NEUSE RIVER BASIN:

STORMWATER PROGRAM FOR NITROGEN CONTROL

CITY OF KINSTON
Kinston, North Carolina

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DEFINITIONS

Algal Bloom	-	A rapid temporary increase in the population of aquatic microorganisms to the extent that the water becomes discolored.
Best Management Practices (BMP)	-	Activities or structural improvements that help reduce the quantity and improve the quality of stormwater runoff.
Bioretention	-	To utilize soils and both woody and herbaceous plants to remove pollutants from stormwater runoff (ex. rain gardens).
Constructed Wetlands	-	A wetland that is created on a site that previously was not a wetland. This wetland is designated specifically to remove pollutants from stormwater runoff.
Impervious Surface	-	A hard surface area which either prevents or retards the entry of water into the soil (ex. rooftops, driveways, parking lots, etc.)
LANDSAT	-	High quality visible and infrared images of all landmass and coastal areas from a satellite.
Nitrogen Loading	-	The amount of nitrogen being released into stormwater.
Nonpoint Source Pollution	-	Stormwater that picks up and carries away natural and human-made pollutants, finally depositing them into lakes, ponds, rivers and wetlands.
Nutrient Pollution	-	Excessive amounts of nutrients that lead to degradation of water quality and algal blooms. Some nutrients can be toxic at high concentrations.
Open Channel Practices	-	To use ditches or grassed swales instead of pipes or lined ditches, which will allow runoff to be slowed and filtered as it is transported.
Pervious Surfaces	-	Surfaces that absorb or allow water to pass through.
Proprietary BMP's	-	Man-made structures used for the removal of pollutants from stormwater.
Rational Method	-	A means of computing storm drainage flow rates **(Q)** by use of the formula **Q = CIA**, where **C** is a coefficient describing the physical drainage area, **I** is the rainfall intensity and **A** is the Area.

Retrofit	-	The modification of stormwater management systems through the construction or enhancements of BMP's to improve water quality.
Riparian Buffers	-	Strips of grass or other erosion resistant vegetation located between a waterway and an area of more intensive land use.
Stormwater	-	That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows into a defined surface water channel, or a constructed infiltration facility.
Watershed	-	That geographical area which drains to a specified point on a water course, usually a confluence of streams or rivers.
Wet Detention Pond	-	A facility that treats stormwater for water quality by utilizing a permanent pool of water to remove conventional pollutants from runoff through sedimentation, biological uptake, and plant filtration.

ACRONYMS

BMP	**-**	Best Management Practices
DWQ	-	Division of Water Quality
EMC	**-**	Environmental Management Commission
NPDES	**-**	National Pollution Discharge Elimination Systems
NPS	**-**	Nonpoint Sources
NSW	**-**	Nutrient Sensitive Waters
TN	**-**	Total Nitrogen
USGS	**-**	United States Geological Survey

1. Introduction

1-A. Purpose of the Neuse Stormwater Rule

Water quality has been an issue in the Neuse River Basin for more than a century. In 1887, legislation was passed to "prevent the throwing of dead stock into the waters of the Neuse River and its tributaries." A number of water quality initiatives have been undertaken in the Neuse River Basin between 1950 and 1995.

- The State Stream Sanitation Act of 1951 required a statewide survey of all surface waters.

- Since the 1960s, better regulations and technology for wastewater treatment and development of stream classifications with accompanying water quality standards have been implemented.

- In 1983, the Falls Lake watershed Nutrient Sensitive Waters (NSW) Strategy required more stringent controls for wastewater treatment facilities.

- In 1988, the Environmental Management Commission (EMC) classified the remainder of the Neuse River Basin as NSW, which brought about more stringent nutrient limits for wastewater facilities. Some of the nutrient loading from nonpoint sources (NPS) was controlled through The Agricultural Cost Share Program. In addition, the NC General Assembly adopted a statewide phosphate detergent ban on January 1, 1988.

- In 1993, the Division of Water Quality (DWQ) completed the first Basinwide Management Plan for the Neuse River Basin. The plan recommended an accelerated schedule for reducing nitrogen runoff from nonpoint sources. Since 1993, DWQ has continued to monitor and evaluate conditions in the Neuse River.

Despite these initiatives, the Neuse River basin has continued to have water quality problems. During July, September, and October 1995, extensive fish kills occurred in the Neuse River, primarily from New Bern to Minnesott Beach. Millions of menhaden, as well as numerous flounder, croaker and rock fish, were killed. Unusual meteorological conditions in 1995 were partly responsible for the fish kills. During June, record rainfalls delivered a tremendous amount of nonpoint source nutrients into the Neuse River.

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

On February 8, 1996, the EMC approved a draft comprehensive Neuse River NSW strategy. The goal of the strategy was and still is to achieve a 30 percent nitrogen reduction from each controllable and quantifiable source of nitrogen in the basin. These sources are: Wastewater

Treatment, Urban Stormwater, Agriculture and Nutrient Application. The NSW Strategy also includes a rule to protect Riparian Buffers in order to maintain their existing nitrogen removal capabilities.

The NSW Strategy was noticed for public comment several times between its initial development in February 1996 and its final adoption in August 1998. These comment periods included six public workshops in May, 1996, four public hearings in November 1996 and two public hearings in October 1997. As a result of the public hearings, each rule, including the Stormwater Rule, was modified to increase flexibility for the regulated community and to improve the mechanisms to insure that the 30% nitrogen reduction goal is met. The full text of the Neuse Stormwater Rule is included in Appendix A.

1-B. Requirements of the Neuse Stormwater Rule

The Neuse stormwater rule applies only to the largest and fastest-growing local governments in the Neuse River basin (shown below). The EMC may also designate additional local governments within the Neuse River basin to comply with the stormwater rule in the future. The rule establishes a broad set of objectives for reducing nitrogen runoff from urban areas. The rule also set up a process for DWQ to work with the affected local governments to develop a model stormwater program for meeting the objectives.

The affected local governments are:

Cary	Durham County
Durham	Johnston County
Garner	Orange County
Goldsboro	Wake County
Havelock	Wayne County
Kinston	
New Bern	
Raleigh	
Smithfield	
Wilson	

The timeframe for implementation of the rule is as follows:

August 1, 1998:	Effective date of the rule
August 1, 1999:	Deadline for approval of the Model Stormwater Program by the Environmental Management Commission
September 9, 2000:	Deadline for submittal of local Stormwater Program to the Environmental Management Commission.
March 9, 2001:	Deadline for local governments to begin implementing local Stormwater Programs.

Following implementation in March 2001, The City of Kinston is required to make annual progress reports to the EMC that will include nitrogen loading reduction estimates.

The general elements that are included in the City of Kinston Stormwater Management Program are:

` **1. New Development Review/Approval**
New developments will have to meet the 30% reduction goal by implementing planning considerations and best management practices, such as constructed wetlands. The rule imposes a 3.6 pound per acre per year (lb/ac/yr) nitrogen loading limit on new development. Nitrogen load from new developments that exceeds this performance standard may be offset by payment of a fee to the Wetlands Restoration Fund provided, however, that no new residential development can exceed 6.0 lb/ac/yr and no new non-residential development can exceed 10.0 lb/ac/yr.

2. Illegal Discharges
Illegal discharges are substances deposited in storm sewers (which lead directly to streams) that should be handled as wastewater discharges. Depending on the source, illegal discharges may contain nitrogen. The City of Kinston must identify and remove illegal discharges.

3. Retrofit Locations
There are a number of funding sources available for water quality retrofit projects, such as the Clean Water Management Trust Fund and the Wetland Restoration Program that the NC General Assembly has established. To assist technical experts, The City of Kinston is required to identify sites and opportunities for retrofitting existing development to reduce total nitrogen loads.

4. Public Education
Citizens can reduce the nitrogen pollution coming from their lawns and septic systems if they understand the impact of their actions and respond with appropriate management measures. The City of Kinston shall develop and implement a public education program.

2. New Development Review/Approval

2-A. Requirements in the Rule

The Neuse Stormwater Rule (15A NCAC 2B. 0235) has the following requirements for new development located within the jurisdiction of the City of Kinston.

- The nutrient load contributed by new development activities is held at 3.6 pounds per acre per year. This is equivalent to 70% of the estimated average nitrogen load contributed by the non-urban areas in the Neuse River Basin (as defined using 1995 LANDSAT data).The Environmental Management Commission may periodically update the performance standard based on the availability of new scientific information.

- Developers shall have the option of partially offsetting projected nitrogen loads by funding wetland or riparian area restoration through the North Carolina Ecosystem Enhancement Program. However, the total nitrogen loading rate cannot exceed 6.0 pounds per acre per year for residential development or 10 pounds per acre per year for non-residential development.

- There is no net increase in peak flow leaving the site from the pre-development conditions for the 1-year, 24-hour storm. The City is requiring a no net increase in peak flow leaving the site based on the 2-year 24 hour storm.

