February 2007

A Study of the Costs Associated with Providing Nutrient Controls that are Adequate to Offset Point Source and Nonpoint Source Discharges of Nitrogen and Other Nutrients

First Deliverable: Study Methodology

Prepared for

Environmental Review Commission

Prepared by

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1. INTRODUCTION AND BACKGROUND

The Neuse River Basin has experienced significant environmental harm as a result of high levels of nutrients being emitted into its water. These nutrients are directly emitted into the water at "point sources" (such as wastewater treatment facilities) and indirectly emitted at "nonpoint sources" (such as agricultural and developed lands where rain runoff carries the nutrients into the river). To address this problem, the North Carolina General Assembly set limits for the amount of nutrients these sources could emit into the river system (NCDOWQ, 2006).

In lieu of meeting this limit, dischargers and developers can either construct more stringent nutrient controls on site or they can pay a specified fee to the Riparian Buffer Restoration fund as part of the Nutrient Offset Fee Payment Program (NOFPP). The NOFPP is administered by the Ecosystem Enhancement Program (EEP), which can use the funds paid by excess emitters to construct nutrient controls within the river basin that offset the excess nutrients they emit (NCDOWQ, 2006).

During fiscal year 2005–06, payments were made by 302 customers located in the counties of Craven, Durham, Johnston, Pitt, Wake, Wayne, and Wilson and the municipalities of Cary, Durham, Garner, Goldsboro, Greenville, Havelock, New Bern, Raleigh, Smithfield, and Wilson. During fiscal year 2005–06, EEP received $2,349,247 in payments for 213,567.9 pounds of nutrient reduction.

EEP has accepted 526,373.04 total pounds of nitrogen removal in the Neuse River Basin since the program's inception. EEP has instituted projects that will reduce 527,339.68 total pounds of nitrogen. NOFPP projects are currently a combination of traditional NOFPP projects and instituted Riparian Buffer Restoration projects in the Neuse River Basin. During the last year, EEP began accepting mitigation payments to reduce nitrogen and phosphorus in the Tar-Pamlico River Basin. The mitigation for these payments is not yet due.

Currently, the cost of reducing nitrogen and phosphorus exceeds the fee schedule. In 2006, the Department of Water Quality (DWQ) raised fees through rulemaking, but the General Assembly postponed these rules so that a cost study could be implemented.

The original offset fee NOFPP charged for excess nitrogen emissions was set in 1998 at $11 per pound of nitrogen per year for the Neuse River Basin. However, this fee was estimated without the benefit of historical data for what offset mitigation projects would cost (NCDOWQ, 2006). Thus, in 2006, several changes to the original 1998 payment rules were proposed to better reflect the true costs of mitigation and to expand the program to new river systems. These changes included the following:

- raising the nitrogen offset fee from $11 to $57 per pound per year,
- expanding the NOFPP to the Tar-Pamlico River Basin, and
- creating a nutrient offset program for phosphorous in the Tar-Pamlico River Basin.

These changes became effective on March 1, 2006, during the 2005 session of the North Carolina General Assembly (NCDOWQ, 2006). However, later in the 2005 General Assembly session, some of these changes were temporarily rescinded by Senate Bill 1862. This bill required that nitrogen offset fees be temporarily returned to their previous levels of $11 per pound per year and that there be no nutrient offset program for phosphorous. The bill also called for the General Assembly's Environmental Review Commission to conduct a study of the NOFPP. The objectives of this study include the following:

- Objective 1: Evaluate the sustainability of the program at the current fee of $11 per pound of nitrogen
- Objective 2: Develop a proposed fee based on the cost-effectiveness analysis
- Objective 3: Develop a formula for the calculation of the offset payment fee
- Objective 4: Assess the advantages and disadvantages of expanding the nutrient offset payments to other nutrients and additional areas of the state
- Objective 5: Evaluate the ability of public (other than the EEP) and private entities to provide nutrient offsets
- Objective 6: Develop a comprehensive review of potential nutrient mitigation efforts available

This study was contracted to RTI International in 2007. RTI's approach to meeting each of the seven study objectives is based on the formula for emission payments that was introduced by the 2006 amendments to the 1998 Nutrient Offset Payments Rule. This formula is described in Section 2. Sections 3 through 6 discuss how the parameters of this formula will be estimated. Section 7 concludes with a discussion of the timeline for completing the study.

