification reviews, pretreatment program support and operator training and certification assistance. In addition, they respond to water quality emergencies such as oil spills and fish kills, investigate complaints and provide information to the public.

Although the basic structure and major responsibilities within the Water Quality Section will remain unchanged, implementation of a basinwide approach to water quality management will require some modification of and additions to the tasks currently conducted by each branch and the regional offices. The goal of basinwide planning is to broaden the scope of management activities from a stream reach to the entire basin. Accomplishing this goal will require more complex water quality modeling, data interpretation, and database management within the water quality program. For example, more sophisticated methods of quantitatively estimating nonpoint source pollutant loads will need to be developed and applied. In addition, these quantitative estimates of nonpoint source loads will have to be integrated with information on point sources to determine the total loading to the system.

Planning for future growth and the possibility of incorporating "agency banking" (see Section 5.3) into the Water Quality Section's management objectives will require model projections of various potential scenarios to properly allocate the remaining assimilative capacity and fairly distribute control requirements. Finally, the link between water quality data and model projections for the multiple stream reaches within a basin, and the overlay of other relevant types of information, such as land use, will require expanded use of geographic information systems (GIS) with coordination and support from this state's Center for Geographic Information Analysis (CGIA).

1.5 STATE AND FEDERAL LEGISLATIVE AUTHORITIES FOR NC's WATER QUALITY PROGRAM

Authorities for some of the programs and responsibilities carried out by the Water Quality Section are derived from a number of federal and state legislative mandates outlined below.

Federal Authorities - The major federal authorities for the state's water quality program are found in various sections of the Clean Water Act (CWA).

- **Section 301** - Prohibits the discharge of pollutants into surface waters unless permitted by EPA (see Section 402, below).
- **Section 303(c)** - States are responsible for reviewing, establishing and revising water quality standards for all surface waters.
- **Section 303(d)** - Each state shall identify those waters within its boundaries for which the effluent limits required by section 301(b)(1) A and B are not stringent enough to protect any water quality standards applicable to such waters.
- **Section 305(b)** - Each state is required to submit a biennial report to the EPA describing the status of surface waters in that state.
- **Section 319** - Each state is required to develop and implement a nonpoint source pollution management program.
- **Section 402** - Establishes the National Pollutant Discharge Elimination System (NPDES) permitting program. Allows for delegation of permitting authority to qualifying states (includes North Carolina).
- **Section 404/401** - Section 404 prohibits the discharge of fill materials into navigable waters and adjoining waters unless permitted by the US Army Corps of Engineers. Section 401 requires the Corps to receive a state Water Quality Certification prior to issuance of a 404 permit.

State Authorities - The following authorities are derived from North Carolina state statutes.

- **G.S. 143-214.1** - Directs and empowers the NC Environmental Management Commission (EMC) to develop a water quality standards and classifications program.
  G.S. 143-214.2 - Prohibits the discharge of wastes to surface waters of the state without a permit.
- **G.S. 143-214.5** - Provides for establishment of the state Water Supply Watershed Protection Program.
- **G.S. 143-214.7** - Directs the EMC to establish a Stormwater Runoff Program.
- **G.S. 143-215** - Authorizes and directs the EMC to establish effluent standards and limitations.
- **G.S. 143-215.1** - Outlines methods for control of sources of water pollution (NPDES and nondischarge permits, statutory notice requirements, public hearing requirements, appeals, etc.).
- **G.S. 143-215.1** - Empowers the EMC to issue *special orders* to any person whom it finds responsible for causing or contributing to any pollution of the waters of the state within the area for which standards have been established.
- **G.S. 143-215.3(a)** - Outlines additional powers of the EMC including provisions for adopting rules, charging permit fees, delegating authority, investigating fish kills and investigating violations of rules, standards or limitations adopted by the EMC.
- **G.S. 143-215.6A, 143-215.6B and 143-215.6C** - Includes enforcement provisions for violations of various rules, classifications, standards, limitations, provisions or management practices established pursuant to G.S. 143-214.1, 143-214.2, 143-214.5, 143-215, 143-215.1, 143-215.2. 6A describes enforcement procedures for civil penalties. 6B outlines enforcement procedures for criminal penalties. 6C outlines provisions for injunctive relief.
- **G.S. 143-215.75** - Outlines the state's Oil Pollution and Hazardous Substances Control Program.

REFERENCES CITED: CHAPTER 1

Clayton, C.S., and J. P. Baker, 1991, North Carolina's Basinwide Approach to Water Quality Management: Program Description, DEM Water Quality Section, Raleigh, NC.

CHAPTER 2

GENERAL BASIN DESCRIPTION WITH WATER QUALITY STANDARDS AND CLASSIFICATIONS

2.1 TAR-PAMLICO RIVER BASIN OVERVIEW

The Tar-Pamlico River Basin stretches 180 miles from its headwaters in north central North Carolina to the Atlantic Ocean. The basin, encompassing 5440 square miles, is the fourth largest river basin in North Carolina and is one of only four of the 17 major river basins in North Carolina whose boundaries are located entirely within the state (figure 2.1). There are 2,355 miles of freshwater streams in the basin, 634,400 acres classified as salt waters and thousands of acres of impoundments. It is subdivided into eight subbasins represented on the map by six digit subbasin codes (03-03-01 through 03-03-08). Throughout the document the individual subbasins will often be referred to by the last two numbers in their respective six digit codes (i.e., 03-03-01 equals subbasin 01).

The Tar-Pamlico River basin originates in north central North Carolina in Person and Granville Counties west of Interstate 85. The upper portion of the river from its headwaters to US highway 17 in the Town of Washington is called the Tar River. From Washington to Pamlico Sound it is called the Pamlico River. Major tributaries include Swift Creek, Fishing Creek, Cokey Swamp, Tranters Creek and the Pungo River. Most of the Tar River is fresh and free-flowing. Tidal influence begins near Greenville. The Pamlico River is an estuary.

The population of the basin, based on 1990 census data, was 364,862. The basin encompasses all or part of the following 16 counties: Beaufort, Dare, Edgecombe, Franklin, Granville, Halifax, Hyde, Martin, Nash, Pamlico (<5%), Person, Pitt, Vance, Warren, Washington and Wilson. Municipalities with a population of 5,000 or more include Washington, Rocky Mount, Tarboro, Oxford, Greenville and Henderson. The overall population density of the basin is 80 persons per square mile versus a state average of 127 persons per square mile. The percent population growth over the past ten years (1980 to 1990) was 7.9 % versus a statewide percentage increase of 13.1%. However, cities such as Greenville and Rocky Mount have experienced 10-year percentage increases of 26% and 18%, respectively.

Average rainfall in the basin ranges from less than 44 inches per year in the upper portion of the basin to more than 50 inches per year near Pamlico Sound. The average July temperature is just under 80°F with the average January temperature ranging from 46°F near Pamlico Sound to 42°F in the upper basin. The evapotranspiration rate for the basin is about 40 inches per year.

Land cover is dominated by agriculture (33.6%) and forests (29.6%) which jointly comprise a little less than two thirds of the land/water surface area in the entire basin. Open water (19.7%) and wetlands (11.4%) comprise slightly less than one third of the total area. The remaining land is made up of scrub growth (3.4%), urban area (1.8%) and barren land.

The upper one-fifth of the basin, or that area generally encompassed by Franklin, Warren, Vance, Granville and Person Counties is located in the Piedmont physiographic region (Figure 2.2). That portion of the basin east of this area is located in the Coastal Plain region. The Piedmont is typified by highly-erodible clay soils; rolling topography with broad ridges and sharply indented stream valleys; and low gradient streams composed of a series of sluggish pools separated by riffles and occasional small rapids. Stream floodplains are relatively narrow and mostly forested. There are

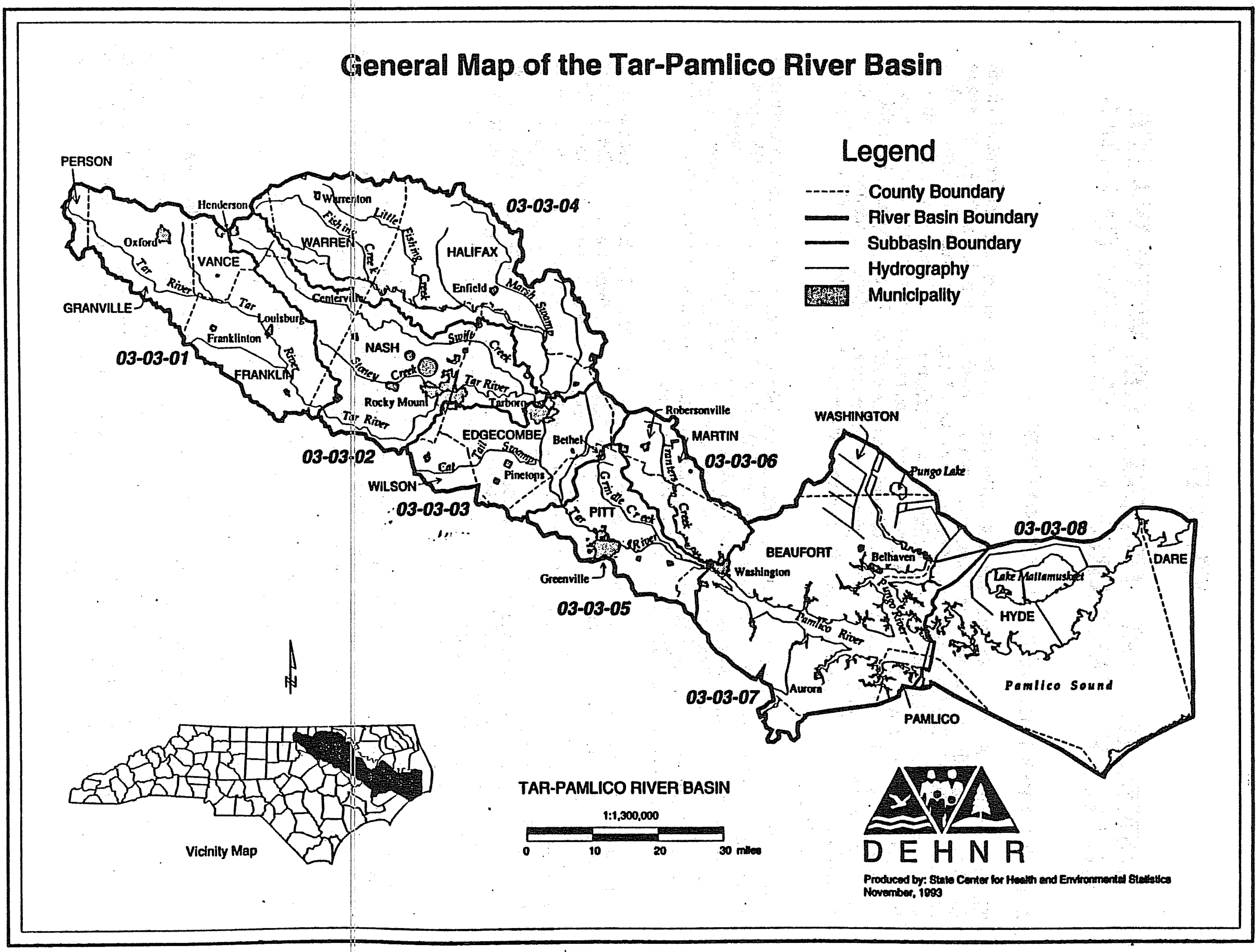

Figure 2.1 Generalized Map of the Tar-Pamlico River Basin

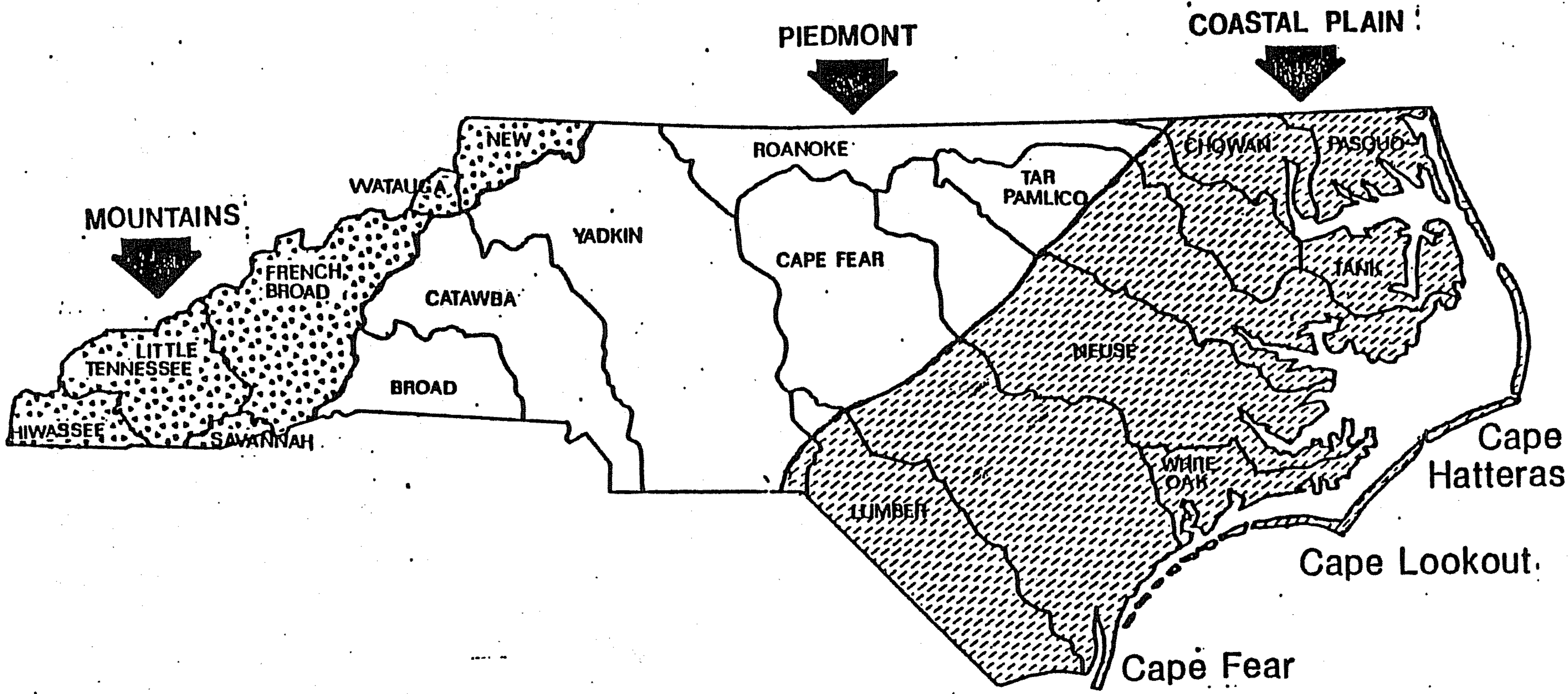

Figure 2.2 Physiographic Regions and Major River Basins of North Carolina

no natural lakes in the Piedmont region. Soils in the region are underlain by a fractured rock formation with limited water storage capacity which offers only a limited supply of groundwater.The Coastal Plain, by contrast to the Piedmont, is characterized by flat terrain, numerous "blackwater streams", low-lying swamplands and productive estuarine areas. Streams, including the mainstem of the Tar, are much more meandering, slower-moving, have lower banks, and are often lined by extensive swamps, bottomland hardwood forests, or marshes. This is particularly true in the lower half of this region sometimes referred to as the outer Coastal Plain. Streams flowing through swampland areas are naturally discolored by tannic acid from decomposing plant material and become tea-colored, hence the name "blackwater". The Coastal Plain is underlain by deep sands and groundwater is abundant although availability of groundwater is limited within the cone of depression created by mine dewatering at the Texasgulf phosphate mine near Aurora.

Hydric soils, because of their high moisture content, pose limitations for land uses such as agriculture, development and land application of wastewater. The presence of hydric soils has also been used to determine the extent of wetlands prior to European settlement in a 1991 study entitled Original Extent, Status and Trends of Wetlands in North Carolina (NC Department of Environment, Health and Natural Resources, 1991). Today, the percent of land area in wetlands is substantially less than the percentages shown below (see Table 2.2 for land cover types, acreages and percent cover by subbasin).

Table 2.1 presents the percentage of hydric soils for 10 of the 16 counties in the Tar-Pamlico Basin. These ten counties generally encompass the Coastal Plain portion of the basin. Of these ten, five (Hyde, Dare, Washington, Beaufort and Martin) have over 50%, and as much as 97.3%, of their land area classified as hydric soils based on USDA soil classification. These five make up the outer Coastal Plain portion of the basin. The percentage of land area in the other five Coastal Plain counties, which generally represent the inner Coastal Plain portion of the basin, ranges from about 30% for Nash and Halifax (the most upstream counties) to nearly 50% for Pitt County.

Table 2.1 Percentage of Land Surface in Hydric Soils by County in the Tar-Pamlico Basin

County	Hydric Soils	County	Hydric Soils
Hyde	97.3%	Pitt	46.7%
Dare	89.7%	Wilson	38.3%
Washington	85.6%	Edgecombe	34.8%
Beaufort	71.4%	Halifax	30.0%
Martin	53.4%	Nash	29.5%

Forestry and agriculture are the primary land use activities in the Coastal Plain along with the Texas Gulf phosphate mining operation in Beaufort County. The largest natural lake in the state, Lake Mattamuskeet, is located in Hyde County as all, or portions of three national wildlife refuges (Lake Mattamuskeet, Swanquarter and Poccosin Lakes National Wildlife Refuges).

2.2 LAND USE, POPULATION AND GROWTH TRENDS

2.2.1 General Land Cover/Land Use Patterns

Land cover information for the basin is summarized in Table 2.2 by acreage, percent cover and land cover type for each of the eight subbasins in the Tar-Pamlico basin. This information is further summarized in Figures 2.3, which presents acreages of land cover types in bar chart form , and Figure 2.4, a pie chart showing land cover distribution by permit cover. Land cover information is based on interpretation of 1987 Landsat satellite data that was made available through the North Carolina Center for Geographic Information and Analysis (CGIA). The eight land cover types presented in this section are a composite of 20 land cover categories available through CGIA.

Land Cover Type	Land Cover Description
1) Agriculture	Agriculture, Bare Soil, Grass and Disturbed Land
2) Urban	Greater than 25% paved surfaces
3) Forest	Pine, Hardwood and Mixed Upland Forest
4) Wetlands	Bottomland Hardwoods, Riverine Swamp, Evergreen Hardwood/Conifer, Atlantic White Cedar Low Pocosin, High Marsh, Low Marsh
5) Scrub	Low Density Vegetation
6) Water	Lakes, Reservoirs, Ponds, Estuaries, Sounds, Rivers
7) Barren	Sand
8) Shadow	Areas in shadows or appearing to be in shadows and where actual cover types are indiscernible.

Table 2.2 Land Cover in the Tar-Pamlico Basin by Subbasin, Acreage and Percent Cover

Subbasin	Agric (Acres)	Agric %	Forest (Acres)	Forest %	Urban (Acres)	Urban %	Wetland (Acres)	Wetland %	Water (Acres)	Water %	Scrub (Acres)	Scrub %	Barren (Acres)	Barren %	Shadow (Acres)	Shadow %	Total Acres	Total %
01	142,997	33.6	185,621	43.6	41,394	9.7	34,627	8.1	1,314	0.3	18,935	4.5	0	0.0	562	0.1	425,450	12.22
02	186,917	60.6	76,243	24.7	7,435	2.4	24,758	8.0	2,472	0.8	10,127	3.3	0	0.0	430	0.1	308,382	8.86
03	150,438	55.4	106,228	39.1	981	0.4	8,284	3.1	512	0.2	4,974	1.8	0	0.0	132	0.0	271,549	7.80
04	191,727	33.5	297,610	52.0	4,779	0.8	61,141	10.7	533	0.1	16,355	2.9	0	0.0	657	0.1	572,802	16.45
05	92,879	49.0	49,925	26.3	1,119	0.6	31,912	16.8	1,826	1.0	11,801	6.2	0	0.0	94	0.0	189,556	5.44
06	78,499	50.3	30,627	19.6	849	0.5	21,426	13.7	85	0.1	24,375	15.6	0	0.0	53	0.0	155,914	4.48
07	254,530	33.4	205,804	26.9	5,488	0.7	134,472	17.6	123,393	16.2	28,722	3.8	9,539	1.3	1,451	0.2	762,599	21.90
08	72,922	9.2	78,702	9.9	1,082	0.1	80,677	10.1	554,576	69.7	3,300	0.4	3,300	0.4	998	0.1	795,557	22.85
Total Acres	1,170,909		1,029,960		63,127		397,297		684,711		118,589		12,839		4,377		3,481,809	
	33.63		29.58		1.81		11.41		19.67		3.41		0.37		0.13			100.00

Land cover, as shown in Figure 2.3 is dominated by agriculture (33.6%) and forests (29.6%) which jointly comprise a little less than two thirds of the land/water surface area in the entire basin. Open water (19.7%) and wetlands (11.4%) comprise slightly less than one third of the total area. The remaining land is made up of scrub growth (3.4%), urban area (1.8%), barren land, and shadow. It should be noted that the area determined to be urban is most likely very conservative and could be up to 50 percent higher than indicated (Holman, pers. comm. 1994). This is because residential developments with tree cover were often interpreted as forest from the satellite imagery. Conversely, this would also mean that forested areas might be slightly less than indicated. In addition, the land area attributed to agriculture also includes such open areas as golf courses, beach grasses, wide transportation corridors (e.g. interstate highways), large athletic fields and other grassy features. Land cover distribution for each category is discussed briefly below.

AGRICULTURE - The percent of land cover in agriculture is highest in the central portion of the basin (generally coinciding with the lower Piedmont and upper Coastal Plain regions). Factors limiting the extent of agriculture elsewhere in the basin include difficult slopes/soils in the upper basin and unsuitable soils (wetlands) and the large amount of open water in the lower basin. Those subbasins having at least 50% of their area in agriculture include 02 (61% - 186,917 acres), 03 (55% - 150,438 acres), and 06 (50% - 78,499 acres).

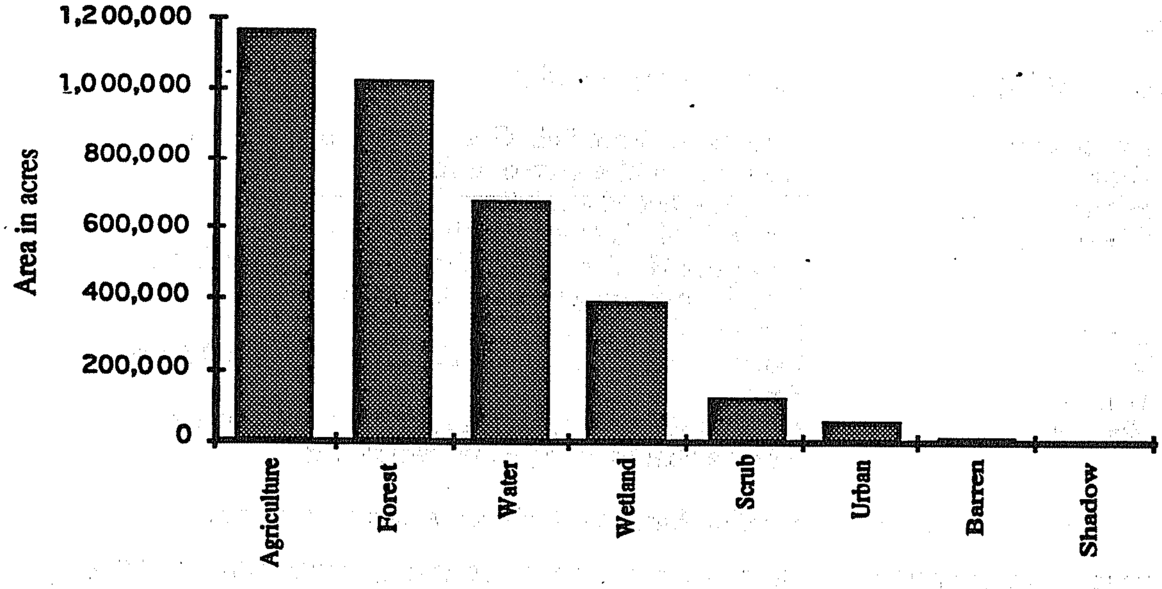

Figure 2.3 Land Cover in the Tar-Pamlico Basin by Acreage

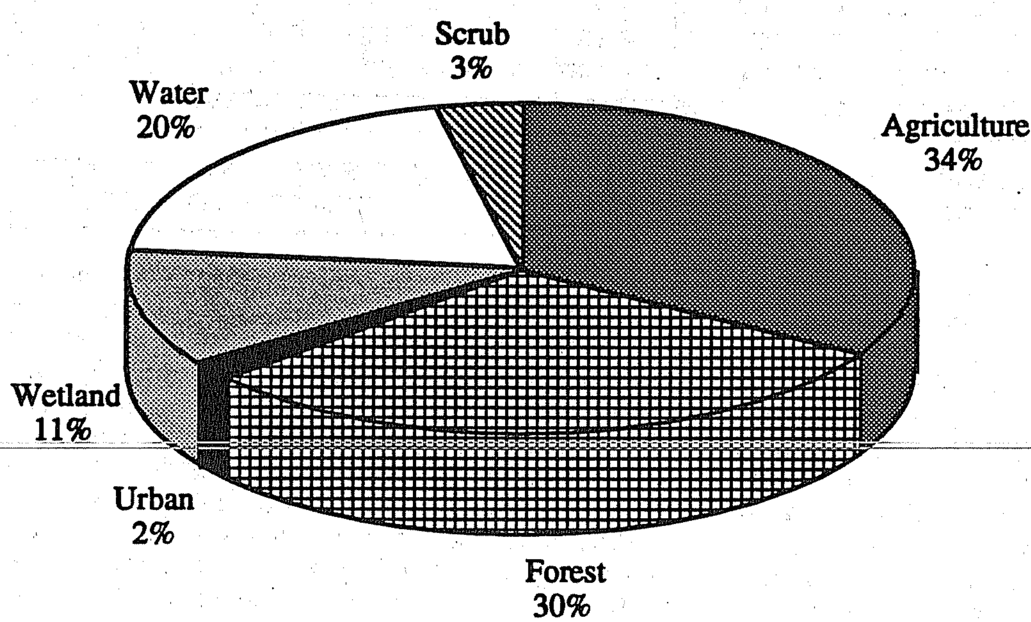

Figure 2.4 Land Cover in the Tar-Pamlico Basin by Percent Cover

FOREST - Subbasin 07 had the highest acreage in forest (205,004 acres), but due to the large open water area, this made up only 27% of the subbasin. Other subbasins with a significant portion of their land in forest include: 04 (297,610 acres - 52% of land), 01 (185,621 acres - 44% of land), and 03 (106,228 acres - 39% of land).

URBAN - This category is made of lands that are more than 25% paved. It is composed of developed areas such residential subdivisions, office complexes, shopping centers, industrial parks, college campuses, and commercial development . Subbasin 01, which includes Oxford, Franklinton, and Louisburg, has the largest acreage (41394 acres) and largest percentage (10) of area categorized as urban. This subbasin encompasses 12% of the Tar-Pamlico basin, but contains 66% of the basin's total urban area. Subbasin 02 which contains Rocky Mount and Nashville has the second largest acreage (7435 acres) and percentage (2) of urban land.

WETLANDS - The largest area of wetlands is located in the lower reaches of the basin in subbasin 07 (134,472 acres, 18% of subbasin). Approximately one third of the wetlands in the Tar-Pamlico basin are located in subbasin 07.

WATER - The largest expanses of open water are located in the two subbasins encompassing the Pamlico estuary and portions of Pamlico Sound (subbasins 07 and 08). Ninety-nine percent (677,969 acres) of the total open water area in the Tar-Pamlico basin is found in these two subbasins. Subbasin 02, which includes the Tar River Reservoir, has the third largest acreage of open water with 2472 acres.

SCRUB - These are lands with low density vegetation that do not fall within the forested, wetland or agricultural land cover types. Typically they are disturbed or cleared areas that have been allowed to revegetate to some extent. The largest areas in category are located subbasins 07 (28,722 acres) and 06 (24,375 acres). Those scrub areas are likely associated with timber harvests or fallow agricultural land.

Land cover trends in the Tar-Pamlico Basin

The US Department of Agriculture Soil Conservation Service (renamed the Natural Resources Conservation Service) recently released the 1992 National Resources Inventory (USDA, SCS, 1994). Comparison of acreages of selected land cover types between 1982 and 1992 NRI studies reveals the following changes in land cover:

Cover type	1982 Acreage	1992 acreage	% change (+/-)
Cultivated cropland	896,300	827,700	-8
Noncultivated cropland	5,600	14,300	+155
Pastureland	113,500	85,200	-25
Forest	1,571,500	1,510,300	-4
Urban and builtup	116,400	144,900	+25

It should be noted that the smaller the acreage, the less accurate the data. For example, the estimated margin of error for the noncultivated cropland acreages is roughly ± 100%. By contrast, the estimated margin of error for the forested acreage is roughly ± 20%.

2.2.2 Population and Growth Trends in the Basin

The Tar-Pamlico River basin has an estimated population of 361,680 based on 1990 census data. Table 2.3 presents census data for 1970, 1980 and 1990 for each of the subbasins. It also includes land areas and population densities (persons/square mile) by subbasin based on the *land area* (excludes open water) for each subbasin. Most the population is located near the center of the basin as depicted in the population density map (Figure 2.5). The percentage increase in population for the entire basin from 1970 to 1990 was 27% , and was 8.5% for the 10-year period from 1980 to 1990. This compares to a statewide increase of 12.7% over the same 10-year period. The highest growth areas, by subbasin, are presented in Figure 2.6 and include subbasin 01 (Oxford, Franklinton and Louisburg) and subbasin 05 (includes Greenville).

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

Figure 2.5 shows population densities by census block group based on 1990 census data. The population density categories are based on persons/acre. An average family unit size is close to 2.5 persons. Therefore, a density of 2.5 persons/acre (1600 persons/square mile) is very roughly equivalent to one house per acre. The lowest density category of less than 0.1 persons/acre is equivalent to less than 64 persons/square mile. The highest population densities are generally located in the center of the basin and include the municipalities of Washington, Greenville, Tarboro and Rocky Mount. Oxford, Henderson and Belhaven also densities of 0.5 persons/acre or more. The subbasins with the lowest population density include subbasin 04 (Fishing Creek) and subbasins 07 and 08 which border the Pamlico River and Pamlico Sound. Figure 2.6 displays percent population growth by subbasin for the time period from 1970 to 1990. During that twenty year period, subbasins 01 and 05 experienced population increases in the 25-50 range. All of the other subbasins had population increases in the 0-25 except subbasin 04 (Fishing Creek) which had a slight decrease over the twenty year period.

Table 2.3 Tar-Pamlico River Subbasin Population (1970, 1980 and 1990) and Land Area Summaries

SUBBASIN	POPULATION (Number of Persons)			POPULATION DENSITY (Persons/Square Mile)			LAND AND WATER AREAS			
							Total Land and Water Area		Water Area	Land Area
	1970	1980	1990	1970	1980	1990	(Acres)	(Sq. Miles)	(Sq. Miles)	(Sq. Miles)
03-03-01	47,485	51,559	57,544	72	78	87	424,960	664	3	661
03-03-02	76,629	87,672	100,777	121	138	159	408,320	638	3	635
03-03-03	43,867	47,474	48,211	104	112	114	272,000	425	2	423
03-03-04	37,369	38,860	35,582	42	43	40	572,800	895	1	894
03-03-05	44,039	56,615	65,799	150	193	225	189,440	296	3	293
03-03-06	13,626	13,043	14,177	56	54	58	155,520	243	0	243
03-03-07	33,727	38,869	37,658	34	39	38	762,880	1,192	206	986
03-03-08	4,000	4,111	5,114	10	10	12	784,000	1,225	813	412
TOTALS	300,742	338,203	364,862	66	74	80	3,569,920	5,578	1031	4,547

Note: Population, land area and water area were derived from 1970, 1980 and 1990 census data.

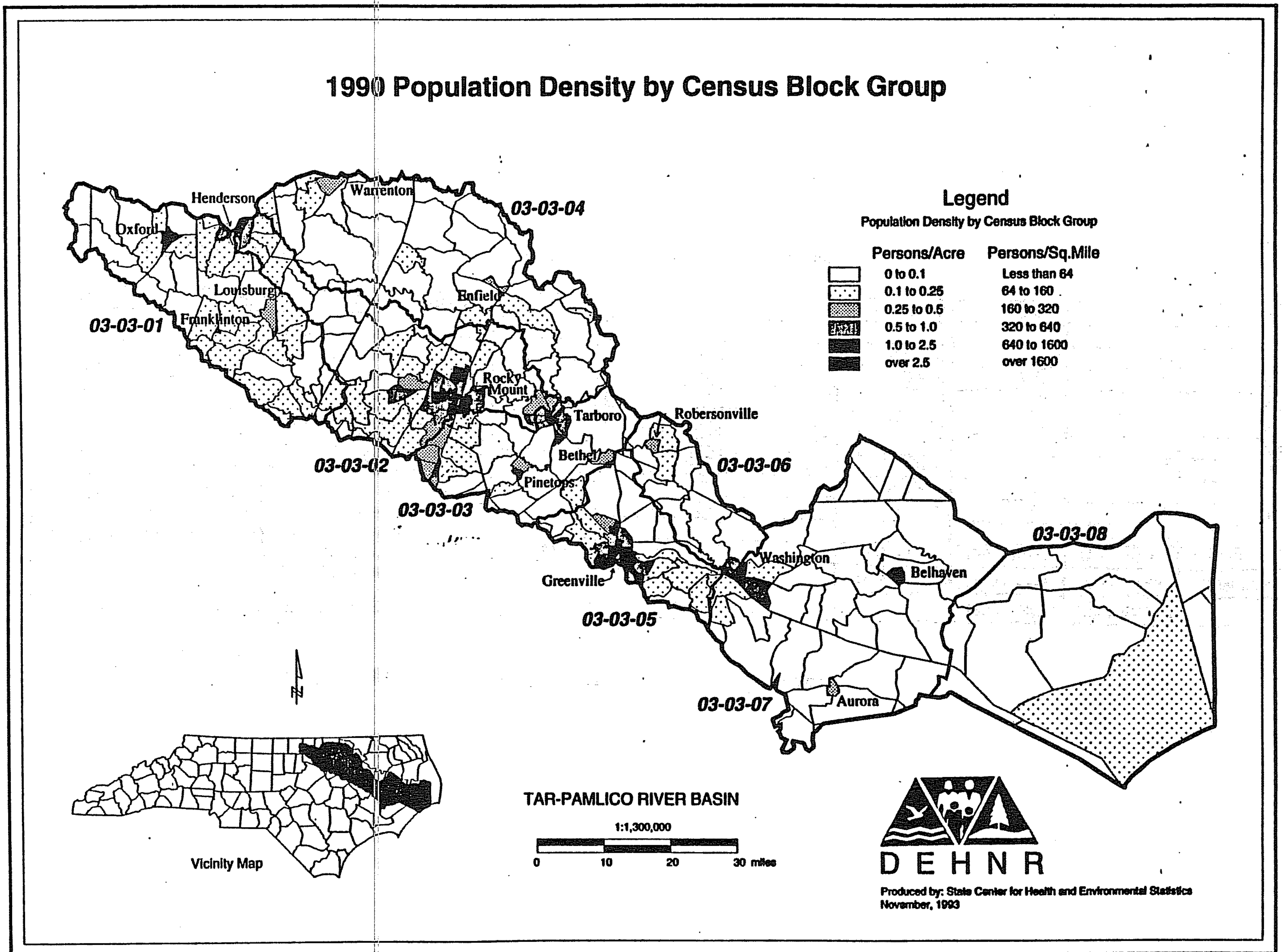

Figure 2.5 1990 Population Density by Census Block Group

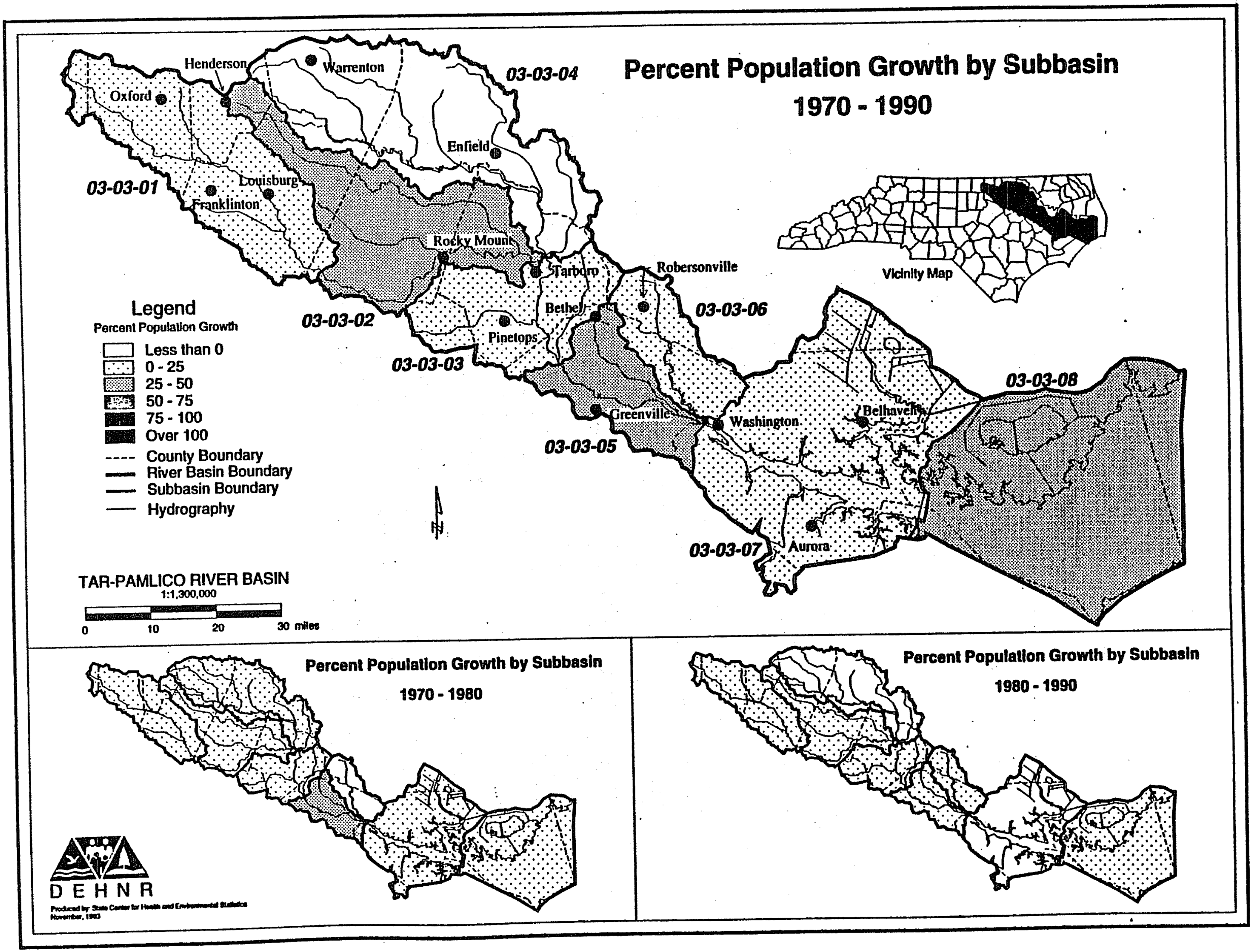

Figure 2.6 Population Growth Increases by Subbasin (1970 to 1990)

2.3 REGISTERED ANIMAL OPERATIONS

In 1992, the Environmental Management Commission adopted a rule modification (15A NCAC 2H .0217) to establish procedures for properly managing and reusing animal wastes from intensive livestock operations. The rule applies to new, expanding or existing feedlots with animal waste management systems designed to serve more than or equal to the following animal populations: 100 head of cattle, 75 horses, 250 swine, 1,000 sheep or 30,000 birds with a liquid waste system. The deadline for submittal of registrations to DEM for existing facilities was December 31, 1993. Table 2.4 summarizes the number of registered intensive livestock operations and animals, by type and subbasin, for those registrations received for the basin through May 1994. Figure 2.7 shows the distribution of these facilities in the basin.

Table 2.4 Registered Animal Operations in the Tar-Pamlico River Basin

TYPE OF	SUBBASINS								
OPERATION	01	02	03	04	05	06	07	08	TOTALS
CATTLE									
Operations	6	4		9		1	1		21
Animals	793	695		3,534		130	45		5,197
CHICKENS									
Operations					1				1
Animals					38,000				38,000
DAIRY									
Operations	3	2		3			1		9
Animals	986	270		768			150		2,174
POULTRY									
Operations	5	17	1	4	3				30
Animals	254,800	1,535,000	25,000	164,000	240,000				2,218,800
SWINE									
Operations	4	33	26	26	22	12	49	13	185
Animals	7,880	66,177	45,062	79,758	63,310	19,881	111,646	15,227	408,941
TOTALS									
Operations	18	56	27	42	26	13	51	13	246
Animals	264,459	1,602,142	70,062	248,060	341,310	20,011	111,841	15,227	2,673,112

Separate categories have been added for chicken and poultry. The poultry category includes bird numbers from those registration forms where it not specified whether the listed birds were chickens or turkeys. It should also be noted that only poultry operations with wet waste systems ~~are required to register, and this makes up well under 5% of all the poultry operations in the basin.~~ Operations with dry litter waste management systems are not required to register.

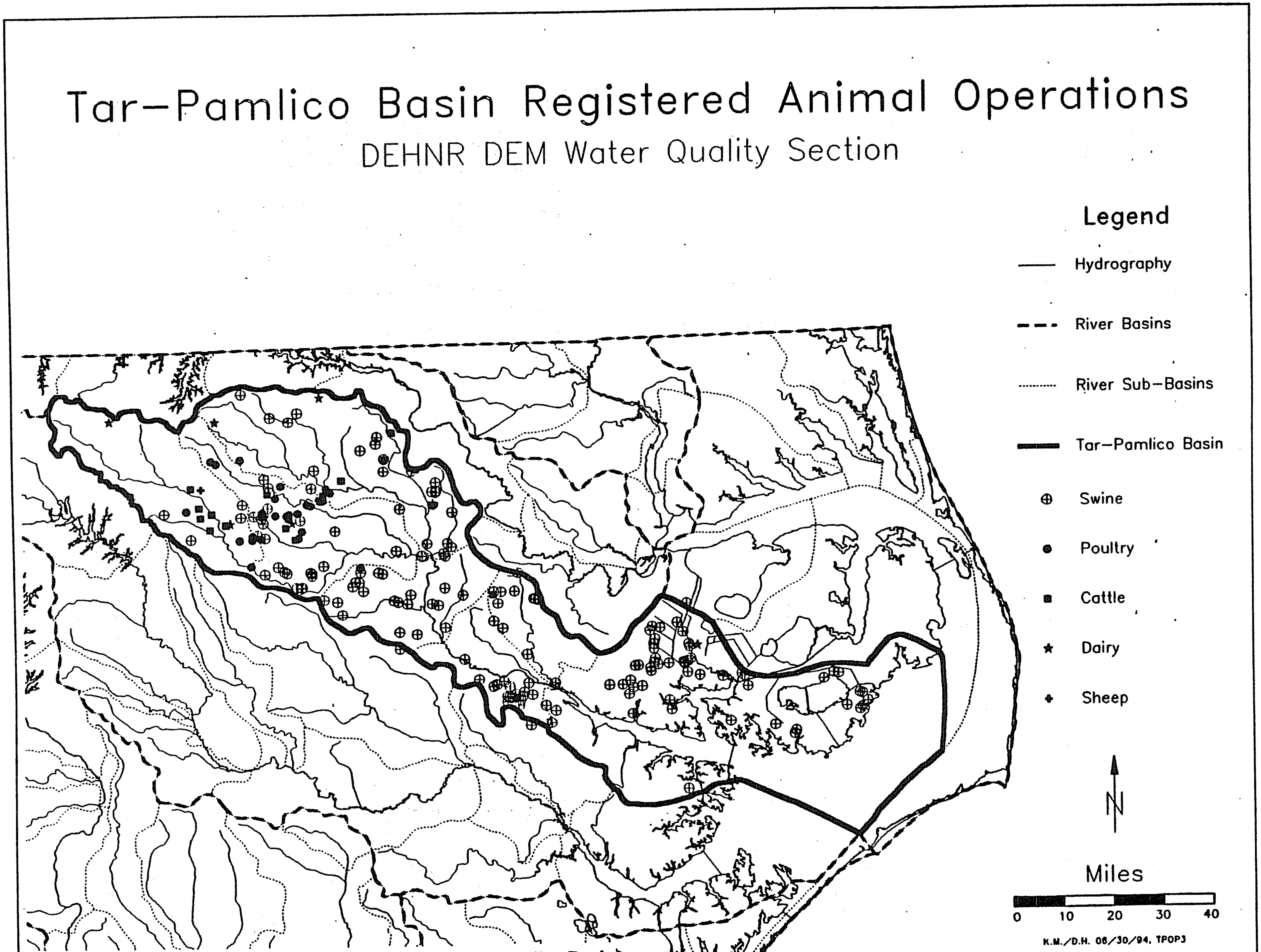

Figure 2.7 Registered Animal Operation in the Tar-Pamlico Basin

2.4 THREATENED AND ENDANGERED AQUATIC FAUNAL SPECIES

The Tar-Pamlico River Basin provides habitat for nine, state and/or federally listed, threatened and endangered freshwater mussel species. There are no known state or federally listed threatened or endangered fish species in the basin. Two state-listed fish species of special concern include the Carolina Darter and the Carolina Madtom (Alderman, 1994 and Pearsall, 1994). Table 2.5 lists the mussel species along with the subbasins where they are found and their listing status. Factors in their continued survival at these locations would appear to be the minimal amount of urban development that has occurred in these subbasins (as shown in Figure 2.5) and the relatively low number of smaller-sized wastewater treatment plants.

Table 2.5 Threatened and Endangered Freshwater Mussel Species in the Tar-Pamlico River Basin (Source: NC Wildlife Resources Commission, 1993 and Gantt, 1994)

Common Name	Scientific Name	Subbasins where found	Listing Status: State	Listing Status: Federal
Dwarf Wedge Mussel	(Alasmidonta heterodon)	030301, 02, 04	E	E
Triangle Floater	(Alasmidonta undulata)	030301, 02, 04	T	
Yellow Lance Mussel	(Elliptio lanceolata)	030301, 02, 04	T	(E)
Roanoke Slab Shell Mussel	(Elliptio roanokensis)	030302	T	
Tar River Spiny Mussel	(Elliptio steinstansana)	030301, 02, 03, 04	E	E
Atlantic Pigtoe	(Fusconaia masoni)	030301, 02, 04	T	(E)
Yellow Lamp Mussel	(Lampsilis cariosa)	030301, 02, 03, 04	T	(E)
Green Floater	(Lasmigona subviridis)	030301	E	
Squawfoot Mussel	(Strophitus undulatus)	030301, 02, 03, 04	T	

Listing abbreviations: E = Endangered;
T = Threatened;
(E) = Candidate for Federal Listing

The Swift Creek subbasin, in particular, has been singled out as having unique and special values as habitat for threatened and endangered species and for its zoogeographic importance. In a 1993 report entitled "Biological Inventory: Swift Creek Subbasin", prepared jointly by staff of the NC Natural Heritage Program, NC State Museum of Natural Sciences and NC Wildlife Resources Commission (WRC) and published by WRC, Swift Creek was identified as one of the most valuable freshwater stream ecosystems remaining along the Atlantic Seaboard (Alderman et. al., 1993). This creek provides habitat for all of the above-listed species except for the Dwarf Wedge Mussel and Green Floater. It supports the best population in North Carolina of the Atlantic Pigtoe, Yellow Lance Mussel, Yellow Lamp Mussel, Squawfoot Mussel, and supports the only viable population of the Tar River Spiny Mussel in the world. The report indicates that this basin is essentially rural but that it is threatened by sedimentation from improperly conducted logging operations and agricultural activities. The report further emphasizes the need to protect the creek in light of "its high species diversity, presence of numerous pollution intolerant species, number of endemic species (Neuse plus Tar ranges), presence of federally listed and candidate species, and its importance in understanding the zoogeography, ecology and evolution of its associated species."

2.5 SURFACE WATER CLASSIFICATIONS AND WATER QUALITY STANDARDS

2.5.1 Program Overview

Clean water is critical to the health, economic well-being and the quality of life of those residing or working in the Tar-Pamlico River basin. Most water users throughout the basin rely on surface water for basic needs such as water supply and/or wastewater disposal. In addition, many businesses and residents of the Tar-Pamlico Basin rely directly or indirectly on a healthy river and its tributaries for their source of living. Commercial fisherman, water-oriented real estate and building industries, and those businesses that serve the recreational needs of the basin such as fishing, boating and vacationing are just some examples. To these groups and the public they serve, it is important that the waters support viable fisheries and shellfish resources. In addition, full enjoyment of boating, swimming and residing along the water requires the waters to be relatively safe (low risk of contracting water-borne disease) and aesthetically desirable (free of objectionable colors, odors and smells). Yet maintaining clean water becomes increasingly difficult and more expensive as the population grows, as land develops and as competition for its resources heighten. In order to assure that water quality throughout the basin is maintained at levels that support the various uses presented above as well as aquatic life, North Carolina has established a water quality classification and standards program (15A NCAC 2B 0.200).

Waters were classified for their "best usage" in North Carolina beginning in the early 1950's, with classification and water quality standards for all the state's river basins adopted by 1963. The effort to accomplish this included identification of water bodies (which included all named water bodies on USGS 7.5 minute topographic maps), studies of river basins to document sources of pollution and appropriate best uses, and formal adoption of standards/classifications following public hearings.

The Water Quality Standards program in North Carolina has evolved over time and has been modified to be consistent with the Federal Clean Water Act and its amendments. Water quality classifications and standards have also been modified to promote protection of surface water supply watersheds, high quality waters and the protection of unique and special pristine waters with outstanding resource values. Classifications and standards have been broadly interpreted to provide protection of uses from both point and nonpoint source pollution. Stormwater rules to protect uses and standards of coastal water are an example of North Carolina's water quality authorities.

2.5.2 Statewide Classifications and Water Quality Standards

Appendix I summarizes the state's primary and supplemental classifications including, for each classification, the best usage, key numeric standards, stormwater controls and other requirements as appropriate.

Primary Classifications

Under this system, all surface waters in the state are assigned a *primary* classification that is appropriate to the best uses of that water body (e.g., aquatic life support and swimming). Primary freshwater classifications include the following: *C, B* and *WS* (Water Supply) *I* through *WS V*. The WS freshwater classifications may also include a *CA* designation which stands for *critical area*. The critical area is an area in close proximity to a water supply intake and/or the shoreline of the reservoir in which it is located. Primary saltwater classifications include *SC, SB* and *SA*. SC and SB are saltwater counterparts to the freshwater C and B classifications. SA is a classification assigned to waters used for shellfish harvesting. SA, WS-I and WS-II are also, by definition, considered to be High Quality Waters.

Supplemental Classifications

In addition to primary classifications, surface waters may be assigned a supplemental classification. The supplemental classifications include *HQW* (High Quality Waters), *ORW* (Outstanding Resource Waters), *NSW* (Nutrient Sensitive Waters), *Tr* (Trout Waters) and *Sw* (Swamp Waters). Most of these have been developed in order to afford special protection to sensitive or highly valued resource waters. While all surface waters are assigned a primary classification, they may have one or more supplemental classifications. For example, all surface waters in the basin will have an NSW supplemental classification because the entire basin has been designated by the Environmental Management Commission as nutrient sensitive. Therefore, a typical freshwater stream might have a C NSW classification where C is the primary classification followed by the NSW supplemental classification. In another example, Tranters Creek, located just upstream of the City of Washington's water supply intake is classified WS-IV Sw NSW CA.

Water Quality Standards
Each primary and supplemental classification is assigned a set of water quality *standards* that establish the level of water quality that must be maintained in the water body to support the uses associated with each classification. Some of the standards, particularly for HQW and ORW waters, outline protective management strategies aimed at controlling point and nonpoint source pollution. These strategies are summarized in Appendix I and are discussed briefly in section 2.5.3, below. Tables 1 and 2 in Appendix 1 summarize the state's freshwater and saltwater numeric standards. The standards for C and SC waters establish the basic protection level for all state surface waters. With the exception of Sw, all of the other primary and supplemental classifications have more stringent standards and provide for higher levels of protection. The Sw classification allows for a lower dissolved oxygen and pH standard than other waters due to naturally-occurring low dissolved oxygen and high pH conditions in swamp waters. Dissolved oxygen is discussed more fully in Chapter 3.

2.5.3 Surface Water Classifications in the Tar-Pamlico Basin

The Tar-Pamlico Basin has examples of all but three of the classifications and supplemental classifications presented above. The exceptions include trout waters (Tr), which are found only in the western half of the state, as well as WS-I and WS-III. All surface waters in the basin, except for Pamlico Sound, are supplementally classified as NSW (nutrient sensitive). Most freshwater streams in subbasins 06, 07 and 08 are supplementally classified as Sw (swamp). There are a few occurrences of B and SB waters throughout the basin.

There are no water supply (WS) classifications in subbasins 07 and 08. Most waters classified for water supply purposes are WS-IV. Three stream segments are classified WS-II (which automatically establishes them as High Quality Waters):

- Hatchers Run upstream from Devin Lake near Oxford,
- Sally Kearney Creek upstream from Old Franklinton Lake and
- Cedar Creek upstream from New Franklinton Lake.

Portions of the Tar River, below the Oxford and Louisburg water intakes, and a segment of Fishing Creek are classified as WS-V. A large portion of the saltwaters in the basin are classified as SA, which by definition are also considered high quality waters (HQW). These are listed below under the High Quality Waters heading.

Miles of Class C, B and WS streams are as follows (NCDEHNR, 1992):

C:	1774 miles
B:	69 miles
WS:	503 miles

High Quality Waters (HQW) in the Tar-Pamlico Basin
High Quality Waters in the Tar-Pamlico River Basin include the following:

- Waters classifed as WS-II (listed above);
- Waters classified SA (shellfish) Waters;
- Waters that are designated Primary Nursery Areas (PNA);
- Flax Pond from source to Pungo River;
- Battalina Creek from source to Pungo River
- Tooleys Creek from source to Pungo River
- Vale Creek from source to Pungo Creek
- Far Creek (a portion downstream from Hwy 264)
- Kitty Creek from source to Far Creek
- Waupopin Creek from source to close to Far Creek
- Waupopin Canal from Boundary Canal to Waupopin Creek
- Cumberland Creek from source to Long Shoal Creek.

Special HQW protection management strategies are presented in 15A NCAC 2B.0201(d), which is included in its entirety in Appendix I under Antidegradation Policy. These measures are intended to prevent degradation of water quality below present levels from both point and nonpoint sources. HQW requirements for new facilities and facilities which expand beyond their currently permitted loadings address oxygen-consuming wastes, total suspended solids, disinfection, emergency requirements, volume, nutrients (in nutrient sensitive waters) and toxic substances. For oxygen-consuming wastes, for example, effluent limitations for new or expanding facilities are as follows: BOD_5 = 5 mg/l; NH_3-N = 2 mg/l; DO = 6 mg/l (except for those expanding discharges which expand with no increase in permitted pollutant loading).

For nonpoint source pollution, development activities which require an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or local erosion and sedimentation control program approved in accordance with 15A NCAC 4B .0218, and which drain to and are within one mile of high quality waters will be required to control runoff from the one-inch design storm using either a low density or high density option described in the rules.

Outstanding Resource Waters in the Tar-Pamlico Basin
The only waters in the Tar-Pamlico Basin classified as outstanding resource waters (ORW) are situated in and along the north shore of Pamlico Sound near the mouth of the river adjacent to the Swanquarter National Wildlife Refuge (Figure 2.8). Waters classified as ORW in this area include:

- the Swanquarter Bay/Juniper Bay ORW Area, including the Northeast Swanquarter Bay Area,
- Shell Bay (entire bay),
- Judith Narrows from White Perch Bay to Shell Bay,
- Shell Narrows from Swanquarter Bay to Shell Bay,
- Smokehouse Cover (entire cove),
- Swanquarter Bay (entire bay and three tributaries: Shingle, Cowpen and Oyster Creeks),
- Eastard Bay,
- Caffee Bay,
- Crab Cove,
- Great Island Narrows from Juniper Bay to Swanquarter Bay,
- Juniper Bay (entire bay and four tributaries: Juniper Bay, Doe, Buck and Laurel Creeks).

Special protection measures that apply to North Carolina ORWs are set forth in 15A NCAC 2B .0216, most of which is included in Appendix I. At a minimum, no new discharges or expansions will be permitted, and stormwater controls for most new development will be required.

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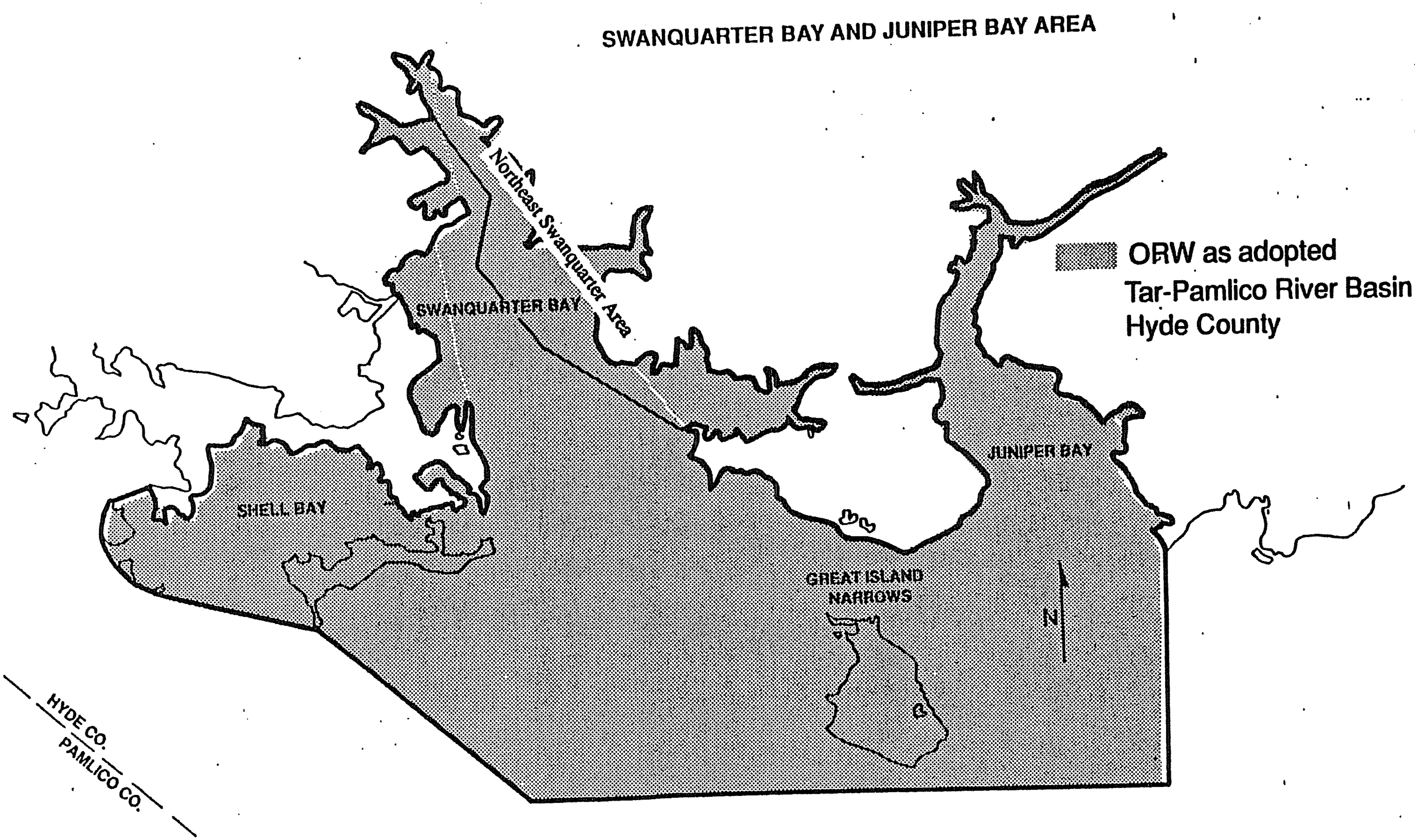


Figure 2.8 ORW Waters in the Tar-Pamlico River Basin

CHAPTER 3

CAUSES AND SOURCES OF WATER POLLUTION IN THE TAR-PAMLICO BASIN

3.1 INTRODUCTION

Water pollution is caused by a number of substances including sediment, nutrients, bacteria, oxygen-demanding wastes, metals and organics. *Sources* of these pollution-causing substances are divided into broad categories called *point* sources and *nonpoint* sources. Point sources are typically piped discharges from wastewater treatment plants and large urban and industrial stormwater systems. Nonpoint sources can include stormwater runoff from small urban areas (population less than 100,000), forestry, mining, agricultural lands and others. **Section 3.2** identifies and describes the major causes of pollution in the Tar-Pamlico basin. **Sections 3.3 and 3.4** describe point and nonpoint source pollution in the basin.

3.2 CAUSES OF POLLUTION

The term *causes* of pollution refers to the substances which enter surface waters from point and nonpoint sources and can result in water quality degradation. The major causes of pollution discussed throughout the basin plan include *biochemical oxygen demand (BOD)*, *nutrients*, *sediment*, *toxicants* (such as heavy metals, chlorine and ammonia), *color* and *fecal coliform bacteria*. Each of the following descriptions indicates whether the cause is point or nonpoint source-related (or both).

3.2.1 Oxygen-Consuming Wastes

Oxygen-consuming wastes are substances such as decomposing organic matter or chemicals which remove dissolved oxygen from the water column. Maintaining a sufficient level of dissolved oxygen in the water is critical to most forms of aquatic life. Understanding oxygen-consuming wastes and their impact on water quality is enhanced by some basic knowledge of the factors which affect dissolved oxygen concentrations in the water.

The concentration of dissolved oxygen (DO) in a water body is one indicator of the general health of an aquatic ecosystem. A lack of sufficient DO in the water will threaten aquatic life. The United States Environmental Protection Agency (USEPA) states that 3.0 milligrams per liter (mg/l) is the threshold DO concentration needed for many species' survival (USEPA, 1986). Higher concentrations are needed to promote propagation and growth of most aquatic life in North Carolina's surface waters. North Carolina has adopted a water quality standard of 5.0 mg/l to protect the majority of its surface waters. Exceptions to this standard exist for waters supplementally classified as *trout waters* (not found in the Tar-Pamlico Basin) and those supplementally classified as *swamp*. Trout waters have a DO standard of 6.0 mg/l due to the higher sensitivity of trout to low DO levels. Swamp waters often have naturally low levels of DO, and aquatic life typically found in these waters is adapted to the lower DO levels. Sluggish swamp waters in the coastal plain portion of the state may have natural DO levels of 3.0 to 4.0 mg/l or less at times. Therefore, the DO standard for swamp waters may be less than 5.0 mg/l if that lower level is judged to be the result of natural conditions. Many of the freshwater streams in the Coastal Plain portion of the basin are supplementally classified by the state as swamp waters (see section 2.5 for further discussion on standards and classifications).

DO concentrations are affected by a number of factors. Higher DO is produced by turbulent actions which mix air and water such as waves, rapids and water falls. In addition, lower water temperature generally allows for greater retention of dissolved oxygen.

Dissolved oxygen is produced by algae and other plants in the presence of sunlight through a process called *photosynthesis*. At night, however, photosynthesis and DO production stop and DO is consumed by plants through a process called *respiration*. During the summer months, this daily cycle of daytime oxygen production and nighttime depletion often results in supersaturation of the surface water by oxygen during the afternoon hours on bright, sunny days, and low DO concentrations during the late night and early morning hours.

A major cause of DO depletion is the decomposition of organic matter such as leaves, dead plants and animals, and organic waste matter discharged into the water from point sources. Human and household wastes are high in organic matter, and bacterial decomposition of these wastes once they enter surface waters can rapidly deplete DO levels unless these wastes are adequately treated at a wastewater treatment plant. In addition, some chemicals may react with and bind up DO.

Temperature, flow and depth also play important roles in dissolved oxygen concentrations. Higher water temperatures reduce the ability of water to retain DO. Therefore, in general, lowest DO concentrations usually occur during the warmest summer months. Low DO levels often occur in warm, slow-moving waters that receive a high input of effluent from wastewater treatment plants. During low-flow periods, the instream waste concentation of organic matter from point source discharges is higher than during normal flow periods. Depth is also a factor. In deep slow moving waters such as lakes or estuaries, the water column may become stratified by water temperatures and/or salinity (with cooler and more saline waters being denser and settling to the bottom). Under stratifed conditions, DO concentrations may be very high near the surface due to wind action and plant (algae) photosynthesis but may be entirely depleted (anoxic) at the bottom.

Biochemical oxygen demand, or BOD, is a technical term that describes the overall demand on DO from the various oxygen-depleting processes presented above. BOD can be further subdivided into two broad categories: *carbonaceous* biochemical oxygen demand (CBOD) and *nitrogenous* biochemical oxygen demand or NBOD (largely comprised of ammonia (NH_3)). CBOD accounts for the DO consumed by organic substances breaking down. NBOD refers to the bacterial conversion of ammonia to nitrite and nitrate which also uses dissolved oxygen. NPDES permits administered by DEM typically have limits for BOD_5 in each point source permit.

A large portion of the organic material discharged into the water from a wastewater treatment plant is readily decomposed as the oxygen-consuming decay process may begin to occur within a matter of hours. As this decay process occurs in a moving water column, the area of greatest impact may be several miles below the point of discharge. This area can be readily identified by a marked reduction in instream dissolved oxygen concentrations and is commonly referred to as the *sag zone*. Frequently, DO concentrations will gradually rise downstream of the sag zone as the amount of readily decomposed organic matter is reduced. However, a significant portion of the organic matter in wastewater treatment plant effluent may take days to decompose. A commonly used measure of BOD is called BOD_5 where the "5" stands for five days. BOD_5 is a standard waste limit in most discharge permits. A limit of 30 mg/l of BOD_5 is the highest concentration allowed by federal and state regulations for municipal and domestic wastewater treatment plants. However limits less than 30 mg/l and sometimes as low as 5 mg/l are becoming more common in order to maintain DO standards in the receiving waters.

Oxygen Consuming Wastes in the Tar-Pamlico Basin

Four areas have been identified in Section 6.3 of Chapter 6 where specific point source control strategies for BOD are being recommended in order to protect dissolved oxygen standards in the receiving waters. These areas are shown in Figure 6.1 (Chapter 6) and include Fishing Creek and its tributaries in and around Oxford, the Tar River mainstem between Rocky Mount and Greenville, Tranters Creek and several of its tributaries, and those waters in and around Swanquarter National Wildlife Refuge which have been supplementally classified as Outstanding Resource Waters (ORW). In addition, all wastewater treatment plants must meet their permitted limits for BOD and ammonia in order to protect and maintain water quality standards throughout the basin.

Despite the localized concerns noted above, the overall total daily BOD loading from NPDES (National Pollutant Discharge Elimination System) dischargers in the Tar-Pamlico River Basin in 1993 is estimated to be much lower now than it was 20 years ago despite the fact that the total volume of treated wastewater increased significantly over that period of time. As noted in Figure 3.1a, the total loading of BOD has decreased from approximately 3.5 tons per day in the mid-1970s to approximately 1.3 tons per day in 1993 while the total effluent discharge increased by 67% from 21 MGD in the mid 1970s to 35 MGD in 1993. This reduction in BOD loading has come about because of more stringent point source pollution control requirements mandated by the federal Clean Water Act and implemented through the state's NPDES program. Credit is given to the NPDES-permitted facilities in the basin that have met and continue to meet these requirements for water quality protection.

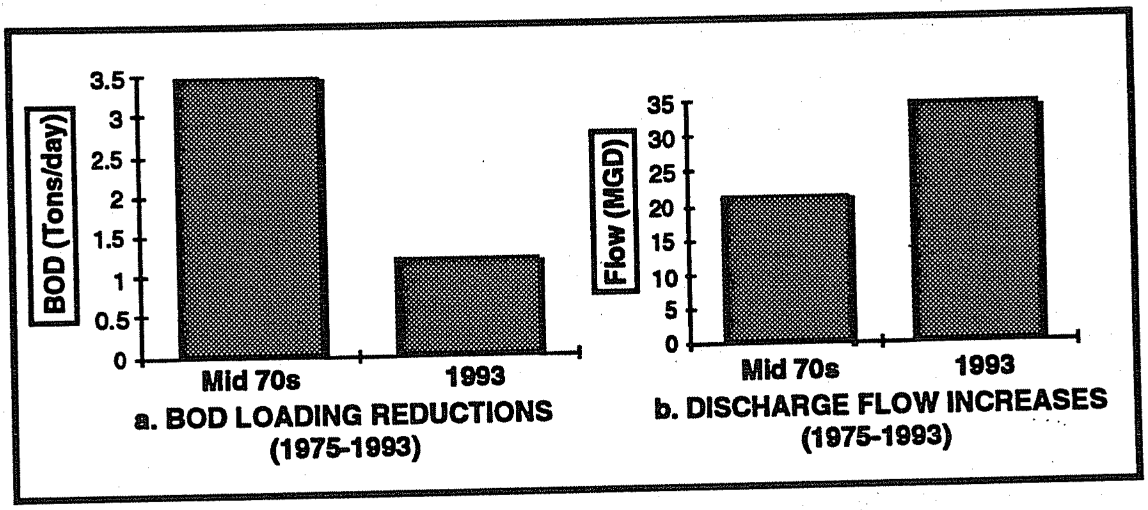


Figure 3.1 Comparison of Total BOD Loading and Effluent Flows from NPDES dischargers in the Tar-Pamlico River Basin Between Mid-1970s and 1993

3.2.2 Nutrients

The term *nutrients* in this document refers to the substances phosphorus and nitrogen, which are essential elements for plant growth. Nutrients in surface waters come from both point and nonpoint sources. While nutrients can be beneficial to aquatic life in small amounts, in overabundance and under conducive conditions, they can stimulate algal blooms and other excessive plant growth in quiet waters such as ponds, lakes, reservoirs and estuaries. Algae blooms, through respiration and decomposition, deplete the water column of dissolved oxygen and can contribute to serious water quality problems. Nutrient overenrichment and the resultant problems of low DO are called *eutrophication*. In addition to problems with low DO, the blooms are aesthetically undesirable, impair recreational use, impede commercial fishing and pose difficulties in water treatment at water supply reservoirs. Researchers have recently found evidence that some fish kills in the Pamlico River may have been caused by toxic dinoflagellates, and that certain life stages are stimulated by nutrient enrichment, particularly phosphorus. Excessive growth of larger plants, or macrophytes, such as milfoil, alligator weed and Hydrilla, can also be a problem. These plants, in overabundance, can reduce or eliminate swimming, boating and fishing in infested waters.

Agricultural runoff and wastewater treatment plants along with forestry and atmospheric deposition are the main cultural sources of nutrients in the estuary. Nutrients in nonpoint source runoff come mostly from fertilizer and animal wastes. Nutrients in point source discharges are from human wastes, food residues, some cleaning agents and industrial processes. A statewide phosphorus detergent ban implemented in 1988 significantly reduced the amount of phosphorus reaching and being discharged into surface waters from wastewater treatment plants. A report was prepared by the North Carolina Department of Environment, Health, and Natural Resources in 1991 to evaluate the effects of the ban (NCDEHNR, 1991). The Tar-Pamlico River Basin has also been supplementally classified as nutrient sensitive waters (NSW) as discussed in Chapter 2 (Section 2.5.3) and Chapter 6 (Section 6.4).

At this time, North Carolina has no instream standards for total phosphorus (TP) and total nitrogen (TN), but analysis is underway, and standards or instream criteria may be developed for these parameters in the future. Limits on the amount of phosphorus that may be discharged into surface waters are presented in Chapter 6. In addition, the State has a standard of 40 ug/l (micrograms per liter or parts per billion) for chlorophyll *a* . Chlorophyll *a* is a constituent of most algae (it gives algae its green color). A chlorophyll *a* reading above the 40 ug/l standard is indicative of excessive algal growth and portends bloom conditions.

Nutrient Loading in the Tar-Pamlico Basin

The following four nutrient loading models have been developed for the Tar-Pamlico Basin to determine the amount and sources of nutrients.

1. Nutrient Source Budget Model Using Export Coefficients - This model is the simplest of the loading models and was developed by DEM and subsequently updated by Research Triangle Institute (RTI) as part of the Albemarle Pamlico Estuarine Study to help identify the amount and sources of nutrients within the basin as a whole.
2. FLUX Model - The FLUX Model, developed by the US Army Corps of Engineers, was used by RTI to statistically estimate the annual load of nutrients at discrete locations within the basin based on continuous flow and nutrient grab data collected at the site. The model does not indicate the source of the nutrients.
3. Generalized Watershed Loading Function (GWLF) model - Research Triangle Institute developed the GWLF model for the Tar-Pamlico Basin (RTI, 1994). The GWLF is a more complex model than the empirical models listed above and is intended to estimate nutrient and sediment loadings from various sources within each of 15 watersheds comprising the Tar-Pamlico Basin.
4. ~~Mass Balance Model - RTI developed a mass balance model for nutrients for the portion of the~~ Tar-Pamlico watershed above the mainstem gage at Tarboro. Mass balance models do not quantify nutrient loading, but instead are used to quantify nutrient sources and sinks. The mass balance can identify areas where improvements in nutrient management can be made, and the method is gaining popularity from national experts in nutrient contol (RTI, 1994).

Each of these four models and the information derived from them is presented below.

1. Nutrient Budget Model Using Export Coefficients

The simplest type of loading model, the nutrient source budget, was first developed by DEM in 1986 in order to provide an analysis for use in preparing the nutrient sensitive waters (NSW) strategy for the basin. Nutrient budgets identify the amount of nutrient loading from each pollutant source within a given watershed. Nonpoint source loading was estimated through the use of *export coefficients* for different land cover types. The term, export coefficients, refers to the amount of a substance, such as sediment or nutrients, that might be expected to be transported from the land by stormwater runoff to nearby surface waters. Export coefficients, which are based on research studies, are expressed in terms of the amount of loading per unit area per year (e.g. lbs/acre/year or kg/hectare/year). The amount of loading of a specific type of substance will vary with the type of land use; different land uses and cover types have been demonstrated to export different amounts of nutrients. Therefore, in a nutrient budget analysis, an estimate is made of the land area in each type of land use; this area is then multiplied by the export coefficients to estimate nonpoint source loading from each land use type. This type of model does not include any mathmetical or statistical expressions describing the nutrient loading process.

Flow and nutrient concentrations from point sources are used to determine point source nutrient loading. The 1986 nutrient budget indicated that point sources contributed 18.2% of the total nitrogen (3.5% from Texas Gulf) and 74.4% of the total phosphorus (64.6% from Texas Gulf). However, of special note is that Texas Gulf's 1988 NPDES permit required them to recycle all their process wastewater from their phosphate rock mining and chemical manufacturing operation near Aurora. As a result, the company invested approximately $30 million in the design and construction of a Water Management System which became fully operational in 1992. Based on self-monitoring data from Texas Gulf (from September 1992 through March, 1994), their Water Management System has reduced phosphorus loading to the estuary by 93%.

As part of the Albemarle Pamlico (A/P) Estuarine Study Program, the Research Triangle Institute (RTI) conducted a study that updated the nutrient budget for the Tar-Pamlico River Basin (Dodd and McMahon, 1992). RTI used actual discharger data from 1989 and 1990 to estimate the point source loading to the basin. For use in this basin plan, the nutrient loading was updated to include discharge data from 1992 for subbasins 01 through 06 and 08. Data from 1993 were used for subbasin 07 which reflect the Texas Gulf treatment upgrade noted above.

In the RTI study, land use data were obtained from a 1987-1988 LANDSAT land cover classification survey (discussed in Chapter 2), and export coefficients were estimated from a literature search of numerous studies. A range of export coefficients (high, median and low) was identified in the literature for each land cover type. For the purpose of the RTI work, the median, or "most likely", value for each land cover type was used to estimate the total loading. These values and the number of studies on which they are based are presented in Table 3.1, below.

TABLE 3.1. Export Coefficient Literature Review

	Agriculture		Forest/Wetland		Developed		Atmospheric	
	lbs/ ac-yr	kgs/ (ha-yr)	lbs/ ac-yr	kgs/ (ha-yr)	lbs/ ac-yr	kgs/ (ha-yr)	lbs/ ac-yr	kgs/ (ha-yr)
Total Phosphorus								
Low (25%)	0.49	(0.55)	0.08	(0.09)	0.40	(0.45)	0.22	(0.25)
Median	**0.88**	**(0.99)**	**0.12**	**(0.13)**	**0.95**	**(1.06)**	**0.58**	**(0.65)**
High (7%)	1.81	(2.03)	0.19	(0.21)	1.34	(1.50)	0.62	(0.69)
Total Nitrogen								
Low (25%)	4.46	(5.00)	0.62	(0.69)	4.46	(5.00)	7.76	(8.7)
Median	**8.74**	**(9.80)**	**2.08**	**(2.33)**	**6.71**	**(7.50)**	**11.06**	**(12.4)**
High (7%)	12.75	(14.3)	3.39	(3.80)	8.67	(9.72)	21.41	(24.0)
Number of Studies	**77**		**36**		**78**		**6**	

Tables 3.2 and 3.3 present RTI's estimated nonpoint source nitrogen and phosphorus loading data by land cover type for each of the Tar-Pamlico's eight subbasins. As noted above, the point source data are based on 1992 discharge monitoring report data from permitted facilities (1993 data for subbasin 07). Figures 3.2 and 3.3 then summarize the relative contributions of total nitrogen (TN) and total phosphorus (TP) loadings to the whole Tar-Pamlico River from point sources and non-point sources.

Table 3.2 Nitrogen Loading from Point and Nonpoint Sources to the Tar-Pamlico River Basin Based On Export Coefficient Method

Subbasin	Agric.	Forest	Urban	Wetland	Water	Scrub	Sand	Shadow	Point source	Total	Total	Areal Load
	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	Percent	kg/ha-yr
30301	567,135	175,032	125,641	32,652	6,594	17,855	0	530	35,327	960,765	9.4	5.38
30302	741,324	71,893	22,567	23,346	12,405	9,549	0	405	157,637	1,039,127	10.1	7.06
30303	596,646	100,168	2,978	7,811	2,569	4,690	0	124	48,516	763,503	7.4	6.51
30304	760,401	280,632	14,505	57,653	2,675	15,422	0	620	34,831	1,166,738	11.4	4.88
30305	368,364	47,077	3,396	30,091	9,163	11,128	0	89	146,467	615,775	6.0	6.12
30306	311,332	28,880	2,577	20,204	427	22,984	0	50	49,979	436,432	4.2	6.12
30307	1,009,481	193,309	16,657	126,801	619,221	27,083	8,995	1,368	51,124	2,054,039	20.0	6.49
30308	289,213	74,212	3,284	76,074	2,783,018	3,112	3,112	941	1,825	3,234,791	31.5	10.04
Total Loading	4,643,895	971,202	191,606	374,632	3,436,072	111,824	12,107	4,127	525,706	10,598,623		
Percentages	45.21	9.46	1.87	3.65	33.45	1.09	0.12	0.04	5.12		100.0	

Table 3.3 Phosphorus Loading from Point and Nonpoint Sources to the Tar-Pamlico River Basin based on Export Coefficient Method

Subbasin	Agric.	Forest	Urban	Wetland	Water	Scrub	Sand	Shadow	Point Source	Total	Total	Areal Load
	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	kg/yr	Percent	kg/ha-yr
30301	57,292	9,766	17,757	1,822	346	996	0	30	3,457	91,465	10.7	0.51
30302	74,889	4,011	3,189	1,303	650	533	0	23	22,124	106,722	12.5	0.68
30303	60,273	5,589	421	436	135	262	0	7	3,673	70,795	8.3	0.61
30304	76,816	15,658	2,050	3,217	140	860	0	35	3,483	102,259	11.9	0.43
30305	37,212	2,627	480	1,679	480	621	0	5	17,437	60,541	7.1	0.56
30306	31,451	1,611	364	1,127	22	1,282	0	3	3,541	39,402	4.6	0.57
30307	101,978	10,785	2,354	7,075	32,459	1,511	502	76	44,230	200,971	23.5	0.51
30308	29,216	4,141	464	4,244	145,884	174	174	53	53	184,402	21.5	0.57
Total Loading	469,128	54,187	27,080	20,902	180,117	6,239	675	230	97,998	856,557		
Percentages	54.77	6.33	3.16	2.44	21.03	0.73	0.08	0.03	11.44		100.0	

Table 3.2 indicates that the majority of the nitrogen loading occurs in the lowest two subbasins (07 and 08), and subbasin 08 also has the highest areal (per unit area) loading of nitrogen. Subbasin 04 has high nitrogen loading, but it has the lowest areal loading rate which indicates that the high loading is due in part to the large surface area of the basin. Subbasin 02 has the second highest

areal nitrogen loading rate and constitutes 10% of the nitrogen loading in the basin. The highest percentage of phosphorus is also found in subbasins 07 and 08, with subbasin 02 contributing about 10% of the phosphorus. Subbasin 02 also has the highest areal TP loading rate. Agriculture is the largest contributor of nutrients in subbasin 02 followed by point source dischargers.

Figures 3.2 and 3.3 indicate that point source discharges contribute 5% of the TN and 12% of the TP to the basin. Agriculture is the main nonpoint source contributor of TN (45%) and TP (44%) in the basin. Atmospheric deposition is also a major contributor of TN (33%) and TP (17%), particularly in the estuary where the open water is the major land cover.