- The City of Kinston must review new development plans to assure compliance with requirements for protecting and maintaining riparian areas as specified in 15A NCAC 2B.0233.

2-B. Protecting Riparian Areas on New Development

The Neuse Stormwater Rule requires the City of Kinston to ensure that riparian areas are protected on new developments in accordance with the Riparian Buffer Rule (15A NCAC 2B .0233). The Riparian Buffer Rule requires that 50-foot riparian buffers be maintained on all sides of intermittent and perennial streams, ponds, lakes and estuaries in the Neuse River Basin. The rule includes some uses that are allowable within the riparian buffer, such as road and utility crossings.

The City of Kinston shall disapprove any new development activity that is proposed to take place within the first 50 feet adjacent to a waterbody that is shown on either the USGS topographic map or the NRCS Soil Survey maps unless the owner can show that the activity has been approved by DWQ. DWQ approval may consist of either of the following:

- An Authorization Certificate documenting that DWQ has approved an allowable use such as a road crossing or utility line. A detailed list of allowable uses is included in the Riparian Buffer Rule.

- A letter from DWQ documenting that a variance has been approved for the proposed development activity.

2-C. Calculating N Export from New Development

For the purposes of the Neuse Stormwater Program, new development shall be defined as to include the following:

- Any activity that disturbs greater than one acre of land in order to establish, expand or modify a single family or duplex residential development or a recreational facility.

- Any activity that disturbs greater than one-half an acre of land in order to establish, expand or modify a multifamily residential development or a commercial, industrial or institutional facility.

New development shall **NOT** include agriculture, mining or forestry activities. Land disturbance is defined as grubbing, stump removal and or/grading.

Property owners that can demonstrate that they have vested rights as of the effective date of the City of Kinston Stormwater Program for Nitrogen Control (March 9, 2001) will not be subject to the requirements for new development. Vested rights may be based on at least one of the following criteria and expire March 9, 2006:

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

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

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

Projects that require a state permit, such as landfills, NPDES wastewater discharges, land application of residuals and road construction activities shall be considered to have vested rights if a state permit was issued prior to the effective date of this program.

The nitrogen export from each new development must be calculated. This export will be calculated in pounds per acre per year (lbs/ac/yr). Model methodologies that may be used to make this calculation are presented below.

- *Method 1 is intended for residential developments where lots are shown but the actual footprint of buildings are not shown on site plans.* This method does not require calculation of the area of building footprints. Rather, the impervious surface resulting from building footprints is estimated based on typical impervious areas associated with a given lot size. This method is shown in Figure 2a.

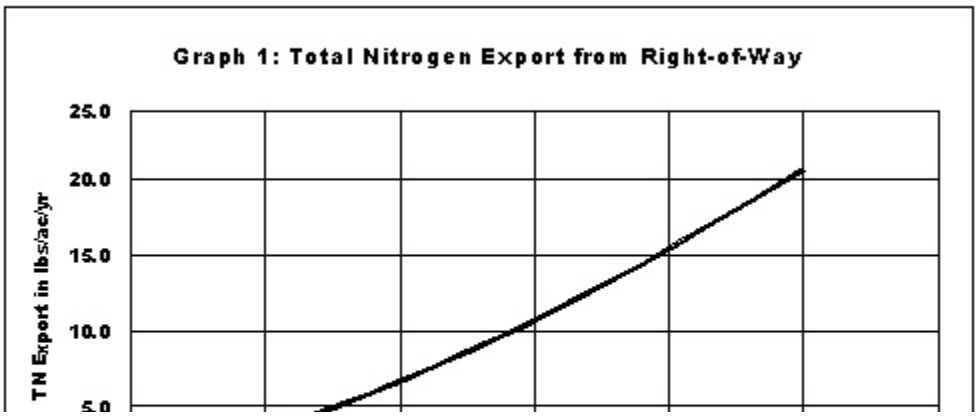
- *Method 2 is for residential, commercial and industrial developments when the entire footprint of the roads, parking lots, buildings and any other built-upon area is shown on the site plans*. This method is simpler and more accurate since it does not require estimating the impervious surface based on lot size like Method 1. Method 2 is shown in Figure 2b. The development of these methods is described in Appendix B.

One situation that is not addressed in either of these methods is a non-residential subdivision where the impervious surfaces are not shown on the plans at the time of submittal. In this case the City of Kinston shall require that the property owner specify the areas of impervious surface, undisturbed open space and managed open space on the property in a restrictive covenant or other legal enforceable mechanism. Then, Method 2 could be applied.

Figure 2a: Method 1 for Quantifying TN Export from Residential Developments when Building and Driveway Footprints are Not Shown

Step 1: Determine area for each type of land use and enter in Column (2).
Step 2: Total the areas for each type of land use and enter at the bottom of Column (2)
Step 3: Determine the TN export coefficient associated with rights-of-way using Graph 1.
Step 4: Determine the TN export coefficient associated with lots using Graph 2.
Step 5: Multiply the areas in Column (2) by the TN export coefficients in Column (3) and enter in Column (4).
Step 6: Total the TN exports for each type of land use and enter at the bottom of Column (4).
Step 7: Determine the export coefficient for site by dividing the total TN export from uses at the bottom of Column (4) by the total area at the bottom of Column (2).

(1) **Type of Land Cover**	(2) **Area (acres)**	(3) **TN export coeff. (lbs/ac/yr)**	(4) **TN export from use (lbs/yr)**
Permanently protected undisturbed open space (forest, unmown meadow)		0.6	
Permanently protected managed open space (grass, landscaping, etc.)		1.2	
Right-of-way (read TN export from Graph 1)			
Acreage of Lots (read TN export from Graph 2)			
TOTAL			


Graph 1: Total Nitrogen Export from Right-of-Way
TN Export in lbs/ac/yr
25.0
20.0
15.0
10.0
5.0

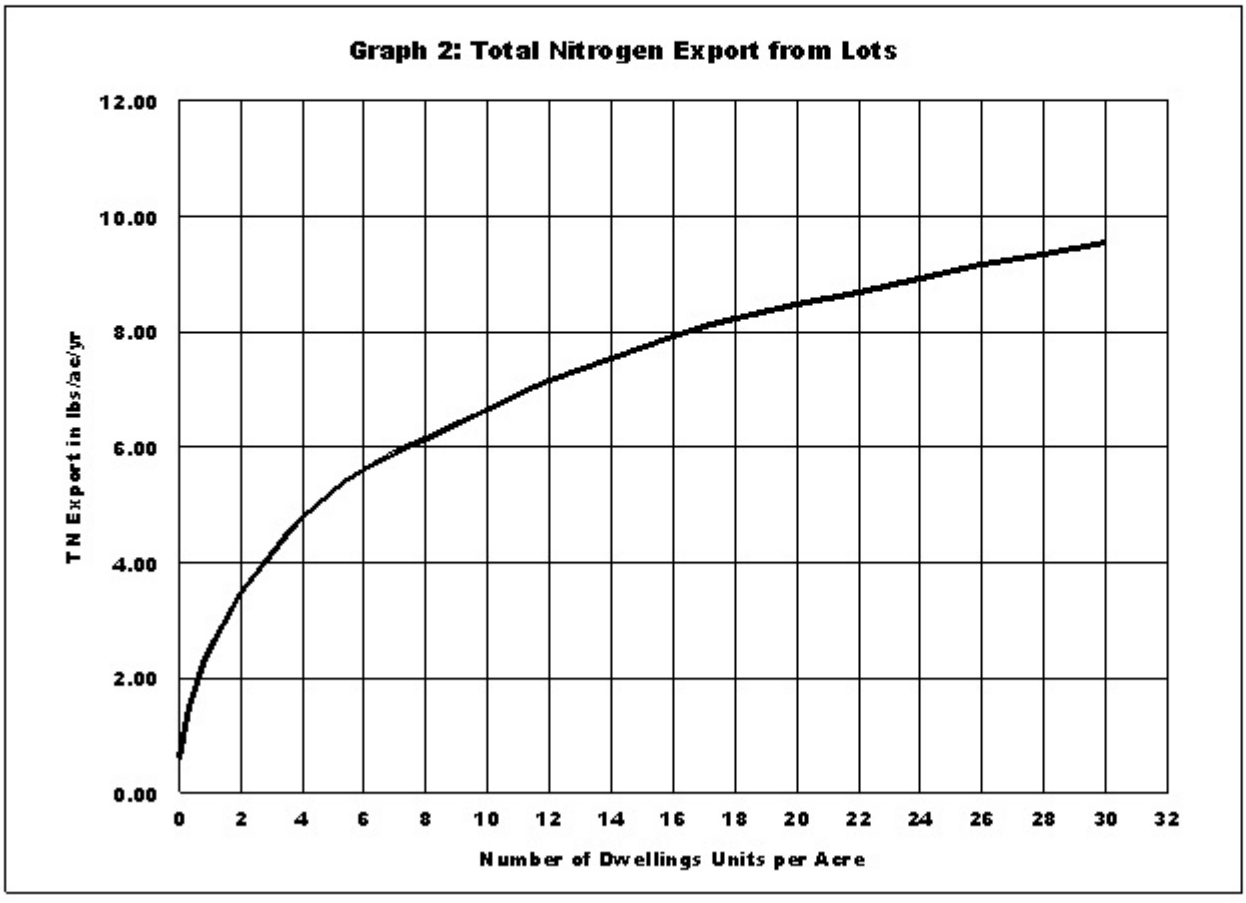

Graph 2: Total Nitrogen Export from Lots
TN Export in lbs/ac/yr
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
Number of Dwellings Units per Acre

Figure 2b: Method 2 for Quantifying TN Export from Residential/Industrial/Commercial Developments when Footprints of all impervious Surfaces are Shown.

