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

Presented by

Michael P. Gallaher

Dallas W. Wood

RTI International

Presented at

Legislative Office Building

June 11, 2007

Raleigh, NC

RTI INTERNATIONAL

3040 Cornwallis Road ▪ P.O. Box 12194 ▪ Research Triangle Park, NC 27709

Phone 919-541-5935 Fax 919-541-6683 E-mail mpg@rti.org

Study Overview

- Study is being prepared for:
  - Environmental Review Commission with the approval of the Legislative Services Commission

- Project activities and reporting schedule:

First stakeholders meeting	March 2, 2007
Draft report	April 30, 2007
Second stakeholders meeting	May 4, 2007
Final report	June 1, 2007
Presentation to General Assembly	June 11, 2007

Project Team

- RTI International
  - Michael Gallaher
  - Randy Dodd
  - Kim Matthews
  - Dallas Wood
- Center for Watershed Protection
  - Tom Scheuler
  - Anne Kitchell
- Bill Hunt (NCSU)

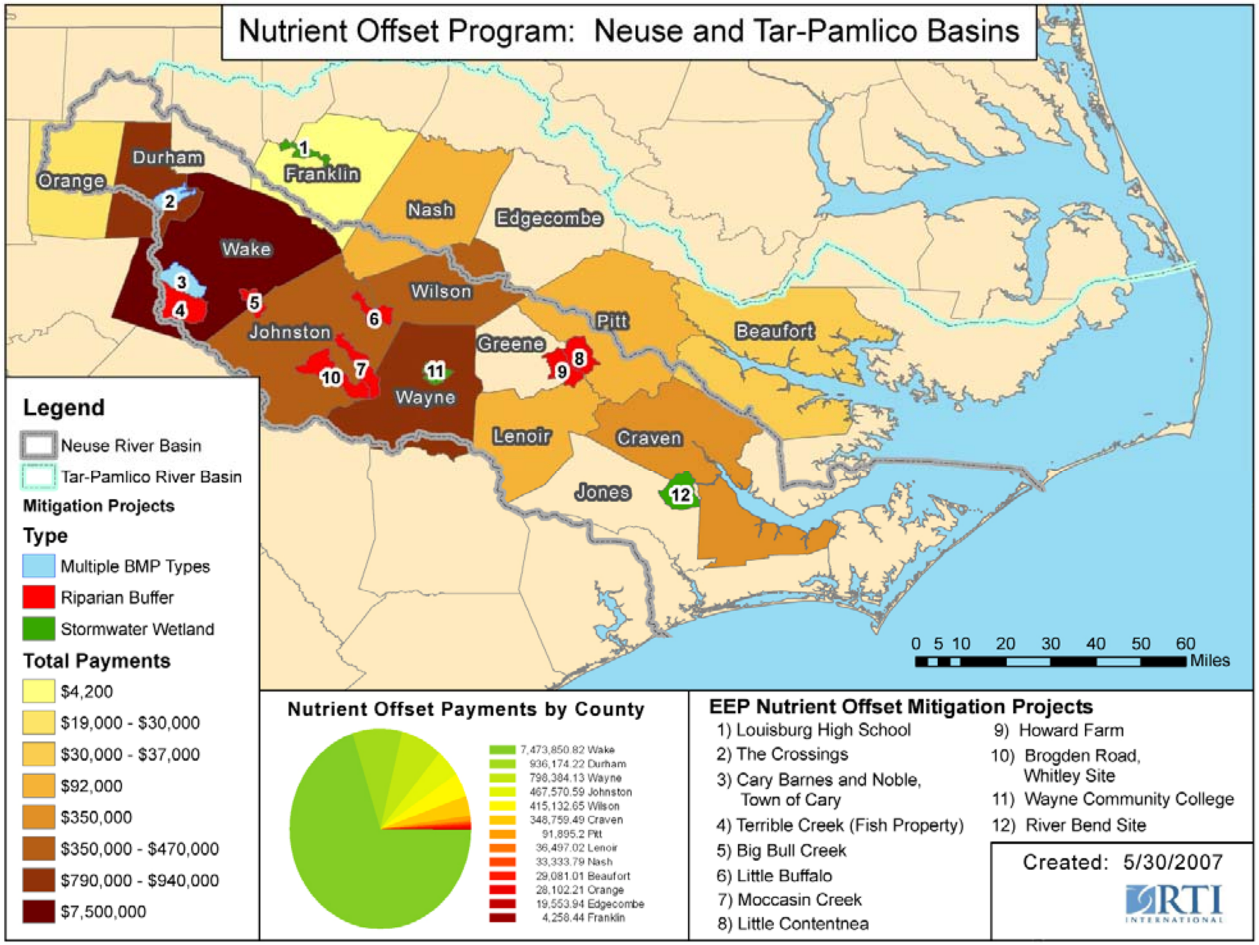
Presentation Outline

- Historical Background of Nutrient Offset Payment Program
- Discussion of 6 Project Objectives
- Financial Analysis Methods and Policy Scenarios
- RTI's Data Collection Efforts
- Findings are Recommendations for the Objectives
- Caveats and Future Research

Historical Background: The Nutrient Offset Payment Program

- Nutrient Offset Fee Payment Program (NOFPP): The NOFPP is administered by the Ecosystem Enhancement Program (EEP).
- Funds paid by excess dischargers are used to construct nutrient controls within the river basin that offset the excess nutrients they discharge.
- The majority of current NOFPP projects are riparian buffer restoration projects in the Neuse River Basin.