2. OVERVIEW OF NITROGEN AND PHOSPHOROUS PAYMENT FORMULAS

Among the changes presented in the 2006 amendments to the original Nutrient Offset Payments Rules were new formulas for calculating the total dollar amount that a new development or wastewater discharger would be required to pay in lieu of meeting the nutrient loading limits. The formula for calculating the nitrogen offset payment is:

$$\begin{aligned}&\mathit{Nitrogen\ Payment} = [(\$ / \mathit{lb})(\#\ \mathit{of\ lbs} / \mathit{year})(\mathit{30\ years}) + \\ &(\mathit{Land\ Cost}\ \$ / \mathit{Ac})(\mathit{1\ Ac} / \mathit{35\ Ac})(\mathit{Devel.\ In\ Ac})] \times \\ &(\mathit{1.1\ Ad\ Costs})\end{aligned}$$

where,

$/lb =	the cost of mitigation in dollars per pound of nitrogen mitigation. As discussed in the previous section, this cost is currently set to $11 per pound.
# of lbs/year =	the number of pounds of nitrogen discharged each year for which mitigation is being requested.
Land Cost $/Ac =	the current property value of the property being developed as measured in dollars per acre. This value is based on the most recent county tax assessment.
1 Ac / 35 Ac =	an adjustment factor, indicating that 1 acre of mitigation is required for every 35 acres of development.
Devel. in Ac =	the overall size of the development, as measured in acres, for which mitigation is being requested.
1.1 Ad Costs =	an adjustment factor used to reflect the administrative costs associated with the requested mitigation.

The formula for calculating payments for phosphorus is similar (NCDENR, 2005). These formulas will serve as the backbone of how RTI will address the seven study objectives discussed in the introduction. The remainder of this document explains how RTI will evaluate the formulas and their specific components.

3. COST ESTIMATION "$/LB"

At the core of this study will be the identification, integration, and analysis of project costs. RTI's team has a significant amount of information in-house that we can leverage. In 1997 and more recently in 2006, the Center for Watershed Protection (CWP) compiled and analyzed actual cost data for constructing ponds, wetlands, bioretention, filtering systems, and retrofits around the country. This effort generated average costs for design, engineering, and permitting of these projects; maintenance costs have not been well estimated. In addition, Dr. Bill Hunt, at North Carolina State University (NCSU), has access to expenses accrued by NCSU for constructing bioretention cells and storm water wetlands, including maintenance costs (annual labor hours to maintain, maintenance equipment costs, and materials).

RTI will augment this information through interviews and literature reviews described below. Because construction costs will vary regionally depending on differences in labor and materials costs, we recommend as much as possible acquiring and analyzing cost data specifically from North Carolina to either support or adjust the national retrofit cost estimates discussed in Section 7.

3.1 Recommended Protocol to Acquire and Analyze New North Carolina Retrofit Cost Data

This task involves three components: identifying projects to analyze, interviewing project managers, and analyzing the data. We recommend starting with EEP offset program records to identify appropriate retrofit projects, then following up with other state agencies or the Natural Resources Conservation Services (NRCS) offices, municipal staff from progressive jurisdictions with retrofit programs, and NCSU and other university researchers.

Table 3-1 summarizes the type of data that will need to be collected on each project based on our previous efforts to determine retrofit costs. This table includes the minimum amount of information needed, as well as a list of desirable information.

Table 3-1. North Carolina Retrofit Cost Data to Collect

<table>
<tr><th>Minimum Data Required</th><th>Desirable Data</th></tr>
<tr><td>

- Retrofit identifier and contact person
- Primary best management practice (BMP) type
- Secondary BMP type(s)
- Physiographic region
- Geographic location
- Urban/suburban/rural
- Drainage area
- % impervious or impervious area
- Drainage area land use
- Design storm and/or volume treated
- Year built (to account for inflation)
- Design cost
- Construction cost
- Land acquisition cost (if applicable)

</td><td>

- Surface area or volume (depends on practice)
- Funding source
- Costs broken down by actual expenses versus in-kind costs (e.g., staff time)
- Costs broken down by BMP, if multiple BMPs part of same retrofit site
- Design cost broken down by
  - Permitting
  - Landscape
  - Engineering
- Project management costs separated from design/construction, as
  - Planning and misc. project management
  - Project management during construction
- Construction costs broken down by at least
  - Landscaping
  - Erosion and sedimentation control
  - Educational signage or brochures

  And, if possible
    - Filter media
    - Stone
    - Earthwork
    - Drainage structures
    - Labor (if reported separately)

</td></tr>
</table>

In addition to these data, a narrative of factors that contributed to the cost being especially high or low (e.g., site owner did design and project management, project had to be rebuilt after first storm) would also be helpful. If maintenance or land acquisition costs are available, then they should be collected as well.