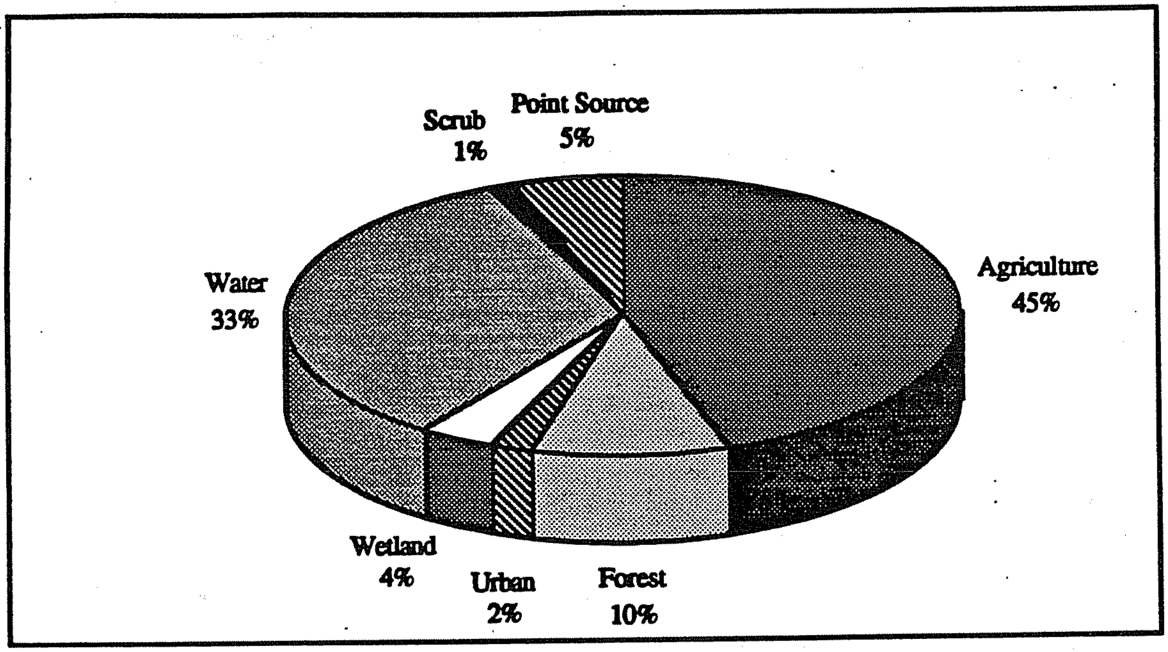


Figure 3.2 Estimated *Nitrogen* Loading by Source and Percentage to the Tar-Pamlico Basin Based on Export Coefficient Method

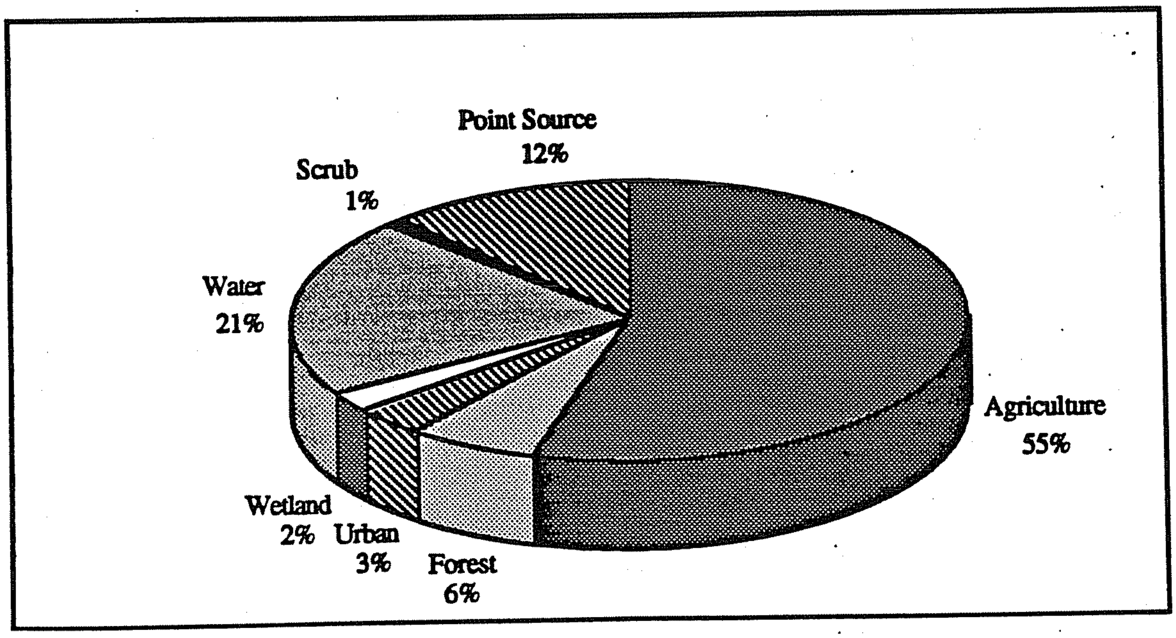


Figure 3.3 Estimated *Phosphorus* Loading by Source and Percentage to the Tar-Pamlico Basin Based on Export Coefficient Method

2. Flux Model

The FLUX model, developed by the U.S. Army Corps of Engineers, estimates the annual load of nutrients at a given point within a basin based on continuous flow and nutrient grab data collected at the site, but it does not indicate the source of the nutrients. RTI esimated nutrient loading at eight sites within the basin using the FLUX model. Table 3.4 summarizes the data for each site (RTI, 1994). For further information on the FLUX model, the reader is referred to the user's manual (Walker, 1985) and RTI's modeling report (RTI, 1994). Table 3.5 summarizes the flux results and areal loading rates at each site. The areal loading rates were estimated by subtracting the point source inputs at the site from the flux estimate and dividing by the watershed area.

Table 3.4: Station Data Used in FLUX Model

Station No.	Stream	Site Description	County	No. TP and TN Samples
2081747	Tar River	at US Hwy 401 at Louisburg	Franklin	28
2082585	Tar River	at NC Hwy 97 at Rocky Mt	Edgecombe	29
2082770	Swift Ck	at SR 1310 at Hilliardston	Nash	29
2083000	Fishing Ck	at US Hwy 301 near Enfield	Edgecombe	12
2083500	Tar River	at Tarboro	Edgecombe	17 TP; 16 TN
2083800	Conetoe Ck	at SR 1409 near Bethel	Pitt	30
2084160	Chicod Ck	at SR 1760 near Simpson	Pitt	4
2084540	Durham Ck	at SR 1949 at Edward	Beaufort	20

Table 3.5: FLUX Results and Comparison of Areal Loading at Gaged Sites

Site	TP Flux (kg/yr)	Areal TP Load (kg/ha-yr)	TN Flux (kg/yr)	Areal TN Load (kg/ha-yr)
Tar River at Louisburg	26,020	0.16	203,269	1.34
Tar River at Rocky Mt	81,053	0.26	623,999	2.14
Swift Creek at Hilliardston	19,530	0.46	129,432	3.03
Fishing Creek near Enfield	34,985	0.23	261,188	1.74
Tar River at Tarboro	213,239	0.15	1,701,893	1.63
Conetoe Creek near Bethel	3,548	0.06	165,279	8.04
Chicod Creek near Simpson	17,674	1.51	127,500	10.93
Durham Creek at Edward	1,232	0.18	11,332	1.68

The results, as expected, indicate that the highest total loads occur at the most downstream site on the Tar River at Tarboro. On an areal loading rate, Chicod Creek had the highest phosphorus and nitrogen loads. Swift Creek also had a fairly high phosphorus load, and Conetoe Creek and Swift Creek had higher nitrogen loads.

The results listed in Table 3.5 should be reviewed with care. For example, Chicod Creek is listed as having the highest areal loading. However, Table 3.4 indicates that only 4 nutrient data points were available for the analysis, and less faith can be put in these numbers. In addition, most of the nutrient samples were not taken during high flow events. Since highest flux occurs during storm events, the under-representation of high flow sampling may have resulted in an underestimation of total nutrient load. Of the stations sampled, Conetoe Creek had the best representation of high flow events, and this may be part of the reason for the estimated high areal loading of TN (RTI, 1994). DEM should consider random monthly sampling at gaged sites for nutrients in basins where nutrients are considered an issue. Such random sampling would eliminate some of the bias which may have been introduced in the results here.

3. Generalized Watershed Loading Function Model (GWLF)

RTI developed a Generalized Watershed Loading Function (GWLF) model for the Tar-Pamlico Basin (RTI, 1994). The GWLF is a spatially lumped nutrient and sediment model which is more complex than the empirical models listed above. However, it is not as complex and therefore less data intensive than other available models. The model distributes dissolved nitrogen and phosphorus loads into rural runoff, groundwater, and point sources. Solid phase nitrogen, phosphorus, and sediment loads are distributed to rural runoff and urban runoff. The model is driven by daily precipitation and temperature data. The GWLF estimates runoff from the Soil Conservation Service Curve Number Equation, and it is assumed to occur on the date on which the precipitation was recorded. Erosion is computed using the Universal Soil Loss Equation (RTI, 1994). The GWLF model was run for each of 15 watersheds in the basin (hydrologic units) which nest within DEM's eight Tar-Pamlico subbasins (Figure 3.4).

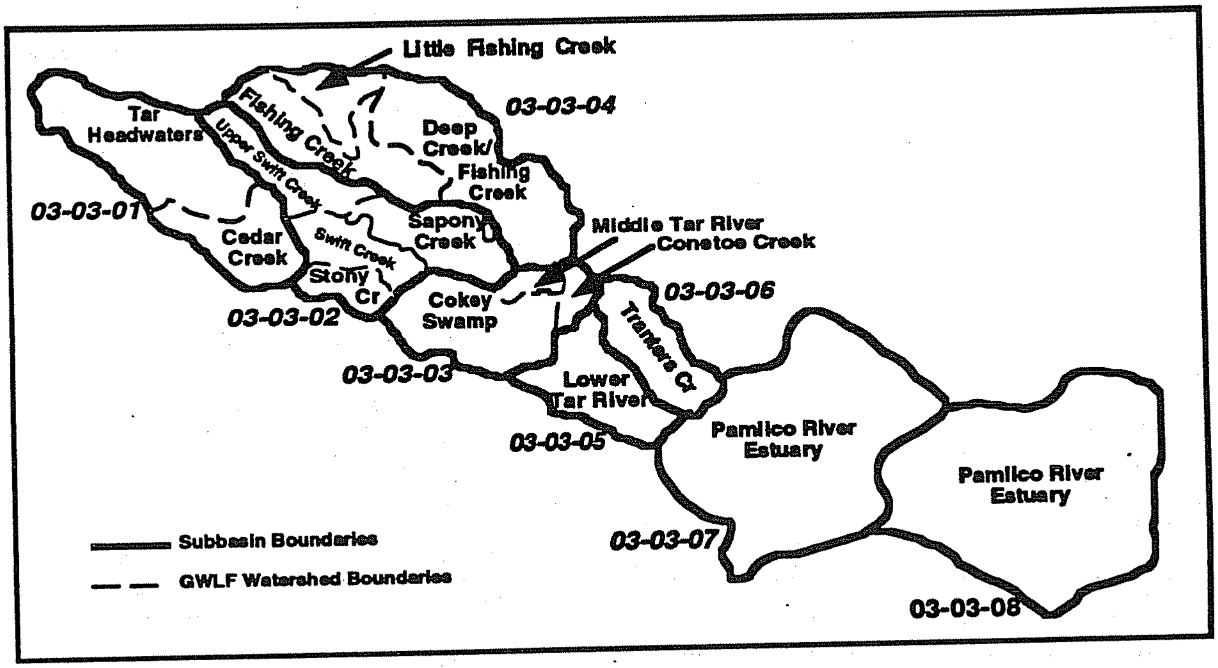


Figure 3.4 Comparison of GWLF Watersheds and DEM subbasins

For the purposes of this report, the model was run using two different land use data sources, the LANDSAT land use data collected through the Albemarle-Pamlico Estuarine Study and the North Carolina Agricultural Statistics. The agricultural statistics estimates of the area planted in different crops. This gives the user higher resolution for agricultural land use which is advantageous in choosing the model paramters as many of them are based on crop type. However, these data have limitations. First, other land uses are clumped into a non-agricultural category so the user cannot determine loadings from forest, wetlands, and urban areas. Second, the data are published on a county level rather than on a watershed level so areas had to be reapportioned based on the percent of each watershed within a given county. This method assumes that different land uses are uniformly distributed throughout a given county. Under both land use scenarios, the model was run from April 1987 through March 1992 and the results averaged over the 5 year period.

The GWLF model results are illustrated in Table 3.6 and Figures 3.5 - 3.7. The sediment loading results between the two land use scenarios are quite different, and future improvements in the modeling will depend on better land use information to further study this issue. The results indicate that the highest nutrient loading occurs in the Pamlico River Estuary and in the Lower Tar River. The headwaters of the Tar River, Fishing Creek, Deep Creek, and Cokey Swamp Creek are also predicted to contribute relatively high amounts of nitrogen and sediment. The GWLF model run results are compared to the results of the FLUX model at selected gaged sites within the basin in Figures 3.8 and 3.9. The figures indicate that some major discrepancies exist in these model results as well. Future nutrient work in the Tar-Pamlico River Basin should attempt to resolve these discrepancies.

Finally, the GWLF results (using the LANDSAT land use data) were compared to the results using the export coefficients method, and the results are presented in Figures 3.10 and 3.11 and Table 3.7. The hydrologic units used in the GWLF model were combined to fit within the DEM subbasins, while DEM subbasins 07 and 08 were combined to fit within the GWLF unit named the Pamlico River Estuary. Table 3.7 gives further information on this combining of watersheds. The TN loading for the entire river basin is approximately 7 million kg/yr greater using the export coefficients instead of the GWLF results while the TP loading is approximately 400,000 kg/yr greater using the export coefficients. Figures 3.10 and 3.11 further show that the predicted TP and TN loading in each subbasin is greater using the export coefficient model than the GWLF model with the exception of predicted TP in DEM subbasin 05. Some of this discrepancy is due to the lack of good land use data which breaks down agricultural and nonagricultural land by watershed. The export coefficient model also accounts for direct atmospheric deposition onto water surfaces, a large component of nutrient loading in the estuary, which the GWLF model does not include.

Table 3.6 Predicted Nutrient and Sediment Loading using GWLF Model with LANDSAT and State Agricultural Statistics Land use Data

Watershed	LANDSAT TN kg/yr	LANDSAT TP kg/yr	LANDSAT Sediment Mg/yr	State Ag Stat TN kg/yr	State Ag Stat TP kg/yr	State Ag Stat Sediment Mg/yr
Tar River Hdwtrs	466,197	44,297	7,734	217,486	9,412	2,489
Tar Hdwtr-Cedar Ck	194,702	14,993	4,107	131,563	5,352	1,473
Tar Hdwtr-Sapony Ck	227,614	24,271	2,342	207,791	21,218	1,318
Stony Creek	86,270	6,626	1,777	69,020	3,876	3,876
Upper Swift Ck	140,739	11,633	4,398	94,887	3,331	1,483
Swift Creek	111,776	8,525	4,018	90,267	4,651	1,815
L. Fishing Ck	82,196	4,399	1,438	78,725	3,906	1,206
Fishing Ck	214,624	15,132	6,254	168,805	7,725	3,216
Deep Ck-Fishing Ck	216,609	15,069	4,999	187,997	10,191	2,656
Cokey Swamp Ck	245,915	14,823	3,014	221,037	10,939	1,716
Middle Tar River	20,439	1,958	505	13,262	884	260
Conetoe Ck	48,659	4,087	977	41,851	3,066	614
Tranters Ck	175,551	13,873	1,959	148,908	9,865	1,000
Lower Tar River	287,839	116,915	2,560	256,348	112,486	1,695
Pamlico River Est	641,172	360,406	1,871	601,212	348,031	1,145
Total	3,160,301	657,009	47,954	2,529,160	554,934	25,963

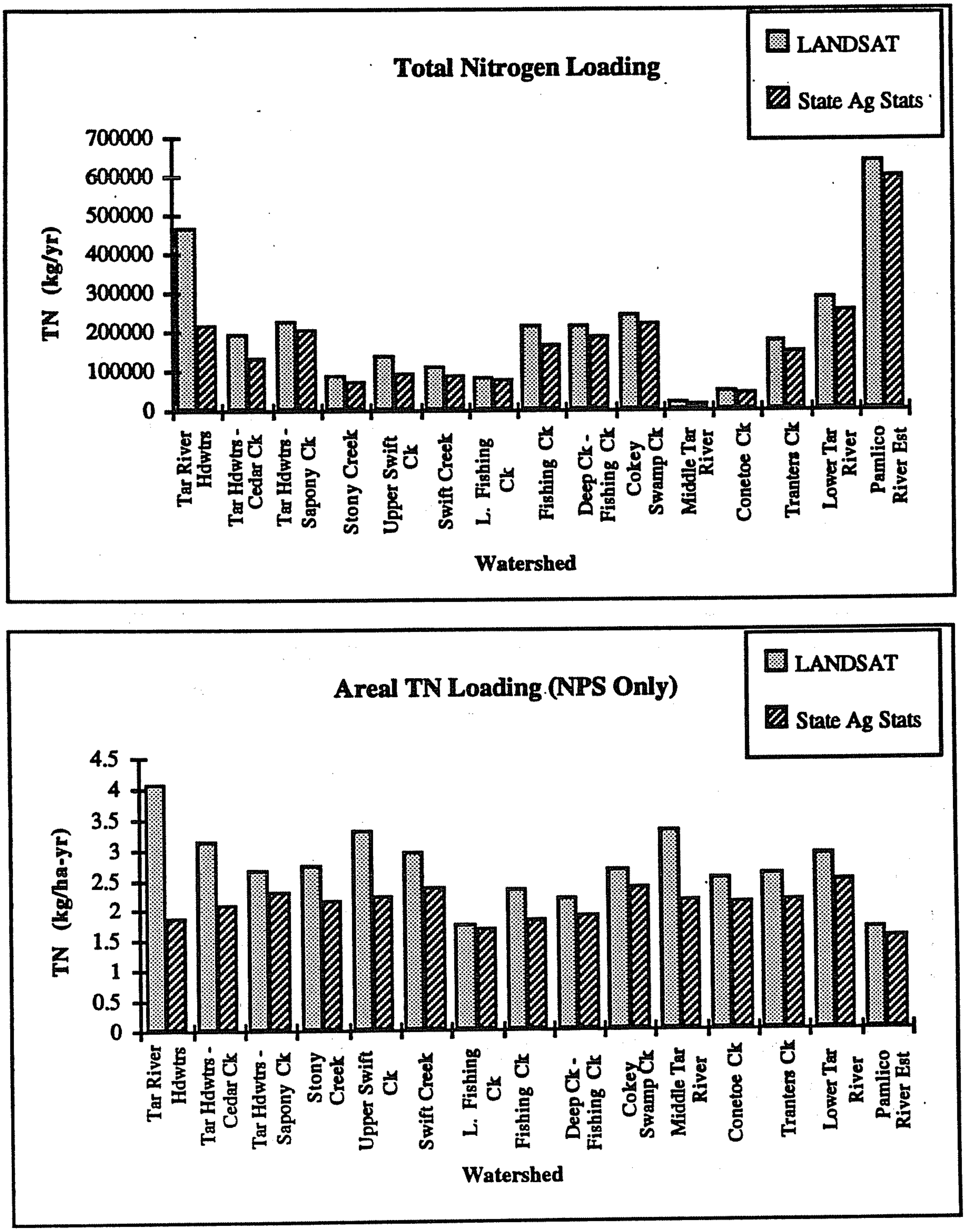
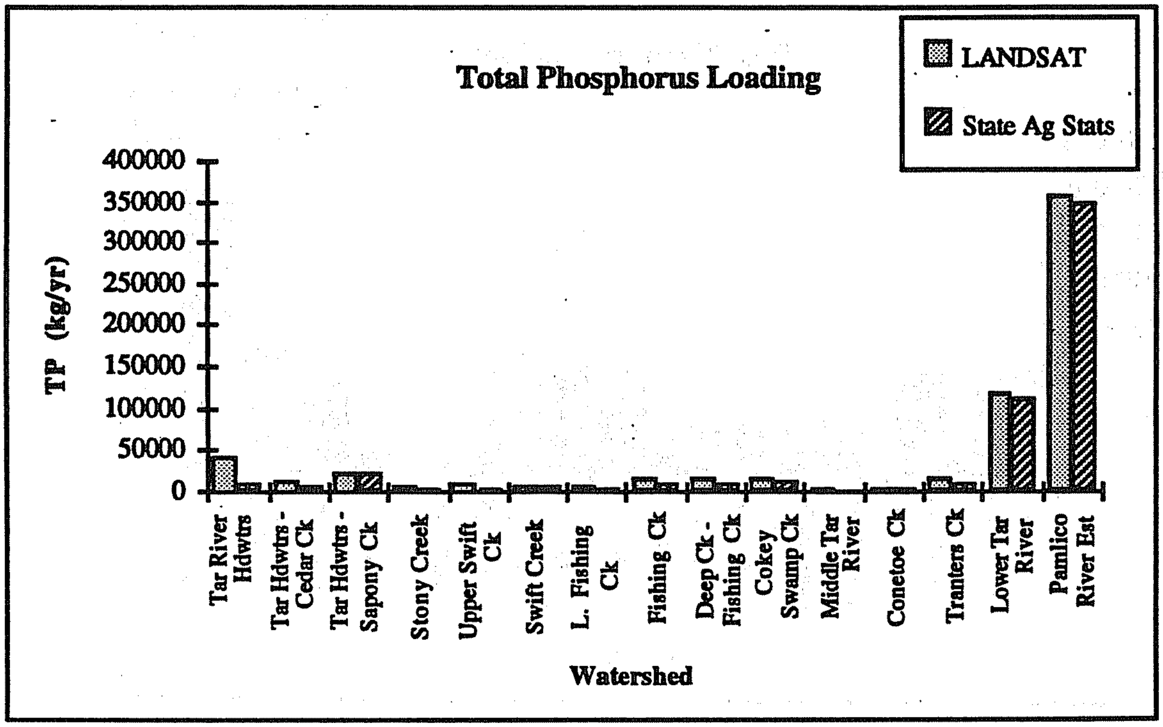


Figure 3.5 Predicted Nitrogen Loading Using the GWLF Model



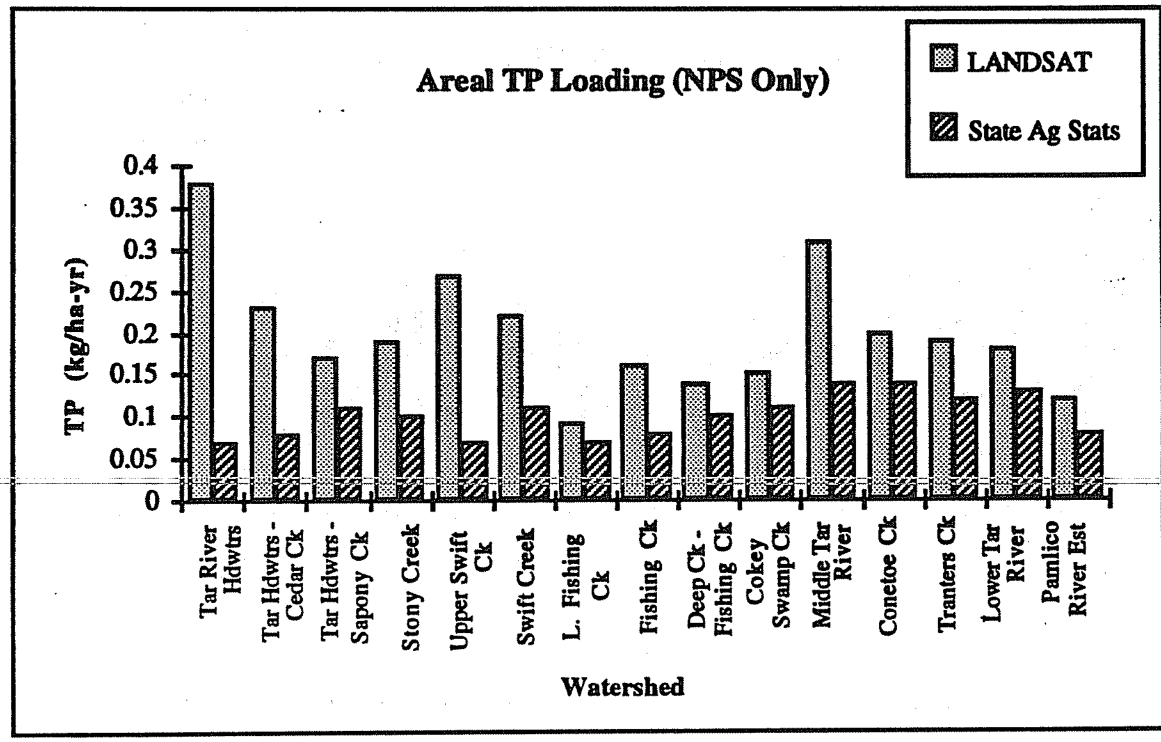
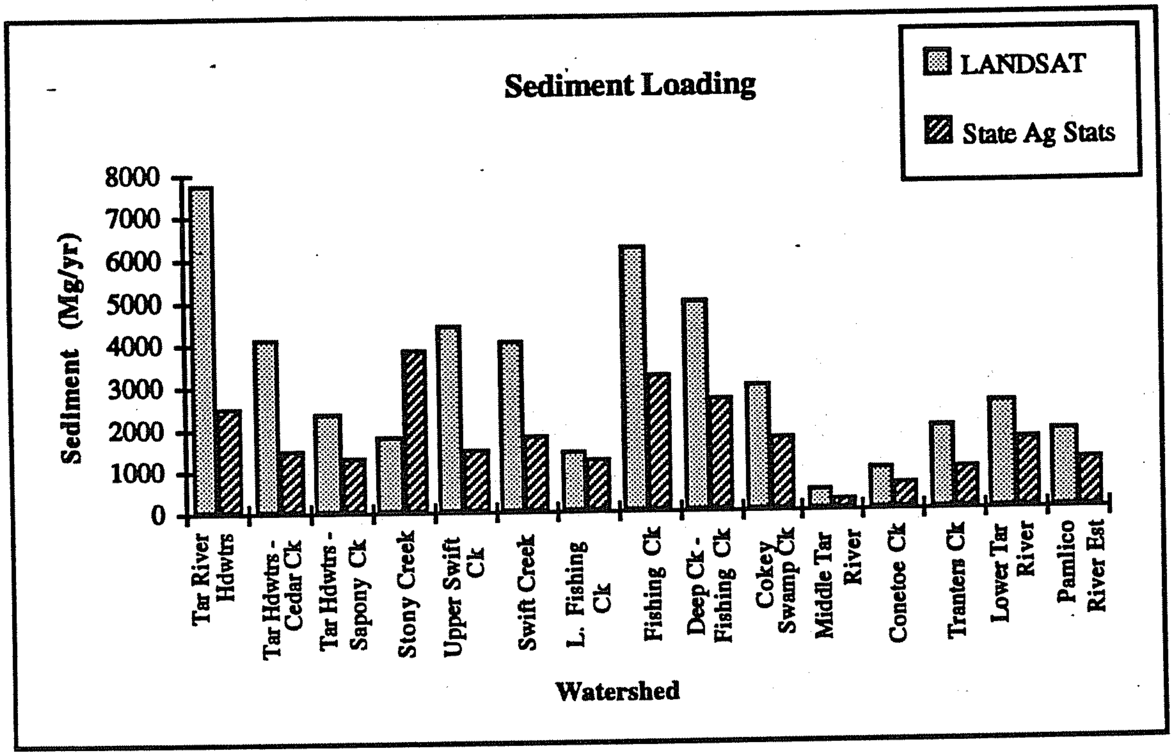


Figure 3.6 Predicted Phosphorus Loading Using the GWLF Model



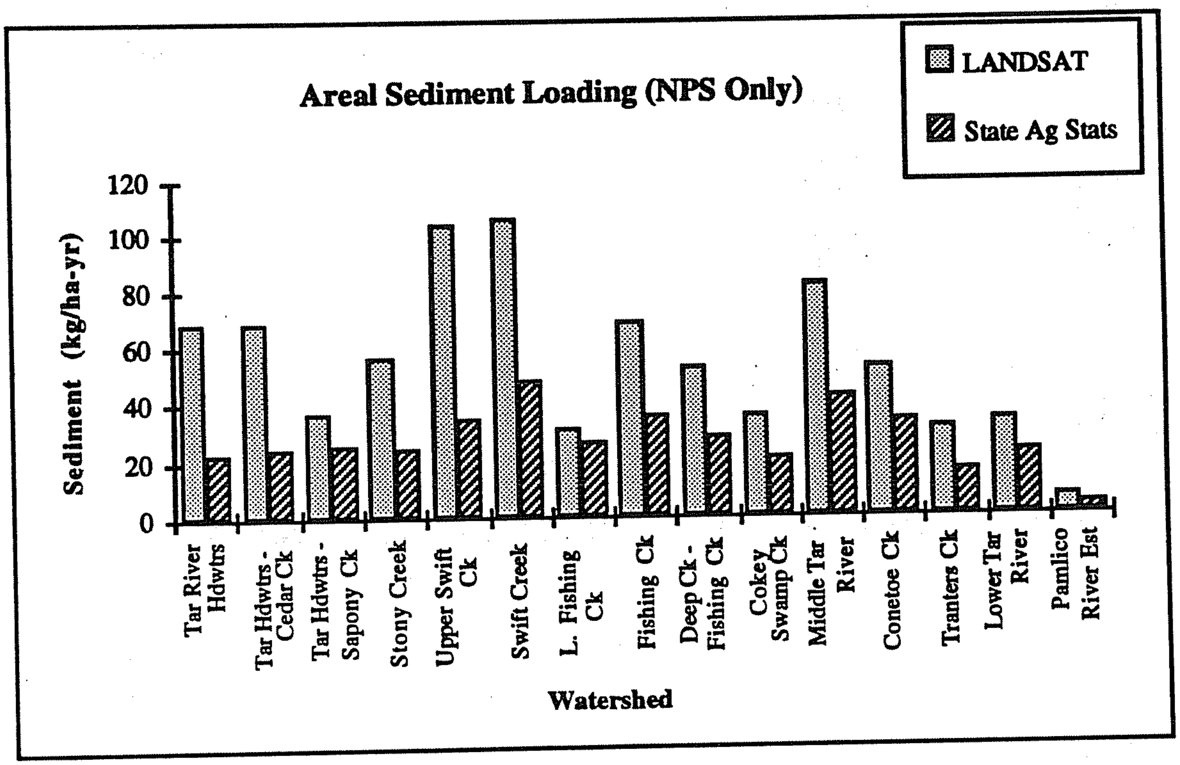


Figure 3.7 Predicted Sediment Loading Using the GWLF Model

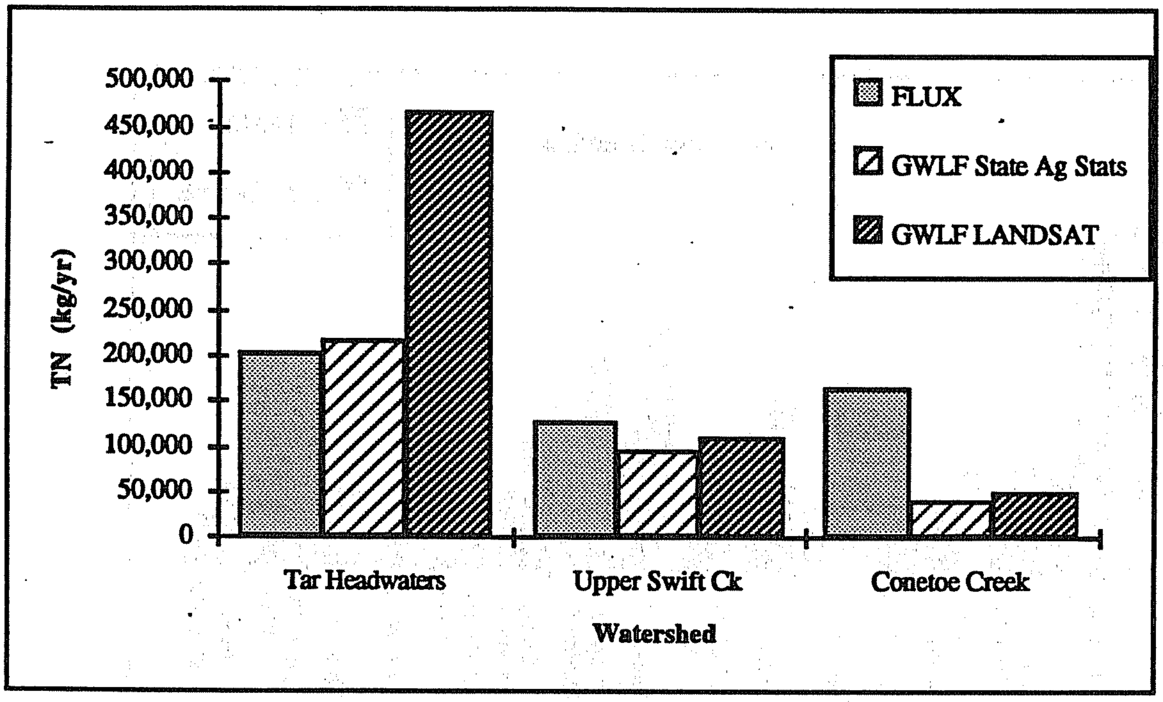


Figure 3.8 Predicted Total Nitrogen Loading from GWLF and Flux Models

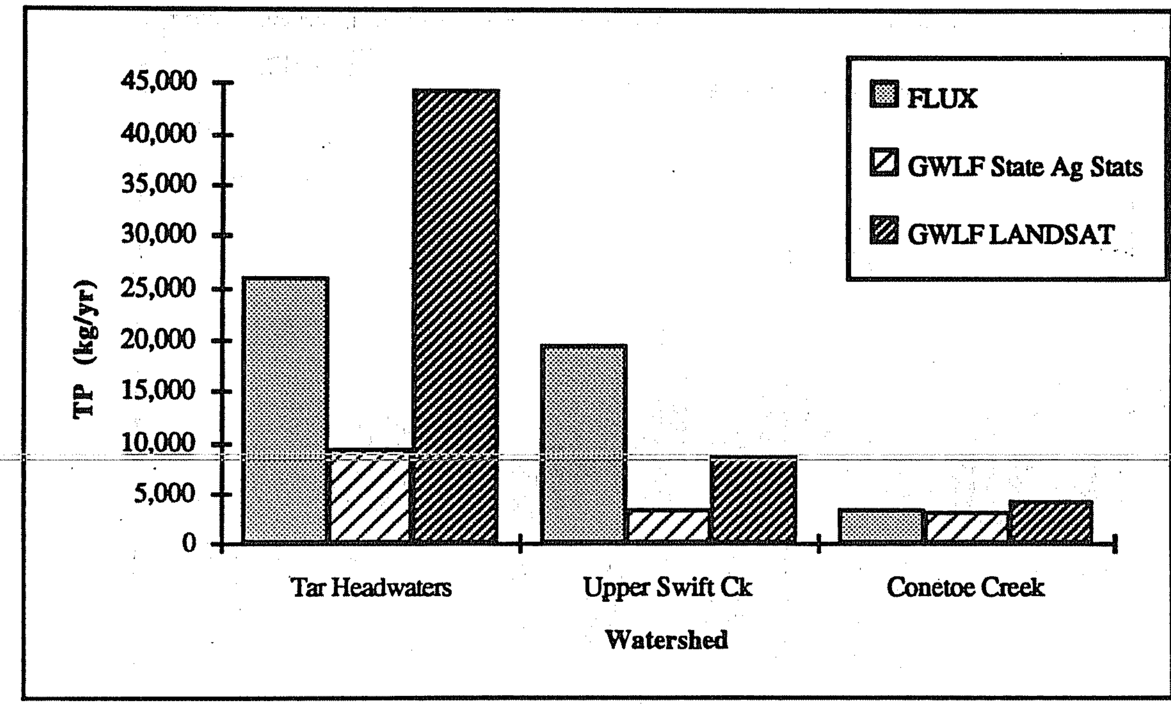


Figure 3.9 Predicted Total Phosphorus Loading from GWLF and Flux Models

Table 3.7 Comparison of Nutrient Loading Results from GWLF and Export Coefficients Models

DEM Subbasin(s)	Export Coef. TP Load (kg/yr)	Export Coef. TN Load (kg/yr)	GWLF Hydrologic Units	GWLF TP Load (kg/yr)	GWLF TN Load (kg/yr)
03-03-01	91,465	960,765	Tar Hdwtrs, Cedar Ck	59,290	660,899
03-03-02	106,722	1,039,127	Sapony, Stony, Upper Swift, Swift Ck	51,055	566,399
03-03-03	70,795	763,503	Mid Tar R, Cokey Swp, Conetoe Ck	20,868	315,013
03-03-04	102,259	1,166,738	L Fishing, Fishing, Deep Ck	34,600	513,429
03-03-05	60,541	615,775	Lower Tar River	116,915	287,839
03-03-06	39,402	436,432	Tranters Ck	13,873	175,551
03-03-07 & 03-03-08	589,335	5,616,283	Pamlico R. Estuary	360,406	641,172
Totals	1,060,519	10,598,623		657,007	3,160,302

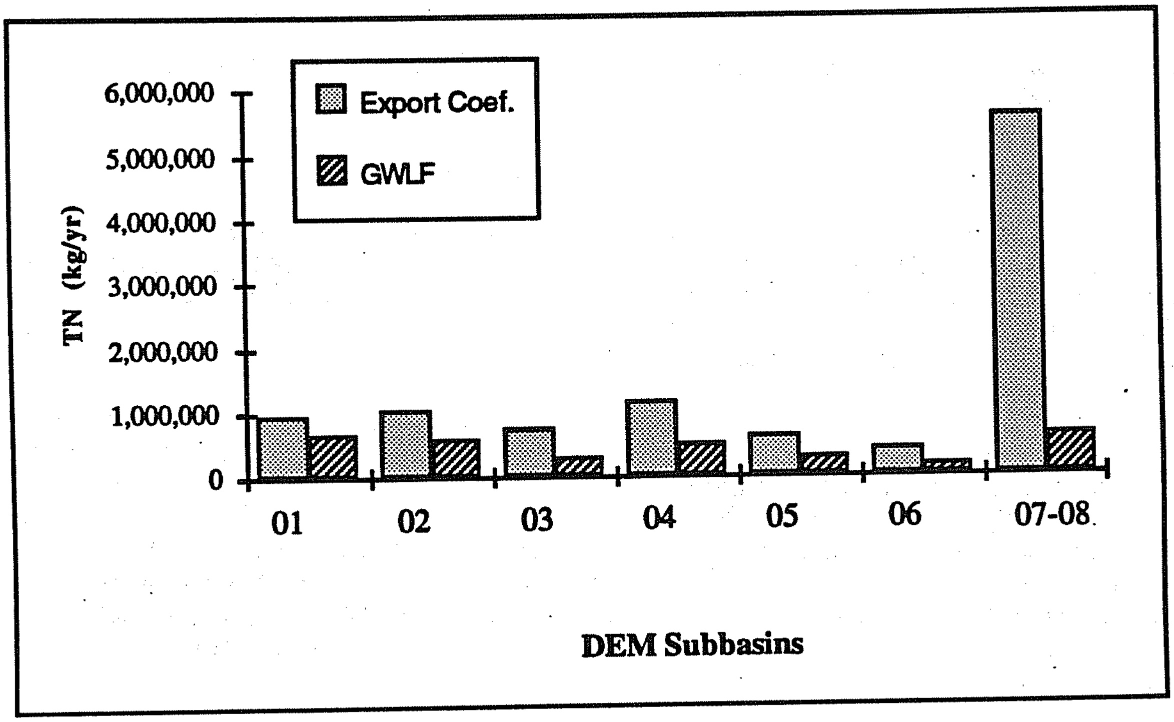


Figure 3.10 Predicted Total Nitrogen Loading from GWLF and Export Coefficient Models

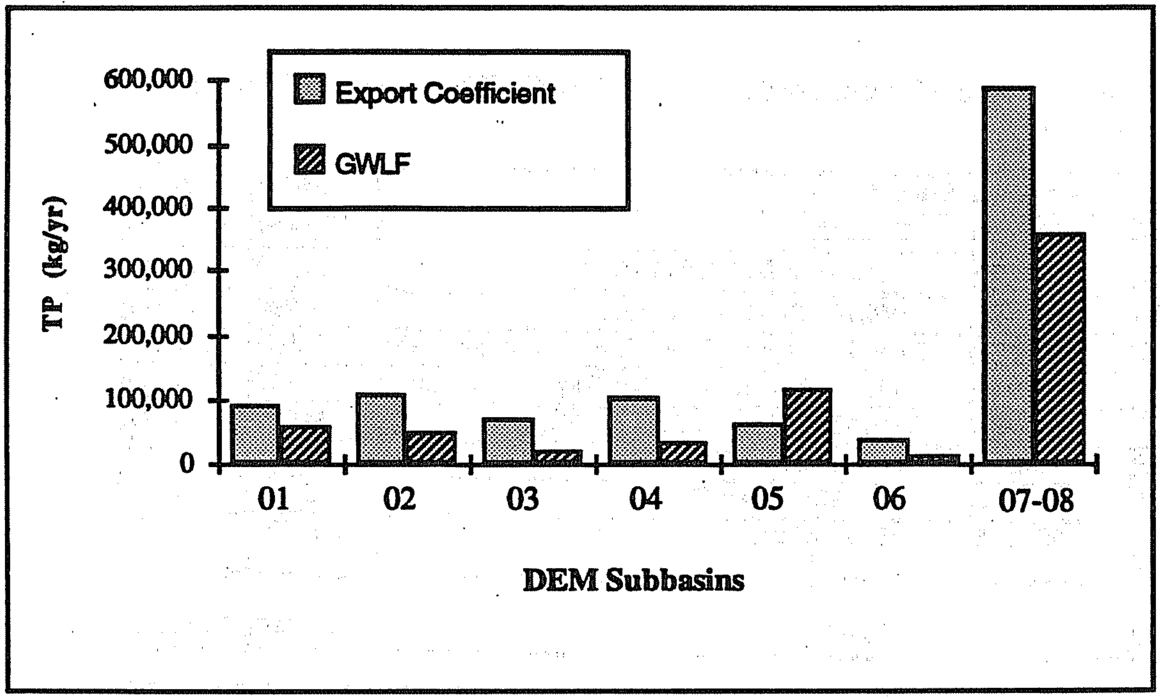


Figure 3.11 Predicted Total Phosphorus Loading from GWLF and Export Coefficient Models

4. Mass Balance Model

Finally, RTI developed a mass balance model for nutrients for the portion of the Tar-Pamlico watershed above the mainstem gage at Tarboro. Mass balance models do not quantify nutrient loading, but instead are used to quantify nutrient sources and sinks. The mass balance can identify areas where improvements in nutrient management can be made, and the method is gaining popularity from national experts in nutrient control (RTI, 1994).

Nutrient inputs included in the mass balance model were commercial fertilizer and manure and nitrogen fixation by legumes. Other inputs were omitted from the analysis due to a lack of data. Further assumptions about the nutrient inputs can be obtained from RTI's report (RTI, 1994). A desirable nutrient output is that taken up by crops. This output was estimated by obtaining land area in each crop and multiplying literature values for nitrogen and phosphorus crop content by the crop yield. Other outputs include nutrients lost to the environment through volatilization, erosion, and leaching. These outputs potentially have an adverse impact on water quality and are included in the storage term in the equation stated above. Table 3.8 summarizes the results of RTI's mass balance model (RTI, 1994).

The results indicate that 40% of the nitrogen applied in the basin above Tarboro is lost to the environment. It should be noted that this is an average value for the entire study area, and given areas within this portion of the basin may have less nitrogen lost. However, since only 60% of the nitrogen applied is taken up by crops on average, reducing the amount of nitrogen applied to cropland may be an economical way to reduce nitrogen loading in the basin.

Table 3.8 Inputs and Outputs of Nutrients in the Tar River at Tarboro

	Nitrogen		Phosphorus	
Inputs	kg	% of total input	kg	% of total input
Fertilizer	7.4	56%	0.5	22%
Manure	1.2	9%	1.8	78%
Legumes	4.5	34%	---	
Outputs				
Harvested crops	7.8	60%	2.1	91%
Balance	**5.3**	**40%**	**0.2**	**9%**

3.2.3 Toxic Substances

Regulation 15A NCAC 2B. 0202(51) defines a toxicant as "any substance or combination of substances ... 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 or other adverse health effects". Toxic substances frequently encountered in water quality management include *chlorine*, *ammonia*, *organics* (hydrocarbons, pesticides, herbicides), and *heavy metals*. These materials are toxic to different organisms in varying amounts, and the effects may be evident immediately or may only be manifested after long-term exposure or accumulation in living tissue. The state maintains an ambient monitoring system which includes about 380 permanent sampling locations. Physical and chemical water quality sampling is done once a month at these sites. Biological monitoring is also done that can serve as an indicator of potential toxicity problems. DEM's water quality monitoring programs are described in Section 4.2 and Appendix II.

North Carolina has adopted standards and action levels standards for numerous toxic substances in both fresh and salt waters. These are contained in 15A NCAC 2B .0200 and are summarized in Tables 1 and 2 in Appendix I. Action levels are denoted in the appendix with AL in parentheses (AL). Usually, limits are not assigned for parameters which have action level standards unless monitoring indicates that the parameter is causing toxicity or federal guidelines exist for a given discharger for an action level substance. This process of determining a limits for action level parameters exists because these toxic substances are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics and/or associated waste characteristics. Water quality based limits may also be assigned to a given NPDES permit if data indicate that a substance is present for which there is a federal criterion but no state water quality standard.

Whole effluent toxicity (WET) testing is required on a quarterly basis for major dischargers and any discharger containing complex (industrial) wastewater. This test shows whether the effluent from a treatment plant is toxic, but it does not identify the specific cause of toxicity. If the effluent is found to be toxic, further testing is done to determine the specific cause. This followup testing is called a *toxicity reduction evaluation* (TRE). Each of the substances below can be toxic in sufficient quantity.

Metals

Municipal and industrial dischargers along with urban runoff are the main sources of metals contamination in surface water. North Carolina has stream standards for many heavy metals, but the most common ones in municipal permits are cadmium, chromium, copper, nickel, lead, mercury, silver, and zinc. Each of these metals (with the exception of silver) is also monitored through the ambient network along with aluminum and arsenic. Point source discharges of metals are controlled through the NPDES permit process. Mass balance models (Appendix II) are employed to determine appropriate limits. Municipalities with significant industrial users discharging wastes to their treatment facilities limit the heavy metals coming to them from their industries through their *pretreatment program*. Source reduction and wastewater recycling at WWTPs also reduces the amount of metals being discharged to a stream.

Nonpoint sources of pollution are controlled, to the extent possible, through implementation of best management practices. The new urban stormwater program described in Chapter 5 should help control nonpoint source metals loading instream.

Chlorine

Chlorine is commonly used as a disinfectant at NPDES discharge facilities which have a domestic (i.e., human) waste component. These discharges are the main source of chlorine in the State's surface waters. Chlorine dissipates fairly rapidly once it enters the water, but its toxic effects can have a significant impact on sensitive aquatic life such as trout and mussels. At this time, no standard exists for chlorine, but one may be adopted in the near future. In the meantime, all new and expanding dischargers are required to dechlorinate their effluent if chlorine is used for disinfection. If a chlorine standard is developed for North Carolina, chlorine limits may be assigned to all dischargers in the State that use chlorine for disinfection.

Ammonia (NH_3)

Point source dischargers are one of the major sources of ammonia. In addition, decaying organisms which may come from nonpoint source runoff and bacterial decomposition of animal waste products also contribute to the level of ammonia in a waterbody. At this time, there is no standard for ammonia in North Carolina. However, DEM has agreed to address ammonia toxicity through an interim set of instream criteria of 1.0 mg/l in the summer (April - October) and 1.8 mg/l in the winter (November - March). These interim criteria are under review, and the State may adopt a standard in the near future.

Toxic Substances in the Tar-Pamlico River Basin

An analysis of toxic substances in the Albemarle-Pamlico estuarine system was performed by Research Triangle Institute as part of the Albemarle-Pamlico Estuarine Study (Cunningham, et. al., 1992). It was funded by the NC Department of Environment, Health, and Natural Resources and the US Environmental Protection Agency. It addressed several major topics including: toxics loading from point source dischargers, potential for exceedances of water quality standards/criteria, ambient water quality, sediment water quality, fish contamination-hazard to wildlife and fish contamination-human health risk. Overall, the Pamlico estuarine system had the fewest toxicity-related problems in the APES region. While there are no EPA or state sediment toxicity criteria, thirteen sites in the Pamlico estuary were found to have metals levels that exceeded "median effects range" (ER-M) values derived by the National Oceanic and Atmospheric Administration (NOAA). Lead accounted for exceedances at 12 of the sites and zinc for the one other site. All of these sites were situated in the vicinity of Kennedy Creek near Washington. Only one monitoring station in the Tar-Pamlico basin had an exceedance of state water quality standards and that was for copper.

Toxicity-related and other water quality monitoring data collected by DEM are summarized in an assessment report for the Tar-Pamlico River Basin (NC EHNR, 1993 - see references for Chapter 4). Thirty NPDES facilities are required by DEM to conduct aquatic toxicity testing. Fish tissue analyses conducted throughout the entire basin by DEM found levels of mercury above FDA actions levels at two locations: Pungo Lake and in Tranters Creek near Washington.

3.2.4 Sediment

Sediment is the most widespread cause of nonpoint source pollution in both the Tar-Pamlico River basin and the state. It impacts streams in several ways. Eroded sediment may gradually fill lakes and navigable waters and may increase drinking water treatment cost. Sediment may clog the gills of fish, eliminate the available habitat of organisms which serve as food for fish (i.e. aquatic insect lasvae), or even completely cover shellfish beds. Sediment also serves as a carrier for other pollutants including nutrients (especially phosphorus), toxic metals and pesticides. Most sediment-related impacts are associated with nonpoint source pollution.

North Carolina does not have a numeric water quality standard for suspended solids, however all discharges must meet federal effluent guideline values at a minimum (e.g. 30 mg/l for domestic discharges). Also, most point source BOD limitations usually require treatment to a degree that removes sediments to a level well below federal guideline requirements. Discharges to high quality waters (HQW) must meet a total suspended solids (TSS) limit of 10 mg/l for trout waters and primary nursery areas and 20 mg/l for all other HQWs. In addition, the state has adopted a numerical instream turbidity standard for point and nonpoint source pollution (50 NTU). Nonpoint sources are considered to be in compliance with the standard if approved best management practices (BMPs) have been implemented.

Sedimentation in the Tar-Pamlico River Basin

Sediment is the most widespread cause of freshwater stream impairment in the Tar-Pamlico River Basin. Use support information presented in Section 4.5 of Chapter 4 indicates that 387 miles of streams are impaired as a result of sedimentation. Freshwater stream impairment from sedimentation is distributed as follows:

Subbasin No.:	01	02	03	04	05	06	07	08
Stream Miles Impaired by Sediment:	42	76	42	100	71	30	27	0

Sediment loading information is also presented in Table 3.6 and Figure 3.7 earlier in this chapter under discussion of nutrients in the basin. Section 6.6 of Chapter 6 discusses strategies for controlling sediment.

3.2.5 Fecal Coliform Bacteria

Fecal coliforms are bacteria typically associated with the intestinal tract of warm-blooded animals and are widely used as an indicator of the potential presence of pathogenic, or disease-causing, bacteria and viruses. They enter surface waters from improperly treated discharges of domestic wastewater and from nonpoint source runoff. Common nonpoint sources of fecal coliforms include leaking or failing septic systems, leaking sewer lines or pump station overflows, runoff from livestock feedlots and grazing areas and wildlife.

Fecal coliforms are used as indicators of waterborne pathogenic organisms (which cause such diseases as typhoid fever, dysentery, and cholera) because they are easier and less costly to detect than the actual pathogens. Fecal coliform water quality standards have been established in order to ensure safe use of waters for water supplies, recreation and shellfish harvesting. The current State standard for fecal coliforms is 200 MF/100 ml for all waters except SA waters. MF is an abbreviation for the Membrane Filter procedure for determining fecal coliform concentrations. This procedure entails pouring a 100 ml water sample through a membrane filter. The filter is then placed on a cultured medium and incubated for a specified period of time. The number of colonies of bacteria that grow on the medium is then compared to the standard of 200 colonies per 100 ml. SA waters, which are suitable for shellfish harvesting, have a standard of 14 MF/100 ml. The majority of domestic waste dischargers receive a limit of 200 MF /100 ml in their NPDES permit

(14 MF/100 ml in SA waters). Fecal coliforms in treatment plant effluent are controlled through disinfection methods including chlorination (sometimes followed by dechlorination), ozonation or ultraviolet light radiation. No new discharges are allowed into shellfish waters.

Fecal Coliform Bacteria in the Tar-Pamlico River Basin

Fecal coliform contamination is most evident in the estuarine portion of the basin where approximately 10,000 acres of SA waters are closed to shellfish harvesting (see Table 4.7 in Chapter 4). These closures are attributed almost entirely to nonpoint source pollution. There is also a reach of the Tar River downstream from Louisburg in which fecal coliform concentrations at ambient water quality sampling sites at Louisburg and Bunn frequently exceed the water quality standard of 200 MF/100 ml (see Figures 4.12 and 4.23).

3.2.6 Color

Color in wastewater is generally associated with industrial wastewater or with municipal plants that receive certain industrial wastes, especially from textile manufacturers, that use dyes to color their fabrics, and from pulp and paper mills. For colored wastes, 15A NCAC 2B .0211(b)3(F) states that the point sources shall discharge only such amounts as will not render the waters injurious to public health, secondary recreation, or aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses. NPDES permit requirements regarding color are included on a case by case basis since no numeric standard exists for color, and because a discharger may have high color values but no visual impact instream due to dilution or the particular color of the effluent. Color monitoring is included in the NPDES permit where it has been perceived to be a problem instream.

Color in the Tar-Pamlico River Basin

There are three NPDES dischargers which may be required to monitor color in their effluent: Oxford, Rocky Mount and Tarboro. Greenville had a problem with color in their influent, but they are handling it through their pretreatment program.

3.3 POINT SOURCES OF POLLUTION

3.3.1 Defining *Point* Sources

Point sources refers to discharges that enter surface waters through a pipe, ditch or other well-defined points of discharge. The term most commonly refers to discharges associated with wastewater treatment plant facilities. These include *municipal* (city and county) and *industrial* wastewater treatment plants as well as small *domestic* discharging treatment systems that may serve schools, commercial offices, residential subdivisions and individual homes. In addition, discharges from *stormwater systems* at industrial sites are now considered point source discharges and are being regulated under new urban stormwater runoff regulations being required by the U.S. Environmental Protection Agency (EPA). The urban stormwater runoff program is discussed in more detail in Chapter 5. The primary substances and compounds associated with point source pollution are oxygen-demanding wastes, nutrients and toxic substances including chlorine, ammonia and metals. Color, pathogens, pH, temperature, oil and grease are several other potential pollutants.

Point source discharges are not allowed in North Carolina without a permit from the state. Discharge permits are issued under the National Pollutant Discharge Elimination System (NPDES) program delegated to North Carolina from EPA. The amount or loading of specific pollutants that may be allowed to be discharged into surface waters are defined in the NPDES permit and are called *effluent limits*. Under the NPDES permitting program, each NPDES discharger is assigned either *major* or *minor* status. Major facilities are large with greater flows. For municipalities, all dischargers with a flow of greater than 1 million gallons per day (MGD) are classified as major.

Most point source discharges, other than urban and industrial stormwater discharges, are continuous and do not occur only during storm events as do nonpoint sources. They generally have the most impact on a stream during low flow conditions when the percentage of stream flow composed of treated effluent is greatest. Permit limits are generally set to protect the stream during low flow conditions. The standard low flow used for determining point source impacts is called the *7Q10*. This is the lowest flow which occurs over seven consecutive days and which has an average recurrence of once in ten years.

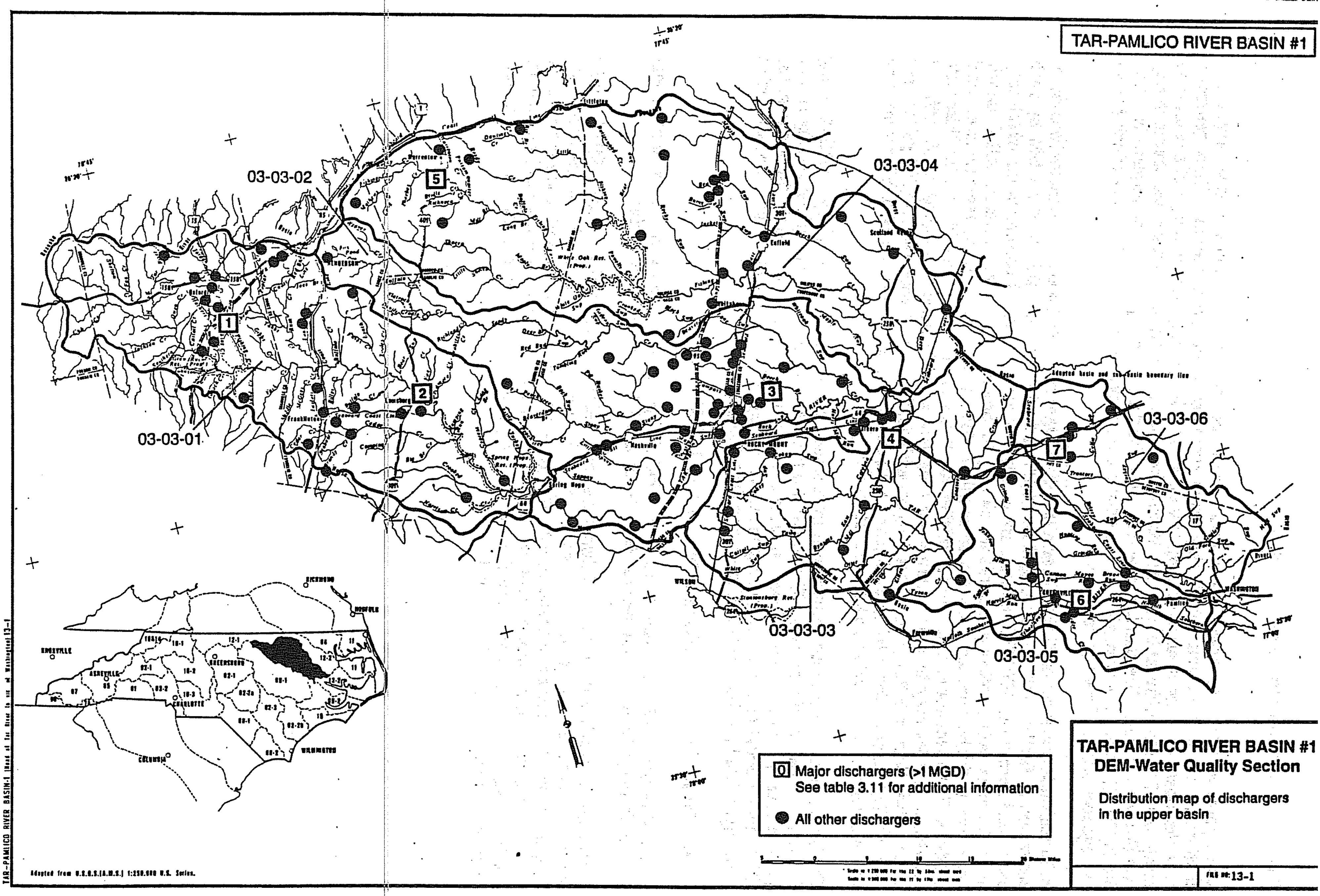
Information is collected on NPDES permitted discharges in several ways. The major method of collection is facility self-monitoring data which are submitted monthly to the DEM by each individual permittee. NPDES facilities are required to monitor for all pollutants for which they have limits as well as other pollutants which may be present in their wastewater. All domestic wastewater dischargers are required to monitor flow, dissolved oxygen, temperature, fecal coliform, BOD, ammonia, and chlorine (if they use it as a disinfectant). In addition, facilities with industrial sources may have to monitor for chemical specific toxicants and/or whole effluent toxicity (see Section 3.2.3); and all dischargers with design flows greater than 50,000 gallons per day (GPD) monitor for total phosphorus and total nitrogen. Minimum NPDES monitoring requirements are provided in 15A NCAC 2B .0500.

Other methods of collecting point source information include effluent sampling by DEM during inspections and special studies. The regional offices may collect data at a given facility if they believe there may be an operational problem or as a routine compliance check. In addition, the DEM may collect effluent data during intensive surveys of segments of streams, and extensive discharger data have been collected during onsite toxicity tests.

3.3.2 Point Source Discharges in the Tar-Pamlico

In the Tar-Pamlico River Basin, there are 178 NPDES permitted dischargers. A distribution map of the discharge facilities is shown in Figure 3.12a and b (upper and lower basin).

Table 3.9 summarizes the number of dischargers and their total permitted and actual 1993 flows for each subbasin. Information is also summarized by broad categories of dischargers including majors, minors, domestic, municipal, industrial (process and nonprocess) and stormwater. Table 3.10 summarizes this information for the entire basin. Table 3.11 lists the major dischargers in the basin. Location numbers are provided for each major discharger that correlate with numbered locations shown in Figure 3.12 (a and b).


TAR-PAMLICO RIVER BASIN #1
03-03-01
03-03-02
03-03-03
03-03-04
03-03-05
03-03-06
1
2
3
4
5
6
7
0 Major dischargers (>1 MGD)
See table 3.11 for additional information
All other dischargers
TAR-PAMLICO RIVER BASIN #1
DEM-Water Quality Section
Distribution map of dischargers
in the upper basin
13-1

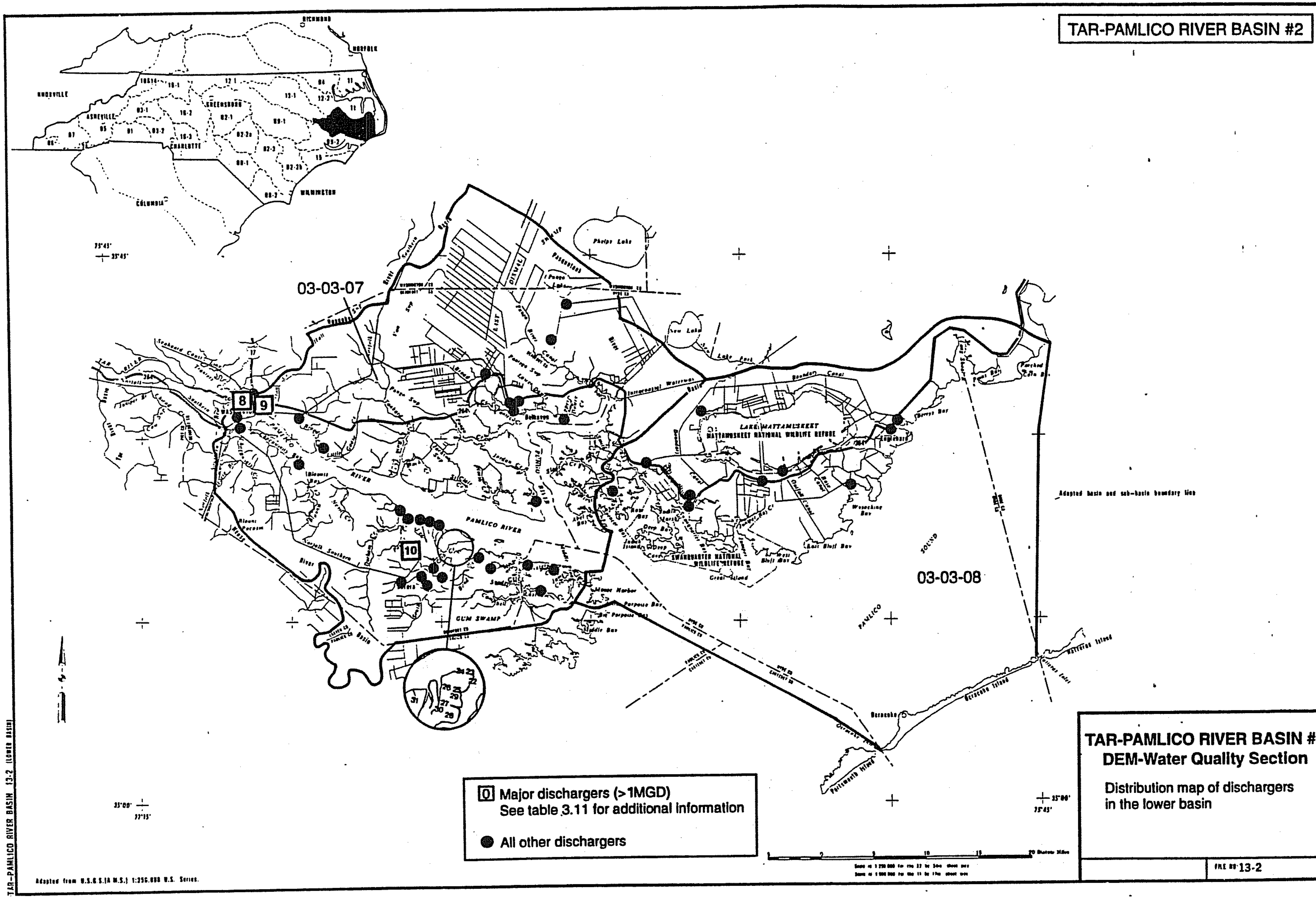

TAR-PAMLICO RIVER BASIN #2
03-03-07
03-03-08
PAMLICO RIVER
LAKE MATTAMUSKEET
GUM SWAMP
Major dischargers (>1MGD)
See table 3.11 for additional information
All other dischargers
8
9
10
TAR-PAMLICO RIVER BASIN #2
DEM-Water Quality Section
Distribution map of dischargers
in the lower basin
13-2

Table 3.9 Summary of Major/Minor Dischargers and Permitted and Actual Flows by Subbasin

	Subbasins						
	01	02	03	04	05	06	*07-08
Total Facilities	39	48	11	13	14	9	44
Total Permitted Flow (MGD)	3.8855	15.422	6.325	3.569	11.5	2.105	5.6227
Total Avg. Flow 1993 (MGD)	2.4467	14.901	2.9341	1.731	9.1258	1.279	76.719
Major Dischargers	2	1	1	1	1	1	3
Total Permitted Flow (MGD)	2.97	14	5	2	10.5	1.8	4.37
Total Avg. Flow 1993 (MGD)	1.9447	13.691	1.8736	0.349	8.2509	1.218	76.0773
Minor Dischargers	37	47	10	12	13	8	41
Total Permitted Flow (MGD)	0.9155	1.4218	1.325	1.569	1	0.305	1.2527
Total Avg. Flow 1993 (MGD)	0.502	1.2104	1.0605	1.381	0.8749	0.061	0.6417
100% Domestic Wastewater	12	6	0	4	1	1	5
Total Permitted Flow (MGD)	0.2595	0.0768	0	0.114	1	0.005	0.093
Total Avg. Flow 1993 (MGD)	0.0593	0.0228	0	0.006	0	0	0.0197
Municipal Facilities	4	2	4	4	1	1	3
Total Permitted Flow (MGD)	3.62	14.4	6.225	3.455	10.5	1.8	2.74
Total Avg. Flow 1993 (MGD)	2.3462	13.881	2.9341	1.596	8.2509	1.218	2.2247
Major Process Industrial	0	0	0	0	0	0	1
Total Permitted Flow (MGD)	0	0	0	0	0	0	2.25
Total Avg. Flow 1993 (MGD)	0	0	0	0	0	0	1.1984
Minor Process Industrial	1	3	3	2	0	1	2
Total Permitted Flow (MGD)	0.006	0.025	0.1	0	0	0.3	0
Total Avg. Flow 1993 (MGD)	0.0014	0.0252	0	0.129	0	0.061	0
Nonprocess Industrial	10	19	2	1	7	3	32
Total Permitted Flow (MGD)	0	0.92	0	0	0	0	0.5397
Total Avg. Flow 1993 (MGD)	0.0398	0.9721	0	0	0	0	73.2762
Stormwater Facilities	12	18	2	2	5	3	1
Total Permitted Flow (MGD)	0	0	0	0	0	0	0
Total Avg. Flow 1993 (MGD)	0	0	0	0	0	0	0

* NPDES data for these two subbasins is combined

Table 3.10 Summary of NPDES Discharge Permits in the Tar-Pamlico Basin

	No. of Facilities	% of Facilities	Permitted Flow (MGD)	Avg 1993 Flow (MGD)	% of Permitted Flow
Total NPDES discharge permits:	178	100	48.4294	109.1359	225.35
Major Dischargers:	10	5	40.64	103.4042	254.44
Minor Dischargers:	168	95	7.7894	5.7317	73.58
Nonprocess Permits:	74	41.6	1.4597	75.163	5,149.21
Domestic Discharges:	29	16.3	1.5487	0.1077	6.95
Municipal Permits:	19	10.7	42.74	32.4499	75.92
Major Process Industrial Permits:	1	0.6	2.25	1.1984	53.26
Minor Process Industrial Permits:	12	6.7	0.431	0.2169	50.32
Stormwater:	43	24.1	0	0	0

Table 3.11 Major Dischargers in the Tar-Pamlico River Basin

*Map No.	Facility Name	NPDES Permit No.	Receiving Stream	Discharger Category	Subbasin	1993 Flow (MGD)
1	Oxford/Southside Industrial WWTP	NC0025054	Fishing Cr	Municipal	01	1.4
2	Louisburg WWTP	NC0020672	Tar River	Municipal	01	0.6
3	Rocky Mount WWTP	NC0030317	Tar River	Municipal	02	13.9
4	Tarboro WWTP	NC0020605	Tar River	Municipal	03	1.9
5	Warrenton WWTP	NC0020834	Fishing Cr	Municipal	04	0.4
6	Greenville Utilities Commission	NC0023931	Tar River	Municipal	05	8.6
7	Robersonville WWTP	NC0026042	Flat Swamp	Municipal	06	1.3
8	National Spinning Co.	NC0001627	Tar River	Industrial (P)	07	1.2
9	Washington WWTP	NC0020648	Kennedy Cr	Municipal	07	1.7
10	Texas Gulf	NC0003255	UT Pamlico R	Industrial (NP)	07	73.2

* Map numbers correspond to numbers on Figure 3.12a and b.

Abbreviations: WWTP = wastewater treatment plant, UT = unnamed tributary, (P) = processed wastewater, (NP) = nonprocessed wastewater (mine dewatering)

Of the total 178 dischargers, 10 are major facilities, 29 are purely domestic, 19 are municipalities and 13 are industries. The total permitted flow for all facilities is 48.43 million gallons per day (MGD). Average actual flow is higher than the permitted flow because some industrial discharges, such as those for cooling water, stormwater or nonprocess wastewater (mine dewatering), do not have a total flow limit specified in their permit. In this case, Texas Gulf, which is located in subbasin 07, reported discharging 73.17 MGD of nonprocess water that was not subject to a flow limitation. If that amount is subtracted from the total permitted flow, the remaining actual 1993 average daily flow is 35.97 MGD, or 74% of the permitted flow. The Texas Gulf flow is evident in Table 3.9 under subbasin column 07 for the categories of Total Facilities, Major Dischargers and Nonprocess Industrial. It also shows up in the same categories in Table 3.10.

3.4 NONPOINT SOURCES OF POLLUTION

Nonpoint source (NPS) refers to runoff that enters surface waters through stormwater or snowmelt. There are many types of land use activities that can serve as sources of nonpoint source pollution including land development, construction, crop production, animal feeding lots, forest harvesting, failing septic systems, landfills, roads and parking lots. As noted above, stormwater from large urban areas (>100,000 people) and from certain industrial sites is technically considered a point source by the U.S. Environmental Protection Agency since NPDES permits are required for piped discharges of stormwater from these areas. However, a discussion of urban runoff will be included in this section.

Sediment and nutrients are major pollution-causing substances associated with nonpoint source pollution. Others include fecal coliform bacteria, heavy metals, oil and grease, and any other substance that may be washed off the ground or removed from the atmosphere and carried into surface waters. Unlike point source pollution, nonpoint pollution sources are diffuse in nature and occur at random intervals depending on rainfall events. Below is a brief description of major areas of nonpoint sources of concern in the Tar-Pamlico Basin.

3.4.1 Agriculture

There are a number of activities associated with agriculture that may serve as sources of water pollution. Land clearing and plowing render soils susceptible to erosion which in turn can cause stream sedimentation. Pesticides and fertilizers (including chemical fertilizers and animal wastes) can be washed from fields or improperly designed storage or disposal sites. Improperly managed wastes from concentrated animal feed lot operations can be a significant source of both BOD and nutrients. The untreated discharge from a large operation would be comparable to the nutrient load in the discharge from a secondary waste treatment plant serving a small town. Animal wastes from both concentrated feed lot and pastured livestock in or adjacent to streams can be a significant source of bacterial contamination of surface waters. Construction of drainage ditches on poorly drained soils enhances the movement of stormwater into surface waters.

In the Tar-Pamlico Basin, 455.4 (or 87%) of the miles of freshwater streams estimated to be impaired from nonpoint sources of pollution are attributed to agriculture. The highest number of impaired stream miles in any subbasin attributed to agriculture is 109 miles in subbasin 04 (Fishing Creek). In other subbasins, the number of stream miles estimated to be impaired by agriculture ranges from 11 miles in subbasin 08 to 84 miles in subbasin 05. This information is derived from the table in Section 4.5 of Chapter 4 entitled Probable Sources of Use Support Impairment. The prime cause of freshwater stream impairment associated with agriculture is sedimentation.

Another important water quality concern associated with agriculture in the Tar-Pamlico basin is nutrient runoff. As presented in Tables 3.2 and 3.3, agriculture is estimated to contribute approximately 44% of the total nitrogen and 44% of the total phosphorus loading to the Pamlico River estuary. Nutrient-related problems are not always evident in the receiving stream adjoining a farm but may manifest themselves in a downstream impoundment, sluggish creek or estuary many miles away. Chapter 5 discusses agricultural nonpoint source control programs, and recommended management strategies for reducing nutrients and sediment runoff are found in Section 6.2 and 6.6 respectively, in Chapter 6.. A list of agricultural BMPs is included in Appendix VI.

3.4.2 Urban

Runoff from urbanized areas, as a rule, is more predictable and generally more severe than agricultural runoff although far fewer stream miles are actually impacted. The rate and volume of runoff in urban areas is much greater due both to the high concentration of impervious surface areas and to storm drainage systems that rapidly transport stormwater to nearby surface waters. These drainage systems, including curb and guttered roadways, also allow urban pollutants to reach surface waters quickly and with little or no filtering. These pollutants include lawn care products such as pesticides and fertilizers; automobile-related pollutants such as fuel, lubricants, abraded tire and brake linings; lawn and household wastes (often dumped in storm sewers); and fecal coliform bacteria (from animals and failing septic systems). Runoff form urban areas can also lead to downstream stream bank erosion and flooding if proper controls are not utilized. In addition, urban development may lead to a loss of riparian areas and the important benefits that they provide for protecting water quality. Many urban streams are rated as biologically poor. The population density map in Chapter 2 is a good indicator of where urban development and potential urban stream impacts are likely to occur. Section 5.3.2 summarizes existing regulatory programs that have an urban stormwater control component. Section 6.8 discusses strategies for addressing urban stormwater and several basic urban stormwater BMPs are presented in Appendix VI.

3.4.3 Construction and Development

Construction activities that entail excavation, grading or filling, such as road construction or land clearing for development, can produce large amounts of sediment if not properly controlled. As a pollution source, construction activities are temporary in nature but the impacts, discussed under the section on sediment, above, can be long lasting and severe. Construction activity tends to be concentrated in the more rapidly developing areas of the basin such as Rocky Mount and Greenville. However, road construction is widespread and often involves stream crossings in remote or undeveloped areas of the basin.

Section 5.3.3 briefly summarizes the NC Sedimentation Pollution Control Act and special sedimentation control programs for highways and high quality waters. Section 6.6 discussess management strategies for controlling sedimentation, and Appendix lists sedimenation and erosion control BMPs used widely in North Carolina.

3.4.4 Forestry

Forests are an ideal land cover for water quality protection. They stabilize the soil, filter rainfall runoff and produce minimal loadings of organic matter to waterways. In addition, forested stream buffers, of sufficient width, can filter impurities from runoff from adjoining nonforested areas. However, improperly conducted forest management activities can impact water quality in a number of ways. Ditching and draining of naturally forested low-lying lands in order to create pine or hardwood plantations can change the hydrology of an area and significantly increase the rate and flow of stormwater runoff downstream. Careless harvesting, logging road construction and stream crossings can produce damaging sedimentation in nearby waters. Removing riparian vegetation along stream banks can cause water temperature to rise substantially, destabilize the shoreline and minimize or eliminate the runoff purification benefits of the buffer. Also, improperly applied pesticides and fertilizers can result in toxicity and nutrient enrichment problems, respectively, in nearby surface waters.

Timber harvesting is widespread throughout the Tar-Pamlico basin and is often done at the onset of clearing for site development. Commercial timber operations involving intensive management techniques such as ditching and draining are located in the lower Coastal Plain portion of the basin. Localized hydrologic impacts can be expected downstream of these operations unless water management structures are employed. Section 5.3.6 describes several programs that are aimed at either encouraging or requiring utilization of forest best management practices. A list of forest BMPs in presented in Appendix VI.

3.4.5 Mining

Mining is a common activity in the Piedmont and upper Coastal Plain regions and can produce high localized levels of stream sedimentation if improperly conducted. Sediment may be washed from mining sites or it may enter streams from the wash water used to rinse some mined products. In addition, abandoned gold mined lands are suspected of being the sources of mercury in stream waters because of its historic use for the amalgamation of gold. The most prevalent type of mining activity in the basin is for sand and gravel. It is widespread and is commonly found in or near the floodplain of the river and its major tributaries. Section 5.3.7 introduces the North Carolina Mining Act and the state's mining program. Mining BMPs are listed in Appendix VI.

3.4.6 Onsite Wastewater Disposal

Septic tank soil absorption systems are the most widely used method of on-site domestic wastewater disposal in North Carolina. These systems can provide safe and adequate treatment of wastewater; however, improperly placed, constructed or maintained septic systems can serve as a significant source of pathogenic bacteria and nutrients. These pollutants may enter surface waters both through or over the soil. They may also be discharged directly to surface waters through *straight pipes* (i.e., direct pipe connections between the septic system and surface waters). These types of discharges, if unable to be eliminated, must be permitted under the NPDES program and be capable of meeting effluent limitations specified to protect the receiving stream water quality which includes a requirement for disinfection.

Onsite wastewater disposal is most prevalent in rural portions of the basin and at the fringes of urban areas.. Fecal coliform contamination from failing septic systems poses a problem in some coastal waters where it can result in closure of shellfish waters (Table 4.7 in Chapter 4). Nutrients from failing septic systems also contribute to eutrophication problems in some impoundments and coastal waters.

Regulatory programs pertaining to onsite wastewater disposal are presented in Section 5.3.4. and BMPs are listed in Appendix VI.

3.4.7 Solid Waste Disposal

Solid wastes may include household wastes, commercial or industrial wastes, refuse or demolition waste, infectious wastes or hazardous wastes. Improper disposal of these types of wastes can serve as a source of wide array of pollutants. The major water quality concern associated with modern solid waste facilities is controlling the leachate and stabilizing the soils used for covering many disposal facilities. Properly designed, constructed and operated facilities should not significantly effect water quality. Federal, state and local programs to address solid waste disposal are introduced in Section 5.3.5.

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CHAPTER 4

WATER QUALITY AND USE SUPPORT RATINGS IN THE TAR-PAMLICO RIVER BASIN

4.1 INTRODUCTION

This chapter provides a detailed overview of water quality and use support ratings in the Tar-Pamlico River Basin. **Section 4.2** presents a summary of the types of water quality assessment work conducted by the Environmental Sciences Branch of the NCDEM Water Quality Section including consideration of information reported by researchers and other agencies within the Tar-Pamlico River Basin. Program areas covered within Section 4.2 include: benthic macroinvertebrate monitoring, phytoplankton monitoring, aquatic toxicity monitoring, fish population and tissue monitoring, special chemical/physical water quality investigations, lake assessments, sediment oxygen demand monitoring and ambient water quality monitoring. **Section 4.3** summarizes water quality based on analyses of chemical water quality data from ambient monitoring stations along the mainstem of the river and tributary stations. **Section 4.4** then presents a narrative summary of water quality findings for each of the eight subbasins based on all of the other monitoring approaches outlined in Section 4.2.

Sections 4.5 and **4.6** address the topic of use support in the Tar-Pamlico Basin. Using this approach, water quality for specific surface waters in the basin is assigned one of four ratings: fully supporting, support-threatened, partially supporting or not supporting uses. **Section 4.5** describes the methodologies used in developing the use support ratings. Use support utilizes much of the data presented in Sections 4.3 and 4.4, along with other relevant data. The use support ratings for evaluated streams and subbasins are then presented in **Section 4.6** through a series of tables and figures along with a color-coded use support map of the basin.

4.2 WATER QUALITY MONITORING PROGRAMS

NCDEM's monitoring program integrates biological, chemical, and physical data assessment to provide information for basinwide planning. A more complete review of this information and data summaries is included in a separate support document that was prepared by NCDEM's Environmental Sciences Branch (NC DEHNR, 1993).

4.2.1 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrates, or *benthos*, are predominantly aquatic insect larvae that live in and on the bottom of rivers and streams. Stream sampling, or *biomonitoring*, of the number, type and diversity of these organisms can be used to assess water quality. Those benthos that are most intolerant of pollution, and used most commonly in evaluating water quality, fall into three taxonomic groups: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Water quality is rated from Poor to Excellent based on evaluation criteria presented in Appendix II. Detailed benthic data are presented in Table 1 of Appendix II.