Historical Background: EEP Projects Pursued



RTI INTERNATIONAL

Historical Background: Proposed Amendments

- 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.

Project Objectives

- 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 calculating 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

Financial Analysis: Description

Because of the cost differences across different projects, RTI needed to forecast the **distribution** of project types to be used in each of these analyses:

- ***Scenario A: All Buffers.*** The EEP implements exclusively riparian buffers on land obtained through conservation easements and purchased land.

  Scenario B: Integrated Implementation. In addition to buffers, the EEP pursues a number of stormwater wetland offset projects to target integrated environmental objectives. This results in higher costs per pound of nitrogen and phosphorous.

- ***Scenario C: All Stormwater Wetland Retrofit.*** The EEP does not undertake any buffer projects and instead installs all stormwater wetland projects, which again enables offset projects to be implemented closer in proximity (e.g., in local watersheds) to where development is occurring, and again increasing the costs per pound of nitrogen and phosphorous.

Financial Analysis: Potential Policy Scenarios

Scenario/BMP	BMP Share	Land Cost	Design Cost	Construction Cost	Maintenance Cost
Scenario A: All Buffers					
Riparian buffers	100%	√	√	√	√
Scenario B: Integrated Implementation					
Riparian buffers	70%	√	√	√	√
Stormwater wetlands[a]	5%		√	√	
Stormwater wetlands	25%	√	√	√	√
Scenario C: All Stormwater Wetlands					
Stormwater wetlands[a]	5%		√	√	
Stormwater wetlands	95%	√	√	√	√

√ = EEP assumes full cost.

[a] Local municipalities donate land and assume maintenance costs.

Data Collection: Description

- Any nutrient offset fee chosen by policy makers will ultimately have to cover the costs of pursuing the various BMPs required to offset the nutrient emissions of nonpoint sources.
- Therefore, understanding and obtaining cost data for various BMP projects became the focus of RTI's data collection efforts.
- RTI interviewed 37 stakeholders. Of those interviewed, 8 provided detailed BMP cost information.

Data Collection:
Data Sources

BMP Type	Number of Projects	Data Sources
Riparian Buffers	8	Provided by private-sector firms that constructed riparian buffers for the EEP. These projects were primarily located in the Piedmont and inner Coastal Plain regions of the state.
Stormwater Wetlands	17	Provided by academics in North Carolina State University's Water Quality and Stormwater Engineering Groups and engineers working for the city of Charlotte's Storm Water Services. These projects were scattered across the state but were primarily located in the state's Piedmont and Coastal Plain regions.
Large Bioretention Areas	12	Provided by academics in North Carolina State University's Water Quality and Stormwater Engineering Groups as well as individuals working for the North Carolina Department of Transportation and the town of Garner. These projects were scattered across the state but were primarily located in the state's Piedmont and Coastal Plain regions.
Wetponds	9	Provided by academics in North Carolina State University's Water Quality and Stormwater Engineering Groups. These projects were scattered across the state but were primarily located in the state's Piedmont and Coastal Plain regions.

Data Collection: BMP Cost Components

- **Land** costs are incurred in obtaining access to or purchasing the land where the BMP will be placed.
- **Design costs** are fees associated with the designing and engineering the BMP. Design costs for a typical mitigation project are about 32% of construction costs
- **Construction** costs relate to the actual time, labor, capital, and materials used in designing and constructing the BMP; for example, the costs of constructing level spreaders on a riparian buffer.
- **Maintenance** costs are incurred in repairing, maintaining, and monitoring the BMP after it is constructed. For this analysis, we assumed a 30-year maintenance period, which corresponds to the offset fee formula.

Data Collection: BMP 30 year costs

Restoration Expenditures = Land costs +

Installation costs +

Maintenance costs

Restoration Expenditures = One time costs +

$\sum$ (annual costs)

Restoration Expenditures = Present Value (costs)

Data Collection: BMP Cost Data Summary

Mean Expenditures by BMP Cost Category ($/lb-N per 30 year)

BMP	Land Cost		Design Cost	Construction Cost	Present Value of 30-Year Maintenance Cost[a]	Total	
	Neuse	Tar-Pamlico				Neuse	Tar-Pamlico
Riparian buffers	$11.63[b]	$7.01	$1.95	$5.75	$2.04	$21.4	$16.8
Stormwater wetlands	$25.85[c]	$22.43	$14.38	$32.08	$9.68	$82.0	$78.6
Large bioretention areas	$71.18[c]	$61.77	$129.83	$329.69	$43.55	$574.3	$564.8
Wet Ponds	$43.94[c]	$38.13	$41.85	$130.79	$47.43	$264.0	$258.2

[a] Present value calculations use a discount rate of 5%.

[b] Based on average rural area land price. Prices are slightly higher in the Neuse compared with the Tar-Pamlico.

[c] Based on average low-density urban land price. Prices are slightly higher in the Neuse compared with the Tar-Pamlico.

Data Collection:
BMP Cost Data Summary (cont.)

Mean Expenditures by BMP Cost Category ($/0.10 lb-P per 30 year)

BMP	Land Cost		Design Cost	Construction Cost	Present Value of 30-Year Maintenance Cost[a]	Total	
	Neuse	Tar-Pamlico				Neuse	Tar-Pamlico
Riparian buffers	$18.06 [b]	$10.89	$3.03	$8.93	$3.17	$33.2	$26.0
Stormwater wetlands	$25.06 [c]	$21.75	$10.71	$20.98	$8.91	$65.7	$62.3
Large bioretention areas	$46.96 [c]	$40.75	$86.87	$221.30	$30.48	$385.6	$379.4
Wet Ponds	$23.29	$20.21	$28.12	$87.87	$26.08	$165.4	$162.3

[a] Present value calculations use a discount rate of 5%.