Step 1: Determine area for each type of land use and enter in Column (2).
Step 2: Total the areas for each type of land use and enter at the bottom of Column (2).
Step 3: Multiply the areas in Column (2) by the TN export coefficients in Column (3) and enter in Column (4).
Step 4: Total the TN exports for each type of land use and enter at the bottom of Column (4).
Step 5: Determine the export coefficient for site by dividing the total TN export from uses at the bottom of Column (4) by the total area at the bottom of Column (2).

(1) **Type of Land cover**	(2) **Area (acres)**	**(3)** **TN Export coeff. (lbs/ac/yr)**	**(4)** **TN export from use (lbs/yr)**
Permanently protected undisturbed open space (forest, unmown meadow)		0.6	
Permanently protected managed open space (grass, landscaping, etc.)		1.2	
Impervious surfaces (roads, parking lots, driveways, roofs, paved storage areas, etc.)		21.2	
TOTAL			

The rule requires that all new developments achieve a nitrogen export of less than or equal to 3.6 pounds per acre per year. If the development contributes greater than 3.6 lbs/ac/yr of nitrogen, then the options shown in Table 2a are available based on whether the development is residential or non-residential.

Table 2a: Nitrogen Export Reduction Options

Residential	**Commercial/Industrial**
If the computed export is less than 6.0 lbs/ac/yr, then the owner may either: 1. Install BMPs to remove enough nitrogen to bring the development down to 3.6 lbs/ac/yr. 2. Pay a one-time offset payment to bring the nitrogen down to 3.6 lbs/ac/year. 3. Do a combination of BMPs and offset payment to achieve a 3.6 lbs/ac/yr export.	If the computed export is less than 10.0 lbs/ac/yr, then the owner may either: 1. Install BMPs to remove enough nitrogen to bring the development down to 3.6 lbs/ac/yr. 2. Pay a one-time offset payment to bring the nitrogen down to 3.6 lbs/ac/yr. 3. Do a combination of BMPs and offset payment to achieve a 3.6 lbs/ac/yr export.
If the computed export is greater than 6.0 lbs/ac/yr, then the owner must use on-site BMPs to bring the development's export down to 6.0 lbs/ac/yr. Then, the owner may use one of the three options above to achieve the reduction between 6.0 and 3.6 lbs/ac/yr.	If the computed export is greater than 10.0 lbs/ac/yr, then the owner must use on-site BMPs to bring the development's export down to 10.0 lbs/ac/yr. Then, the owner may use one of the three options above to achieve the reduction between 10.0 and 3.6 lbs/ac/yr.
To determine the amount of offset payment required: 1. Calculate the final TN export coefficient for the site, including all BMP nitrogen reductions (must be less than 6.0 lb/ac/yr). 2. If less than 3.6 lb/ac/yr then no fee is required. 3. If greater than 3.6 lb/ac/yr then subtract 3.6 lb/ac/yr from the final TN export coefficient. 4. Multiply step 3 by the the number of acres from the bottom of column 2 in Figure 2a or 2b. 5. Multiply step 4 by $28.35/lb and by 30 years to get the total offset payment.	To determine the amount of offset payment required: 1. Calculate the final TN export coefficient for the site, including all BMP nitrogen reductions (must be less than 10.0 lb/ac/yr). 2. If less than 3.6 lb/ac/yr then no fee is required. 3. If greater than 3.6 lb/ac/yr then subtract 3.6 lb/ac/yr from the final TN export coefficient. 4. Multiply step 3 by the the number of acres from the bottom of column 2 in Figure 2a or 2b. 5. Multiply step 4 by $28.35/lb and by 30 years to get the total offset payment.

Table 2a discusses the option of using offset fees to meet the nitrogen export levels set for new development activities. These offset fees go to the North Carolina Ecosystem Enhancement Program (EEP). The EEP will utilize these fees in accordance with the EEP's policies to accomplish nitrogen reduction in the Neuse River Basin.

2-D. Calculating Peak Runoff Volume

The City of Kinston's Stormwater Program requires there be no net increase in peak flow leaving the site from the pre-development conditions for the 2-year, 24-hour storm.

Acceptable methodologies for computing the pre- and post-development conditions for the 2-year, 24-hour storm include:

- The Rational Method
- The Peak Discharge Method as described in USDA Soil Conservation Service's Technical Release Number 55 (TR-55).
- Other methods as approved by the City Engineer

The same method must be used for both the pre- and post-development conditions.

Table 2b: Rainfall depths for the 2-year, 24-hour storm

Location	2yr-24 hr depth (Inches)	2 yr - 24 hr intensity* (in/hr)
Kinston	**3.91 inches**	**0.163 (in./hr.)**

The flow control requirement is not required for developments that meet one or all of the following requirements:

- The increase in peak flow between pre - and post - development conditions does not exceed ten percent (note that this exemption makes it easier to conduct redevelopment activities)
- The proposed new development meets all of the following criteria: overall impervious surface is less than fifteen percent, and the remaining pervious portions of the site are utilized to the maximum extent practical to convey and control the stormwater runoff.

It is recognized that in certain parts of drainage basins, stormwater detention can aggravate local flooding problems. The City may provide exemptions to those specific locations.

2-E. BMPs for Reducing Nitrogen

Designing best management practices (BMPs), that remove nitrogen from stormwater is a developing field. Researchers throughout the country, particularly in the Southeast, are conducting studies to determine effective means of controlling nitrogen. At the present time, current data indicate that most BMPs remove only 20 to 40 percent of total nitrogen on a consistent basis. All BMPs require regular maintenance and some have varying performance depending on soil type and the season. It is crucial to consider the issues of aesthetics, long-term maintenance, safety and reliability in BMP design.

Since it is relatively difficult to design and maintain BMPs that remove nitrogen, the TN accounting method in Table 2.c is designed to provide credits for site planning practices that reduce nitrogen loadings from new development. These practices include reducing impervious surfaces and protecting open spaces. More details on planning measures that reduce nitrogen loading are given in Appendix C.

The estimated total nitrogen removal rates for various BMPs in Table 2.c have been determined based on various research and studies. These rates are from the North Carolina BMP Manual. Should this manual be revised at a later date, the City of Kinston will use only recognize the removal in the version of the NC BMP Manual that is in effect at the time of the site plan approval. A summary of some literatures studies is given in Appendix D. BMPs must meet the minimum design requirements found in the appropriate manual to receive the nitrogen removal rate.

Table 2c: BMP types, TN Removal Rates and Design Standards

BMP TYPE	TN Removal Rate	Appropriate Design Standards
Wet detention basins	25%	N.C. Stormwater BMP Manual
Constructed wetlands	40%	N.C. Stormwater BMP Manual
Grass swales	20%	N.C. Stormwater BMP Manual
Restored riparian buffers	30%	N.C. Stormwater BMP Manual
Vegetated filter strips	20%	N.C. Stormwater BMP Manual
Bioretention	35%	N.C. Stormwater BMP Manual
Sand Filters	35%	N.C. Stormwater BMP Manual
Dry extended detention basins	10%	N.C. Stormwater BMP Manual
Infiltration devices	30%	N.C. Stormwater BMP Manual
Other BMPs	Varies	Subject to DWQ approval

If more than one BMP is installed in series on a development, then the removal rate shall be determined through serial rather than additive calculations. For example, if a wet detention pond discharges through a riparian buffer, then the removal rate shall be estimated to be 47.5 percent. (The pond removes 25 percent of the nitrogen and discharges 75 percent to the buffer. The buffer then removes 30 percent of the nitrogen that is discharged from the pond, which is 22.5 percent of the original load. The sum of 25 and 22.5 is 47.5. The removal rate is NOT 25 percent plus 30 percent.)

2-F. BMP Maintenance

If BMPs are implemented to achieve the nitrogen loading and flow attenuation requirements for a development, then a stormwater permit must be acquired for the development from the City and a maintenance plan must be submitted to the City for the BMPs.

The City of Kinston shall notify the owner upon finding that maintenance is needed on a BMP. If the owner does not complete the maintenance himself in a timely manner, then the City can contract out the maintenance itself and recover costs in the manner it determines most appropriate.