4.2.2 Aquatic Plants and Phytoplankton

Plants, through the process of photosynthesis, produce the foods necessary to support higher organisms. In ecological terms, plants are considered primary producers. They provide the base of the food web in aquatic and terrestrial ecosystems. Both phytoplankton (microscopic algae) and aquatic plants (macrophytes) are present and necessary in well balanced aquatic ecosystems.

Aquatic Plants
The North Carolina Division of Environmental Management does not routinely survey for large aquatic plants, or macrophytes. However, aquatic plants are an extremely important component of the Tar-Pamlico estuary and have been surveyed by Ferguson et al. (1988) and Davis and Brinson (1990). A compilation of the submerged aquatic vegetation (SAV) surveys in the Pamlico River is provided by Davis and Brinson (1990). The Pamlico River estuary had lush beds of SAV during the mid-1970's which declined dramatically during the 1980's. This decline may have been a result of high turbidities and salinities, however a definitive cause is not known.

Phytoplankton and Water Quality
Phytoplankton are microscopic algae found in the water column of lakes, rivers, streams, and estuaries. Phytoplankton populations respond to nutrient availability and other environmental factors such as light, temperature, pH, salinity, water velocity, and grazing by organisms in higher trophic levels. Phytoplankton are especially useful as indicators of eutrophication and are often collected with ambient water quality samples including, but not limited to, dissolved oxygen (DO), pH, conductivity, salinity, nutrients, and metals. The concurrent collection of a biological indicator of water quality (i.e. phytoplankton), and chemical and physical data allows relationships between the two types of samples to be made.

Phytoplankton have been monitored in the Tar-Pamlico River by DEM since 1984. Samples have been collected only in the lower portion of the river, generally below Washington, since higher flows above this area prevent large populations of phytoplankton from developing. Nutrient loads into the Pamlico estuary from the Tar River explain some of the spatial and temporal patterns of phytoplankton.

Previous studies of phytoplankton in the Pamlico River have been conducted by Hobbie (1971) for the period August 1966 through April 1968, and by Stanley (1983, 1984) and Stanley and Daniel (1985a, 1985b and 1986). Stanley's studies were conducted from April 1982 through December 1985, and were sponsored by the North Carolina Phosphate Corporation. Stanley (1992) provides a review his and Hobbie's (1971) data. Discrepancies in sampling methodology and enumeration between Hobbie (1971) and Stanley's studies do not allow a quantitative comparison.

DEM'S Phytoplankton Monitoring Programs
The Division of Environmental Management monitors prolific growths of phytoplankton (algal blooms), ambient phytoplankton and conducts special studies such as characterizing reference lake phytoplankton communities. In addition, DEM works with Dr. JoAnn Burkholder of NC State University, in monitoring populations of a toxic dinoflagellate.

Algal bloom program
Prolific growths of phytoplankton, often due to high concentrations of nutrients, sometimes result in "blooms" in which one or more species of algae may discolor the water or form visible mats on top of the water. Blooms may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. The algal bloom program was initiated in 1984 to document suspected algal blooms with quantitative biovolume and density estimates. Usually, an algal sample with a biovolume larger than 5000 mm^3/m^3, density greater than 10,000 units/ml, or chlorophyll *a* concentration approaching or exceeding 40 µg/l (the North Carolina state standard) constitutes a bloom. Bloom samples are collected often as a result of complaint investigations, fish kills, or during routine monitoring if a bloom is detected.

A global increase in algal blooms has been noted by Hallegraeff (1993). Various types of shellfish poisonings have been noted since 1976 and are the result of toxic dinoflagellate and diatom species. In addition, there has been an increased awareness of the harmful effects of algal blooms.

Evidence is accumulating that connects algal blooms and occurrences of toxic algal species to cultural eutrophication throughout the world.

Toxic dinoflagellate
A small dinoflagellate that commonly occurs in the Tar-Pamlico River estuary has proven to be toxic and may account for many previously unexplained fish kills. The dinoflagellate, to be named Pfiesteria piscimortuis, represents a new family, genus and species (Burkholder et al. 1992, Burkholder et al. 1993). Although present since phytoplankton monitoring by DEM began in the Pamlico estuary in 1984, it was not recognized as a toxic species since it often comprises a small percentage of the algal biomass and is generally found with several other species of dinoflagellates. In addition, many fish kills occurred in conjunction with salt wedges and resultant hypoxia making it difficult to determine the causative agent of the kills. This organism is apparently not always toxic as it has also been found in high numbers without causing fish kills, but recent unpublished data has implicated it in nearly 50% of fish kills in the estuary (Burkholder, 1994, personal communication). It is stimulated by substances excreted by fish, feeds on fish flesh and encysts in the sediments once the fish have died. There is also an apparent stimulatory effect of nutrients (particularly phosphorus) on some growth stages of this organism. The extent to which this growth is the result of direct nutrient stimulation versus preying on smaller algal flagellates whose populations may be increased by nutrient availability will be the subject of further study (Burkholder, 1994). Species involved in fish kills in the Tar-Pamlico estuary as a result of this dinoflagellate include menhaden, croaker, spot, eel, flounder, mullet, blue, hogchoker and crab. Other species of fish involved in fish kills associated with Pfiesteria in other North Carolina coastal waters include sheepshead, perch and catfish. Appendix II includes a table summarizing estuarine/coastal fish kills linked to the presence of flagellated stages of Pfiesteria.

Ambient phytoplankton
Phytoplankton are often collected in conjunction with ambient water quality samples. Although the frequency of sampling is greater for physical and chemical parameters, phytoplankton samples are taken more frequently during critical periods, such as during the summer when they are stimulated by high temperatures and high nutrients. These data provide information on seasonal and daily changes in phytoplankton densities, biovolumes, and algal community composition. Phytoplankton blooms are often detected as part of the ambient program.

Phytoplankton and Water Quality in the Tar-Pamlico Basin
The basin assessment begins with a historical review of phytoplankton and water quality in the Tar-Pamlico basin and concludes with a summary of water quality and phytoplankton collected by DEM for the period 1988-1992. Phytoplankton data are presented by subbasin, however, water quality data as it relates to phytoplankton may deviate from the subbasin format.

Historical Review of Water Quality and Phytoplankton
The Tar-Pamlico River has been the focus of much research. Early reports on nutrients in the river are provided by Hobbie et al. (1972) and Hobbie (1974). More recent data have been collected by Donald Stanley (East Carolina University) as part of his efforts to determine the water quality impacts of phosphate mining near Aurora (e.g., Stanley 1986). An excellent review of water quality trends in the Pamlico River is provided by Stanley (1992). Reviews of the physical and chemical parameters collected at ambient water quality stations between 1988-1992 are presented in NC DEHNR (1992a) and data for the period 1991-1992 are presented in NC DEHNR (1992b).

Hobbie et al. (1972) and Hobbie (1974) provide information on the seasonal distribution of nitrogen and phosphorus concentrations in the Pamlico estuary. These studies describe seasonal patterns of nutrients and describe interactions between nutrients and phytoplankton. Hobbie et al. (1972) note that phosphorus concentrations are high throughout the estuary with continuous inputs from tributaries and sporadic inputs from phosphate mining. Concentrations of particulate phosphorus increased in the upper estuary during the study (1965-1971). Although these patterns were noted during the 1970's, current fluxes of phosphorus may have changed as a result of changing mining operations and the removal of phosphates from detergents due to the phosphate detergent ban in 1988.

The single most important parameter implicated in eutrophication in these studies was inorganic nitrogen concentration (nitrite, nitrate and ammonia), which was found to be controlled by the flow of the Tar River. During low flow, inflowing waters contained high concentrations of nitrate, but the total amount of inorganic nitrogen was low. When flow was high a large amount of nitrate could be found in the upper estuary. Tributary inputs of inorganic nitrogen were small.

High rates of photosynthesis by phytoplankton occurred during the summer and ended in early Fall. A second peak occurred in January through March. These peaks were related to increased nitrate concentrations in the estuary. Algal blooms occurred during the winter in the middle reaches of the estuary. Algal blooms in the upper reaches of the estuary were thought to be inhibited by turbid waters even though nitrate concentrations were high (~0.4-0.6 mg/l).

Further studies by Hobbie (1974) elucidated some of his earlier observations. The total quantity of nitrates increased during the winter and high concentrations moved down river as far as the middle reaches of the estuary before being used up by biological activity (phytoplankton) and diluted by Pamlico Sound water.

Dissolved oxygen during Hobbie's studies was usually abundant in the surface waters of the estuary, but often became depleted in the bottom waters. This oxygen depletion often caused large kills of benthic life such as clams and snails. The kills occurred in the summer or fall when stratification prevented reaeration of the bottom waters.

Stanley and Nixon (1992) studied stratification and bottom-water hypoxia in the Pamlico River estuary using a 15 year data set of biweekly measurements and some recent continuous monitoring data. Stanley and Nixon found that hypoxia develops only when there is both vertical water column stratification and warm temperatures (>15°C). Since stratification can form or disappear in a short period (hours to days), episodes of hypoxia are short-lived. Hypoxia occurs more frequently in the upper half of the estuary than towards the mouth. No trend toward lower bottom water dissolved oxygen could be detected for the 15 year period.

A recent and well written summary of water quality trends is provided by Stanley (1992). This review summarizes the major environmental concerns in the Albemarle-Pamlico sounds with an emphasis on the Pamlico River Estuary. Although a variety of environmental concerns are discussed by Stanley (1992) the section on water quality trends is particularly germane to our discussion on ambient water quality data.

Stanley reviewed data collected by John Hobbie (discussed above) for the period 1967 to 1973, East Carolina University's Institute for Coastal and Marine Resources (1975 to the present), Ed Kuenzler's investigations of nitrogen and phosphorus cycling and Graham Davis and Mark Brinson's studies on organic carbon and deoxygenation. Since sample stations from different studies were located at the same site, Stanley was able to test statistically for trends in water quality. Note that ambient water quality data collected by the NC Division of Environmental Management were not included in the study.

A complete summary of Stanley's historical trends (1992) report will not be presented here. However, since Hobbie et al. (1972) and Hobbie (1974) have elucidated the spatial and temporal patterns in nutrient concentrations and phytoplankton blooms we will summarize Stanley's (1992) findings for these parameters.

Nitrate concentrations show a seasonal variability with the highest concentrations occurring upriver during the winter, coincident with high Tar River flows, and lowest concentrations down river in the summer. This pattern is present due to higher nitrate concentrations in the Tar River than in the Pamlico Sound and because phytoplankton assimilate nitrate.

A statistically significant decrease in nitrates occurred in the upper estuary during the period 1967 and 1986, but no significant change occurred for the period 1975 to 1986. This suggests the change in nitrate concentrations occurred during the early 1970's. This change occurred concomitantly with a significant increase in salinity during the period 1967-1975. Thus, the decrease in nitrates in the upper estuary may be the result of dilution by seawater. A significant increase in total phosphorus was detected throughout the estuary for the period 1967-1986.

Chlorophyll *a* is used as an indicator of phytoplankton biomass and has been monitored in the Pamlico River since 1970. Chlorophyll *a* values show that algal blooms occur in late winter or early spring in the middle reaches of the estuary. Statistically significant increases in chlorophyll *a* values have occurred in the middle and upper portions of the Pamlico River during the 1967-1986 period. No trend was detected in the lower portion of the estuary.

These studies suggest that nitrogen is the limiting nutrient for phytoplankton growth in the estuary. Nitrate concentrations decrease downstream because of seawater dilution and phytoplankton assimilation. Algal blooms are common in the middle reaches of the estuary and winter blooms always occur. Bottom water hypoxia has been responsible for benthic organism kills and only occurs when there is stratification and warm temperatures.

4.2.3 Aquatic Toxicity Monitoring (Whole Effluent Toxicity Testing)

Aquatic toxicity monitoring is used to determine the toxicity of treated effluent from a wastewater treatment facility. Under laboratory conditions, sensitive aquatic species (usually fathead minnows or the water flea, Ceriodaphnia dubia) are placed in a sample of the effluent that has been diluted to the same dilution ratio as occurs after the effluent is discharged to a receiving stream (e.g., if the effluent makes up 50% of the receiving stream's flow, then the sample will be diluted by 50%). Results of these tests have been shown by numerous researchers to be predictive of toxic discharge effects on aquatic life in receiving streams. DEM maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to DEM regional offices and DEM administration. This program is discussed further in Chapter 5. There are thirty facilities in the Tar-Pamlico River basin required to conduct aquatic toxicity testing.

4.2.4 Fisheries Studies (Fish Community Structure and Tissue Analyses)

To the public, the condition of the fishery is one of the most meaningful indicators of water quality. Fish occupy the upper levels of the aquatic food web and are both directly and indirectly affected by chemical and physical changes in the environment. Water quality conditions that significantly affect lower levels of the food web will affect the abundance, species composition, and condition of the fish population.

Fish Community Structure Methods
The North Carolina Index of Biotic Integrity (NCIBI) is a modification of Karr's IBI (1981) which was developed as a method for assessing a streams biological integrity by examining the structure and health of its fish community. The index incorporates information about species richness and composition, trophic composition, fish abundance and fish condition.

The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effect of biotic interactions and energy supply. Fish abundance and condition information indicates additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

The assessment of biological integrity using IBI is provided by the cumulative assessment of 12 parameters, or metrics. The values provided by the metrics are converted into scores on a 1, 3, 5 scale. A score of 5 represents conditions expected for undisturbed streams in the area, while a score of 1 indicates that the conditions vary greatly from those expected in undisturbed streams of the region. The scores for each metric are summed to attain the overall IBI score. Further information on the NCIBI is presented in Appendix II.

Fish Tissue

Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Therefore, by analyzing fish tissue, determinations about what chemicals are in the water can be made. Once contaminants reach surface waters, they may be available for bioaccumulation either directly or through aquatic food webs and may accumulate in fish and shellfish tissues. Thus, results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water. Fish tissue analysis results are also used as indicators for human health concerns and fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem. Contamination of aquatic resources, including freshwater, estuarine, and marine fish and shellfish species have been documented for heavy metals, pesticides, and other complex organic compounds.

In evaluating fish tissue analysis results, several different types of criteria are used. Currently human health concerns related to fish consumption are screened by comparing results with Federal Food and Drug Administration (FDA) action levels. The FDA levels were developed to protect humans from the chronic effects of toxic substances consumed in foodstuffs and thus employ a "safe level" approach to fish tissue consumption. A list of fish tissue parameters accompanied by their FDA criteria are presented in Appendix II. Individual parameters which appear to be of potential human health concern are evaluated by the North Carolina Division of Epidemiology by request of the Water Quality Section.

4.2.5 Intensive Surveys and Sediment Oxygen Demand (SOD)

Intensive water quality surveys are performed on water bodies below existing or proposed wastewater dischargers and usually consist of a time-of-travel dye study, stream flow measurements, physical and chemical samples, long-term biochemical oxygen demand (BOD_{lt}) analysis, water body channel geometry, and effluent characterization analysis. If oxygen depletion from sediments is suspected, *sediment oxygen demand (SOD)* studies may be performed along with intensive surveys. Intensive surveys and SOD's are performed where there is insufficient in-stream field data to calibrate and verify a water quality simulation model for a specific wastewater discharge location or on a larger scale for basin modeling. Water quality simulation models, described in Appendix III and discussed in Chapter 6, are often used for the purpose of determining the potential impact of a point source discharge on receiving waters and to determine appropriate effluent limits as requirements in National Pollutant Discharge Elimination System (NPDES) permits.

4.2.6 Lakes Assessment Program

A North Carolina Lakes Assessment Program has been implemented to protect lake waters through monitoring, pollution prevention and control. Assessments have been made at all publicly accessible lakes, at lakes which supply domestic drinking water, and lakes (public or private) where water quality problems have been observed. Data are used to determine each lake's *trophic status*. Trophic status is a relative measure of nutrient enrichment and productivity. Data are also used to evaluate whether the lake's uses have been threatened or impaired by pollution (see Appendix II for trophic status ratings). More detailed studies are conducted to evaluate loading and system response where specific management strategies are necessary to restore a lake to full use support status (Section 4.6.3).

4.2.7 Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake and estuarine (saltwater) water quality monitoring stations (about 380 statewide) strategically located for the collection of physical and chemical water quality data. The type of water quality data, or parameters, that are collected is determined by the waterbody's freshwater or saltwater classification and corresponding water quality standards. Table 4.1 summarizes the types of water quality data collection conducted at ambient stations. AMS data for the Tar-Pamlico Basin are summarized Section 4.3. The presentation of data involves the use of graphs that utilize box and whisker plots. Box and whisker plots are explained in Figure 4.1.

Table 4.1. Ambient Monitoring System Parameters

C and SC WATERS (minimum monthly coverage for all stream stations)

- dissolved oxygen,
- pH,
- conductivity,
- temperature,
- salinity (SC),
- secchi disk (where appropriate),
- nutrients: total phosphorus, ammonia, total Kjeldahl nitrogen, nitrate+nitrite
- total suspended solids,
- turbidity,
- hardness,
- chlorides (SC),
- fecal coliforms,
- metals: aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, silver, zinc

NUTRIENT-SENSITIVE WATERS

- Chlorophyll *a* (where appropriate)

WATER SUPPLY

- chlorides,
- total coliforms,
- manganese,
- total dissolved solids

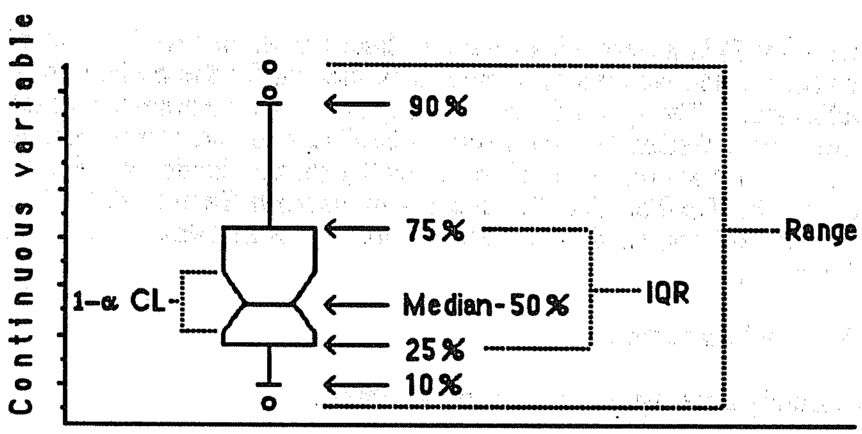
SA WATERS

- Fecal coliforms (tube method where appropriate)

PLUS any additional parameters of concern for individual station locations

Box and Whisker Plots

Box and whisker plot are useful for comparing sets of data comprised of a single variable by the visualization of selected order statistics. After the data have been ordered from low to high, the 10th, 25th, 50th, 75th, and 90th percentiles are calculated for plot construction. Box and whisker plots display the following important information: 1) the interquartile range (IQR) which measures the distribution and variability of the bulk of the data (located between the 25th and 75th percentiles), 2) the desired confidence interval (1- CL) for measuring the statistical significance of the median (50th percentile), 3) indication of skew from comparing the symmetry of the box above and below the median, 4) the range of the data from the lowest to highest values, and 5) the extreme values below the 10th percentile and above the 90th percentile (depicted as dots).



Visual comparison of confidence level notches about the medians of two or more box plots can be used to roughly perform hypothesis testing (Figure 4.1). If the box plots represent data from samples assumed to be independent, then overlapping notches indicate no significant difference in the samples at a prescribed level of confidence. Formal tests should subsequently be performed to verify preliminary conclusions based on visual inspection of the plots.

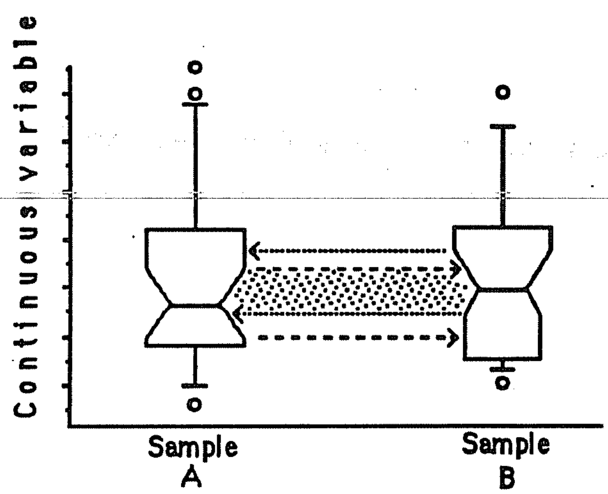


Figure 4.1 Explanation of Box and Whisker Plots

4.3 AMBIENT WATER QUALITY SUMMARY FOR THE TAR-PAMLICO RIVER MAINSTEM AND TRIBUTARY STATIONS.

4.3.1 Ambient Monitoring System (AMS) in the Tar-Pamlico Basin

Figure 4.2 shows ambient water quality monitoring stations in the Tar-Pamlico Basin. A listing of these stations is presented in Table 4.2. The table includes each station's Primary Number (which correlates with the location numbers in Figure 4.2), STORET Number and brief location description. Water quality data have been collected from many of these stations since the mid-1970's; however, coverage was expanded both spatially and temporally in 1988 as part of the Albemarle-Pamlico Estuary Study (APES) conducted by DEHNR with the cooperation the Environmental Protection Agency. Reviews of the physical and chemical parameters collected at ambient water quality stations between 1988-1992 are presented in NC DEHNR (1992a). Data for the period 1991-1992 are presented in NC DEHNR (1992b).

Section 4.3.2 summarizes data from 16 AMS stations along the mainstem of the river beginning at NC Highway 96 near Tar River, NC downstream to the mouth of the river. Section 4.3.3 summarizes data collected at 13 tributary stations.

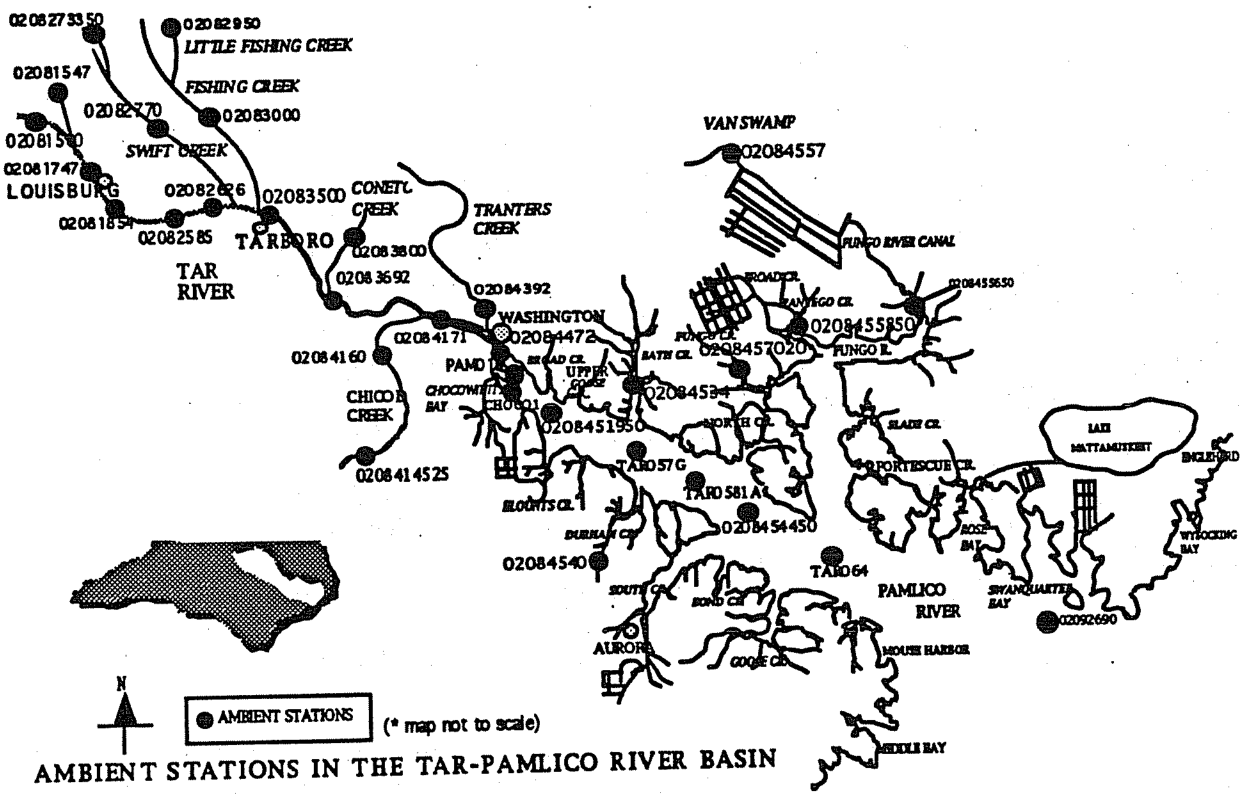


Figure 4.2 Ambient Monitoring System Stations in the Tar-Pamlico River Basin

Table 4.2 List of Ambient Monitoring System (AMS) Stations in the Tar-Pamlico River Basin

Tar/Pamlico Mainstem AMS Stations

Primary No	STORET No	Location
02081500	O0100000	Tar River at NC Hwy 96 near Tar River, NC
02081747	O1100000	Tar River at US Hwy 401 at Louisburg, NC
02081854	O2000000	Tar River at SR 1001 near Bunn, NC
02082585	O3180000	Tar River at NC Hwy 97 at Rocky Mount, NC
02082626	O3600000	Tar River at SR 1252 near Heartsease, NC
02083500	O5250000	Tar River at US Hwy 64 at Tarboro, NC
02083692	O6200000	Tar River at SR 1400 near Falkland, NC
02084171	O6500000	Tar River at SR 1565 near Grimesland, NC
02084472	O7650000	Pamlico River at US Hwy 17 at Washington, NC
PAM016	O7680000	Pamlico River at Marker #16 near Whichards Beach
0208451950	O7870000	Pamlico R. at mouth of Broad Cr nr Bunyan, NC (Transect)
TAR057G	O8498000	Pamlico River at Light #5 near Core Point, NC
TAR0581A	O8650000	Pamlico River at Light #4 near Gum Point, NC
0208454450	O9059000	Pamlico River at Hickory Point nr S Creek, NC (Transect)
TAR064	O9825000	Pamlico River at Pungo River Entrance Marker (Transect)
02092690	O9850000	Pamlico Sound at Great Island

Tar/Pamlico Tributary AMS Stations

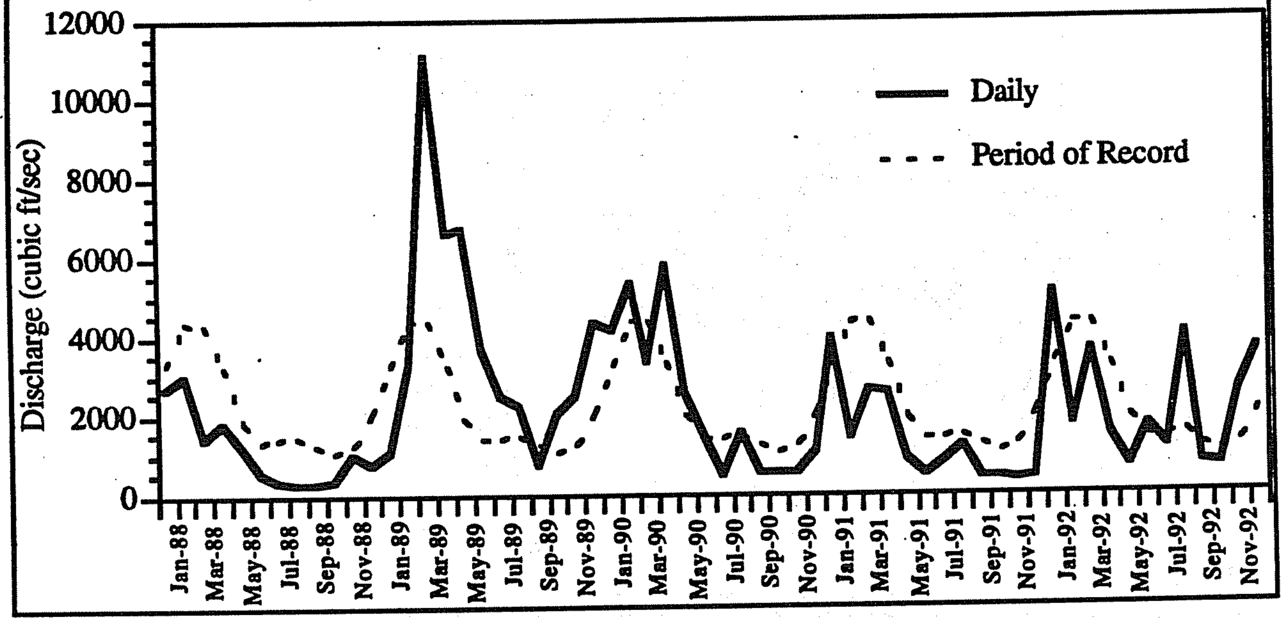
Primary No	STORET No	Location
02081547	O0600000	Fishing Creek at SR 1643 near Clay, NC
0208273350	O3830000	Sandy Creek at SR 1432 near Gupton, NC
02082770	O3870000	Swift Creek at SR 1310 at Hilliardston, NC
02083000	O4680000	Fishing Creek at US Hwy 301 near Enfield, NC
02083800	O6205000	Conetoe Creek at SR 1409 near Bethel Hill, NC
0208414525	O6340000	Chicod Creek at SR 1565 near Black Jack, NC
02084160	O6450000	Chicod Creek at SR 1760 near Simpson, NC
02084392	O7300000	Tranters Creek at SR 1403 near Washington, NC
CHOC01	O7710000	Chocowinity Bay above Silas Creek near Whichards Beach
02084534	O8495000	Bath Creek at NC Hwy 92 near Bath, NC
02084540	O8499000	Durham Creek at SR 1949 at Edward, NC
0208457020	O9750500	Pungo Creek at NC Hwy 92 at Sidney Crossroads, NC
0208455850	O9751000	Pantego Creek at NC Hwy 92 at Belhaven, NC
02084557	O9755000	Van Swamp at NC Hwy 32 near Hoke, NC
0208455650	O9758500	Pungo River at US Hwy 264 near Ponzer, NC

4.3.2 Summary of AMS Data for the Tar-Pamlico River Mainstem

Flow

Tar River mean daily flow, as measured at Tarboro, was generally low or normal as compared to the period of record for the years 1988 and 1991. In general, runoff in this basin is highest in late winter and early spring, and lowest in late summer and fall (Stanley 1992). The spring of 1989 had the highest flow recorded during the 5 years being reviewed in this report, with discharge at Tarboro reaching 11,000 cubic ft/sec as compared to less than 5000 cubic ft/sec for the mean period of record. Flow was also above normal for the spring of 1990 and the summer and fall of 1992 (Fig. 4.3).

Figure 4.3 Daily mean flow for the Tar River at Tarboro, N.C. from January 1988 through December 1992 as compared to the mean period of record flow (July 1896 - December 1900 and October 1931 - current year).



Temperature
Median surface temperatures for 1988 - 1992 increased slightly on an upstream to downstream transect in the mainstem Pamlico River (Fig. 4.4). Median temperatures at stations in the outer most estuary were ~5° C higher than the freshwater stations. Temperatures within the basin ranged from 1 - 31° C during the study period. A notable increase in temperature occurred between stations 02081854 (Tar River near Bunn) and 02082585 (Tar River at Rocky Mount), then decreased by station 02082626 (Tar River near Heartsease).

Dissolved Oxygen
Median DO values were between 6.8 and 8.9 mg/l (Fig. 4.5). Instantaneous DO measurements below the state standard (4 mg/l for non-trout waters per 15A NCAC 2B.0211(b)(3)(B)) occurred at stations 02081500 (Tar River at Tar River) and 02084472 (Pamlico River at Washington). These values may be due to the proximity of these stations to swamp waters which naturally have low DO levels. Incidence of DO values which exceeded the state standard of 110% saturation were the greatest between stations 0208451950 (Pamlico River at the mouth of Broad Creek) and TAR064 (Pamlico River at the mouth of the Pungo River), coinciding with elevated algal growth.

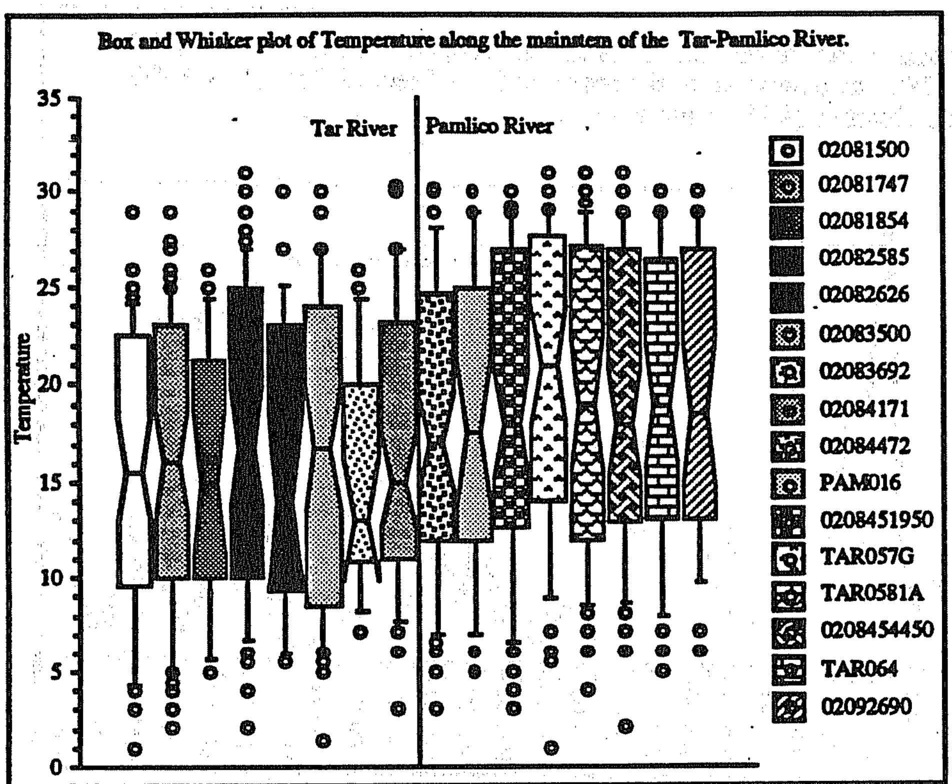


Figure 4.4 Temperature at AMS Stations Along the Tar-Pamlico River Mainstem

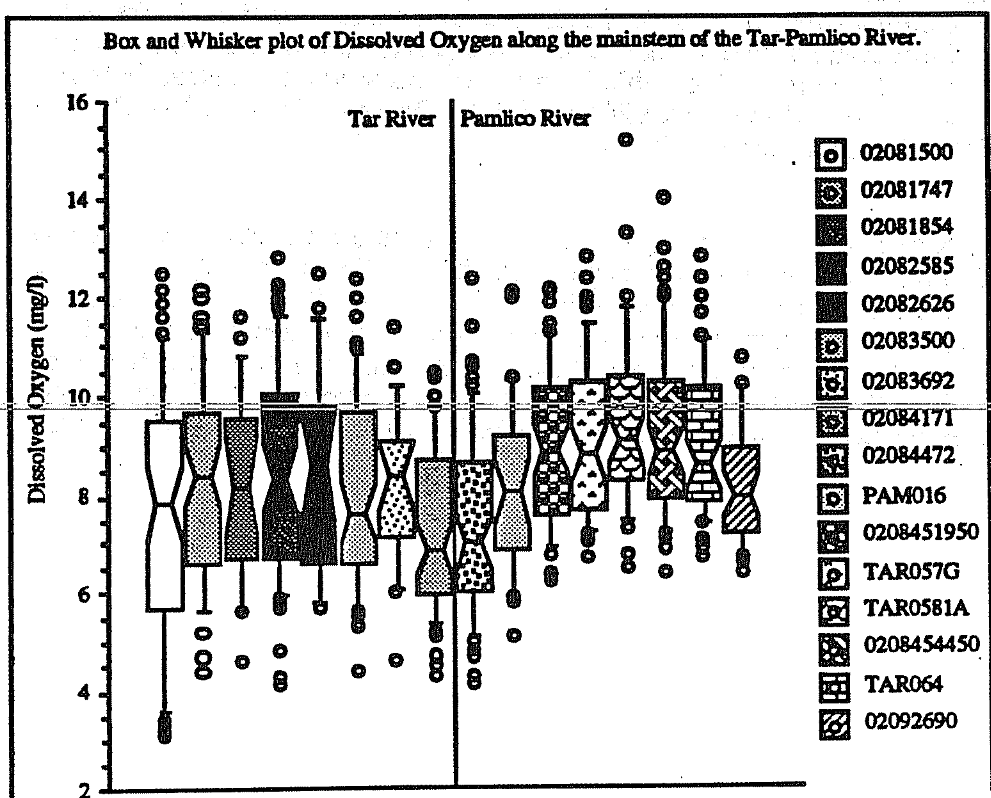


Figure 4.5 Dissolved Oxygen at AMS Stations Along the Tar-Pamlico River Mainstem

pH

The pH values in the Tar-Pamlico Basin ranged from 2.9-9.5 standard units. with highest values occurring in the lower Pamlico River in conjunction with algal blooms and the lowest values at station 02084557 (Van Swamp near Hoke) in association with tannic waters. Other freshwater sites with low pH values were stations 02083800 (Conetoe Creek near Bethel Hill), 02084392 (Tranters Creek near Washington) and 02084171 (Tar River near Grimesland; NC DEHNR 1992a and 1992b). The increase in pH in the Pamlico River is the result of photosynthesis by algae (Figure 4.6).

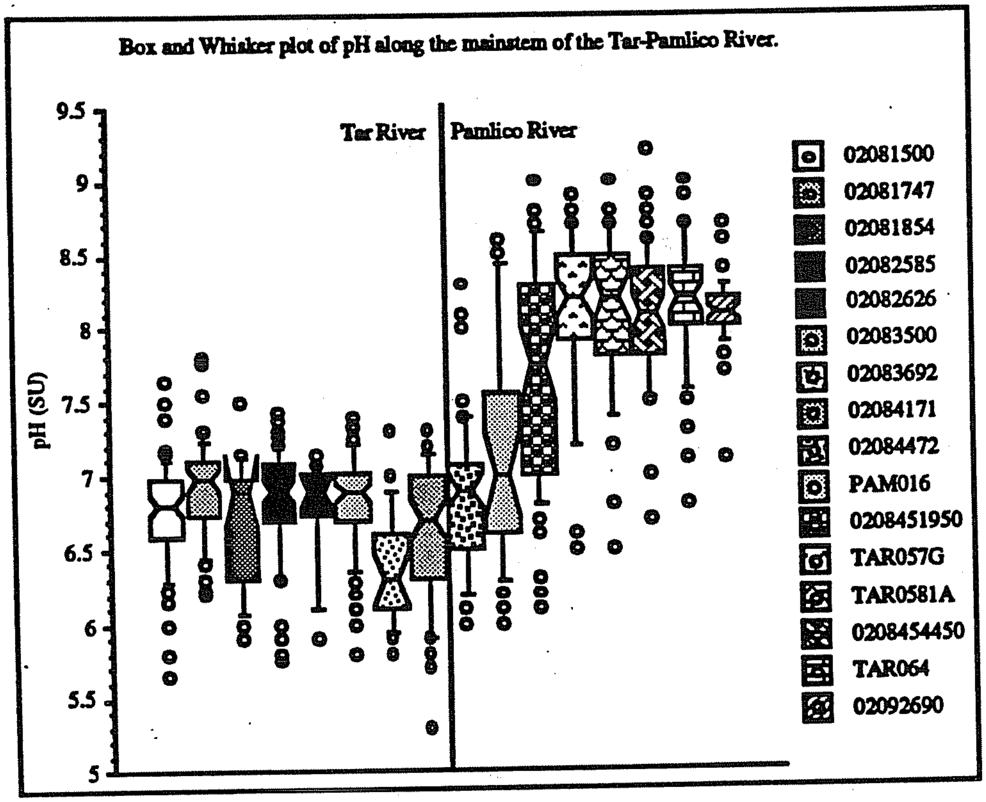


Figure 4.6 pH at AMS Stations Along the Tar-Pamlico River Mainstem

Conductivity and Salinity

The Tar River becomes the Pamlico River, which is estuarine in nature, below the Highway 17 bridge (AMS Station 02084472, Figure 4.7). At this point, conductivities increase in conjunction with increased salinities. The lowermost estuarine station 02092690 (Pamlico Sound at Great Island) has the highest median salinity (17 ppt) and conductivity (26,790 µmhos) in the basin.

Turbidity

Turbidity ranged from 1 to 60 Nephelometric Turbidity Units (N.T.U.) in the basin (Fig. 4.8). Median turbidity decreased from the upper Tar River to the lower Pamlico estuary, with the highest values occurring at the most riverine stations. This trend of increasing water clarity from the upper to lower estuary was observed by Hobbie (1972). Several contraventions of the turbidity standard (50 N.T.U. for freshwater and 25 N.T.U. for saltwater) occurred in the upper stations of the Pamlico River. Maximum turbidity (60 N.T.U.) occurred at 02081747 (Tar River at Louisburg).

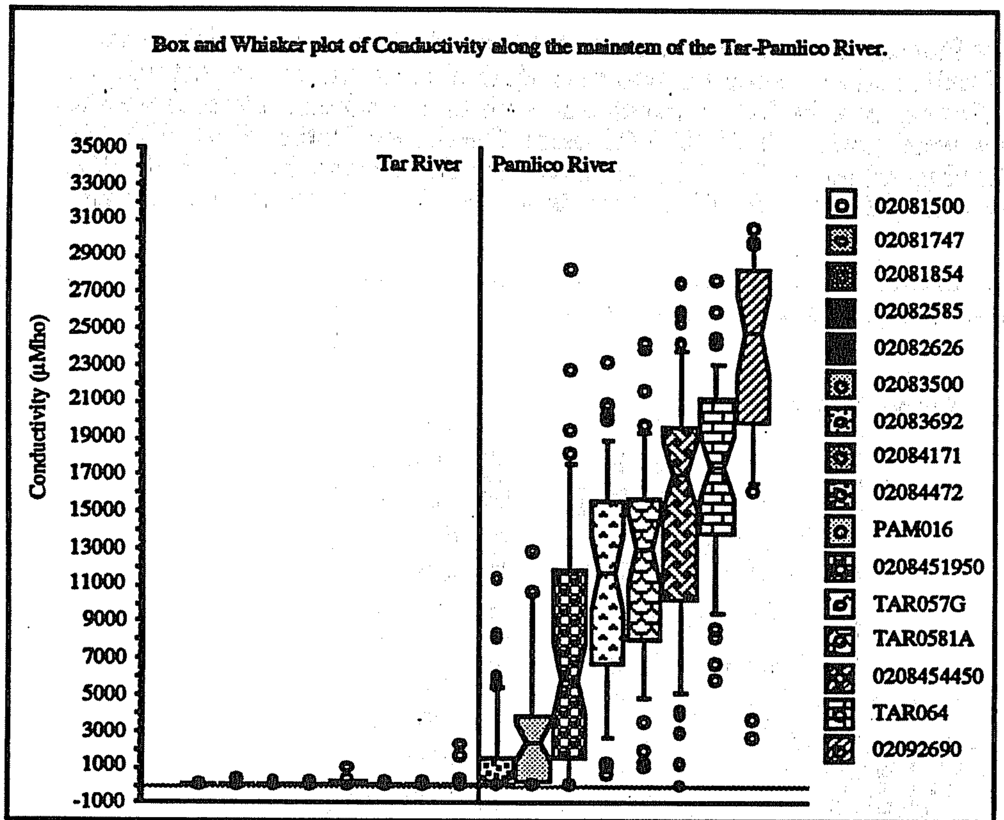


Figure 4.7 Conductivity at AMS Stations Along the Tar-Pamlico River Mainstem

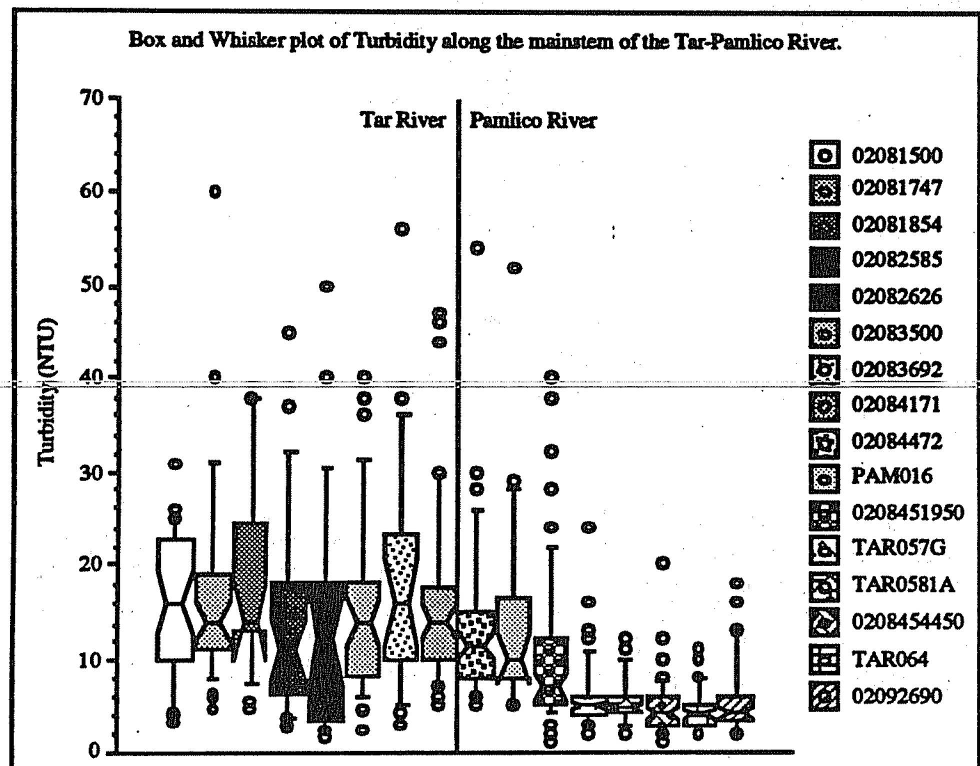


Figure 4.8 Turbidity at AMS Stations Along the Tar-Pamlico River Mainstem

Nutrients

The highest median levels of nitrite and nitrate (NO_x; Figure 4.9) and total nitrogen (TN) were found at stations 02082626 (Tar River at Heartsease) and 02084171 (Tar River near Grimesland), where median values for TN reached 1.12 and 1.13 mg/l, respectively. Although this pattern of high concentrations occurring where the Tar River converges with the Pamlico River is consistent with previous studies, no temporal pattern for NO_x could be detected.

The spatial profile for ammonia is depicted in Figure 4.10. Chicod Creek may contribute to the non-point source nutrients found at station 02084171 (Tar R. near Grimesland; NC DEHNR 1990a).

Levels of phosphorus were generally elevated throughout the basin. Peaks of phosphorus were most noticeable at 02082626 (Tar River at Heartsease) and TAR0581A (Pamlico River near Gum Point; Fig. 4.11). The latter station is just downstream of Texasgulf phosphate mining facility. Phosphorus shows a distinct seasonal pattern for stations beginning with 02084472 (Pamlico R. at Washington), and continuing downstream to station 02092690 (Pamlico R. at Great Island). High values occur during the summer months with maximums occurring in August or September; low values occur during late winter-early spring with minimums occurring in April or May. The lowest values for phosphorus occur at station 02092690 (Pamlico R. at Great Island).

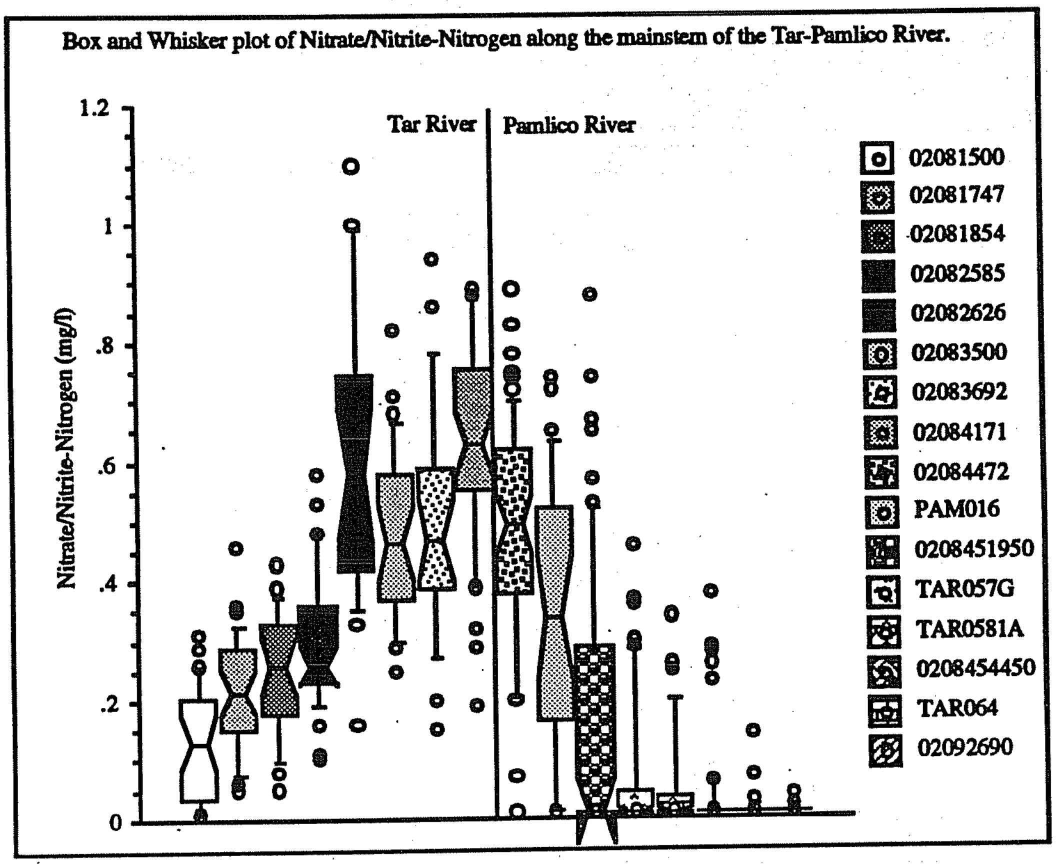


Figure 4.9 Nitrate/Nitrite Nitrogen at AMS Stations Along the Tar-Pamlico River Mainstem

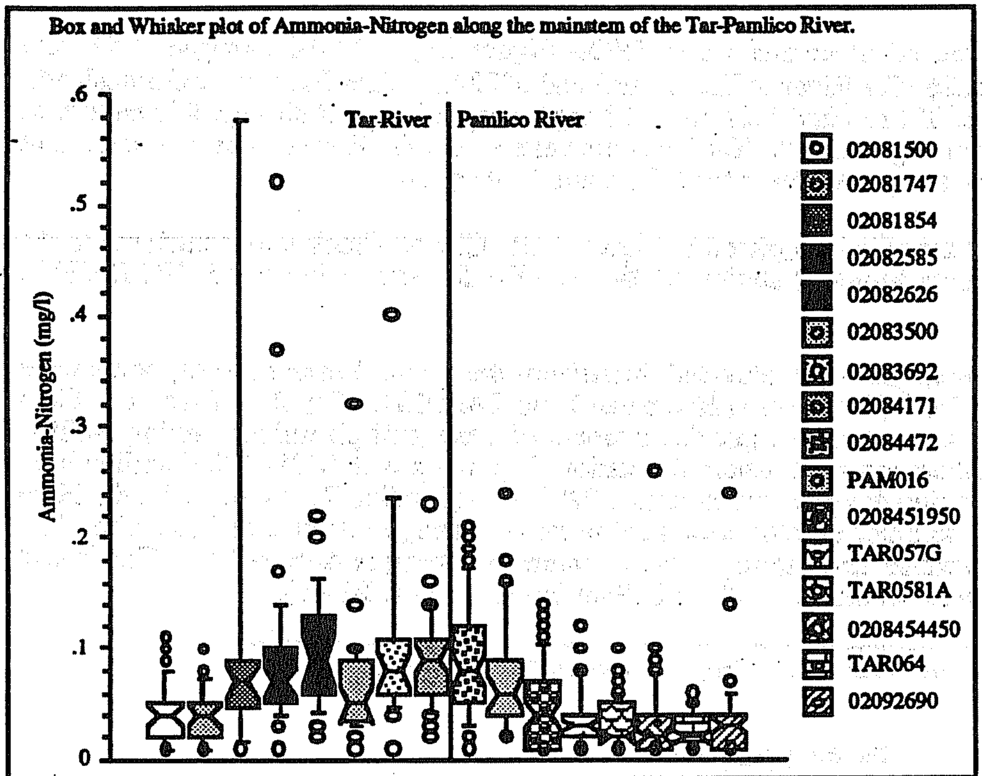
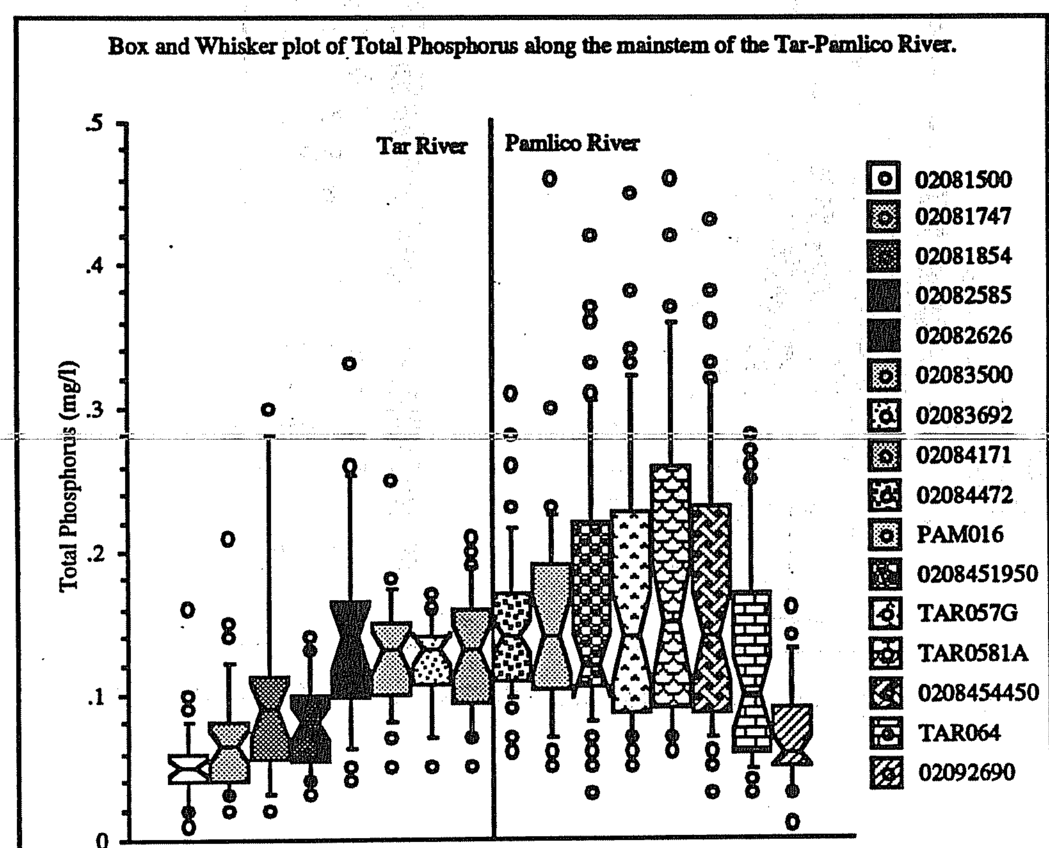


Figure 4.10 Ammonia-Nitrogen at AMS Stations Along the Tar-Pamlico River Mainstem



4.11 Total Phosphorus at AMS Stations Along the Tar-Pamlico River Mainstem

Fecal Coliforms

Figure 4.12 shows box and whisker plots of fecal coliform bacteria along the mainstem of the Tar-Pamlico River. The water quality standard for surface waters other than shellfish waters is 200 MPN per 100 ml with an allowance for exceedance of this standard after storm events. It can been seen that there are occasional exceedances of standards at all of the stations from the Pamlico River near Core Point all the way upstream to Tar River. However, the station at Louisburg has had exceedances of the standard in more than 25% of the samples, and station near Bunn has exceeded the standard in more than 50% of the samples. The section of the river from Louisburg to Bunn has been rated as not supporting its uses based on this data.

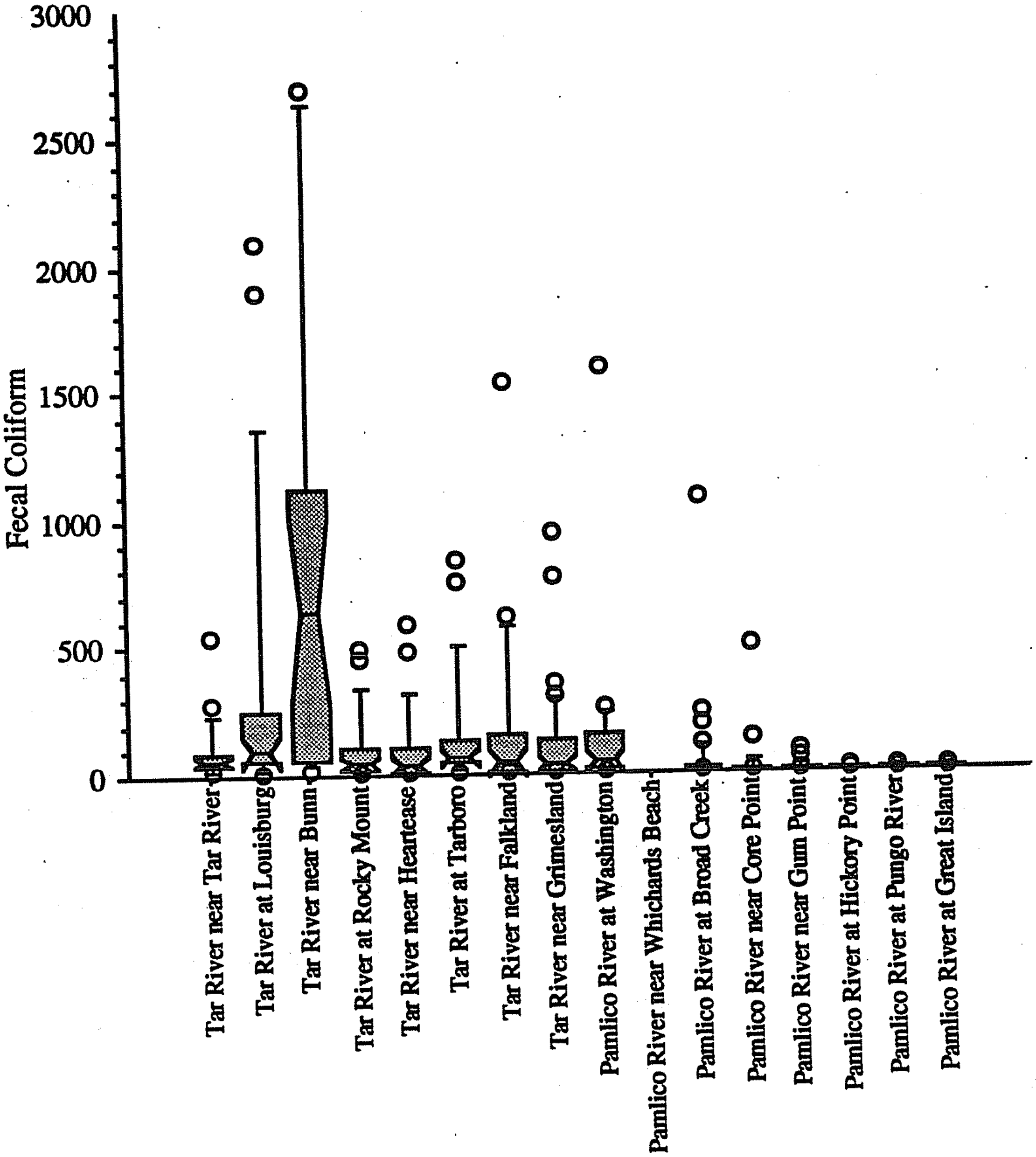
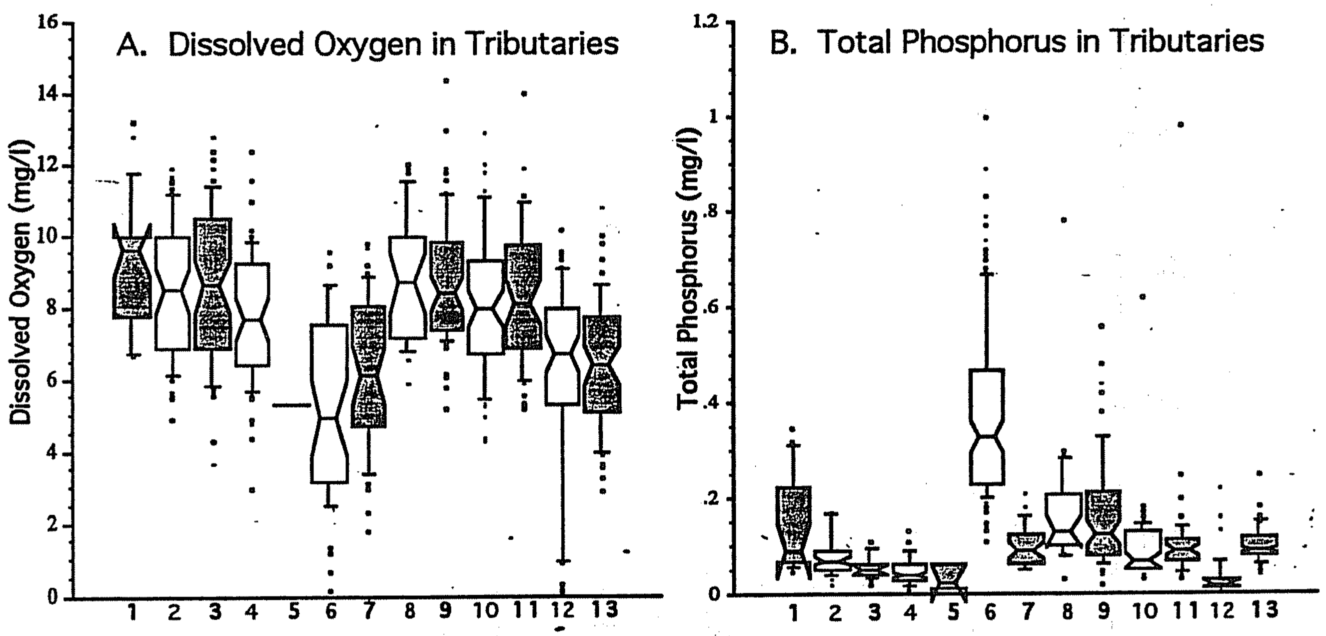


Figure 4.12 Fecal Coliforms at AMS Stations Along the Tar-Pamlico River Mainstem

4.3.3 Ambient Water Quality at Tributary Stations

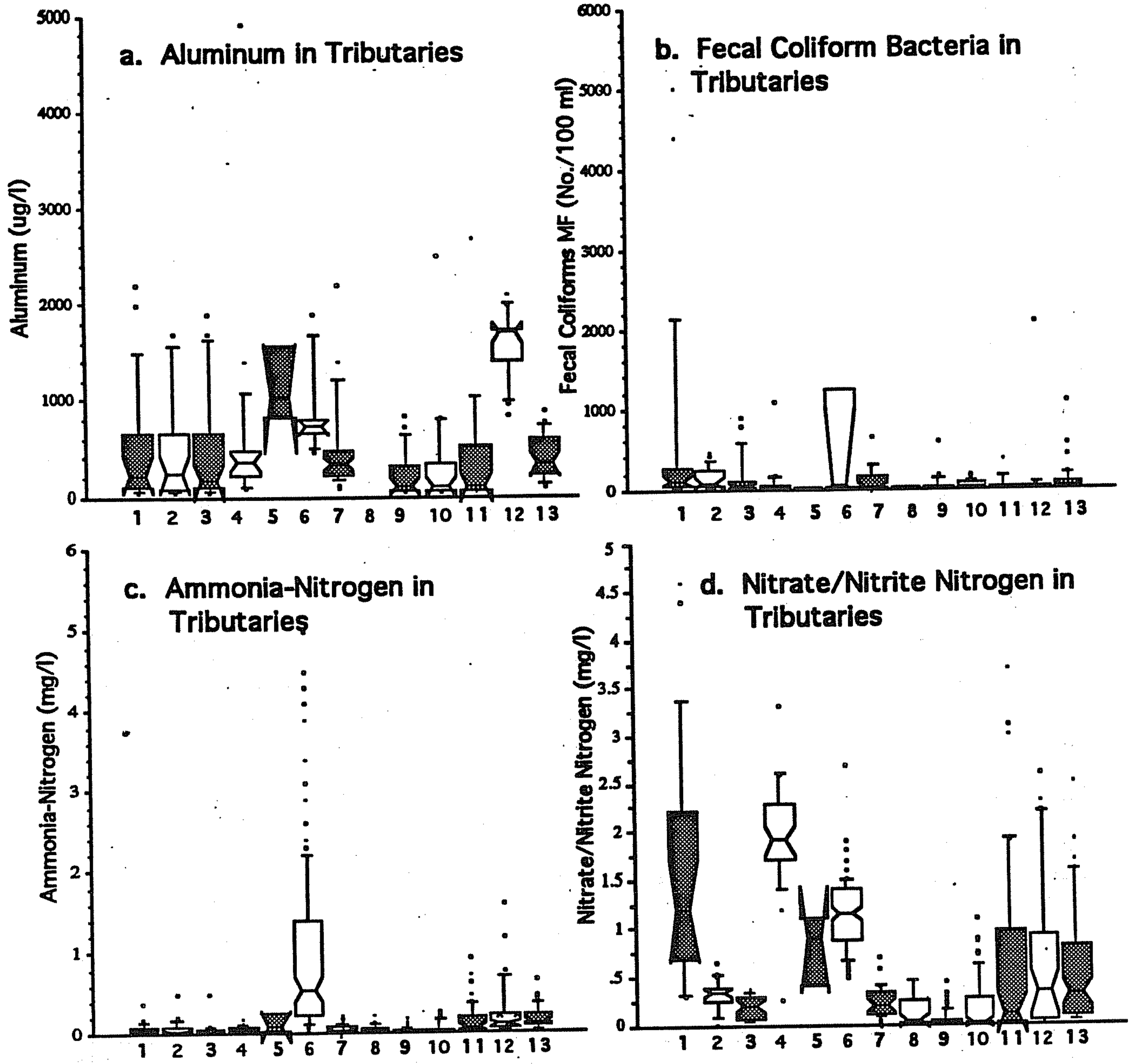
Figure 4.13.A shows box and whisker plots for dissolved oxygen in Tar-Pamlico tributaries. Low dissolved oxygen is encountered in the Chicod Creek stations (0208414525, 02084160), Van Swamp (02084557) and Pungo River (0208455650). All of these systems are subject to the naturally low dissolved oxygen of swamps. It is also important to note the Chicod Creek stations in the following figures (Figures 4.13.B and 4.14.a through d). Of all tributary stations, this area seems to have high readings in many parameters. Chicod Creek appears to have excessive runoff problems with nutrients and fecal coliforms and has been targeted by DEM for a Best Management Practices study of confined animal operations surrounding the Chicod Creek watershed.

High readings of copper were recorded at Fishing Creek near Clay and Chicod Creek and of manganese at Fishing Creek near Enfield, Pungo Creek, Pantego Creek, and Pungo River. Readings for other metals and at other tributaries were at or below detection levels.



Loc. No.	Location	AMS Sta. No.	Loc. No.	Location	AMS Sta. No.
1	~~Fishing Creek, SR 1643 at Clay~~	~~02081547~~	8	Chocowinity Bay above Silas Cr near Whichards Beach	CHOCO1
2	Swift Creek, SR 1320 at Hilliardston	02082770	9	Bath Creek, NC 92 near Bath	02084534
3	Fishing Creek, US 301 near Enfield	02083000	10	Pungo Cr, NC 92, Sidney Crossrds.	0208457020
4	Conetoe Creek, SR 1409 near Bethel	02083800	11	Pantego Cr, NC 92 at Belhaven	0208455850
5	Chicod Cr, SR 1565 nr Black Jack	0208414525	12	Van Swamp, NC 32 near Hoke	02084557
6	Chicod Cr, Sr 1760 nr Simpson	02084160	13	Pungo River, US 264 near Ponzor	0208455650
7	Tranters Cr, SR 1403 nr Washington	02084392			

Figure 4.13 Dissolved Oxygen and Total Phosphorus at AMS Tributary Stations.



Loc. No.	Location	AMS Sta. No.	Loc. No.	Location	AMS Sta. No.
1	Fishing Creek, SR 1643 at Clay	02081547	8	Chocowinity Bay above Silas Cr near Whichards Beach	CHOCO1
2	Swift Creek, SR 1320 at Hilliardston	02082770	9	Bath Creek, NC 92 near Bath	02084534
3	Fishing Creek, US 301 near Enfield	02083000	10	Pungo Cr, NC 92, Sidney Crossrds.	0208457020
4	Conetoe Creek, SR 1409 near Bethel	02083800	11	Pantego Cr, NC 92 at Belhaven	0208455850
5	Chicod Cr, SR 1565 nr Black Jack	0208414525	12	Van Swamp, NC 32 near Hoke	02084557
6	Chicod Cr, Sr 1760 nr Simpson	02084160	13	Pungo River, US 264 near Ponzor	0208455650
7	Tranters Cr, SR 1403 nr Washington	02084392			

Figure 4.14 Aluminum, Fecal Coliform, Ammonia-Nitrogen and Nitrate/Nitrate Nitrogen at AMS Tributary Stations

4.4 NARRATIVE WATER QUALITY SUMMARIES BY SUBBASIN

Water quality is summarized below for each of the eight subbasins in the Tar-Pamlico Basin. The summaries are based on monitoring data collected by DEM. Locations of the monitoring sites are presented in the accompanying subbasin maps. Table 1 in Appendix II contains more detailed information for each of the benthic monitoring sites. Data upon which these summaries are based are compiled in the draft basinwide assessment document for the Tar-Pamlico basin (NC DEHNR, 1993).

4.4.1 Subbasin 01 - Tar River Headwaters (Headwaters to Spring Hope)

Description

This subbasin contains the uppermost reaches of the Tar River, from its headwaters in Person County to the community of Spring Hope in Nash county. Primary urban areas contained within the subbasin are Louisburg, Franklinton and Oxford. Large sections of this subbasin are within the Carolina Slate Belt (headwater areas primarily) and Piedmont ecoregions. Streams in the Carolina Slate Belt ecoregion (i.e. Tar River at the Town of Tar River) are characterized by extremely low flows during periods of little rainfall. The subbasin is characterized by large amounts of agricultural land. Erosion rates for this region are above average, and there are high rates of nutrient and pesticide application.

Overview of Water Quality

Water quality conditions in the upper Tar River are generally in the Good to Good/Fair range, based on the most recent benthos data from the Tar River at ambient monitoring locations near Tar River and Louisburg (Figure 4.15). These data indicate a slight decline in water quality at the Tar River location (1984 vs 1992 data) and improvement at the Louisburg location (1983 and 1986 vs 1992 data). The Tar River site is in the slate belt, has a rocky substrate, and can have greatly reduced flow during drought periods. The Louisburg site has a very sandy substrate. A benthos sample noted only Fair water quality conditions at an upstream site in Granville County. However, somewhat atypical habitat conditions and the presence of an upstream dam may have altered the "normal" benthic community structure at this location. Most tributary sites, including Fishing Creek, Shelton Creek, Crooked Creek and Cedar Creek were found to have Good/Fair water quality using benthos data. Two sites on Cedar Creek, above and below the Franklin County WASA Wastewater Treatment Plant (WWTP), indicated no instream impacts. The Good/Fair bioclassification for Fishing Creek denotes an improvement in water quality following elimination of the town of Oxford's Southside WWTP # 1 and an upgrade at the Southside WWTP #2.

In contrast to benthos data, fish data found the Tar River in this subbasin to have Good-Excellent water quality and the tributary sites, Shelton Creek, Cedar Creek and Lynch Creek, to have Good water quality. Fish tissue samples from three sites had results lower than FDA criteria.

Lake Devin, a small water supply reservoir built by the town of Oxford, was assessed in the lakes program in 1989 and 1992. High chlorophyll *a* and nutrient values were found in 1989, but only high nutrient values were noted in 1992. Phytoplankton data have indicated blooms of a chloromonadophyte in 1989 and a cyanophyte in 1992 in Lake Devin. Blooms of cyanophytes, which are common during hot dry weather, were also reported from Lake Royale and Hart Pond.

Based on recent biological investigations, there do not appear to be any stream or river reaches within this subbasin that would qualify as HQW or ORW. However, the upper Tar River does support viable populations of the state and federally endangered Dwarf Wedge mussel (Alasmidonta heterodon) and could be designated as critical habitat by the North Carolina Wildlife Resources. If such a designation is made, then the stream would qualify for consideration as High Quality Waters by the Environmental Management Commission.

Tar River Basin
030301

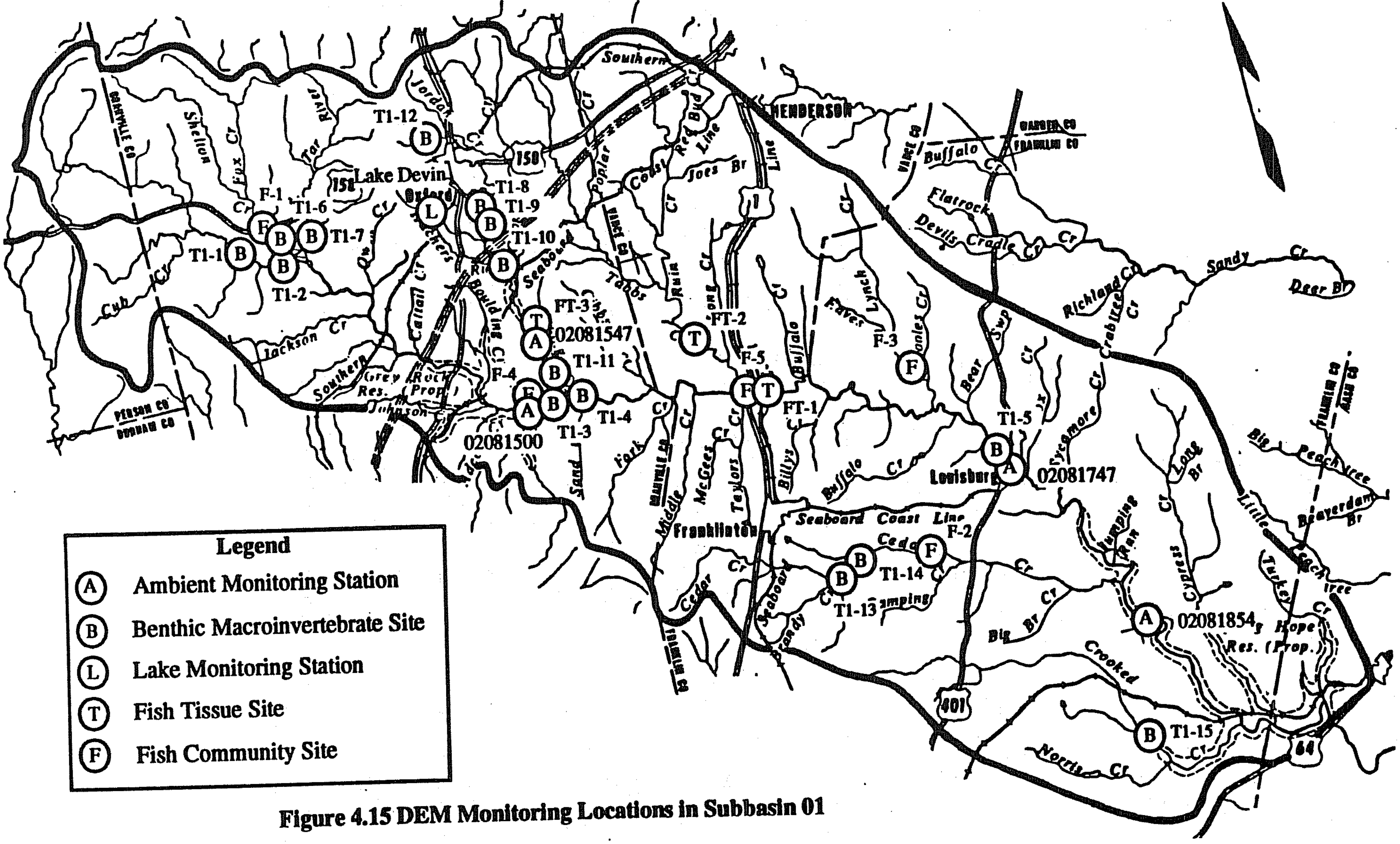


Figure 4.15 DEM Monitoring Locations in Subbasin 01

4.4.2 Subbasin 02 - Upper Tar River and Swift Creek (Tar River from Spring Hope to below Confluence with Swift Creek)

Description

This subbasin contains an approximate 50 mile river reach of the Tar River, from the community of Spring Hope in Nash County to below the confluence of Swift Creek in Edgecombe County. Major metropolitan areas include Henderson, Nashville, and Rocky Mount. The Sandy/Swift Creek system originates in the eastern piedmont near Henderson and flows 86 miles to its confluence with the Tar River near Tarboro, draining approximately 266 square miles. Streams in this subbasin are within the Piedmont ecoregion. This area is characterized by large amounts of agricultural land.

Overview of Water Quality

Benthos data from the Tar River near Rocky Mount indicate generally Good/Fair water quality, with no long term changes. Benthos from stations sampled in 1992 above and below the Rocky Mount WWTP noted no impact, while prior studies have noted a slight impact based on Biotic Index values. Ambient water chemistry data indicate that nitrate/nitrite nitrogen values and total phosphorus values increase substantially between the Rocky Mount site and the Heartsease site. The latter site is below the Rocky Mount WWTP. Monitoring locations are presented in Figure 4.16. .

Good water quality conditions have been consistently recorded from several benthos locations and one fish sampling site on Swift Creek. These include intensive surveys on Swift Creek near Wake Stone Company in Nash County, HQW surveys in Nash and Edgecombe counties, and the ambient location near Hilliardston. Benthos data from near Hilliardston in 1992, however, had much lower EPT taxa richness and abundance values, and a Good/Fair rating was assigned. An upstream site on Sandy Creek also had Good/Fair water quality. Swift Creek is a very important stream because it harbors viable populations of the Tar River spiny mussel (Elliptio (C.) steinstansana), which is an endangered species under the Federal Endangered Species Act of 1973.

A cooperative investigation conducted by DEM and USGS on Devils Cradle Creek in Franklin County related severe erosion to low taxa richness of the benthic macroinvertebrate community and a Fair water quality rating. A similar rating was derived from fish sampling. A fish community structure sampling from Peachtree Creek resulted in a rating in the fair range. Fish tissue samples from the Tar River Reservoir have contained trace amounts of pesticides.

Lake and phytoplankton data have only been collected from the Tar River Reservoir, Rocky Mount's drinking water supply. This reservoir is fully supporting its uses, but is considered eutrophic and has had violations of the state chlorophyll *a* standard.

There are no stream reaches within this subbasin that would qualify for reclassification based entirely on water quality data. However, Swift Creek does support viable populations of the state and federally endangered Tar River spiny mussel (Elliptio (C.) steinstansana) and could be designated as critical habitat by the North Carolina Wildlife Resources. If such a designation is made, then the stream would qualify for consideration as High Quality Waters by the Environmental Management Commission.