[b] Based on average rural area land price. Prices are slightly higher in the Neuse compared with the Tar-Pamlico.

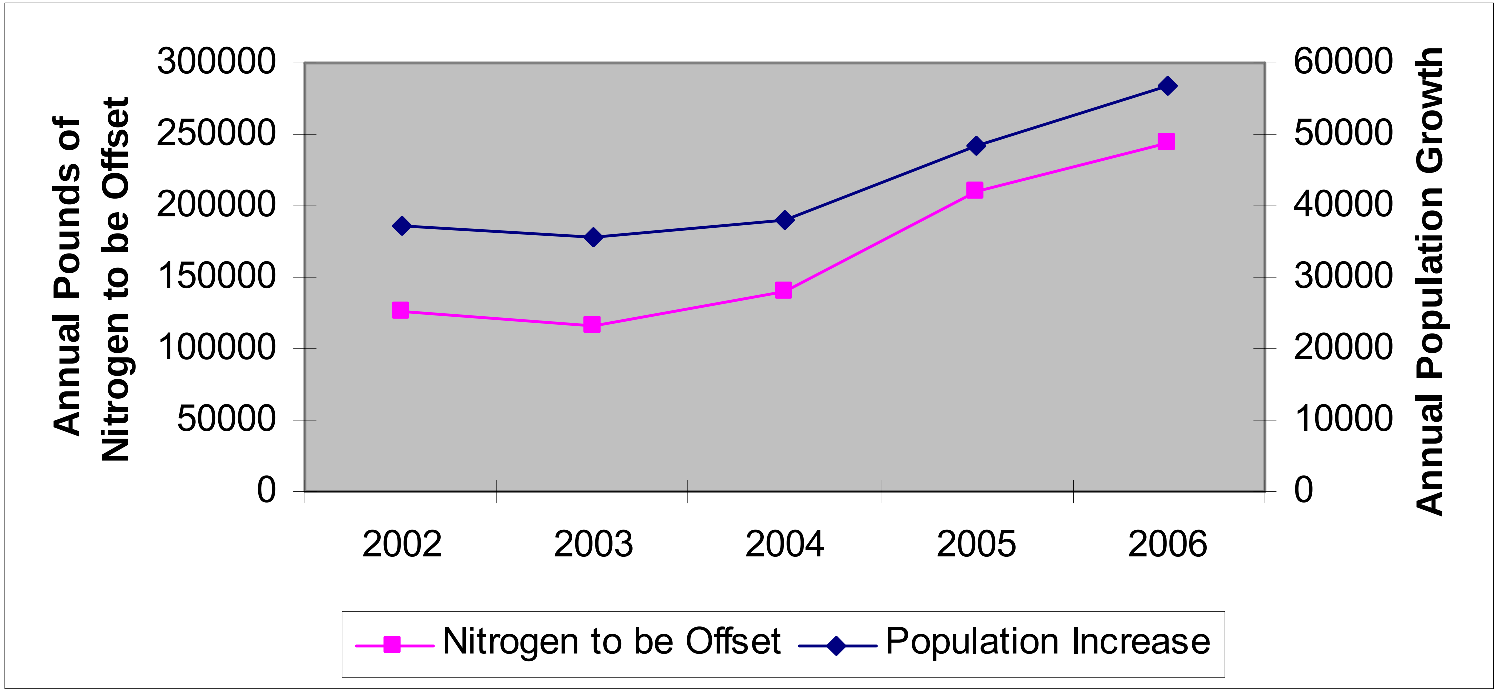
[c] Based on average

Data Collection: Additional Data Components

- In addition to the BMP cost data that RTI collected through stakeholder interviews, other data components were acquired to complete our financial analysis. These components included:
  - Forecasted demand for nutrient offsets
  - Amount of land available for riparian buffer projects
  - Estimated land costs in Neuse and Tar-Pamlico river basins ($/acre)
  - Estimate growth rates for land, design, construction, and maintenance costs

Data Collection: Forecasted Demand for Nutrient Offsets

Nutrient Offset Demand and Annual Population Growth in the Neuse River Basin: 2002–2006