Once this information is collected, it should be analyzed by retrofit type and a cost/area treated/practice type can be developed. These data will be compared with the national study conducted by CWP and used to develop standard retrofit costs for developing the dollar-per-pound portion of the offset fee.

3.2 Protocol for Estimating Retrofit Program Delivery Costs

The offset fee should adequately cover not only the cost of constructing a retrofit or pushing paper, but should also be used to cover the costs to administer a retrofit offset program. This cost relates to the local government cost to find, prioritize and choose best retrofit sites in a subwatershed and to deliver those projects.

We have fairly good data on staff effort (hours) to perform all basic subwatershed retrofit assessment methods presented in the forthcoming *Manual on Stormwater Retrofit Practices*. Given a decent labor rate for consultants/local government, it would be possible to estimate these costs as well. To estimate this associated cost, the following subtasks should be completed:

- Gain an understanding of what the current 10% administrative portion of the Neuse offset fee covers. This may involve interviewing EEP program staff to obtain actual or anecdotal information regarding program administration effort.
- Identify staff costs and appropriate labor rates for agency staff, consultants, and watershed group volunteers.
- Establish average staff effort involved (using CWP manuals) for various administrative tasks for the program including, at a minimum, the following components:
  - Project management costs: to include budgeting, scoping, data management, and developing subcontracts
  - Direct costs: travel, printing, reproduction, phone, field supplies, and GIS equipment
  - Identifying appropriate retrofit opportunities in the watersheds: compilation of appropriate GIS mapping data to prepare for watershed assessment, conducting a retrofit inventory, postprocessing data (e.g., determining drainage areas, impervious cover)
  - Developing retrofit concept designs (30% and final)
  - Ranking and prioritizing projects: based on cost, area treated, watershed benefit, feasibility, synergy with other restoration projects, and visibility, for example

- Soliciting support for the project: community involvement/stakeholder meetings to include direct outreach costs
- Modeling to show benefits associated with the project (e.g., water quality and flooding)
- Developing a monitoring and maintenance plan
- Establishing and maintaining a project tracking database

3.3 Discuss Nitrogen/Phosphorus Reduction Issues Associated with Stream Repair/Riparian Reforestation

The majority of the dollars per pound is based on stormwater retrofits in urban settings. This is based on the assumption that most projects under the offset fee program are retrofits. A secondary offset option is to include other restoration alternatives such as stream restoration and rural/agricultural practices. Currently, we have limited cost data on urban stream repair, riparian reforestation practices, impervious cover removal, and on-site retrofits, but we lack much quantifiable removal data. We also lack good data on rural/agricultural practices.

What We Know about Stream Restoration Costs

CWP compiled stream restoration costs in Manual 4 of the Urban Watershed Restoration Manual for Stream Restoration. Table 3-2 summarizes unit costs for various repair practices. These costs were derived in 2004; however, the cost data came from projects dated even earlier.

What We Know about Nitrogen/Phosphorous Pollutant Removal from Stream Restoration or Riparian Reforestation

Stream restoration projects are primarily used to improve aquatic habitat and physical channel conditions in degraded streams, with little attention to their nutrient removal capabilities. Consequently, little research is available for setting an accurate removal efficiency number for total nitrogen (TN) or total phosphorous (TP). Table 3-3 provides some guidance on estimated TN and TP removal efficiency for stream restoration based on the stream restoration efficiency numbers used by the Maryland DNR. Recent research has begun to examine the issue of the removal efficiencies of stream restoration projects for nitrogen and phosphorus. The work of a number of researchers suggests that urban stream restoration