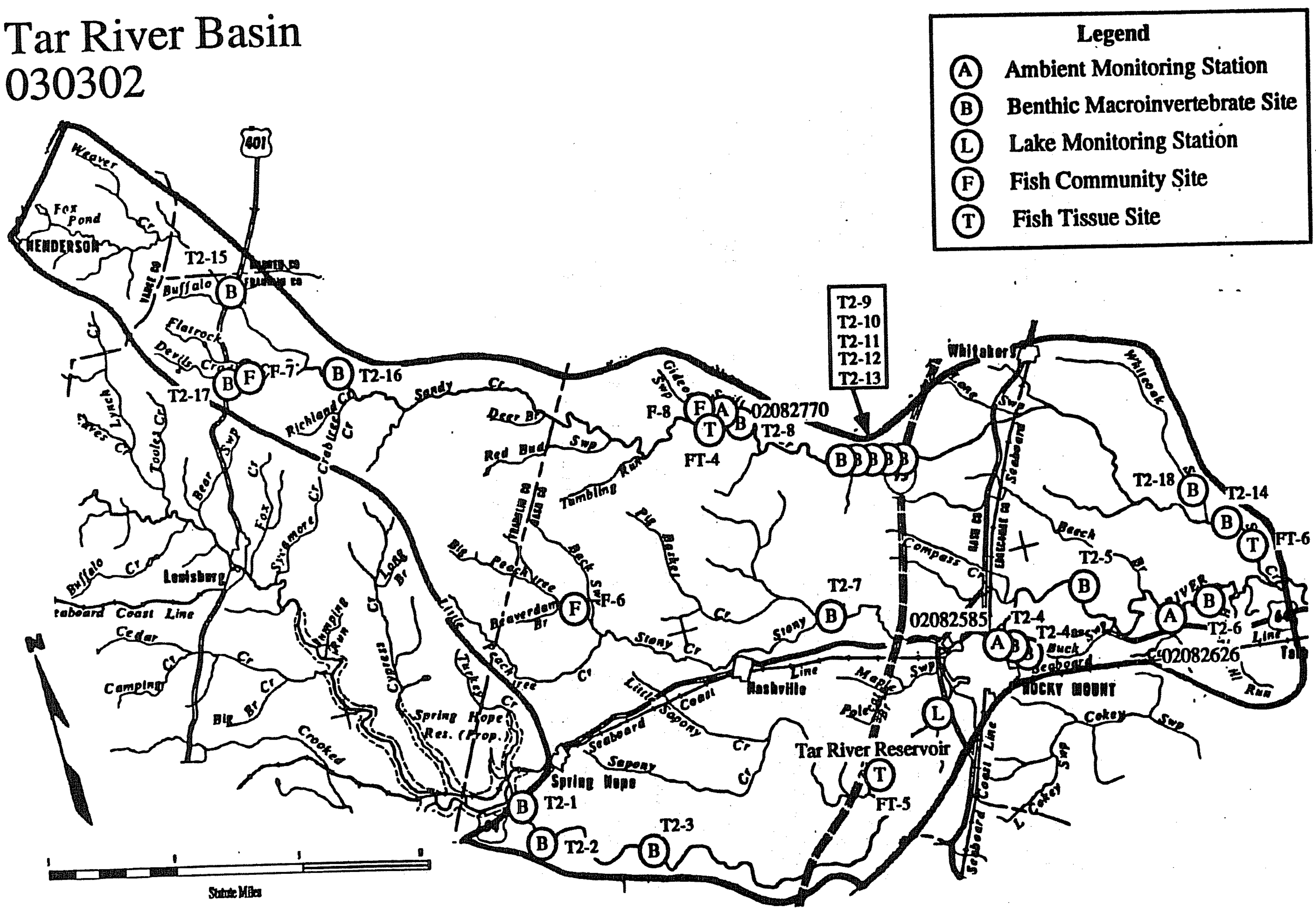


Figure 4.16 DEM Monitoring Locations in Subbasin 02

4.4.3 Subbasin 03 - Mid Tar River (Tar River from below Swift Creek to confluence with Conetoe Creek)

Description

This subbasin includes approximately 40 river miles of the Tar River from near the confluence of Swift Creek in Edgecombe County to the confluence of Conetoe Creek in Pitt County. This subbasin also includes the entire Conetoe Creek catchment. Streams in this subbasin are primarily within the coastal plain ecoregion, are swamp-like, and stress may be associated with low dissolved oxygen, low current velocity and low pH. Many streams in this area were channelized prior to 1970, when "stream improvement" included digging out and straightening the channel, with removal of most riparian vegetation. The area is characterized by large amounts of agricultural land. There are no major metropolitan areas in the subbasin.

Overview of Water Quality

The only ambient monitoring location on the Tar River in this subbasin is the Tar River at Tarboro (Figure 4.17). Benthos data from this location have consistently produced a Good bioclassification, with consistent EPT taxa richness values (23-29). The river at this point also supports a population of rare and endangered mussel species: Elliptio (Canthyria) steinstansana (Tar River spiny mussel) and Alasmidonta heterodon (dwarf wedge mussel). In addition to these data, an EPT benthos sample was collected at NC 42 below Tarboro in 1992. These data resulted in an Excellent bioclassification. Further investigations are warranted in this reach of the Tar River as a potential HQW or ORW candidate.

Benthos information from the ambient location on Conetoe Creek near Bethel has been consistently Fair during the period of record (1985 to 1992). This station often has low pH values, that are probably a result of the swamp-like nature of the watershed. The Tar River ambient site near Falkland has the lowest median pH value of all mainstem sites.

Other benthos data were collected in 1992 from Otter Creek and Bynum Mill Creek as part of an ongoing attempt to develop swamp stream collection methods and criteria. Another special benthos study included sampling Little Cokey Swamp (Poor) and Town Creek (Fair and Good/Fair), both very small streams with discharges to them.

Fisheries sampling of Town Creek and Otter Creek resulted in Good NCIBI ratings.

Tar River Basin
030303

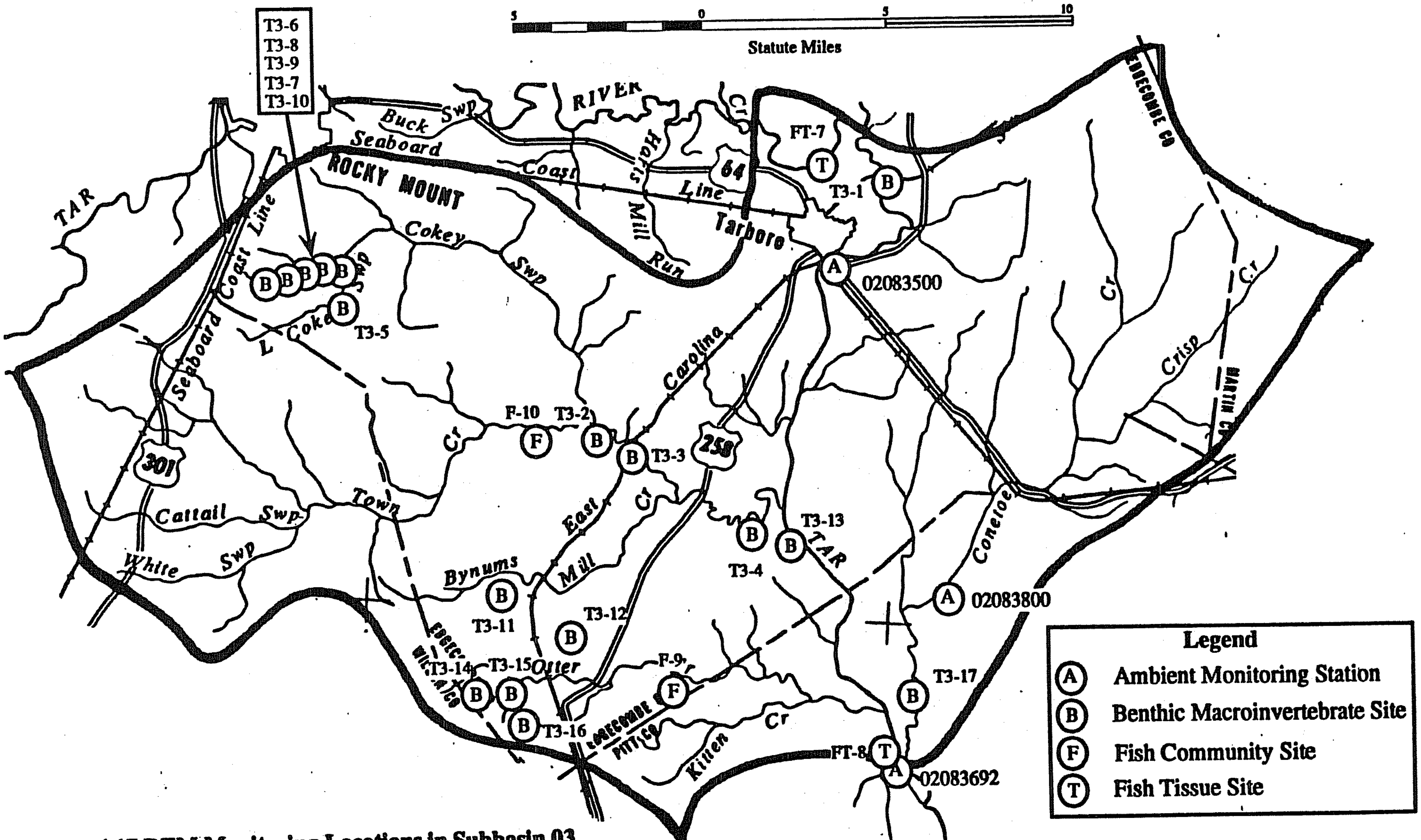


Figure 4.17 DEM Monitoring Locations in Subbasin 03

4.4.4 Subbasin 04 - Fishing Creek (Entire watershed to confluence with Tar River)

Description

Tar subbasin 04 contains the entire Fishing Creek watershed, from its headwaters near Warrenton to the confluence with the Tar River near Tarboro (Figure 4.18). Most stream reaches in the upper section of the subbasin are typical piedmont streams, while streams in the eastern section are swamp streams typical of the coastal plain. Many of these swamp streams may have stress associated with low dissolved oxygen, low current velocity, and low pH. Warrenton and Enfield are the only metropolitan areas in the subbasin.

Overview of Water Quality

Benthos data from 1992 indicated Fair water quality at an upstream site on Fishing Creek, but Good bioclassifications at all other Fishing Creek sites. These data primarily reflect the effects of nonpoint sources of water pollution in the subbasin. Little Fishing Creek was rated Good/Fair, down from Good in 1988, but this could be related to the effects of scour prior to sampling. Shocco Creek received a Fair bioclassification. A special benthos study on Beech Swamp noted an abundance of organic indicator species below the Enfield WWTP.

Fisheries data also gave a fair rating to Shocco Creek, and gave a Fair-Good rating to Rocky Swamp. In contrast to benthos data, fisheries sampling of Fishing Creek gave NCIBI scores in the Good-Excellent range, while Little Fishing Creek scored in the Good range. Based on the most recent biological information from this subbasin, there do not appear to be any stream or river reaches that would qualify for reclassification to either HQW or ORW.

4.4.5 Subbasin 05 - Lower Tar River (Tar River from Conetoe Cr to Tranters Creek)

Description

This subbasin (Figure 4.19) contains the most downstream freshwater reach of the Tar River and is completely within the coastal plain ecoregion. This area is characterized by large amounts of agricultural land. The only major metropolitan area is Greenville. The Tar River becomes deeper and much slower flowing in this area compared to upstream reaches.

Overview of Water Quality

The only ambient monitoring station on the lower Tar River is the station at Grimesland. Benthos data from this location have indicated Fair to Good/Fair water quality conditions for the period of record. The Tar River at Grimesland is located below the Greenville area and is subjected to the effects of urban runoff and numerous small dischargers. The lowest median dissolved oxygen values for the Tar River and the highest median levels of nitrate/nitrite-nitrogen are found at this ambient station. This station supports sparse populations of fresh water algae which are subject to washout following spate events. All phytoplankton samples from this site were below the limits used to define an algal bloom for density and biovolume. Several algal blooms of chlorophytes and cyanophytes have been reported from Greenville Utilities Impoundment.

Benthos data from Chicod Creek have indicated Fair water quality. Fisheries data from the Chicod Creek watershed also noted Fair ratings. The Chicod Creek watershed is targeted for nutrient reductions as part of the Tar-Pamlico nutrient trading program. The lower ambient station on Chicod Creek has the lowest DO values and the highest Total Phosphorus values of all Tar-Pamlico tributary stations. Grindle Creek was rated Fair from benthos data and Good from fisheries data.

Fish tissue samples in this subbasin were either below FDA criteria, or contained low levels of pesticides, except for elevated mercury levels from some largemouth bass collected from the Tar River at US-264 near Greenville and the Tar River near Grimesland.

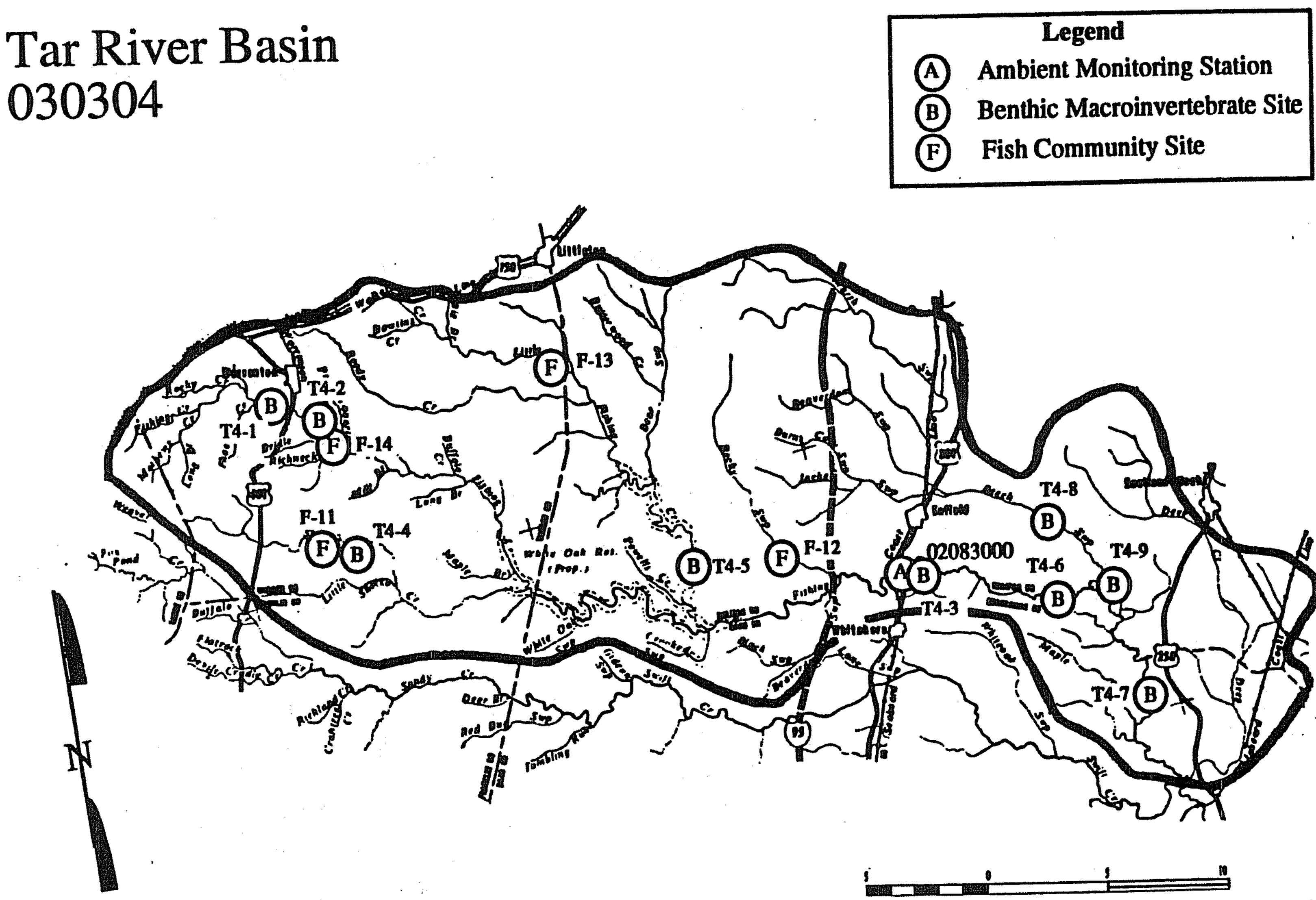


Figure 4.18 DEMMonitoring Locations in Subbasin 04

Tar River Basin
030305

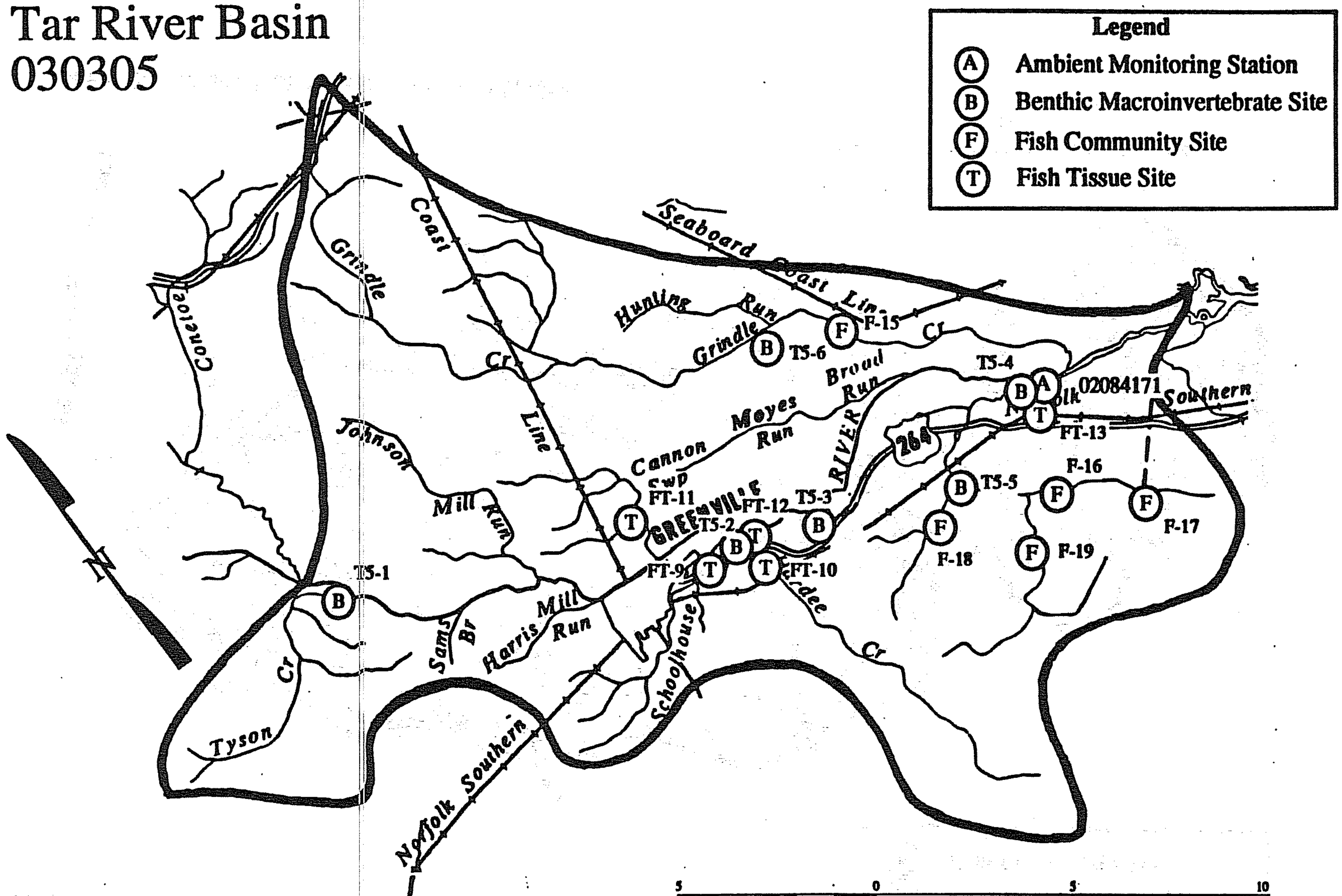


Figure 4.19 DEM Monitoring Locations in Subbasin 05

4.4.6 Subbasin 06 - Tranters Creek (Entire Tranters Creek Watershed to Tar River)

Description
The entire Tranters Creek catchment is a very small subbasin contained completely within the coastal plain ecoregion. Streams in this subbasin are typical swamp streams having low current velocities, dissolved oxygen and pH. Many streams in this area were channelized prior to 1970. There are no major metropolitan areas within this subbasin.

Overview of Water Quality
Very few biological investigations have been conducted in this subbasin (Figure 4.20). Data have only been collected from the ambient location on Tranters Creek near Washington from 1983 through 1989. Bioclassifications from this station have been in the Fair to Poor range. However, the data is difficult to interpret because of the possible influence of saline water. Several euryhaline benthic taxa are often collected at this location.

4.4.7 Subbasin 07 - Pamlico River (from Highway 17 in Washington to Pamlico Sound)

Description
This area is primarily estuarine in nature, extending from tidal freshwater areas around Washington to the mouth of the Pamlico River. Tides in these estuarine areas tend to be more wind dominated than lunar. Freshwater streams in this subbasin are limited to headwaters of estuarine creeks and the East Dismal Swamp. Most streams in the East Dismal Swamp are ditched canals. Primary land use is agriculture, with an urban area around Washington, and a phosphate mine near Aurora. Four major discharges, the largest being the Texas Gulf phosphate mine, are permitted to discharge into this subbasin. The subbasin includes primary nursery areas and waters classified as SA.

Overview of Water Quality
Extensive phytoplankton sampling and other types of water quality monitoring have been conducted in this subbasin (Figures 4.21a and 4.21b). Where the Pamlico River typically becomes brackish near Washington, phytoplankton populations were comprised of a diversity of algal classes. This station hosts both fresh and brackish water species of algae since the fresh-brackish water interface migrates depending on flow and winds. Downstream, phytoplankton communities at mainstem stations were comprised of typical estuarine phytoplanktors including bacillariophytes, dinoflagellates and cryptophytes. Small filamentous cyanophytes and bacillariophytes were also common by density estimates. Mainstem stations often exhibited bloom numbers of algae during the summer. In addition, these stations exhibited winter blooms of cool weather dinoflagellates, Heterocapsa triquetra and Prorocentrum minimum. These dinoflagellate blooms cause little concern during winter months because sufficient oxygen is present in the water column even with high levels of algal respiration. Concern has been expressed, though, that these blooms result in nutrient enrichment in early summer due to recycling. Fish kills associated with the toxic dinoflagellate have been documented in this subbasin.

Benthos data have been collected from estuarine sites, but no water quality ratings are associated with this data. Fisheries data from Horse Creek gave a Fair-Good NCIBI rating. Fish tissue samples indicated elevated mercury levels (above FDA action level) in fish from the Pungo River and Tranters Creek. Lakes data note that Pungo Lake is a dystrophic lake that is considered eutrophic due to high nutrients. A peak of total phosphorus values were noticeable at the ambient water quality site on the Pamlico River near Gum Point. This station is just downstream of the Texas Gulf phosphate mining facility.

Tar River Basin
030306

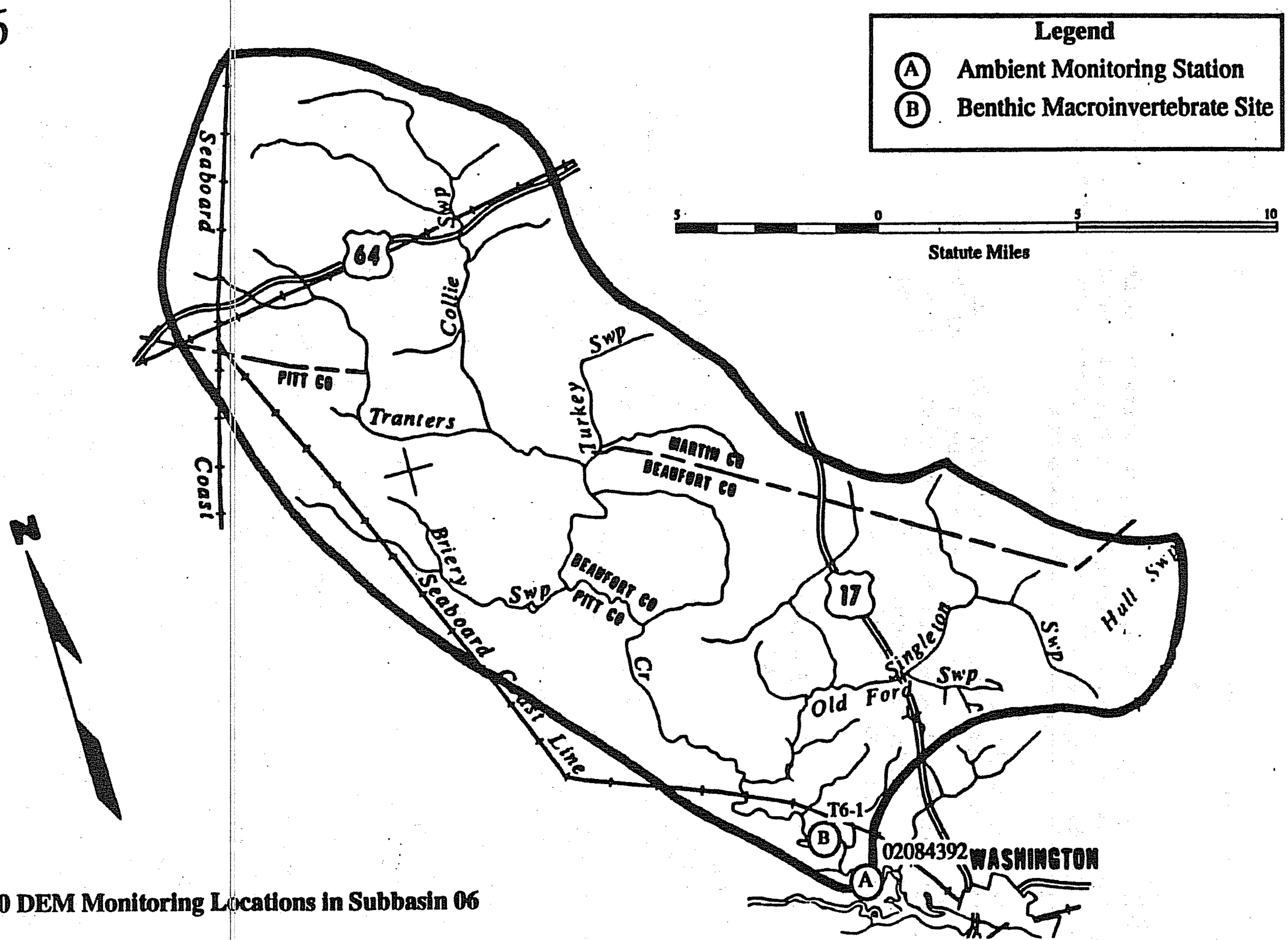


Figure 4.20 DEM Monitoring Locations in Subbasin 06

Tar River Basin
030307

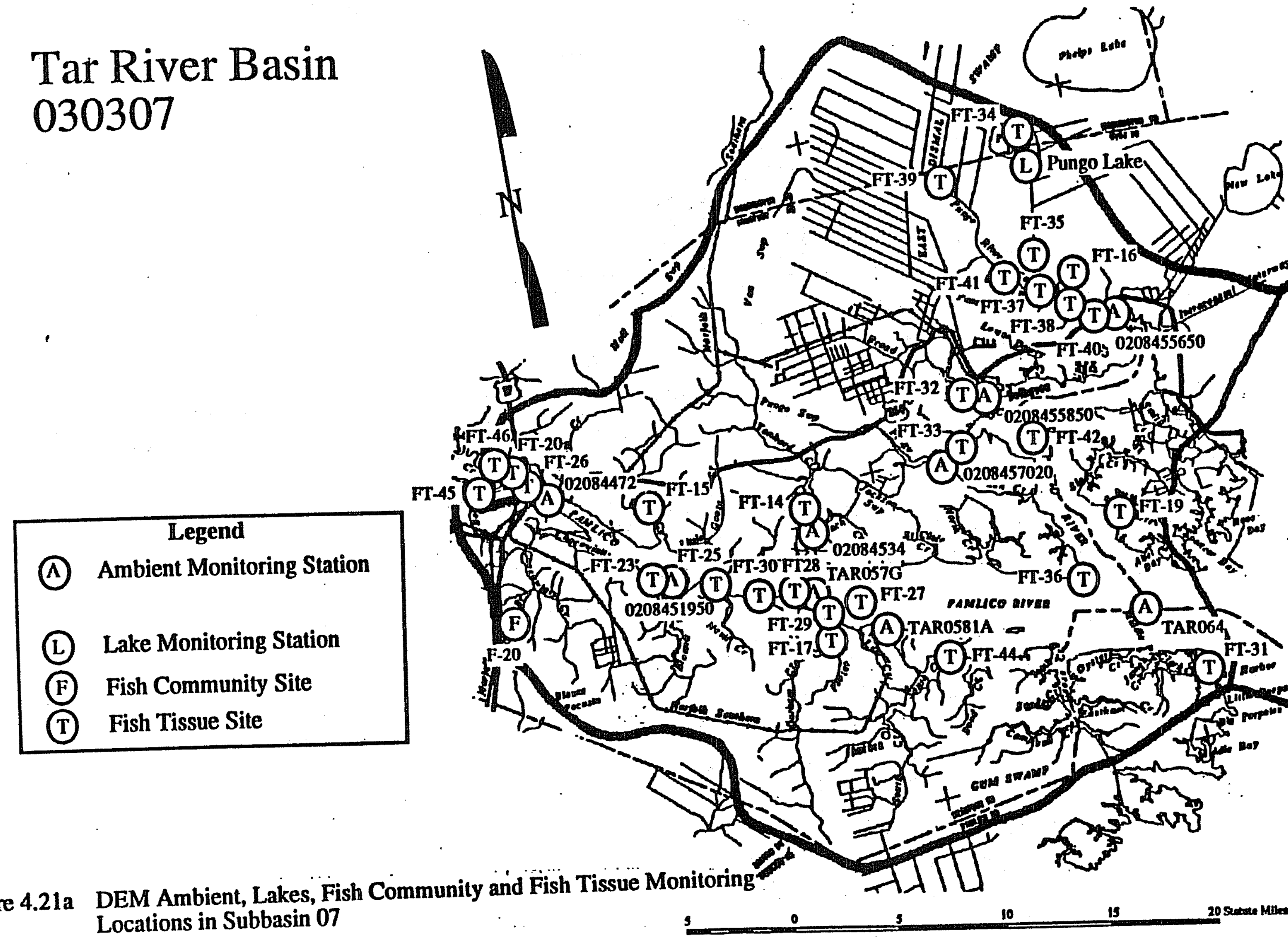


Figure 4.21a DEM Ambient, Lakes, Fish Community and Fish Tissue Monitoring Locations in Subbasin 07

Tar River Basin
030307

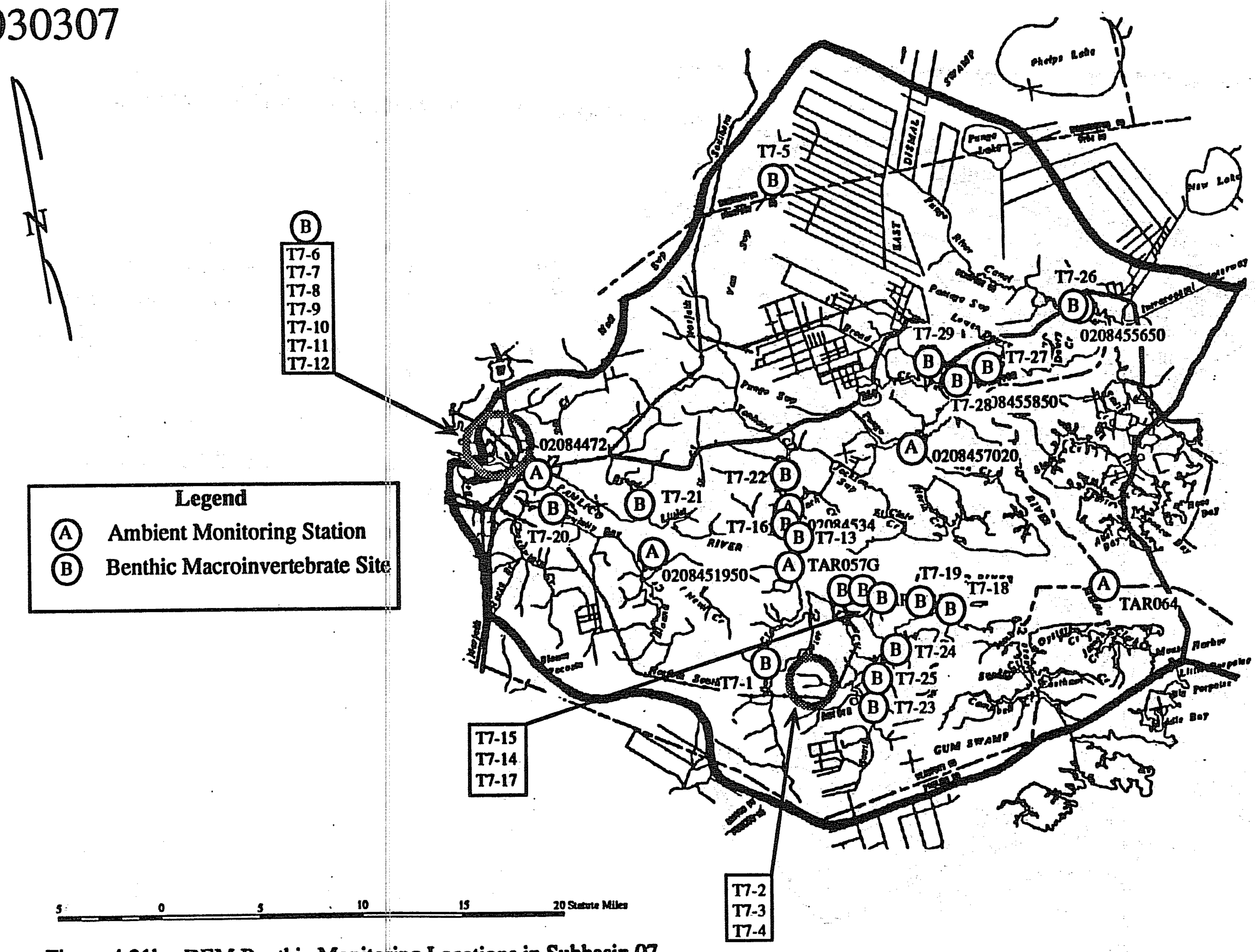


Figure 4.21b DEM Benthic Monitoring Locations in Subbasin 07

4.4.8 Subbasin 08 - Pamlico Sound (Most of Pamlico Sound and Lake Mattamuskeet)

Description

This area, which includes most of Pamlico Sound, is almost entirely estuarine in nature with the exception of Lake Mattamuskeet, which is the largest natural lake in North Carolina (Figure 4.22). Tides in these estuarine areas tend to be more wind dominated than lunar. Freshwater streams in this subbasin are limited to headwaters of estuarine creeks. Most streams in this area have been ditched for agricultural drainage. There are no urban areas in this subbasin and primary land use is agriculture, with many undeveloped areas including the Mattamuskeet and Swanquarter National Wildlife Refuges. There are no major dischargers in this subbasin.

Overview of Water Quality

Data from phytoplankton samples are almost always below bloom thresholds from the ambient station in the lower Pamlico River estuary. Ambient water quality data show low nutrient values for stations in this subbasin. Lake Mattamuskeet is classified as fully supporting its designated uses. There is one major Outstanding Resource Water area in this subbasin, in the Swanquarter National Wildlife Refuge, which includes Swanquarter Bay, Juniper Bay, Shell Bay and most of their tributaries. Some creeks in this subbasin, Far Creek, Kitty Creek, Waupopin Creek and Cumberland Creek have received a High Quality Waters designation because of their designation as primary nursery areas.

Tar River Basin
030308

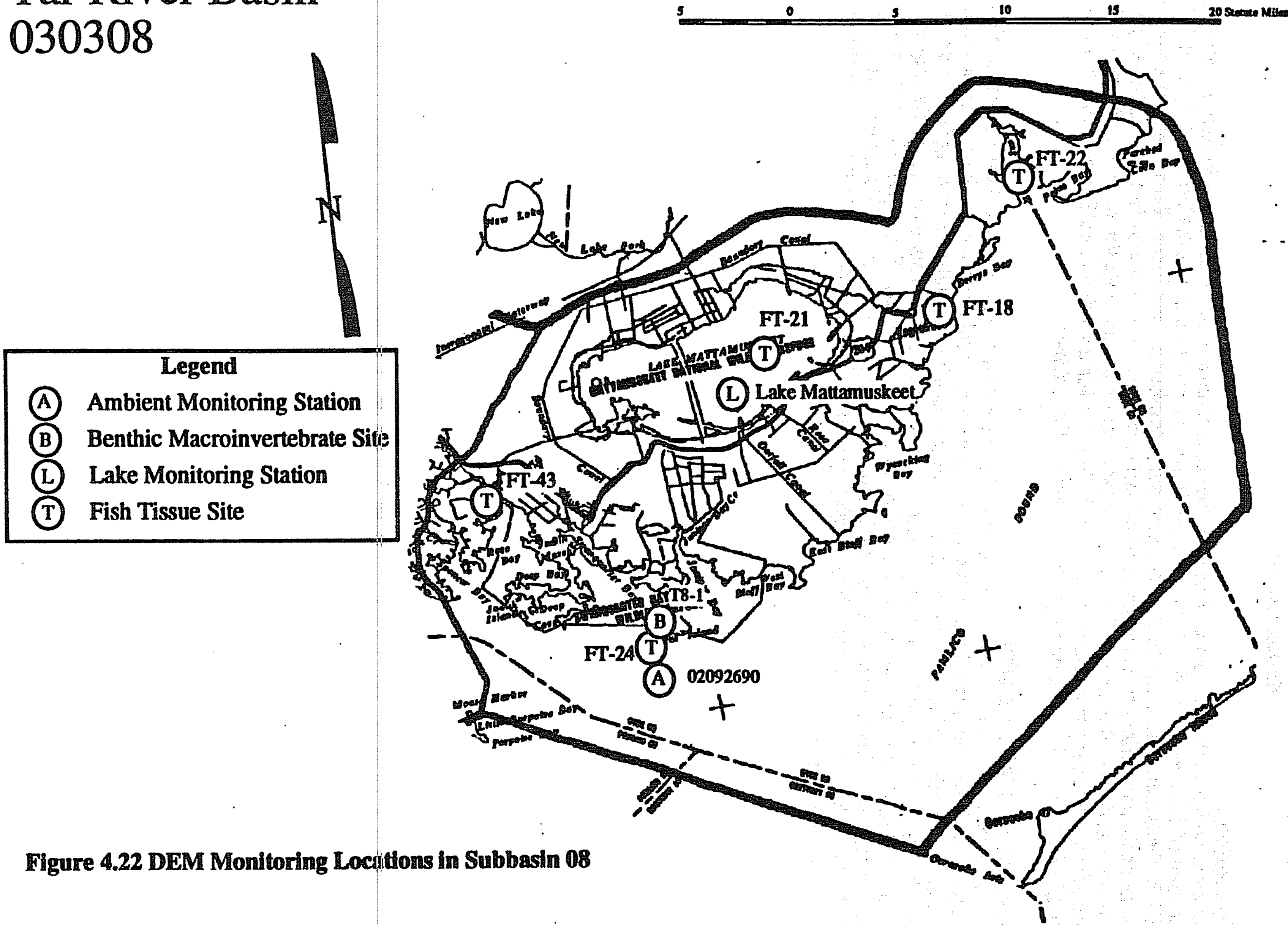


Figure 4.22 DEM Monitoring Locations in Subbasin 08

4.5 USE-SUPPORT: DEFINITIONS AND METHODOLOGY

4.5.1 Introduction to Use Support

Determining the *use support* status of a waterbody, that is how well a waterbody supports its designated uses, is another important method of interpreting water quality data and assessing water quality. Use support assessments are presented in Section 4.6 using figures, tables and maps for freshwater streams, lakes and estuaries within the Tar-Pamlico River Basin.

Surface waters (streams, lakes or estuaries) are rated as either *fully supporting* (S), *support-threatened* (ST), *partially supporting* (PS), or *nonsupporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and swimming) are being fully supported, partially supported or are not supported. For instance, saltwaters classified for commercial shellfish harvesting (SA) would be rated as fully supporting if bacterial levels in the water were low enough to allow harvesting (<14 MPN). However, if fecal coliform bacteria levels were too high to allow shellfish to be harvested (>14 MPN), but not too high to prevent swimming (<200 MPN), then the waters would be rated as partially supporting since they only support the swimming. If the waters were impacted to the point that even swimming was disallowed, the waters would be rated as nonsupporting. Streams rated as either partially supporting or nonsupporting are considered *impaired*. The support-threatened category for freshwater rivers and streams refers to those waters classified as good-fair based on water quality data, in contrast to excellent or good which are considered fully supporting. An overall support rating, however, does include <u>both</u> fully supporting and support-threatened waters. Streams which had no data to determine their use support were listed as non-evaluated (NE).

For the purposes of this document, the term *impaired* refers to waters that are rated either partially supporting or not supporting their uses based on specific criteria discussed more fully below. There must be a specified degree of degradation before a stream is considered impaired. This differs from the word impacted, which can refer to any noticeable or measurable change in water quality, good or bad.

4.5.2 Interpretation of Data

The assessment of water quality presented below involved evaluation of available water quality data to determine a water body's use support rating. In addition, an effort was made to determine likely causes (e.g., sediment or nutrients) and sources (e.g., agriculture, urban runoff, point sources) of pollution for waters that did not support their designated uses (i.e., those found to be either partially or nonsupporting). These data consisted of biological and chemical ratings, reports of citizen complaints, responses to mailings requesting water quality information, land-use reviews of topographic maps, and best professional judgment (see Data Analysis Methodology section for more details). By including best professional judgments (i.e., perceived water quality problems) in deciding the overall water quality ratings and the potential sources of pollution, a much broader, but less precise, picture of water quality conditions in the basin was developed.

Interpretation of these data compiled by DEM should be done cautiously. The methodology used to acquire the numbers must be understood, as should the purpose for which the numbers were generated. The intent of this use-support assessment was to gain an overall picture of the relative contribution made by different categories of pollution within the Tar-Pamlico basin. In order to comply with guidance received from EPA to identify likely sources of pollution for all impaired stream mileage, DEM used the data mentioned above.

The data are not intended to provide precise conclusions about pollutant budgets for specific watersheds. Since the assessment methodology is geared toward general conclusions, it is important to not manipulate the data to support policy decisions beyond the accuracy of these data. For example, according to this report, nonpoint source pollution is thought to be the most widespread source of the impairment of water quality. However, this does not mean that there should be no point source control measures. As discussed in previous sections of this chapter, and in Chapter 6, many stream miles in the basin are impacted by point source dischargers, but the degree of impact has not resulted in a partial or nonsupport rating. What is clear from the plan is that all categories of point and nonpoint source pollution have the potential to cause significant water quality degradation if proper controls and practices are not utilized.

This threat to water quality from all types of activities heightens the need for point and nonpoint source pollution control. It is important to not neglect any source (or potential source) of pollution in developing appropriate management and control strategies. Data exist which document water quality problems from every major pollution category that has been considered in this report. Certainly, the potential for further problems remains high as long as the activity in question continues carelessly. Because of this potential, neglecting one pollution source in an overall control strategy can mask the benefits achieved from controlling all other sources.

4.5.3 Assessment Methodology - Freshwater Bodies

Many types of information were used to make use support assessments and to determine causes and sources of use support impairment. Chemical, physical and biological data as well as wastewater treatment plant self-monitoring data and toxicity data were the primary sources of information used to make use support assessments. Information was also obtained from other agencies, workshops, and pertinent reports.

The most recent water quality chemical data (January 1988 through August 1993) were interpreted for use support utilizing the STAND(ards) program available through the STORET system. The program determines water quality standard violations and computes percentages of the values in violation based on applicable North Carolina water quality standards. According to EPA guidance, use support determinations based on chemical data are to be made as follows:

Fully Supporting - for any one pollutant, criteria exceeded in $\leq$ 10% of the measurements,
Partially Supporting - for any one pollutant, criteria exceeded in 11- 25% of the measurements, and
Not Supporting - for any one pollutant, criteria exceeded in > 25% of the measurements.

The following parameters were evaluated in the STAND(ards) program: dissolved oxygen (surface values), temperature, pH, turbidity, fecal coliform bacteria, chlorophyll *a*, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, mercury, zinc, chloride, fluoride and selenium.

Another valuable source of data used for the report was biological rankings from 1983 through 1992 as determined from benthic macroinvertebrate surveys discussed in section 4.2. The most recent report on these surveys (NCDEHNR, DEM 1991) is available from DEM's Environmental Sciences Branch. Data from North Carolina's Biological Monitoring Ambient Network (BMAN), in addition to special macrobenthic studies were ranked on a five point scale. This scale is based on taxa richness for the three pollution intolerant groups of Ephemeroptera, Plecoptera and Trichoptera (EPT).

Collected specimens are identified to the lowest possible taxonomic level. Total species (or taxa) richness values for the EPT groups are calculated and biological classifications assigned to each station (Excellent, Good, Good-fair, Fair or Poor). Higher species richness values are associated with better water quality. For ranking purposes, stations classified as "Poor" with regard to biological data are rated not supporting (NS) and stations classified as "Fair" are rated partially supporting (PS). Stations classified as "Good-Fair" are rated as support-threatened (ST) and those having a Good to Excellent biological classified are rated as supporting their designated uses (S).

Other types of DEM-collected data used to make use support assessments were toxicity data related to discharging facilities, fish tissue and fish community structure data and phytoplankton bloom information. In addition, fish consumption advisories and information from other agencies, workshops held in 1987 and pertinent reports were utilized. In general, stream segments which received a discharge from a facility significantly out of compliance with permit limits or failing their whole effluent toxicity test were rated as support-threatened, unless water quality data indicated otherwise. Streams which had a fish consumption advisory in place were rated as partially supporting. Assessments were made on either a monitored (M) or evaluated (E) basis. A *monitored* basis represents data which are less than five years old. An *evaluated* basis refers to the use of best professional judgment or data older than five years old. Overall ratings were determined for stream segments as follows:

1. *Biological ratings* generally were preferred over any other source of information since they are a direct measurement of aquatic life support.
2. *Chemical ratings* (when biological ratings were unavailable) were preferred over information from older reports or information from workshops.
3. *Workshop "evaluations"* or best professional judgments were preferred over information from older reports.
4. Information from older reports was used when no other information was available.

After overall ratings were assigned, probable sources of pollution (point or nonpoint) for partially supporting and nonsupporting streams were sought. Information on point sources, such as permit compliance records, was reviewed in order to identify major and minor dischargers potentially affecting streams. The Aquatic Toxicology Unit was also consulted to identify facilities known to have toxic effects based on chronic and acute toxicity tests. Information related to nonpoint source pollution (e.g., agricultural, urban and construction) was obtained from other agencies (federal, state and local), citizens, land-use reviews and best professional judgment.

Causes of use support impairment, such as sedimentation and low dissolved oxygen, were also identified for specific stream segments. For ambient water quality stations, those parameters which exceeded the water quality standard >10% of the time for the review period were included as probable causes. For segments without ambient stations, information from reports, other agencies and best professional judgment were used. In general, facility self-monitoring data and facility aquatic toxicity data were not included in the cause or overall problem parameter column since these data may not reflect instream conditions occurring during the reporting period because they are based on 7Q10 conditions.

Once all monitored and evaluated information was located on water basin maps, remaining "unassessed" streams and segments were evaluated to have the same use-support if they were a direct or indirect tributary to monitored or evaluated segments rated supporting and support-threatened. Partially and nonsupporting segments were not extended. US Geological Survey (USGS) 7.5 minute topographic maps (1:26,000 scale) and orthophotoquads were used to determine probable sources for all impaired streams when other sources, such as WWTP compliance data, were insufficient.

4.6 USE SUPPORT RATINGS FOR THE TAR-PAMLICO BASIN

Use support ratings and background information for all monitored stream segments are presented in Table 4.3. Ratings for all monitored and evaluated surface waters are presented on color coded maps in Figures 4.23 and 4.24.

4.6.1 Freshwater Streams and Rivers

Of the 2354.7 miles of freshwater streams and rivers in the Tar-Pamlico basin, use support ratings were determined for 89% or 2087.9 miles with the following breakdown: 21% were rated fully supporting, 43% support-threatened, 20% partially supporting, 5% not supporting, and 11% nonevaluated. Table 4.4 and Figure 4.25 present the use support determinations by subbasin. In general, subbasins 01, 02, 03, 04, 06 and 07 had a majority of their streams which were either supporting or support-threatened. While subbasins 05 and 08 had a larger percentage of streams which were partially supporting or not supporting.

Probable causes and sources of impairment were determined for about 87% of the impaired streams with the information summarized in Table 4.5 and 4.6. When a stream segment had more than one cause or source listed, the total stream segment information was added to each cause or source. This means that the miles of stream impaired by the combination of all sources or all causes may be more than the total miles of partially and not supporting streams presented in Table 4.4. As an example, if a 10-mile long stream segment was determined to be impaired as a result of both point sources and urban development, then 10 miles would be entered under both the urban column and point source column in Table 4.5. Where the sources of impairment could not be identified, no mileage for that segment was entered into the table. Sediment was the most widespread cause of impairment, followed by pH and fecal coliform bacteria.

Information on sources of impairment for stream miles rated partially or not supporting indicated that 520.2 stream miles were impaired by nonpoint sources, and 43.5 stream miles were impaired by point sources. Agriculture was the most widespread nonpoint source, followed by hydrologic/habitat modification, and unknown sources (general erosion.) Forestry and urban activities also contributed substantially to the nonpoint source pollution in this basin. Subbasins 04 and 05 had the highest number of streams thought to be impaired by agriculture and subbasin 05 had the highest number attributed to hydrologic modification.

4.6.2 Salt (Estuarine) Waters

Use support determinations were made for all 634,400 acres of saltwater in the Tar-Pamlico Basin which includes 120,000 acres in the Pamlico River (subbasin 03-03-06) and 514,400 acres in Pamlico Sound and its tributaries (03-03-07). Use support data for all saltwaters are presented in Table 4.7. Data are presented for each of 12 shellfish management areas used by the NC Division of Environmental Health's Shellfish Sanitation Branch (Figure 4.27). In evaluating all 634,400 saltwaters in the basin, approximately eighty-four percent of the saltwaters were rated as fully supporting, 7.1 percent were rated support threatened and 8.6 percent were rated partially supporting. However, as shown in Table 4.8, all of the support-threatened and most of the partially supporting waters are located in the Pamlico River. Therefore, while 99.5% of the waters in Pamlico Sound are considered supporting (with only 0.5% partially supporting), just 19% of the Pamlico River's saltwaters are fully supporting with 38% being fully supporting but threatened and 43% being partially supporting.

Chlorophyll *a* was the most widespread probable cause of impairment followed by low dissolved oxygen, and fecal coliform bacteria. Elevated levels of Chlorophyll *a* and fecal coliform bacteria are both indicators of water quality degradation, with the first related to nutrient overenrichment and the second to elevated bacterial levels that require the closure of shellfishing areas. The majority of partially supporting waters were in the upper part of the Pamlico River estuary where these waters were mainly impacted by nutrient overenrichment

Nonpoint source pollution is estimated to be the primary pollution source in 85% of the impaired waters, while point source impacts were identified in 15%. Waters were impacted primarily by multiple nonpoint sources including agriculture, urban runoff, septic tanks and marinas.

4.6.3 Lakes

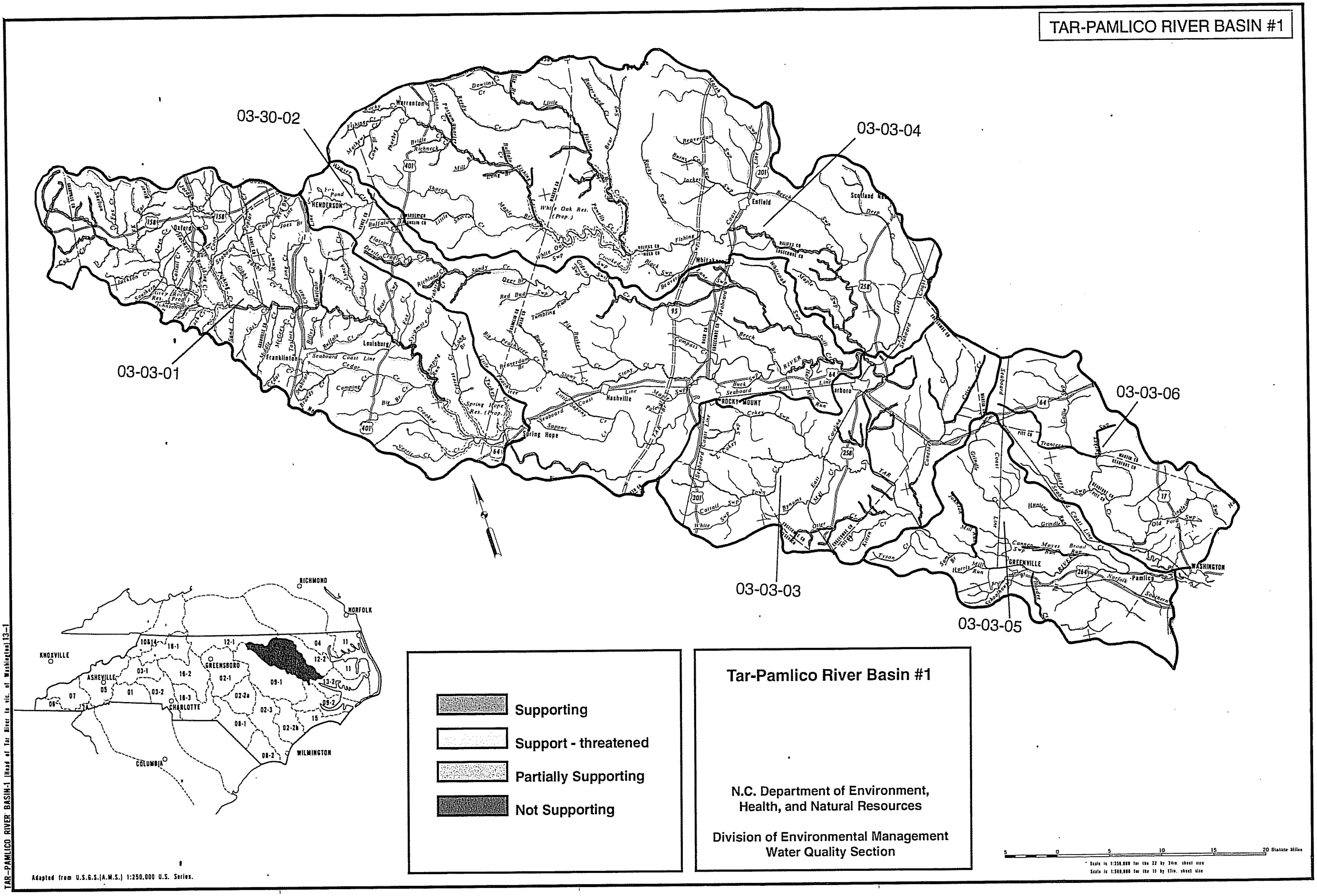
Four lakes in the Tar-Pamlico Basin, totaling 46,985 acres, were monitored and assigned use support ratings (Table 4.9). Of these four, one fully supported its use, and three were support-threatened. Lake Mattamuskeet is the largest natural lake in North Carolina at 42,000 acres, and fully supports its designated use. It is shallow with no natural outlets and has a maximum depth of only 1.2 meters. Lake Devin and Tar River Reservoir are water supply reservoirs. Both lakes are eutrophic and rated support threatened due to elevated nutrient levels. Pungo Lake is dystrophic, which means it has humic, tea colored water, rich in natural organic matter. It overlies a peat deposit, has no overland tributaries, and is recharged from precipitation and groundwater. Pungo Lake was rated support threatened due to elevated nutrient levels.

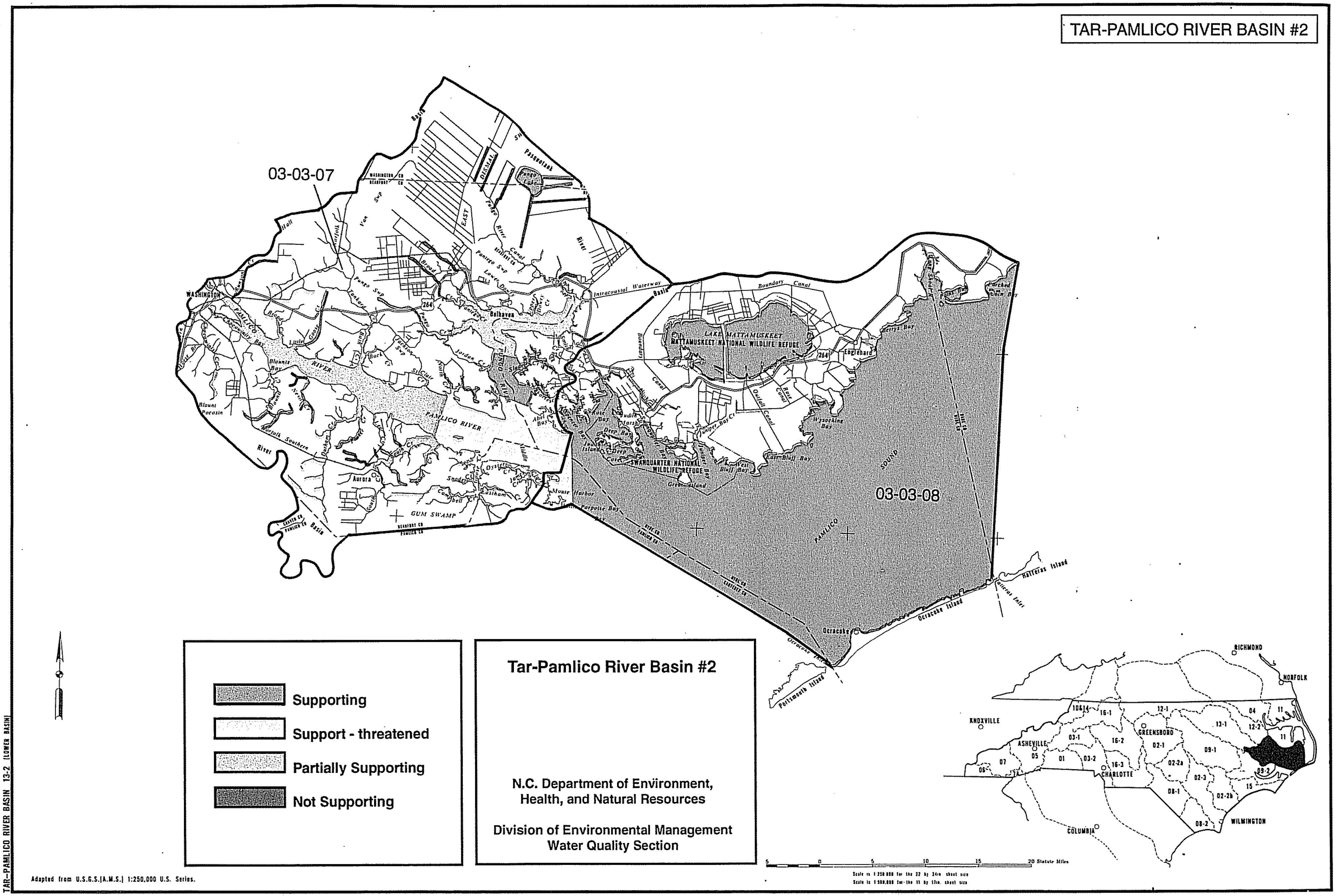
Table 4.3 Tar-Pamlico River Basin Monitored Freshwater Segments (1988-1992) (1 of 2))

Station Number	Station Location	Classification	Index Number	Miles	Chem Rating 89-93	Biological Rating: Benthos 88	89	90	91	92	Problem Parameters	<--Overall Rating---> Use Support	Source
SUBBASIN 30301													
	Tar River at SR 1138, Granville Co.	WS-IV NSW	28-(1)a	15.1			G					S	NP
	Tar River SR 1150, Granville, Co.	WS-IV NSW	28-(1)b	4.6						F		PS	NP
	N Fk Tar R, US 158, Granville Co.	WS-IV NSW	28-5	7.6						F		PS	P
02081500	Tar R. nr Tar River, NC Hwy 96, Gran. Co.	WS-V NSW	28-(5.7)a	11.4	PS		G-F			G-F	DO	ST	NP
	Tar River SR 1622, Granville Co.	WS-V NSW	28-(5.7)b	7.9						G		S	NP,P
	Fishing Creek at SR 1649, Granville Co.	C NSW	28-11a	2			P	F			Sed	PS	NP,P
	Fishing Creek 200 meters below, Gran. Co.	C NSW	28-11b	0.4			P				Sed	NS	NP
	Fishing Creek at SR 1608, Granville Co.	C NSW	28-11c	0.9				P			Sed	NS	NP,P
02081547	Fishing Creek at SR 1643, Granville Co.	C NSW	28-11d	7	NS			F		G-F	Bact, Turb,Sed	ST	NP
	Coon Creek at SR-1515, Granville Co.	C NSW	28-11-5	10.1			G-F					ST	
02081747	Tar River at NC 401, Franklin Co.	WS-V NSW	28-(24.7)a	1	NS					G	Fecal	S	
02081854	Tar River at SR 1001 Franklin Co.	WS-V NSW	28-(24.7)b	11.5	NS						Fecal	NS	P
	Tar River at NC 64, Nash Co.	WS-V NSW	28-(24.7)c	11.3						G-F		ST	
	Cedar Creek at SR 1116, Franklin co.	WS-II NSW	28-29-(2)a	4.9				G-F		G-F	Sed	ST	NP
	Cedar Creek at SR 1105, Franklin co.	WS-II NSW	28-29-(2)b	13.2				G-F		G-F	Sed	ST	NP,P
	Crooked Cr. NC 98, Franklin Co	C NSW	28-30	19.5						G-F		ST	P
SUBBASIN 30302													
	Tar River at SR 1001, Nash Co.	WS-IV NSW	28-(34.5)	6.5			F					PS	
02082506	Tar R. below Tar River Res. nr Rocky Mt.	WS-IV NSW CA	28-(66.5)	0.7	S							S	NP
	Stoney Cr, SR 1603, Nash Co.	C NSW	28-68	23.2						F	Sed	PS	NP
02082585	Tar R. at NC 97, Rocky Mount, Edgec. Co,	C NSW	28-(69)a	1	PS			G		G-F	Fecal	ST	
	Tar River at SR1400, Edgecombe Co.	C NSW	28-(69)b	2.7		G-F						ST	P
	Tar R. at SR1243, be WWTP, Edge. Co	C NSW	28-(69)c	6.9						G-F		ST	
02082626	Tar R. at SR 1252 Edgecombe Co.	WS-IV NSW	28-(74)a	5.3	S	F						PS	
02082770	Swift Creek near Hilliardston, SR-1310	C NSW	28-78-(0.5)a	2.8	NS	G	G	G	G	G-F	Fecal	ST	
	Swift Creek at SR-1003, Nash Co.	C NSW	28-78-(0.5)b	7.2			G					S	P
	Swift Creek at Wake Stone, Nash Co.	C NSW	28-78-(0.5)c	2.7				G	G			S	
	Swift Creek at I-95	C NSW	28-78-(0.5)d	26.4				G	G			S	
	Sandy Cr NC 401, Franklin Co.	B NSW	28-78-1-(8)a	3.8		G						S	
	Sandy Cr, SR 1436, Franklin Co.	B NSW	28-78-1-(8)b	12.2						G-F		S	
	NC 401, Granville County	B NSW	28-78-1-12-1	7.3								S	NP
	Swift Creek at SR-1253, Edgecombe Co.	WS-IV NSW	28-78-(6.5)	7.6			G					S	
	Whiteoak Swamp SR 1428, Edgecombe Co.	WS-IV NSW	28-78-7-(2)	2.7		F					Sed	PS	NP

Table 4.3 (Continued)

Station Number	Station Location	Classification	Index Number	Miles	Chem Rating 89-93	Biological Rating: Benthos 88	89	90	91	92	Problem Parameters	<--Overall Rating---> Use Support	Source
SUBBASIN 30303													
02083692	Tar R. at SR1400 (222) nr Falkland, Pitt Co.	WS-IV NSW	28-(84)	12.7	PS						Fecal	ST	NP
02083500	Tar R. at Tarboro, NC Hwy. 64 Edge. Co	C NSW	28-(80)a	4.3	S	G		G		G		S	
	Tar River at NC 42 Edgecombe Co.	C NSW	28-(80)b	10.5						Excel		S	
	Town Cr, SR 1202 ab Pinetops, Edge. Co	C NSW	28-83a	18						F	Sed	PS	NP
	Town CR SR 1200, be Pinetops, Edge. Co	C NSW	28-83b	5.5						G-F	Sed	ST	NP
	Town CR SR 1601, Edgecombe Co.	C NSW	28-83c	2.3						G-F	Sed	ST	NP
	Cokey Swamp at SR-1141,Edgecomb e Co	C NSW	28-83-3	13.8			F					PS	NP
	Little Cokey Swp at Branch Ck, Edge. Co	C NSW	28-83-3-1a	0.8			P					NS	NP
	Little Cokey Swamp at CSX's spill, Edge. Co.	C NSW	28-83-3-1b	0.5			P					NS	NP
	Little Cokey Swamp at SR 1141, Edge. Co.	C NSW	28-83-3-1c	4.2			F					PS	NP
	Briery Branch at NC 124, Edgecombe Co	C NSW	28-83-4-1-1	0.6				P				NS	P
	UT Otter Creek at Sr-1113,Edgecombe Co	C NSW	28-86a	0				P				NS	
	Otter Cr. SR 1009, Edgecombe Co.	C NSW	28-86-(0.3)	11.8						G		S	
02083800	Conetoe Creek near Bethel Hill, SR-1409	C NSW	28-87-(0.5)	15.3	NS	F	F				Sed,pH	PS	NP,P
SUBBASIN 30304													
	Fishing Cr, ab Warrenton WWTP, Warren Co.	C NSW	28-79-(1)a	14.2						F		PS	NP
	Fishing Cr., SR 1600 be Warrenton, Warren C	C NSW	28-79-(1)b	23.3						G		S	NP
	Shocco Cr SR 1613 Warren Co.	C NSW	28-79-22	30.7						G-F	Sed	ST	
02082950	Little Fishing CreekSR 1338, Halifax Co.	C NSW	28-79-25-(1)	30.2	S	G						S	NP,P
02083000	Fishing Creek at NC 301, Edgecombe Co.	C NSW	28-79-(29)a	0.5	PS	G-F				G	Fecal,Sed	S	
	Fishing Creek at SR 1429, Edgecombe Co.	C NSW	28-79-(29)b	24.3			G				Sed	S	
	Fishing Cr SR 1500 Edgecombe Co.	WS-IV NSW	28-79-(30.5)	15.1						G		S	
SUBBASIN 30305													
02084171	Tar River near Grimesland, SR-1565	B NSW	28-(99.5)	9.2	PS		G-F			F	pH,Fecal	PS	NP
	Grindle Cr, US 264	C NSW	28-100	27.3						F	Sed	PS	NP
02084160	Chicod Ck at SR1760 nr Simpson, Pitt Co.	C NSW	28-101	13	NS			F		F	DO,NH3,Sed	PS	NP
SUBBASIN 30307													
02084392	Tranters Ck nr Wash., SR1403, Beau. Co	WS-IV Sw CA	28-103-(16.5)	0.9	PS						Fecal,Chl,Sed	PS	NP
	Tranters Creek near Wash., Beaufort Co	C Sw	28-103-(18)	0.8			F				Sed	PS	NP
02084540	Durham Cr at Edward, SR1949, Beau. Co	C NSW	29-21-(1)	8.9	NS					G-F	DO,pH	ST	NP
	Whitehurst Cr, W&S Prgs, SR1937, Beau. Co.	C Sw	29-28-7-(1)a	0.4						P		NS	
	Whitehurst Cr, SR 1941, Beaufort Co.	C Sw	29-28-7-(1)b	2						P		NS	
02084557	Van Swamp, NC 32, Washington Co.	C Sw	29-34-2-3	4	NS					G-F	pH	ST	NP


TAR-PAMLICO RIVER BASIN #1
03-30-02
03-03-01
03-03-04
03-03-03
03-03-05
03-03-06
Supporting
Support - threatened
Partially Supporting
Not Supporting
Tar-Pamlico River Basin #1
N.C. Department of Environment, Health, and Natural Resources
Division of Environmental Management
Water Quality Section
HENDERSON
Warrenton
Louisburg
Franklinton
Nashville
ROCKY MOUNT
Enfield
GREENVILLE
WASHINGTON
Spring Hope
20 Statute Miles
Adapted from U.S.G.S.(A.M.S.) 1:250,000 U.S. Series.
TAR-PAMLICO RIVER BASIN-1 (Head of Tar River to vic. of Washington) 13-1



TAR-PAMLICO RIVER BASIN #2
03-03-07
03-03-08
Supporting
Support - threatened
Partially Supporting
Not Supporting
Tar-Pamlico River Basin #2
N.C. Department of Environment, Health, and Natural Resources
Division of Environmental Management
Water Quality Section
Adapted from U.S.G.S.(A.M.S.) 1:250,000 U.S. Series.
PAMLICO RIVER
PAMLICO SOUND
LAKE MATTAMUSKEET
MATTAMUSKEET NATIONAL WILDLIFE REFUGE
SWANQUARTER NATIONAL WILDLIFE REFUGE
WASHINGTON
Belhaven
Engelhard
Aurora
Ocracoke
GUM SWAMP
Intracoastal Waterway
Ocracoke Island
Hatteras Island
Portsmouth Island
RICHMOND
NORFOLK
KNOXVILLE
ASHEVILLE
GREENSBORO
CHARLOTTE
COLUMBIA
WILMINGTON
20 Statute Miles

Table 4.4 Use Support Ratings for Freshwater Streams by Subbasin

USE SUPPORT STATUS FOR FRESHWATER STREAMS (MILES) (1988-1992)						
Subbasin	S	ST	PS	NS	NE	Total Miles
030301	59.1	343.7	58.6	12.8	9	483.2
030302	140.8	234.2	96.6	0	15.7	487.3
030303	43.3	47.8	51.3	10.9	24.2	177.5
030304	148.2	243.9	143.6	0	29.1	564.8
030305	12.1	28.1	71.3	23.4	40.3	175.2
030306	0.6	61.4	16.9	12.3	43.8	135
030307	89.8	37.4	25.1	63.6	86.2	302.1
030308	0	0	8.6	2.5	18.5	29.6
TOTAL	493.9	996.5	472	125.5	266.8	2354.7
PERCENTAGE	21	43	20	5	11	

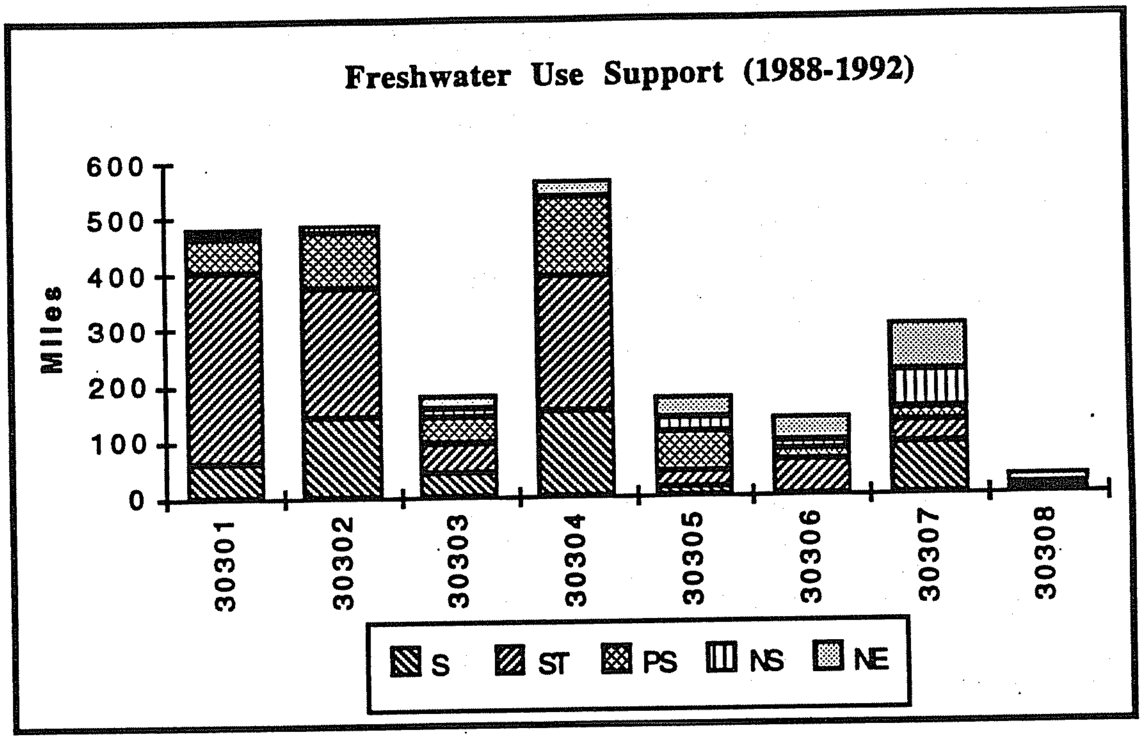


Figure 4.25 Bar Graph Showing Freshwater Use Support Distribution by Subbasin

Table 4.5 Sources of Use Support Impairment in Freshwaters of the Tar-Pamlico Basin

PROBABLE SOURCES OF USE SUPPORT IMPAIRMENT (MILES)					
Subbasin	Non-Point Source	Point Sources	Agriculture	Hydromod	Unknown/ Other
030301	46.3	2.9	41.5	0	4.8
030302	84.8	0	61.6	0	23.2
030303	61.6	15.3	61.6	24.3	19.3
030304	113.9	0	108.7	0	5.2
030305	94.7	6	84.1	40.1	0
030306	29.2	16.2	23.2	0	6
030307	78.6	3.1	63.6	14.3	0
030308	11.1	0	11.1	7.6	0
Total Miles	520.2	43.5	455.4	86.3	58.5
% of PS and NS	87	7	76	14	10

* **Total Miles = miles of impaired streams where a probable source has been identified.**
** PS = Partially supporting; NS = Not supporting; PS and NS = Impaired streams.
Total miles of impaired streams (PS+NS) = 597.5miles

Table 4.6 Major Causes of Use Support Impairment in Freshwaters in the Tar-Pamlico Basin

CAUSES OF USE SUPPORT IMPAIRMENT (MILES)			
Subbasin	Sediment	pH	Fecal
030301	41.7	0	11.5
030302	76.2	0	0
030303	42.3	15.3	0
030304	99.7	0	0
030305	70.9	9.2	9.2
030306	29.2	0	0
030307	26.8	0	0.9
030308	0	0	0
Total Miles	386.8	24.5	21.6
% of PS and NS	65	4	4

Table 4.7 Tar-Pamlico River Estuarine Waterbodies Use Support Status (Acres)

Area Name	Total Acres	DEH AREA	Overall Use Support (Acres)				Major Causes (Acres)			Major Sources		Source Comments
			S	ST	PS	NS	Fecal	DO	Chl a	PtS	NPS	
Goose Creek	17,000	G1	0	16,700	300	0	300				300	ag,urban marina
Pamlico Riv	29,000	G2	0	28,500	500	0	500				500	ag, urban, septic tanks
Swanquarter	45,000	G3	44,333	0	667	0	667			40	627	WWTP, ag, sep. tanks, marinas
Wysocking Bay	23,000	G4	22,570	0	430	0	430			20	410	ag, septic tanks
Long Shoal	46,400	G5	44,834	0	1,566	0	1,566				1,566	ag, septic tanks, marinas
Ocracoke	13,300	G6	13,205	0	95	0	95				95	urban, septic tanks, marinas
Open	400,000	G7	400,000	0	0	0						
Pungo River	13,200	G8	9,900	0	3,300	0	3,180		120	272	3,028	WWTP, ag, urban, marinas
Pungo River	8,000	G9	0	0	8,000	0		1,680	6,320	1,176	6,824	WWTP, ag, urban, marinas
Pamlico Riv	15,500	G10	0	0	15,500	0		5,500	10,000	3,657	11,843	WWTP, ag, urban, marinas
Pamlico Riv	20,700	G11	0	0	20,700	0		4,347	16,353	3,043	17,657	WWTP, ag, urban, marinas
South Creek	3,300	G12	0	0	3,300	0	3,300				3,300	WWTP, ag, urban, marinas
Totals	634,400		534,842	45,200	54,358	0	10,038	11,527	32,793	8,208	46,150	
Percent			84.3	7.1	8.6	0.0	18.47	21.21	60.33	15.1	84.9	

DEFINITIONS

DEH Area	Shellfish management areas defined by the NC Division of Environmental Health	
Overall Use Support (Refer to section 4. in text)		
	S	Supporting
	ST	Support-threatened
	PS	Partially Supporting
	NO	Not supporting
Major Causes		
	Fecal	Fecal coliform bacteria
	DO	Dissolved oxygen
	Chl a	Chlorophyll-a
Major Sources		
	PtS	Point sources
	NPS	Nonpoint sources
Source Comments		
	WWTP	Wastewater Treatment Plants
	Ag	Agricultural runoff
	Urban	Urban stormwater runoff

* *DEH Area* refers to shellfish water areas designated by the Division of Environmental Health (DEH). See Figure 4.27 for DEH shellfish area boundaries.

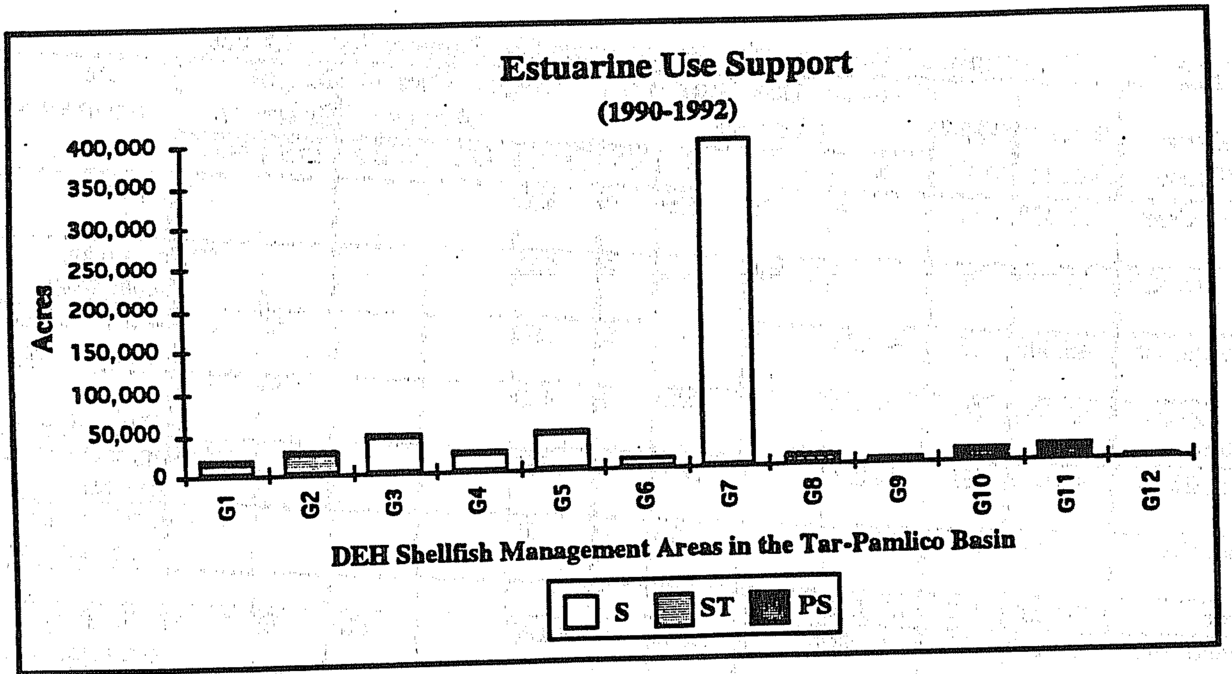


Figure 4.26 Bar Graph of Estuarine Use Support Status (1989-1991)

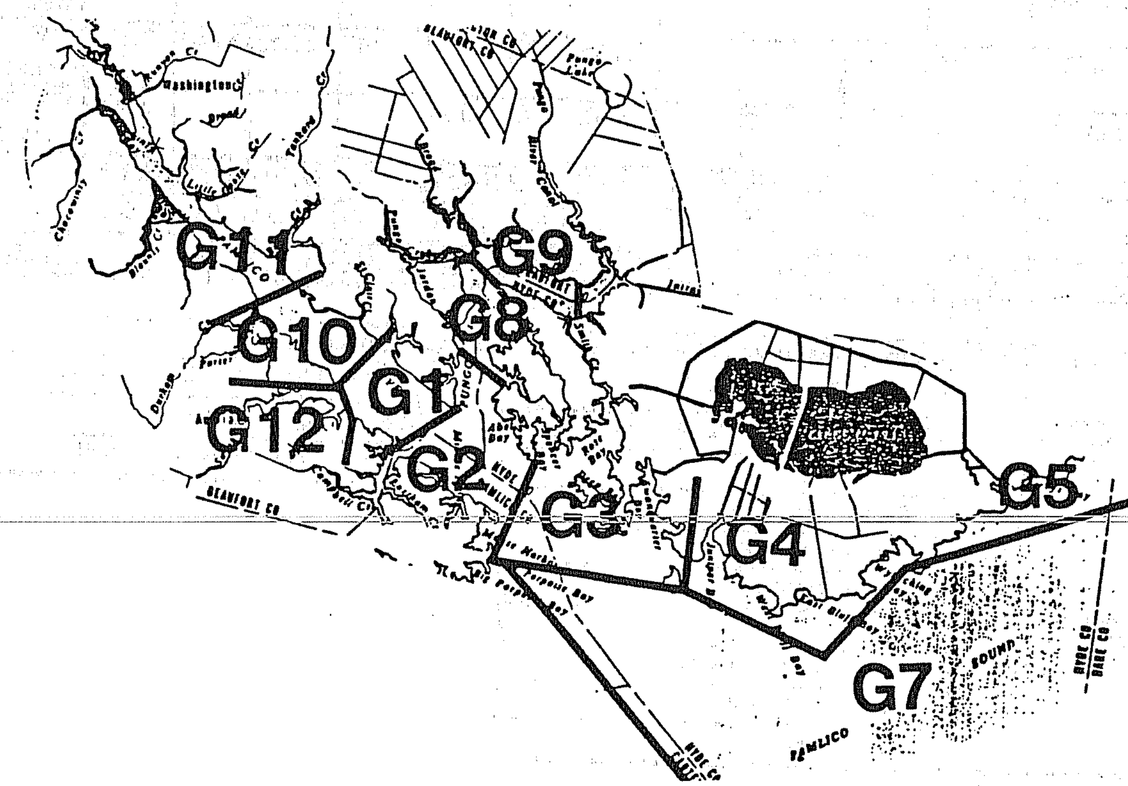


Figure 4. 27 Map of DEH Shellfish Management Areas in the Tar-Pamlico Basin

Table 4.8 Comparison of Use Support Ratings Between Pamlico River and Pamlico Sound

DEH Areas	Total Acres	-----Use Support Ratings (acres)---- S	ST	PS	NS
Pamlico River					
G1, G2, G6, G8 to G12	120,000	23,105	45,200	51,695	0
Percent of area	*100%*	*19%*	*38%*	*43%*	*0%*
Pamlico Sound and Tributaries					
G3, G4, G5 and G7	514,400	511,737	0	2663	0
Percent of area	*100%*	*99.5%*	*0%*	*0.5%*	*0%*

S - Supporting, ST - Support-Threatened, PS - Partially Supporting, NS - Not Supporting

Table 4.9 Lakes Use Support Status and Causes and Sources of Impairment

Subbasin No. Lake Name	Index Number	Size (acres)	Classification	Use Support	Fish Cons-sump.	Aq.Life/ Second. Contact	Swimming	Drinking Water	*Trophic Level	Problem Parameters	Sources
Sub. 030301 Lake Devin	28-11-3-(1)	125	WS-NSW	ST	S	ST	n/a	S	Eutro.	Nutrients	NPS
Sub. 030302 Tar River Reserv.	28-(1), 28-(36)	1,860	WS,B-NSW	ST	S	S	S	S	Eutro.	Nutrients	NPS
Sub. 030307 Pungo Lake	29-34-3-1	3,000	C-SW,NSW	ST	S	S	S	n/a	Dystro.	Nutrients	NPS
Sub. 030308 Lk Mattamuskeet	29-57-1-1	42,000	SC-NSW	S	S	S	S	n/a	Eutro.		