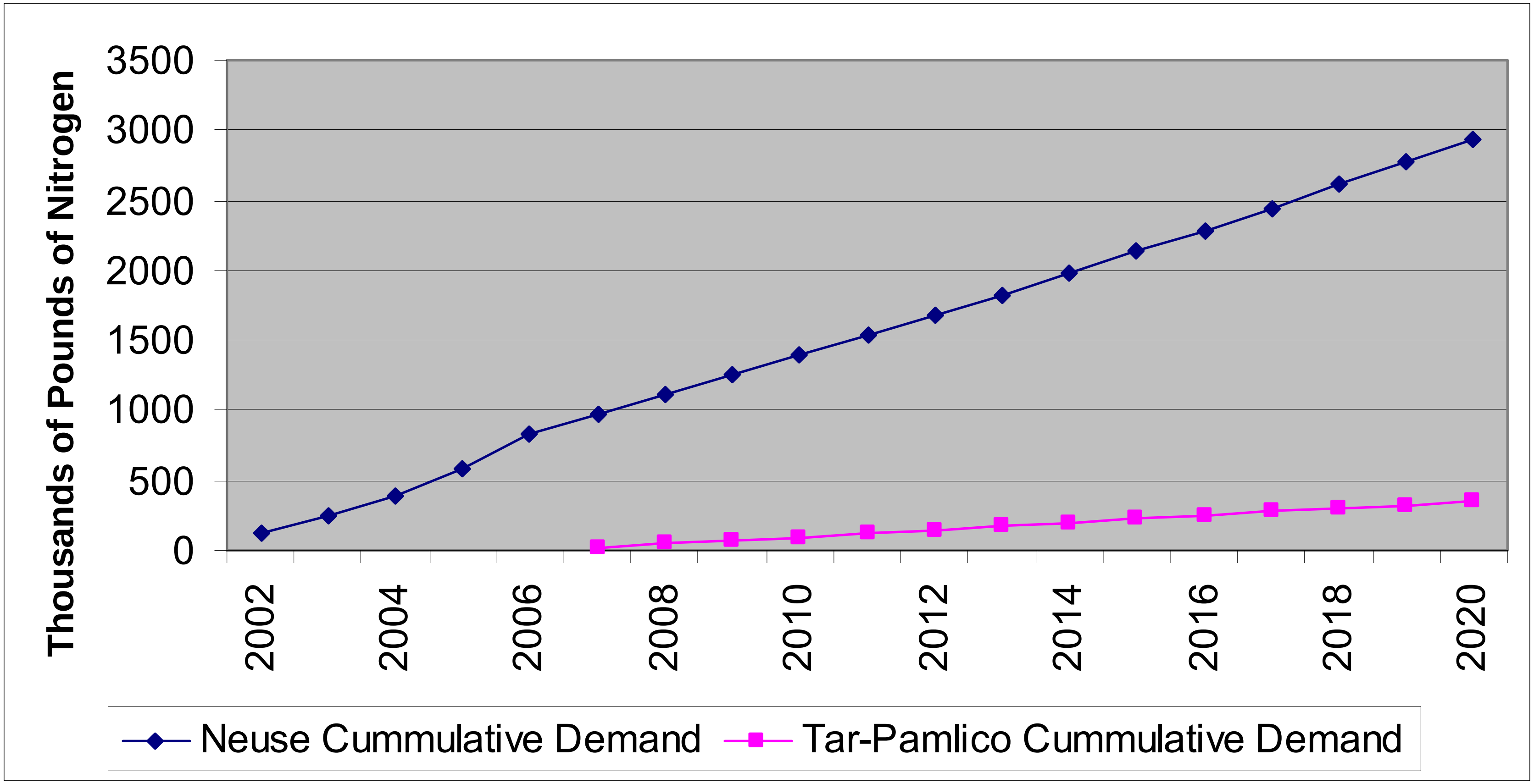


Between 2002 and 2006, every new person entering the Neuse River Basin was associated with an average of 3.9 new pounds of nitrogen needing to be offset.

RTI INTERNATIONAL

Data Collection: Forecasted Nutrient Offset Demand (cont.)

Forecast of Cumulative Nitrogen Offset Demand in Neuse and Tar-Pamlico River Basins to 2020.



RTI INTERNATIONAL

Data Collection: Land Available for Riparian Buffer Projects

Distribution of Land within 50-Foot Buffer, by River Basin

Description	Neuse Area	Tar-Pamlico Area
Open Water	10,973	8,757
Developed	5,040	2,980
Barren	552	683
Forest Cover	24,748	21,486
Grassland	8,384	8,147
Cultivated Crops	7,349	9,733
Woody Wetlands	39,459	33,667
Acres of Land	85,533	76,695
Total Acres (including Open Water)	96,507	85,452

Data Collection:
Riparian Buffer Analysis (cont.)

- By excluding forest, developed, wetland, and other types of land uses, RTI estimates that 18% of the land within the Neuse's 50-foot buffer is viable for potential riparian buffer projects.

Land Cover Description	**Neuse (Acres)**	**% of Total Land**	**Tar-Pam (Acres)**	**% of Total Land**
Developed Land	5,040	6%	2,980	4%
Forest, Wetland, and Other	64,760	76%	55,836	73%
Potential Land for Buffers	**15,734**	**18%**	**17,880**	**23%**
Total Land	85,533	100%	76,659	100%

Data Collection: Riparian Buffer Analysis (cont.)

	Neuse River Basin	Tar-Pamlico River Basin
Acres of land suitable for buffers	15,734	17,880
Acres required for EEP stream mitigation until 2020	266	5
Acres of agricultural land consumed by development	1,385	1,573
Acres of land potentially available for buffer	14,083	16,302
Buffer required by NOFPP	925	155
NOFPP percentage of available buffer land	7%	1%

- RTI predicts that 2.1 million pounds of nitrogen in the Neuse River Basin and 353,000 pounds of nitrogen in the Tar-Pamlico will need to be offset through the year 2020.
- If all of this nutrient loading was offset using riparian buffers, RTI predicts (using EEP's estimate that 1 acre of buffer offsets 2,273 pounds of nitrogen on average) that this would require 925 acres of riparian buffer to be restored in the Neuse River Basin and 155 acres to be restored in the Tar-Pamlico.

Data Collection: Estimated Land Costs

Land Category	Neuse River Basin Dollars per Acre	Tar-Pamlico River Basin Dollars per Acre
High-density urban	$200,311	$123,961
Low-density urban	$145,498	$126,264
Rural areas	$19,139	$8,646

- RTI downloaded recent tax parcel GIS data from 8 counties that made these data freely available for download from the Internet: Beaufort, Carteret, Craven, Dare, Edgecombe, Halifax, Johnston, and Wake counties.
- Tax parcel data were used because no databases exist for actual sales data. Experts thought this was an appropriate proxy for a combination of conservation easements and purchases that would be used to implement the program in the future.