Table 3-2. Comparative Cost of Stream Repair Practices

Repair Practice	Unit Cost	Feasibility Notes
Boulder revetments	$20 to 40 per linear foot (lf)	Noncohesive soils
Rootwad revetments	$10 to 100 per lf	recreational use
Imbricated rip-rap	$60 to 90 per lf	Nondeformable
A-jacks	$65 to 85 per lf	Toe protection only
Live cribwalls	$250 to 300 per lf	Slope failure
Streambank shaping	varies	Need toe protection
Coir fiber logs	$8 to 30 per lf	2 to 5 year lifespan
Erosion control fabrics	$1 to 5 per sy	Woven/non-woven
Soil lifts	$12 to 30 per lf- f	Need toe protection
Live stakes	$1 to 3 per stake	Reach water table
Live fascines	$ 5 to 22 per lf	Sunlight
Brush mattresses	$ 30 to 50 per lf	Toe protection
Vegetation establish.	varies	Invasive species
Wing deflectors	$400 to 800 each	Rock size
Rock or log vanes	$ 400 to 1400 each	Outflanking
Rock vortex weirs	$1200 to $2100 each	High failure rate
Rock cross vanes	$1200 to $1700 each	Outflanking
Step pools	$2000 to $6000 each	Head drop
V-log drops	$800 to $2600 each	Armoring
Lunkers	$45 to 60 per lf	Bedload transport
LWD placement	$20 to 40 per lf	Orientation
Boulder clusters	$60 to 250 each	Rock size
Baseflow enhancement	varies	Bedload transport
Parallel pipes	$50 to 300 per lf	Available head
Stream daylighting	$100 to 300 per lf	Overburden depth
Culvert modification	Varies	
Culvert replacement	Varies	Needs of target fish species
Devices to pass fish	Varies	
Combinations	Varies	Varies
Channel redesign	Varies	Incision
Dechannelization	Varies	Utilities

Note: These cost estimates were derived in 2004 and are based on numbers from earlier studies.

projects may increase the ability of streams to act as nitrogen "sinks" and remove additional levels of nitrogen from urban streams (Groffman et al., 2005; Mayer et al., 2003). Mayer suggests that restoration may enhance denitrification by reestablishing flood plain hydrology and increasing carbon availability, and that structures installed in the stream channel to reduce erosion also may trap organic matter that increase opportunities for nitrogen assimilation. The restoration projects should theoretically also function to reduce phosphorus, because much of the phosphorus will be bound to sediment loads that will be controlled by stream repair practices.

Although the research on pollutant removal appears promising, currently the documented research is not to the point that a reasonable pollutant removal efficiency number could be derived. There is also the issue of high-volume urban stream scenarios, which may result in stream restoration not providing nitrogen removal during storm events because of the rapid movement of water.

Nitrogen and phosphorus removal efficiencies for riparian reforestation are more easily derived. Numerous literature reviews on riparian buffers have been conducted that document their effectiveness (Mayer et al., 2003; Wenger, 1999; Castelle, 1994). Table 3-3 provides some pollutant removal efficiencies for riparian forest planting.

To support this analysis, we recommend completing the following tasks:

1. Determine percentage of current projects funded by offset fees that are nonurban, retrofit projects.
2. Conduct similar investigation specifically in North Carolina for stream repair and buffer restoration project costs as described in Task 1 with retrofits.
3. Investigate additional pollutant removal data for stream restoration and potentially riparian buffer restoration from other sources such as North Carolina Stream Restoration Institute, University of Maryland Center for Environmental Science (http://www.al.umces.edu/), Institute of Ecosystem Studies (http://www.ecostudies.org/), USGS Baltimore Ecosystem Study (http://www.beslter.org/frame4-page_3f_02.html).

Table 3-3. Pollutant Reduction Efficiencies and Reporting Units for Stream Restoration and Riparian Reforestation Practices

Practice	Total Nitrogen (TN) Efficiency (%)	Total Phosphorus (TP) Efficiency (%)	Total Suspended Solids (TSS) Efficiency (%)	Reporting Units
Stream restoration	0.02 lbs/ft	0.0035 lbs/ft	2.55 lbs/ft	Linear feet
Riparian forest buffer planting (urban)	25	50	50	Acres
Upland reforestation (from turf)[a]	90	90	0	Acres
Upland reforestation (from Impervious Cover)[a]	95	95	50	Acres
Riparian forest buffers (rural)[a]	60	70	75	Per acre treated
Riparian grass buffers (rural)	17–57	50–75	50–75	

[a]Provisional estimate

Sources: Removal efficiencies derived from CBP (2005), MD DNR (2002), Cappiella et al. (2005), and land cover loading analysis.

4. METHODS FOR ESTIMATING "# OF LBS/YEAR"

As part of evaluating the formula for payments, we will investigate methods used for calculating both the incremental pounds of nuturients generated from development as well as the number of pounds offset through restoration. It is essential that pounds "in" (generated) equal pounds "out" (offset) by the offset program. To this end, as part of this project, we will investigate how the number of pounds per acre purchased is calculated by design engineers/contractors, as well as how the pounds per acre from site restoration are calculated by the program. Below is our current understanding of how these calculations are developed.