* See Appendix II under Lakes Assessments for discussion of Trophic Level.

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CHAPTER 5

EXISTING POINT AND NONPOINT SOURCE POLLUTION CONTROL PROGRAMS

5.1 INTRODUCTION

This chapter summarizes the point and nonpoint source control programs available for addressing water quality problems in the Tar-Pamlico River basin. Sections 5.2 and 5.3, respectively, describe existing point and nonpoint source pollution control programs. Application of these programs to specific water quality problems and water bodies is presented in Chapter 6. Section 5.4 discusses integration of point and nonpoint source control management strategies and introduces the concept of *total maximum daily loads* (TMDLs).

5.2 NORTH CAROLINA'S POINT SOURCE CONTROL PROGRAM

5.2.1 Introduction

Point source discharges, which are also described in Section 3.3 in Chapter 3, are not allowed in North Carolina without a permit from the state. Discharge permits are issued under the authority of North Carolina General Statute (NCGS) 143.215.1 and the National Pollutant Discharge Elimination System (NPDES) program which was delegated to North Carolina from the USEPA. These permits serve as both state and federal permits. NPDES permits contain effluent limitations which establish the maximum level of various wastes, or pollutants, that may be discharged into surface waters. North Carolina has a very comprehensive NPDES program which includes permitting, enforcement, wasteload allocation modeling, pretreatment, aquatic toxicity testing, operator training and consideration of nondischarge alternatives. Below is a brief summary of key components of North Carolina's NPDES program

5.2.2 Basinwide Review and Processing of NPDES Permits

Under the basinwide approach, all discharge permits within a given basin are set to expire and be renewed at about the same time. In the Tar-Pamlico basin, for example, all of the existing permits will expire and be renewed in January through March of 1995. The permitting schedule for the Tar-Pamlico Basin is presented in Chapter 1 by subbasin. Permits are issued with an effective life of not more than five years, thus basin plans are renewed at five-year intervals. New discharge permits issued during an interim period between cycles will be given a shorter expiration period in order to coincide with the next basin permitting cycle.

DEM will not process a permit application until the application is complete. Rules outlining the discharge permit application and processing requirements are contained in Administrative Code Section: 15A NCAC 2H .0100 - Wastewater Discharges to Surface Waters. Under this rule, all applications must include a written summary of waste treatment and disposal options that were considered, and why the proposed system and point of discharge were selected. The summary should have sufficient detail to assure DEM that the most environmentally sound alternative was selected from the reasonably cost effective options.

Also, applications for new discharges which propose to discharge wastewater in excess of 500,000 gallons per day or 10 million gallons per day (MGD) of cooling water or any other proposed discharge of 1 MGD or greater to surface waters must include an *assessment* report in addition to the normal permit application. The assessment is to provide sufficient information to describe the impact of the proposed action on the waters in the area. An Environmental Impact Statement or Environmental Assessment, under the NC Environmental Policy Act may also be required for certain publicly funded projects.

Once an application is considered complete, a staff review is initiated and a wasteload allocation is performed in order to establish permitted waste limits (described in the following section). The staff review includes a site inspection (which may actually be conducted prior to submittal of complete application for existing facilities that are up for renewal). If the Division finds the application acceptable, then a public notice, called a Notice of Intent to Issue, is published in newspapers having wide circulation in the local area. The public is given a 30-day period in which to comment, and a public hearing may be held if there is sufficient interest. Under Basinwide Management, the Notice of Intent will include all of the permit applications for a particular subbasin (or subbasins) that will be issued within a given month. A public hearing would be scheduled for just those applications where sufficient interest is indicated. Copies of the Notice of Intent are also sent to a number of state and federal agencies for comment. For example, the Division of Environmental Health reviews the applications for their potential impact on surface water sources of drinking water. Once all comments are received and evaluated, a decision is made by the Director of DEM on whether to issue the permit. The final permit will include recommended waste limits and other special conditions which may be necessary to ensure protection of water quality standards.

5.2.3 Establishing Discharge Permit Effluent Limitations/Wasteload Allocations

As noted above, effluent limitations, or waste limits as they are sometimes called, dictate the amounts of wastes (pollutants), that are allowed to be discharged into surface waters under an NPDES permit. Where a discharge permit is required, an evaluation is conducted to determine the projected impact of the discharge on the receiving waters. This determination, called a wasteload allocation (WLA), is often based on computer modeling which considers such factors as the rate of waste flow, the type of waste to be discharged, and characteristics of the receiving waters (e.g. rate and quantity of flow, waste assimilative capacity, channel configuration, rate of reaeration, water quality classification, etc.). Permit limits that are determined by models are called water quality-based limits. Permits may also be based on federal effluent guidelines established by the USEPA.

Wasteload allocations are performed by DEM using models of varying scope and complexity, depending on the parameter (type of waste) of interest and the characteristics of the receiving waters. Model frameworks, which are discussed in more detail in Appendix III, can range from simple mass balance analyses to 3-dimensional dynamic water quality models. Modeling fits into the basin plan by drawing on the current conditions within the basin and evaluating the effects of various management strategies. In general terms, modeling can be used to determine the fate and transport of pollutants, reduction goals for point and nonpoint sources of environmental contaminants, and to derive effluent limits for NPDES permits. More specifically, models can be used to predict concentrations of a parameter at a given site, such as instream DO or chlorophyll *a* in a lake, and can be used as a tool to determine what is needed to protect instream standards. Uncertainty analysis of water quality models expand the predictive capabilities and the confidence in results, and can produce probabilities that an event would occur under a certain set of circumstances. Waste limits may vary from summer to winter for some parameters, such as nutrients and ammonia, with winter limits being somewhat less stringent than summer limits due to higher instream flows during the winter months.

It should be noted that where point sources are responsible for water quality problems, WLAs offer a solution by yielding appropriate permit limits that offer adequate water quality protection. Where a sole discharge is responsible for the water quality impacts, a simple WLA can be performed and no other discharges need be affected. If the issues are not complex, and a standard WLA analysis was performed, the management practice is to establish limits in accordance with

DEM's Standard Operating Procedures (SOP) for Wasteload Allocations manual. The SOP manual has been developed to support State and Federal regulations and guidelines and has been approved by the EPA.

In considering a wasteload for an individual discharge facility, a critical factor is whether the receiving waters have a flow during 7Q10 or 30Q2 conditions. It is DEM's policy not to allow new or expanded discharges into "no flow" streams having a 7Q10 and 30Q2 equal to zero. In addition, existing facilities on such streams will be targeted for removal unless it is determined that there are no reasonable alternatives. If that is the case, then the facility will be required to meet limits of 5 mg/l BOD_5 and 2 mg/l NH_3N in summer (and 10 mg/l BOD_5 and 4 mg/l NH_3N in winter).

If the water quality issues involve numerous discharges, the Environmental Management Commission, pursuant to NCGS 143-215.1(b)(2), is required to consider the cumulative impacts of all permits in order to prevent violations of water quality standards. Such areas are identified and discussed in Chapter 6. Generally, these are areas where the SOP alone does not provide adequate guidance. Since the SOP addresses mostly single discharge or relatively simple interaction of multiple discharges, WLA procedures outside the realm of the SOP represent the larger, basinwide strategy that DEM is implementing.

5.2.4 Compliance Monitoring and Enforcement

Most dischargers are required to periodically sample the treated effluent from their discharge pipes. Also, many larger and more complex dischargers are required to sample points in the receiving waters both up and downstream from the discharge point. This process is called self-monitoring and it is typically required five days a week for some parameters (Monday through Friday) for major facilities. The sampling results (contained in a discharge monitoring report or DMR) are then submitted each month to DEM for compliance evaluations. If the limits are not being met, the state may issue a notice of violation, initiate enforcement action, place the facility on moratorium, and/or enter into a Special Order by Consent (SOC) to ensure compliance. An SOC is a legal commitment entered into by the state and the discharger that establishes a time schedule for bringing the wastewater treatment plant back into compliance. During this time period, interim waste limits may be assigned to the facility until the improvements can be made.

In addition to the DMR data, illegal or improperly treated discharges may be identified in other ways including through third party reports, routine DEM site inspections, and water quality monitoring conducted by DEM staff.

5.2.5 Aquatic Toxicity Testing

There are literally thousands of chemicals or compounds in use today which may enter wastewater systems and eventually be discharged to surface waters. Monitoring the concentration of each of these chemicals individually would be impossible due both to cost/time considerations as well as the inability of current analytical technique to detect many of them. Even if the existence and potential effects of every constituent of a wastewater were known, the combined effects of these constituents could not be predicted.

North Carolina utilizes an integrated approach to address this problem which relies on chemical specific monitoring, assessment of resident aquatic populations, and analysis of whole effluent toxicity (WET) to control the potential effects of these chemicals and their interactions. Whole effluent toxicity limits allow protection against predicted impacts of toxicants through measurement of those impacts in the laboratory. It is from this same foundation of aquatic toxicity laboratory tests that chemical specific limits and criteria are derived for the majority of chemical toxicants.

Whole effluent toxicity limitations were implemented by North Carolina in February, 1987 through a policy to incorporate these limits in all major and complex minor permits. As of August 1992, there were 530 permitted NPDES discharges in North Carolina required to perform whole effluent toxicity monitoring, and over 9,000 individual toxicity analyses had been performed across the state. These limitations are developed to protect aquatic life from the discharge of toxic substances in toxic amounts as prescribed by 15 NCAC 2B. 0208 (i.e. so as not to result in chronic toxicity at permitted discharge flow and 7Q10 receiving flow volumes). Since the inception of the aquatic toxicity program a shift in observed WET has been seen from a time when approximately 25% of the facilities tested would be predicted to have been acutely toxic instream to a point now where less than 10% would be considered chronically toxic.

Aquatic toxicity testing, no less than any other complex analytical technique, requires a great deal of quality assurance and quality control to achieve reliable results. In 1988, North Carolina adopted regulations that initiated a program which required all laboratories performing NPDES analyses in North Carolina to be certified by the state as a biological laboratory. As of August, 1992, 21 commercial, municipal, and industrial laboratories had achieved this certification in either aquatic toxicity analyses and/or aquatic population survey. The NC Biological Laboratory Certification Program, much like WET permitting in North Carolina, is looked at as a national leader in its field.

5.2.6 Pretreatment Program

The goal of the pretreatment program is to protect municipal wastewater treatment plants, or publicly-owned treatment works (POTWs), and the environment from the adverse impacts that may occur when hazardous or toxic wastes are discharged into a public sewage system. The pretreatment program is designed to achieve this protection primarily by regulating non-domestic (e.g. industrial) users of POTWs that discharge toxic wastes under the Domestic Sewage Exclusion of the Resource Conservation and Recovery Act (RCRA). In essence, the program requires that businesses and other entities that use or produce toxic wastes pretreat their wastes prior to discharging their wastewater into the sewage collection system of POTW. State-approved pretreatment programs are typically administered by local governments that operate POTWs.

There are four major areas of concern addressed through implementation of a local pretreatment program: 1) interference with POTW operations, 2) pass-through of pollutants to a receiving stream, 3) municipal sludge contamination, and 4) exposure of workers to chemical hazards. Interference may involve any aspect of plant operation from physical obstruction to inhibition of biological activity. The process for developing technically based local pretreatment limits involves determining the maximum amount of each pollutant that can be accepted at the influent, or headworks, of the POTW and still protect the receiving water, the POTW itself, and the POTW's sludge disposal options.

5.2.7 Operator Certification and Training Program

Water pollution control systems must be operated by state-certified operators. These systems include: wastewater treatment plants, wastewater collection systems and "non-discharge" ground absorption systems, such as alternative on-site disposal technologies and spray irrigation facilities. Systems are classified based on system type and complexity and are required to have an appropriately trained and certified operator. The Certification Commission currently certifies operators in four grades of wastewater treatment, four grades of collection system operation, one grade of subsurface operation, and a variety of specialized conditional exams for other technologies. Training and certification programs are also being developed for land application of residuals and groundwater remediation.

Training is accomplished in cooperation with the state university and community college system as well as through the professional associations for operators and pollution control professionals. Specialty courses and seminars for operators are also offered by operators' associations and the NC Water Pollution Control Association/American Water Works Association (WPCA/AWWA).

Training and certification of operators is essential to the proper operation and maintenance of pollution control systems. Without proper operation and maintenance, even the most highly designed treatment system will not function efficiently. It is the goal of the Training and Certification Program to provide competent and conscientious professionals that will provide the best wastewater treatment and protect the environment and the public health.

5.2.8 Nondischarge and Regionalized Wastewater Treatment Alternatives

As discussed in section 5.2.2, discharge permit applicants are required to consider other forms or alternatives of wastewater treatment other than discharging into a stream. For some, there may be no other economically feasible alternatives. However, for others, particularly smaller dischargers, there are a number of potentially cost-effective and environmentally sound alternatives. There are several types of non-discharging wastewater treatment systems including spray irrigation, rapid infiltration, trickling systems and underground injection. Artificial wetlands wastewater systems are also being evaluated in this state. Permit requirements for nondischarging systems are presented in Administrative Code Section 15 NCAC 2H .0200 - Waste Not Discharged to Surface Waters.

Another alternative to a surface water discharge is to tie into an existing wastewater treatment system. Where possible, DEM is encouraging smaller dischargers to connect to large established municipal systems. Regionalization, as this is called, has several advantages. First, large municipal facilities, unlike smaller package type plants, are manned most of the time thereby reducing the potential for plant malfunctions, and where malfunctions do occur, they can be caught and remedied more quickly. Second, these larger facilities can provide a higher level of treatment more economically and more consistently than can smaller plants. Third, the larger plants are monitored daily. And fourth, centralizing the discharges reduces the number of streams receiving effluent. In evaluating future permit expansion requests by regional facilities, DEM will take into consideration the amount of flow accepted by them from the smaller discharges.

In addition to the nondischarging wastewater treatment systems mentioned above, nondischarge permits are also issued for the land application of residual solids (sludge) from wastewater treatment processes.

5.3 NONPOINT SOURCE CONTROL PROGRAMS

Land use control as well as technology-based best management practices (BMPs) are the two most widely used tools for controlling nonpoint source pollution and protecting designated uses of waterbodies. In developing areas, land use control through low density development has often been selected by municipalities as the preferred method of treatment for urban stormwater because it avoids potential problems with long-term BMP maintenance requirements. In situations where low density development is not feasible or where higher densities are preferred, stormwater control devices (BMPs) are available. These include, but are not limited to stormwater retention and wet detention ponds, vegetated buffer strips along streams, and designated infiltration areas.

Nonpoint source strategies for other categories of pollution (e.g., agriculture, construction, or mining) depend more on the installation of BMPs and waste reduction/management systems. The installation of these BMPs and management systems may be voluntary or required by a set of regulations, depending on the designated management agency. Examples of nonpoint source management approaches that combine land use controls and BMPs include the coastal stormwater regulations and the Water Supply Watershed Protection Program rules. Lists of BMPs for agriculture, mining, forestry, sediment control, urban development, solid waste management and onsite wastewater treatment systems are presented in Appendix VI.

Once a management strategy is developed for each category of nonpoint source pollution, a schedule can be developed for implementing these strategies for specific geographic areas and waterbodies. Management strategies are developed for both highly valued resource waters where a potential for degradation exists and for areas already impacted by nonpoint source pollution.

Regulations or programs are in place at the local, state and federal level, which address most categories of nonpoint source pollution (Table 5.1). For example, discharges are not allowed into state waters without a discharge permit from DEM. This includes discharges from septic systems and animal operations. In addition, water quality standards apply to all categories of land-use activities. In the case of the turbidity standard, it is assumed that the standard will be met if proper BMPs are in place, as determined by the appropriate lead nonpoint source agency.

It is important to note that these programs do not purport to be 100% effective in controlling all sources of nonpoint source pollution. If that were the case, of course, then there would be few, if any, impaired waters in the state. Effectiveness of each program relies on a number of factors including, but not limited to, skill in the design and implementation of the BMPs, proper maintenance, staff limitations on review and enforcement, public education and funding availability for BMP implementation. Further information on the effectiveness of *state* water quality protection programs can be found in a document entitled Evaluation of State Environmental Management and Resource Protection Programs in the Albemarle-Pamlico Region (Nichols et. al., 1990).

After acceptable BMPs are established and geographic areas or waterbodies are targeted for implementation, steps must then be taken to assure that the chosen management strategies and BMPs are protecting water quality. DEM utilizes both chemical and biological sampling procedures to test the effectiveness of BMPs.

In general, the goals of the nonpoint source management program include the following:

1) Continue to build and improve existing programs,
2) Develop new programs that control nonpoint sources of pollution not addressed by existing programs,
3) Continue to target geographic areas and waterbodies for protection,
4) Integrate the NPS Program with other state programs and management studies (e.g. Albemarle-Pamlico Estuarine Study), and
5) Monitor the effectiveness of BMPs and management strategies, both for surface and groundwater quality.

North Carolina has a variety of statewide programs which are used in the Tar-Pamlico River Basin and statewide to address nonpoint source pollution. Table 5.1 lists these programs by categories based on the type of activity. Below is a brief overview of existing nonpoint source control programs for various categories of land use activities.

5.3.1 Agricultural Nonpoint Source (NPS) Control Programs

Agricultural BMPs have been developed largely to control the five major agriculturally-related causes of pollution: sediment, nutrients, pesticides, oxygen-demanding substances and bacteria. BMPs vary from site to site and are dependent upon a particular pollutant but include practices such as grassed waterways and vegetated buffers, nondischarging animal waste lagoons, integrated crop and pest management and soil testing. BMPs may be administered through one or more of the agricultural programs described below.

Table 5.1 Examples of Nonpoint Source Programs

PROGRAM	MANAGEMENT AGENCIES LOCAL	STATE	FEDERAL
AGRICULTURE			
Agriculture Cost Share Program	SWCD	SWCC, DSW	
N.C. Pesticide Law of 1971		NCDA	
Pesticide Disposal Program		NCDA	
Animal Waste Management	SWCD	DEM, DSW, CES	NRCS
Laboratory Testing Services		NCDA	
Watershed Protection (PL-566)			NRCS
1985 and 1990 Farm Bills			USDA
- Conservation Reserve Program			"
- Conservation Compliance			"
- Sodbuster			"
- Swampbuster			"
- Conservation Easement			"
- Wetland Reserve			"
- Water Quality Incentive Program			"
URBAN			
Water Supply Watershed Protection Program	city, county	DEM	
Coastal Stormwater Program		DEM	
ORW, HQW, NSW Management Strategies		DEM	
Stormwater Control Program	city, county	DEM	EPA
CONSTRUCTION			
Sedimentation and Erosion Control	ordinance	DLR, DOT	
Coastal Area Management Act	ordinance	DCM	
Coastal Stormwater Program		DEM	
ON-SITE WASTEWATER DISPOSAL Sanitary Sewage Systems Program	county	DEH	
SOLID WASTE DISPOSAL			
Resource Conservation and Recovery Act			EPA
Solid Waste Management Act of 1989	city, county	DSWM	
FORESTRY			
Forest Practice Guidelines		DFR	
National Forest Management Act			NFS
Forest Stewardship Program		DFR	
MINING Mining Act of 1971		DLR	
HYDROLOGIC MODIFICATION			
Clean Water Act (Section 404)		DCM, DEM	COE
Rivers and Harbors Act of 1899			COE
Dam Safety Permit		DLR	
WETLANDS			
Clean Water Act (Sections 401 and 404)		DEM	COE
Wetland Reserve Program			USDA

(ABBREVIATIONS: **COE**, US Army Corps of Engineers; **DCM**, Div. of Coastal Mgmt.; **DEM**, Div. of Environ. Mgmt.; **DLR**, Div. of Land Resources; **DFR**, Div. of Forest Resources; **DOT**, Dept. of Transportation; **DSW**, Division of Soil and Water; **DSWM**, Div. of Solid Waste Mgmt.; **NCDA**, NC Dept. of Agric.; **NRCS**, Natural Resource Conservation Service; **SWCC**, Soil and Water Conservation Commission; **SWCD**, Soil and Water Conserv. District; **USDA**, US Dept. of Agric.)

- **North Carolina Agriculture Cost Share Program**
  In 1984, the North Carolina General Assembly budgeted approximately $2 million to assist landowners in 16 counties within the "Nutrient Sensitive Water" (NSW) watersheds including the Upper Neuse River (Falls Lake) to implement BMPs for agricultural and silvicultural activities. These funds were increased in May 1987 to include 17 additional coastal counties by the passage of a General Statute formally creating the *Agriculture Cost Share Program for Nonpoint Source Pollution Control (NCACSP)*. In 1989 the NCACSP became a statewide program. The NCACSP will pay a farmer 75 percent of the average cost of implementing approved BMPs and offer technical assistance to the landowners or users which would provide the greatest benefit for water quality protection. The primary purpose of this voluntary program is water quality protection.

  The local Soil and Water Conservation District Boards under the administration of the North Carolina Soil and Water Conservation Commission (SWCC) are responsible for identifying treatment areas, allocating resources, signing contractual agreements with landowners, providing technical assistance for the planning and implementation of BMPs and generally encouraging the use of appropriate BMPs to protect water quality. The criteria for allocating funds to the District is "based on the identified level of agricultural related nonpoint source pollution problems and the respective District's BMP installation goals and available technical services as demonstrated in the Districts annual strategy plan" (NC Administrative Code, Title 15, Chapter 6, Section 6E). This local participation is crucial to the success of the program.

  The DEHNR-Division of Soil and Water Conservation (DSWC) provides staff, administrative and technical support to the SWCC. The DSWC also coordinates the efforts of various associated Program committees and acts as the clearinghouse for District strategy plans, contracts, etc. A legislated Technical Review Committee meets quarterly "to review the progress of the Program" (G.S. 143-215.74B) and to make technical recommendations to the Commission.

  Technical assistance for the implementation of approved BMPs is provided to the Districts through a 50:50 cost share provision for technical positions to be filled at the District level. The USDA-Natural Resource Conservation Service also provides technical assistance.

  The current annual statewide budget to cost share BMPs (75% - NCACSP / 25% landowner) with landowners is approximately $ 6.7 million. The budget to share the cost of providing technical assistance with Districts is approximately $ 1.3 million. Additional support for administration and staff is provided by local governments. In Tar-Pamlico River Basin districts, approximately $4.5 million in BMP cost share dollars have been spent (see section 6.4.3 in Chapter 6) on BMPs applied to 131,128 acres of land. There is also federal assistance through ASCS for BMP implementation.

- **North Carolina Pesticide Law of 1971**
  In 1971 the General Assembly created and authorized the North Carolina Pesticide Board to regulate the use, application, sale, disposal and registration of pesticides for the protection of the health, safety, and welfare of the people and for the promotion of a healthy and safe environment. Some of the responsibilities of the Pesticide Board and the North Carolina Department of Agriculture include registering all pesticides prior to distribution and sale in N.C., sampling pesticides to insure that all products are up to guaranteed analysis and unadulterated by any other pesticide, sampling pesticides at time of application to insure that the applicator is following label instructions. certifying the competency of applicators and dealers of restricted use pesticides.

The Pesticide Section of the North Carolina Department of Agriculture conducts mandatory annual inspections of all aircraft used in pesticide application and conducts random inspections of ground application equipment and chemigation (application of pesticides through irrigation systems) systems. These inspections are intended to encourage proper calibration and use of equipment in order to avoid excessive application rates and accidental spills from faulty systems. Stop use orders are issued for noncompliance with the regulations.

Inspections are also required for bulk storage tanks prior to filling. All commercial pesticide storage facilities are required to have an approved Pre-fire Plan. In addition, each large commercial storage facility is required to develop and maintain an Emergency Contingency Plan. This plan describes the actions facility personnel shall take to respond to fires, explosions, spills, or any other sudden or gradual release of pesticides or pesticide contaminated materials to air, soil, or surface waters. The Contingency Plan is designed to minimize hazards to human health and the environment.

Penalties are assessed to careless pesticide applicators. Enforcement of the law is based on where the pesticide is deposited rather than just where it is applied. For example, if a pesticide is found in a stream as a result of wind drift, the applicator is subject to legal action. The Raleigh Office staff of the NCDA Pesticide Section is comprised of 20 employees. There are 10 Inspectors who conduct field-level compliance monitoring and investigation services. The annual budget for pesticide control and analytical work is $1.4 million.

- **NCDA Pesticide Disposal Program**
  In 1976, the North Carolina Pesticide Board adopted regulations governing the disposal of pesticides. These regulations make it illegal in North Carolina to dispose of hazardous waste (which includes certain pesticides) in sanitary landfills. While households and farms which generate less than 220 lbs of hazardous waste and less than 2 lbs of acutely hazardous waste are exempt from federal disposal requirements, the regulations prohibiting the disposal of these wastes in sanitary landfills still applies to them. The option to use commercial hazardous waste disposal companies is too expensive and most companies will not pickup small quantities. As a result of this dilemma, the NCDA created the Pesticide Disposal Program in 1980 through appropriations from the General Assembly.

  The goal of the Program is to provide an available, affordable and environmentally acceptable mechanism in which any homeowner, farmer, or institution can dispose of unwanted or unusable pesticides. It is mandatory, however, that all pesticide products are labeled correctly before NCDA will pick them up. An EPA permitted hazardous waste treatment or disposal facility (TSD) requires proper identification before the products can be disposed.

  The Food and Drug Division of the North Carolina Department of Agriculture administers the Pesticide Disposal Program. The same staff used for enforcing the North Carolina Pesticide Law of 1971 are used in the Disposal Program.

- **Animal Waste Management Regulations**
  On December 10, 1992, the Environmental Management Commission adopted a rule modification (15A NCAC 2H .0217) to establish procedures for properly managing and reusing animal wastes from intensive livestock operations. The goal of the rule is for intensive animal operations to operate so that animal waste is not discharged to waters of the state. This means that if criteria are met and no waste is discharged to surface waters, then an individual permit from DEM is not required. The rule applies to new, expanding or existing feedlots with animal waste management systems designed to serve more than or

equal to the following animal populations: 100 head of cattle, 75 horses, 250 swine, 1,000 sheep or 30,000 birds with a liquid waste system. These operations are deemed permitted if a signed registration and an approved waste management plan certification are submitted to DEM by the appropriate deadlines.

The deadline for submittal of registrations to DEM for existing facilities is December 31, 1993. Facility plans must be certified by a technical specialist designated by the Soil and Water Conservation Commission and submitted to DEM by December 31, 1997. The standards and specifications of the USDA Natural Resource Conservation Service are the minimum criteria used for plan approval by the local Soil and Water Conservation Districts.

In the past, DEM inspected intensive animal operations mostly in response to third party complaints. However, with the passage of the above rules, the increasing numbers of these operations and their potential impact on water quality, DEM will be making more routine inspections to make sure that their waste management systems are adequate and are being operated properly. Animal waste management systems that are determined to have an adverse impact on water quality may be required to obtain an approved animal waste management plan or to apply for and receive either an individual nondischarge permit.

An illegally discharging operation may also be designated as a concentrated animal feeding operation (CAFO) and an NPDES discharge permit could be required.

- **NC Cooperative Extension Service and Agricultural Research Service**
  Crop and animal production programs are administered under the research and education activities of the N.C. Agricultural Research Service (ARS) and the N.C. Cooperative Extension Service (CES). The research and education efforts are broad and include areas such as variety development, crop fertilizer requirements, soil testing, integrated pest management, animal housing, animal waste management, machinery development and irrigation. Guidelines for most agricultural enterprises have been developed and made available to farmers. A more intensified water quality emphasis is being incorporated in these area and many other projects undertaken by ARS and CES. The local contact that county CES agents have with farmers and homeowners provides an excellent opportunity for dialogue and education in nonpoint source pollution control. This network of contacts can be used to inform people about BMPs and to provide some structure for a general NPS education program.

  The N.C. Agricultural Research Service and the N.C. Cooperative Extension Service conduct broad research and education efforts that include areas such as variety development, crop fertilizer requirements, soil testing, integrated pest management, animal housing, animal waste management, machinery development, and irrigation. County Cooperative Extension agents work closely with farmers and homeowners, providing an excellent opportunity for dialogue and education in nonpoint source pollution control.

- **Soil, Plant Tissue, and Animal Waste Testing Program**
  These services provide farmers with information necessary to improve crop production efficiency, to manage the soil properly and to protect environmental quality. The Soil, Plant Tissue and Animal Waste Testing Program is administered by the Agronomic Division of the North Carolina Department of Agriculture. Water and wastewater from lagoons is also tested for irrigation and fertilizer use.

- **Watershed Protection and Flood Prevention Program (PL 83-566)**
  The purpose of the Watershed Protection and Flood Prevention Program is to provide technical and financial assistance in planning, designing, and installing improvement projects for protection and development of small watersheds. The Program is administered

by the USDA-Natural Resource Conservation Service in cooperation with the N.C. Division of Soil and Water Conservation, the State Soil and Water Conservation Commission, the U.S. Forest Service, Soil and Water Conservation Districts, and other project sponsors.

The emphasis of the Program over the past three decades has been to provide flood control. However, legislation has shifted emphasis of PL-566 land treatment projects so that a project proposal must demonstrate off-site water quality benefits in order to have any chance of funding. In the Tar-Pamlico River Basin, there are a number of land treatment projects underway with more in the planning stages.

- **Food Security Act of 1985 (FSA) and the Food, Agriculture, Conservation and Trade Act of 1990 (FACTA)**
There are several provisions authorized by the federal Food Security Act of 1985 (FSA) and re-authorized by the Food, Agriculture, Conservation, and Trade Act of 1990 (FACTA) which offer excellent opportunities for the abatement of agricultural nonpoint source pollution. The FSA and FACTA make the goals of the USDA farm and conservation programs more consistent by encouraging the reduction of soil erosion and production of surplus commodities and the retention of wetlands. At the same time, the provisions can serve as tools to remove from production those areas which critically degrade water quality by contributing to sedimentation. Important water quality-related provisions are known as the Conservation Reserve, Conservation Compliance, Sodbuster, Swampbuster, and Conservation Easement, Wetland Reserve, and Water Quality Incentive Program. These provisions are administered by the USDA.

Conservation Reserve Program
The Conservation Reserve Program (CRP) is administered by the USDA Agricultural Stabilization and Conservation Service (ASCS) and the USDA Natural Resource Conservation Service (SCS). Other cooperating agencies include the NC CES, NC Division of Forest Resources and local Soil and Water Conservation Districts. The CRP was established to encourage removing highly erodible land from crop production and to promote planting long-term permanent grasses and tree cover. The ASCS will share up to half of the cost of establishing this protective cover. The intention of the program is to protect the long term ability of the US to produce food and fiber by reducing soil erosion, improving water quality and improving habitat for fish and wildlife. Additional objectives are to curb the production of surplus commodities and to provide farmers with income supports through rental payments over a 10 year contract period for land entered under the CRP.

Conservation Compliance
The Conservation Compliance provision of the FSA and FACTA discourages the production of crops on highly erodible cropland where the land is not carefully protected from erosion. Highly erodible land is defined as land where the potential erosion (erodibility index) is equal to eight times or greater than the rate at which the soil can maintain continued productivity. This rate is determined by the Natural Resource Conservation Service.

A farmer had until January 1, 1990 to develop and begin applying a conservation plan on highly erodible land. The plan must be operational by January 1, 1995. If a conservation plan is not developed and implemented, the farmer loses eligibility in price and income supports, crop insurance, FHA loans, Commodity Credit Corporation storage payments, farm storage facility loans, Conservation Reserve Program annual payments, and other programs under which USDA makes commodity-related payments. In other words, Conservation Compliance is an economic disincentive, quasi-regulatory program.

Sodbuster
The Sodbuster provision of the FSA and FACTA is aimed at discouraging the conversion of highly erodible land for agricultural production. It applies to highly erodible land that was not planted in annually tilled crops during the period 1981-85. As with the other provisions of the FSA, the Natural Resource Conservation Service determines if a field is highly erodible. If a highly erodible field is planted in an agricultural commodity without an approved conservation system, the landowner (or farmer) becomes ineligible for certain USDA program benefits.

Swampbuster
The purpose of Swampbuster is to discourage the conversion of wetlands to cropland use. Wetlands are defined as areas that have a predominance of hydric soils that are inundated or saturated by surface water or groundwater at a frequency or duration sufficient to support a prevalence of hydrophytic (water loving) vegetation. It is the responsibility of the Natural Resource Conservation Service to determine if an area is a wetland. Like the other provisions of the FSA and FACTA, a farmer will lose eligibility for certain USDA program benefits on all the land which is farmed if a wetland area is converted to cropland.

Conservation Easement
The Conservation Easement provision encourages producers whose FHA loans are in or near default to place their wetland, highly erodible land, and fragile land in conservation, recreation, or wildlife uses for periods of at least 50 years. The producer benefits by having the FHA loan partially canceled. The environment benefits by reducing the level of soil disturbing activities and the threat of agricultural pollutants.

Wetland Reserve
FACTA established a voluntary program for farmers to grant the federal government a 30-year or perpetual easement to wetlands. Eligible land includes farmed or converted wetlands which could be restored to their highest wetland function and value. The goal is to enroll one million acres by the end of 1995. The Wetland Reserve program is funded annually and the long term availability of this opportunity is unknown.

Water Quality Incentive Program
FACTA established this cost sharing program to help farmers control pollution problems associated with agricultural activities. A producer could receive up to $3,500 in cost share assistance to implement approved BMPs. The goal is to enroll 10 million acres by 1995.

5.3.2 NPS Programs for Urban and Developed Lands

- **Federal Urban Stormwater Discharge Program / NC NPDES Stormwater Program**

In 1987, Congress passed the Water Quality Act Amendments to the Clean Water Act requiring the U.S. Environmental Protection Agency (EPA) to develop regulations on permit application requirements for stormwater discharges associated with industrial activities as well as those associated with large and medium municipal separate storm sewer systems (population greater than 100,000). These regulations became effective in December 1990.

The goal of the stormwater discharge permitting regulations in North Carolina is to prevent pollution of the stormwater runoff by controlling the source(s) of pollutants. Defining the potential pollutant sources and establishing controls of the sources that will reduce and minimize pollutant availability will result in an improvement to the water quality of the receiving streams, consistent with the overall goal of the water quality program.

Authority to administer these regulations has been delegated to the North Carolina Division of Environmental Management (DEM). The NPDES stormwater regulations require that facilities with stormwater point source discharges associated with industrial activity and municipalities defined as either large or medium municipal separate storm sewer systems be permitted.

The municipal permitting requirements are designed to lead to the formation of site-specific stormwater management programs for a municipal area Therefore, the permits issued to municipalities for their municipal separate storm sewer systems will be explicitly written for each individual municipality. Municipal permits of this type in North Carolina are currently required for Charlotte, Durham, Greensboro, Raleigh, Winston-Salem and Fayetteville/Cumberland County. The municipalities will develop and implement comprehensive stormwater quality management programs to reduce the discharge of pollutants in stormwater to the maximum extent practicable (MEP). MEP will be defined separately for each municipality required to be permitted. Industrial facilities discharging through a municipal separate storm sewer system are required to submit a permit application to the state and receive their own NPDES stormwater permit.

Industrial activities which require permitting are defined in eleven categories in the federal regulations ranging from sawmills and landfills to phosphate manufacturing plants and hazardous waste treatment, storage or disposal facilities. The regulations cover point source discharges that are related to manufacturing, processing, or material storage areas at an industrial facility. Stormwater discharges associated with industrial activities are required to be covered by permits which contain technology based controls based on Best Available Technology (BAT)/Best Conventional Pollutant Control Technology (BCT) considerations or water quality controls, if necessary. Through monitoring and regulating stormwater discharge quality, the goal of the NPDES stormwater program is to reduce the pollutant load in stormwater runoff. In North Carolina, the stormwater regulations affect more than 16,000 industrial facilities. Of the 16,000, it is projected that six to ten thousand will require permitting.

The permitting requirements described here represent Phase I of the stormwater program. EPA and Congress are currently involved in studies to determine the scope of additional stormwater coverage under Phase II of the stormwater program. Further stormwater NPDES coverage could include additional industrial activities or additional municipal areas. If additional areas of coverage are added under the federal stormwater programs, DEM will be responsible for the appropriate permitting of these areas within North Carolina.

- **Water Supply Protection Program**
  Approximately 50 percent of North Carolina's population depends on surface water supplies for drinking, commercial, and industrial uses. Water supplies have become more important in recent years because of increased demand for water, concern over potential contamination by toxic substances, and protection of human health. As a result, the General Assembly passed the Water Supply Watershed Protection Act of 1989 (House Bill 156). This Act requires all local governments that have land-use jurisdiction within surface water supply watersheds, or a portion thereof, to be responsible for implementation and enforcement of nonpoint source management requirements related to urban development according to minimum standards adopted by the state. NPS control strategies are included in the rules for urban, agricultural, silvicultural, and Department of Transportation activities. The Water Supply Watershed Protection Rules were adopted by the Environmental Management Commission on February 13, 1992.

The purpose of the Water Supply Protection Program is to provide an opportunity for communities to work with the state to provide enhanced protection for their water supply from pollution sources. There are five water supply classes that are defined according to the amount and types of permitted point source discharges, as well as a requirement to control nonpoint sources of pollution. By classifying a watershed as a water supply watershed, a local government and adjacent jurisdictions within the watershed will take steps to control nonpoint sources of pollution at their sources and thereby reduce the potential of pollutants contaminating their drinking water supply. In turn, the state limits the point source discharges that can locate within the watershed and thereby reduces the potential of contamination of the water supply.

This dual approach of state and local government action to preclude potential impacts from stormwater runoff and wastewater discharges is important since only a small fraction of the possible pollutants have water quality standards. As more is learned about the types and effects of pollutants in our drinking waters, the state will proceed to adopt additional water quality standards. One of the effects this would have is that water treatment facilities will be required to remove these pollutants. This could require additional technology and possibly more expensive treatment facilities or operation to ensure safe drinking water. It is therefore very important for the state and local governments to consider the important alternative of preventing pollution from entering their drinking water supplies.

The General Assembly extended the deadline for completing reclassification of existing surface water supply waters to July 1, 1992 in House Bill 873. The bill also established a schedule for local governments' submittal of water supply protection ordinances as follows:

1) July 1, 1993 for municipalities with populations of 5,000 or more,
2) October 1, 1993 for municipalities with smaller populations, and
3) January 1, 1994 for counties.

The Water Supply Protection Program is administered by staff in the Planning Branch of the Water Quality Section in NCDEM. These staff coordinate with the Division of Community Assistance (NCDOC) who helps local governments develop land-use ordinances, the Division of Environmental Health, NCDEHNR who certifies that a proposed reclassification is suitable for a drinking water supply, and NCDEM staff in NCDEHNR regional offices who are responsible for water quality sampling in the proposed water supply. Implementation of the act and adoption of the rules has entailed developing a new set of water supply surface water classifications: WS-I to WS-V. Watersheds draining to waters classified WS carry some restrictions on point source discharges and on many land use activities including urban development, agriculture, forestry and highway sediment control. See Appendix I for a summary of land use and density controls for the five WS water quality classifications.

- **NC Coastal Stormwater Management Regulations**
  In November 1986, the EMC adopted rules which required new development in a limited zone (575 feet) around Class SA (shellfish) waters to control stormwater either by limiting density or completely controlling a 4.5 inch, 24-hour storm with the use of a stormwater treatment system. The regulations applied to development activities which required either a CAMA major permit or a Sediment/Erosion Control Plan (generally development disturbing more than one acre). The design storm, low density limits, and areal coverage were all quite controversial and the adopted rules represented a compromise by all parties. A sunset provision was added to the rules to force the staff and Commission to reconsider the rules after a year. These rules expired December 31, 1987, but new stormwater regulations were adopted having an effective date of January 1, 1988. These regulations are administered by the Water Quality Section in DEM. Approximately five man-years are allocated to implementing this program. Planning Branch staff are responsible for

providing guidance and interpretation to promote consistent implementation of the rules. DEM regional staff review and approve plans and enforce the requirements of the regulations.

Perhaps the most important measure accomplished with the regulations has been the applicability of stormwater controls to development activities within the 20 CAMA coastal counties. Certainly the near-water impact of stormwater as addressed in the original rules is important, but the staff believed the cumulative impact of stormwater runoff throughout the coastal zone also needed to be addressed. Therefore, the expanded area of coverage helps provide better protection of both shellfish waters and coastal water quality in general.

Other major items specified in the rules address the sizing of stormwater treatment systems. For developments adjacent to SA waters, infiltration systems must be able to retain 1.5 inches of rainfall, whereas development in other areas must control one inch of rainfall. Wet detention ponds are not allowed for stormwater control near SA waters and must be sized for 85 percent TSS removal in other areas. In addition, porous pavement is considered an innovative infiltration system (only five are allowed until they are proven to work) as evidence has not been provided regarding its effectiveness in coastal areas. A low density option of the new regulations applies a built-upon limit of 25 percent for SA areas and 30 percent for other coastal areas rather than a limit on effective impervious cover. Development exceeding these levels is required to have a engineered stormwater system as indicated.

In summary, the regulations which have an expanded areal coverage increases the annual number of projects affected from approximately 50 (original rules) to 500. This increase is coincident with a reduction in design storm that is comparable to requirements in other states. In addition, the low density option, retained from the original regulations, is encouraged as operation and maintenance concerns associated with stormwater controls are not applicable.

- **Coastal Nonpoint Pollution Control Programs**
  As part of the Coastal Zone Act Reauthorization Amendments of 1990, Congress enacted a new section 6217 entitled "Protecting Coastal Waters". This provision requires states with coastal zone management programs (which includes North Carolina) that have received Federal approval under section 306 of the Coastal Zone Management Act (CZMA) to develop and implement Coastal Nonpoint Pollution Control Programs. The coastal nonpoint programs will provide additional control for sources of nonpoint pollution that impair coastal water quality. Sources subject to the 6217 Coastal NPS Program include: agriculture, forestry operations, urban and developing areas, marinas, hydromodification projects, and wetlands and riparian areas.

  Section 6217 requires coastal states to submit their coastal nonpoint control programs to the National Oceanic and Atmospheric Administration (NOAA) and the U.S. EPA for approval by July 1995. The programs are to be implemented by January, 1999. Failure to submit an approvable program by July 1995 will result in a state losing substantial portions of its Federal funding under section 306 of the CZMA and section 319 of the Clean Water Act. The coastal nonpoint program will be developed and administered jointly by the NC Division of Coastal Management and DEM.

- **ORW and HQW Stream Classifications**
  Outstanding Resource Waters (ORW) and High Quality Waters (HQW) have management strategies that address handling of urban stormwater. Controls for urban stormwater, either through development density limitations or stormwater treatment systems, are required by DEM. Some of these controls are outlined in Appendix I. Other NPS

management agencies are expected to place priority on protecting these waters as well. For example, the NC Department of Transportation and the NC Division of Land Resources require more stringent sediment control on construction sites in ORW and HQW areas.

5.3.3 Construction - Sedimentation and Erosion Control NPS Program

In 1973, the North Carolina General Assembly enacted the Sedimentation Pollution Control Act. The Act authorized the establishment of a sediment control program to prevent accelerated erosion and off-site sedimentation caused by land-disturbing activities other than agriculture, forestry, and mining. The Land Quality Section of the Division of Land Resources is responsible for administration and enforcement of the requirements of the Act under the authority of the N.C. Sedimentation Control Commission.

The sediment control program requires, prior to construction, the submission and approval of erosion control plans on all projects disturbing one or more acres. On-site inspections are conducted to determine compliance with the plan and to evaluate the effectiveness of the BMPs which are used. The intent is to offer permanent downstream protection for stream banks and channels from damages caused by increased runoff velocities. If voluntary compliance with the approved plan is not achieved and violations occur, the Land Quality Section will pursue enforcement through civil penalties and injunctive relief. House Bill 448, passed in 1991, authorized the issuance of stop-work orders for violations of the SPCA. This additional enforcement mechanism will help improve the overall performance of the program.

There are a three local municipal and county erosion and sedimentation control programs in the Tar-Pamlico River Basin. They include Greenville, Pitt County and Rocky Mount. These local programs are reviewed annually for compliance with the requirements of the Sedimentation Pollution Control Act. The Land Quality Section also conducts educational programs directed toward state and local government officials in order to strengthen the local programs. Persons engaged in land-disturbing activities and interested citizen groups are included in the educational effort.

The Sedimentation Control Commission has delegated to the Division of Highways of the North Carolina Department of Transportation (DOT) the authority to approve erosion and sedimentation control plans for land-disturbing activity conducted by that agency or by other persons under highway contracts with that agency. The DOT sedimentation control program has been reviewed by the Division of Land Resources under the authority of the Sedimentation Control Commission. DOT is required to incorporate more stringent sedimentation controls as specified in the High Quality Water rules. The N.C. Department of Environment, Health, and Natural Resources (NCDEHNR) has established a position to evaluate environmental aspects of DOT highway projects and programs. DOT, in cooperation with DEM, has developed and adopted formal BMPs for protection of surface waters. These BMPs and other efforts are significant improvements in developing a proactive system at DOT toward environmental issues.

Sedimentation control rules remain in effect for High Quality Waters (HQW). These rules require more stringent erosion control measures for projects draining to HQWs.

5.3.4 On-Site Wastewater Disposal - Sanitary Sewage Systems NPS Program

Septic tank soil absorption systems are the most widely used method of on-site domestic wastewater disposal in North Carolina. More than 52 percent of all housing units in the state are served by septic tank systems or other systems besides public or community sewage systems. A conventional septic system consists of a septic tank, a distribution box or equivalent branching lines, and a series of subsurface absorption lines consisting of tile or perforated pipes laid in a bed of gravel.

All subsurface sanitary sewage systems are under the jurisdiction of the Commission for Health Services (CHS) of the Department of Environment, Health, and Natural Resources. The CHS establishes the rules for on-site sewage systems which are administered by the Division to Environmental Health.

According to GS 130A-335(e) and (f), the rules of the CHS and the rules of the local board of health shall address at least the following: sewage characteristics; design unit; design capacity; design volume; criteria for the design, installation, operation, maintenance, and performance of sanitary sewage collection, treatment, and disposal systems; soil morphology and drainage; topography and landscape position; depth to seasonally high water table, rock, and water impeding formations; proximity to water supply wells, shellfish waters, estuaries, marshes, wetlands, areas subject to frequent flooding, streams, lakes, swamps, and other bodies of surface or groundwaters; density of sanitary sewage collection, treatment, and disposal systems in a geographical area; requirements for issuance, suspension, and revocation of permits; and other factors which affect the effective operation in performance of sanitary sewage collection treatment and disposal systems. The rules also must provide construction requirements, standards for operation, and ownership requirements for each classification of sanitary systems of sewage collection, treatment, and disposal in order to prevent, as far as reasonably possible, any contamination of the land, groundwater, and surface waters. There exists a strict permitting procedure which regulates site selection, system design, and installation of on-site sewage systems. Privately owned subsurface sewage discharging systems are governed by NCDEHNR through local county health departments. Authorized local sanitarians serve as agents of NCDEHNR and assist in implementing the state sewage rules. Local boards of health may adopt by reference the state rules and append to those rules more stringent laws and local criteria which they desire. These amendments, however, must be approved by the state. Only nine counties in the state currently operate under local rules. The 1983 amendments of the state public health laws eliminated the co-mingling of state rules with local rules except by state approval.

5.3.5 Solid Waste Disposal NPS Programs

- **Federal Program**
  The major federal legislation in the area of solid waste management is the Resource Conservation and Recovery Act (RCRA) administered by the U.S. Environmental Protection Agency (EPA). RCRA deals almost entirely with hazardous waste management but it does require that states meet minimum standards for solid waste facilities. EPA does not have permitting authority over solid waste management facilities.

- **State Program**
  States are accorded a major role in solid waste management by RCRA. North Carolina now operates under revisions by the General Assembly to Chapter 130A of the General Statutes. The Division of Solid Waste Management (DSWM) in the Department of Environment Health and Natural Resources (NCDEHNR) is authorized as the single state agency for the management of solid waste. DSWM is responsible for the development of the state's solid waste management plan, has permitting authority over all solid waste management facility siting and operation, inspects permitted facilities, provides technical assistance, investigates complaints, responds to emergencies, monitors ground water quality at facilities, promotes the state's recycling effort, and closes non-conforming sites.

  The Solid Waste Management Act of 1989 established the policies and goals of the state to recycle at least 25 percent of the total waste stream by January 1, 1993. This Act created a Solid Waste Management Trust Fund to promote waste reduction and fund research and demonstration projects to manage solid waste. In 1991, the Solid Waste Management Act of 1989 was amended to broaden the goal to reduce the solid waste stream by 40 percent through source reduction, reuse, recycling, and composting by June 30, 2001.

The state adopted solid waste management rules, effective February 1, 1991, requiring liner, leachate collection, and final cover systems at all new landfills, lateral expansions of existing landfills, and at all active landfills by January 1, 1998. Septage rules and regulations also have been adopted and are administered through a permit program.

- **Local Program**
  Solid waste collection and disposal has long been a municipal function. The operation of solid waste collection and disposal facilities is among the enterprises which municipalities are expressly authorized by statute to operate (G.S. 160A-311 through 160A-321). Municipalities are also authorized to regulate the disposal of solid waste within their corporate limits. Such regulations may specify the location and type of receptacles to be used for collection (G.S. 160A-192).

  Outside municipal limits, counties are authorized to operate solid waste collection and disposal facilities either as a function of county government or through establishment of a special service district (G.S. 153A-292 and 301). Since 1970, county governments have increasingly accepted responsibility for solid waste disposal activities and most disposal facilities in the state are now operated by counties or with county financial assistance.

5.3.6 Forestry NPS Programs

- **Forest Practice Guidelines Related to Water Quality**
  In 1989 the Sedimentation Pollution Control Act (SPCA) was amended to limit the forestry exemption to those operations that adhere to forest practice guidelines. The forestry amendment to the SPCA required the Division of Forest Resources to develop performance standards known as the Forest Practices Guidelines Related to Water Quality.

  Guidelines consist of nine performance standards for activities such as maintaining streamside management zones and applying fertilizer and pesticide applications. These Guidelines are used to determine if a forestry operation will fall under the jurisdiction of the Division of Land Resources which enforces the SPCA. The Guidelines were developed in October 1989 and were put into effect on January 1, 1990. A Memorandum of Agreement was also signed between the Division of Forest Resources and the Division of Land Resources to coordinate their respective activities in the sedimentation control program. DLR has also signed an MOA with DEM.

  Site-disturbing forestry activities are being inspected by local DFR personnel as part of a training, mitigation, and monitoring program. Site inspections are conducted when a problem or potential problem is suspected to exist. Sites not brought into compliance within a reasonable time schedule are referred by DFR to DLR or DEM for appropriate enforcement action.

- **National Forest Management Act (NFMA)**
  The National Forest Management Act was passed in 1976 and applies to all lands owned or administered by the National Forest System. The Act stipulates that land management plans be prepared which consider economic and environmental aspects of forest resources. The Act further states that timber will be harvested from National Forest lands only where soil, slope, or other watershed conditions will not be irreversibly damaged; and where protection is provided for streams, streambanks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperatures, blockages of

watercourses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat.

- **Forest Stewardship Program**
  The Division of Forest Resources initiated the Forest Stewardship Program in 1991 along with the cooperation and support of several other natural resource and conservation agencies. This program encourages landowners with ten or more acres of forestland to become involved and committed to the wise development, protection and use of all natural forest resources they own or control.

5.3.7 Mining NPS Program

In 1971 the North Carolina General Assembly passed the Mining Act to ensure that the usefulness, productivity, and scenic values of all land and waters involved in mining will receive the greatest practical degree of protection and restoration. The Mining Commission is the rule-making body for the Act and has designated authority to administer and enforce the rules and regulations of the Act to the Mining Program within the Land Quality Section of the NCDEHNR Division of Land Resources.

The Mining program has four major areas of responsibility. First, the Program requires submission and approval of a mining permit application prior to initiating land disturbing activity if the mining operation is one (1) or more acres in surface area. The mining permit application must have a reclamation plan for these operations. Second, the Program conducts on-site inspections to determine compliance with the approved application and whether or not the plan is effective in protecting land and water quality. Third, the program pursues enforcement action through civil penalties, injunctive relief, and/or bond forfeiture to gain compliance when voluntary compliance is not achieved. Finally, the Mining Program conducts educational efforts for mine operators.

5.3.8 Wetlands Regulatory NPS Programs

There are numerous reasons for preserving wetlands, but of special interest within the context of basinwide planning is their role in protecting water quality. Because of their intrinsic characteristics and location within the landscape, wetlands function to protect water quality in a number of ways. These functions include the retention and removal of pollutants, stabilization of shorelines, and storage of flood waters.

Numerous authors have studied the effectiveness of riparian wetland forests for nutrient retention and transformation (Jones et al. 1976; Yates and Sheridan 1983; Brinson et al. 1984; Lowrance et al. 1984; Peterjohn and Correll 1984; Jacobs and Gilliam 1985; Budd et al. 1987; and Groffman et al. 1991). The location of riparian wetlands allows them the opportunity to receive nutrients from the surrounding landscape as well as through overbank flooding. In addition to the storage of nutrients in wetland vegetation, the microbial and chemical processes within wetland soils may function to completely remove nutrients from the system.

Headwater riparian wetlands are the most important wetland in terms of sediment and associated nutrient and toxicant retention. Since small stream comprise most of the total stream length within a watershed (Leopold 1974), these areas intercept the greatest proportion of eroded sediments and associated substances from uplands before these pollutant reach waters downstream. Novitzki (1978) found that approximately 80% of the sediments entering a stream were retained in headwater wetlands.

Wetlands adjacent to streams, rivers and lakes stabilize shorelines and help protect these bodies of water from erosive forces. This function is particularly important in urbanized watersheds where the prevalence of impervious surfaces contributes to greater peak storm flows. Wetland vegetation serves to dissipate erosive forces and anchors the shoreline in place preventing sediments and associated pollutants from entering waterways. Wetlands by their very nature of being "wet" are also vital for water storage. Those wetlands adjacent to surface waters, that have the opportunity to receive flood waters and surface runoff, are most important to water storage. Wetlands located in headwaters generally desynchronize peaks in tributaries and main channels, and lakes and wetlands with restricted outlets hold back flood waters and attenuate flood peaks (Carter et al. 1978).

Several important state and federal wetland protection programs are described below. In addition to the following wetlands programs, provisions of the 1985 and 1990 Farm Bills, discussed in Section 5.3.1, should also help reduce wetlands impacts. Agriculture conversions should be reduced by the "swampbuster" provision of the 1985 Farm Bill, which encourages farmers not to convert wetlands for agriculture in order not to lose their USDA subsidies, loans, and price supports. Silviculture is exempted from the swampbuster provision and therefore, conversion of wetlands for intensive or managed forestry will not receive the benefits of this incentive device. A Wetland Reserve Program was established by the 1990 Farm Bill with the goal of allowing one million acres of prior-converted wetlands to revert back to wetlands by 1995.

- **Section 10 of the Rivers and Harbors Act of 1899**
  This act, administered by the US Army Corps of Engineers, provides the basis for regulating dredge and fill activities in navigable waters of the United States. Originally, this Act was administered to protect navigation and the navigation capacity of the nation's waters. In 1968, due to growing environmental concerns, the review of permit applications was changed to include factors other than navigation including fish and wildlife conservation, pollution, aesthetics, ecology, and general public interest. Activities which may be covered under the Act include dredging and filling, piers, dams, dikes, marinas, bulkheads, bank stabilization and others.

- **Section 404 of the Clean Water Act**
  The U.S. Army Corps of Engineers administers a national regulatory program under Section 404 of the Clean Water Act aimed at controlling the discharge of dredged or fill material into waters of the United States. Section 404 applies to just the discharge of dredged or fill materials into waters of the United States and does not apply to dredging activities. Waters of the United States refers to navigable waters, their tributaries, and adjacent wetlands. Activities covered under Section 404 include dams, dikes, marinas, bulkheads, utility and power transmission lines and bank stabilization. Although the 404 program does not fully protect wetlands, it is nonetheless the only federal tool at this time for regulating wetland development statewide. State legislation has not been adopted to protect inland freshwater wetlands in North Carolina, as has been done for coastal wetlands, but DEM is in the process of drafting rules which will formalize the wetlands protection measures associated with the 401 Water Quality Certification review process.

- **Section 401 Water Quality Certification (from CWA)**
  The Division of Environmental Management is responsible for the issuance of 401 Water Quality Certifications (as mandated under Section 401 of the Clean Water Act). A 401 certification is required for the discharge of pollutants into surface waters and wetlands for projects that require a section 404 federal permit. The 401 certification indicates that the discharged pollutant will not violate state water quality standards. A federal permit cannot be issued if a 401 certification is denied. The 401 certification process is coordinated with the 404 and CAMA processes in the 20 counties of CAMA jurisdiction.

- **North Carolina Coastal Area Management Act (CAMA) Of 1974**
  This act is aimed at controlling development pressures in North Carolina's coastal region in order to preserve the region's economic, aesthetic and ecological values. The program,

which applies to 20 coastal counties, is administered by the NC Division of Coastal Management under the oversight of the Coastal Resources Commission (CRC), a 15-member board. Part of the CRC's responsibility is the identification of Areas of Environmental Concern (AEC). These areas are regarded as sensitive and productive coastal lands and waters where uncontrolled development might cause irreversible loss of property, public health, and the natural environment. Four categories of AEC are defined: 1) the estuarine system, 2) the ocean system, 3) public fresh water supplies and 4) natural and cultural resource areas. AECs cover practically all coastal waters and three percent of the land in coastal counties.

Under CAMA, permits are required for projects that may cause damage to Areas of Environmental Concern (AECs). A permit program was established to protect AECs based on standards that guide development. CAMA permits require an obligation to meet the CRC's development guidelines. Permits are revoked if these guidelines are not followed and fines can be levied if the development has harmed the state's coastal resources. A joint permitting process allows a CAMA-permitted project to simultaneously receive a Section 404 permit. The 401 certification process is coordinated with the 404 and CAMA processes in the 20 counties of CAMA jurisdiction. There is a joint application form, joint public notice, and a single place to apply for the required permits.

Any proposed project requiring federal permits or authorization in the 20 coastal counties are reviewed by the Division of Coastal Management for consistency with the Coastal Management Program (as mandated by the U.S. Coastal Zone Management Act of 1972). Generally, major federal permits reviewed for consistency are Section 10 of the Rivers and Harbors Act, Section 404 of the Clean Water Act, and U.S. Coast Guard permits for bridge and causeway construction and modification over navigable waters.

- **North Carolina Dredge and Fill Act (1969)**
  This act requires permits for "excavation or filling begun in any estuarine waters, tidelands, marshlands, or state-owned lake". This law is currently administered with North Carolina's Coastal Area Management Act (CAMA) (1974).

5.3.9 Hydrologic Modification

Hydrologic modification is defined as channelization, dredging, dam construction, flow regulation and modification, bridge construction, removal of riparian vegetation, streambank modification/destabilization, and dam collapse. By its very nature hydrologic modification is closely tied to wetland issues. It is not surprising then that the U.S. Army Corps of Engineers (Corps) is the agency most involved in issuing permits for land-disturbing activities in wetlands. These permits are issued through Section 404 and the Rivers and Harbors Act discussed above.

In addition to wetland issues, dam construction and the lack of low flow releases into streams can severely impact downstream aquatic resources. Dam construction, repair, modification, and removal are regulated by the NC Division of Land Resources under the Dam Safety Law of 1967. A dam safety permit is required for any dam which is 15 feet or greater in height (from top of dam to lowest point on downstream toe) and the impoundment capacity is 10-acre-feet or greater at the top of the dam. Low-flow release requirements to maintain adequate instream flows are established in permits where appropriate. Instream flows are recommended by the NC Division of Water Resources.

There are several other programs which can affect hydrologic modification. The Forest Practice Guidelines Related to Water Quality requires streamside management zones to be maintained during logging operations. The Water Supply Watershed Protection Program also has requirements to maintain buffers for certain activities. The Conservation Reserve Program encourages the establishment of vegetative filter strips (66-99 feet wide) for farming operations. A significant number of local governments have established greenway programs within urban settings in order to maintain and protect riparian areas.

5.4 INTEGRATING POINT AND NONPOINT SOURCE POLLUTION CONTROLS STRATEGIES

Integrating point and nonpoint source pollution controls and determining the amount and location of the remaining assimilative capacity in a basin are key long-term objectives of basinwide management. The information can be used for a number of purposes including determining if and where new or expanded municipal or industrial wastewater treatment facilities can be allowed; setting the recommended treatment level at these facilities; and identifying where point and nonpoint source pollution controls must be implemented to restore capacity and maintain water quality standards.

The U.S. Environmental Protection Agency (USEPA) has developed a means to help accomplish these objectives called *total maximum daily loads (TMDL)*. The TMDL approach, which is being required by the United States Environmental Protection Agency (USEPA) pursuant to Section 303(d) of the Clean Water Act, is based on the concept of determining the total waste (pollutant) loading, from point and nonpoint sources, that a water body (such as a stream, lake or estuary) can assimilate while still maintaining its designated uses.

A TMDL is a strategy for establishing water quality-based controls on point and nonpoint sources of a given pollutant identified as contributing to a waterbody's impairment. In the Tar-Pamlico basin, nutrients and biochemical oxygen demand (BOD) are the primary pollutants for which TMDLs are being developed. The TMDL can reflect quantifiable limits to be placed on specific pollution sources or it can be comprised of programmatic strategies (e.g., implementation of nonpoint source best management practices) established to reduce pollutant loadings, in general, throughout the targeted waterbody. The overall goal in establishing the TMDL is to set forth a course of management actions necessary for a waterbody to meet water quality standards.

It should be noted that a targeted water body does not necessarily refer to an entire basin. TMDLs for smaller streams may serve as important elements in a TMDL covering a larger portion of the basin. Nesting of TMDLs in this fashion constitutes a flexible yet comprehensive management approach that allows for specific strategies to be developed for smaller problem areas and yet offers the means to address the large scale problems as well.

As DEM's abilities to quantify and predict the impacts of point and nonpoint source pollution become more sophisticated, the basinwide approach will make more innovative management strategies possible. Possible strategies that can be facilitated by a basinwide planning approach include agency banking, pollution trading among permitted dischargers, industrial recruitment mapping and consolidation of wastewater discharges.

Agency banking refers to the concept of holding assimilative capacity in reserve by DEM for future growth and development in the basin. *Pollution trading* involves trading of waste loading and stream assimilative capacity among permitted dischargers, or between point and nonpoint sources, adding flexibility to the permitting system and also using the free market system as an aid to identifying the most cost effective solution to water quality protection. A nutrient reduction pollution trading plan is already being carried out in the Tar-Pamlico River Basin under an agreement signed by the state, and association of dischargers and two environmental groups (see Appendix IV). *Industrial recruitment mapping* involves providing specific recommendations on the types of industry and land development best suited to the basin's long-term water quality goals and also an individual basin's ability to assimilate a particular type or quantity of discharge or nonpoint source pollutants. *Consolidation of wastewater discharges*, also referred to as regionalization, entails combining several dischargers into one facility. Input from local authorities, regulated industries, landowners, and other interested parties will be needed to develop these strategies. By accommodating, to the degree possible, local needs and preferences, the probability of the plan's long-term success can be increased.

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CHAPTER 6

WATER QUALITY CONCERNS, GOALS AND RECOMMENDED MANAGEMENT STRATEGIES FOR THE TAR-PAMLICO RIVER BASIN

6.1 BASINWIDE MANAGEMENT GOALS

The long-range goal of basinwide management is to provide a means of addressing the complex problem of planning for reasonable economic growth while protecting and/or restoring the quality and intended uses of the Tar-Pamlico Basin's surface waters.

In striving towards the long-range goal stated above, DEM's highest priority near-term goals will be as follows:

- identify and restore the most seriously waters impaired in the basin **(Section 6.2.1)**
- protect those waters known to be of the highest quality or supporting biological communities of special importance **(Section 6.2.2)**
- manage problem pollutants, particularly nutrients, biological oxygen demand and sediment and fecal coliforms, in order to correct existing water quality problems and to ensure protection of those waters currently supporting their uses **(Sections 6.2.3 and 6.3 through 6.8)**

6.2 MAJOR WATER QUALITY CONCERNS AND PRIORITY ISSUES

6.2.1 Identifying and Restoring Impaired Waters

Impaired waters are those rated in Chapter 4 as either partially supporting or not supporting their designated uses. A list of impaired waters has been compiled in Tables 6.1 and 6.2. Table 6.1 includes those stream segments which have been monitored, while Table 6.2 includes those stream segments which have been evaluated. *Monitored* streams are those that are based on biological or chemical data collected between 1988 and 1992, and *evaluated* streams are those whose ratings are based on data collected prior to 1988 or on best professional judgment. Since the ratings on monitored streams are based on recent data, monitored streams will receive higher priority for TMDL development than evaluated streams. Both tables include the current and planned water quality management strategies for these waters. When more detailed information is known about a waterbody listed in one of the tables, summaries of the water quality problem and management strategies are presented in sections 6.3 through 6.8. If further information is not available, this will be indicated, and DEM will strive to collect more data on the waterbody in order to evaluate it better in the next Tar-Pamlico Basin Plan update in 2000.

Current Management Strategies, as presented in the table, are those that have been implemented. However, the program may not have been in place long enough to affect water quality. For example, the nutrient sensitive waters (NSW) strategy has been in place for several years, and dischargers in the basin belonging to the Tar-Pamlico Basin Association have made some modifications to treatment at their wastewater treatment plants (WWTPs) in order to reduce nutrient loading. In addition, the Association may provide money for use in nonpoint source controls when Phase I of the NSW strategy is completed in 1995. However, even where nutrient reductions have been achieved, it may take some time for the effects to be measurable,

Table 6.1 Management Strategies for *Monitored Impaired Streams in the Tar-Pamlico Basin

Subbasin	Stream Name	Source	Current Mgmt Strategy	Future Mgmt. Strat.	Use Rating	319 NPS Priority
01	Fishing Creek	NP, P	NSW, NPS, NPDES, PL-566	PTS	NS	H
01	Tar River	NP	NSW, NPS, NPDES, WS	WQ Model / IS-fecals	NS	H
01	North Fk Tar R	P	NSW, NPS, NPDES, WS		PS	
02	Tar River	NP	NSW, NPS, WS	PTS, IS	PS	M
02	Stony Creek	NP	NSW, NPS		PS	M
02	Whiteoak Swp	NP	NSW, NPS, WS		PS	M
03	L. Cokey Swp	NP	NSW, NPS		NS	H
03	Briery Branch	P	NSW, NPS, NPDES	Reclass to swamp	NS	
03	UT Otter Creek	NP	NSW, NPS	IS	NS	H
03	Town Creek	NP	NSW, NPS		PS	M
03	Cokey Swamp	NP	NSW, NPS		PS	M
03	Conetoe Creek	NP, P	NSW, NPS, NPDES	Reclass to swamp	PS	H
04	Fishing Creek	NP	NSW, NPS		PS	M
05	Tar River	NP	NSW, NPS	PTS	PS	M
05	Grindle Creek	NP	NSW, NPS		PS	M
05	Chicod Creek	NP	NSW, NPS, BMP study begun		PS	M
05	Cow Swamp	NP	NSW, NPS, BMP study begun		PS	H
07	Jack Creek	NP	NSW, NPS	CZARA, SW, IS	NS	H
07	Whitehurst Cr	NP	NSW, NPS	CZARA. SW, IS	NS	H
07	Tranters Creek	NP	NSW, NPS, WS	CZARA, SW	PS	H
07	Chocowinity Cr	NP	NSW, NPS	CZARA, SW	PS	M

* Monitored streams are those whose use support ratings are based on chemical or biological data collected between 1988 and 1992

Abbr..	Definitions
NP	Impairment caused by nonpoint sources
P	Impairment caused by point sources
PS	Stream is partially supporting its uses (See section 4.4)
NS	Stream is not supporting its uses (See Section 4.4)
NSW	Nutrient Sensitive Waters classification requires total phosphorus and total nitrogen limits on specified dischargers (see Section 6.4.2)
WS	Water Supply Protection Program requires local implementation and enforcement of NPS Mgmt (Section 5.4.2)
NPS	Includes any applicable nonpoint source control programs listed in Table 5.1
NPDES	NPDES permit limits or compliance program
CZARA	Coastal Zone Act Reauthorization Amendments require NPS control plans in yet to be defined coastal area.
PTS	Point Source Controls. Specific control strategies are needed to address impairment (Fig. 6.1a and b)
Reclass	Stream may need to be reclassified as a swamp water (see Section 2.5.2 and Appendix I)
SW	Future DEM study to determine natural vs impacted swamp conditions more accurately (See section 6.1)
IS	Investigate Sources. Coop. efforts between govt. agencies to identify sources and prioritize mgmt.
H	High priority for nonpoint source control implementation
M	Medium priority for nonpoint source control implementation
CEP	Continue Existing Programs. Many of the nonpoint source programs described in Chapter 5 have not been fully implemented. More time is needed to monitor their effectiveness.

Table 6.2 Management Strategies for Evaluated Impaired Streams in the Tar-Pamlico Basin

Subbasin	Stream Name	Source	Current Management Strategy	Planned Management Strategy	Rating
01	Jackson Creek	NP	NSW, NPS	CEP	PS
01	Hatchers Run		NSW, NPS	CEP, WS	PS
01	Jordan Creek	NP	NSW, NPS	CEP	PS
01	Billys Creek	NP	NSW, NPS	CEP, WS	PS
01	Brandy Creek	NP	NSW, NPS	CEP	PS
02	L. Sapony Creek	NP	NSW, NPS	CEP, WS	PS
02	Maple Swamp	NP	NSW, NPS	CEP, WS	PS
02	Back Swamp	NP	NSW, NPS	CEP	PS
02	Katy Branch	NP	NSW, NPS	CEP	PS
02	Pigbasket Creek	NP	NSW, NPS	CEP	PS
02	Beech Branch	NP	NSW, NPS	CEP, WS	PS
02	Weaver Creek	NP	NSW, NPS	CEP	PS
03	Crisp Creek	NP	NSW, NPS	CEP	NS
04	Matthews Creek	NP	NSW, NPS	CEP	PS
04	Rocky Creek	NP	NSW, NPS	CEP	PS
04	Bridle Creek	NP	NSW, NPS	CEP	PS
04	Richneck Creek	NP	NSW, NPS	CEP	PS
04	Little Shocco Creek	NP	NSW, NPS	CEP	PS
04	Walkers Creek	NP	NSW, NPS	CEP	PS
04	Reedy Creek	NP	NSW, NPS	CEP	PS
04	Bear Swamp	NP	NSW, NPS	CEP	PS
04	Butterwood Creek	NP	NSW, NPS	CEP	PS
04	Burnt Coal Swamp	NP	NSW, NPS	CEP, SW	PS
04	Deep Creek	P	NSW, NPS	CEP, WS	PS
05	Johnsons Mill Run	NP	NSW, NPS	CEP, WS	NS
05	Parker Creek	NP	NSW, NPS	CEP	NS
05	Greens Mill Run	NP	NSW, NPS	CEP	NS
05	Cannon Swamp	NP	NSW, NPS	CEP	NS
05	Cabin Branch	NP	NSW, NPS	CEP	PS
06	Tranters Creek	NP	NSW, NPS	CEP, SW	NS
06	Turkey Swamp	NP, P	NSW, NPS	CEP, WS, SW	NS
06	Tranters Creek	NP, P	NSW, NPS	CEP, WS, SW	PS
07	Jacks Creek	NP	NSW, NPS	CEP, CZMA	NS
07	Runyon Creek	NP	NSW, NPS	CEP, CZMA	NS
07	South Creek	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Pungo River Canal	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Canal A	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Canal B	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Oregon Canal	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Canal D	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Great Branch	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Indian Run		NSW, NPS	CEP, CZMA, SW	NS
07	Pungo Lake Canal	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Lake Canal	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Clark Mill Creek	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Scranton Creek	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Pantego Creek	NP, P	NSW, NPS	CEP, CZMA, SW	NS
07	Broad Creek Canal	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Phillips Canal	NP	NSW, NPS	CEP, CZMA, SW	NS
07	Tar River		NSW, NPS	CEP, CZMA	PS
07	Saint Clair Creek	NP	NSW, NPS	CEP, CZMA, SW	PS
07	North Creek	NP	NSW, NPS	CEP, CZMA, SW	PS
07	Pungo River	NP	NSW, NPS	CEP, CZMA, SW	PS
07	Piney Grove Run		NSW, NPS	CEP, CZMA, SW	PS
07	Shallop Creek	NP	NSW, NPS	CEP, CZMA, SW	PS
08	Boundary Canal	NP	NSW, NPS	CEP, CZMA, SW	PS
08	Rose Canal	NP	NSW, NPS	CEP, CZMA, SW	PS
08	Long Shoal River	NP	NSW, NPS	CEP, CZMA, SW	PS

Evaluated streams are those whose use support ratings are based on data collected prior to 1988 or based on best professional judgment.
For explanation of abbreviations, see Table 6.1.

particularly in the Pamlico estuary. Further information on the Tar-Pamlico NSW strategy is provided in Section 6.4.

The state has also adopted new water supply watershed protection regulations which require local governments to develop watershed protection ordinances for portions of the water supply watersheds that fall within their jurisdiction. Municipalities with a population of 5,000 or more were to develop ordinances by July 1, 1993 while smaller municipalities had until October 1993, and counties had until January 1, 1994. Since these plans are fairly new, their impacts on water quality may not have been realized.

Nonpoint source programs also constitute an extremely important set of management strategies that are in various stages of implementation. These programs, described briefly in Chapter 5, are wide-ranging and are grouped under general nonpoint source categories such as urban development, construction, agriculture, forestry, mining, onsite wastewater treatment and wetlands protection. Agricultural programs such as the North Carolina Agricultural Cost Share Program, which provides farmers with financial assistance to install BMPs, and the Farm Bill (Food, Agriculture, Conservation and Trade Act of 1990), which among its provisions reduces government funding subsidies for farming on highly erodible land, are examples of potentially effective ongoing programs that should reduce long-term water quality impacts.

Future Management Strategies fall into two major categories. The first is implementing planned programs. For example, in the coastal counties in subbasins 07 and 08, the federal government, pursuant to the Coastal Zone Act Reauthorization Amendments of 1990, is requiring the state to develop new coastal nonpoint pollution control programs. Such programs will take time to develop and will require action on the part of local governments, but their eventual implementation should help reduce nonpoint source pollution in these areas. The Divisions of Coastal Management and Environmental Management are currently defining the area where these plans need to be developed. For the purpose of Tables 6.1 and 6.2, it was assumed that the CZARA program would, at a minimum, include all the waterbodies in subbasins 07 and 08. The second category includes several other initiatives. Where water quality problems have been identified but the source(s) is not evident, investigation of the source(s) will be necessary before any specific actions can be outlined. Investigating sources has been identified as a strategy in Tables 6.1 and 6.2 where it is not known if point sources or nonpoint sources are the primary contributor. However, further investigation of sources is likely to be needed even when nonpoint sources have been identified as the source of water quality degradation. Further information on the type of nonpoint source or location of the source will probably be needed to develop a good management strategy.

The *319 NPS Priority* column in Table 6.1 indicates DEM's recommended priority rating for nonpoint source management of impaired streams under Section 319 of the federal Clean Water Act. Monitored streams have been prioritized in Table 6.1 for nonpoint source controls which may be implemented through programs such as Section 319, the Agriculture Cost Share Program and the Forest Practice Guidelines Related to Water Quality. A schedule of priority from high to low has been established to help direct the resources of these programs so that the nonpoint source problems can be addressed. High priority streams are identified as follows:

1. Monitored streams that have an overall rating of "non-supporting",
2. Monitored streams that have a "partial-support" rating but have predicted loading of one or more pollutants that is high;
3. Streams that are unusually sensitive as documented by special studies (e.g., high quality waters, presence of endangered species).

Medium-priority streams are monitored streams that are rated as "partially supporting". Low priority are all supporting streams and streams that are considered impacted on the basis of evaluated data or best professional judgment. Any streams listed as a medium or low priority can be reconsidered as a high priority at any time by DEM if special studies support the change in priority.

6.2.2 Identification and Protection of High Resource Value or Biologically Sensitive Waters

Waters considered to be biologically sensitive or of high resource value may be afforded protection through reclassification to HQW (high quality waters), ORW (outstanding resource waters) or WS (water supply), or they may be protected through more stringent permit conditions. Waters eligible for reclassification to HQW or ORW (see Appendix I) may include those approved for commercial shellfish harvesting (SA), designated primary nursery areas, designated critical habitat for threatened or endangered species (as designated by the NC Wildlife Resources Commission), waters having excellent water quality or those used for domestic water supply purposes (WS I and II). The HQW, ORW and WS classifications generally require more stringent point and nonpoint source pollution controls than do basic water quality classifications such as C or SC (Appendix I).

The only areas in the Tar-Pamlico River Basin which are designated ORW are the Swanquarter and Juniper Bay areas. There are also a number of waters tributary to the Pamlico River which are designated as HQW. The Tar River at Highway 42 near Old Sparta in Edgecombe County received an excellent bioclassification which makes it a candidate HQW or ORW. Further investigation is needed in this stream reach to determine if a reclassification is warranted.

In addition, where waters are known to support state or federally listed endangered or threatened species or species of concern, but where water quality is not Excellent and where no critical habitat has been designated, consideration will be given during NPDES permitting and nonpoint source control efforts to minimize impacts to these habitat areas consistent with the requirements of the federal Endangered Species Act and North Carolina's endangered species statutes. There are several endangered species in the Tar-Pamlico River basin. Table 6.3 lists the species and the subbasins in which they occur. Possible protection measures associated with wastewater treatment facilities may include effluent dechlorination or alternative disinfection, tertiary or advanced tertiary treatment, outfall relocation, backup power provisions to minimize accidental plant spills, consideration of nondischarge alternatives and others. The need for special provisions will be determined on a case-by-case basis during review of individual permit applications and take into account the degree of impact and the costs of protection.