The City of Kinston shall inspect all BMPs on an annual basis. The resources needed for this will be recovered through annual inspection fees as determined in the Stormwater BMP Fees and Charges schedule in the City of Kinston Manual of Fees and Charges. The City of Kinston shall keep a database of BMPs and their locations to assist in the inspection process.

BMPs, when used, shall be part of the development site, not on a separate lot.

2-G. Land Use Planning Provisions

Developers are encouraged to use site design techniques to reduce impervious surfaces on their developments. As discussed previously, reducing impervious surfaces reduces the need for BMPs to control nitrogen and peak stormwater flows and also reduces associated BMP maintenance concerns.

The City of Kinston will review local ordinances with regard to the following topics and provide adequate flexibility for developers to utilize planning measures to reduce impervious surfaces. This review is intended to look for opportunities where these measures could be allowed, or obstacles to their use could be removed.

The City of Kinston will consider the following planning techniques and the general advantages and disadvantages of incorporating these approaches at the local level.

- Reducing road widths
- Reducing minimum parking requirements
- Minimizing use of curb and gutter
- Cluster or open-space developments
- Traditional neighborhood developments
- Mixed-use developments

Descriptions of these techniques are provided in Appendix C.

2-H. References

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Schueler, T.S. December 1995. Site Planning for Urban Stream Protection. Metropolitan Washington Council of Governments. Silver Spring, MD 231 pp.

Stimmel Associates. 1993. Traditional Neighborhood Development Design Guidelines. Chapel Hill, NC.

3. Illegal Discharges

3-A. Requirements in the Rule

The Neuse Stormwater Rule requires that the City of Kinston establish a program to prevent, identify and remove illegal discharges. Illegal discharges are flows in the stormwater collection system that are not associated with stormwater runoff or an allowable discharge.

3-B. What is an Illegal Discharge?

Stormwater collection systems are vulnerable to receive illegal discharges (even though the person responsible for the discharge may be unaware that it is illegal). Depending on their source, illegal discharges may convey pollutants such as nutrients, phenols, and metals to receiving water. Table 3a identifies some potential flows to the stormwater collection system that may be allowable. Table 3b identifies some discharges that are not allowed.

Table 3a: Discharges that may be allowable to the stormwater collection system

Waterline Flushing	Landscape Irrigation	Diverted Stream Flows
Uncontaminated Rising Ground Water	Uncontaminated Ground Water Infiltration to stormwater collection system	Uncontaminated Pumped Ground Water
Discharges from potable water sources	Foundation Drains	Uncontaminated Air Conditioning Condensation
Irrigation Water	Springs	Water from Crawl Space Pumps
Footing Drains	Lawn Watering	Non-commercial Car Washing
Flows from Riparian Habitats and Wetlands	NPDES permitted discharges	Street wash water
Fire Fighting Emergency Activities	Wash Water from the Cleaning of Buildings	Dechlorinated backwash and draining associated with swimming pools

Table 3b: Types of Discharges that are not allowed to stormwater collection system

Dumping of oil, anti-freeze, paint, cleaning fluids	Commercial Car Wash	Industrial Discharges
Contaminated foundation Drains	Cooling water unless no chemicals added and has NPDES permit.	Washwater from commercial / industrial activities
Sanitary Sewer Discharges	Septic Tank Discharges	Washing Machines Discharges
Chlorinated backwash and draining associated with swimming pools		

3-C. Collecting Jurisdiction-Wide Information

The City of Kinston is required to collect geographic information at three increasing levels of detail:

- The first, most cursory level, is information that shall be collected for the entire jurisdiction. The associated requirements are discussed in this section.

- The second level is a more detailed screening for high priority areas within the jurisdiction. The associated requirements are discussed in Section 3-D.

- The third level is a very detailed investigation that shall be done upon the discovery of an illegal discharge. The associated requirements are discussed in Section 3-E.

The purpose of collecting jurisdiction-wide information is to assist with identifying potential illegal discharge sources and characterizing illegal discharges after they are discovered.

The City of Kinston shall compile maps that show the following information.

- Location of sanitary sewers in areas of the major stormwater collection systems and the location of areas that are not served by sanitary sewers.

- Waters that appear on the USDA - Natural Resources Conservation Service Soil Survey Maps and the U. S. Geological Survey 1:24,000 scale topographic maps.

- Land uses. Categories shall include undeveloped, residential, commercial, agriculture, industrial, institutional, publicly owned open space and others.

- Currently operating and known closed municipal landfills and other treatment, storage, and disposal facilities, including those for hazardous materials.

- Major stormwater structural controls.

- Known NPDES permitted discharges to the stormwater collection system.

Written descriptions should be provided for the map components as follows:

- A summary table of municipal waste facilities that includes the name of the permit holder, the address of the facility, permit number and status (open or closed).

- A summary table of the NPDES permitted discharges that includes the name of the permit holder, the address of the facility and permit number.

- A summary table of the major structural stormwater control structures that shows the type of structure, area served, party responsible for maintaining, and age of structure.

- A summary table of publicly owned open space that identifies size, location, and primary function of each open area.

The City of Kinston shall complete this collection of jurisdiction-wide information by the time the second annual report is due (October 2002).

3-D. Mapping and Field Screening in High Priority Areas

Beginning in the second year after implementation of the local stormwater program, the City of Kinston shall identify a high priority area of its jurisdiction for more detailed mapping and field screening. This high priority area shall comprise at least ten percent of the jurisdiction's area. This requirement will begin in the third year after implementation. Each subsequent year, the City of Kinston is responsible for selecting and screening another high priority area that comprises at least ten percent of its jurisdiction.

"High Priority" means areas within a jurisdiction where it is most likely to locate illegal discharges. The most likely locations for identifying illegal discharges are areas with older development. Each year the City of Kinston shall explain their basis for selection of the high priority areas.

The first part of the screening process for the selected high priority area is mapping the stormwater system. The map that is produced shall include the following:

- Locations of the outfalls of any pipes from non-industrial areas that are greater than or equal to 36 inches.
- Locations of the outfalls of any pipes from industrial areas that are greater than or equal to 12 inches.
- Locations of drainage ditches that drain more than 50 acres of non-industrial lands.
- Locations of drainage ditches that drain more than 2 acres of industrial land.
- An accompanying summary table listing the outfalls that meet the above criteria that includes outfall ID numbers, location, primary and supplemental classification of receiving water, and use-support of receiving water.

The second part of the screening process for the selected high priority area is conducting a dry weather field screening of all outfalls that meet the above criteria to detect illegal discharges. The dry weather field screening shall not be conducted during or within 72 hours following a rain event of 0.1 inches or greater. In residential areas, it is recommended to conduct the field screening either before 9:00 am or after 5:00 pm, since these are hours that citizens are most likely to be home and thus any illegal discharges are more likely to be evident.

Figure 3a illustrates a suggested process for conducting field screening sampling activities and following up with any findings of dry weather flow. As shown in the figure, if the field screening shows that an outfall is dry, then the outfall should be checked for intermittent flow at a later date.

If the field screening shows that an outfall has a dry weather flow, then the City of Kinston shall complete a screening report for the outfall. The information that should be contained in the screening report is outlined in Table 3c. Screening reports shall be kept on file for a minimum of five years.

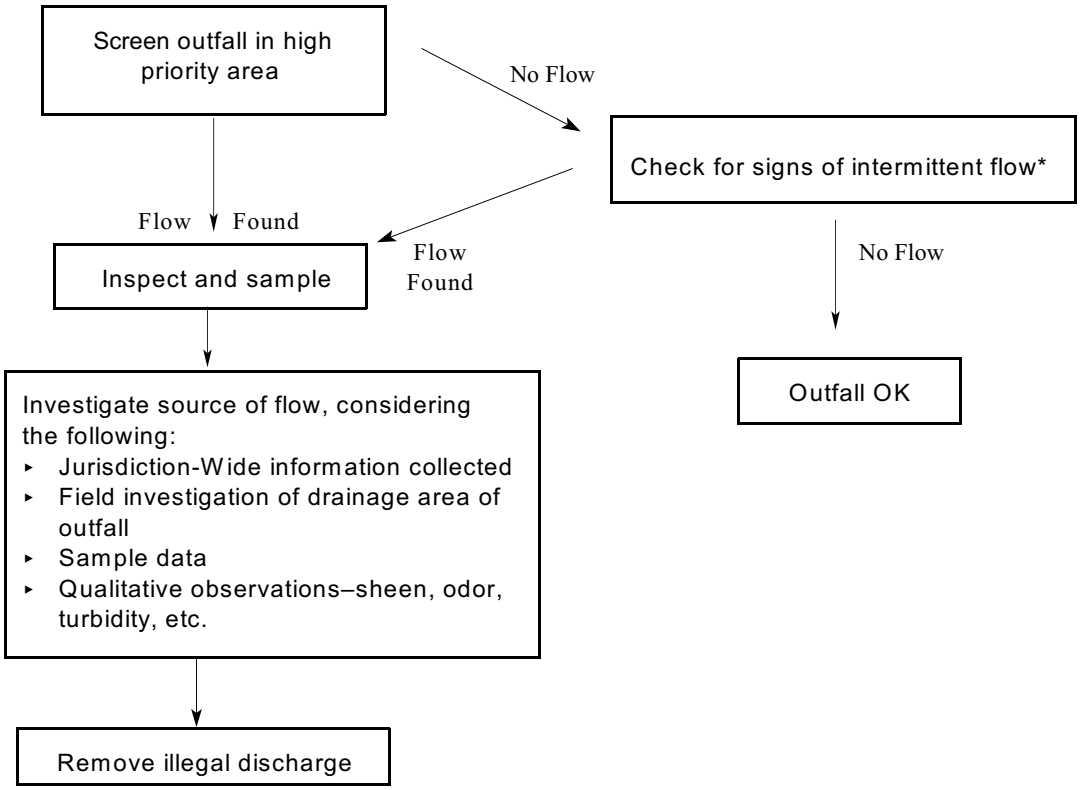
Table 3c: Field Screening Report information