4.1 Nutrient Loads Resulting from Development

An important component of the offset fee formula is establishing the dollar per pound of nitrogen or phosphorus. The basic approach involves the following steps:

<u>Step 1: Calculate Predevelopment Pollutant Load</u> (Estimate acceptable background unit area nutrient load [e.g., forest]). The simple method is used to calculate the pollutant load per acre of impervious cover based on rainfall, impervious cover, mean pollutant concentration, and site area. Impervious cover

is any surface in the urban landscape that cannot effectively infiltrate or absorb rainwater, including roofs; buildings; paved streets; parking areas; and any concrete, asphalt, compacted dirt, or compacted gravel surface.

<u>Step 2: Calculate Postdevelopment Pollutant Load</u> (Estimate unit nitrogen and phosphorus loading rate per acre of impervious cover for new or existing development). The simple method is also used with estimated postdevelopment event-mean-concentrations (EMCs) to obtain the postdevelopment pollutant load.

<u>Step 3: Calculate Pollutant Removal Requirement</u>. The pollutant removal requirement (RR) is calculated by subtracting the predevelopment pollutant loads from the postdevelopment loads.

$$\%RR = [(Load_{post} - Load_{pre})/Load_{post}]*100.$$

The engineer designing the stormwater management plan for the new development site determines the nitrogen and phosphorus loading for the site based on NCDENR's *Manual of Stormwater Best Management Practices* (draft 2005), *Neuse River Basin:* (1999) and *Tar-Pamlico River Basin:* (2004). The calculation for total nutrient export from a proposed site is slightly different for each river basin but is based on the total area and nutrient export coefficients for impervious surfaces and open spaces on the developed site. The Tar-Pamlico River Basin has different calculations for the Piedmont and Coastal regions. If the overall nitrogen and/or phosphorus export is greater than specified in the regulations (15A NCAC 02B.0235 for the Neuse River Basin and 15A NCAC 02B.0258 for the Tar-Pamlico River Basin), then the three nitrogen export reduction options described in Table 4-1 are available.

4.2 Nutrient Loads Offset Through Restoration

The removal efficiencies listed in Table 4-2 are used as listed in NCDENR's *Manual of Stormwater Best Management Practices* (draft 2005).

Table 4-1. Nitrogen Export Reduction Options for the Neuse and Tar-Pamlico River Basins

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 (4.0) lbs/ac/yr. 2. Pay a one-time offset payment of $330/lb to bring the nitrogen down to the 3.6 (4.0) lbs/ac/yr. 3. Do a combination of BMPs and offset payment to achieve a 3.6(4.0) 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 (4.0) lbs/ac/yr. 2. Pay a one-time offset payment of $330/lb to bring the nitrogen down to the 3.6 (4.0) lbs/ac/yr. 3. Do a combination of BMPs and offset payment to achieve a 3.6 (4.0) 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 (4.0) 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 (4.0) lbs/ac/yr.

Note: Values in parentheses apply to Tar-Pamlico Basin.

These data are based on available research data and were updated in 2004. Actual reductions of some BMPs are determined by DWQ based on site-specific design, and others require identification of soil characteristics to determine actual removal efficiencies. BMP pollutant removal efficiencies from the National Pollutant Removal Performance Database (NPRPD) can be examined for the Piedmont and Coastal Plain physiographic regions to determine the magnitude of any differences.

Some factors affecting selection of BMPs include depth to the water table, shallow depth to bedrock, high sediment input, poorly drained soils, slope, and on-site space limitations. These factors will vary between river basins and will even vary between individual regions inside a single river basin. Therefore, the selection of BMP will differ based on the characteristics of the proposed location. For example, Table 4-3 indicates the most acceptable BMPs for each part of the Neuse River basin, as based on decisions of the Neuse River Basin Oversight Committee.

Table 4-2. Assumed Removal Efficiencies (NCDENR, 2005 Draft)

BMP	Nitrogen Removal Efficiency	Phosphorous Removal Efficiency
Stormwater wetlands	40%	35%
Bioretention	35%[a]	45%[b]
Wet detention basin	25%	40%
Extended dry detention basin	10%[c,d]	10%
Grassed swale	20%[c,d]	20%
Filter strip with level spreader	20%	35%
Infiltration device	40-70%[c,d]	
Manufactured BMP system	Varies[e]	Varies[e]
Buffer (50-ft restored buffer with level spreader)	30%	30%
Rooftop runoff management	Varies[c]	Varies[c]
Open sand filter	35%	45%
Closed sand filter	35%	45%

[a]To achieve the nutrient removal efficiency listed requires the use of fill soils with an infiltration rate of between 1 and 3 inches per hour, and the use of mulch on the surface.