Table 6.3: Threatened and Endangered Species in the Tar-Pamlico River Basin

Dwarf Wedge Mussel (Alasmidonta heterodon) - Subbasins 0, 02 and 04
Triangle Floater (Alasmidonta undulata) - Subbasins 01, 02 and 04
Yellow Lance Mussel (Elliptio lanceolata) - Subbasin 01, 02 and 04
Roanoke Slab Shell Mussel (Elliptio Roanokensis) - Subbasin 02
Tar River Spiny Mussel (Elliptio steinstansana) - Subbasins 01, 02, 03 and 04
Atlantic Pigtoe (Fusconaia masoni) - Subbasins 01, 02 and 04
Yellow Lamp Mussel (Lampsilis cariosa) - Subbasins 01 through 04
Green Floater (Lasmigona subviridis) - Subbasin 01
Squawfoot Mussel (Strophitus undulatus) - Subbasins 01 through 04

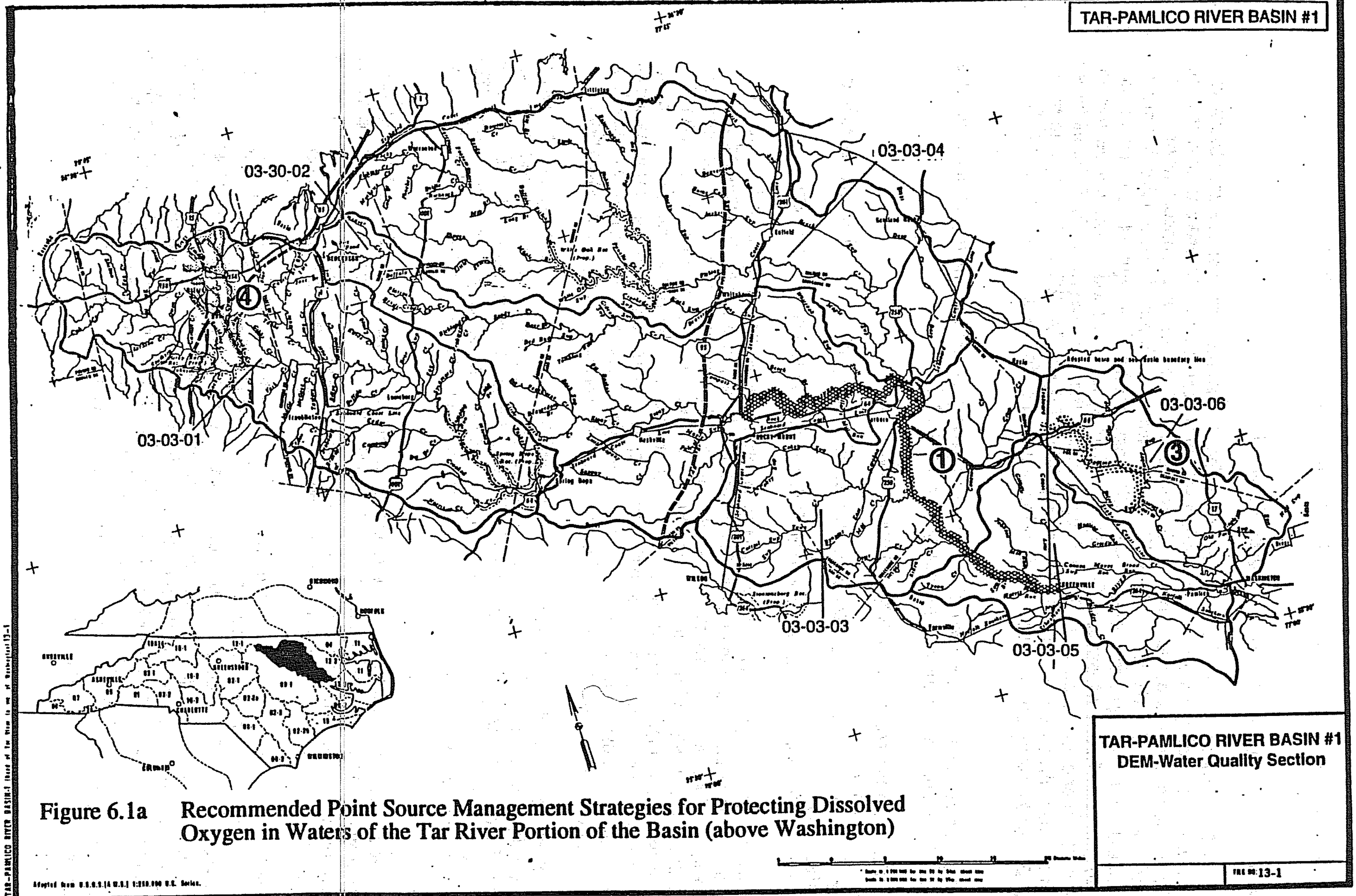

Figure 6.1a Recommended Point Source Management Strategies for Protecting Dissolved Oxygen in Waters of the Tar River Portion of the Basin (above Washington)

① New / expanding discharges to be capped at 15 mg/l BOD and 4 mg/l ammonia; Rocky Mount to Receive limits of 5 mg/l BOD and 2 mg/l ammonia at expansion

② No new / expanding discharges

③ No new discharges to be constructed

④ Any new or expanding discharge must examine feasibility of tying on to Oxford's WWTP

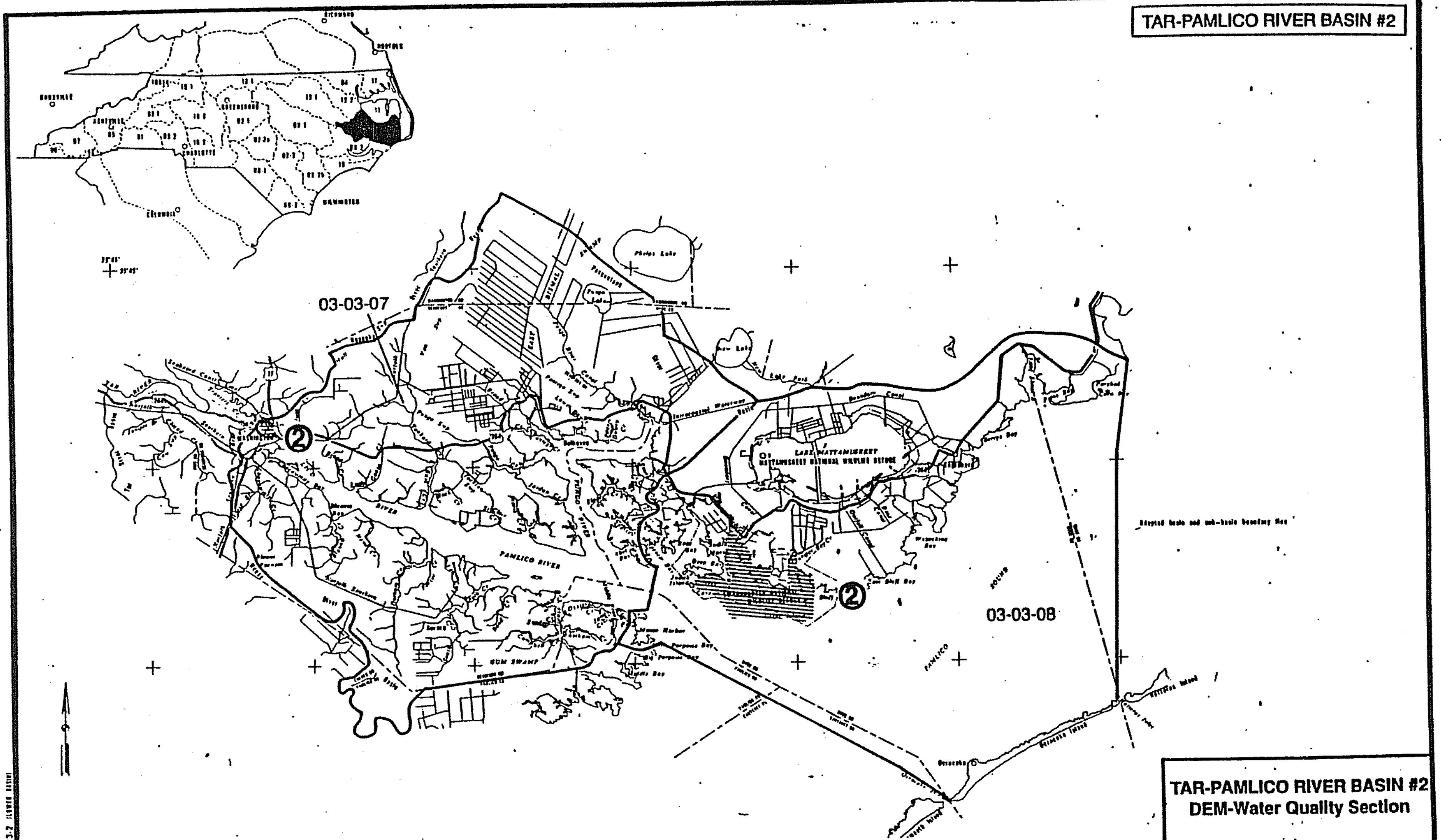

Figure 6.1b Recommended Point Source Management Strategies for Protecting Dissolved Oxygen in Waters of the Pamlico River Portion of the Basin (below Washington)

① New / expanding discharges to be capped at 15 mg/l BOD and 4 mg/l ammonia; Rocky Mount to Receive limits of 5 mg/l BOD and 2 mg/l ammonia at expansion

② No new / expanding discharges

③ No new discharges to be constructed

④ Any new or expanding discharge must examine feasibility of tying on to Oxford's WWTP

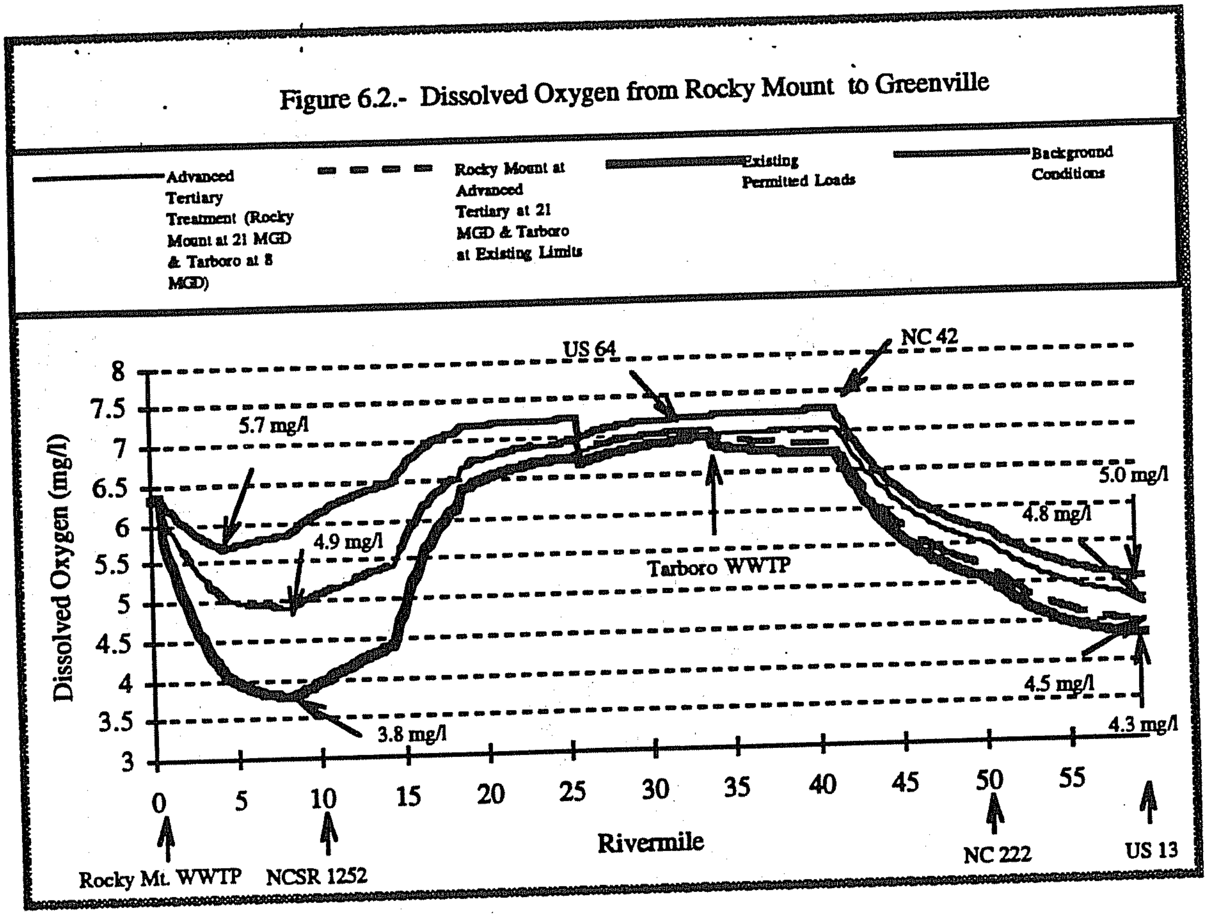

Figure 6.2 Predicted Dissolved Oxygen Concentrations in the Tar River from Rocky Mount to Greenville Based on QUAL2E Model

The model should be run to determine NPDES permit limits for other new and expanding dischargers to the Tar mainstem and to tributaries near the mainstem. Given the model uncertainty at the model endpoints, care should be taken to evaluate cost of various treatment scenarios and the predicted DO sags at the model endpoints. Since the Tar River has already been overallocated, and DO violations have been observed, no new or expanded discharge should receive limits less stringent than 15 mg/l BOD_5, 4 mg/l ammonia, and 5 mg/l DO.

6.3.3 Discharges to Swamp Waters

Many of the streams in the Tar-Pamlico River Basin are classified as swamp waters. DEM does not have a good tool to evaluate these streams' ability to assimilate oxygen-consuming wastes as our desktop dissolved oxygen model assumes a steady-state, one-dimensional flow, and these conditions may not exist in a swamp water. In addition, data analysis from the previously-studied Lumber River basin indicated that critical flow conditions in a swamp system are not necessarily during low flow conditions. Inadequate flow and water quality data prevent verification of the relationship between flow and dissolved oxygen in many of the tributaries which are classified as swamp waters. Given the difficulty of determining assimilative capacity in these waters, DEM has identified the need to develop a better tool to evaluate a swamp system's ability to assimilate waste flow. Since the large influx of low from a pipe may have a larger impact on these systems than actual treatment levels, DEM will be investigating the potential for innovative outfall designs which will allow a slower release of effluent to the system. Until these studies are completed, new discharges will not be permitted at limits greater than 15 mg/l BOD_5 and 4 mg/l NH_3-N (NH_3-N may be lower if dilution is low). On occasion more stringent limits may be given if staff believe that adverse impacts will occur. Existing facilities will receive existing limits unless they expand or site specific information is available which indicates more stringent limits are needed. Upon expansion they will receive existing loading (mass basis). The following subbasin summaries describe other management strategies that may pertain to a given stream.

6.3.4 BOD Control Strategies by Subbasin

Subbasin 01
There are only a few areas in subbasin 01 which have dissolved oxygen problems, and these are mainly in streams which have low flow. These areas are being addressed through the Division's zero flow policy. Other dissolved oxygen problems can be solved using current wasteload allocation procedures for point source dischargers and current nonpoint source management strategies. Further information on given streams is provided below.

The City of Oxford had three discharges in the Fishing Creek watershed, but has consolidated them into one at its Southside plant. Although few DO violations have been observed by the City in recent years, the City of Oxford's existing NPDES permit limits were based on the Division's old empirical model, and the new model indicates that more stringent limits are needed to protect water quality during critical low flow conditions. If the City expands or modifies its treatment plant, more stringent limits would be assigned to the facility. Any proposed and expanding dischargers in the basin should examine the feasibility of connecting to Oxford before they can receive an NPDES permit (Strategy number 2 in Figure 6.1a). A portion of Hatchers Run, located in the Fishing Creek watershed, along with Sally Kearney Creek (upstream of Old Franklinton Lake) and Cedar Creek (upstream of New Franklinton Lake) are classified as WS-II, and are therefore high quality waters (HQW). Accordingly, any new discharger to the HQW section of these streams will receive BOD_5 limits of 5 mg/l and ammonia limits of 2 mg/l. Expanding dischargers will be given existing loadings unless ammonia limits are required to protect against toxicity.

Subbasin 02
This subbasin contains many non-process discharges such as mine dewatering and cooling water. The domestic waste facilities on the tributaries to the Tar River are small and do not interact. No tributaries should adversely affect the mainstem. Current wasteload allocation procedures will be used to determine NPDES permit limits.

The Raleigh Regional Office has indicated that Swift Creek is a pristine stream in this subbasin, and has unique habitat. Benthic data collected by the Division resulted in a Good/Fair rating in 1992. Therefore, on the basis of water quality alone, the creek does not qualify for HQW or ORW status, but the stream does support viable populations of endangered species. The Wildlife Resources Commission is currently developing legislation to define and delineate critical habitat, and these efforts may enable the Environmental Management Commission to designate the stream as HQW. If these efforts fail, water quality staff should work with the U.S. Fish and Wildlife Service, the Wildlife Resources Commission, and other stakeholders in the basin to develop a strategy to protect this stream.

Subbasin 03
The Tar River mainstem at Highway 42 near Old Sparta in Edgecombe County has received an excellent bioclassification. This rating makes it a candidate for HQW or ORW designation, and the Division should perform further investigations to determine if one of these supplemental classifications is appropriate.

Many tributaries in this subbasin exhibit swamp-like characteristics, but are not classified as swamp waters. These tributaries include: Town Creek, Bynums Creek, and Conetoe Creek. The Division should perform studies to see if a reclassification of these streams to swamp waters is warranted.

The Town of Bethel is permitted to discharge wastewater to Conetoe Creek during periods when the flow instream exceeds 14 cfs. At present, Bethel is out of compliance with its BOD_5 limit, and Construction Grants is working with the facility to improve its treatment plant. Conetoe Creek is also listed as impaired due to low pH values and substandard DO concentrations. These low pH and DO values may be partially due to natural swamp like conditions, and the Division should perform studies to determine whether the stream should be reclassified.

The Town of MacClesfield discharges to Briery Branch. Instream dissolved oxygen data collected by the facility indicate substandard concentrations both upstream and downstream of the facility although the facility has advanced tertiary limits and has been in compliance. Benthic data collected downstream of the facility in 1990 yielded a poor biological rating. The Division should further investigate the source of the problems in this stream.

Subbasin 04
There are no known streams in subbasin 04 which are impaired due to low dissolved oxygen values. In addition, there are no clusters of dischargers which need to be addressed through a more complex modeling effort. Current wasteload allocation procedures will be used to determine NPDES permit limits for oxygen-consuming wastes.

Subbasin 05
Chicod Creek - The Chicod Creek subbasin has experienced substandard DO concentrations as shown through data collected by USGS and the state's ambient network. There are no point source discharges in the basin, and chicken and swine operations are the primary source of oxygen-consuming wastes. In addition, the DO is being degraded by eutrophic conditions which are also resulting from nonpoint sources. Intensive studies of Chicod Creek have begun to gather more information on the problems. Further details are provided in section 6.4.2.

Subbasin 06
The Town of Robersonville and Eagle Snacks Company discharge into Flat Swamp which drains into Tranters Creek. These streams are relatively flat and have low velocities particularly in the lower portion of Flat Swamp and Tranters Creek. A QUAL2E model was calibrated for this section of stream which indicated that assimilative capacity is limited (Strategy number 3 in Figure 6.1a). Each of the above dischargers was assigned advanced tertiary limits based on the modeling analysis. In addition to the modeling results, substandard DO concentrations have been observed at an ambient site in Tranters Creek. Due to the limited assimilative capacity, no new dischargers should be allowed into Flat Swamp and the upper portion of Tranters Creek (to Turkey Swamp Creek). In addition, Robersonville and Eagle Snacks should be required to do an engineering alternatives analysis prior to any expansions. If an environmental assessment is needed for an expansion of either of these facilities, the alternatives analysis may be incorporated into the document.

Subbasin 07
Dissolved oxygen standard violations have occurred in Kennedy Creek. The City of Washington discharges into the creek, and due to poor flushing, the effluent remains in the creek contributing to the water quality standard violations. The City of Washington has not been allowed to expand its discharge and is in the process of planning the removal of its discharge from the creek. If the City does not relocate, no flow expansion will be permitted and limits of 5 mg/l BOD_5 and 2 mg/l NH_3 will be included in its NPDES permit. No new discharges shall be allowed to Kennedy Creek. (Strategy number 2 in Figure 6.1a).

Subbasin 08
The Swanquarter Bay and Juniper Bay Area has been designated as outstanding resource waters (ORW). No new or expanded NPDES discharges are allowed in this area (Strategy number 2 in Figure 6.1b). Marina restrictions apply in this area. New and expanded marinas must have less than 30 slips, no boats over 21 feet in length are allowed, and no boats with heads are allowed.

6.4 MANAGEMENT STRATEGIES FOR NUTRIENTS

The Tar River basin has exceeded its assimilative capacity for nutrients. Due to its hydraulic conditions, the estuary from Washington downstream to the Pungo River is experiencing degradation from excessive nutrient loadings. Algal blooms are common in the middle reaches of the estuary, and winter blooms regularly occur. Lack of dissolved oxygen near the bottom of the sound (hypoxia) has been responsible for the die-off of bottom dwelling (benthic) organisms. This condition occurs during periods of water layer stratification (no mixing of waters between the top and bottom layers) and warm temperatures. To address this problem, and based on the results of extensive computer modeling of nutrient loadings and their impacts on the estuary, a 30% reduction in TN and existing TP loading at Washington are recommended for the Tar-Pamlico River Basin. These loading targets correspond to 1,361,000 kg/yr of TN and 180,000 kg/yr of TP at Washington.

Control of nutrients is necessary to limit algal growth potential, to assure protection of the instream chlorophyll *a* standard, and to avoid development of nuisance conditions in the state's waterways including anoxic conditions in bottom waters and fish kills. To meet this goal further reductions in both point and nonpoint source loadings of TP and TN will be necessary. Point source controls typically involve NPDES permit limits on total phosphorus (TP) and total nitrogen (TN). Nonpoint controls of nutrients generally include best management practices (BMPs) to control nutrient loading from areas such as agricultural land, forests, and urban centers.

6.4.1 Existing Nutrient Control Strategies

Designation of the Tar-Pamlico Basin as Nutrient Sensitive Waters (NSW)
The Environmental Management Commission (EMC) declared the Tar-Pamlico River basin as nutrient sensitive waters (NSW) in September 1989. The NSW policy stated that new discharges greater than 0.05 MGD (50,000 gallons per day) and expanding dischargers to flows greater than 0.5 MGD (500,000 gallons per day) would receive total phosphorus (TP) limits of 2 mg/l. New discharges greater than 0.1 MGD and expanding discharges to flows greater than 0.5 MGD would also receive a summer total nitrogen (TN) limit of 4 mg/l and a winter TN limit of 8 mg/l. Nutrient budget work in the basin indicated that nonpoint sources contributed the majority of the total nitrogen to the basin's waters and a considerable amount of the total phosphorus, particularly when Texas Gulf was eliminated from the analysis. More information on the original nutrient budget is outlined in section 3.2.2.

Point/Nonpoint Source Nutrient Reduction Trading Plan
Due to the large component of nonpoint source loading, an innovative method of implementing the strategy was devised which allowed dischargers to provide funding for nonpoint source controls in place of expensive facility upgrades at their respective plants. The EMC approved an NSW Implementation Strategy agreement in December 1989 which was subsequently revised in February 1992 (see Appendix V). The purpose of this agreement was to formalize and clarify the details of the first phase (Phase I) of the NSW Strategy (1990 - 1994). An association of discharges, the Tar-Pamlico Basin Association (the Association), was formed. This group agreed to fund the creation of an estuarine water quality model which would aid the Division in developing nutrient reduction goals. In exchange, expanding discharges which belonged to the Association would have their individual NPDES nutrient limits waived. Association members were also required to conduct engineering evaluations of their wastewater treatment plants (WWTPs) and implement minor operational and capital improvements to reduce nutrient loading. Extensive effluent monitoring for TP and TN was also required of all Association members.

The effluent nutrient monitoring was to be used to judge compliance with nutrient reduction goals laid out in the Implementation Strategy. The Implementation Strategy projected flows for the Association members to be 30.555 MGD by the end of Phase I of the NSW strategy (i.e., by end of 1994). Assuming that no nutrient reductions would be made at any of the Association facilities, it was estimated that the total nutrient load from Association facilities would be 625,000 kg/yr by the end of 1994. The NSW strategy for the basin recommended point source nutrient reductions of 200,000 kg/yr. Thus nutrient goals were established for the Association for each year ending with a goal of 425,000 kg in 1994, a reduction of 200,000 kg from the projected 625,000 kg. Any year that the Association did not meet its goal, payments of $56 for every kilogram above the goal were to be paid into a nutrient-reduction trading fund. The allowable nutrient loading for each year is summarized below:

Calendar Year	Allowable Nutrient Load (kg)
1991	525,000
1992	500,000
1993	475,000
1994	425,000

For 1991, 1992 and 1993, the Association met its nutrient goals with the following calculated loads:

Year	Total Nitrogen (kg)	Total Phosphorus (kg)	Total Nutrients (kg)	Total Effluent Flow (MGD)
1991	396,916	64,478	461,394	24.88
1992	386,208	50,170	436,378	26.85
1993	371,336	45,881	417,217	28.57

The data indicate that the Association members had improved their nutrient treatment since loading decreased between the three years while total monthly average flow for the facilities had increased from 24.88 MGD in 1991 to 28.57 MGD in 1993. In addition to meeting their Phase I reduction goals, the Association was able to obtain 1.2 million dollars for nonpoint source controls and development of a nutrient model, discussed below.

6.4.2 Nutrient Modeling in the Tar-Pamlico River Estuary

The Association contracted with HydroQual, Inc. to perform the estuary modeling. HydroQual developed a two dimensional, laterally averaged hydrodynamic water quality model to predict the impacts of nutrient loading in the estuary. The model extends from Greenville to Pamlico Point, a distance of approximately 60 miles. Figure 6.3 illustrates the model segmentation below Washington. Further information on the HydroQual model can be found in the draft modeling report (Gallagher et al, 1994).

Nutrient Assimilative Capacity Exceeded in the Tar-Pamlico Estuary
DEM ran the model under the 1991 calibration conditions as well as under various nutrient reduction scenarios and plotted the results for a site located near Washington in order to evaluate possible management strategies. The Washington site was chosen since modeling results indicated that this was where the greatest number of chlorophyll *a* and DO violations occurred, and the magnitude of the violations was the greatest. Thus, it is the critical portion of the river. Under 1991 loading conditions, the model indicates that the chlorophyll *a* standard was violated approximately 18% of the time at Washington. In addition, chlorophyll *a* concentrations as high as 70 ug/l were predicted at that site (Figure 6.4). The reader should note that these predictions are daily averages and are averaged across the river. Therefore specific areas within a model segment or given times of day may indicate better or worse water quality than that predicted. Dissolved oxygen concentrations on the bottom were also plotted for the site at Washington (Figures 6.5 and 6.6). The results indicate that DO concentrations as low as 0.5 mg/l can occur at Washington for prolonged periods. Again, since the model was laterally averaged, there may be areas within the segment where anoxic conditions occur or where low DO concentrations occur more frequently than noted on the frequency diagram. In addition, dynamic plots of DO showed predicted prolonged anoxic conditions in the bottom and middle layers of certain portions of the estuary.

The nutrient inputs were then cut by varying amounts to determine what loading was necessary to protect water quality standards. The model was run for a five year period to allow improvements in the sediment concentrations to be reflected in the water column quality. The results indicate that a 45% reduction in total nitrogen is needed to maintain the chlorophyll *a* standard of 40 ug/l (Figure 6.4) at Washington. This 45% reduction also results in a significant increase in bottom water DO and prevents extended anoxic conditions as well as decreases the frequency of supersaturation conditions (Figure 6.5). Dynamic plots indicate that the extent of low oxygen bottom waters is over a shorter stretch of estuary and does not go as far up into the water column as was noted in the calibration run.

6.4.3 Recommended Nutrient Reduction Goals for Nitrogen and Phosphorus

It is difficult to determine what would be an acceptable level of water quality in the basin. Even if the basin was not developed, it is likely that blooms would occasionally occur naturally. In addition, a 45% reduction in nitrogen loading may not be feasible given current BMP methods and point source treatment technologies. There is also model error and uncertainty in predictions which could result in costly treatments which are not needed to meet water quality standards. The reader should also note that the model was calibrated under relatively high nutrient loading conditions. The modeling results must be evaluated within the context of the model calibration. The further a given nutrient loading scenario is from calibration conditions, the greater the uncertainty is for obtaining an accurate prediction of the water quality impacts of such loading. At present, interpretation of modeling suggest that algal and DO concentrations in the estuary will respond significantly to reductions in the nitrogen loading. A 45% TN reduction is predicted to result in no chlorophyll-a violations. However, the model cannot be considered fully reliable for conditions so different from existing conditions. To improve confidence in the

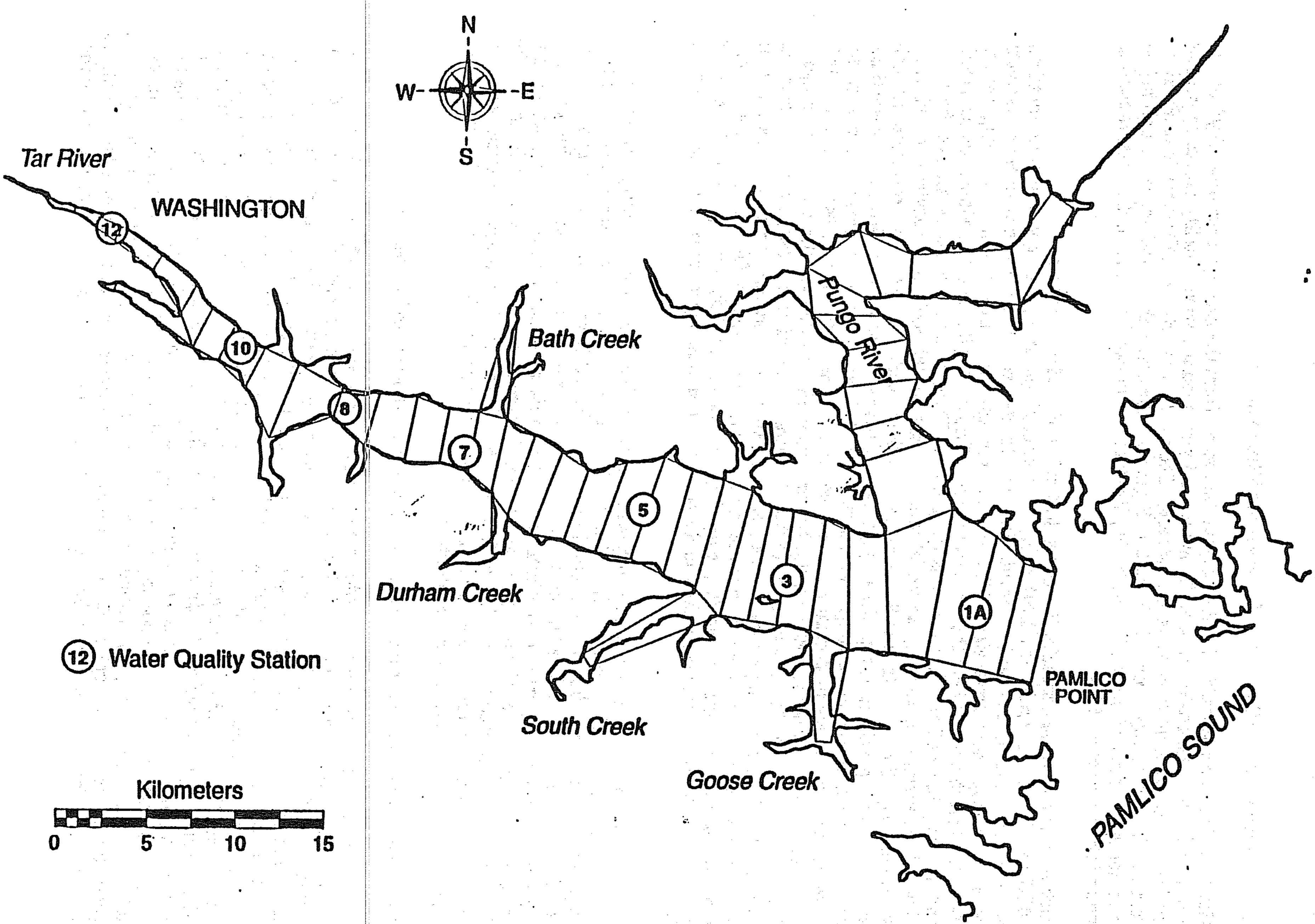

Figure 6.3 HydroQual, Inc. Nutrient Model Segmentation Below Washington

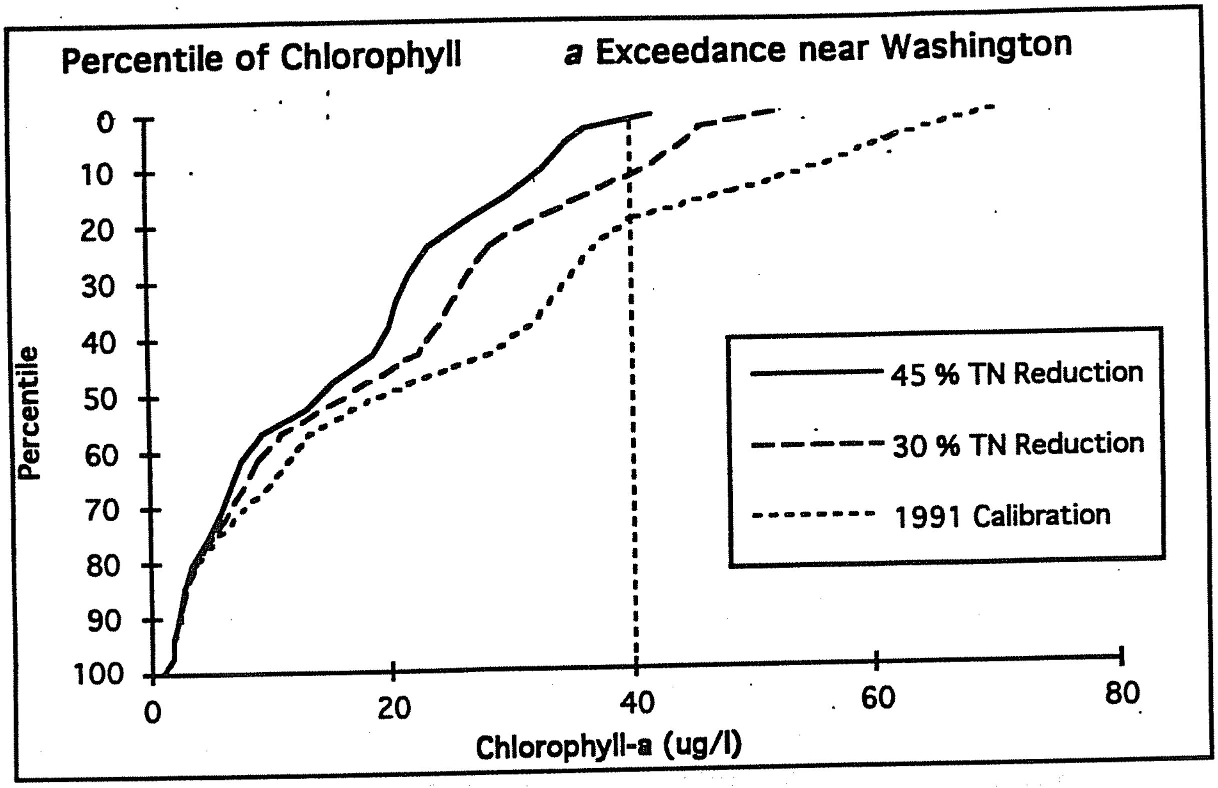

Figure 6.4 Percentile of Chlorophyll *a* Exceedances of the 40 ug/l Standard at Washington Based HydroQual Model

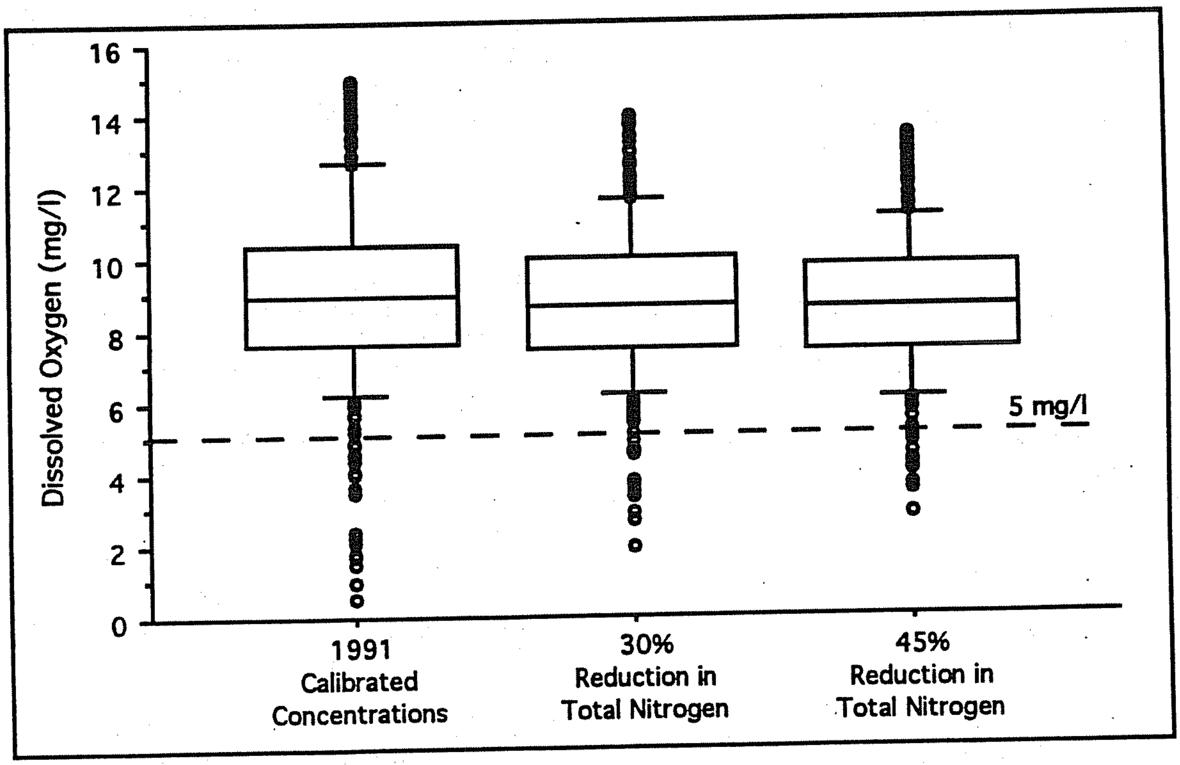

Figure 6.5 Predicted Dissolved Oxygen (DO) Concentrations for Calibrated and Nutrient Reduction Scenarios for Bottom Waters at Washington

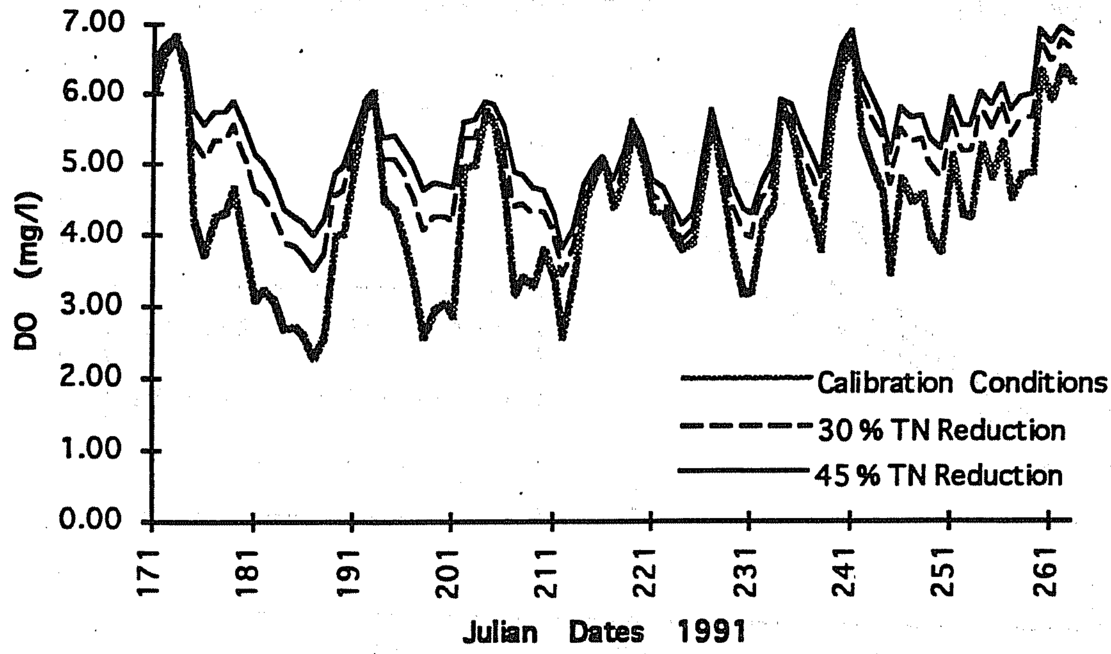

Figure 6.6 Predicted Summer Dissolved Oxygen Concentrations for Calibrated and Nutrient Reduction Scenarios for Station 3 (Days 171 through 261 in 1991)

modeling results, the model must be recalibrated to reflect changing conditions as nutrient loading is reduced. Given the uncertainty inherent to a predictive model, an interim target will be established while model calibration will continue. The interim goal for TN reduction is 30% from 1991 conditions. This level of reduction was selected because it resulted in most of the predicted change in chlorophyll-a and DO that was observed under TN reduction scenarios applied to the model (Figures 6.4-6.6). It is likely that a further TN reduction will be required, but a more exact target cannot be established until the model is calibrated to lower nutrient loading conditions. This 30% reduction is an interim goal. The final target of no violations remains the ultimate goal for the Tar-Pamlico estuary.

The model indicates that the middle estuary does not respond significantly to phosphorus reductions. This is probably because more saline estuarine waters tend to be nitrogen limited. However, it is important to consider the upper and lower bounds of the study area, where phosphorus is more likely to be limiting on a seasonal basis. Phosphorus levels may become more important in the future after significant nitrogen reductions cause a commensurate shift in ratios of nitrogen to phosphorus. However, the proposed targets, if achieved, would result in TN:TP ratios within a desired range. Another important consideration associated with elevated concentrations in either or both nutrients in this estuary is the loss of important submerged aquatic vegetation (SAV). While it is extremely difficult to model and predict recovery of SAV and their effect on nutrient dynamics, it would not be prudent to support additional increases in a phosphorus rich estuary. Finally, there are initial indications that certain life stages of the toxic dinoflagellate may be stimulated by nutrients, particularly phosphorus. Accordingly, the recommended strategy is no additional increase in load of total phosphorus into the estuary.

Therefore a 30% reduction in TN and existing TP loading at Washington are the recommended TMDLs for the Tar-Pamlico River Basin. These loading targets correspond to 1,361,000 kg/yr of TN and 180,000 kg/yr of TP at Washington.

It should be noted that the estuary model as currently calibrated does not allow examination of the impacts of nutrient controls in the estuary portion of the watershed. The flow calibration in the lower estuary was weak, and there would be much uncertainty involved in an analysis which examined nutrient controls below Washington. Therefore, the numeric TMDL strategies have been set at Washington. However, nutrient controls should be implemented in this lower portion of the basin in order to reduce direct loading to the estuary.

Point/Nonpoint Source Reduction Targets for Nitrogen
A 30% reduction goal provides a TN target load at Washington of 1.361 million kg/yr or a TN load reduction of 583,000 kg/yr for both point and nonpoint sources. It is estimated that approximately 8% of the TN load at Washington is from point sources based on use of the export coefficient model described in section 3.2.2 of Chapter 3. The remaining 92% is from nonpoint sources. The targeted TN loads for point and nonpoint sources at Washington are therefore as follows:

Point sources:	8% X 583,000 = 46,640 kg/yr
Nonpoint sources:	92% X 583,000 = 536,360 kg/yr

6.4.4 Nonpoint Source Control Strategies for Meeting Nutrient Goals

In order to achieve the needed TN reduction in nonpoint source nutrient loading, DEM has made a commitment to convene and coordinate meetings with appropriate groups and agencies to establish a coordinated and focused plan to achieve the required nonpoint source nutrient reductions. This additional strategy that will provide further details of how such reductions are to achieved by nonpoint sources and the accounting of such actions is to be established by September, 1995. DEM's commitment is included in the Tar-Pamlico NSW Implementation Strategy: Phase II. The Phase II strategy can be found in Appendix IV.

Feasibility of Meeting Nonpoint TN Source Reduction Target
It is not reasonable to expect that the loading targets at Washington can be met during the next basin cycle. The export coefficient nutrient loading described in Chapter 3 indicated that point sources contribute approximately 8% of the total nitrogen in the basin upstream from the estuary (subbasins 01 through 06). Therefore, in order to meet the loading targets, additional nonpoint source controls will need to be implemented. Since DEM does not have good information on where current BMPs are located, what types of BMPs are in place, and the cost and effectiveness of BMPs in North Carolina, it will not be possible to fully evaluate the time frame and the best strategies to meet these targets until better information relating to BMPs is known. However, to evaluate the feasibility of being able to meet the loading targets, the export coefficient model described in Chapter 3 was slightly modified.

To estimate nutrient loading in chapter 3, the median export coefficient values were used. It was assumed that effective BMPs would result in lower export coefficients, and the low nitrogen coefficients listed in Table 3.1 were input to the model for agricultural landuse in subbasins 01 through 06. The change was made for agriculture only since much of the land in the Tar-Pamlico River Basin is agricultural. In addition, changing only agriculture will result in a more conservative estimate of loading reduction than if all land use coefficients were changed. The changes were only made for subbasins 01 to 06 since the loading targets were set at Washington, and changes in subbasins 07 to 08 will not result in lower loading at Washington. The results indicated that if the relative change in the median and low nitrogen export coefficients is similar to what will happen when BMPs are fully implemented, the nitrogen loading will be reduced by 33% above Washington. Actual changes in predicted loading have not been noted, due to the uncertainty in the model. This uncertainty results from inadequacies in the land use data (all agriculture was lumped together) and in assumptions which were made in applying the model (export coefficients based on literature values rather than measured values). The reader should also note that the export coefficient model does not account for any assimilation of a given pound of nitrogen before it reaches the estuary, and therefore these results should be interpreted carefully. Given the assumptions listed above, the results indicate that it is possible to meet the loading targets by implementing BMPs.

Priority Management Areas for Nonpoint Source Nutrient Reductions

Agencies other than DEM have jurisdiction over many of the nonpoint source programs. In order to give them guidance in prioritizing areas in need of BMPs, a list of streams with high areal loadings is given below. This list should also be used by DEM to prioritize waterbodies for 319 project moneys as they become available to the state. This prioritized list is as follows:

- Chicod Creek
- Swift Creek
- Conetoe Creek
- Cokey Swamp Creek
- Tranters Creek
- Tar River Estuary

This prioritized listing was based on the results of the nutrient loading models described in Chapter 3. Each of these streams was predicted to have fairly high nutrient loading or areal nutrient loading. In addition, each of the streams with the exception of Swift Creek is listed on the state's 303(d) list with nonpoint sources being the cause of the degradation (see Table 6.1). Swift Creek was given highest priority even though it is not considered degraded since it harbors endangered species populations which are threatened by high nutrient and sediment loads. The estuary was also listed as a priority area since more of the nutrient loading in the lower basins will be transported to the estuary rather than from the upper basins where they will have time to be assimilated. Other areas can be prioritized through the use of Table 6.1 and the nutrient loading model results described in chapter 3. Other modeled streams that are impaired include: the Upper Tar River, Lower Tar River, Stony Creek and Fishing Creek.

Strategies to Reduce Nutrient Loading from Agriculture

- Nutrient Management Plans Recommended for Agricultural Lands

  In addition to the strategies listed above, the mass balance model described in chapter 3 indicated that on average, 40% of the nitrogen applied as fertilizer is lost to the environment. Research should be done to see if this number can be reduced. In addition, as part of the Coastal Zone Act Reauthorization Amendments (CZARA), all farms in the defined coastal area will have to develop nutrient management plans which evaluate the nutrients needed for their crops and identify timing and application methods to achieve realistic crop yields and reduce losses to the environment. For any areas not defined as being in the coastal area through CZARA, the agricultural agencies may want to consider nutrient management planning as a cost effective method to reduce nutrient loading. Information assimilated through the Chesapeake Bay program indicates that nutrient management is one of the least costly methods to reduce nutrient loading and when combined with other BMP practices is very effective at reducing nutrients (Chesapeake Bay Program, 1988).

  In North Carolina, the NC Cooperative Extension Service (NCCES) is in the process of offering Nutrient Management Training. Specialists from the Departments of Soil Science and Biological and Agricultural Engineering at North Carolina State University have developed a nutrient management training program for county extension agents to teach them the concepts behind nutrient management planning and how to write plans. The program is voluntary; no agent is required to take the training or to write plans. However, it is recommended that agents from all counties in the Tar-Pamlico River basin and other watersheds or basins that are classified as nutrient sensitive waters receive this training.

Each three-day training session includes lectures, discussions, case-study development, along with presentations and an exam. Participants receive a comprehensive notebook containing plan development materials and additional resources. The training builds on individuals' current knowledge basis, tying in concepts of nutrient cycling, nutrient movement and plant use of nutrients, including fertilizers and organic nutrient sources.

An exam at the end of the training is meant to test agents' knowledge and competency in writing nutrient management plans. Agents who pass the test are certified by the Cooperative Extension Service to write nutrient management plans on behalf of the organization. More than 60 agents have been certified in three training sessions given in the mountains, Piedmont and Coastal Plain. The results of this training will become more significant in the future, especially in the areas included under the (CZARA), where, as noted above, total nutrient management planning for all agricultural operations will be required.

The Cooperative Extension Service, in conjunction with the Natural Resources Conservation Service, will conduct a modified version of the training to NRCS and District employees. This version of the training will emphasize fertilizer nutrient sources since most NRCS and District employees have considerable experience in developing animal waste management plans.

- <u>Develop an Agricultural Nonpoint Source BMP Database</u>
  During the next five years, DEM should continue to work with the nonpoint source agencies to develop a good database on the type, location and effectiveness of BMPs. Of special note is a new data management system soon to be used by the USDA-Natural Resources Conservation Service to track all of its field office activities including those that are water quality oriented. This new system is called Field Office Computer System or FOCS.

  FOCS trainers training has been under way since May 1994. These trainer's will be returning to their areas to provide training to the local NRCS staff on the operation of the new FOCS system. It will take at least six months to implement the FOCS systems in all of the local area offices. The major task element here being the conversion of existing data from the old computer data management system to the compatible form in the new FOCS environment. All of the data in FOCS will be available by new 14 digit Hydrologic Unit (HU) codes and county locations.

- <u>Promote Voluntary BMP Installation Through Education and Use of State and Federal Cost Share Programs</u>
  A concerted effort to educate the nonpoint source contributors on the importance of reducing nutrient loading to encourage further voluntary participation in the BMP programs should occur.

  One such program is the ASCS Water Quality Incentive Projects (WQIP). Established by FACTA, the goal of WQIP is to achieve the source reduction of nonpoint source agricultural pollutants in an environmentally and economically sound manner. WQIP utilizes an ecosystem approach in dealing with the resource issues. Agricultural producers will be provided with the financial, educational, and technical assistance required to make changes in management systems to: a) restore or enhance impaired water resources where agricultural nonpoint source pollution has detrimental effect, and/or b) prevent future impairments. Farmers may receive up to three years of funding (up to $3,500 per year) depending on whether Long Term Agreement (LTA) is signed. The national ASCS target is to enroll 10 million acres by 1995.

In 1992, 32 farms and 18 producers, accounting for 5400 acres in Beaufort County signed contracts and received WQIP funds. Most of the allocated funds were utilized in development of total nutrient management plans for these farms. These plans were written by local cooperative extension agents or by consultants who submitted them to NRCS for approval. The farms in Beaufort Co. received an average of $8.90/ acre in contracts which extend through 1995.

At the state level, the NC Agricultural Cost Share Program (ACSP), administered by the NC Division of Soil and Water Conservation, provides cost share funds to farmers to install BMPs. Under the ACSP in the Tar-Pamlico basin:

- Contracts totaling $4,519,060.26 have been signed.
- A total of 131,127.2 acres have been treated.
- A total of 75 animal waste systems have been installed.
- A total of 443 water control structures have been built.

- <u>Costs for Additional Agricultural NPS Controls to Meet the Recommended Nitrogen Reduction Goal</u>

The total load of total nitrogen (TN) from point and nonpoint sources in subbasins 01 through 06 is 4,982,340 kg/year based on the coefficient method data summarized in Table 3.2 in Chapter 3. Runoff from agricultural activities is estimated to contribute approximately 65% of this load compared to 24% for dischargers that are members of the Association. However, in order to account for fate and transport losses and for equity purposes, the agricultural load is estimated to be 50% of the total compared to 9% for the Association of dischargers (a net reduction of 15%). The TN reduction requirement for point and nonpoint sources from 1991 loadings is 583,000 kg/yr at Washington. Therefore, load reductions from agriculture should be approximately 291,500 kg/yr (583,000 x .50).

The Research Triangle Institute conducted a study on the cost-effectiveness of agricultural BMPs in reducing nutrient loading. An approximate cost of $29/kg was determined for overall agricultural nutrient reductions (somewhat higher for animal waste operations and somewhat lower for nutrient management on cropland). Using this figure, the total cost for a 30% reduction in TN from agriculture from 1991 is estimated to be $8,453,500. It is recommended that funding of the North Carolina Agricultural Cost Share Program for Nonpoint Source Pollution Control be increased.

<u>Voluntary implementation of nutrient BMPs is preferred over mandatory controls.</u> To make this happen, there needs to be a concerted effort to educate the nonpoint source contributors on the importance of reducing nutrient loading, to encourage further voluntary participation in the BMP programs, and <u>to provide them with cost-effective options</u>. Education may be conducted through the NC Cooperative Extension Service, Soil and Water Conservation Districts, Farm Bureau, NC Department of Agriculture and others. Cost share opportunities are offered through the USDA Agricultural Stabilization and Conservation Service and the NC Agricultural Cost Share Program. DEM will need assess the need for mandatory nonpoint source control measures during updating of the basin plan in 1999.

Support Development of Cost Effective Measures and New Technologies for Nonpoint Sources
DEM should also work with the agencies to obtain better information on BMP cost/effectiveness to supplement the research that Research Triangle Institute is performing. A portion of 319 funds and cost share moneys should be used to perform site specific monitoring before and after BMPs are implemented. This will provide data specific to the North Carolina coastal plain to help develop cost effective nutrient management strategies.

Wetlands Protection and Nutrient Reductions
Protection and/or restoration of wetlands may prove to be a cost-effective tool in controlling nutrients. Numerous authors have studied the effectiveness of riparian wetland forests for nutrient retention and transformation (see section 5.3.8). The location of riparian wetlands allows them the opportunity to receive nutrients from the surrounding landscape as well as through overbank flooding. In addition to the storage of nutrients in wetland vegetation, the microbial and chemical processes within wetland soils may function to completely remove nutrients from the system.

Headwater riparian wetlands are the most important wetlands in terms of sediment and associated nutrient and toxicant retention. Since small stream comprise most of the total stream length within a watershed, these areas intercept the greatest proportion of eroded sediments and associated substances before these pollutant reach waters downstream. One study found that approximately 80% of the sediments entering a stream were retained in headwater wetlands.

In the Tar-Pamlico River Basin, there is a project being funded under the Clean Water Act (CWA) Section 319 (h) Nonpoint Source Program to restore an Atlantic White Cedar wetland at Pocosin Lakes National Wildlife Refuge. This project is intended to restore Atlantic white cedar wetlands to 640 acres of prior converted wetlands with peaty soils to achieve nonpoint source reductions of nitrogen and mercury to surface waters which drain into the Pungo River. The hydrology of the area will be restored through the placement of a single large flashboard riser. Extensive measurements of ground elevations have been made by the U.S. Natural Resources Conservation Service to determine where the riser should be placed to achieve the desired restoration. The sites selected for planting have been extensively degraded by heavy grazing of cattle to the point that natural regeneration of the plant community is not occurring.

6.4.5 Point Source Nutrient Reduction Strategy

The Division finalized Phase II of the Tar-Pamlico Basin NSW Implementation Strategy. This is in followup to Phase I which ends this year. The Phase II agreement outlines loading targets for point source facilities and other actions the dischargers will take to reduce nutrient loading in the basin. It includes reduction strategies for both dischargers that are members of the Tar-Pamlico Basin Association and non-association dischargers. It also includes a commitment by DEM to work with the appropriate nonpoint source agencies to develop a plan by September, 1995 to meet the nutrient reduction goals outlined in the preceding section. The Phase II strategy is included in Appendix IV (pages *A-IV*-11 through *A-IV*-32).

6.4.6 Future Monitoring and Research Needs

Performance Monitoring Needed to Evaluate Nutrient Reductions Strategies
A monitoring plan should be developed during the next year which will allow DEM to evaluate this management strategy. As part of the monitoring, a gaging station should be located Tarboro and Grimesland, and monthly ambient data including the nutrient series should be measured. This will give DEM more accurate loading downstream estimates. DEM should also consider setting up gages to obtain better flow data in the estuary as this will allow the model

hydrodynamics to be recalibrated so the model can be used to evaluate nutrient control strategies in the lower portion of the basin. In addition, extensive monitoring should continue throughout the estuary. East Carolina University has been collecting data in the Pamlico River for many years, and continuation of these studies should be encouraged. In addition, as part of the Albemarle-Pamlico (A/P) Estuarine Study, the Washington Regional Office had an extra monitoring staff position to provide sampling data in the A/P study area. The funding for this position will be halted soon, and DEM or the Association should consider finding alternative funds to keep the position open. An alternative would be to set up a monitoring network that would be funded by the Association and would replace NPDES instream monitoring requirements. Data obtained through this monitoring will be used to document nutrient reductions, evaluate changes in estuary quality, and improve the modeling analysis and loading targets.

Further Studies on Fate and Transport of Nutrients Recommended
Finally, a long term goal should be to develop methods to perform fate and transport modeling to examine how nutrients are assimilated instream. Current models available in the Tar-Pamlico Basin do not allow one to determine what percentage of nutrients which run off into a stream in the upper portion of the watershed actually is transported to the estuary. Fate and transport modeling is extremely data intensive and is not practical to perform on a large basin at this time. However, it is feasible to do this type of modeling on a small watershed if data are available. If future monitoring indicates severe nutrient problems on a smaller watershed, it may be cost effective to perform studies to develop a fate and transport model. In addition, people are beginning to develop simpler models which examine nutrient transport which will not require as much data. Finally, if estuary data indicate that problems are still prevalent in the estuary after loading targets are met, it may be prudent to develop a more sophisticated modeling tool.

6.4.7 Near-term Watershed-scale Nutrient Control Strategies for Subbasins Within the Tar-Pamlico River Basin

In addition to the NSW strategy, other strategies are necessary in localized areas. While the NSW designation was designed to protect the basin as a whole on an annual basis, some localized areas are impacted by a constant discharge. These areas are outlined below. No localized nutrient related problems have been identified in subbasins 03, 04, 06, and 08.

Subbasin 01
This subbasin is characterized by large amounts of agricultural land (143,000 acres or 34% of land area). Erosion rates for this region are above average, and there are high rates of fertilizer application. These characteristics can cause eutrophication under the right hydrologic conditions. Phytoplankton data have indicated that there are eutrophic conditions in Lake Devin, Lake Royale, and Hart Pond.

Lake Devin is a small water supply reservoir for the Town of Oxford, and is primarily forested with some agricultural land use. Lake Devin is located on Hatchers Run in the Fishing Creek basin. Fishing Creek Watershed, a PL-566 watershed protection project, was completed in 1994. Measures installed through the project will address some of the nonpoint nutrient problems, and DEM should continue to monitor the subbasin for improvements.

Lake Royale is a privately owned lake on Cypress Creek, and there are no permitted dischargers in the watershed. There has been a history of sanitary problems at Lake Royale since the early 1980's. In addition, there are a number of hog operations upstream which may be contributing to the problem. As part of the animal waste management operations adopted in December 1992 (15A NCAC 2H .0217), many of these hog operations will have to register with the state (see section 5.3.2). This listing will help DEM determine the source of some of the problems and indicate specific areas in need of BMP development.

Hart Pond, in Granville County, had a large algal bloom reported in 1990. Several thousand caged catfish died. It is likely that anoxic conditions caused by deteriorating algal mats and algal respiration contributed to the fish kill. DEM should explore the sources of this nutrient problem.

Subbasin 02

Subbasin 02 is characterized by large areas of agricultural land (187,000 acres; 61% of land). Elevated concentrations of nitrogen have been detected on Swift Creek near Hilliardston during biological studies in 1992. Heavy growths of macrophytes have also been noted at this location. Nonpoint sources of pollution appear to be the source, and DEM should work with the agricultural agencies to address the problem. Modeling by RTI shows high areal nutrient and sediment loads (Chapter 3). This stream provides habitat for a large number of threatened and endangered mussel species. and should be given a high priority for BMP implementation.

Elevated chlorophyll *a* values have been noted within the Tar River Reservoir, a water supply for the City of Rocky Mount. Although biovolume estimates have not indicated bloom conditions, DEM should continue to monitor this lake to ensure that conditions do not worsen.

Subbasin 05

The Chicod Creek subbasin is primarily agricultural. In the past decade a dramatic increase in the number of confined animal operations has occurred. As a result, nutrient loading in this watershed has become a major concern. Data collected through NAWQA have shown instream concentrations of TP as high as 3 mg/l and NH_3 as high as 25 mg/l, and modeling by RTI shows high predicted areal loads of TN (see Chapter 3). In order to reduce nutrient loading, the Association arranged for federal funds from the Environmental Protection Agency (EPA) under section 104(b)(3) of the Clean Water Act to be provided to the Division of Soil and Water to implement best management practices (BMPs). In addition, DEM has begun an intensive survey of the watershed in which nutrients are collected daily at the USGS gaging station on Chicod Creek at SR 1760. Turbidity, TSS, fecal coliform, pH, conductivity, DO, hardness, and metals are sampled bimonthly in the creek. Benthic and fish tissue data are also being collected in the basin. These data are being collected to demonstrate present conditions in Chicod Creek and to document changes in nutrient loading and water quality resulting from the BMPs.

Subbasin 07

Kennedy Creek is tidally influenced and has little freshwater inflow. Since there is little flushing in the creek and winds often push waters upstream, phytoplankton populations proliferate. Algal blooms have been reported in the creek in 1987, 1988, and 1991. The City of Washington currently discharges into the creek, but it has been told that no expansions will be allowed, and the City is trying to remove its discharge. If the discharge is not removed, stringent nutrient limits will be applied to the NPDES permit in the future. It is recommended that no new discharges be permitted in the creek.

6.5 MANAGEMENT STRATEGIES TO CONTROL TOXIC SUBSTANCES

Toxic substances routinely regulated by DEM include metals, organics, chlorine and ammonia. Section 3.2.3 of the basin plan describes toxic substances.

6.5.1 Assimilative Capacity

The assimilative capacity available for toxicants in the Tar-Pamlico River Basin varies from stream to stream, and is based on designated flow conditions (7Q10 for aquatic life based standards, average flow for carcinogens). In larger streams where there is more dilution flow, there is more assimilative capacity . In areas with little dilution, facilities will receive chemical toxicant limits which are close to the water quality standard for those waters. Toxicants from nonpoint sources typically enter a waterbody during storm events. The waters need to be protected from immediate acute effects and residual chronic effects. A review of the ambient and fish tissue data in the Tar River Basin indicates that a few waterbodies have toxicant problems. These waterbodies are discussed by subbasin below.

6.5.2 Control Strategies

Point source dischargers will be allocated chemical specific toxicant limits and monitoring requirements based on a mass balance technique discussed in the Instream Assessment Unit's Standard Operating Procedures manual and in Appendix III of this report. In addition, all major dischargers used to be required to perform annual pollutant scans for all priority pollutants. These data are used at permit renewal to determine if any other toxic parameters need to be monitored more frequently or assigned limits in the NPDES permit. Whole effluent toxicity limits are also assigned to all major dischargers and any discharger of complex wastewater. Nonpoint sources of toxics are controlled through various strategies described in Chapter 5.

Subbasin 01

The City of Oxford discharges to Fishing Creek, and the toxicant study performed by Research Triangle Institute as part of the Albemarle-Pamlico Estuarine Study (DEHNR, 1992) predicted water quality violations of cadmium, chromium, lead, mercury, and cyanide during 7Q10 conditions based on facility DMR data from 1989 and 1990. The City of Oxford has entered into an SOC to address its toxicity problems. Data from the past year indicate that improvements are occurring. It appears that the facility may still be having trouble addressing cyanide.

Subbasin 03

CSX Transportation discharges to a UT to Little Cokey Swamp. CSX's toxicity data indicated consistent failures from 1990-1992. Benthic data were collected on May 1, 1992 on Little Cokey Swamp above and below the unnamed tributary on which CSX is located. Both sites received a poor rating making it impossible to evaluate any discharge effects. Little Cokey Swamp may also be impacted by runoff from the CSX railroad and urban runoff in Rocky Mount. It should be noted that the facility has recently been upgraded, reduced its flow, and has not recently discharged. CSX is also trying to connect to the City of Rocky Mount. DEM should continue to monitor the stream to determine if CSX's actions will improve the stream. If improvements do not occur, DEM should examine the feasibility of BMPs to reduce nonpoint loadings.

Subbasin 04

The Town of Enfield discharges to Beech Branch. The facility failed its whole effluent toxicity tests during 1991 and 1992. Benthic data were collected above and below the facility in May 1992, and the area upstream of the discharge received a fair rating. The downstream site received a poor rating. The data suggested that Enfield was impacting the stream. The facility should be required to perform TIE/TRE to determine the toxicant responsible for whole effluent toxicity.

Subbasin 05

Data collected by NAWQA have shown several pesticides to be present in the Chicod Creek basin. In addition, toxic concentrations of ammonia have been detected. Agricultural operations are the primary source, and 319 funds have been allocated for BMPs (see section 6.4.2, above). Fish tissue data collected on the Tar River near Greenville indicated that mercury was approaching the FDA action level of 1.0 mg/kg. Sample values ranged from 0.64 to 0.92 mg/kg. The source of this mercury is unknown.

Subbasin 07

Benthic macroinvertebrate sampling indicates that Kennedy Creek may have been impacted by the Washington outfall and the old outfall location of National Spinning. Elevated sediment concentrations of nickel, mercury, zinc, copper, cadmium, and lead have been found here. National Spinning has relocated its discharge to the Tar mainstem, and Washington is working on removing its discharge. No new outfalls will be allowed into Kennedy Creek.

Fish tissue data from several water bodies in this subbasin have revealed elevated mercury concentrations. At Lake Mattamuskeet five samples out of fifty exceeded the FDA criteria of 1.0 mg/kg, and five other fish samples contained mercury ranging from 0.71 mg/kg to 0.97 mg/kg. Two largemouth bass samples collected in 1992 on Tranters Creek near Washington exceeded the FDA action level for mercury. One fish tissue sample collected in 1983 on the Pungo River near Pantego contained mercury in excess of the FDA criteria although subsequent samples collected in 1985 yielded no metals above FDA criteria.

The source (or sources) of this mercury is unknown at this time. DEM's Environmental Sciences Branch is conducting a major study throughout much of the state's coastal plain to identify the extent of elevated mercury levels in fish tissues. Identification of the geographic extent of this phenomenon will hopefully lead to source identification. The State Health Director has issued fish consumption advisories for waters in the Lumber River basin.

6.6 MANAGEMENT STRATEGIES FOR CONTROLLING SEDIMENTATION

Sedimentation is the most widespread cause of freshwater stream impairment in the state. The causes, sources and water quality impacts of sedimentation are described in section 3.2.4 of Chapter 3. The purpose of this section is to describe ongoing sediment control program strategies, to summarize some achievements in sediment control, and to stress the need to continue to develop and apply more effective and widespread sediment control measures.

Sedimentation is a widespread nonpoint source-related water quality problem which results from land-disturbing activities. The most significant of these activities include agriculture, land development (e.g., highways, shopping centers, schools and residential subdivisions), forestry and mining. For each of these major types of land-disturbing activities, there are programs being implemented by various government agencies at the state, federal and/or local level to minimize soil loss and protect water quality (see Chapter). These programs are listed in Table 6.4.

DEM works cooperatively with those agencies that administer the sediment control programs in order to maximize the effectiveness of the programs and protect water quality. Where programs are not effective, as evidenced by violation of instream water quality standards (section 3.2.4), and where DEM can identify a source, then appropriate enforcement action can be taken. This process usually entails requiring the land owner or responsible party to install acceptable best management practices (BMPs) although fines may be issued. BMPs vary with the type of activity, but are generally aimed at minimizing the area of land-disturbing activity and the amount of time the land remains unstabilized; setting up barriers, filters or sediment traps (such as temporary ponds or silt fences) to reduce the amount of sediment reaching surface waters; and recommending land management approaches that minimize soil loss, especially for agriculture. Lists of BMPs for several types of nonpoint sources of pollution

Some sedimentation control measures, principally for construction or land development activities of 1 acre or more, are required by law under the state's Sedimentation Control Act administered by the NC Division of Land Resources. For activities not subject to the act such as agriculture, sediment controls are carried out on a voluntary basis through programs administered by several different agencies. The NC Agricultural Cost Share Program administered by the NC Division of Soil and Water Conservation provides incentives to farmers to install BMPs by offering to pay up to 75% of the average cost of approved BMPs. The 1985 Food Security Act (FSA) administered by the US Department of Agriculture requires producers to comply with conservation plans developed by the Natural Resources Conservation Service on highly erodible land (HEL) in order to participate in federal farm programs (Farmers Home Administration loans, subsidies, etc.).

Table 6.4 State and Federal Sediment Control-related Programs (Sections listed in parentheses are found in Chapter 5)

- <u>Agricultural Nonpoint Source (NPS) Control Programs (Section 5.3.1)</u>
  - North Carolina Agriculture Cost Share Program
  - NC Cooperative Extension Service and Agricultural Research Service
  - Watershed Protection and Flood Prevention Program (PL 83-566)
  - Food Security Act of 1985 (FSA) and the Food, Agriculture, Conservation and Trade Act of 1990 (FACTA) (Includes Conservation Reserve Program, Conservation Compliance, Sodbuster, Swampbuster, Conservation Easement, Wetland Reserve and Water Quality Incentive Program)

- <u>Construction, Urban and Developed Lands (Sections 5.3.2 and 5.3.3)</u>
  - Sediment Pollution Control Act (Section 5.3.3)
  - Federal Urban Stormwater Discharge Program
  - Water Supply Protection Program
  - NC Coastal Stormwater Management Regulations
  - Coastal Nonpoint Pollution Control Programs
  - ORW and HQW Stream Classifications

- <u>Forestry NPS Programs (Section 5.3.6)</u>
  - Forest Practice Guidelines Related to Water Quality
  - National Forest Management Act (NFMA)
  - Forest Stewardship Program

- <u>Mining Act (Section 5.3.7)</u>

- <u>Wetlands Regulatory NPS Programs (Section 5.3.8)</u>
  The sediment trapping and soil stabilization properties of wetlands are particularly important to nonpoint source pollution control. Several important state and federal wetland protection programs are listed below.
  - Section 10 of the Rivers and Harbors Act of 1899
  - Section 404 of the Clean Water Act
  - North Carolina Coastal Area Management Act (CAMA) Of 1974
  - ~~Section 401 Water Quality Certification (from CWA)~~
  - North Carolina Dredge and Fill Act (1969)

Considerable progress toward sediment control has been made under the Food Security Act (FSA) of 1985 and the Food, Agriculture, Conservation, and Trade Act (FACTA) of 1990. There have been a total of twelve sign-ups for farmers to participate in the Conservation Reserve Program through 1994. There are 10,996 Conservation District Cooperators managing 2,203,806 acres in the 16 counties comprising the Tar-Pamlico river basin. The USDA-NRCS has made 17,516 highly erodible land (HEL) determinations which represent 365,773 acres. USDA-NRCS has also written 16,190 HEL conservation plans covering 376,236 acres, as well as performed soil surveys encompassing 5,118,040 acres. There are also 8,782 tracts in the basin with NRCS approved conservation systems applied on fields identified as HEL covering 249,097 acres. To date, 22,828 Cropland acres have benefited by best management practice application, with a total savings of 272,583 tons of soil losses within the 16 counties.

6.7 MANAGEMENT STRATEGIES FOR CONTROLLING FECAL COLIFORM BACTERIA IN SHELLFISH WATERS

Use support data presented in Section 4.5 of Chapter 4 indicates that over 10,000 acres of shellfish waters are closed as a result of fecal coliform bacterial contamination. DEM has identified nonpoint source pollution as the primary source of impairment with potential sources including stormwater runoff from coastal development, failing septic systems, marinas and agricultural runoff. Shellfish water closures are administered by the NC Division of Marine Fisheries (DMF) based on the recommendations of the NC Division of Environmental Health's (DEH) Shellfish Sanitation Branch.

From a management standpoint, there are two objectives concerning shellfish (SA) waters. One is to protect open shellfish waters through preventing closure due to bacterial contamination. The second, and more difficult, is to reopen closed shellfish waters.

An important lesson learned from past efforts to reopen closed shellfish waters has been the realization that identifying the specific sources of bacterial pollution and then ensuring implementation of effective control measures has been a major stumbling block. Because of the high costs of treatment (e.g., replacement of septic systems with centralized wastewater treatment systems or installation of BMPs in urban or agricultural areas), there has been a reluctance to require control measures without being able to document specific sources. However, documentation of sources requires expensive and time-consuming monitoring, and there is little money and insufficient staff time and resources available to pinpoint sources "beyond a shadow of a doubt". And finally, even when a source has been identified, control of bacteria to meet shellfish water standards may be extremely difficult as in the case of runoff from densely developed areas.

Clearly, if the continued closure of shellfish waters is to be prevented, and the reopening of closed shellfish waters is to be accomplished, there needs to be a concerted effort by state, local and federal government agencies, cooperation of landowners and support by the state legislature to make it happen. Such an effort will require funding, staff time, public education, and probably new regulations aimed clearly at controlling fecal coliform bacteria in the area of shellfish waters. The basinwide planning process is not empowered with the authority to require these actions, however, it does offer the opportunity to draw attention to this issue and to set into motion actions that may lead to positive results.

There are four new efforts underway that may provide additional protection of shellfish waters. The first is a new coastal nonpoint pollution control program being developed by the NC Division of Coastal Management under requirements of the Coastal Zone Act Reauthorization Amendments (CZARA). It is unclear to what extent these rules would reduce bacterial loadings from existing land uses, particularly developed areas, however, they may be able to strengthen requirements aimed at controlling pollution from new development through more effective density controls and/or use of BMPs. These rules are in the process of being drafted and are to be completed in 1995. The second approach is the Governor's Coastal Futures Committee initiative. This initiative is taking a close look at coastal problems, including the closure of shellfish waters. Third, the Comprehensive Conservation Management Plan (CCMP) prepared under the Albemarle - Pamlico Estuarine Study includes recommendations for addressing closed shellfish waters. Finally, DEM is working on development of a new supplemental water classification that would be applied to waters that are not supporting their uses. Under this new supplemental classification, a watershed restoration plan would be developed for the impaired water body, and some BMPs could be made mandatory. The classification has yet to be formally requested for consideration by the EMC. If eventually approved, reclassification of waters under this new classification would follow the same formal process as any other reclassification.

In addition to these possibilities, DEM has identified the need for increased interagency coordination to develop a common understanding of the extent and nature of shellfish water closures, to identify existing weaknesses in shellfish water protection, and to outline a strategy of what would be required to protect and reopen these waters, including the need for new rules or legislation. Staff should continue to evaluate the sources of bacteria contamination of shellfish waters and to develop necessary statutory and/or rule modifications to provide the necessary means to address such situations where standards are not being met nor uses being attained.

6.8 MANAGEMENT STRATEGIES FOR STORMWATER CONTROL

A number of studies, including the Nationwide Urban Runoff Program (NURP) sponsored by the US Environmental Protection Agency, have shown that urban stormwater runoff, and the pollutants it carries, can be a significant contributor to water quality impairment. DEM administers a number of programs aimed at controlling urban stormwater runoff. These include: 1) programs for the control of development activities near High Quality Waters (HQW) and Outstanding Resource Waters (ORW) and activities within designated Water Supply (WS) watersheds and the 20 coastal counties and 2) NPDES stormwater permit requirements for industrial activities and municipalities greater than 100,000 in population (see Section 5.3.2).

6.8.1 HQW, ORW and Water Supply Watersheds

The Tar-Pamlico River Basin includes a number of streams and lakes that are assigned these sensitive water classifications. As described in other parts of this plan, these waters carry with them specific management strategies to protect their uses, including measures to control stormwater runoff from urban development (Section 2.5.3 and Appendix I). The HQW and ORW requirements in this basin are implemented by DEM through it's Washington and Raleigh Regional Offices. Any development activities subject to the HQW or ORW requirements must submit plans and receive stormwater approvals from these regional offices. The water supply protection requirements are implemented by all local governments that have jurisdiction in a water supply watershed. There are 25 local governments in the French Broad basin that have developed water supply watershed protective ordinances for watersheds in the basin. Development activities covered by water supply protection requirements must be reviewed and approved by the appropriate local government.

6.8.2 NPDES Stormwater Management

Throughout the Tar-Pamlico Basin, various types of industrial activities with point source discharges of stormwater are required to be permitted under the NPDES stormwater program. These include discharges related to manufacturing, processing, materials storage areas and construction activities with greater than five acres of disturbance. All of those areas requiring coverage must develop Stormwater Pollution Prevention Plans (SWPPP) to minimize and control pollutants discharged from their stormwater systems. These SWPPPs are subject to review and modification by the permitted facilities and DEM to assure that management measures are appropriate.

6.8.3 Recommendations for Controlling Stormwater Impacts by Local Governments Not Subject to NPDES Stormwater Requirements

Other local governments throughout the Tar-Pamlico basin are encouraged to evaluate the potential impacts of stormwater runoff and develop stormwater management programs for control of these sources of pollutants. In this process a few program areas consistent with existing municipal NPDES programs are recommended as starting points for stormwater management. These include:

- Mapping of the local government's storm sewer system and outfall points, and developing procedures to update this information.
- Evaluating existing land uses in the local government's jurisdictional area to determine where sources of stormwater pollution may exist. In addition, local government activities and programs should be evaluated to determine where existing activities address stormwater management in some way, or could be modified to do so.
- Developing educational programs to alert people to the activities that may contribute pollutants to stormwater runoff and how they can change their practices to minimize or eliminate these problems.
- Developing programs to locate and remove illicit connections (illegal discharge of non-stormwater materials) to the storm sewer system. These often occur in the form of floor drains and similar connections. In practice, stormwater management programs represent an area where local governments can develop their own ideas and activities for controlling sources of pollution.
- Reviewing local ordinances pertaining to parking, curb and gutter and open space requirements. Many of these local ordinances could be modified to enhance water quality protection from urban stormwater runoff impacts.

REFERENCES - Chapter 6

Gallagher, Thomas W., Andrew J. Thuman, and Kirk C. Ziegler, 1994, "Application of Coupled Hydrodynamic/Water Column/Sediment Model for the Tar-Pamlico River, NC", Draft, HydroQual, Inc., Mahwah, NJ.

NC Department of Environment, Health, and Natural Resources, 1992, Watershed Planning in the Albemarle-Pamlico Estuarine System: Toxics Analysis. Report prepared by Patricia A. Cunningham, Randall E. Williams, Robert L. Chessin, J. Michael McCarthy, Ross J. Curry, Karen W. Gold, Richard W. Pratt, Steven J. Stichter of Research Triangle Institute.

NC Division of Environmental Management, 1994, A QUAL2E-UNCAS Application to the Tar River from Rocky Mount Mills Dam to Greenville in North Carolina, NCDEM Water Quality Section, Raleigh, NC.

APPENDIX 1

CONTENTS:

- **Summary of North Carolina's Water Quality Classifications and Standards**
- **Anti-Degradation Policy and High Quality Waters (15A NCAC 2B .0201)**
- **Outstanding Resource Waters (15A NCAC 2B .0216)**

SUMMARY OF NORTH CAROLINA'S WATER QUALITY CLASSIFICATIONS AND STANDARDS

PRIMARY CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
Freshwater:				
Class C (standards apply to all freshwaters, unless preempted by more stringent standard for more protective classification)	Secondary recreation (including swimming on an unorganized or infrequent basis); fish and other aquatic life propagation and survival; agriculture and other uses, except for primary recreation, water supply or other food - related uses	See attached Table 1.; WATER QUALITY STANDARDS FOR FRESHWATER CLASSES; standards listed under "Standards For All Freshwaters" column (aquatic life and human health sections) apply to Class C waters, unless preempted by more protective standard.	Stormwater Disposal Rules apply in the 20 coastal counties as described in 15A NCAC 2H .1000	
Class B	Primary recreation (swimming on an organized or frequent basis) and all uses specified for Class C (and not water supply or other food-related uses)	Same as for Class C	Same as for Class C	Wastewater treatment reliability requirements (dual train design; backup power capability) may apply to protect swimming uses (15A NCAC 2H .0124)
WS-I Water Supply NOTE: Revised water supply classifications and standards effective as of 8/3/92	Water supplies in natural and undeveloped watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; no point sources except groundwater remediation when no alternative exists	Not applicable since watershed is undeveloped	No landfills, sludge/residual or petroleum contaminated soils application allowed in watershed
WS-II Water supply	Water supplies in predominantly undeveloped watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; only general permit wastewater discharges allowed in watershed and groundwater remediation discharges allowed when no alternative exists	Local land management program required as per 15A NCAC 2B .0211(d): 2-acre lots or 6% built-upon area in critical area; 1-acre lots or 12% built-upon area outside of critical area; up to 64% in the critical area and 30% built upon area outside of the critical area allowed with engineered stormwater controls for the 1" storm[1]	Buffers required along perennial waters; no new landfills allowed in the critical area and no new discharging landfills outside of critical area; no new sludge/ residual or petroleum contaminated soils application allowed in the critical area; hazardous material and spill/failure containment plan required; spill containment structures required for new industries in the critical area using, storing or manufacturing hazardous materials
WS-III Water Supply	Water supplies in low to moderately developed watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; general permits allowed throughout watershed, domestic and non-process industrial outside of the critical area, groundwater remediation discharges allowed when no alternative exists	Local land management program required as per 15A NCAC 2B .0211(e): 1-acre lots or 12% built-upon area in critical area; ½-acre lots or 24% built-upon outside of critical area; up to 30% in critical area and 50% built-upon area outside critical area with engineered stormwater controls for the 1" storm[1]	Buffers required along perennial waters; no new landfills allowed in the critical area and no new discharging landfills outside of the critical area; no new sludge/ residual or petroleum contaminated soils application allowed in the critical area; hazardous material and spill/failure containment plan required; spill containment structures required for new industries in the critical area using, storing or manufacturing hazardous materials

PRIMARY CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
WS-IV Water Supply	Water supplies in moderately to highly developed watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; general permits, domestic and industrial discharges allowed throughout water supply [2]; groundwater remediation discharges allowed when no alternative exists	Local land management program required as per 15A NCAC 2B .0211(f): ½-acre lots or 24% built-upon area in critical area and protected area [3,4]; up to 50% in critical area and 70% built-upon area outside critical area with engineered stormwater controls for the 1" storm[1]	Buffers required along perennial waters; no new landfills allowed in the critical area; no new sludge/residual or petroleum contaminated soils application allowed in the critical area; hazardous material and spill/failure containment plan required
WS-V Water Supply	River segment	No categorical restrictions on development or wastewater dischargers. Instream water quality standards for water supply waters are applicable.		

NOTE: Please refer to 15A NCAC 2B .0101, .0104, .0202, .0211 and .0301 for more specific requirements for surface water supply protection.

[1] If the high density development option is utilized, then wet detention basins are required and local governments will assume ultimate responsibility for the operation and maintenance of these engineered stormwater control structures.

[2] New industrial process wastewater discharges in the critical area are allowed but must meet additional treatment requirements.

[3] Applies to projects requiring an Erosion/Sedimentation Control Plan.

[4] 1/3 acre or 36% built-upon area is allowed for projects without a curb and gutter street system in the protected area.