General Information	Sheet Number Outfall ID Number Date Time Date, Time and Quantity of Last Rainfall Event	
Field Site Description	Location Type of Outfall Dominant Watershed Land Use (s)	
Visual Observations	Photograph Odor Color Clarity Floatables	Deposits/Stains Vegetation Condition Structural Condition Biological Flow Estimation
Sampling Analysis*	Temperature pH Nitrogen-Ammonia	Nitrogen-Nitrate/Nitrite Fluoride or Chlorine

* Analytical monitoring is required only if an obvious source of the dry weather flow cannot be determined through an investigation of the upstream stormwater collection system.

Outfalls with flow be screened again within 24 hours for the above parameters. The tests for ammonia and nitrate/nitrate that are purchased should be sensitive for 0.1 to 10 mg/L.

Figure 3a: Field Screening Process



* Checking for intermittent flow includes rechecking outfall at a later date as well as visual observations for evidence of intermittent flow.

Note: Analytical monitoring is required only if an obvious source of the dry weather flow cannot be determined through an investigation of the upstream stormwater collection system.

The purpose of the field screening is to provide clues as to the source of the illegal discharge. The characterization should be in conjunction with the jurisdiction-wide information and a field investigation to identify the source of the illegal discharge. The process of identifying and removing illegal discharges is discussed in the next section.

3-E. Identifying and Removing Illegal Discharges

After the field screening is complete, the City of Kinston shall take measures to identify and remove illegal discharges. Identifying illegal discharges will require a combination of office and field work. After the field screening, the City of Kinston should consult the jurisdiction-wide information they have compiled (see Section 3-D) to obtain information about the land uses, infrastructure, industries, potential sources and types of pollution that exist in the drainage area of the outfall.

After potential sources have been identified in the office, a systematic field investigation shall be planned that minimizes the amount of resources required to identify the source. Several field methods may be used to identify illegal discharges. It is recommended that the City of Kinston use a simple approach if that will suffice. Listed below are several approaches, starting with simple approaches and moving to more complex ones.

- Site Investigation
- Additional Chemical Analysis (recommend testing for fecal coliform if the ammonia concentration is found to exceed 1.0 mg/L)
- Flow Monitoring (recommended to use multiple site visits rather than a depth indicator)
- Dye Testing (fluorescent dye is recommended)
- Smoke Testing
- Television Inspection

Documentation of the results of the office and field investigation shall be kept on file for five years with the screening report.

After the City of Kinston identifies the source of an illegal discharge, it shall take enforcement action to have the source removed. The legal authority that is established for the illegal discharge program shall provide the means to accomplish this requirement. Enforcement shall include requiring the person responsible for the discharge to remove or redirect it to the sanitary sewer. There shall be remedies to deal with cases of non-compliance. Records of all compliance actions shall be kept for five years with the screening report.

In addition to keeping all screening reports on file, the City of Kinston shall maintain a map that includes the following:

- Points of identified illegal discharges.
- Watershed boundaries of the outfalls where illegal discharges have been identified.
- An accompanying table that summarizes the illegal discharges that have been identified that includes location, a description of pollutant(s) identified, and removal status.

3-F. Preventing Discharges and Establishing a Hotline

The City of Kinston shall contact persons who are responsible for establishments that are likely sources of illegal discharges. Some of these sources include automotive sales, rental, repair and detailing establishments, lawn care companies, cleaners and certain types of contractors. Previous experience has shown that many illegal discharges are actually unintentional.

The City of Kinston shall establish a hotline. The hotline will require designation of a new phone number or use an existing service. The hotline shall include a recording advising citizens what to do if they call during non-business hours. There will be another number given in cases where the illegal discharge is perceived to be an emergency.

3-G. Implementation Schedule

In keeping with their goal of having an efficient and cost-effective program, the Neuse Stormwater Team created a phased implementation schedule for illegal discharges (Table 3d). The schedule allows for collecting jurisdiction-wide information during the first year of implementation and then screening the high priority areas during future years. This phased schedule is also intended to allow communities to evaluate and make improvements to their program as they progress through high priority areas.

Table 3d: Implementation Schedule and Annual Reporting Requirements

Year	Implementation Requirements	Annual Report Requirements
By March 2001	• Establish legal authority to address illegal discharges	• Submit report identifying established legal authority to meet requirements
By October 2002	• Collect jurisdiction-wide information • Select high priority area for additional screening • Initiate illegal discharge hotline	• Report on completion of jurisdiction-wide information collection. • Submit map of high priority areas and reason for selection. • Report on initiation of illegal discharge hotline.
Each subsequent year after 2002	• Complete mapping and field screening for high priority area. • Select next high priority area. • Identify and remove illegal discharges as encountered. • Continue operating illegal discharge hotline.	• Submit map of stormwater collection system in high priority area upon request by DWQ. • Document illegal discharges found and resulting action • Report on hotline usage and actions taken. • Submit map of next high priority area and reason for selection.

3-H. References

Debo, Thomas N. and Reese, Andrew J., Municipal Stormwater Management, CRC Press, Inc. 1995

U.S. Environmental Protection Agency (EPA). 1992, Manual of Practice - Identification of Illicit Connections. EPA 833/R-90-100

U.S. Environmental Protection Agency (EPA). 1993. Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems - A User's Guide. EPA 600/R-92-238.

U.S. Environmental Protection Agency (EPA). 1991. Guidance Manual for the Preparation of Part 1 of the NPDES Permit Applications for Discharges from Municipal Separate Storm Sewer Systems. EPA 505/8-91003A.

4. Retrofit Locations

4-A. Requirements in the Rule

The rule requires that the City of Kinston establish a program to identify places within existing developed areas that are suitable for retrofits.

4-B. Approach for Meeting the Requirements

Retrofit opportunities will be considered acceptable if all of the following conditions have been investigated:

- The retrofit, if implemented, clearly has the potential to reduce nitrogen loading to the receiving water.
- The watershed is clearly contributing nitrogen loading above background levels.
- The landowner where the retrofit is proposed is willing to have the retrofit installed on his property. Securing the landowner's cooperation is one of the most important tasks for the local government, as this is often the most difficult aspect of implementing a retrofit.
- There is adequate space and access for the retrofit.
- It is technically practical to install a retrofit at that location.

The minimum number of retrofit opportunities that the City of Kinston is required to identify is two. Sites may be carried over to meet the minimum requirements for up to two subsequent years provided that BMPs/retrofits have not been implemented and the site continues to meet the criteria above on an annual basis.

4-C. Data Collection and Notification

Each retrofit opportunity that is identified shall be accompanied by information to describe the location of the retrofit, the type of retrofit being proposed, the property owner, as well as basic information about the watershed and the receiving water.

The tables shall be submitted to the Division of Water Quality on October 30 of each year beginning in the year 2001 as part of the annual report.

The Division will post these retrofit opportunities on its Web Page and will notify the following organizations of the opportunities for retrofitting within existing developed areas:

- Clean Water Management Trust Fund
- N.C. State University Cooperative Extension Service
- Triangle J. Council of Governments
- Kerr-Tar Council of Governments
- Eastern Carolina council of Governments

- Environmental programs at N.C. State University, Duke University, University of N.C., East Carolina University and others
- N.C. Sea Grant
- USDA - Natural Resources Conservation Service
- Upper Neuse Basin Association
- Lower Neuse Basin Association
- N.C. Wetlands Restoration Program

4-D. Mapping Requirements

The City of Kinston will provide maps that show the locations of retrofit opportunities. Mapping will be accomplished by using computers or with existing hard copy maps. The scale of the map should be large enough to adequately identify the following required parameters:

- Drainage area to retrofit opportunity site.
- Land uses within the drainage area.
- Location of retrofit opportunity.
- Property boundaries in the vicinity of the retrofit opportunity.
- Significant hydrography (as depicted on U.S.G.S. topographic maps and USDA NRCS Soil Survey maps).
- Roads.
- Environmentally sensitive areas (steep slopes, wetlands, riparian buffers, endangered/ threatened species habitat - where available).
- Publicly owned parks, recreational areas, and other open lands.