Data Collection: Annual Growth in Cost Components

RTI identified historical price data for several commodities linked to each cost category and used linear regression analysis to forecast growth in each time series to the year 2020.

Cost Component	Secondary Data	Source	Estimated Growth Rate	
			Neuse	Tar-Pam
Rural Land	Assessed Value of Taxable Real Property by County	NCDOR	**3.6%**	**3.5%**
Urban Land	Assessed Value of Taxable Real Property by County	NCDOR	**3.9%**	**3.7%**
Design	Architectural, engineering and related services price index	USBLS	**2.1%**	**2.1%**
Construction	Construction machinery manufacturing price index	USBLS	**1.6%**	**1.6%**
Maintenance	Employment Cost Index: Compensation: Private Industry Workers	FRED	**2.4%**	**2.4%**

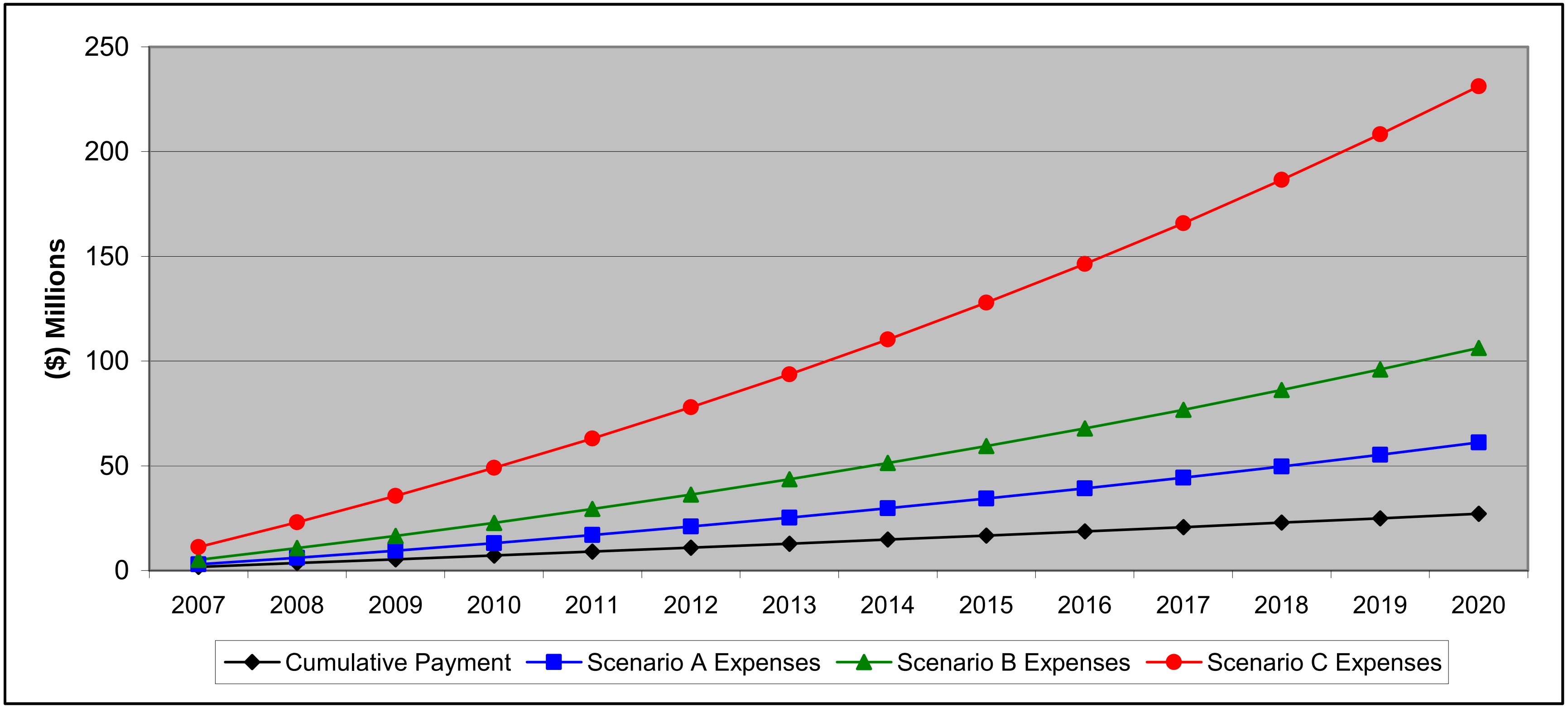
Objective 1:
NOFPP Sustainability at Current Fee of $11/lb

NOFPP Cumulative Expenses Exceed Cumulative Payments in Both River Basins.

Year	Cumulative Payments	Scenario A Expenses	Scenario B Expenses	Scenario C Expenses
2007	$1,748,308	$2,962,207	$5,198,938	$11,210,910
2008	$3,522,850	$6,124,101	$10,715,511	$23,086,927
2009	$5,324,034	$9,496,141	$16,565,661	$35,661,105
2010	$7,152,275	$13,089,298	$22,766,084	$48,968,055
2011	$9,007,995	$16,915,072	$29,334,262	$63,044,017
2012	$10,891,623	$20,985,523	$36,288,503	$77,926,941
2013	$12,803,594	$25,244,846	$43,600,064	$93,656,559
2014	$14,744,350	$29,701,951	$51,285,976	$110,274,477
2015	$16,714,341	$34,366,176	$59,364,067	$127,824,257
2016	$18,714,024	$39,247,309	$67,853,001	$146,351,510
2017	$20,743,861	$44,355,611	$76,772,311	$165,903,993
2018	$22,804,325	$49,701,838	$86,142,450	$186,531,709
2019	$24,895,893	$55,297,267	$95,984,826	$208,287,012
2020	$27,019,052	$61,153,722	$106,321,851	$231,224,720

Objective 1: NOFPP Sustainability (cont.)