- Critical area is ½ mile and draining to water supplies from normal pool elevation of reservoirs, or ½ mile and draining to a river intake.
- Protected area is 5 miles and draining to water supplies from normal pool elevation of reservoirs, or 10 miles upstream of and draining to a river intake.
- Agricultural activities are subject to provisions of the Food Security Act of 1985 and the Food, Agriculture, Conservation and Trade Act of 1990. In WS-I watersheds and critical areas of WS-II, WS-III and WS-IV areas, agricultural activities must maintain a 10 foot vegetated buffer or equivalent control, and animal operations >100 animal units must use BMPs as determined by the Soil and Water Conservation Commission.
- Silviculture activities are subject to the provisions of the Forest Practices Guidelines Related to Water Quality (15A NCAC 1I .0101-.0209).
- The Department of Transportation must use BMPs as described in their document, "Best Management Practices for Protection of Surface Waters".

PRIMARY CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
Saltwater:				
Class SC	Saltwaters protected for secondary recreation, aquatic life propagation and survival and other uses as described for Class C	See attached Table 2.; WATER QUALITY STANDARDS FOR SALTWATER CLASSES; standards listed under "Standards For All Tidal Saltwaters" column (aquatic life and human health sections) apply to Class SC waters, unless preempted by more protective standard.	Stormwater Disposal Rules (15A NCAC 2H .1000) apply to all waters in the 20 coastal counties; low density option: 30% built-upon area or 1/3 acre lots, or structural stormwater controls with higher density, as specified	
Class SB	Saltwaters protected for primary recreation and all Class SC uses (similar to Class B)	Same as Class SC except no floating solids, settleable solids or sludge deposits attributable to sewage, industrial or other wastes	Same as Class SC	Reliability requirements same as for Class B
Class SA	Shellfishing and all Class SC and SB uses	Same as for Class SC, except fecal coliform = 14 colonies per 100 ml of water; all other waters = 200/100 ml fecal	Same as for Class SC, except low density option = 25% built-upon area	No domestic discharges and only nonprocess industrial discharges, such as seafood packing house or cooling water discharges

SUMMARY OF NORTH CAROLINA'S WATER QUALITY CLASSIFICATIONS AND STADARDS (continued)

Supplemental Classifications are added to the primary classifications as appropriate (Examples include Class C-NSW, Class SA-ORW, Class B-Trout, etc.) and impose additional requirements.

SUPPLEMENTAL CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
High Quality Waters (HQW) (categories: (1) waters rated as Excellent by DEM; (2) Primary Nursey Areas; (3) Native or Special Native Trout Waters; (4) Critical Habitat Areas; (5) WS-I and WS-II water supplies; (6) SA waters)	Waters with quality higher than the standards (EPA's Tier II waters; the minimum standards for Class C and SC define Tier I); see Standards and Stream Classifications Rules (15A NCAC 2B .0100) for detailed description (15A NCAC 2B .0101(e)(5))	For new or expanded discharges, advanced treatment requirements are: BOD_5=5 mg/l; NH_3-N= 2 mg/l; DO=6 mg/l	Projects requiring Erosion/ Sedimentation Control Plan and are within 1 mile and draining to HQW waters: 1-acre lots or 12% built-upon area, or higher density with engineered structural controls (wet detention ponds); WS-I, WS-II and 20 coastal counties exempt since stormwater control requirements already apply	Other treatment requirements may apply, dependent upon type of discharge and characteristics of receiving waters (see pp. 1 and 2 of Section .0200 Rules: 15A: NCAC 2B .0201(d) of Antidegradation Policy)
Outstanding Resource Waters (ORW)	Unique and special waters having exceptional water quality and being of exceptional state or national ecological or recreational significance; must meet other certain conditions and have 1 or more of 5 outstanding resource value criteria as described in Rule 2B .0216	Water quality must clearly maintain and protect uses, including outstanding resource values; management strategies must include at a minimum: no new or expanded discharges to freshwater ORWs; some discharges may be allowed in coastal areas	Same as for High Quality Waters for Freshwater ORWs; for Saltwater ORWs, development activities within a 575' buffer must comply with the low density option of Stormwater Disposal Rules (generally, 25% built-upon area around SA waters and 30% around other waters)	Other management strategy components as described in Rule .0216
Trout Waters (Tr)	Protected for natural trout propagation and survival of stocked trout;	More protective standards for cadmium, total residual chlorine, chlorophyll-a, dissolved oxygen, turbidity and toluene to protect these sensitive species (see Table 1. under "Trout" heading)		
Nutrient Sensitive Waters (NSW)	Waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation	No increase of nutrients over background levels		Nutrient management strategies developed on a case-by-case basis
Swamp Waters (Sw)	Waters with low velocities and other characteristics different from other waterbodies (generally, low pH, DO, high organic content)	pH as low as 4.3 and DO less than 5 mg/l allowed if due to natural conditions		

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TABLE 1. WATER QUALITY STANDARDS FOR FRESHWATER CLASSES

Parameters	Standards For All Freshwater		More Stringent Standards To Support Additional Uses	
	Aquatic Life	Human Health	WS Classes	Trout
Arsenic (ug/l)	50			
Barium (mg/l)			1.0	
Benzene (ug/l)		71.4	1.19	
Beryllium (ng/l)		117	6.8	
Cadmium (ug/l)	2.0			0.4
Carbon tetrachloride (ug/l)		4.42	0.254	
Chloride (mg/l)	230 (AL)		250	
Chlorinated benzenes (ug/l)			488	
Chlorine, total residual (ug/l)	17 (AL)			17
Chlorophyll a, corrected (ug/l)	40 (N)			15 (N)
Chromium, total (ug/l)	50			
Coliform, total (MFTCC/100ml)			50 (N)(2)	
Coliform, fecal (MFTCC/100ml)		200 (N)		
Copper (ug/l)	7 (AL)			
Cyanide (ug/l)	5.0			
Dioxin (ng/l)		0.000014	0.000013	
Dissolved gases	(N)			
Dissolved oxygen (mg/l)	5.0 (Sw)(1)			6.0
Fluoride (mg/l)	1.8			
Hardness, total (mg/l)			100	
Hexachlorobutadiene (ug/l)		49.7	0.445	
Iron (mg/l)	1.0 (AL)			
Lead (ug/l)	25 (N)			
Manganese (ug/l)			200	
MBAS (ug/l) (Methylene-Blue-Active Substances)	500			
Mercury (ug/l)	0.012			
Nickel (ug/l)	88		25	
Nitrate nitrogen (mg/l)			10	
Pesticides				
Aldrin (ng/l)	2.0	0.136	0.127	
Chlordane (ng/l)	4.0	0.588	0.575	
DDT (ng/l)	1.0	0.591	0.588	
Demeton (ng/l)	100			
Dieldrin (ng/l)	2.0	0.144	0.135	
Endosulfan (ng/l)	50			
Endrin (ng/l)	2.0			
Guthion (ng/l)	10			
Heptachlor (ng/l)	4.0	0.214	0.208	
Lindane (ng/l)	10			
Methoxychlor (ng/l)	30			
Mirex (ng/l)	1.0			
Parathion (ng/l)	13			
Toxaphene (ng/l)	0.2			
2,4-D (ug/l)			100	
2,4,5-TP (Silvex) (ug/l)			10	
pH (units)	6.0-9.0 (Sw)			
Phenolic compounds (ug/l)		(N)	1.0 (N)	
Polychlorinated biphenyls (ng/l)	1.0	0.079		
Polynuclear aromatic hydrocarbons (ng/l)		31.1	2.8	
Radioactive substances		(N)		
Selenium (ug/l)	5			
Silver (ug/l)	0.06 (AL)			
Solids, total dissolved (mg/l)			500	
Solids, suspended	(N)			
Sulfates (mg/l)			250	
Temperature	(N)			
Tetrachloroethane (1,1,2,2) (ug/l)		10.8	0.172	
Tetrachloroethylene (ug/l)			0.8	
Toluene (ug/l)	11			0.36
Toxic Substances	(N)			
Trialkyltin (ug/l)	0.008			
Trichloroethylene (ug/l)		92.4	3.08	
Turbidity (NTU)	50; 25 (N)			10 (N)
Vinyl chloride (ug/l)		525	2	
Zinc (ug/l)	50 (AL)			

Note: (N) See 2B .0211 (b), (c), (d), or (e) for narrative description of limits.

(AL) Values represent action levels as specified in .0211 (b)(4).

(Sw) Designated swamp waters may have a pH as low as 4.3 and dissolved oxygen less than 5.0 mg/l if due to natural conditions.

(1) An instantaneous reading may be as low as 4.0 ug/l but the daily average must be 5.0 ug/l or more.

(2) Applies only to unfiltered water supplies.

TABLE 2. WATER QUALITY STANDARD FOR SALTWATER CLASSES

Parameters	Standards For All Tidal Saltwaters		More Stringent Standards To Support Additional Uses
	Aquatic Life	Human Health	Class SA
Arsenic (ug/l)	50		
Benzene (ug/l)		71.4	
Beryllium (ng/l)		117	
Cadmium (ug/l)	5.0		
Carbon tetrachloride (ug/l)		4.42	
Chlorophyll a (ug/l)	40 (N)		
Chromium, total (ug/l)	20		
Coliform, fecal (MFFCC/100ml)		200 (N)	14 (N)
Copper (ug/l)	3 (AL)		
Cyanide (ug/l)	1.0		
Dioxin (ng/l)		0.000014	
Dissolved gases	(N)		
Dissolved oxygen (mg/l)	5.0 (1)		
Hexachlorobutadiene (ug/l)		49.7	
Lead (ug/l)	25 (N)		
Mercury (ug/l)	0.025		
Nickel (ug/l)	8.3		
Phenolic compounds		(N)	
Polychlorinated biphenyls (ng/l)	1.0	0.079	
Polynuclear aromatic hydrocarbons (ng/l)		31.1	
Pesticides (ng/l)			
Aldrin	3.0	0.136	
Chlordane	4.0	0.588	
DDT	1.0	0.591	
Demeton	100		
Dieldrin	2.0	0.144	
Endosulfan	9.0		
Endrin	2.0		
Guthion	10		
Heptachlor	4.0	0.214	
Lindane	4.0		
Methoxychlor	30		
Mirex	1.0		
Parathion	178		
Toxaphene	0.2		
pH (units)	6.8-8.5 (1)		
Radioactive substances		(N)	
Salinity	(N)		
Selenium (ug/l)	71		
Silver (ug/l)	0.1 (AL)		
Solids, suspended	(N)		
Temperature	(N)		
Tetrachloroethane (1,1,2,2) (ug/l)		10.8	
Toxic substances	(N)		
Trialkyltin (ug/l)	0.002		
Trichloroethylene (ug/l)		92.4	
Turbidity (NTU)	25 (N)		
Vinyl chloride (ug/l)		525	
Zinc (ug/l)	86 (AL)		

Note: (N) See 2B .0212 (b), (c), or (d) for narrative description of limits.
(AL) Values represent action levels as specified in .0212(b)(4).
(1) Designated swamp waters may have a pH as low as 4.3 and dissolved oxygen less than 5.0 mg/l if due to natural conditions.

HIGH QUALITY WATERS

Excerpt from Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina 15 NCAC 2B .0200

.0201 ANTIDEGRADATION POLICY

(a) It is the policy of the Environmental Management Commission to maintain, protect, and enhance water quality within the State of North Carolina. Pursuant to this policy, the requirements of 40 CFR 131.12 are hereby incorporated by reference including any subsequent amendments and editions. This material is available for inspection at the Department of Environment, Health, and Natural Resources, Division of Environmental Management, Water Quality Planning Branch, 512 North Salisbury Street, Raleigh, North Carolina. Copies may be obtained from the U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402-9325 at a cost of thirteen dollars ($13.00). These requirements will be implemented in North Carolina as set forth in Paragraphs (b), (c) and (d) of this Rule.

(b) Existing uses, as defined by Rule .0202 of this Section, and the water quality to protect such uses shall be protected by properly classifying surface waters and having standards sufficient to protect these uses. In cases where the Commission or its designee determines that an existing use is not included in the classification of waters, a project which will affect these waters will not be permitted unless the existing uses are protected.

(c) The Commission shall consider the present and anticipated usage of waters with quality higher than the standards, including any uses not specified by the assigned classification (such as outstanding national resource waters or waters of exceptional water quality) and will not allow degradation of the quality of waters with quality higher than the standards below the water quality necessary to maintain existing and anticipated uses of those waters. Waters with quality higher than the standards are defined by Rule .0202 of this Section. The following procedures will be implemented in order to meet these requirements:

(1) Each applicant for an NPDES permit or NPDES permit expansion to discharge treated waste will document an effort to consider non-discharge alternatives pursuant to 15A NCAC 2H .0105(c)(2).

(2) Public Notices for NPDES permits will list parameters that would be water quality limited and state whether or not the discharge will use the entire available load capacity of the receiving waters and may cause more stringent water quality based effluent limitations to be established for dischargers downstream.

(3) The Division may require supplemental documentation from the affected local government that a proposed project or parts of the project are necessary for important economic and social development.

(4) The Commission and Division will work with local governments on a voluntary basis to identify and develop appropriate management strategies or classifications for waters with unused pollutant loading capacity to accommodate future economic growth.

Waters with quality higher than the standards will be identified by the Division on a case-by-case basis through the NPDES permitting and waste load allocation processes (pursuant to the provisions of 15A NCAC 2H .0100). Dischargers affected by the requirements of Paragraphs (c)(1) through (c)(4) of this Rule and the public at large will be notified according to the provisions described herein, and all other appropriate provisions pursuant to 15A NCAC 2H .0109. If an applicant objects to the requirements to protect waters with quality higher than the standards and believes degradation is necessary to accommodate important social and economic development, the applicant can contest these requirements according to the provisions of General Statute 143-215.1(e) and 150B-23.

(d) The Commission shall consider the present and anticipated usage of High Quality Waters (HQW), including any uses not specified by the assigned classification (such as outstanding national resource waters or waters of exceptional water quality) and will not allow degradation of the quality of High Quality Waters below the water quality necessary to maintain existing and anticipated uses of those waters. High Quality Waters are a subset of waters with quality higher than the standards and are as described by 15A NCAC 2B .0101(e)(5). The following procedures will be implemented in order to meet the requirements of this part:

(1) New or expanded wastewater discharges in High Quality Waters will comply with the following:

(A) Discharges from new single family residences will be prohibited. Those that must discharge will install a septic tank, dual or recirculating sand filters, disinfection and step aeration.

(B) All new NPDES wastewater discharges (except single family residences) will be required to provide the treatment described below:

(i) Oxygen Consuming Wastes: Effluent limitations will be as follows: BOD_5= 5 mg/l, NH_3-N = 2 mg/l and DO = 6 mg/l. More stringent limitations will be set, if necessary, to ensure that the cumulative pollutant discharge of oxygen-consuming wastes will not cause the DO of the receiving water to drop more than 0.5 mg/l below background levels, and in no case below the standard. Where background information is not readily available, evaluations will assume a percent saturation determined by staff to be generally applicable to that hydroenvironment.

(ii) Total Suspended Solids: Discharges of total suspended solids (TSS) will be limited to effluent concentrations of 10 mg/l for trout waters and PNA's, and to 20 mg/l for all other High Quality Waters.

(iii) Disinfection: Alternative methods to chlorination will be required for discharges to trout streams, except that single family residences may use chlorination if other options are not economically feasible. Domestic discharges are prohibited to SA waters.

(iv) Emergency Requirements: Failsafe treatment designs will be employed, including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs.

(v) Volume: The total volume of treated wastewater for all discharges combined will not exceed 50 percent of the total instream flow under 7Q10 conditions.

(vi) Nutrients: Where nutrient overenrichment is projected to be a concern, appropriate effluent limitations will be set for phosphorus or nitrogen, or both.

(vii) Toxic substances: In cases where complex wastes (those containing or potentially containing toxicants) may be present in a discharge, a safety factor will be applied to any chemical or whole effluent toxicity allocation. The limit for a specific chemical constituent will be allocated at one-half of the normal standard at design conditions. Whole effluent toxicity will be allocated to protect for chronic toxicity at an effluent concentration equal to twice that which is acceptable under design conditions. In all instances there may be no acute toxicity in an effluent concentration of 90 percent as measured by the North Carolina "Pass/Fail Methodology for Determining Acute Toxicity in a Single Effluent Concentration". Ammonia toxicity will be evaluated according to EPA guidelines promulgated in the Ammonia Criteria Development Document (1986); EPA document number 440/5-85-001; NTIS number PB85-227114; July 29, 1985 (50 FR 30784).

(C) All expanded NPDES wastewater discharges in High Quality Waters will be required to provide the treatment described in part (1)(B) of this Rule, except for those existing discharges which expand with no increase in permitted pollutant loading.

(2) Development activities which require an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or local erosion and sedimentation control program approved in accordance with 15A NCAC 4B .0218, and which drain to and are within one mile of High Quality Waters (HQW) will be required to control runoff from the one inch design storm as follows:

(A) Low Density Option: Developments which limit single family developments to one acre lots and other type developments to 12 percent built-upon area, have no stormwater collection system as defined in 15A NCAC 2H .1002(13), and have built-upon areas at least 30 feet from surface waters will be deemed to comply with this requirement, unless it is determined that additional runoff control measures are required to protect the water quality of High Quality Waters necessary to maintain existing and anticipated uses of those waters, in which case more stringent stormwater runoff control measures may be required on a case-by-case basis. Activities conforming to the requirements described in 15A NCAC 2H .1003(a) [except for Subparagraphs (2) and (3) which apply only to waters within the 20 coastal counties as defined in 15A NCAC 2H .1002(9)] will also be deemed to comply with this requirement, except as provided in the preceding sentence.

(B) High Density Option: Higher density developments will be allowed if stormwater control systems utilizing wet detention ponds as described in 15A NCAC 2H .1003(i), (k) and (l) are installed, operated and maintained which control the runoff from all built-upon areas generated from one inch of rainfall, unless it is determined that additional runoff control measures are required to protect the water quality of High Quality Waters necessary to maintain existing and anticipated uses of those waters, in which case more stringent stormwater runoff control measures may be required on a case-by-case basis. The size of the control system must take into account the runoff from any pervious surfaces draining to the system.

(C) All waters classified WS-I or WS-II and all waters located in the 20 coastal counties as defined in Rule 15A NCAC 2H .1002(9) are excluded from this requirement since they already have requirements for nonpoint source controls.

If an applicant objects to the requirements to protect high quality waters and believes degradation is necessary to accommodate important social and economic development, the applicant can contest these requirements according to the provisions of G.S. 143-215.1(e) and 150B-23.

(e) Outstanding Resource Waters (ORW) are a special subset of High Quality Waters with unique and special characteristics as described in Rule .0216 of this Section. The water quality of waters classified as ORW shall be maintained such that existing uses, including the outstanding resource values of said Outstanding Resource Waters, will be maintained and protected.

OUTSTANDING RESOURCE WATERS

Excerpt from Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina 15 NCAC 2B .0200

.0216 OUTSTANDING RESOURCE WATERS

(a) General. In addition to the existing classifications, the Commission may classify certain unique and special surface waters of the state as outstanding resource waters (ORW) upon finding that such waters are of exceptional state or national recreational or ecological significance and that the waters have exceptional water quality while meeting the following conditions:

(1) there are no significant impacts from pollution with the water quality rated as excellent based on physical, chemical or biological information;

(2) the characteristics which make these waters unique and special may not be protected by the assigned narrative and numerical water quality standards.

(b) Outstanding Resource Values. In order to be classified as ORW, a water body must exhibit one or more of the following values or uses to demonstrate it is of exceptional state or national recreational or ecological significance:

(1) there are outstanding fish (or commercially important aquatic species) habitat and fisheries;

(2) there is an unusually high level of water-based recreation or the potential for such recreation;

(3) the waters have already received some special designation such as a North Carolina or National Wild and Scenic River, Native or Special Native Trout Waters, National Wildlife Refuge, etc, which do not provide any water quality protection;

(4) the waters represent an important component of a state or national park or forest; or

(5) the waters are of special ecological or scientific significance such as habitat for rare or endangered species or as areas for research and education.

(c) Quality Standards for ORW.

(1) Freshwater: Water quality conditions shall clearly maintain and protect the outstanding resource values of waters classified ORW. Management strategies to protect resource values will be developed on a site specific basis during the proceedings to classify waters as ORW. At a minimum, no new discharges or expansions of existing discharges will be permitted, and stormwater controls for all new development activities requiring an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or an appropriate local erosion and sedimentation control program will be required to control stormwater runoff as follows:

(A) Low Density Option: Developments which limit single family developments to one acre lots and other type developments to 12 percent built-upon area, have no stormwater collection system as defined in 15A NCAC 2H .1002(13), and have built-upon areas at least 30 feet from surface water areas will be deemed to comply with this requirement, unless it is determined that additional runoff control measures are required to protect the water quality of Outstanding Resource Waters necessary to maintain existing and anticipated uses of those waters, in which case such additional stormwater runoff control measures may be required on a case-by-case basis.

(B) High Density Development: Higher density developments will be allowed if stormwater control systems utilizing wet detention ponds as described in 15A NCAC 2H .1003(i), (k) and (l) are installed, operated and maintained which control the runoff from all built-upon areas generated from one inch of rainfall, unless it is determined that additional runoff control measures are required to protect the water quality of Outstanding Resource Waters necessary to maintain existing and anticipated uses of those waters, in which case such additional stormwater runoff control measures may be required on a case-by-case basis. The size of the control system must take into account the runoff from any pervious surfaces draining to the system.

(2) Saltwater: Water quality conditions shall clearly maintain and protect the outstanding resource values of waters classified ORW. Management strategies to protect

resource values will be developed on a site-specific basis during the proceedings to classify waters as ORW. At a minimum, new development will comply with the low density options as specified in the Stormwater Runoff Disposal rules [15A NCAC 2H .1003 (a)(2)] within 575 feet of the mean high water line of the designated ORW area. New non-discharge permits will be required to meet reduced loading rates and increased buffer zones, to be determined on a case-by-case basis. No dredge or fill activities will be allowed where significant shellfish or submerged aquatic vegetation bed resources occur, except for maintenance dredging, such as that required to maintain access to existing channels and facilities located within the designated areas or maintenance dredging for activities such as agriculture. A public hearing is mandatory for any proposed permits to discharge to waters classified as ORW.

Additional actions to protect resource values will be considered on a site specific basis during the proceedings to classify waters as ORW and will be specified in Paragraph (e) of this Rule. These actions may include anything within the powers of the commission. The commission will also consider local actions which have been taken to protect a water body in determining the appropriate state protection options. Descriptions of boundaries of waters classified as ORW are included in Paragraph (e) of this Rule and in the Schedule of Classifications (15A NCAC 2B .0302 through .0317) as specified for the appropriate river basin and will also be described on maps maintained by the Division of Environmental Management.

(d) Petition Process. Any person may petition the Commission to classify a surface water of the state as an ORW. The petition shall identify the exceptional resource value to be protected, address how the water body meets the general criteria in Paragraph (a) of this Rule, and the suggested actions to protect the resource values. The Commission may request additional supporting information from the petitioner. The Commission or its designee will initiate public proceedings to classify waters as ORW or will inform the petitioner that the waters do not meet the criteria for ORW with an explanation of the basis for this decision. The petition shall be sent to:

Director
DEHNR/Division of Environmental Management
P.O. Box 29535
Raleigh, North Carolina 27626-0535

The envelope containing the petition shall clearly bear the notation: RULE-MAKING PETITION FOR ORW CLASSIFICATION.

APPENDIX II

CONTENTS:

DEM Water Quality Monitoring Programs:

- **Benthic Macroinvertebrate Sampling**
- **Fisheries Studies**
- **Lakes Assessment**

BENTHIC MACROINVERTEBRATES

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

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera and Trichoptera (EPT S). Likewise, ratings can be assigned with a "biotic index". This index summarizes tolerance data for all taxa in each collection. The two rankings are given equal weight in final site classification. Higher taxa richness values are associated with better water quality. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is poorly assessed by a taxa richness analysis. Different criteria have been developed for different ecoregions (mountains, piedmont and coastal) within North Carolina.

Classification Criteria by Ecoregion*

A. EPT taxa richness values

	10-sample Qualitative Samples			4-sample EPT samples		
	Mountains	Piedmont	Coastal	Mountains	Piedmont	Coastal
Excellent	>41	>31	>27	>35	>27	>23
Good	32-41	24-31	21-27	28-35	21-27	18-23
Good-Fair	22-31	16-23	14-20	19-27	14-20	12-17
Fair	12-21	8-15	7-13	11-18	7-13	6-11
Poor	0-11	0-7	0-6	0-10	0-6	0-5

B. Biotic Index Values (Range = 0-10)

	Mountains	Piedmont/Coastal
Excellent	<4.18	<5.24
Good	4.17-5.09	5.25-5.95
Good-Fair	5.10-5.91	5.96-6.67
Fair	5.92-7.05	6.68-7.70
Poor	>7.05	>7.71

*These criteria apply to flowing water systems only. Biotic index criteria are only used for full-scale (10-sample) qualitative samples

Table 1 presents a summary of benthic macroinvertebrate samples collected in the Tar-Pamlico River Basin.

Table 1. Benthic macroinvertebrate collections in the Tar River basin, 1983-1992.

Tar-Pam 01

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Tar R, SR 1138, Granville	39/T1-1	28-(1)	02/89	-/25	-/3.96	Good
Tar R, SR 1150, Granville	-/T1-2	28-(1)	09/92	65/12	6.63/5.38	Fair
Tar R at Tar R, NC 96, Granville	A/T1-3	28-(1)	07/92	78/19	6.06/5.66	Good-Fair
			07/89	86/20	6.40/5.74	Good-Fair
			07/86	59/7	6.30/5.82	Fair
			09/84	78/25	5.80/5.22	Good
Tar R, SR 1622, Granville	-/T1-4	28-(1)	07/92	89/23	5.32/5.24	Good
Tar R at Louisburg, NC 401, Franklin	B/T1-5	28-(1)	09/92	74/27	5.66/5.02	Good
			07/86	73/24	6.34/5.20	Good-Fair
			07/83	58/17	6.48/5.24	Good-Fair
Shelton Cr, NC 158, Granville	-/T1-6	28-4	07/92	-/15	-/5.14	Good-Fair
N Fork Tar River, NC 158, Granville	-/T1-7	28-5	07/92	-/8	-/6.51	Fair
Fishing Cr, SR 1649, ab WWTP, Granville	24/T1-8	28-11	09/90	55/11	7.78/6.90	Fair
			06/89	27/0	9.18/-	Poor
Fishing Cr, be old WWTP, Granville	25/T1-9	28-11	06/89	16/0	9.20/-	Poor
Fishing Cr, SR 1608, be new WWTP, Granville	27/T1-10	28-11	09/90	54/3	8.20/7.84	Poor
Fishing Cr, SR 1643, Granville	28/T1-11	28-11	09/90	-/11	-/5.68	Fair
			07/92	78/18	6.21/5.56	Good-Fair
Coon Cr, SR 1515, Granville	26/T1-12	28-11-5	06/89	-/19	-/4.72	Good-Fair
Cedar Cr, SR 1116, ab WASA, Franklin	22/T1-13	28-29-(2)	07/92	-/14	-/5.56	Good-Fair
			09/90	72/15	6.48/5.32	Good-Fair
Cedar Cr, SR 1105, be WASA, Franklin	23/T1-14	28-29-(2)	07/92	-/13	-/4.92	Good-Fair
			09/90	80/18	6.10/5.34	Good-Fair
Crooked Cr, NC 98, Franklin	-/T1-15	28-30	07/92	-/16	-/5.40	Good-Fair

Tar-Pam 02

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Tar R, NC 581, Nash	2/T2-1	28-(36)	05/86	79/22	5.24/4.21	Good
Tar R, NC 64, Nash	1/T2-2	28-(36)	09/92	-/19	-/4.80	Good-Fair
Tar R, SR 1001, Nash	42/T2-3	28-(36)	02/89	-/15	-/5.58	Fair
Tar R, NC 97, Edgecombe	D/T2-4	28-(67)	07/92	79/24	6.03/4.99	Good-Fair
			07/90	77/23	5.65/4.77	Good
			07/87	63/18	5.96/5.35	Good-Fair
			05/86	78/25	5.94/5.12	Good
			07/85	79/21	6.51/4.98	Good-Fair
			08/83	62/17	6.15/4.82	Good-Fair
Tar R, SR 1400 Edgecombe	17/T2-4a	28-(67)	03/88	67/15	6.01/5.14	Good-Fair
Tar R, SR 1243, be WWTP, Edgecombe	3/T2-5	28-(67)	07/92	80/21	6.57/5.45	Good-Fair
Tar R, SR1252, Edgecombe	4/T2-6	28-(67)	03/88	66/14	7.03/5.53	Fair
Stoney Cr, SR 1603, Nash	-/T2-7	28-68	07/92	-/9	-/5.51	Fair
Swift Cr, SR 1310, Nash	C/T2-8	28-78	06/91	93/26	5.42/4.26	Good
			10/90	79/30	5.40/4.18	Good
			07/90	84/30	5.26/4.72	Good
			06/90	78/31	5.38/4.70	Good
			04/90	85/35	5.34/4.12	Good
			01/90	84/34	5.22/4.28	Good
			07/89	79/22	5.84/4.64	Good
			07/86	93/25	5.76/4.44	Good
			07/84	64/22	5.50/4.66	Good
Swift Cr, SR 1003, Nash	40/T2-9	28-78	02/89	-/31	-/3.30	Good
Swift Cr, ab Wake Stone	29/T2-10	28-78	06/91	85/26	5.36/4.34	Good
			06/90	68/27	5.26/4.50	Good
Swift Cr, 0.2 mi be Wake Stone, Nash	30/T2-11	28-78	06/91	-/28	-/4.38	Good
			06/90	-/22	-/5.06	Good

Table 1. Benthic macroinvertebrate collections in the Tar River basin, 1983-1992.

Tar-Pam 02

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Swift Cr, 0.5 mi be Wake Stone, Nash	31/T2-12	28-78	06/91	93/28	5.54/4.22	Good
			06/90	66/25	5.74/5.02	Good
Swift Cr, I-95, Nash	32/T2-13	28/78	06/91	-/23	-/4.44	Good
			06/90	-/23	-/5.04	Good
Swift Cr, SR 1253, Edgecombe	41/T2-14	28/78	02/89	74/29	5.07/3.79	Good
Sandy Cr, NC 401, Franklin	19/T2-15	28-78-1-(1)	05/88	-/27	-/4.78	Good
Sandy Cr, SR 1436, Franklin	-/T2-16	28-78-1-(8)	07/92	-/20	-/5.26	Good-Fair
Devils Cradle Cr. NC 401, Granville	15/T2-17	28-78-1-12-1	11/84	71/15	7.33/5.96	Fair
			06/84	81/12	7.34/6.32	Fair
			04/84	78/15	6.62/5.36	Fair
			01/84	61/14	6.26/5.92	Fair
White Oak Swp, SR 1428, Edgecombe	18/T2-18	28-79-23	05/88	-/11	-/5.46	Fair

Tar-Pam 03

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Tar R, at Tarboro, bus. 64, Edgecombe	E/T3-1	28-(80)	07/92	81/29	5.99/4.95	Good
			07/90	70/29	5.59/4.92	Good
			07/88	84/24	5.60/4.78	Good
			07/87	82/24	6.03/5.12	Good
			07/86	92/27	6.27/5.28	Good
			05/86	93/28	6.12/5.12	Good
			07/85	73/23	5.89/5.28	Good
			07/83	78/27	6.03/5.04	Good
Town Cr, SR 1202 ab Pinetops, Edgecombe	-/T3-2	28-83	05/92	76/14	6.92/5.95	Fair
Town Cr, SR 1200 be Pinetops, Edgecombe	-/T3-3	28-83	05/92	64/17	6.43/4.98	Good-Fair
Cokey Swp, SR 1141,	36/T3-4	28-83-3	04/89	36/3	8.10/4.28	Fair
Cokey Swp, SR 1601	-/T3-5	28-83-3	07/92	64/14	6.34/5.80	Good-Fair
Little Cokey Swp, @ Branch Cr, Edgecombe	33/T3-6	28-83-3-1	04/89	26/0	7.89/-	Poor
Little Cokey Swp, SR 1614, Edgecombe	34/T3-7	28-83-3-1	04/89	11/0	8.89/-	Poor
Little Cokey Swp, SR 1158 ab UT, Edgecombe	-/T3-8	28-83-3-1	05/92	46/1	8.38/6.57	Poor
Little Cokey Swp, be UT, Edgecombe	-/T3-9	28-83-3-1	05/92	42/0	8.66/-	Poor
Little Cokey Swp, SR 1141, Edgecombe	35/T3-10	28-83-3-1	04/89	39/2	8.35/3.04	Fair
Bynum Mill Cr, SR 1200, Edgecombe	/T3-11	28-83-4	08/92	31/2	7.84/8.87	NA
			05/92	44/1	7.55/4.94	NA
			02/92	48/4	7.56/7.26	NA
Briery Br, NC 124, Edgecombe	37/T3-12	28-83-4-1-1	09/90	51/3	7.87/6.36	Poor
Tar R, NC 42, Edgecombe	-/T3-13	28-(84)	07/92	-/27	-/4.40	Excellent
Otter Cr, SR 1009, Edgecombe	-/T3-14	28-86	02/92	83/15	6.91/5.66	Good
Otter Cr, SR 1614, Edgecombe	-/T3-15	28-86	08/92	31/1	8.04/9.29	NA
			05/92	62/9	7.24/5.85	NA
UT Otter Cr, SR 1113, Edgecombe	-/T3-16	28-86	09/90	51/1	8.01/6.57	Poor
Conetoe Cr, SR 1409 nr Bethel, Pitt	L/T3-17	28-27	07/92	50/7	6.72/5.80	Fair
			10/89	62/13	7.09/5.23	Fair
			07/89	62/8	6.93/5.33	Fair
			07/88	55/8	6.74/5.07	Fair
			07/85	44/7	6.53/5.46	Fair

Table1 Benthic macroinvertebrate collections in the Tar River basin, 1983-1992.

Tar-Pam 04

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Fishing Cr, ab Warrenton WWTP, Warren	-/T4-1	28-79-(1)	07/92	-/10	/4.93	Fair
Fishing Cr, SR 1600 be Warrenton, Warren	-/T4-2	28-79-(1)	07/92	-/18	-/4.29	Good
Fishing Cr, NC 301, nr Enfield, Edgecombe	F/T4-3	28-79-21	07/92	93/27	5.82/4.55	Good
			07/88	75/21	6.15/4.84	Good-Fair
			07/85	89/27	5.70/4.64	Good
			07/83	72/28	5.78/4.82	Good
Shocco Cr, SR 1613, Warren	-/T4-4	28-97-22	07/92	-/15	-/4.43	Good-Fair
			9/92	64/18	5.79/4.85	Good-Fair
Little Fishing Cr, SR 1338, Halifax	K/T4-5	28-79-25-66	07/88	89/24	5.50/4.07	Good
Fishing Cr, SR 1429, Edgecombe	43/T4-6	28-79-29	03/89	71/29	4.83/3.48	Good
Fishing Cr, SR 1500, Edgecombe	-/T4-7	28-79-29	07/92	-/23	-/3.95	Good
Beech Swamp, NC 301, Halifax	-/T4-8	28-79-30	05/92	34/3	8.53/7.46	NA
Beech Swamp, SR 1001, Halifax	-/T4-9	28-79-30	05/92	70/7	7.33/5.66	NA

Tar-Pam 05

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Tar R, NC 222 ab Greenville, Pitt	7/T5-1	28-(84)	11/85	75/22	5.83/5.06	Good-Fair
Tar R, SR 1533, Pitt	8/T5-2	28-(94)	11/85	49/13	6.78/5.25	Fair
Tar R, Rainbow Banks, Pitt	9/T5-3	28-(94)	11/85	50/9	7.21/5.41	Fair
Tar R, SR 1565 @ Grimesland, Pitt	G/T5-4	28-(94)	06/92	59/10	7.54/6.23	Fair
			07/89	66/16	6.71/5.92	Good-Fair
			07/86	70/8	7.56/6.73	Fair
			11/85	53/10	7.34/5.83	Good-Fair
			07/84	74/15	6.87/5.23	Fair
Chicod Cr, SR 1760 nr Simpson, Pitt	I/T5-5	28-100	07/92	55/4	7.33/6.83	Fair
			07/90	42/6	7.63/6.36	Fair
			07/87	51/2	8.43/7.66	Poor
Grindle Cr, US 264, Pitt	-/T5-6	28-101	07/92	-/10	-/5.43	Fair

Tar-Pam 06

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Tranters Cr, SR 1403, Beaufort	H/T6-1	28-103-(18)	07/89	51/8		Fair
			07/86	36/3		Poor
			07/83	43/5		Poor

Tar-Pam 07

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Durham Cr, SR 1949 nr Edward, Beaufort	16/T7-1	29-21-(1)	02/92	49/5	7.44/6.28	Good-Fair
			07/87	38/3	7.62/6.33	Fair
Whitehurst Cr, SR 1937, W-Prong, Beaufort	-/T7-2	29-28-7-(1)	02/92	13/1	8.80/2.34	Poor
Whitehurst Cr, SR 1937, S-Prong, Beaufort	-/T7-3	29-28-7-(1)	02/92	18/2	8.97/4.46	Poor
Whitehurst Cr, SR 1941, Beaufort	-/T7-4	29-28-7-(1)	02/92	30/2	8.74/3.44	Poor
Van Swamp, NC 32, Washington	-/T7-5	29-34-2-3	02/92	30/5	6.57/4.52	Good-Fair
Tar R nr marker 4, Beaufort	-/T7-6	28-(94)	04/92	15/0		NR
Tar R ab Kennedy Cr, nr Nat'l Spin, Beaufort	-/T7-7	28-(94)	04/92	17/1		NR
Tar R nr Washington, Beaufort	-/T7-8	28-(94)	04/92	15/0		NR
Tar R ab US 17, Beaufort	-/T7-9	28-(94)	04/92	16/1		NR
Kennedy Cr at point, Beaufort	-/T7-10	28-104	04/92	17/1		NR
Kennedy Cr nr Washington WWTP, Beaufort	-/T7-11	28-104	04/92	10/0		NR
Kennedy Cr be black water tank, Beaufort	-/T7-12	28-104	04/92	10/0		NR
Pamlico R ab Texas Gulf, Beaufort	-/T7-13	29-(5)	02/92	11/0		NR
Pamlico R @ Texas Gulf, Beaufort	-/T7-14	29-(5)	02/92	12/0		NR
Pamlico R nr Texas Gulf marina, Beaufort	-/T7-15	29-(5)	03/92	11/0		NR
Pamlico R nr Bath Cr, Beaufort	-/T7-16	29-(5)	03/92	15/0		NR
Pamlico R nr Ferry, Beaufort	-/T7-17	29-(5)	03/92	15/0		NR
Pamlico R nr marker 1, Beaufort	-/T7-18	29-(5)	03/92	17/0		NR

Table 1. Benthic macroinvertebrate collections in the Tar River basin, 1983-1992.

Tar-Pam 07 (Con't)

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Pamlico R at Hickory Pt, Beaufort	N11/T7-19	29-(5)	06/92	40/0		NR
			07/89	26/0		NR
			07/87	23/0		NR
			07/85	21/0		NR
			07/83	22/0		NR
Chocowinity Bay, Beaufort	-/T7-20	29-6-(1)	12/92	7/0		NR
		10/92	7/0		NR	
			07/92	7/0		NR
			04/92	10/0		NR
			02/92	9/0		NR
Broad Cr, nr McCotters Marina, Beaufort	-/T7-21	29-10-(3)	02/92	11/0		NR
Bath Cr, NC 92 nr Bath, Beaufort	N13-T7-22	29-19-(7)	06/92	33/0		NR
			06/83	31/0		NR
South Cr, be Aurora WWTP, Beaufort	-/T7-23	29-28-(6.5)	03/92	16/0		NR
South Cr, nr marker 10, Beaufort	-/T7-24	29-28-(6.5)	03/92	16/0		NR
South Cr, btw markers 14 &16	-/T7-25	29-28-(6.5)	03/92	17/0		NR
Pungo R, US 264 nr Ponzer, Beaufort	N1/T7-26	29-34-(12)	07/92	32/0		NR
			07/89	17/0		NR
			07/87	22/0		NR
			07/86	21/0		NR
			07/85	20/0		NR
			07/84	20/0		NR
			06/83	30/0		NR
			06/83	29/2		NR
Battalina Cr, be Belhaven WWTP	-/T7-27	29-34-32	06/92	23/0		NR
Pantego Cr, NC 92 nr Belhaven, Beaufort	N15/T7-28	29-34-34-(2)	06/92	41/0		NR
			04/92	17/0		NR
			07/84	27/0		NR
			06/83	33/2		NR
Pantego Cr, ab Belhaven (be Cuckolds Cr and Broad Cr), Beaufort	-/T7-29	29-34-34-(2)	04/92	17/0		NR

Tar-Pam08

Site	Old/New DEM #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Pamlico R @ Great Island, Hyde	N12/T8-01	29-(46.5)	06/92	49/0		NR
		07/85	21/0		NR	
			07/84	23/0		NR
			07/83	23/0		NR

FISHERIES

To the public, the condition of the fishery is one of the most meaningful indicators of water quality. Fish occupy the upper levels of the aquatic food web and are both directly and indirectly affected by chemical and physical changes in the environment. Water quality conditions that significantly affect lower levels of the food web will affect the abundance, species composition, and condition of the fish population.

FISH COMMUNITY STRUCTURE METHODS

The North Carolina Index of Biotic Integrity (NCIBI) is a modification of Karr's IBI (1981) which was developed as a method for assessing a streams biological integrity by examining the structure and health of its fish community. The index incorporates information about species richness and composition, trophic composition, fish abundance and fish condition.

The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effect of biotic interactions and energy supply. Fish abundance and condition information indicates additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

The assessment of biological integrity using IBI is provided by the cumulative assessment of 12 parameters, or metrics. The values provided by the metrics are converted into scores on a 1, 3, 5 scale. A score of 5 represents conditions expected for undisturbed streams in the area, while a score of 1 indicates that the conditions vary greatly from those expected in undisturbed streams of the region. The scores for each metric are summed to attain the overall IBI score.

Each metric is designed to contribute unique information to the overall assessment. A discussion of each metric is presented below; some metrics have been grouped together.

1. The total number of species and individuals supported by streams of a given size in a given region decrease with environmental degradation.
2. Darters are sensitive to environmental degradation particularly as a result of their specific reproductive and habitat requirements. Darter habitats are degraded as a result of channelization, siltation, and reduced oxygen levels. Collection of fewer than expected darter species can indicates that some habitat degradation is occurring.
3. Sunfish species are used because they are particularly responsive to degradation of pool habitats and to other aspects of habitat degradation like quality of instream cover.
4. Sucker species are intolerant of habitat and chemical degradation and, because they are long lived, provide a multiyear integrated perspective.
5. Intolerant species are those which are most effected by environmental perturbations and therefore should have disappeared, at least as viable populations, by the time a stream is degraded to a fair rating.
6. Tolerant species are those which are often present in a stream in moderate numbers, but as the stream degrades they tend to dominate.
7. The three trophic composition metrics, proportion of omnivores, insectivores, and piscivores, are used to measure the divergence from expected production and consumption patterns in the fish community that can result from environmental degradation. The main cause for a shift in the trophic composition of the fish community (a greater proportion of omnivores and few insectivores) is nutrient enrichment.

8. The proportion of fish with disease, tumors, fin damage, and skeletal anomalies increases as a stream is degraded. The length distribution metric measures the amount of reproduction which is occurring in the community by looking at the number of age groups, determined by length range, present for each species.

A field methodology for fish collections to be used for NC IBI is included in the standard operating procedures of the NC Division of Environmental Management (NCDEM, 1989). A representative section of stream, 600 feet in length, is selected, measured, and blocked at the upstream and downstream ends with small mesh nets. The stream is then sampled with one or two backpack electrofishing units depending upon stream width. After collection, the fish are examined for sores, lesions, fin damage, and skeletal anomalies and preserved in 10% formalin. Once preserved the fish are identified to species, length recorded, and batch weighed by species.

Streams with larger watersheds or drainage areas can be expected to support more fish species and a larger number of fish. Figures 1 and 2 represent the relative number of species and number of fish that can be expected in the North Carolina river basins.

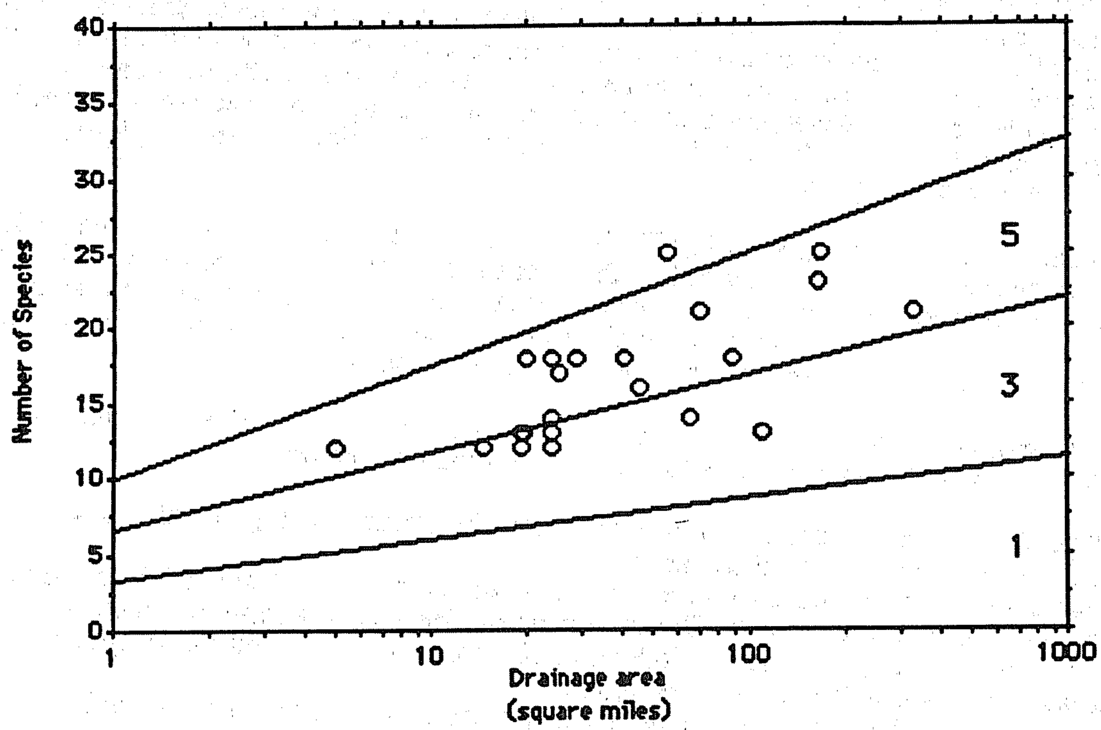

Figure 1. Expectations of the Number of Species based upon Drainage Area Size

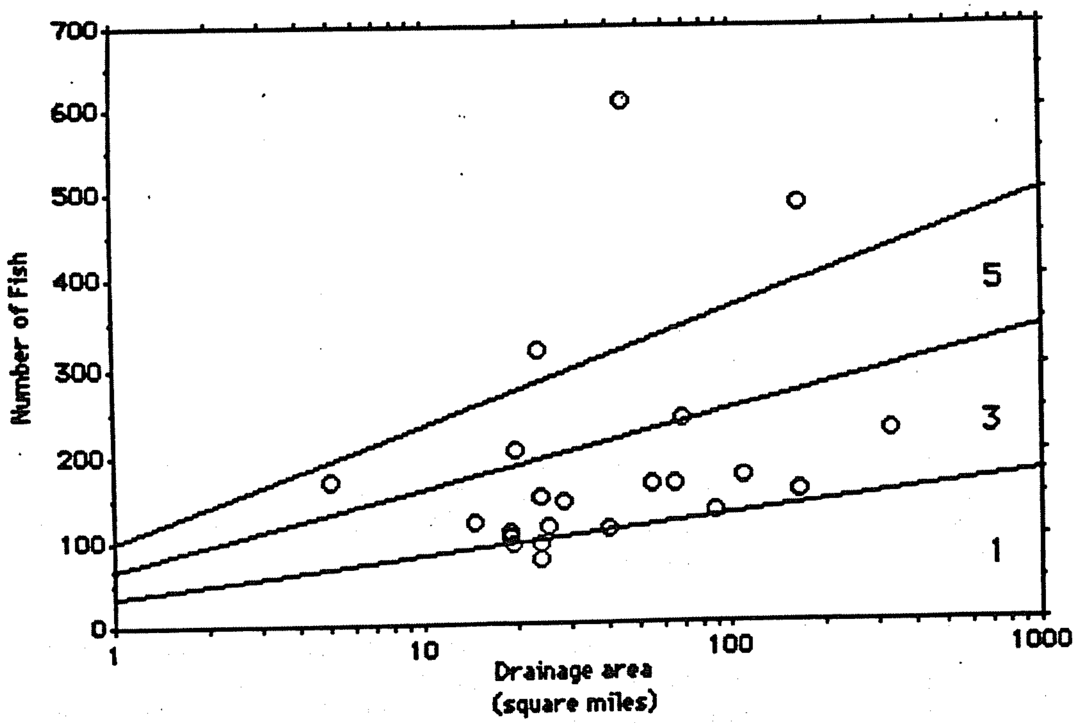

Figure 2. Expectations of the Number of Fish based upon Drainage Area Size

FISH TISSUE
Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Therefore, by analyzing fish tissue, determinations about what chemicals are in the water can be made. Once contaminants reach surface waters, they may be available for bioaccumulation either directly or through aquatic food webs and may accumulate in fish and shellfish tissues. Thus results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water. Fish tissue analysis results are also used as indicators for human health concerns and fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem. Contamination of aquatic resources, including freshwater, estuarine, and marine fish and shellfish species have been documented for heavy metals, pesticides, and other complex organic compounds.
In evaluating fish tissue analysis results, several different types of criteria are used. Currently human health concerns related to fish consumption are screened by comparing results with Federal Food and Drug Administration (FDA) action levels. The FDA levels were developed to protect humans from the chronic effects of toxic substances consumed in foodstuffs and thus employ a "safe level" approach to fish tissue consumption. A list of fish tissue parameters accompanied by their FDA criteria are presented below. Individual parameters which appear to be of potential human health concern are evaluated by the N.C. Division of Epidemiology by request of the Water Quality Section.

Metals

	FDA		FDA
Cadmium	None	Chromium	None
Nickel	None	Lead	None
Copper	None	Arsenic	None
Mercury	1.0 mg/kg	Selenium	None

Synthetic Organics

	FDA		FDA
Aldrin	0.3 mg/kg	o,p DDD	5.0 mg/kg
Dieldrin	0.3 mg/kg	p,p DDD	5.0 mg/kg
Endrin	0.3 mg/kg	o,p DDE	5.0 mg/kg
Methoxychlor	None	p,p DDE	5.0 mg/kg
Alpha BHC	None	o,p DDT	5.0 mg/kg
Gamma BHC	None	p,p DDT	5.0 mg/kg
PCB-1254	2.0 mg/kg	cis-chlordane	3.0 mg/kg
Endosulfan I	None	trans-chlordane	3.0 mg/kg
Endosulfan II	None	Hexachlorobenzene	None

The USEPA is currently developing screening values for target analytes which are formulated from a risk assessment procedure. The EPA screening value for a particular analyte is the concentration of that analyte in edible fish tissue that is associated with a maximum limit of acceptable health risk to the general population or subpopulation of concern.

LAKES ASSESSMENT PROGRAM

Lakes are valued for the multiple benefits they provide to the public, including recreational boating, fishing, drinking water, and aesthetic enjoyment. The North Carolina Lake Assessment Program seeks to protect these waters through monitoring, pollution prevention and control, and restoration activities. Assessments have been made at all publicly accessible lakes, at lakes which supply domestic drinking water, and lakes (public or private) where water quality problems have been observed. Data are used to determine each lake's trophic status-a relative measure of nutrient enrichment and productivity, and whether the lake's uses have been threatened or impaired by pollution.

Tables presented in each subbasin summarize data used to determine the trophic status and use support status of each lake. These determinations are based on information from the most recent summertime sampling (date listed). The most recent North Carolina Trophic State Index (NCTSI) value is shown, followed by the descriptive trophic state classification (O=oligotrophic, M=mesotrophic, E=eutrophic, H=hypereutrophic, D=dystrophic).

Numerical indices are often used to evaluate the trophic status of lakes. An index was developed specifically for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NRCD 1982). The North Carolina Trophic State Index (NCTSI) is based on total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), Secchi depth (SD in inches), and chlorophyll-a (CHL in µg/l). Lakewide means for these parameters are integrated to produce a NCTSI score for each lake, using the following equations:

$$\text{TON score} = \frac{\text{Log(TON)} + (0.45)}{0.24} \times 0.90$$

$$\text{TP score} = \frac{\text{Log(TP)} + (1.55)}{0.35} \times 0.92$$

$$\text{SD score} = \frac{\text{Log(SD)} - (1.73)}{0.35} \times -0.82$$

$$\text{CHL score} = \text{Log(CHL)} - (1.00) \times 0.83$$

0.43

NCTSI = TON score + TP score + SD score + CHL score

In general, NCTSI scores relate to trophic classifications as follows: less than -2.0 is oligotrophic; -2.0 to 0.0 is mesotrophic; 0.0 to 5.0 is eutrophic; and greater than 5.0 is hypereutrophic. When scores border between classes, best professional judgment is used to assign an appropriate classification. NCTSI scores are also skewed by the highly colored water typical of dystrophic lakes. These acidic, "black-water" lakes are scattered throughout the coastal plain, often located in swampy areas or overlying peat deposits.

The summary tables list lakewide averages of total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), and chlorophyll *a* (CHLA in µg/l), followed by surface water classification. There are four lakes in the Tar-Pamlico Basin sampled as part of the Lakes Assessment Program. These are Lake Devin, Lake Mattamuskeet, Tar River Reservoir, and Pungo Lake. Each lake is discussed in the appropriate subbasin section.

TABLE

Estuarine Fish Kill Data Associated with Toxic Dinoflagellate

Source: Dr. Joanne Burkholder, NSCU

Table 1. Estuarine / coastal fish kills linked to the presence of flagellated stages (FLAG.) of *Pfiesteria piscimortuis* through sample identification with confirming scanning electron micrographs and bioassays for fish toxicity.

DATE	LOCATION	SALINITY (‰)	TEMP. (°C)	NUTRIENTS ($\mu g\ L^{-1}$)	*PFIESTERIA* (FLAG. ML^{-1}) [a]	AFFECTED FISH
1991						
MAY	PAMLICO, BLOUNT BAY-CORE PT. - BATH CR.	4-6	24-26	TP 130-240 $PO_4^{-3}P$ 70 TKN 500-600 $NH_4^{+}N$ 10-20	750	ATL. MENHADEN, SOUTHERN FLOUNDER, SPOT, HOGCHOKER (1,000,000)
JUNE	PAMLICO, TRIPP PT. [c]	4	29	TP 130-140 $PO_4^{-3}P$ 40-50 TKN 500-600 $NO_3^{-}N$ < 10 $NH_4^{+}N$ 10	1,050	ATL. MENHADEN, OTHERS (15,000)
AUG.	PAMLICO, WASHINGTON [b] (NEAR WWTP)	8	28	TP 500, TKN 700 $NO_3^{-}N$ < 10 $NH_4^{+}N$ 70	> 7,400	ATL. MENHADEN (> 1,000)
AUG.	PAMLICO, HAWKINS BEACH	12	29	TP 490, TKN 700 $NO_3^{-}N$ < 10 $NH_4^{+}N$ 40	26,050	FLOUNDER "WALK" (1,000)
SEP.	NEUSE, DAWSON CR.	7-8	30	TP 120 $PO_4^{-3}P$ 70 TKN 500-600 $NO_3^{-}N$ < 10 $NH_4^{+}N$ 20	350	PERCH, CATFISH, MULLET (NUMBER NA)

Table 1, cont'd.

DATE	LOCATION	SALINITY (‰)	TEMP. (°C)	NUTRIENTS ($\mu g\ L^{-1}$)	*PFIESTERIA* (FLAG. ML^{-1})	AFFECTED FISH
1991 (cont'd.)						
SEP.	PAMLICO, NEAR HILLS CR.	4	27	TP 420 TKN 700-800 NO_3^-N < 10 NH_4^+N 30	525	SPOT, EEL, ETC. (2,000)
SEP.-OCT.	NEUSE, MINNESOTT BEACH - CHERRY POINT [b] (NEAR WWTP)	7 - 10	18 - 30	TP 120-150 $PO_4^{-3}P$ 70 TKN 500-600 NO_3^-N < 10 NH_4^+N 20	525 - 1,120	ATL. MENHADEN, BLUE CRABS "WALKS;" 1 BILLION
DEC.	TAYLORS CR. [b] (NEAR WWTP)	30	15	NA	11,960	FISH "WALK" (FLOUNDER, EEL, SHEEPSHEAD, OTHERS; 2,000)
DEC.	WRIGHTSVILLE BEACH (SEA, ca 5 km FROM SHORE)	35	17	NA	50 [c]	ATL. MENHADEN (> 5,000)
1992						
JULY	PAMLICO, BAYVIEW [b] (NEAR WWTP)	7	29	TP 150-210 $PO_4^{-3}P$ 80-100 TN 400-500 NO_3^-N 40 NH_4^+N < 10	350	ATL. MENHADEN (100-500)

Table 1, cont'd.

DATE	LOCATION	SALINITY (‰)	TEMP. (°C)	NUTRIENTS ($\mu g \cdot L^{-1}$)	*PFIESTERIA* (FLAG. ML^{-1})	AFFECTED FISH
1992 (cont'd.)						
JULY	PAMLICO, HAWKINS BEACH	8	29	TP 370, TKN 800 $NO_3^-N < 10$ NH_4^+N 80	910	ATL. MENHADEN, CROAKER (1,000 - 2,000)
JULY	PAMLICO, RAGGED PT.	7	30	TP 220, TKN 500 $NO_3^-N < 10$ NH_4^+N 100	3,310	ATL. MENHADEN, CROAKER (> 100,000)
JULY	PAMLICO, SOUTH CR. [b] (P MINING)	8	30	TP 200, TKN 400 $NO_3^-N < 10$ NH_4^-N 10	2,410	ATL. MENHADEN (THOUSANDS WITH LESIONS)
JULY	NEUSE, MINNESOTT BEACH - CHERRY PT. [b] (NEAR WWTP)	9	26	TP 150, TKN 400 $PO_4^{-3}P$ 100 NO_3^-N 10 NH_4^+N 10	630	ATL. MENHADEN, OTHERS (1,000 - 5,000)
DEC.	TOPSAIL BEACH (SEA, ca 0.5 km FROM SHORE)	35	9	NA	1,400 [c]	ATL. MENHADEN ("THOUSANDS")

Table 1, cont'd.

DATE	LOCATION	SALINITY (‰)	TEMP. (°C)	NUTRIENTS ($\mu g\ L^{-1}$)	*PFIESTERIA* (FLAG. ML^{-1})	AFFECTED FISH
1993[b]						
JUNE	NEUSE, MINNESOTT	7	26	TP 70-110 TKN 400 < 1,000 $PO_4^{-3}P$ 10-48 $NO_3^{+}N$ 3-17 $NH_4^{+}N$ < 5 - 40	830	ATL. MENHADEN (ca 100); SKIN IRRITATION (HUMANS – "SWIMMERS ITCH")
JULY	PAMLICO, SOUTH CR. (P MINING)[b]	5	31	TP 60-320 $PO_4^{-3}P$ 20-30 TN 300-500 $NO_3^{-}N$ < 10 $NH_4^{+}N$ 10	270	ATL. MENHADEN, SPOT, CROAKER, BLUE CRAB (30,000)
JULY	NEUSE, FLANNERS BEACH	15	29	TP 300, TKN < 1,000 $PO_4^{-3}P$ 187 $NO_3^{-}N$ 8 $NH_4^{+}N$ 34	1,100	ATL. MENHADEN, SPOT (250,000)
JULY	NEUSE, FLANNERS BEACH - CHERRY PT.[a, b] (NEAR WWTPs)	14	29	TP 314, TN < 1,000 $PO_4^{-3}P$ 154 $NO_3^{-}N$ 10 $NH_4^{+}N$ 18	1,105 (W) > 100,000 (S)	ATL. MENHADEN (15,000)

Table 1, cont'd.

DATE	LOCATION	SALINITY (‰)	TEMP. (°C)	NUTRIENTS ($\mu g\ L^{-1}$)	*PFIESTERIA* (FLAG. ML^{-1})	AFFECTED FISH
1993 (cont'd.)						
SEP.	NEUSE, COFFEE CR. (ANIMAL WASTES) [b]	17	29	TP 300, TN 2,700	900	ATL. MENHADEN (25,000)

[a] Adult fish were observed. Prior to Dec. 1991, only TFVCs were recognized; hence, gametes and zoospores were excluded. An asterisk (*) indicates that bioassays were not completed to confirm toxicity; W = water column; S = slick with foam that was wind-borne from the kill area (July 1993, Neuse R., Flanners Beach - Cherry Point). Surface water-column nutrients (mean concentrations) are given to indicate general nutrient regime in sites with toxic dinoflagellate activity (unpubl. data of NC DEM, JMB & HBG). For the July 1993 kill at Flanners Beach - Cherry Point, nutrient concentrations are listed for surface waters outside the slick area. The brownish slick (which consisted of accumulated *P. piscimortuis* gametes among menhaden secreta and sloughed fish skin) was ca 100 m wide prior to wind dispersal, partly as foam. Nutrient concentrations within the slick were 957 μg TP L^{-1}, 312 μg $PO_4^{-3}P$ L^{-1}, and 1,722 μg NH_4^+N L^{-1}. Note: A fish "walk" is local fishermen's vernacular, referring to the behavior of finfish and shellfish when they attempt to leave the water and beach before they die -- in this case, an apparent escape response from the toxin. Such behavior of fish in the southeastern United States, also sometimes called "jubilees" (in which local people collect the fish for consumption), formerly has been attributed to stress from low dissolved oxygen (Miller *et al.* 1991).

[b] The sampling site was < 1 km downstream from municipal wastewater treatment plant discharge (WWTP) or other anthropogenic nutrient loading (e.g., Texasgulf's phosphate mining Chemical Company on the Pamlico).

[c] The Tripp Point kill was also associated with low dissolved oxygen (DO) in the bottom water; in all other cases DO was > 5 mg L^{-1}. During kills in Jan. - Feb. 1992, samples were taken 1-4 d after fish death (ca 25 cells mL^{-1} present). Water collected 1-2 d after fish kills off Wrightsville Beach and Topsail Beach still contained ≥ 50 TFVCs mL^{-1}, with toxicity confirmed from bioassays with fish. With exception of the last July listing (Flanners Beach - Cherry Point, which was sampled by HBG and R. Dove), during 1993 water was collected by NC DEHNR staff on the 15-16th of the month, coinciding with sampling schedules but generally ≥ 2 d after fish kills.

APPENDIX III

Modeling Information

APPENDIX III

MODELING INFORMATION

INTRODUCTION

In order to assess the impact of pollutants on surface water quality, the Division must often develop and apply water quality models. A water quality model is a simplified representation of the physical, chemical, and biological processes which occur in a water body. The type of model used is dependent on the purpose for which it is needed, the amount of information that is available or attainable for its development, and the degree of accuracy or reliability that is warranted. In most cases, the Division develops and applies a given model to predict the response of the system to a given set of inputs that reflect various management strategies. For example, water quality models such as QUAL2E or the Division's Level B model are used to predict what the instream dissolved oxygen concentration will be under various sets of NPDES wasteflows and discharge limits. The following sections briefly summarize the types of models used by the Division.

Oxygen-Consuming Waste Models

Several factors are considered when choosing an oxygen-consuming waste model including: the type of system (stream, lake, or estuary), whether one, two, or three dimensions are needed, the temporal resolution needed, and the type of data available. Many of the factors are related. For example, in streams, flow usually occurs in one direction and one can assume that a steady state model will result in adequate predictions. A steady state model is one in which the model inputs do not change over time. However, in open water estuaries, the tide and wind affect which way water moves, and they must often be represented by 2 or 3 dimensional models. In addition, the wind and tide can affect the model reaction rates, and therefore a dynamic model must be used rather than one which is steady state. The last factor, the amount of data available, dictates whether an empirical or calibrated model will be used. An empirical model is used when little water quality information is available for a given water body, and hydraulics and decay rates are estimated through the use of equations. For example, in North Carolina's empirical stream model (referred to as a Level B analysis) velocity is determined through a regression equation developed from North Carolina stream time-of-travel (TOT) studies which includes stream slope and flow estimates as independent variables. Stream slope can be measured from a topographic map, and flow is estimated at a given site by the U.S. Geological Survey. Therefore, the empirical model can be run without TOT information specific to a given stream since parameters are estimated through the use of information which can easily be obtained in the office environment. More information regarding the empirical dissolved oxygen model used by DEM can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Field calibration of a BOD/DO model requires collection of a considerable amount of data. For example, in order to develop hydraulics equations specific to a given stream, TOT studies using rhodamine dye are recommended under at least two flow scenarios including one summer low flow period. In addition, during one summer low flow study, dissolved oxygen, temperature, long term BOD and nitrogen series data are collected. Sediment oxygen demand (SOD) data may also be collected. These data are then used to calibrate reaction rates specific to the stream. QUAL2E is the most commonly used calibrated DO/BOD model for streams in North Carolina. A copy of the model guidance can be obtained from EPA's Environmental Research Lab in Athens, Georgia, and further information on North Carolina's calibration procedures can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Data collection for an estuary DO model is even more extensive. Since the system is multi-dimensional and not steady-state, many more data are needed. Dye is often injected into a system over a period of time, and the dye cloud is then followed for a period of time which may last for days. In addition, several tide gages may need to be set up. Due to the stratification which occurs in an estuary, depth integrated data must also be collected. Calibrated estuary models which have been used by DEM include WASP, GAEST, and QUAL2E. WASP is also supported by EPA, and a user manual may be obtained from them. You should note that both GAEST and QUAL2E are one dimensional and are not applicable to many of North Carolina's estuaries.

Lakes are rarely modeled for BOD. Tributary arms of lakes are modeled as slow moving streams. Depending on the system, a one, two, or three dimensional model may be used. If a one dimensional model is needed, the modeler may choose the Level B (if little or no data), or QUAL2E. In multidimensional lake systems, WASP will be used.

The calibrated model will be more accurate than the empirical model since it is based on data collected specifically for a given stream in the State. However, it is much more expensive to develop a calibrated model. Not only do a number of staff spend several days to weeks collecting field data (sometimes having to wait months for appropriate conditions), but it also takes the modeling staff several months to develop and document the calibrated model. An empirical model can be developed and applied in a matter of hours. Therefore, due to resource constraints, the majority of the BOD/DO models developed in North Carolina are empirical.

Eutrophication Models

Eutrophication models are used to develop management strategies to control trophic response of a system to nutrient inputs (usually total phosphorus (TP) or total nitrogen (TN)). Nutrient management strategies are typically needed in areas which are sensitive to nutrient inputs due to long residence times, warm temperature, and adequate light penetration. These characteristics are found in deep slow moving streams, ponds, lakes, and estuaries. Modeling and insitu research are used to relate nutrient loading to the trophic response to the system allowing the manager to establish nutrient targets. Models which may be used include the Southeastern Lakes Model (Reckhow, 1987), Walker's Bathtub Model (Walker, 1981), QUAL2E, and WASP.

Once the nutrient targets are known, watershed nutrient budgets are developed to evaluate the relative nutrient loadings from various point and nonpoint sources. Land use data are obtained for the basin, and export coefficients based on literature values are applied to each land use. An export coefficient is an estimate of how may pounds of nutrient will runoff from each acre of land in a given year.

Toxics Modeling

Toxics modeling is done to determine chemical specific limits which will protect to the no chronic level in a completely mixed stream. The standards developed for the State of North Carolina are based on chronic criteria. These chemical specific toxics limits are developed through the use of mass balance models:

TAR-PAMLICO NSW IMPLEMENTATION STRATEGY
Adopted December 14, 1989
Revised February 13, 1992

1. Purpose

On September 12, 1989, the Environmental Management Commission (EMC) classified the Tar-Pamlico River Basin as Nutrient Sensitive Waters (NSW). On December 14, 1989, the EMC approved an NSW Implementation Strategy for the basin; as part of this strategy an association of dischargers in the basin, the Tar-Pamlico Basin Association (the Association), agreed to fund the creation of an estuarine computer model that would facilitate development of a long-term nutrient reduction strategy for the basin. The December 14, 1989 NSW strategy document also provided for an interim nutrient-reduction trading program pending completion of the model and adoption of a long-term strategy.

The purpose of this document is to formalize and clarify the details of the first phase of Tar-Pamlico NSW strategy (1990-1994; referred to hereinafter as "Phase I"), including the interim nutrient-reduction trading program. As reflected below, this document has been approved by the parties who fashioned the December 14, 1989 Tar-Pamlico NSW Implementation Strategy, approved by the EMC: the Division of Environmental Management (DEM); the North Carolina Environmental Defense Fund (NCEDF); the Pamlico-Tar River Foundation (PTRF); and the Association. Upon completion of the computer model, but in any event not later than March 1, 1994, the parties to this agreement will begin development of the post-1994 phase ("Phase II") of the Tar-Pamlico NSW strategy.

2. Association Members

Members of the Tar-Pamlico Basin Association include the following facilities: Belhaven, Bunn, Enfield, Franklin Water and Sewer Authority, Greenville, Louisburg, Oxford, Pine Tops, Rocky Mount, Spring Hope, Warrenton, and Washington. National Spinning is also a member of the Association but is not subject to Sections 4, 5, and 6, except as otherwise specified in these sections. There will be no new members added to the Association after adoption of this agreement. Association membership may be reopened to include other parties for participation in Phase II of the NSW strategy.

3. Estuarine Model Development

An estuarine computer model for the Tar-Pamlico River Basin will be developed during Phase I of the strategy. The purpose of this model will be to better define the relationship between nutrient loading and estuarine water quality. Results of this model will be used to develop refined nutrient reductions for Phase II of the strategy which will begin January 1995.

Development of the model shall meet the following requirements:

- model shall be funded by the Association,
- model shall be completed by July 1, 1993,
- DEM shall assist in gathering available data, with emphasis on the results of the Albemarle-Pamlico Estuarine Study,
- model shall assess relative importance of nitrogen (N) and phosphorus (P) from wastewater dischargers, nonpoint sources (NPS), sediments, and atmosphere to algal growth and oxygen stress,
- model shall recommend future target nutrient reductions,
- model shall include Center for Geographic Information Analysis (CGIA) system for tracking and targeting best management practices (BMPs),
- model shall be developed in coordination with DEM, NCEDF, and PTRF,
- developers of model shall submit quarterly status reports to DEM in North Carolina,
- model shall be in a form of computerized software compatible with DEM systems,
- upon completion, model shall be provided to DEM along with documentation and staff training, and
- cost of model development shall not be included in nutrient trading costs.

4. <u>Engineering Evaluation of Existing Wastewater Treatment Plants</u>

The Association shall conduct an engineering evaluation of their existing wastewater treatment plants and shall take steps to implement operational and minor capital improvements recommended by the consultants (Note: this report was completed on March 12, 1991). Removal efficiencies for nutrients and conventional pollutants shall have a goal of attaining total phosphorus (TP) of 2 mg/l and total nitrogen (TN) of 4 mg/l in summer and 8 mg/l in winter.

National Spinning shall complete a similar facilities evaluation, submit a report of this review to DEM, and take steps to implement recommendations of the evaluation.

5. <u>Monitoring</u>

Beginning July 1, 1991, facilities which are members of the Association shall perform weekly effluent monitoring for TP and TN. A report detailing the nutrient loadings for each facility shall be prepared by the Association and submitted to DEM by March 1, 1992. This report shall incorporate effluent nutrient monitoring data through December 31, 1991.

Association facilities shall continue to monitor effluent TP and TN and the Association shall submit an annual report to DEM every March 1 detailing this monitoring data from the previous year. The annual report will be used to determine compliance with this strategy. DEM may authorize less frequent monitoring (i.e., other than weekly) where the discharger demonstrates that less frequent sampling is adequate to characterize facility loadings.

Where a facility fails to report flow data, its flow for the unreported period shall be estimated based on the ratio of the facility's reported flow in the remainder of the year to the combined flow of the other Association POTW members during the same time period. Where a facility fails to report TP or TN concentrations for any period in 1991, annualized concentration data may be used. For any period after 1991, the facility's nutrient concentrations for the unreported period shall be estimated by DEM using the best available data.

6. Nutrient-Reduction Trading Program

The purpose of this agreement is to allow facilities to achieve DEM's original NSW goals by substituting other, more cost-effective pollutant reduction measures such as agricultural best management practices. DEM has structured the nutrient-reduction trading program to achieve a similar reduction in nutrient loadings as its original point source strategy, which was summarized in the following reports: Tar-Pamlico River Basin Nutrient Sensitive Waters Designation and Nutrient Management Strategy, April 1989 and The Proposed Classification of the Tar-Pamlico River Basin as "Nutrient Sensitive Waters", June 15, 1989. The following conditions shall apply to the nutrient-reduction trading program:

a. Cost Estimate for NPS Improvements

The original NSW strategy adopted in December, 1989 recommended a nutrient reduction goal of 200,000 kg/yr from point sources. This goal represents a reduction of 180,000 kg/yr TN and 20,000 kg/yr TP. If this nutrient reduction goal were met entirely through the funding of agricultural BMPs, it is estimated that over $11 million dollars would be needed for nonpoint source improvements. This estimate is based on funding agricultural BMPs at a rate of $56/kg/yr (drawn from experience in the Chowan River Basin using safety factors of three for cropland BMPs and two for animal BMPs).

b. Fund Administration and Allocation

The Division of Soil and Water Conservation (DSWC), located within the Department of Environment, Health, and Natural Resources, shall administer funds which are generated by the nutrient-reduction trading program. These funds shall be allocated and targeted within the Tar-Pamlico Basin at their discretion through the North Carolina Agricultural Cost Share Program (NCACSP). DSWC shall prioritize funding to BMPs that have the highest potential and efficiency for nutrient removal.

c. Funding of Additional DSWC Personnel

The Association shall contribute $150,000 over a two year period to fund additional DSWC personnel to assist in BMP review and identification. The purpose of these initial funds shall be to design and establish the nutrient-reduction trading system, including targeting and documenting existing BMPs in the basin and similar activities. After the initial two years, funds to continue these employees shall come from additional nutrient-reduction trading funds. The $150,000 shall be paid according to the following payment schedule:

March 1990	$25,000	(paid in full)
August 1990	$41,666	(paid in full)
February 1991	$41,666	(paid in full)
August 1991	$41,668	(paid in full)
Total	$150,000	

An annual report shall be prepared identifying the projects funded through this nutrient-reduction trading program.

d. Alternative Funding Sources

If the Association can locate sources of additional federal funding, exclusive of funds available to the states, these funds can be credited toward the nutrient-reduction trading fund, including required minimum payments. Any additional funds that the Association receives for BMP funding must be in addition to that which would have occurred from federal, state, and local sources if not for the existence of this agreement.

e. Allowable Nutrient Loading and Payment Schedule

During Phase I, which will last through December 1994, the Association shall summarize the annual nutrient loading of its members (see Section 5), and shall place $56 into the nutrient-reduction trading fund for every kilogram of nutrients (total nitrogen and/or total phosphorus) that is discharged by the Association above the following values:

Calendar Year	Allowable Nutrient Loading (kg/yr)	Report Results	Payment Due
1991	525,000	March 1, 1992	Sept 30, 1992
1992	500,000	March 1, 1993	Sept 30, 1993
1993	475,000	March 1, 1994	Sept 30, 1994
1994	425,000	March 1, 1995	Sept 30, 1995

The above nutrient loading levels are for Association POTW members only and do not include National Spinning. If a POTW member withdraws from the Association, the allowable levels as set out above will remain in effect and the Association's nutrient loadings will be calculated to include the loadings of all POTW members as of the date of this document.

f. Projected Growth and Associated Nutrient Loading During Phase I

The projected 1994 flow for all Association members, excluding National Spinning, is estimated to be 30.555 MGD. Given these projected flows and assuming no nutrient reductions from prestrategy concentrations, it is estimated that by the end of 1994 the Association's annual nutrient loading would reach approximately 625,000 kg/yr. The schedule of Allowable Nutrient Loading as presented above achieves similar nutrient reductions as the original strategy by reducing nutrient loading by 200,000 kg/yr from 625,000 kg/yr to 425,000 kg/yr.

g. Minimum Payments

In order to ensure the availability of funds for agricultural BMP implementation through the nutrient-reduction trading program, the Association has agreed to make a minimum payment to the nutrient-reduction trading fund each year. The total minimum payment during Phase I shall be $500,000 and shall be paid according to the following schedule:

Minimum Payment	Payment Due
$150,000	September 30, 1992
$250,000	September 30, 1993
$100,000	September 30, 1994

In the event that the Association's annual payment for excess nutrient loading amounts to less than the scheduled minimum payment, the Association shall supplement this amount so that the required minimum payment will be made to the nutrient-reduction trading fund for the calendar years 1991, 1992, and 1993.

h. Payment Calculations

~~The Association's annual payment shall be the greater of~~ (1) the scheduled minimum payment under subsection 6g; or (2) an excess loading payment, calculated as set out below. As the following formula reflects, the Association shall receive credit for both minimum payments and excess loading payments made in prior years.

Excess Loading Payment = (Association actual annual loading - allowable nutrient loading) x $56/kg/yr - prior payments (minimum + excess loading).

i. Useful Life of BMP Credits

All BMP credits shall have a useful life of ten years or such longer period as may by provided for in DSWC's BMP contracts.

j. Expansion of Association Members During Phase I

Except as specified in subsection 6k, during Phase I, Association members expanding to > 0.5 MGD or requesting permit renewals will not receive effluent permit limitations for TN and TP. A reopener clause will be placed in the permit, however, to allow the inclusion of effluent nitrogen and phosphorus limits at a future date.

k. Credits for Facility Commitment to Future Nutrient Removal

Where a facility agrees in writing, as reflected in its NPDES permit, to bring new nutrient removal facilities into operation before December 31, 1995, DEM is authorized to provide the Association credit toward its allowable annual nutrient loadings, as set out in subsection 6e. DEM shall determine the level of nutrient reduction credits allowable in light of the project's timing and anticipated performance and shall place a reopener clause in the facility's NPDES permit to allow the inclusion of effluent nitrogen and phosphorus limits in the event that the facility does not meet its projected nutrient removal level. To the extent that the Association relies on such credits to reduce its excess loading payments under this program, and the anticipated nutrient reductions on which such credits were based are not achieved by the facility by December 31, 1995:

1) The Association shall, by September 30, 1996, render foregone payments plus 10%.
2) DEM may add nutrient limits to the facility's NPDES permit. Nutrient limits shall be effective January 1, 1996, and in no case shall be less stringent than the treatment level on which credit was based.

l. Phase II of the Nutrient-Reduction Trading Program

Phase II will begin in January 1995 after the model has been completed and nutrient reductions have been established for the whole basin, including the members of the Association. Details of the Phase II trading mechanism will be determined after the model is completed.

m. Local Water Quality Impacts

This alternative strategy does not preclude DEM from requiring individual point sources to remove nutrients where a localized water quality problem exists. DEM shall provide copies of any proposed wasteload allocation or permit requiring nutrient control for an Association member such that the Association, NCEDF, and PTRF may provide timely comments on the proposed agency action.

7. Existing Non-Association Facilities

Existing non-Association dischargers expanding to ≥ 0.5 MGD will receive effluent permit limitations to remove TP to 2 mg/l and TN to 4 mg/l (summer) and 8 mg/l (winter). Less stringent permit limitations may be obtained if offset by nutrient-reduction trading based upon $62/kg/yr. If a facility chooses to utilize the NPS trading option, with less stringent permit limitations, a one-time up-front payment must be made to the nutrient-reduction trading fund prior to permit issuance. This payment will be calculated as follows:

BMP payment ($) = New Design Flow (MGD) x Excess Nutrients (mg/l) x $62/kg/yr x Conversion Factor,

where:

Excess Nutrients (TP and TN in mg/l) =
(TP limit - 2 mg/l) + (TN limit - 6 mg/l) and
Conversion Factor = 1382 = 3.7854 l/gal x 365 day/year

8. New Facilities

New dischargers will receive the following effluent permit limitations:

- New ≥ 50,000 gpd: 2 mg/l TP year round
- New ≥ 100,000 gpd: 2 mg/l TP year round; 4 mg/l TN May-October and 8 mg/l TN November-April

An existing facility with an NPDES permit that increases its treatment plant capacity shall not be considered "new" within the meaning of this section.

9. Departmental Tar-Pamlico Ad-hoc Advisory Committee:

The Secretary of the Department of Environment, Health and Natural Resources may appoint a Tar-Pamlico Ad-hoc Advisory Committee to address nonpoint source and related water quality issues within the Tar-Pamlico Basin.

a. Ad-Hoc Committee Membership

The Committee shall include (among others):
(1) municipal and industrial dischargers,
(2) counties,
(3) Soil and Water Conservation Districts,
(4) environmental groups,
(5) DEM and DSWC representatives,
(6) appropriate representatives of the N.C. Agricultural Task Force, and
(7) other state agencies.

b. Ad-Hoc Committee Responsibilities

The Committee's role will be to:

(1) accelerate planning of the basinwide nutrient management strategy as it relates to pollution reduction trading,
(2) advise and recommend to DEM nutrient tradeoffs and allocations,
(3) assist in model development and BMP tracking and targeting,
(4) encourage active participation from a wide variety of agencies, companies, municipalities and citizens in this Tar-Pamlico Nutrient-Reduction Trading Program, and
(5) involve corporate entities.

c. Decision-Making Authority

DEM shall have final decision-making authority with regard to the adequacy of nutrient tradeoffs and allocations. Similarly, the Soil and Water Conservation Commission shall have final decision-making authority with regard to agricultural BMP implementation. All other designated nonpoint source management agencies shall retain their responsibilities within the basin.