Table 4b: Retrofit Opportunity Table

City of Kinston **Retrofit Opportunity Table**	
Property owner	
Location of retrofit	
Type of retrofit opportunity	
Is owner willing to cooperate?	
Land area available for retrofit (sq. ft.)	
Accessibility to retrofit	
Drainage area size (acres)	
Land use in drainage area (% of each type)	
Average slope in drainage area (%)	
Environmentally sensitive areas in drainage area (steep slopes, wetlands, riparian buffers, endangered/threatened species habitat)	
Approximate annual nitrogen loading from drainage area (lb/ac/yr)	
Potential nitrogen reduction (lb/ac/yr)	
Estimated cost of retrofit	
Receiving water	
DWQ classification of receiving water	
Use support rating of receiving water	
Other important information	

5. Public Education

5-A. Requirements in the Rule

The Neuse Stormwater Rule requires each of the affected jurisdictions in the Neuse River Basin to develop a locally administered environmental education program to address nitrogen loading issues.

5-B. Public Education Action Plan

The City of Kinston shall develop a Public Education Action Plan. The Action Plan will outline the proposed education activities for the upcoming year, identifying target audiences and anticipated costs of the program. The City of Kinston shall submit an annual Action Plan to DWQ for approval prior to October 1 of each year.

The Action Plan shall consist of activities from each of the two categories listed below in Table 5a. Innovative public education activities not included in this list will be considered for approval on a case-by-case basis. All activities must be designed to raise awareness and educate the audience about water quality, nonpoint source pollution, and the effects of everyday activities on water quality and nutrient loading. In addition to the Category One and Two activities our Action Plans shall include two technical workshops (see below) in the first year and a hotline for reporting illegal discharges.

The ultimate goal of the public education program is to utilize major media advertising (television, radio, and newspaper to reach a broad audience.

Table 5a: Public Education Action Plan Categories

Category 1	Category 2
Demonstration Sites (for Best Management Practices)	**Fact Sheets**
"Adopt-a-Program"	**Environmental Freebies**
Quarterly local newspaper articles	**Fertilizer Tags**
Storm drain marking	**Flyers**
Recognition Program (recognize environment friendly participants)	**Postmarks**
Web Page	**Utility bills inserts**
Local Cable TV program	**Close-out Packages (new homeowners)**
Toll free hotline for reporting environmental problems	
Environmental Field Day	
Technical Workshop (only applicable after 1st year)	
Environmental Contest	

The City of Kinston will select two (2) category I activities and two (2) category II Activities on an annual basis.

During the first year of program implementation the City of Kinston shall conduct two (2) technical workshops. One shall be designed to educate local government officials and staff and the other will focus on the development community, including; engineers, developers, architects, contractors, surveyors, planners, and realtors. During subsequent years, technical workshops are considered an option under Category 2 activities.

6. Reporting Requirements

Annual Neuse River Basin Stormwater Program reports must be submitted to the Division of Water Quality by October 30 of each year beginning in 2001. All reports shall contain the following information.

6-A. New Development Review/Approval

The City of Kinston will submit the following information as part of the annual reporting requirement.

- Acres of new development and impervious surface based on plan approvals.
- Acres of new development and impervious surface based on certificates of occupancy.
- Summary of BMPs implemented and use of offset fees.
- Computed baseline and net change in nitrogen export from new development that year.
- Summary of maintenance activities conducted on BMPs.
- Summary of any BMP failures and how they were handled.
- Summary of results from jurisdictional review of planning issues.

6-B. Illegal Discharges

Table 6a outlines the annual reporting requirements for illegal discharges.

Table 6a: Implementation Schedule and Annual Reporting Requirements

Year	Implementation Requirements	Annual Report Requirements
By March 2001	• Establish legal authority to address illegal discharges	• Submit report identifying established legal authority to meet requirements
By October 2002	• Collect jurisdiction-wide information • Select high priority area for additional screening. • Initiate illegal discharge hotline.	• Report on completion of jurisdiction-wide information collection. • Submit map of high priority areas and reason for selection • Report on initiation of illegal discharge hotline.
Each subsequent year after 2002	• Complete mapping and field screening for high priority area. • Select next high priority area. • Identify and remove Illegal discharges as encountered. • Continue operating Illegal discharge hotline	• Submit map of stormwater collection system in high priority area upon request by DWQ. • Document illegal discharges found and resulting action. • Report on hotline usage and actions taken. • Submit map of next high priority area and reason for selection.

6-C. Retrofit Locations

- Data on each retrofit opportunity (Table 4b or other equivalent format).
- Maps of potential retrofit sites as specified in Section 4-D, and
- The status of any retrofit efforts that have been undertaken within the jurisdiction.

6-D. Public Education

The Report will summarize the next years Action Plan and evaluate the implementation of the previous years Action Plan (if applicable). The report should include goals, activities completed, realized education program costs, explanation of experienced shortfalls and a plan as to how the locality will address shortfalls.

APPENDICES

Appendix A - 15A NCAC 2B .0235 Neuse River Basin - Nutrient Sensitive Waters Management Strategy: Basinwide Stormwater Requirements

Appendix B - Development of Nitrogen Export Methodologies

Appendix C - Land Use Planning and Design Techniques

Appendix D - Summary of BMP Literature Studies

Appendix A. 15A NCAC 2B .0235 Neuse River Basin - Nutrient Sensitive Waters Management Strategy: Basinwide Stormwater Requirements

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

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

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

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

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

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

(a) Review and approval of stormwater management plans for new developments to ensure that:

(i) the nitrogen load contributed by new development activities is held at 70 percent of the average nitrogen load contributed by the 1995 land uses of the non-urban areas of the Neuse River Basin. The local governments shall use a nitrogen export standard of 3.6 pounds/acre/year, determined by the Environmental Management Commission as 70 percent of the average collective nitrogen load for the 1995 non-urban land uses in the basin above New Bern. The EMC may periodically update the design standard based on the availability of new scientific information. Developers shall have the option of partially offsetting their nitrogen loads by funding wetland or riparian area restoration through the North Carolina Wetland Restoration Fund at the rate specified in Rule .0240 of this Section. However, before using offset payments, the development must attain, at a minimum, a nitrogen export that does not exceed 6 pounds/acre/year for residential development and 10 pounds/acre/year for commercial or industrial development.

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

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

(c) Implementation of public education programs;

(d) Identification and removal of illegal discharges;

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

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

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

(6) Within 18 months of the EMC's approval of the model local government stormwater program or designation, subject local governments shall adopt and implement a local stormwater management program according to their approved plan. Local governments administering a stormwater management program shall submit annual reports to the Division documenting their

progress and net changes to nitrogen load by October 30 of each year.

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

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

(b) These stormwater management programs shall provide all components that are required of local government stormwater programs in Sub-items (4)(a)-(f) of this Rule.

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

History Note: Authority G.S. 143-214.1; 143-214.7; 143-215.1; 143-215.3(a)(1); S.L. 1995, c. 572; Eff. August 1, 1998.

Appendix B. Development of Nitrogen Export Methodologies

Method for Quantifying TN Export from New Developments

1. Based on water quality monitoring data from Fayetteville, Raleigh and Durham, estimate that:

$C_{pervious}$ 1.4 mg/L
$C_{impervious}$ 2.6 mg/L

2. Utilize Schueler's "Simple Method" for determining pollutant export in lbs/ac/yr from new development:

$L = [(P) (P_j) (R_v) / 12] (C) (2.72)$

where:

P = 42 in (rainfall expected in one year)
P_j = 0.9 (correction factor for storms w/no runoff)
$R_v = 0.05 + 0.009*I$ (runoff coefficient, the fraction of rainfall converted to runoff, I = percent impervious)
C = 1.4 to 2.6 mg/L (flow-weighted mean concentration of the pollutant -- see above)

3. Figure out the concentrations and export coefficients associated with different percentage impervious covers on a right-of-way or lot.

Portion Impervious	C * (mg/L)	Exp. Coeff. ** (lbs/ac/yr)
0%	1.40	0.6
10%	1.52	1.8
20%	1.64	3.2
30%	1.76	4.8
40%	1.88	6.6
50%	2.00	8.6
60%	2.12	10.7
70%	2.24	13.1
80%	2.36	15.6
90%	2.48	18.3
100%	2.60	21.2

* This is a weighted average of the pervious and impervious concentrations given in Step 1.
** This results from applying the formula given in Step 2 with the appropriate concentration.

4. Graph the result to get relationship between percentage of right-of way that is pavement and TN export in lbs/ac/yr.

5. Utilize information from the City of Raleigh on percent impervious cover expected on each lot for various zoning categories.