The costs of BMP construction and maintenance will exceed revenues from both river basins into the forecasted future.

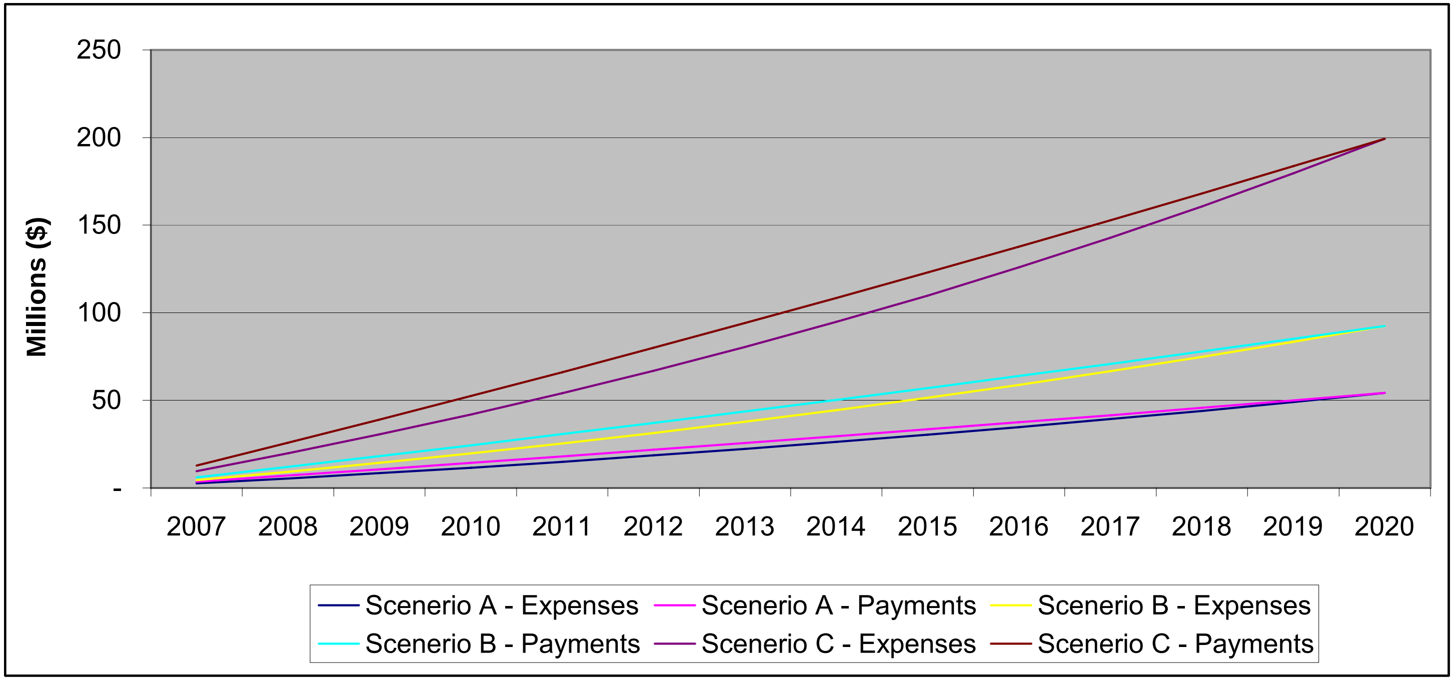


Objective 2:
Proposed Cost-Effective Fee

- RTI defines cost-effectiveness as the NOFPP being sustainable through the year 2020.
- Using the data previously discussed, RTI evaluated two types of fees against this criterion for each river basin.
  - A fixed-offset fee
  - A fee annually adjusted to conform with rising construction costs