10. Violation of Terms of This Agreement

If the terms of this agreement are violated, then the following strategy will be implemented following a presentation to the EMC:

a. All new dischargers shall evaluate non-discharge alternatives as their primary option and implement a non-discharge system unless they can demonstrate that non-discharge is technically or economically infeasible.

b. All new dischargers ≥ 0.05 MGD who cannot utilize a non-discharge alternative shall meet effluent limits of 2 mg/l on total phosphorus.

c. All new dischargers with design flows ≥ 0.1 MGD who cannot utilize a non-discharge alternative shall meet effluent limits on total nitrogen of 4 mg/l during May through October and 8 mg/l during November through April. They shall meet total phosphorus limits of 2 mg/l year round.

d. All new dischargers affected by nutrient limits will be expected to comply with the limits when the wastewater treatment plant becomes operational.

e. All existing discharges with design flows ≥ 0.1 MGD shall meet effluent limits on total nitrogen of 4 mg/l during May through October and 8 mg/l during November through April. Total phosphorus shall be limited to 2 mg/l year round for these facilities. These facilities will be given three years from the date of EMC action following strategy failure to comply with these limits. A reopener clause will be placed in all renewed NPDES permits in the Basin to allow the inclusion of effluent nitrogen and phosphorus limits at the above date.

Agreed to on February 13, 1992 by:

Dr. George Everett, Director
Division of Environmental Management

Steve Levitas, Director
N C Environmental Defense Fund

Malcolm Green
Tar-Pamlico Basin Association

Dave McNaught, Exec Director
Pamlico-Tar River Foundation

Approved by:

Charles Baker, Chairman
Environmental Management Commission

Tar-Pamlico NSW Implementation Strategy: Phase II

December 8, 1994

I. Background and Purpose

On September 12, 1989, the Environmental Management Commission (EMC) classified the Tar-Pamlico River Basin as Nutrient Sensitive Waters (NSW). Figure 1 is a map of the basin. On February 13, 1992, the EMC approved a revised NSW Implementation Strategy that established the framework for a nutrient reduction trading program between point and nonpoint sources of pollution. The Strategy also established certain conditions to be met by an association of dischargers in the basin known as the Tar-Pamlico Basin Association (the Association).

The February 13, 1992 NSW Strategy for the Tar-Pamlico River Basin represents the first phase or "Phase I" of an attempt to establish and achieve a nutrient reduction goal to address eutrophic conditions in the estuary. Phase I covers the period 1990-1994 and is included as Appendix A. Parties to the Phase I agreement as approved by the EMC included the Division of Environmental Management (DEM), the Tar Pamlico Basin Association, the N.C. Environmental Defense Fund (EDF) and the Pamlico-Tar River Foundation (PTRF).

The Association agreed to meet specific conditions in order to avoid effluent limits for nutrients in their permits and to have the opportunity to reduce nutrient loading in the most cost-effective manner, including the option to fund agricultural best management practices (BMPs). These conditions included the development of an estuarine hydrodynamic computer model, engineering evaluations of wastewater treatment plants, annual monitoring reports on nutrient loading, and minimum payments for the administration and implementation of agricultural BMPs. The Association met all conditions established in Phase I. Table 1 summarizes the status of Phase I commitments.

The purpose of this document is to formalize and clarify the details of the second phase of the Tar-Pamlico NSW Strategy covering 1995-2004. This Phase II document has been signed by the Division of Environmental Management, the Tar Pamlico Basin Association and the N.C. Division of Soil and Water Conservation (DSWC) and approved by the EMC. This agreement is also a component of the Tar-Pamlico River Basinwide Water Quality Management Plan adopted by the EMC on December 8, 1994. Future negotiations of the Tar-Pamlico NSW Strategy will be conducted as part of the basinwide planning process.

Generalized Map of the Tar-Pamlico River Basin

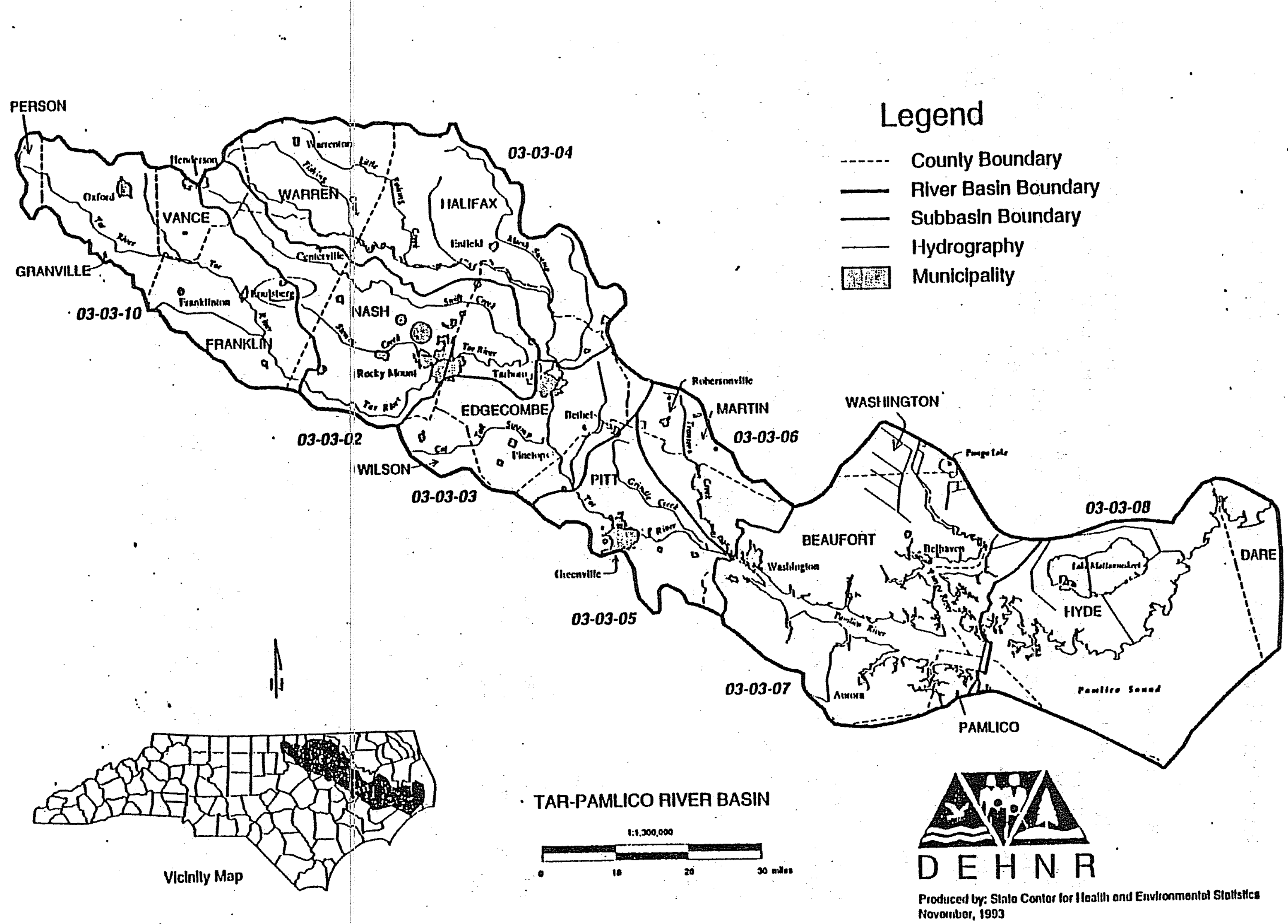

Figure 1

Table 1

Status of Tar-Pamlico NSW Implementation Strategy: Phase I

December 8, 1994

COMMITMENTS	STATUS
1. Estuarine Model	
- Complete by July 1, 1993	- Completed 10/93
- Provide DEM staff training	- Completed 10/93
2. Engineering Evaluations	
- Conduct evaluation of Association members	- Completed 3/91
- Conduct National Spinning evaluation	- Completed 2/93
3. Monitoring	
- Perform weekly effluent monitoring	- Ongoing
- Submit annual reports	- Submitted 2/92;2/93;2/94
	- 1994 report due 3/95

4. Nutrient Loading

Year	Total Allowable Loading (kg/yr)	Measured Total Nitrogen (kg)	Measured Total Phosp. (kg)	Measured Total Nutrients
1991	525,000	396,916	64,478	461,394 (-12%)
1992	500,000	386,014	50,113	436,128 (-13%)
1993	475,000	371,336	45,881	417,217 (-12%)
1994	425,000	?	?	?

*Note: Since the Association has not exceeded the maximum allowable nutrient loading to date, there has not been an actual trade to reduce agricultural nonpoint loadings.

5. Payments by the Association
- Contribute $150,000 for administration to DSWC

Date	Amount Paid
3/90	$ 25,000
8/90	41,666
2/91	41,666
8/91	41,668
Total	$150,000

COMMITMENTS		STATUS
- Obtain alternative funding		- The Association secured federal funds under a 104(b)3 grant in the amount of $750,000
104(b)(3) Grant Budget:		
Trading Document	$ 50,000	- Contract with K&C 1/94
Chicod Creek BMPs	$350,000	- In progress (DSWC)
Nutrient BMPs	$350,000	- In progress (DSWC)
Total	$750,000	

- Funds available for BMP credits:

Chicod Creek BMPs	$350,000	
Nutrient BMPs	$350,000	
Total Credit Available	$700,000	
Amount Credit Used	$250,000 (Min. payment 9/30/93)	
	$100,000 (Min. payment 9/30/94)	
Available Credit Remaining for Phase II	$350,000	

- Make annual minimum payments for agricultural BMP's

Minimum Payment	Payment Due	
$150,000	9/30/92	- Paid $75,000 on 6/92 and $75,000 on 8/92
$250,000	9/30/93	- Credit of $250,000 from alternative funding above
$100,000	9/30/94	- Credit of $100,000 from alternative funding

- Total Payments made toward BMPs	$700,000 (104(b)(3) grant)
	$150,000 paid 9/30/92
	$850,000

6. **Phase II of the NSW Strategy** — - Adopted 12/8/94
   - Phase II of the NSW strategy begins January 1995
   - Revised nutrient reduction goals refined by use of the estuarine model

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II. Association members

Members of the Tar-Pamlico Basin Association include the following facilities: Belhaven, Bunn, Enfield, Franklin Water and Sewer Authority, Greenville, Louisburg, Oxford, Pine Tops, Rocky Mount, Spring Hope, Warrenton, Washington, Tarboro and National Spinning. There will be no new members added to the Association within five years after adoption of this agreement with the exception that corporations (that serve as integrators) and animal producers may apply for and be granted membership. At the end of five years, Association membership may be reopened to include non-Association facilities, but the annual target load will be adjusted accordingly.

III. Nutrient Reduction Targets

The Association contracted with HydroQual, Inc. to perform the estuary modeling. HydroQual developed a two dimensional, laterally averaged hydrodynamic water quality model to predict the impacts of nutrient loading in the estuary. The model extends from Greenville to Pamlico Point a distance of approximately 60 miles. Figure 2 illustrates the model segmentation below Washington. The year 1991 was chosen as the calibration year for the model because it represented when typical impairment of the estuary was evident. It was also the baseline year established in the revised Phase I agreement for tracking nutrient reductions by requiring nutrient monitoring at the facilities.

A. Nutrient Assimilative Capacity Exceeded in the Tar-Pamlico Estuary

DEM applied the model under the 1991 calibration conditions as well as under various nutrient reduction scenarios and plotted the results for a site located near Washington in order to evaluate possible management strategies. The Washington site was chosen since modeling results indicated that this was where the greatest number of chlorophyll a and dissolved oxygen (DO) violations occurred, and the magnitude of the violations was the greatest. Thus, it is the critical portion of the river. Under the 1991 loading conditions, the model indicates that the chlorophyll a standard was violated approximately 18 percent of the time at Washington. These predictions are daily averages and are averaged across the river in each segment. Therefore, specific areas within a model segment or given times of day may indicate better or worse water quality than predicted.

The nutrient inputs during the model applications were reduced by varying amounts to determine what loading was necessary to protect water quality standards. The model was applied to simulate a five year period to allow improvements

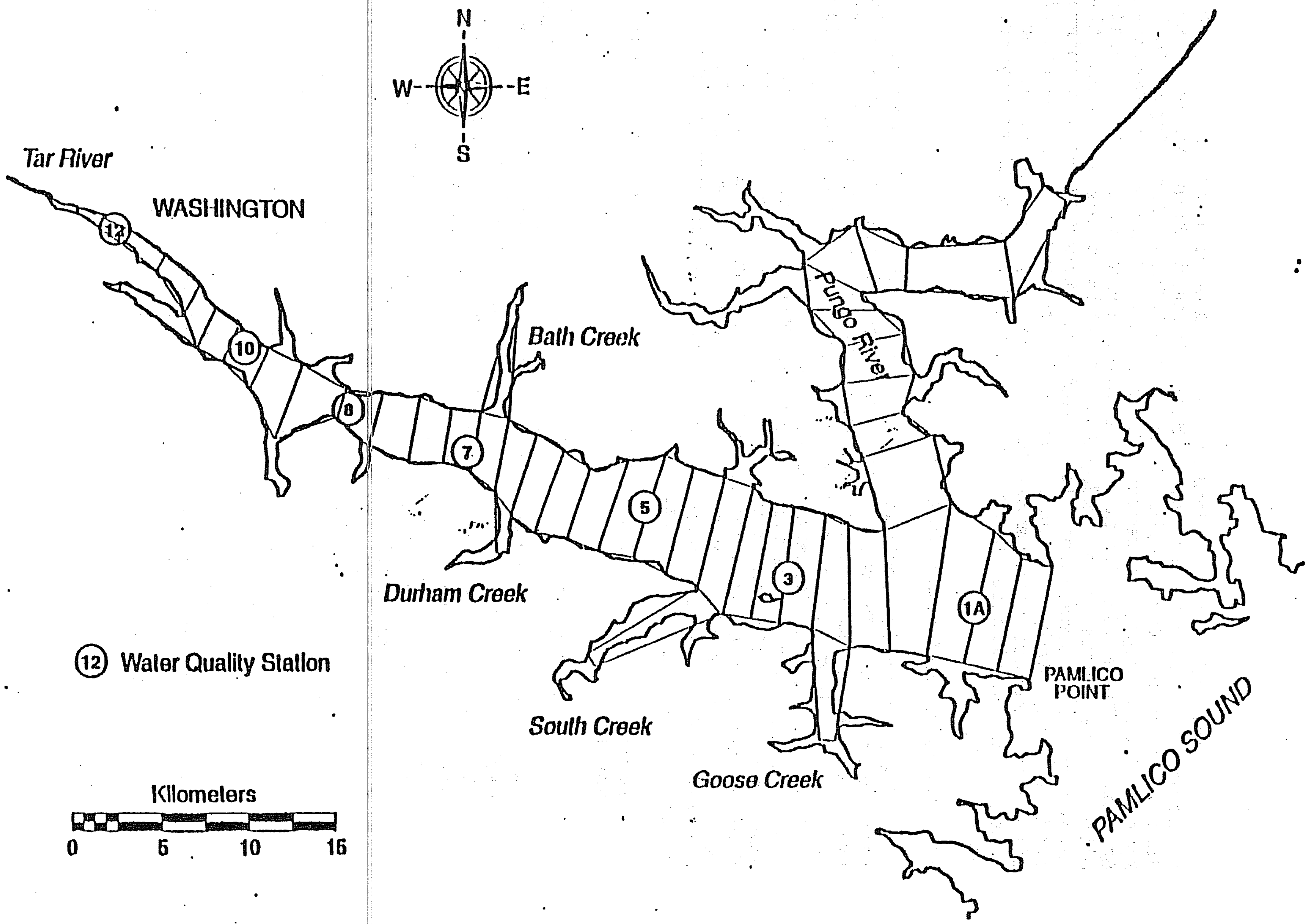

Figure 2 HydroQual, Inc. Nutrient Model Segmentation Below Washington

in the sediment concentrations to be reflected in the water column quality. The results indicate that a 30 percent reduction in total nitrogen (TN) was predicted to significantly reduce the frequency and severity of algal blooms in the estuary. To prevent exceedance of the chlorophyll-a standard of 40 ug/l, the model predicted that a 45 percent reduction in total nitrogen may be needed (Figure 3). Nitrogen reduction is also predicted by the model to significantly increase dissolved oxygen in bottom water, to prevent extended anoxic conditions and to decrease the frequency of supersaturation conditions (Figure 3a).

B. Recommended Nutrient Reduction Goals for Nitrogen and Phosphorus

It is difficult to project exactly what would be an acceptable level of water quality in the basin. Even if the basin was not developed, it is likely that blooms could occasionally occur naturally. In addition, a 45 percent reduction in nitrogen loading may not be feasible given current BMP methods and point source treatment technologies. There is also some model error and uncertainty in predictions which could result in costly treatments which are not needed to meet water quality standards.

The model was calibrated under relatively high nutrient loading conditions. Therefore, the modeling results must be evaluated within the context of the model calibration. The further a given nutrient loading scenario applied to the model is from calibration conditions, the greater the uncertainty is for obtaining an accurate prediction of the water quality impacts of such loading. At present, the interpretation of modeling results suggests that algal and DO concentrations in the estuary will respond significantly to reductions in nitrogen loading and that a 45 percent TN reduction is needed to have no chlorophyll-a violations. However, the model can not be considered fully reliable for conditions so different from existing conditions. To improve confidence in the modeling results, the model must be recalibrated to reflect changing conditions as nutrient loading is reduced. Given the uncertainty inherent to a predictive model, an interim target will be established while model calibration will continue.

The interim goal for TN reduction is 30 percent from 1991 conditions. This level of reduction was selected because it resulted in most of the predicted change in chlorophyll-a and DO that was observed under TN reduction scenarios applied to the model. However, it is likely that further TN reduction will be required, but a more exact target can be established once the model is calibrated to lower nutrient loading conditions. The goal of 30 percent reduction is an interim goal that is more realistic and achievable over the life of

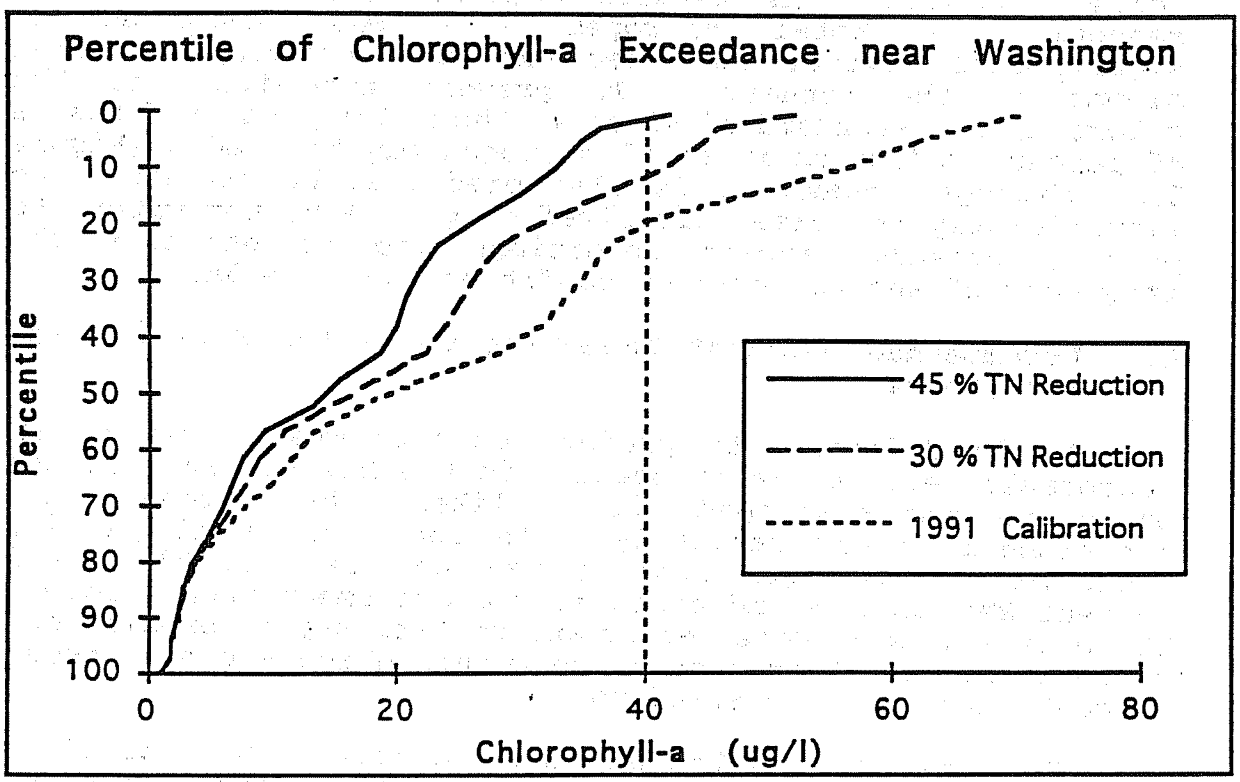

Figure 3. Predicted Percentiles of Chlorophyll-a Exceedances of the 40 ug/l Standard at Washington, NC, for Three Nitrogen Loading Scenarios Using HydroQual's Estuarine Model

Predicted Summer Bottom Layer Dissolved Oxygen at Station 3 for Three Nitrogen Loading Conditions

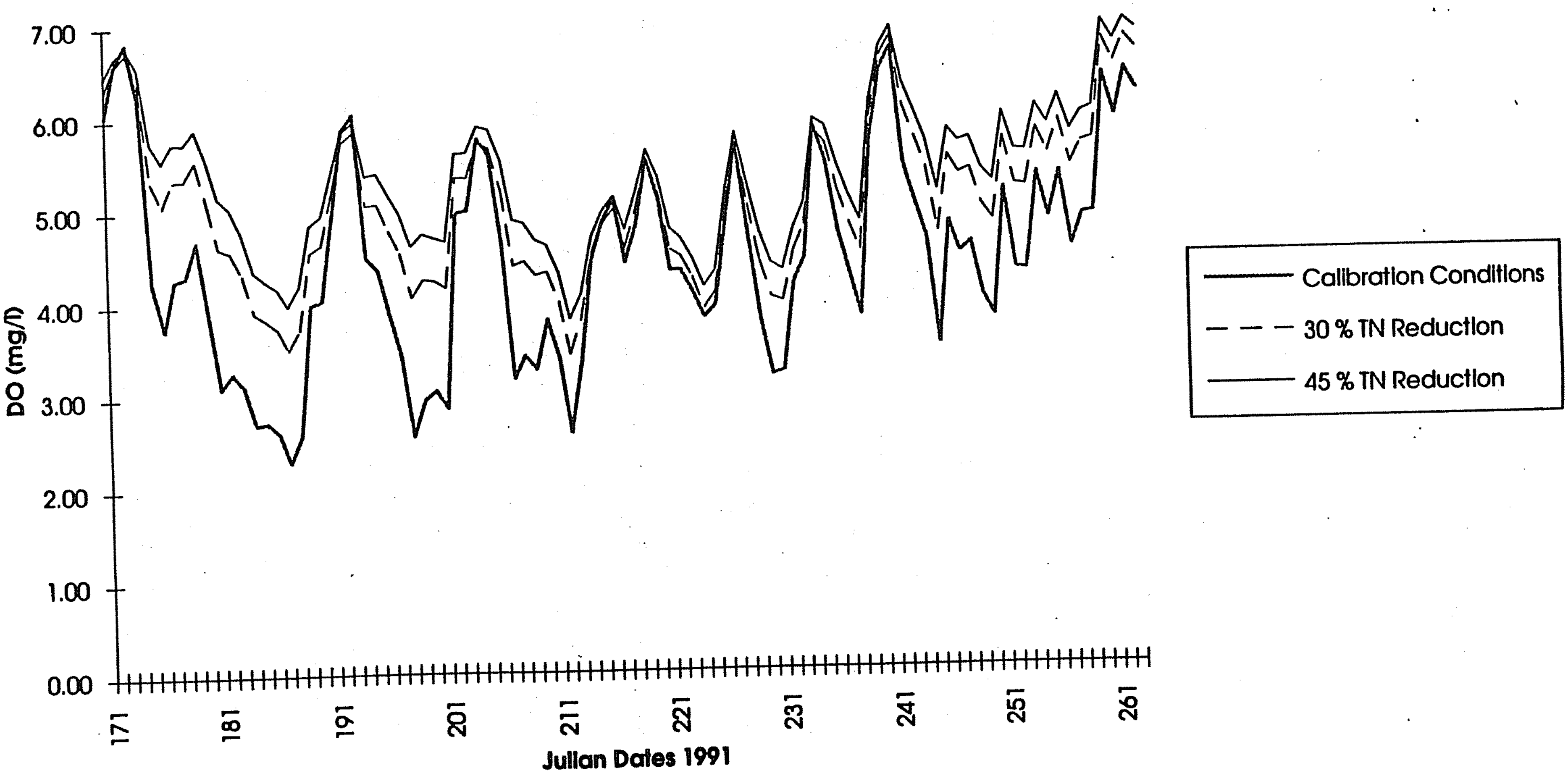

Figure 4

the Agreement. The final target of no water quality standard violations remains an ultimate goal of the Tar Pamlico Basinwide Plan.

The model supports that nitrogen is the most appropriate target nutrient to limit the potential for problematic algal blooms in the middle estuary. The model does not suggest significant improvements in chlorophyll-a levels in the middle estuary based on additional reductions in phosphorus. It is important, however, to consider the upper and lower bounds of the study area, where phosphorus is more likely to be limiting on a seasonal basis. Phosphorus levels may become more important in the future after significant nitrogen reductions cause a commensurate shift in ratios of nitrogen to phosphorus. However, the proposed targets, if achieved, would result in TN:TP ratios within a desired range. Another potential problem associated with elevated concentrations in either or both nutrients in this estuary is the loss of important submerged aquatic vegetation (SAV). While it is extremely difficult to model and predict recovery of SAV and their effect on nutrient dynamics, it would not be prudent to support additional increases in a phosphorus rich estuary. Therefore, this strategy recommends no additional increase in load of total phosphorus into the estuary. Total Maximum Daily Load (TMDL) targets are set for 1,260,000 kg/yr of TN and 180,000 kg/yr of TP at Greenville.

1. **Annual Loading Target for Total Nitrogen for the Association**

The Total Nitrogen (TN) loading from all sources at Greenville in 1991 was calculated to be 1.8 million kilograms (kg). Based on the 30 percent reduction goal developed with the estuary model, the TN loading target at Greenville is calculated to be 1.26 million kg/yr. However, there are Association discharges located below Greenville which need to be incorporated into these figures. In order to do this, loading estimates were developed at Washington based on yields using the average flow to drainage area ratio. This calculation indicates the TN target at Washington to be 1.944 million kg/yr. A 30 percent reduction goal provides a TN target load at Washington of 1.361 million kg/yr or a TN load reduction goal of 583,000 kg/yr for both point and nonpoint sources.

The point source allocation of the total reduction needed is established as 8 percent. The Association's loading accounts for approximately 90 percent of all point source loading. Therefore, Association members should have to reduce their load by approximately 41,976 kg from the 1991 load at Washington (i.e., 583,000 x 0.08 X 0.9). In order to account for in-stream losses to Washington, a nutrient decay rate of 30 percent is assumed. Therefore, the Association's load reduction target needed from 1991 loads at the end of the pipe is 59,966 kg (i.e., 41,976 divided by 0.7).

The TN loading for the Association's discharges (including National Spinning and Tarboro but not including Belhaven) in 1991 is calculated to be 465,222 kg. Therefore, the annual Association target loadings for TN is 405,256 kg at the end of the pipe (i.e., 465,222-59,966 = 405,256). This cap for TN loading by Association members has been established based on water quality parameters and not on treatment technology.

The above calculations are summarized as follows:

TN Load in 1991 at Greenville (kg)	1,800,000
TN Target at Greenville based on estuary Model(kg/yr)(30%reduction):	1,260,000

Since there are Association dischargers below Greenville, loading numbers were estimated at Washington based on yields (average flow to drainage area ratio). The following numbers were calculated:

Estimated TN Load delivered through the Tar River at Washington in 1991(kg)	1,944,000
Target Load at Washington based on 30% reduction (kg/yr)	- 1,361,000
Total Load Reduction Needed from 1991(kg)	= 583,000
Association Load for 1991 (kg)	396,916
Tarboro 1991 Load (kg)	+ 37,129
National Spinning 1991 Load (kg)	+ 31,177
Total Association Load for 1991 (kg)	= 465,222
Point Source Allocation for Total Reduction Needed	8%
Association Contribution to Point Source Loading	90%
Association Load Reduction Needed from 1991 at Washington (583,000 X 0.08 X 0.9)	41,976
Association Load Reduction Needed from 1991 at end of pipe (assume 30% decay rate) (41,976 divided by 0.7)	59,966
Annual Target Association TN Load (kg) at end of pipe (465,222-59,966)	**= 405,256**

This annual target load actually becomes a cap that is not to be exceeded in future years unless new monitoring and modeling results suggest all water quality standards and goals are being met. Any loading above the target load in any year of the Agreement would have to be offset by the purchase of nutrient reduction through funding nonpoint source controls.

2. Annual Loading Target for Total Phosphorus for the Association

To ensure protection of water quality, total phosphorus loading should be held constant at Greenville. Therefore, 1991 loadings for the Association (including National Spinning and Tarboro) should be used as the target. This target is calculated as follows:

Association Load in 1991 (kg)	64,478
Tarboro 1991 Load (kg)	+ 3,498
National Spinning 1991 Load (kg)	+ 1,768
Annual Target TP Load for Association (kg)	**=69,744**

As with TN, this annual target load actually becomes a cap that is not to be exceeded in future years unless new monitoring and modeling results suggest all water quality standards and goals are being met. Any loading above the target load in any year of the Agreement would have to be offset by the purchase of nutrient reduction through funding nonpoint source controls.

3. Nonpoint Sources

The goal to be accomplished at Washington is to reduce total nitrogen loading by 30 percent from 1991 loadings. This reduction amounts to 583,000 kg/yr and is necessary to progress toward the attainment of water quality standards. Since the point source allocation is established at 8 percent of the total reduction needed, nonpoint source activities in the basin must work to attain a reduction of approximately 536,360 kg/yr at Washington (i.e., 583,000 X 92%) to achieve a 30 percent reduction from all sources. In order to account for in-stream losses to Washington, a nutrient decay rate of 30 percent is assumed. Therefore, the in-stream reduction target for nonpoint sources is 766,228 (i.e., 536,360 divided by 0.7).

The success of nonpoint source activities will require substantial coordination by multiple nonpoint source agencies, local governments, environmental groups and the Department of Environment, Health and Natural Resources. The Division of Environmental Management will convene and coordinate meetings with the appropriate groups and agencies to establish a coordinated and focused plan to achieve the required nonpoint source nutrient reductions. This additional strategy that provides further details of how such reductions are to be achieved by nonpoint sources and the accounting of such actions will be established by September 1995.

E. **Non-Association Facilities** (A list of all dischargers and permitted flows is provided in Appendix B. NOTE: The requirement for non-Association facilities to fund nonpoint source controls is beyond the scope of this Agreement. For these requirements to apply, a formal NSW Strategy with these requirements must be adopted by the EMC through rule-making.)

1. **Existing Domestic Dischargers** -

Existing non-Association dischargers ≥ 0.5 MGD will receive effluent permit limitations to remove TP to 1 mg/l and TN to 6 mg/l monthly average within five years of the date of this Agreement.

2. **Expanding Domestic Dischargers** -

Existing non-Association dischargers expanding to ≥ 0.5 MGD will receive effluent permit limitations to remove TP to 1 mg/l and TN to 6 mg/l monthly average at the time of expansion. Compliance with the limits is required when the wastewater treatment plant becomes operational. In addition, the increase in TN and TP loading resulting from the expansion shall be offset by funding nonpoint source control programs approved by DEM. Facilities with a permitted flow of < 0.5 MGD at the time this agreement is signed shall offset TN and TP loading in excess of the loading that would be achieved at best available technology (BAT) (6 mg/l for TN and 1 mg/l for TP) at a flow of 0.5 MGD (i.e., 0.5 MGD X (6 mg/l TN + 1 mg/l TP) X 1384 (conversion factor) = 4,844 kg/yr). Facilities with a permitted flow of ≥ 0.5 MGD at the time this agreement is signed shall offset TN and TP loading in excess of the loading that would be achieved at BAT at the pre-expansion permitted flow. The actual payment rate for the nonpoint source controls shall be 110 percent of the cost established in Section IV of this Agreement. Payment will be based on one year of loading at BAT for the permitted flow. Payment of one year of loading for the life of the permit assumes that BMPs implemented with those funds will be effective for the remaining years of the permit. Payment for the excess loading shall be transacted before the permit can be issued or renewed. The calculation to determine NPS payments is as follows:

Example for a facility with a permitted flow of < 0.5 MGD at the time of signing the agreement:

NPS Payment ($)= [[(Permitted flow including expansion) X (TN and TP limit concentrations) X 1384] - [0.5 MGD X (6 mg/l TN + 1 mg/l TP) X 1384]] X (BMP cost-effectiveness rate) X 1.1

Example for a facility with a permitted flow $\geq$ 0.5 MGD at the time of signing the agreement:

NPS Payment ($)= [[(Permitted flow including expansion > 0.5 MGD) X TN and TP limit concentrations X 1384] - [(Permitted flow at the time agreement was signed) X (6 mg/l TN + 1 mg/l TP) X 1384]] X (BMP cost-effective rate) X 1.1

3. **Existing Industrial Dischargers**

Existing industrial dischargers will be given effluent limits based on a case-by-case determination of BAT. These limits must be achieved within five years of the date of this Agreement.

4. **Expanding Industrial Dischargers**

Industrial dischargers expanding $\geq$ 0.5 MGD will be given effluent limits based on a case-by-case determination of BAT. Compliance with the limits is required when the plant becomes operational. In addition, the increase in TN and TP loading resulting from the expansion shall be offset by funding nonpoint source control programs approved by DEM. Facilities with a permitted flow of < 0.5 MGD at the time this agreement is signed shall offset TN and TP loading in excess of the loading that would be achieved at best available technology (BAT) at a flow of 0.5 MGD (i.e., 0.5 MGD X (BAT concentrations) X 1384 (conversion factor) = base loading (kg/yr). Facilities with a permitted flow of $\geq$ 0.5 MGD at the time this agreement is signed shall offset TN and TP loading in excess of the loading that would be achieved at BAT at the pre-expansion permitted flow. The actual payment rate for the nonpoint source controls shall be 110 percent of the cost established in Section IV of this Agreement. Payment will be based on one year of loading at BAT for the new permitted flow and will be prorated over the life of the permit. Payment of one year of loading for the life of the permit assumes that BMPs implemented with those funds will be effective for the remaining years of the permit. Payment for the excess loading shall be transacted before the permit can be issued or renewed. The calculation to determine NPS payments is as follows:

Example for a facility with a permitted flow of < 0.5 MGD at the time of signing the agreement:

NPS Payment ($)= [[(Permitted flow including expansion) X (TN and TP limit concentrations) X 1384] - [0.5 MGD X (BAT concentrations) X 1384]] X (BMP cost-effectiveness rate) X 1.1

Example for a facility with a permitted flow ≥ 0.5 MGD at the time of signing the agreement:

NPS Payment ($)= [(Permitted flow including expansion ≥ 0.5 MGD) X TN and TP limit concentrations X 1384] - [(Permitted flow at the time agreement was signed) X (BAT concentrations) X 1384]] X (BMP cost-effective rate) X 1.1

F. **New Facilities**

1. Effluent Limits- New dischargers that can not use a nondischarge alternative will receive the following effluent permit limitations:

- New > 50,000 gpd: 1 mg/1 TP monthly average
- New ≥ 500,000 gpd: 1 mg/1 TP monthly average; 6 mg/1 TN monthly average

All new dischargers are required to comply with the nutrient limits when the plant becomes operational.

2. Nonpoint Source Controls- All nutrient loading by a new discharger must be offset by making payments for nutrient reduction through nonpoint source control programs approved by DEM so that there is no net increase in load. That is, the maximum nutrient load allowed by the permit must be accounted for in nutrient reductions through nonpoint source controls. The actual payment rate for the nonpoint source controls shall be 110 percent of the cost established in Section IV of this Agreement. The total cost for NPS payments will be based on one year of loading at 6 mg/1 for TN and 1 mg/1 for TP for the permitted flow and will be prorated over the life of the permit. Payment of one year of loading for the life of the permit assumes that BMPs implemented with those funds will be effective in reducing nutrient loading during the remaining years of the permit. Payment for the life of the permit shall be transacted before the permit can be issued or renewed. Permit renewals will be transacted according to the policy set forth in this paragraph. The calculation to determine the NPS payment for new facilities is as follows:

NPS Payment ($)= (Permitted flow) X (6 mg/1 TN + 1 mg/1 TP) X cost effectiveness rate) X 1.1

IV. Nutrient Reduction Trading Program

The purpose of this agreement is to allow Association facilities to achieve DEM's nutrient reduction goal by funding other more cost-effective nutrient reduction measures than the cost of meeting effluent limits at the Association facilities. The alternative to meeting the point source reduction goals through nutrient reduction at the facilities is to fund enough nonpoint source controls so that, at the very least, the annual nutrient reduction goal for the Association is achieved.

A. **Trading Options-** The nonpoint source control options available to be funded by the dischargers in the nutrient reduction trading program include the following:

- -support the implementation of agricultural BMPs such as those initiated in Phase I (including nutrient management plans),
- -support of a DSWC staff position for administration and technical assistance initiated in Phase I,
- -*support the development and implementation of nutrient management plans for non-agricultural nutrient sources, and
- -*support wetland and riparian buffer restoration projects.

*At this time, there is no mechanism or infrastructure to transact these trading options, so these are just included to allow such future trading options once formal mechanisms are established.

B. **Trading Credits-**

1. **Flat Rate-** A flat rate will be useful for calculating up-front costs associated with new dischargers, but can be applied for all situations. A flat rate for trading purposes during the first two years of this agreement is established at $29/kg of nitrogen reduced in loading to the estuary. This flat rate has been determined by DEM based on a draft report by the Research Triangle Institute entitled "The Cost-effectiveness of Agricultural BMPs for Nutrient Reduction in the Tar-Pamlico Basin (November, 1994) and the inclusion of a safety factor. This flat rate shall be evaluated and adjusted, as necessary, every two years from the date of this agreement. The rate will be established by DEM in consultation with parties to this Agreement.

2. **Credit Life-** All credits for structural BMPs shall have a useful life of ten years or such longer period as may be provided for in DSWC's BMP contracts. The credit life for non-structural BMPs shall be three years. Credit using the

flat rate will be provided to the Association if a staff position is funded.

3. **Payment Schedule-** The annual payment for BMPs shall be made one month after the annual monitoring report is submitted on March 1.

4. **Phase I Credits-** In Phase I, the Association contributed $850,000 for agricultural BMPs, but only $500,000 was required as a condition of the Phase I Agreement. However, approximately $400,000 has been obligated to date. Using the established rate in Phase I of $56/kg for the obligated portion, the Association will have reduced TN by approximately 7,143 kg/yr. Credit for the remaining $450,000 secured under Phase I shall be based on the flat rate of $29/kg or 15,517 kg/yr. The total credit of 22,660 kg/yr will be applied to the Association beginning January 1995 and shall last ten years.

5. **Funding Sources-** If the dischargers can secure additional funding from sources such as federal grants, exclusive of funds available to the states, these funds can be used to make nutrient reduction payments or to fulfill other conditions to this agreement described below. Any additional funds that the dischargers secure for nonpoint source controls must be in addition to that which would have occurred from federal, state, and local sources if not for the existence of this agreement.

V. Minimum Conditions to this Agreement

In order to have access to the option for nutrient trading with nonpoint sources to meet mass limits as a group in lieu of nutrient limits at each discharger, the Association agrees to meet the following minimum conditions:

A. Monitoring

Association facilities shall continue to monitor effluent TP and TN and the Association shall submit an annual report to DEM every March 1 detailing this monitoring data from the previous year. The annual report will be used to determine compliance with this strategy. DEM may authorize less frequent monitoring (i.e., other than weekly) where the discharger demonstrates that less frequent sampling is adequate to characterize facility loadings.

The monitoring protocol to be used is as follows:

-Weekly samples must be taken, but they may be preserved for a monthly "one time" analysis of the four weekly samples. That is, the four weekly samples are to be analyzed separately and not as a mixed or "composite" sample.

-The samples must be stabilized with sulfuric acid at the time of sampling, as prescribed by "Standard Methods for Examination of Water and Wastewater."

-Weekly effluent samples must be held under refrigeration for not more than 28 days before analysis.

Where a facility fails to report flow data, its flow for the unreported period shall be estimated based on the ratio of the facility's reported flow in the remainder of the year to the combined flow of the other Association POTW members during the same time period. Where a facility fails to report TP or TN concentrations, the facility's nutrient concentrations for the unreported period shall be estimated by DEM using the best available data.

B. Modeling

1. Nutrient Fate and Transport Model

Current models available in the Tar-Pamlico Basin do not determine what percentage of nutrients which run off into a stream in the upper portion of the watershed actually is transported to the estuary. Fate and transport modeling is extremely data intensive and is not practical to perform on a large basin at this time. However, it is feasible to do this type of modeling on a small watershed if data are available. If future monitoring indicates severe nutrient problems on a smaller watershed, it may be cost effective to perform studies to develop a fate and transport model. The Association has agreed to pursue federal funding to study fate and transport.

2. Hydrodynamic Model Support Service

With the hydrodynamic model of the estuary completed, the Association will provide funding for a support service with ~~HydroQual, Inc. to answer questions DEM staff members have as~~ they apply the model during Phase II of the project. Specifically, the Association will review reports, participate in application of water quality model, and make recommendations where necessary on how to improve effectiveness of application. The Association also will provide continued technical assistance to DEM by means of a hotline to HydroQual to answer DEM's questions on applying the water quality model.

3. **Model Calibration**

In order to support model recalibration in future years, DEM will establish a flow relationship between Tarboro and Grimesland with funds provided by the Association or other sources. If Association funds are used, it will not affect the credit received by the Association under subparagraph IV.B.4.

VI. **Local Water Quality Impacts**

This Agreement does not preclude DEM from requiring individual point sources to remove nutrients where a localized water quality problem exists. DEM shall provide copies of any proposed wasteload allocation or permit requiring nutrient control for an Association member so that the Association, NCEDF, and PTRF may provide timely comments on the proposed agency action.

VII. **Decision-Making Authority**

DEM shall have final decision-making authority with regard to the adequacy of nutrient tradeoffs and allocations. Similarly, the Soil and Water Conservation Commission shall have final decision-making authority with regard to agricultural BMP implementation. All other designated nonpoint source management agencies shall retain their responsibilities within the basin.

VIII. **Nonpoint Source Controls**

There are other nonpoint source control initiatives underway in the Tar Pamlico River Basin that go beyond the terms of this Agreement to reduce nutrient loading. These initiatives include the following combination of voluntary and regulatory programs:

A. **Animal Operations-** All animal operations in the basin are required to comply with the EMC regulations for animal waste management. All operations are prohibited from discharging animal waste to surface waters of the state. Larger feedlots are required to register the operation with DEM and to obtain and implement an approved animal waste management plan by December 31, 1997. Failure to register or follow an approved plan will lead to civil penalties. New or expanded operations must obtain an approved plan that requires design, construction, operation and maintenance standards and specifications to be met before animals are stocked. Willful dischargers are subject to an immediate civil penalty not to exceed $5,000. Water quality standard violations are subject to civil penalties up to $10,000 per day.

B. **Nutrient Management Plans-** Farms that are not covered under the animal waste rules are encouraged to develop and apply nutrient management plans. Nutrient management planning also is encouraged for use on non-agricultural land. Beaufort County is participating in a Water Quality Incentive Project for nutrient management planning administered by the USDA. A Memorandum of Agreement will be established with the major agricultural corporations to control nutrients at contracting farms. Nutrient management planning will be required in the coastal zone of the basin under the coastal nonpoint source program by January 1999.

C. **Agriculture Cost Share Program-** The ACSP can target critical areas for financial and technical assistance to help reduce nutrient loading. Additional technical assistance for the ACSP was approved by the 1994 General Assembly.

D. **Coastal Nonpoint Point Source Program-** All land within the coastal zone boundary will be required to meet specific management measures for nutrient and sediment control established by EPA and NOAA by 1999. This program will be administered by DEM and DCM.

E. **USDA Programs-** The USDA administers programs that may be targeted for nutrient controls in the basin. These include Conservation Reserve, Conservation Compliance, Sodbuster, Swampbuster, Wetland Reserve, and the Water Quality Incentive Program.

F. **Cooperative Extension Service-** The North Carolina Cooperative Extension Service recently conducted training for their staff in nutrient management planning. Educational programs can be developed and implemented in the basin.

G. **Use Restoration Waters (URW)-** The proposed URW supplemental classification, if adopted by the EMC, may be applied to specific areas in the basin. The URW would require site-specific BMPs to correct documented water quality problems.

IX. Violation of Terms of this Agreement

If the terms of this agreement are violated, then the following strategy will be implemented following a presentation to the EMC.

A. All new dischargers shall evaluate non-discharge alternatives as their primary option and implement a non-discharge system unless they can demonstrate that non-discharge is technically or economically infeasible.

B. All new dischargers ≥ 0.05 MGD who cannot utilize a non-discharge alternative shall meet effluent limits of 1 mg/l on total phosphorus monthly average.

C. All new dischargers with design flows ≥ 0.5 MGD who cannot utilize a non-discharge alternative shall meet effluent limits on total nitrogen of 6 mg/l monthly average. They shall meet total phosphorus limits of 1 mg/l year round.

D. All new dischargers affected by nutrient limits will be expected to comply with the limits when the wastewater treatment plant becomes operational.

E. All existing discharges with design flows ≥ 0.5 MGD shall meet effluent limits on total nitrogen of 6 mg/l monthly average. Total phosphorus shall be limited to 1 mg/l monthly average for these facilities. These facilities will be given three years from the date of EMC action following strategy failure to comply with these limits. A reopener clause will be placed in all renewed NPDES permits in the Basin to allow the inclusion of effluent nitrogen and phosphorus limits.

F. *All new, expanded and existing dischargers shall offset any excess nutrient loading from the annual targets established by DEM for each facility by funding nonpoint source controls according to procedures described in paragraphs III E. and F. of this document (pages 13-15).

*NOTE: The requirement for non-Association facilities to fund nonpoint source controls is beyond the scope of this Agreement. For these requirements to apply, a formal NSW Strategy with these requirements must be adopted by the EMC through rule-making.

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Tar-Pamlico NSW Implementation Strategy: Phase II

Agreed to on Dec 8, 1994 by:

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Director
Division of Environmental
Management

Malcolm Green
Tar-Pamlico Basin
Association

Dewey Botts, Director
Division of Soil and Water
Conservation

Approved by:

David H. Moreau, Chairman
Environmental Management
Commission

APPENDIX V

SUMMARY OF BASINWIDE PLANNING WORKSHOPS

North Carolina
Cooperative Extension Service
NORTH CAROLINA STATE UNIVERSITY
COLLEGE OF AGRICULTURE & LIFE SCIENCES
DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

Albemarle-Pamlico Estuarine Region Program • Vernon G. James Research & Extension Center • Route 2, Box 141 • Plymouth, NC 27962
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MEMO

TO: Basinwide Planning Conference Participants from the Tar-Pamlico Basin

cc: Alan Clark, North Carolina Division of Environmental Management
Paula Thomas, North Carolina League of Municipalities

FR: Greg Jennings, Extension Water Quality Specialist
William Lord, Agricultural Agent, Franklin County Extension Center
Catherine McCracken, Public Policy Education Specialist

DT: June 24, 1994

Two Tar-Pamlico Basinwide Planning Workshops have been held since the Basinwide Planning Conference at the McKimmon Center in January 1994. A Lower Tar-Pamlico Basinwide Planning Workshop was held in Greenville on February 28 and an Upper Tar-Pamlico Workshop was held in Louisburg on April 14.

A Summary of the Tar-Pamlico Workshop held in Greenville on February 28 is enclosed for your information. Participants at the Louisburg meeting identified many of the same issues as priorities that were discussed at the Greenville meeting. There seems to be some consensus that the priority issues for the Tar-Pamlico Basin are:

o increase public education and participation of stakeholders
o improve nonpoint source pollution control
o identify and target problem areas/resources in the river basin
o consider land use planning and property rights
o improve water quality data
o improve funding and enforcement of regulations
~~o consider cost-benefit relationships~~

The draft Tar-Pamlico Basinwide Water Quality Management Plan will be distributed this summer. At least two public meetings on the draft Plan will be conducted in August or September in the evening with possibly a day-time meeting to be held in Raleigh (exact dates and locations to be determined). Public comments will be considered by the Division of Environmental Management before the final Plan is approved by the Environmental Management Commission. It is important for local citizens and officials to be involved in the planning process if this natural resources protection program is to succeed in meeting its water quality protection goals.

Tar-Pamlico Basinwide Planning Workshop Summary

Prepared by Greg Jennings and Catherine McCracken, Extension Specialists
NC Cooperative Extension Service, North Carolina State University

The Tar-Pamlico Basinwide Planning Workshop was conducted February 28, 1994, at the Pitt County Agriculture Center, Greenville, with 62 participants representing the following interests:

11 Local Government	10 Private / Farm Operators	7 CES - County	7 CES - NCSU
6 DEM - State	5 SCS	4 DSWC	3 Industry
2 DEM - Regional	2 DCM	2 APES	1 Marine Fisheries
1 DCA	1 USGS		

Workshop Objectives:

1. Describe local implications of the Tar-Pamlico Basinwide Water Quality Management Plan; and
2. Increase public involvement in developing and implementing the Tar-Pamlico Basinwide Plan.

Workshop Agenda:

8:30 Registration
9:00 Introduction and Video Presentation - Greg Jennings, NCSU
9:30 Description of DEM Basinwide Water Quality Management Program and Implications for the Tar-Pamlico River Basin - Alan Clark, DEM
10:15 Break
10:30 Discussion Groups to Answer: "Based on your knowledge of water quality in the Tar-Pamlico River Basin, what are the key issues and how should they be addressed?"
11:15 Presentations by Discussion Group Facilitators
11:45 DEM Response to Discussion Group Input and Wrap-up

Workshop participants were provided with written materials describing the Basinwide Management program in general and its impacts on the Tar-Pamlico Basin specifically.

The 62 participants were randomly divided into 6 discussion groups to respond to the question: "Based on your knowledge of water quality in the Tar-Pamlico River Basin, what are the key issues and how should they be addressed?" Facilitators from the Cooperative Extension Service limited discussion to allow all group members to have opportunities for input. Facilitators summarized key issues and solution actions in 5-minute presentations to Workshop participants.

Priority issues identified by the 6 Discussion Groups were:

- **Increase public education and participation of stakeholders (4 Groups)**
- **Improve nonpoint source pollution control (4 Groups)**
- **Identify and target problem areas (3 Groups)**
- **Consider land use planning and property rights (3 Groups)**
- **Improve water quality data (2 Groups)**
- **Improve funding and enforcement of regulations (2 Groups)**
- **Consider cost-benefit relationships (2 Groups)**

The Discussion Group summaries below list the issues raised followed by the priority issues with possible solution actions.

Group 1 Issues (Facilitator: Catherine McCracken, CES - Plymouth):

- Sediment
- Nutrient loading - point sources, septic tanks
- Wetlands re-creation/mitigation
- Solid waste
- Marine populations
- Education - where's the problem?
- Involvement
- All types of runoff/NPS-agriculture, urban etc.
- Balancing data to develop goals-dealing with uncertainty
- Critical levels of measuring WQ factors
- Balancing economic development/environmental concerns - who pays?
- Animal waste management
- Research on the natural state of the systems
- Who decides?
- Background info - what are we starting with?
- Residual impacts - models and inputs to models
- Wetlands values
- How do we evaluate our management strategies/prioritize?
- Critical species/habitats
- How do we know we have "done the job?" what are the end points?
- Upstream/downstream issues and cumulative impacts
- Endangered species management-development and implementation of recovery plans
- Private property rights and "takings" issues

Group 1 Priority Issues and Possible Solution Actions:

1. **Land use planning**
   - why do we need it?
   - who does it - local/state/feds/private sector
   - establish ownership
   - strategic planning and understanding tradeoffs
   - zoning - is it a "bad" word?
   - legal issues related to wetlands, takings
   - who pays? - unfunded mandates
2. **NPS control**
   - animal waste management
   - coastal development
   - human waste - septic tanks
   - solid waste
   - forestry
   - agriculture
   - riparian zone impacts
   - stormwater runoff
   - urban - gardening etc.
   - highway construction and landscaping
3. **For all issues, including 1 and 2, early involvement of stakeholders is critical**
   - prioritize resources, people, funding, etc.
   - who pays?
   - individual contacts are preferable to phone/letters etc.

Group 2 Issues (Facilitator: Leon Danielson, CES - NCSU):

- land - public/private property rights - costs of policy options & who pays?
- NPS discharges - agricultural operations
- loss of habitat.
- special orders of consent (SOC) - point sources
- effectiveness - will a plan help & what will help solve the problem? (e.g. dinoflagellate issue)
- local government responsibilities - unfunded mandates (what will be expected of local governments?)
- how are alternative solutions to be selected? (cost-benefit analysis?)
- growth - need to balance with environmental protection
- are wetlands addressed effectively?
- NPS - BMP plans - there is a need to target
- BMPs - how will the money be targeted to the problems?

Group 2 Priority Issues and Possible Solution Actions:

1. **Property Rights**
   a. Costs
   - need to be concerned with effectiveness of spending
   - cost-benefit analysis is needed
   - need menus of options and practices that meet requirements/regulations & estimated costs/benefits to make informed choices

   b. Who Pays?
   - in deciding who will pay, need to know who will benefit
   - "user" pay principle should be applied - if a public benefit, then public should pay; if individuals benefit, then they should pay (e.g. if marinas benefit, then they should pay)
   - what are the criteria to be used in deciding who pays?
   - need to consider creative financing, new options
   - what are other options besides unfunded mandates?
2. **NPS Discharges**
   - loss of habitat - shellfish closures
   - need to target BMPs to most severe problems - how?
   - BMPs - need all types for all land uses, e.g. forestry, agriculture, urban, mining
   - stormwater requirements
   - target sources
   - broadly based
   - need to be correlated to the problem
3. **Growth**
   - complex issue
   - determine how extensive SOCs are and to what extent are they contributing to problems
   - balanced growth is needed - recognize that economic development is needed, but to achieve growth, environmental protection is essential
   - should there be required land use planning for counties beyond CAMA? yes, probably
   - local participation is critical (this requires local involvement)
   - stormwater management must be addressed

Group 3 Issues (Facilitator: Allain Andry, CES - NCSU):

- nutrient cycling/use
- agriculture related nutrients
- sediment

- road ditches/drainage
- management tools for NPS
- planning/permit models
- enforcement of existing regulations
- lack of agency coordination
- estuarine salinity changes
- aquatic habitat impairment
- limits on monitoring
- dissolved oxygen problems
- hydrologic modification
- economic constraints
- airborne contaminants
- public education

Group 3 Priority Issues and Possible Solution Actions:

1. **Education:**
   - Create awareness of problem
   - Teach identification of sources
   - Create awareness of solution
   - Need to target messages:
     - public schools-teachers
     - community colleges
     - DEHNR-programs/materials
     - Extension
     - business
     - chemical suppliers
2. **Sediment/Habitat:**
   - education/awareness
   - local government permitting/programs
   - implement BMPs broadly
   - refine BMPs to local conditions
   - riparian corridor protection
   - better BMP guidance

Group 4 Issues (Facilitator: Bob Rubin, CES - NCSU):

- Animal operations (particularly swine)
- Timber harvest & site preparation
- Public perception (positive or negative)
- Urban runoff & lawn care
- Toxic organisms
- Point source controls
- Abandoned landfills and other sources
- Public participation & education
- Public apathy & fatigue (too much competition for time/energy)
- Pollution loadings from unknown origins (e.g. mercury)
- Operation & maintenance of BMPs
- Establishing target goals
- Cropland erosion

- BMP implementation
- Timing
- Septic systems
- Unsewered communities
- Funding
- Enforcement of regulations
- Incentives for implementation

Group 4 Priority Issues and Possible Solution Actions:

1. **Nutrient enrichment from many sources**
2. **Erosion & sedimentation**
3. **Pollution from urban and rural sectors and abandoned facilities**
4. **Public perception & participation**
5. **Funding & enforcement of regulations**
6. **Communication: education & information**
   - Public service announcements
   - Youth education
   - Teacher training
   - Local government involvement

Group 5 Issues (Facilitator: Mitch Smith, CES - Pitt County):

- Definition of non-point source pollution (defined as sediment, nutrients, pesticides, etc.)
- It was suggested that acid rain needed to be added
- There is not a clear definition of all factors which contribute
- Nutrient and pesticide application may be contributing
- Targeting the general pubic and policy makers needs to be addressed
- There is a lack of reliable data to identify problems
- Need to used standard techniques to collect reliable data
- These techniques should be uniform among agencies
- It is important to consider all possible sources of pollution and not just agriculture
- The need to identify problem "geographic" areas
- What is the cost of implementing this plan and who pays?
- What is the cost to development and to land values?
- Emphasize the need to consider different scenarios

Group 5 Priority Issues and Possible Solution Actions:

1. **Clearly define all contributing factors associated with the Basin**
   - Make sure that all factors are investigated so as not to discriminate against agriculture
2. **There is a lack of consistent data which accurately describes this problem**
   - It is essential that all groups monitoring this problem use same techniques & establish standards
   - Example: APES was using 1987 figures on land use coverage
3. **Identify the "hot" areas along the basin which is contributing to water quality problems**
   - Does this information already exist?
4. **Establish the costs associated with not addressing this problem (water quality)**
   - Consider other scenarios to determine whether or not these costs have ever been established.
5. **Education of the public and political sectors**
   - Unfortunately, this is the usually considered least important when implementing a plan

Group 6 Issues (Facilitator: Robert Evans, CES - NCSU):

- Downstream receiver in nonsupporting reach
- Increase NPS regulations
- Lack of BMPs used in large livestock
- Excessive sedimentation
- NPS inputs into estuary
- Better data on target conditions
- In lower watershed, what is water quality impact of hydromodification? - More emphasis on impacts of pesticides/herbicides
- More/better data on septage impacts
- Develop alternatives to on-site disposal
- Cultural philosophy regarding environmental protection
- Need incentives to promote changes
- Modeling approaches not addressing all sources (DO)
- What happened to philosophy that polluter pays?
- Enforcement of regulations that exist
- Better land use information
- Targeting

Group 6 Priority Issues and Possible Solution Actions:

1. **Better enforcement of existing regulations**
   - Political backbone
   - More people & resources for frequent/random monitoring
   - Better informed public on who to call (public access)
   - Better response to problem identifiers
2. **Better database of cause/effect relationships**
   - Frequent documentation of land use resources
   - Better manage existing resources (targeting)
   - More accurate locations of causes
   - Better documentation of permit applications
3. **Address water quality problems caused upstream**
   - Evaluate wisdom of basinwide trading (consider localized trading)
   - Consider alternative locations for water intakes
   - Public service announcements

APPENDIX VI

LISTS OF BEST MANAGEMENT PRACTICES (BMPs) FOR:

- Agriculture
- Urban Runoff
- Sedimentation and Erosion Control
- Onsite Wastewater Disposal
- Forestry
- Mining

Note: The BMPs lists included in this appendix were excerpted from a document entitled North Carolina Nonpoint Source Management Program (Report 89-02). The document was prepared by the North Carolina Department of Environment, Health, and Natural Resources, Division of Environmental Managment, Water Quality Section.

Table 4. BMPs for Agriculture

I. Crop and Pasture Lands

A. BMPs for sediment control

Conservation Tillage System
Critical Area Planting
Cropland Conversion
Diversion
Field Border
Filter Strip
Grade Stabilization Structure
Grassed Waterway
Rock-lined Waterways or Outlets
Sediment Control Structure
Sod-based Rotation
Stripcropping
Terrace
Water Control Structure
Pastureland Conversion

B. BMPs for nutrient control

Legumes in Rotation
Soil Testing
Liming
Setting Realistic Crop Yield Goals (determines fertilization rates)
Fertilizer Waste Application (method, rate, and timing)
Sediment Control BMP's

C. BMPs for pesticide control

Alternative Pesticides
Optimize Pesticide Formulation, Amount, Placement, Timing, Frequency
Crop Rotation
Resistant Crop Varieties
Other Cultural or Biological Controls
Optimize Crop Planting Time
Plant Pest Quarantines
Proper Disposal of Obsolete Pesticides and Containers
Certification of Applicators
Sediment Control BMP's

Table 4 Cont.

II. Animal Production (esp. Confined Animal Operations)

BMPs for bacteria and nutrient control

- Grade Stabilization Structures
- Heavy Use Area Protection
- Livestock Exclusion
- Spring Development
- Stock Trails and Walkways
- Trough or Tank
- Waste Management System
- Waste Storage Pond
- Waste Storage Structure
- Waste Treatment Lagoon
- Land Application of Waste
- Water Control Structure

Table 5
BEST MANAGEMENT PRACTICES ELIGIBLE FOR COST SHARING UNDER THE AGRICULTURE COST SHARE PROGRAM

Practice	Minimum Life Expectancy (years)
Conservation Tillage System	1
Critical Area Planting	10
Cropland Conversion (Trees, Grasses, or Permanent Wildlife Plantings)	10
Diversion	10
Field Border	10
Filter Strip	10
Grassed Waterway	10
Heavy Use Area Protection	10
Livestock Exclusion	10
Pastureland Conversion	10
Rock-lined Waterway or Outlet	10
Sediment Control Structure	10
Sod-based Rotation	4 or 5
Spring Development	10
Stock Trails and Walkways	10
Stripcropping	5
Terrace	10
Trough or Tank	10
Waste Management System	10
Waste Storage Pond	10
Waste Storage Structure	10
Waste Treatment Lagoon	10
Land Application of Waste	1
Grade Stabilization Structure	10
Water Control Structure	10

The minimum life expectancy of the BMPs is also listed in Table 5. Practices designated by a District shall meet the life expectancy requirement established by the Division for that District BMP.

Conservation tillage systems, sod-based rotation, stripcropping, and land application of animal wastes shall be funded under a cost-share incentive payment. Payments for conservation tillage systems and land application of animal wastes are limited to a maximum of three years per farm. Farmers are expected to incorporate BMPs on their own initiative after this time.

The ACSP has a detailed implementation plan that is to be used in conjunction with the rules and regulations for the Program. The following is a list of definition of practices in the plan:

(1) Conservation Tillage System means a form of non-inversion tillage that retains protective amounts of residue mulch on the surface throughout the year. These include no tillage, strip tillage, stubble mulching and other types of non-inversion tillage which maintain a minimum of 50 percent ground cover at planting or a minimum surface residue of 2,000, 1,500, and 1,000 pounds per acre for corn, soybeans, and small grain, respectively.

(2) Critical Area Planting means planting trees, shrubs, grasses, or legumes on critically eroding agricultural areas in order to reduce erosion, sediment delivery and nonpoint source pollution to receiving waters.

(3) Critical Erosion as applied to critical areas means erosion so severe that special agricultural BMPs must be used to stabilize the area of concern.

(4) Cropland Conversion means the establishment of perennial grasses, trees, or permanent wildlife plantings on excessively eroding cropland. Cost share will be based on 75 percent of the average cost of establishing fescue.

(5) Diversion means a channel with a supporting ridge on the lower side constructed across the slope to divert excess water from cropland areas.

(6) Excessive Erosion means sheet, rill and/or concentrated erosion on agricultural lands occurring at an annual rate greater than the soil loss tolerance (T).

(7) Field Border means a strip of perennial vegetation

established at the edge of the field to control erosion.

(8) Filter Strip means a strip or area of perennial vegetation for removing sediment, organic matter, and other pollutants from cropland or as part of waste management systems for treating runoff from concentrated animal areas.

(9) Grade Stabilization Structure means a structure to stabilize the grade of agricultural cropland or pasture land where concentrated and high velocity runoff results in head cutting and gully formation.

(10) Grassed Waterway means a natural waterway or outlet, shaped or graded, established in suitable vegetation and used to route excess water from cropland, reduce gully erosion and reduce nonpoint source pollutant delivery to receiving waters. As a condition for cost sharing, the field or treatment unit draining into the waterway must have installed, or the farmer must agree to install as part of the agreement, erosion control measures necessary to prevent damage from washout or excessive sedimentation in the waterway.

(11) Heavy Use Area Protection means stabilizing high concentration areas for livestock to reduce stream loading of sediment and/or animal waste.

(12) Livestock Exclusion means permanent fencing used to exclude livestock from an area and is to be used in conjunction with livestock waste treatment systems, stream crossings, streambank protection or other areas as needed to protect surface water quality.

(13) Pastureland Conversion means establishing trees or perennial wildlife plantings on excessively eroding pasture that is too steep to mow or maintain with conventional equipment. (Class VII Land)

(14) Rock-lined Waterway or Outlet means a waterway or outlet having an erosion-resistant lining of permanent material which provides safe disposal of runoff where unlined or grassed waterways would be inadequate.

(15) Sediment Control Structure means a temporary or permanent basin constructed to collect and store sediment and other agricultural nonpoint source pollution.

(16) Sod-based Rotation means establishing perennial grasses and/or legumes or a mixture of them on excessively eroding cropland and maintaining at least a four-year rotation. A one-time incentive payment per field will be made for establishment.

(17) Spring Development means improving springs and seeps by excavating, cleaning, capping or providing collection and storage facilities. Springs are to be developed as a source for livestock watering in conjunction with livestock exclusion from streams. The SWCD's have been made aware of the potential conflict of spring development with habitat preservation for wetland flora and fauna. Conflicts are reviewed on a case-by-case basis.

(18) Stock Trails and Walkways means a system used to control erosion where livestock cross ditches, streams, or other areas where surface water quality needs to be protected. Trails and walkways must be used in conjunction with livestock exclusion.

(19) Stripcropping means growing crops in a systematic arrangement of strips or bands across the general slope. The crops are arranged so that a strip of grass or close-growing crop is alternated with a clean-tilled crop or a crop under a conservation tillage system. Cost sharing will be based on a one-time payment of 75 percent of the average cost of establishing fescue multiplied by the acres in sod plus an incentive payment for the establishment of the strips.

(20) Terrace means an earth embankment, a channel, or a combination ridge and channel constructed across the slope.

(21) Trough or Tank means constructing a device for livestock watering in conjunction with livestock exclusion from streams.

(22) Waste Management System means a planned system for managing liquid, solid waste, and runoff from concentrated animal areas. System components may include:

(A) Waste Storage Pond means an impoundment made by excavation or earthfill for temporary storage of animal or other agricultural waste.

(B) Waste Storage Structure means a fabricated structure for temporary storage of animal or agricultural waste.

(C) Waste Treatment Lagoon means an impoundment made by excavation or earthfill for biological treatment of animal or other agricultural waste.

(D) Land application of Wastes means the application of agricultural wastes on land in an environmentally acceptable manner.

(23) Water Control Structure means a man-made structure installed in on-farm water management systems to reduce the delivery of nonpoint source pollutants into main water courses.

Best Management Practices

Structural best management practices for urban runoff control typically are designed to reduce sediment, its attached pollutants, and nutrients. In addition, other BMPs provide shade to waterbodies and reduce the likelihood of excessive water temperatures. Nonstructural BMPs, such as a design manual or a public education program, encourage the comprehensive and effective implementation of structural BMPs. Table 6 contains a list of both structural and nonstructural BMPs. This list will become more complete when the design manual for urban BMPs (currently being written by the Water Quality Section of DEM) is available.

Table 6. BMPS for Urban Runoff Control

STRUCTURAL
- Wet Detention Basin
- Infiltration Basin
- Vegetative Practices
  - Filter Strips
  - Swales with Check Dams
- Oil and Grease Separator
- Rollover-Type Curbing

NONSTRUCTURAL
- Design Manual for Urban BMPs
- Public Education
- Identification and Enforcement of Illegal Discharges
- Land-Use Control

Structural BMPs may affect groundwater quality in certain situations. Devices that recharge groundwater pose the risk of passing soluble pollutants, collected from stormwater runoff, into groundwater systems. At present it is not known whether pollutant concentrations in recharged groundwater areas pose a significant environmental or health risk. USGS is presently conducting a study of the groundwater quality effects of urban BMPs. In addition, if funds are made available, DEM could conduct a similar study in North Carolina. It is hoped that monitoring projects, like the USGS project, will clarify the groundwater quality impacts of urban BMPs.

Best Management Practices

The typical or suggested BMPs of the North Carolina Sedimentation Pollution Control Act of 1973 are selected on the basis of performance in providing protection from the maximum peak rate of runoff from a 10-year storm. This allows the developer/designer of the control measures, structures, or devices to determine and submit for approval the most economical and effective means of controlling erosion and preventing sedimentation damage. Practices are therefore reviewed for acceptability based upon the characteristics of each individual site and its erosion potential. Ideally, the erosion control plan will employ both practices and construction management techniques which will provide the most effective and reasonable means of controlling erosion while considering the uniqueness of each site. Table 7 provides a list of practices commonly used in sedimentation and erosion control plans across North Carolina.

Table 7. BMPs for Sedimentation Control

- Land Grading
- Surface Roughening
- Topsoiling
- Tree Preservation & Protection
- Temporary Gravel Construction Entrance/Exit
- Temporary Seeding
- Permanent Seeding
- Sodding
- Trees, Shrubs, Vines & Ground Covers
- Mulching
- Riprap
- Vegetative Dune Stabilization
- Temporary Diversions
- Permanent Diversions
- Perimeter Dike
- Right-Of-Way Diversions
- Grass-lined Channels
- Grass Channels with Liner
- Riprap-lined Channels
- Paved Channels
- Temporary Slope Drains
- Paved Flume (Chutes)
- Level Spreader
- Outlet Stabilization Structure
- Temporary Excavated Drop Inlet Protection
- Fabric Drop Inlet Protection
- Temporary Block & Gravel Inlet Protection
- Sod Drop Inlet Protection
- Temporary Sediment Trap
- Sediment Basin
- Sediment Fence
- Rock Dam
- Temporary Stream Crossing
- Permanent Stream Crossing
- Vegetative Streambank Stabilization
- Structural Streambank Stabilization
- Construction Road Stabilization
- Subsurface Drain
- Grade Stabilization Structure
- Check Dam
- Dust Control
- Sand Fence (Wind Fence)

Best Management Practices

In order to protect public health and water quality, best management practices (BMPs) need to be implemented throughout the life cycle of an on-site wastewater disposal system. Life-cycle management problems can be addressed in three phases (Steinbeck, 1984). The first phase includes system siting, design, and installation. The second phase involves the operation of the system and phase three involves maintenance and repair when the system malfunctions or fails. As BMPs are applied in each life-cycle phase, the primary factor influencing the success of the system is the participation of the local health department and the cooperation of the developer, owner, design engineer, system operator, and the state. The following is a summary of the current life-cycle management practices and penalties utilized in North Carolina to implement the on-site sewage systems program (Steinbeck, 1984).

Table 8. BMPs for On-Site Wastewater Disposal

1. Application -- The developer or property owner meets with the staff of the local health department to review the project proposal and submits an application to the local health department that contains information regarding ownership, plat of property, site plan, type of facility, estimated sewage flow, and proposed method of sewage collection, treatment, and disposal.

2. Site Evaluation -- The local health department, with technical assistance from the state, evaluates the proposed sewage effluent disposal site for several factors, including slope, landscape position, soil morphology, soil drainage, soil depth, and space requirements. Next, the local health department will assign a site suitability classification, establish the design sewage flow, and the design loading rate for the soil disposal system.

3. Design Review --The applicant is required to submit plans and specifications for the sewage collection, treatment, and disposal system prepared by a professional engineer, for complex systems, or for systems exceeding 3,000

gal/day. Reviews are made by both state and local health departments. The designer must also include in the plans and specifications, installation procedures, phasing schedules, operation and maintenance procedures, monitoring requirements, and designate the responsible agents for operation and maintenance.

4. Legal Document Review -- For systems with multiple ownership or off-site disposal, the applicant must prepare and submit to state and local health departments for their legal review documents applicable to the project.

5. Improvement Permit -- Issued only after a successful review of the proposed project, including each of the items discussed above and allows construction to begin for the on-site sewage system. The improvement permit must be issued prior to other construction permits and allows only temporary electrical power to the site. This permit contains the necessary conditions for construction of the projects with the plans, specifications, and legal documentation appended to it.

6. Operation Permit -- Issued to the owner of the on-site sewage system by the local health department when it determines that all the requirements in the rules, plans and specifications are met; all conditions on the improvement permit are met; and the design engineer for the sewage collection, treatment, and disposal system certifies in writing to the local health department that the on-site system has been installed in accordance with the approved plans and specifications. The operation permit is also conditioned to establish performance requirements and may be issued for a specific period of time. It allows the on-site sewage system to be placed into use, prevents permanent electrical service to the project and prevents occupancy of the facilities until issued. The operation permit applies to systems larger than 480 gallons per day. A certificate of completion is required for conventional septic tank systems when the design sewage flow is less than 480 gal/day.

7. Surveillance -- Once an on-site sewage system is placed into operation the local health department must make routine inspections at least annually for large systems to determine that the system is performing satisfactorily and not creating a public health nuisance or hazard. Additionally, required monitoring reports are routinely submitted to the local health department as required in the permits. The state provides technical assistance to the local health department and the system operator in assuring adequate performance. While annual inspections are required, frequent performance checks must be made by the local health department.

8. Remedies -- When voluntary compliance with the performance requirements for the on-site system is unsuccessful, the General Statutes (1983) provide for the following remedies:

a. Right of Entry -- Allows the state or local health department to enter the premises to determine compliance with the laws and rules and provides for an administrative search and inspection warrant when entry is denied.

b. Injunction -- The state or local health department may institute an action for injunctive relief against the owner to bring the on-site sewage system into compliance.

c. Order of Abatement -- The state or local health department is empowered to issue an order of abatement directing the owner to take any necessary action to bring the system into compliance. However, if the on-site system is determined to be creating an imminent health hazard, the state or local health department may, after previous unsuccessful attempts at correction, take the necessary action to correct the problem and recover any costs for abatement from the owner. This is the least frequently applied remedy.

d. Administrative Penalties -- The state may impose administrative penalties up to $300 per day for violation of the laws, rules, or any permit condition for on-site sewage systems serving multi-family residences with a flow greater than 480 gal/day. A penalty of up to $50 per day can be assessed for malfunctioning systems where the flow is less than or equal to 480 gal/day.

e. Suspension and Revocation of Permits -- The state may suspend or revoke a permit for violations of the laws, rules, or permit conditions upon a finding that a violation has occurred.

f. Misdemeanor -- The owner who violates the sewage laws or rules shall be guilty of a misdemeanor and punishable by a fine or imprisonment as determined by the courts. This is the most frequently used remedy.

Best Management Practices for Forestry

The North Carolina Forestry Council has prepared a reference document for silvicultural BMPs entitled "Forest Practices Guidelines Related to Water Quality." Table 10 summarizes these BMPs:

Table 10. BMPs for North Carolina Forests

1. Properly design and place access roads, skid trails, and loading areas on forestland.
   a. Avoid streambanks and channels except when crossing streams.
   b. Install water management structures and techniques.
   c. Stabilize bare soil areas.
   d. Prevent steep slopes on roads and trails.
2. Designate streamside management zones (SMZ) which are undisturbed strips of vegetation parallel and adjacent to the stream channels.
3. Avoid placing debris in stream channels (Stream Obstruction Law).
4. Use practices which minimize soil exposure when reforesting.
5. Use environmentally safe procedures when applying chemicals in forested areas.
6. Train forestry related personnel in nonpoint source pollution control methods.

Best Management Practices

Significant environmental damage can and often times does occur during land-disturbing activities of mining operations, especially during the initial stages. The potential for such damage can be substantially reduced with the installation of BMPs. Once the mining has terminated, BMPs are used to reclaim or reasonably rehabilitate the site (for mined lands after June 11, 1971). The basic objective of the reclamation is to establish on a continuing basis the vegetative covers, soil stability, and water and safety conditions appropriate to the area. The BMPs are basically performance oriented allowing the applicant for a mining permit to design and submit for approval the most economical and effective means of a) controlling erosion and preventing off-site sedimentation damage; b) preventing contamination of surface waters and groundwater; and, c) preventing any condition that will have unduly adverse effects on wildlife or freshwater, estuarine, or marine fisheries. BMP selection is site specific and controlled in part by the pre- and post-mining land use(s). The acceptability, therefore, of a BMP is based upon the characteristics of the individual site and its potential for off-site damage.

Table 12 provides a list of BMPs which is virtually the same as apply in the Sedimentation and Erosion Control Program since the problems are similar.

Table 12. BMPs for Mining

Land Grading
Surface Roughening
Topsoiling
Tree Preservation and Protection
Temporary Gravel Construction Entrance/Exit
Temporary Seeding
Permanent Seeding
Sodding
Trees, Shrubs, Vines & Ground Covers
Mulching
Riprap
Vegetative Dune Stabilization
Temporary Diversions
Permanent Diversions
Perimeter Dike
Right-of-Way Diversions
Grass-lined Channel
Grass Channels with Liner

Table 12 (Cont.)

Riprap-lined Channels
Temporary Slope Drains
Paved Flume (Chutes)
Level Spreader
Outlet Stabilization Structure
Temporary Excavated Drop Inlet Protection
Temporary Fabric Drop Inlet Protection
Temporary Block and Gravel Inlet Protection
Sod Drop Inlet Protection
Temporary Sediment Trap
Sediment Basin
Sediment Fence
Rock Dam
Temporary Stream Crossing
Permanent Stream Crossing
Vegetative Streambank Stabilization
Structural Streambank Stabilization
Construction Road Stabilization
Subsurface Drain
Grade Stabilization Structure
Check Dam
Dust Control
Sand Fence (Wind Fence)
Groundwater Monitoring Wells
Mining Newsletter

GLOSSARY

Including

Explanations of Acronyms and Abbreviations

GLOSSARY and Legend of Acronyms. List of Abbreviations

7Q10	a value which represents the lowest average flow for a seven day period that will recur on a ten year frequency. This value is applicable at any point on a stream. 7Q10 flow (in cfs) is used to allocate the discharge of toxic substances to streams.
AGPT	Algal Growth Potential Test.
AMS	Ambient Monitoring System.
BI(BIEPT)	Biotic Index, Biotic Index(EPT).
Bioclass	Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups, and the BI value.
BMAN	Biological Monitoring Ambient Network.
BODlt	Biochemical Oxygen Demand, long term.
cfs	Cubic feet per second, generally the unit in which stream flow is measured.
CHLA	Chlorophyll *a*.
ChV	Chronic Value. Of a toxicity test, defined as the geometric mean of the Lowest Observed Effect Concentration and the No Observed Effect Concentration.
DEM	Division of Environmental Management.
D.O.	Dissolved Oxygen.
Ecoregion	An area of relatively homogeneous environmental conditions, usually defined by elevation, geology, and soil type. Examples include mountains, piedmont, coastal plain, sandhills and slate belt.
EHNR	N.C. Dept. of Environment, Health, and Natural Resources.
EPT	(Ephemeroptera, Plecoptera, Trichoptera) grouping of three orders of frequently sensitive insect larval forms. The total number (N) or diversity (S) of the EPT assemblage is often used to determine water quality impacts.
EPT N	Number of Ephemeroptera, Plecoptera, Trichoptera insects collected.
EPT S	Total number of Ephemeroptera, Plecoptera, Trichoptera taxa collected
HQW	High Quality Waters.
IBI	Index of Biotic Integrity.
IWC	Instream Waste Concentration. The percentage of a stream comprised of an effluent calculated using permitted flow of the effluent and 7Q10 of the receiving stream.
JOC	Judicial Order by Consent An administrative order issued by an administrative law judge which in some way modifies limitations of an NPDES permit by consent of both parties which provides interim limitations and conditions.
LC50	The concentration of a toxicant or percentage dilution of an effluent that is predicted to be lethal to 50% of a test population of organisms.

LOEC	In a toxicity test, the Lowest Observed Effect Concentration.
NOEC	In a toxicity test, the No Observed Effect Concentration.
MGD	Million Gallons per Day, generally the unit in which effluent discharge flow is measured.
MSD	Metropolitan Sewerage District.
NCDEM	North Carolina Division of Environmental Management.
NPDES	National Pollutant Discharge Elimination System.
NCIBI	North Carolina Index of Biotic Integrity.
NCTSI	North Carolina Trophic State Index.
NSW	Nutrient Sensitive Water.
NTU	Nephelometric Turbidity Unit.
ORW	Outstanding Resource Water.
PF	Permitted flow, of an NPDES permit.
POTW	Publicly Owned Treatment Works.
Secchi	a standard measure of water transparency as determined by lowering of a black and white Secchi disk to the depth that the disk is no longer visible.
SOC	Special Order by consent An administrative order entered by the Environmental Management Commission and an NPDES discharger which in some way modifies limitations of an NPDES permit by consent of both parties which provides interim limitations and conditions.
SOD	Sediment oxygen demand, as measured by diver deployed chambers.
TP	Total Phosphorus.
TON	Total Organic Nitrogen.
Total S	Total number of taxa.
TIE	Toxicity Identification Evaluation. A series of toxicity and chemical analyses performed to identify or characterize causative toxicants in an effluent. Generally performed as an early phase of a TRE, followed by toxicant reduction or treatability steps.
TRE	Toxicity Reduction Evaluation. Actions taken or studies made to reduce whole effluent toxicity. These actions may include TIE's.
USGS	United States Geological Survey.
UT	unnamed tributary to named water body.
WWTP	Wastewater Treatment Plant.