[b]To achieve the nutrient removal efficiency listed requires the testing of soils to meet a phosphorus index value of less than 50. Visit http://www.agr.state.nc.us/agronomi/sthome.htm for soil testing information.

[c]Actual reduction will be determined based on site-specific design and installation and DWQ approval.

[d]EPA (2002).

[e]Per manufacturer subject to DWQ approval.

Historically, the BMP most commonly used by the EEP has been riparian buffers—strips of land covered in vegetation (such as trees, shrubs, or grass) and located between a potential pollutant source (such as an agricultural field) and a body of surface water. These buffers are designed to trap nonpoint source pollution, such as runoff from agricultural fields, and to prevent it from entering the body of water. Riparian buffers can be used to mitigate the discharge of a variety of sediments and pollutants, including nutrients like nitrogen and phosphorous (Osmond et al., 2002).

Nitrogen typically reaches surface water from agricultural fields by being dissolved into the groundwater that moves below the surface of the soil and traveling as nitrate. The plant-root system created by the riparian buffer can prevent this nitrate

Table 4-3. BMPs by Region in the Neuse River Basin

Design	Region		
	Piedmont	**Upper and Middle Coastal Plain**	**Lower Coastal Plain**
Buffer: trees 30 ft + grass 20 ft[a]	x	x	
Tree buffer ≥ 20 ft	x	x	
Shrub buffer ≥ 20 ft		x	
Grass buffer ≥ 30 ft	x	x	
Filter strip ≥ 20 ft[b]	x	x	
Nutrient management	x	x	x
Controlled drainage[c]		x	x
Cover crops	x	x	x

[a]The forested area near the stream and the grass area away from the stream. Notice that given the width of 20 feet, the grass area is a filter strip according to NRCS definitions.

[b]Only effective if the drainage area above the filter strip has a greater than 1% but less than 10% slope. Filter strips have to be planted with permanent herbaceous vegetation consisting of grass, legumes, and/or other forbs.

[c]Only effective if slope in channel is less than 1% and water table can be kept within 36 inches of surface soil for 50% of field area.

Source: Wossink, Ada. 2000. "The Economics of BMPs to Control Nitrogen in the Neuse River Basin." NCSU CALS Publ. AGW-2. Available at http://www2.ncsu.edu/unity/lockers/users/g/gawossin/Papers/bmpecon.pdf. As obtained on February 22, 2007.

from reaching the surface water by either absorbing it as food or by creating an environment that supports bacteria that convert nitrate into a gas that escapes into the atmosphere (Osmond et al., 2002).

In contrast, phosphorous reaches a body of water almost exclusively as surface runoff. Therefore, to mitigate phosphorous discharge, runoff water must be intercepted before it reaches the relevant body of water. This interception is performed by the vegetation that comprises a riparian buffer, which slows down the runoff water, allowing phosphorous to settle to the ground before reaching the surface water (Osmond et al., 2002).

The most important site characteristic determining the effectiveness of riparian buffers is how the water moves through or over the buffer itself (hydrology). In the example of phosphorus mitigation, the surface runoff must be slowed so the phosphorous can settle to the ground. If water does not spread evenly over the buffer, it may move through the buffer in "channels." These "channels" allow the water to flow through the buffer more quickly, making it less effective at mitigation (Osmond et al., 2002).

However, the hydrology of a site is not a characteristic of the buffer itself and it is not easily changed. The most important *buffer* characteristic in determining mitigation effectiveness is buffer width. The wider the buffer, the more vegetation can grow, and the more effectively sediments and pollutants can be mitigated. Buffers that are too narrow may not be effective at protecting surface water. On average, the recommended size of an effective buffer is approximately 100 ft in width. Other characteristics that determine the effectiveness of riparian buffers include the types of vegetation used and their location within the buffer (Osmond et al., 2002).

In addition to the removal effectiveness measures reported by NCDENR, other studies have attempted to estimate the effectiveness and appropriateness of various BMPs, including riparian buffers, in the Neuse River Basin. These studies include Osmond et al. (2002) and Wossinick (2000). As part of this study, the RTI team will review these literature estimates and compare them to the efficiency estimates reported in NCDENR's *Manual of Stormwater Best Management Practices*.

The RTI team will also work with DWQ and EEP staff to determine if new data (available in the last 2 years), data not originally considered, or data evaluation approaches indicate a need to change either the export coefficients or removal efficiencies reported in NCDENR's *Manual of Stormwater Best Management Practices*. RTI will additionally investigate the rationale for differing export values in the two basins (3.6 versus 4.0 lbs/ac/yr) and generally compare the methods of the Neuse and Tar-Pamlico River Basins and provide recommendations as appropriate.