Dwelling units per acre	Portion Impervious	C * (mg/L)	Exp. Coeff. ** (lbs/ac/yr)
0	0.00	1.40	0.6
1	0.14	1.57	2.4
2	0.22	1.66	3.5
4	0.30	1.76	4.8
6	0.35	1.82	5.7
8	0.38	1.86	6.2
10	0.41	1.89	6.7
12	0.43	1.92	7.2
14	0.45	1.94	7.6
16	0.47	1.96	8.0
18	0.49	1.98	8.3
20	0.50	2.00	8.6
30	0.55	2.06	9.6

* This is a weighted average of the pervious and impervious concentrations given in Step 1.
** This results from applying the formula given in Step 2 with the appropriate concentration.

6. Graph the relationship between number of dwelling units per acre and TN export in lbs/ac/yr.

Appendix C. Land Use Planning and Design Techniques

Reducing Road Widths

In many instances, road widths are required to be wider than needed to safely convey traffic through residential and commercial areas. Although these wide widths are often adopted to increase safety for automobiles, they often increase speeds through residential areas and, in so doing, may decrease safety for pedestrians and cyclists. Also, some jurisdictions require curb and gutter for aesthetic reasons where it is not actually necessary to control stormwater runoff. This can result in increased flooding and also eliminates the potential for stormwater runoff control and treatment that can occurs in properly designed and maintained roadside swales.

Most local governments model their residential street design standards after state and/or federal highway criteria, although the traffic capacity and function of their street system is considerably different from highways. Very few communities recognize any local road categories that are different from established state and federal street categories. Many local traffic engineers have simply accepted the notion that wider streets adequately address these concerns and that wide streets are safe streets (Schueler 1995). Narrower road widths can reduce the road surface area by up to 35 percent.

A number of communities have implemented standards that promote narrower residential streets and have concluded this to be an attractive, safe and environmentally beneficial alternative.

Communities should also review their standards for turnarounds to reduce the need for unnecessary road surface. One of the most common types of turnaround is a cul-de-sac that may have a diameter of 80 to 100 feet or more (Schueler 1995). Some communities are recognizing that this is excessive and are choosing alternatives that create less impervious cover, such as T-shapes. A 60-foot by 30-foot T-shaped turnaround creates only about 36% as much impervious area as an 80-foot diameter cul-de-sac and is more than adequate for most vehicles.

Local governments should: (1) examine community regulations governing road width and turnaround size; (2) evaluate if the specified widths are necessary; and (3) where feasible, make changes to reduce unnecessary road surfaces.

Reducing Minimum Parking Requirements

Parking lots are often designed to accommodate parking needs on the busiest days of the year. For example, shopping center parking areas are often big enough to handle the busy holiday times, but then sit vacant for much of the rest of the year. This can result in increased nitrogen load (as opposed to maintaining open space).

Some management strategies that would contribute to a reduction in urban nitrogen from parking lots:

- Use angles and smaller parking spaces.
- Use more pervious construction materials in seldom-used parking areas (Land of Sky 1995).
- Provide public transportation to shopping centers during the peak holiday times and encourage

people to use it.
- Design parking areas to drain in sheet flow into stable vegetated areas.

Minimizing Use of Curb and Gutter

Runoff is conveyed along streets and parking areas in one of two ways, either (a) in an open drainage channel located in the right of way, or (b) in an enclosed storm drain located under the street or right of way. The use of an open channel or storm drain in a particular street is determined by a number of factors, such as drainage area, slope, length, housing density, and street type. Open channels can be used on smaller streets, but at some point runoff velocities become too erosive to be adequately handled in an earthen channel and they must be enclosed in a storm drain. This erosive velocity is typically around 4 feet per second. A channel's maximum velocity is generally defined and computed using the peak discharge rate under the two year design storm event.

Open vegetated channels can have many water resource protection benefits. For example, a portion of stormwater pollutants may be removed through grass and soil as they pass through the channel. Performance monitoring has shown that open channels only realize these benefits under ideal conditions (e.g., low slope, sandy soils, dense grass cover, etc.). When these conditions are not met, drainage channels can have a low or even negative removal capability for many pollutants.

Only recently have engineers recognized the value of designing open channels explicitly for pollutant removal during small and moderate-sized storm events. Depending on the depth to the water table, they are known as either grass channels, dry swales or wet swales. Checkdams, underdrains, stone inlets, prepared soil mixes and landscaping are also used to enhance the pollutant removal capability of swales. The use of grass channels or swales along residential streets can be an economical and effective element of a BMP system, as long as the critical erosive velocity is not exceeded. In addition, open channels must be designed to prevent standing water, to ensure that mowing is convenient, and to avoid odors, mosquitoes, or other nuisances associated with standing water.

Even the moderate vertical break of a curb shelters airborne pollutants that blow in by the wind. Thus, dust, pollen, leaves, grass clippings, and other nitrogen-rich organic matter can be trapped by the curb, where they remain until they are washed into the storm drain system.

Some management strategies that may contribute to a reduction in urban nitrogen from roadside drainage systems are:

- Minimize the use of curb and gutter and maximize the use of vegetated swales where feasible.

- If curb and gutter is necessary, consider frequent curb cuts to divert manageable quantities of runoff into stable vegetated areas for infiltration. (Land of Sky 1995).

- Develop a site/landscaping plan that uses landscaped areas for infiltration or detention/retention areas (bioretention).
- Instead of grass that requires chemical applications, use trees, shrubs, ground cover, mulch or other materials that require little or no chemical applications.

Allowing Cluster or Open-Space Developments

Cluster or open-space developments rearrange density on each development tract so that a lower percentage of the tract is covered by impervious surfaces. This results in more land being retained in a natural state.

This approach respects private property rights and the ability of developers to create new homes for the expanding population. Such developments are "density-neutral" since the overall number of dwellings allowed is not less than it would be in a conventional development. This lessens the adverse impact on the remaining natural areas and cultural resources that make our communities such special places to live, work, and recreate.

The most important step in designing an "open space subdivision" is to identify the land to preserve. "Primary Conservation Areas" include unbuildable wetlands, waterbodies, floodplains, and steep slopes. "Secondary Conservation Areas" include mature woodlands, upland buffers around wetlands and waterbodies, prime farmland, natural meadows, critical wildlife habitats, and sites of historic, cultural or archeological significance.

Cluster developments can reduce road lengths by 50 to 70 percent (Arendt 1993). At an average cost of over $100 to construct a linear foot of road, such reductions are extremely cost-effective. The reduction in road length may also reduce the overall capital costs for stormwater controls. The developer may realize a significant savings in the reduced need for storm drain pipes and best management practices. It has been reported that in some cases the overall reduction in capital costs associated with these developments can be 10 to 33 percent (Schueler 1995).

Property owners can realize indirect economic benefits from reduced impervious cover. While a host of factors influence future residential property values, some evidence indicates that homes located adjacent to well designed and maintained open or green space do appreciate at a faster rate than traditional subdivision properties. This premium has been found to range from 5 to 32 percent, according to Land Ethics (1994). Another study in Massachusetts indicated that homes in cluster subdivisions with open space appreciated 13% more in value than similar homes in conventional subdivisions over a 21-year period (Arendt 1993).

For local governments, it is typically more expensive to provide public services on large residential lot developments compared to smaller ones. Clustered developments can greatly reduce the length of water and sewer pipes and roads that local governments have to construct and maintain.

Allowing Traditional Neighborhood Developments

Traditional neighborhood developments (TNDs) are designed so that dwellings, shops, and workplaces are in close proximity. They typically follow a rectilinear pattern of streets and blocks arranged to provide interesting routes of travel that also accommodate and promote pedestrian travel and bicycle travel rather than automobile travel. These developments also include greenways, landscaped streets, churches, stores, schools, and parks woven into the neighborhood for social activity, recreation, aesthetics, and environmental enhancement. See Figure G1 for a diagram of a TND.

One of the most important features of TNDs that affects water quality is their compactness. As

these developments expand, they maintain their compact, rectilinear layout and their accessibility. Another environmental advantage offered by TNDs is that they may reduce automobile traffic and promote increased use of alternative forms of transportation, such as mass transit.