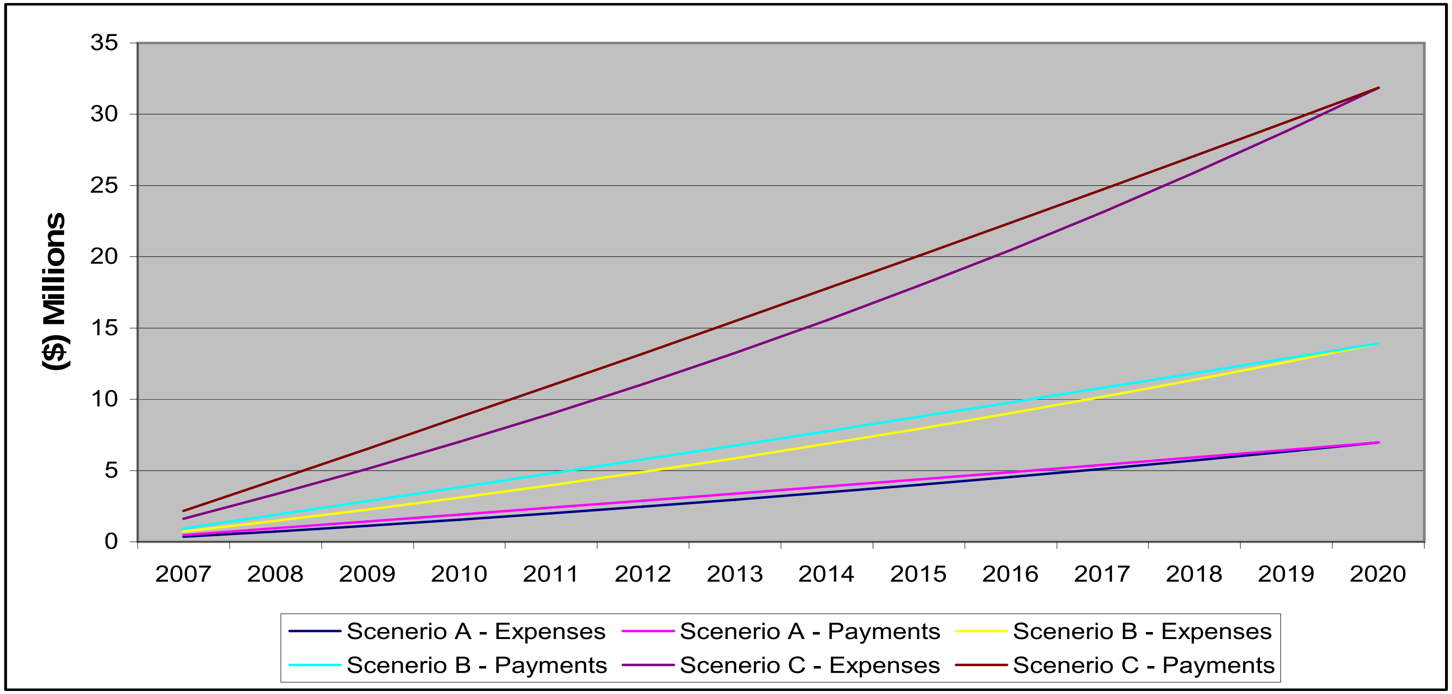
Objective 2: Cost-Effective Fixed Fee (Neuse)

	Cost-Effective Offset Fee ($/lb-30 N)	Cost-Effective Offset Fee ($/0.10 lb-30 P)
Scenario A	$25.77	$33.19
Scenario B	$43.94	$41.23
Scenario C	$94.80	$62.91



Objective 2: Cost-Effective Fixed Fee (Tar-Pam)

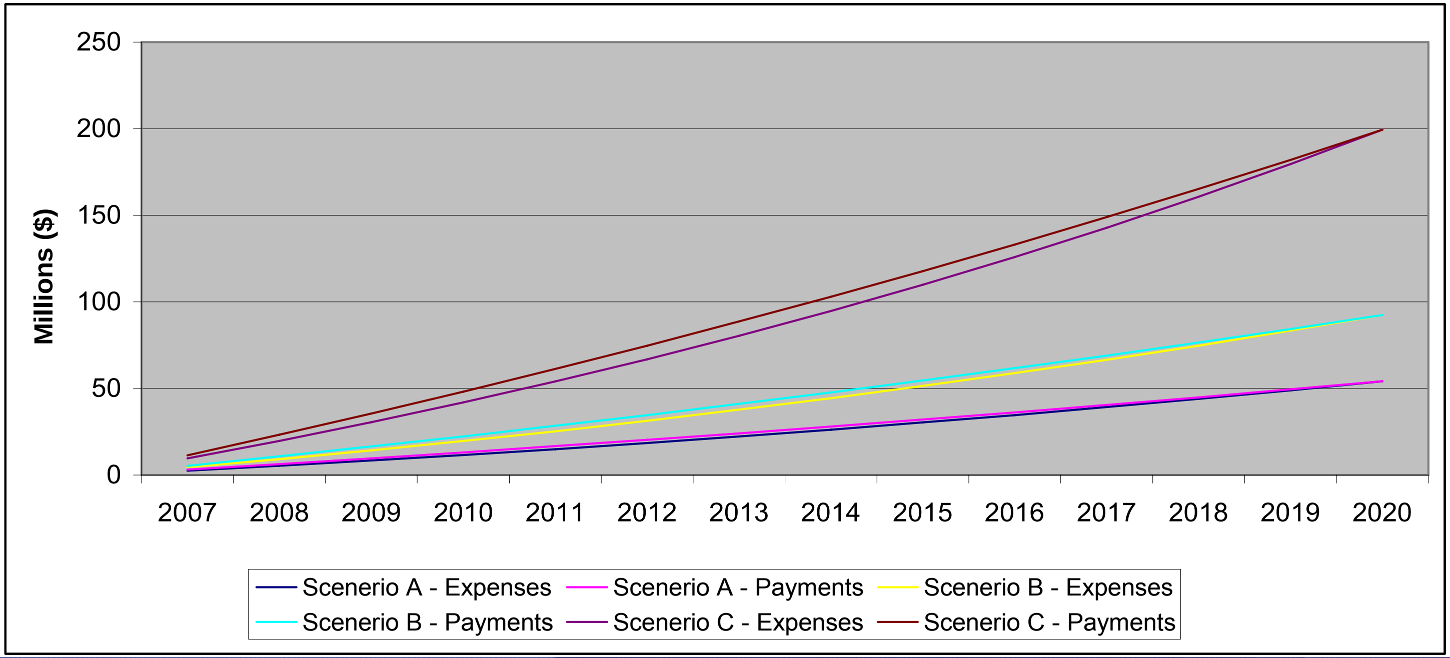
	Cost-Effective Offset Fee ($/lb-30 N)	Cost-Effective Offset Fee ($/0.10 lb-30 P)
Scenario A	$19.70	$26.02
Scenario B	$39.40	$35.38
Scenario C	$90.21	$59.77