5. EVALUATE "1 AC/35 AC PER YEAR" FACTOR

According to Tom Reeder, chief of the Wetland and Storm Water Branch (NCDWQ), a factor of 1 acre mitigation per 35 acres of development was recommended by Dr. Bill Hunt as the average area of mitigation needed for area of site developed. This factor was added to equation to help EEP recoop the cost for mitigation. This factor is roughly based on the average number of acres draining into 1 acre of wetland. This factor varies as a result of a variety of factors such as slope and soil composition and hence will vary by river basin and within river basin.

RTI will investigate whether the "1 ac/35 ac" factor is appropriate for the projected portfolio of future restoration sites. We will talk with buffer experts such as Deanna Osmond and Robert Evans at NCSU to determine if this factor is relevant for both rural and urban restoration projects and how/if it should be interpreted/modified.

In addition, the RTI team will work with EEP and DWQ and look at available data from other states, and work with private entities within North Carolina to review this adjustment factor in order for the administering agencies to be compensated for the actual cost of the mitigation effort. Upon determining the need for the adjustment factor, RTI will determine the degree of the adjustment factor needed and will determine if there are any differences based on river basin (Neuse vs. Tar-Pamlico) or physiographic location (Coastal Plain vs. Piedmont).

6. ASSESSING FUTURE LAND COSTS PER ACRE

To date, nutrient offset payments have been used for the most part to fund riparian buffer restoration. This approach is in general perceived as a cost-effective approach for pursuing nutrient offsets. Factors that influence the selection—and eventual cost—of buffer restoration include available land, current use of land, land cost, slope of land, depth to water table, in-situ soil type, contributing upslope drainage area, and pollutant removal credit/nutrient removal efficiency. In general, the program requires that offset locations are selected within the river basin upstream of the estuary. At the same time, the EEP has mechanisms in place (e.g., through local watershed planning) to prioritize watersheds. Additionally, as mentioned in the public hearing comments and responses, the intent of the offset procedures is

> to create a spatial relationship between the payment and mitigation…..Furthermore, limiting off site mitigation to a more specific spatial relationship, such as a 14-digit hydrologic unit code (HUC), is not considered practical….The EEP must be allowed the flexibility to allow the nutrient payments to be targeted to areas where they can be most beneficially utilized….in keeping

with the original goal of mitigation of nutrient loading into the respective estuaries.

Including a land cost term in the calculation was viewed by staff as a means for encouraging proximity in the relationship between developing and mitigation lands.

These considerations suggest that an important factor in looking at potential future costs of mitigation is projecting the availability of lands for riparian restoration given the 30-year planning horizon for the program and the likely geographic disparity in land available for riparian restoration. With this in mind, RTI will first work with EEP staff to determine where nutrient offset mitigation has been pursued historically and is currently prioritized within the basins, and we will also pursue GIS-based analyses to provide a robust basin-scale estimate of land available for mitigation. These analyses will not involve any field scale truthing or have site-level validity. The analyses will be based on these assumptions and constraints:

- Given resource and time constraints, RTI will rely on data readily available for the entire study area (i.e., including both river basins). RTI will pursue data acquisition for data not currently housed in RTI's geodatabase first from state-level sources (e.g., CGIA, EEP, DWQ) and then from local sources to the degree that project resources allow.
- RTI will use the Neuse and Tar-Pamlico buffer rules (15NCAC 02B.0233 and 15NCAC 02B.0260) as the basis for operationally pursuing an analysis of lands available for riparian restoration. It is important to note that some provisions of these rules require field data or data that are not generally available for a basin-scale analysis (e.g., higher resolution data), and which RTI will not be able to obtain and use in these planning-level estimates for this large area.

RTI will work with EEP to determine how EEP estimates the cost of riparian restoration. For example, is grading for hydrologic control upslope part of cost (e.g., level spreader)? What buffer nutrient reduction efficiency does EEP assume?

Depending on the findings, RTI may provide recommendations to adjust the approach for calculating the offset fee. As a part of the larger assessment, RTI may attempt to complete spatial analyses looking at the spatial variability in land value across the basins based on county tax assessment data. RTI will initially investigate the availability and resource requirements to compile these data before pursuing this analysis.

7. COMPARISON OF NORTH CAROLINA OFFSET FEE AND SITE RESORATION COSTS WITH OTHER STATES

Given that actual nitrogen and phosphorus costs are expected to be higher than the current offset fee, it might be useful to provide some comparative documentation from other municipalities and states with offset fee rules (e.g., Maryland 10%; Austin, TX; Maine; Henrico and Fairfax counties, VA).