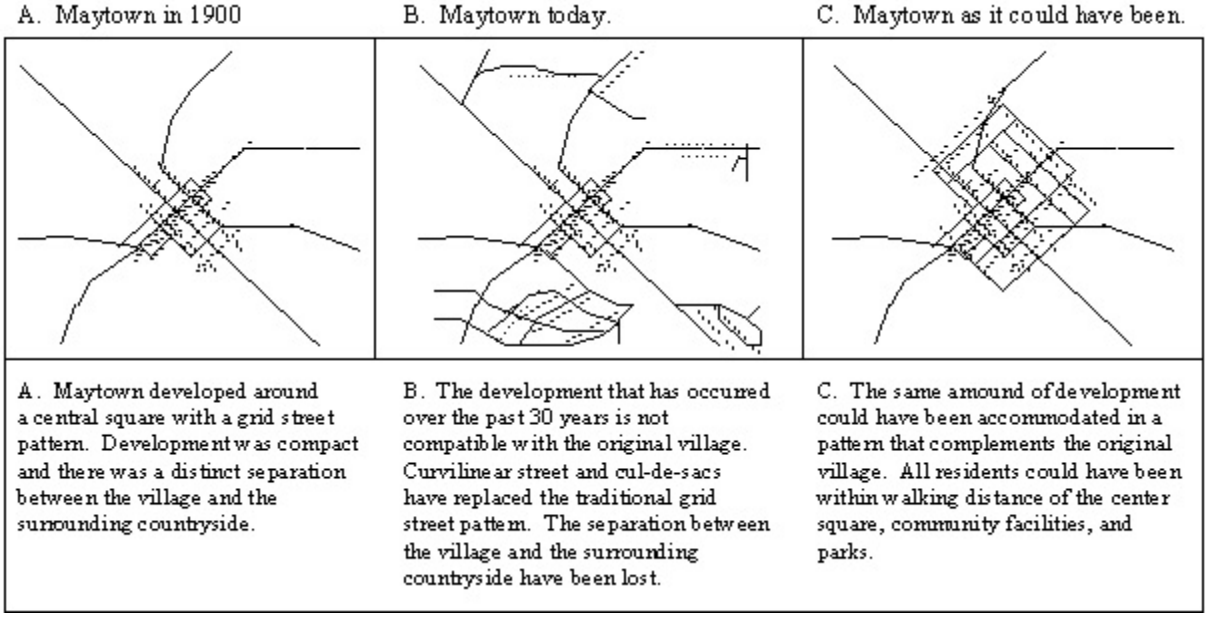
Environmental impacts of TNDs are affected by site conditions and the development intensity and design. Those TNDs that offer environmental benefits may also offer economic benefits. The increased value of real estate in a traditional development is illustrated in Raleigh. The "inside the beltline" neighborhoods in Raleigh that have city blocks, greenways, and accessibility to shopping areas, on the average, sell for 40 percent more per square foot than homes in North Raleigh subdivisions (pers. comm. Marilyn Marks, Simpson and Underwood Realtors, 1997).

Other Techniques

In many instances, subdivision codes contain rigid requirements that govern setbacks from the property lines. These requirements increase the length of driveways, roads, and sidewalks and thus increase the proportion of impervious cover to housing units. These requirements can inadvertently increase impervious surfaces and cause expense for developers and homeowners.

Large-lot zoning also impacts overall imperviousness. Although large-lot zoning reduces rooftop impervious cover in a watershed and spreads development over a wider geographic area, it can increase transport-related impervious cover because of longer road networks. Although large-lot zoning may be wise for individual sensitive watersheds, it is probably not practical as a uniform standard. An alternative is forming more compact neighborhoods in order to decrease impervious surfaces associated with transportation, a factor that has long been overlooked. Another advantage to compact neighborhoods is that they decrease automobile use by allowing better accessibility for walkers and cyclists and facilitating public transportation.

Figure C1. Maytown Before and After (adapted from Stimmel Associates, 1993)



Appendix D. Summary of BMP Literature Studies

Summary of Research Conducted in the Southeast, 1983 - Present

Wet Ponds										
Study	State	No. of Samples	Drainage Area	Land Use	TN (%)	ON (%)	NH4 (%)	TKN (%)	NO3 (%)	Notes
Borden et al.,1998	NC	22	1258ac	farmland	16	—	2	—	16	used continuous samplers during storms, total P=46% DP=58%
Borden et al.,1998	NC	25	1221ac	industrial	36	—	64	—	66	total P=40% DP=15%
City of Austin	TX	14	381ac		39	—	28	26	45	
City of Austin	TX	7	27.1ac	Industrial 66% imp.	19	—	—	47	17	WQV = 0.5
Cullum, 1995	FL	9	122ac	comm.	15	—	—	—	80	3.11 in/ac
Dorman et al., 1989	FL	6	26.3ac	highway	—	—	—	68	97	2.35 in/ac
Driscoll, 1983	MD	32	48ac	—	37	—	—	27	—	1.27ac, high algal uptake
Gain, 1996	FL	22	41.6ac	—	16	20	17	—	24	0.55 watershed-inches of storage
Holler, 1989	FL	8	105.7ac	mall	—	—	55	58	87	First 1" of runoff, detention storage volume = 2.2", 90% impervious watershed
Kantrowitz & Woodham, 1995	FL	6	1280ac	—	—	2	40	—	23	0.21-0.26 watershed-inches of storage
Martin, 1988	FL	11	41.6ac	highway	30	34	34	—	28	0.55 in/ac
MWCOG, 1983	VA	28	88ac	—	10	—	—	—	9	
OWML, 1983 (b)	VA	29	27.1ac	—	32	—	—	—	—	1.22 in/ac
Wu, 1989 (a)	NC	11	437ac	resident.	—	—	—	21	—	0.33 watershed-inches, 38% impervious watershed
Wu, 1989 (b)	NC	11	65ac	mixed res.	—	—	—	32	—	7.1 watershed-inches, 46% impervious watershed, geese population increased N values
Yousef et al., 1986	FL	30-40	49ac	mixed	—	—	82	—	87	3.65 in/ac, multiple-cell pond
AVERAGES	—	—	—	—	**25**	**19**	**24**	**40**	**45**	

Summary of Research Conducted in the Southeast, 1983 - Present

Stormwater Wetlands										
Study	State	No. of Samples	Drainage Area	Land Use	TN (%)	ON (%)	NH4 (%)	TKN (%)	NO3 (%)	Notes
Athansas and Stevenson, 1991	MD		16ac	School roof, field, pk. lot	23	5.4	56	—	55	0.5 in/ac
Rushton et al., 1995	FL	37-42	6.5ac	Office park	---	43	72	—	73	Res. Time = 14 days, 1 watershed-inch
Athanas and Stevenson, 1986	MD		97ac		---	—	43	—	35	0.1 in/ac, extended detention WL
Egan et al., 1995	FL	15	121ac	Industrial	63	—	—	63	75	Packed bed filter - 0.1 to 0.05 acre-ft runoff treated/day
OWML & GMU, 1990	VA		40ac	res./comm.(30% impervious)	36	—	68	81	68	0.1 watershed-inch, extended detention WL
Rushton & Dye, 1993	FL	23-27	6ac	office park	—	3	20	—	67	WQV=0.5 in of runoff, mean res. Time = 3.7 days, C=0.32
Blackburn et al., 1992	FL	72	2340ac	golf course	---	—	15	12	26	
AVERAGES	—	—	—	—	**41**	**14**	**46**	**52**	**57**	

Summary of Research Conducted in the Southeast, 1983 - Present

Sand Filters										
Study	State	No. of Samples	Drainage Area	Land Use	TN (%)	ON (%)	NH4 (%)	TKN (%)	NO3 (%)	Notes
Bell et al., 1995	VA	20	0.7ac	parking lot	47	—	—	71	-53	Perimeter sand filter, 95' length, filter bed area = 238 SF
Welborn & Veehuis, 1987	TX	22	80ac	Commercial	27	—	---	57	-100	Surface sand filter
City of Austin, 1990	TX	18	79ac	Mall - 86%	44	—	43	64	-13	Surface sand filter, 0.5 inch
City of Austin, 1990	TX	17	50ac	66% impervious	71	—	94	90	23	Surface sand filter, 1.7 inch
Barton Springs, 1996	TX	8	4.9ac	highway - 59% impervious	15	—	—	35	-87	Vegetated filter of 36" limestone and gabion, preceded by filtration pond.
AVERAGES	—	—	—	—	**39**	**—**	**43**	**64**	**-55**	

Summary of Research Conducted in the Southeast, 1983 - Present

Open Channel Practices

Study	State	No. of Samples	Drainage Area	Land Use	TN (%)	ON (%)	NH4 (%)	TKN (%)	NO3 (%)	Notes
Barrett, et al.	TX	423	32ac	highway	---	---	—	33	50	total P=44%
Barrett, et al.	TX	423	258ac	highway	---	---	—	44	23	total P=34%
Dorman , et al., 1989	VA	9	1.27ac	highway-67% impervious	---	---	—	17	11	2-yr erosive velocity, 10-yr capacity
Harper, 1988	FL	16	0.83ac	highway-70% impervious	84	86	78	---—	80	2-yr erosive velocity, 10-yr capacity, Tc=45 min., swale age = 16 years
Harper, 1988	FL	11	1.17ac	highway-100% impervious	40	39	-11	---—	52	2-yr erosive velocity, 10-yr capacity, Tc=9 min., swale age = 23 years
OWML, 1983	MD	50	19ac	residential	-18	---—	-----	---—	----	2-yr erosive velocity, 10-yr capacity
OWML, 1983	MD	8	12ac	residential, large lots	37	---—	-----	---—	-----	2-yr erosive velocity, 10-yr capacity
Yousef et al., 1985	FL	6	----	highway	13	---	—	-20	11	30-60 min. residence time, 0-2.8 watershed-inches
AVERAGES	—	—	—	—	**31**	**63**	**34**	**17**	**39**	

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