7.1 Provide a Brief Summary of Other Offset Fee Programs in Other States

This task will involve the following:

- A survey of other communities' offset fees (broad sweep of other communities with offset fees). Specifically, we want to know from this quick search what the dollars per pound are and when they were established. For example, the Austin, TX, Offset Fee Program appears to be fairly robust and would be a good case study for comparison (http://stormwaterfinance.urbancenter.iupui.edu/PDFs/AustinStrmwtrPrgrm.pdf).
- Interview program managers for some of the communities' offset fee programs identified that appear to have reasonable and updated offset fees. Information to collect on each program should include at a minimum what the offset fee covers (e.g., design, engineering, permitting, construction, program administration, project delivery, maintenance), how the fees were set, whether current fees are covering costs to do equivalent water quality improvements elsewhere, and lessons learned (anything they would do differently).
- Write-up communities' offset fee programs as case studies (1 page per community) or summarize in a comparative table (preferred). This table could be used to quickly establish a valid range for effective offset fees and provide examples/models of other programs.

7.2 Review of Key National Cost Data Sources and How They Compare within North Carolina

Much of the data available to establish runoff EMCs, retrofit costs, and removal efficiencies are based on national data sources. Regional variations may result in average EMCs and

BMP removal efficiencies for North Carolina that differ from national averages. In addition, the national cost data are probably higher than North Carolina costs (more complex design requirements, union labor, and expensive metropolitan labor markets). We will conduct a quick analysis to isolate North Carolina-specific data from these databases to compare against national averages.

Table 7-1 summarizes the national databases to be mined for North Carolina-specific analysis.

As part of this task, we will need to determine which databases to mine for North Carolina studies and decide which parameters to run comparative statistics on. Final data can be shown to compare North Carolina with national data to determine if national averages are appropriate to use for the offset fee.

8. NEXT STEPS

The RTI team will present our proposed methodology for the study at a stakeholder meeting to be held March 2, 2007. At this meeting, we will solicit feedback from stakeholders on how the approach could be enhanced. In particular, we will request data that organizations might have on engineering design costs and implementation costs for restoration projects.

Based on comments received during the stakeholder meeting, RTI will revise this methodology document and resubmit it to the Environmental Review Commission for final approval. In general, RTI will make every effort to accommodate stakeholders’ concerns and suggestions in light of the constraints of the existing budget.

Table 7-1. North Carolina vs. National Databases

Database	National	North Carolina	Comments
2005 National Stormwater Quality Database (NSQD)	3,770 separate storm events from 66 agencies and municipalities from 17 states.	Data are available for 114 individual storm events, and a total of 318 observations. The jurisdictions where data were collected include the City of Charlotte, City of Fayetteville, City of Greensboro, and City of Raleigh. Data were collected from a total of 30 different monitoring stations.	Can run stats on EMCs per land use for North Carolina, national, national – North Carolina http://www.eng.ua.edu/~rpitt/Research/ms4/mainms4.shtml http://www.stormwatercenter.net/
2000 National Pollutant Removal Performance Database (NPRP)	139 studies of removal efficiencies for variety of practice types, minimum storm sample criteria of 5. 76 studies include concentration and other data where available.	Five studies, all pond performance (Greenville, Davis, Regional, Runaway Bay, Lakeside)	May need to supplement with removal efficiencies of other types of BMPs
1997 BMP study	73 studies on BMP cost	One from North Carolina	Updated with 2006 study
2006 CWP Retrofit Cost Study	Looked at over 120 projects to estimate costs; combined with CalTrans Study. Also supplemented costs with Wossink and Hunt 2003 study from North Carolina.	Wossink and Hunt had approximately 40 studies	Projects from Maryland, Virginia, Delaware, Oregon, Texas, California, and North Carolina. Most final cost information from Chesapeake Bay area, supplemented with North Carolina data.
1983 NURP	Studied 81 outfalls in 28 communities throughout the U.S. included monitoring of approximately 2,300 storm events.		Old; can access data at http://www.eng.ua.edu/~awra/download.htm.
USGS	More than 1,100 storms from 98 monitoring sites in 20 metropolitan areas.	Currently unknown	Old
Federal Highway Administration (FHWA)	Analyzed stormwater runoff from 31 highways in 11 states during the 1970s and 1980s.		Strecker (personal communication) is also collecting information from highway monitoring as part of a current NCHRP-funded project.

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