RTI INTERNATIONAL

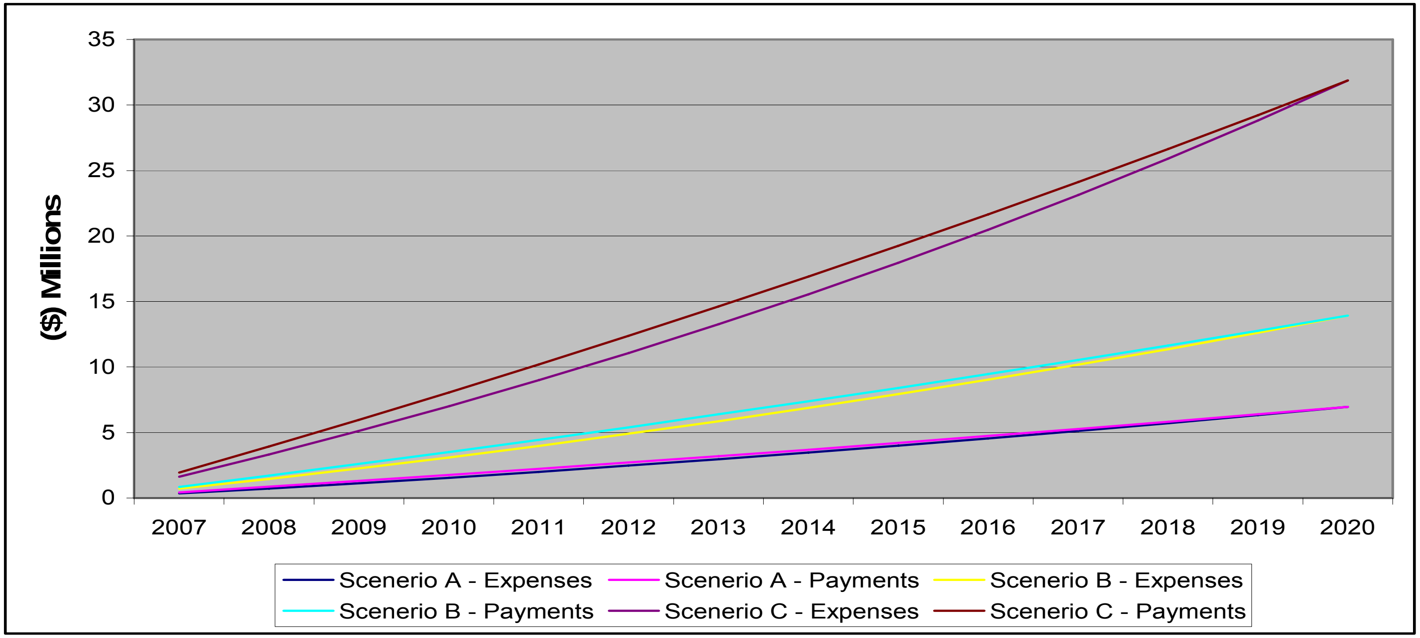
Objective 2: Cost-Effective Adjusted Fee (Neuse)

	2007 Cost-Effective Offset Fee ($/lb-N)	2020 Cost-Effective Offset Fee ($/lb-N)
Scenario A	$23.13	$28.36
Scenario B	$39.44	$48.35
Scenario C	$85.10	$104.32



Objective 2: Cost-Effective Adjusted Fee (Tar-Pam)

	2007 Cost-Effective Offset Fee ($/lb-N)	2020 Cost-Effective Offset Fee ($/lb-N)
Scenario A	$17.72	$21.72
Scenario B	$35.44	$43.45
Scenario C	$81.15	$99.48



Objective 3:
Formulas for calculating the offset payments

- **Formula for Scenario A:**

  <u>Neuse River Basin</u>
  Nitrogen Payment = ($25.77/lb N)(#of lbs/year)(30 years)(1.1 AdminCosts)
  Phosphorus Payment = ($33.19/0.10 lb P)(#of lbs/year)(30 years)(1.1 AdminCosts)

  <u>Tar-Pamlico River Basin</u>
  Nitrogen Payment = ($19.70/lb N)(#of lbs/year)(30 years)(1.1 AdminCosts)
  Phosphorus Payment = ($26.02/0.10 lb P)(#of lbs/year)(30 years)(1.1 AdminCosts)

- **Rationale:** The only factor that directly affects the estuaries is the number of pounds of nutrients needing to be offset. A simple formula incorporating the cost-effective $/lb for nitrogen and $/0.10 lb for phosphorus produces a revenue stream that would allow the EEP to meet its objective of protecting the estuary and be sustainable through 2020.

Objective 3: Proposed Formulas (cont.)

- **Formula for Scenario B:**

  Neuse River Basin
  Nitrogen Payment = [($25.77/lb N)(#of lbs/year)(30 years)*
  ((Land Cost $ per acre/19,000)^(0.64))*(1.1 AdminCosts)

  Phosphorus Payment = [($33.19/0.10 lb P)(#of 0.10 lbs/year)(30 years) *
  ((Land Cost $ per acre/19,000)^(0.31))*(1.1 AdminCosts)

  Tar-Pamlico River Basin
  Nitrogen Payment = [($19.70/lb N)(#of lbs/year)(30 years)*
  ((Land Cost $ per acre/9,000)^(0.58))*(1.1 AdminCosts)

  Phosphorus Payment = [($26.02/0.10 lb P)(#of 0.10 lbs/year)(30 years) *
  ((Land Cost $ per acre/9,000)^(0.31))*(1.1 AdminCosts)

- **Rationale**: Under this scenario, the intent is to provide sufficient funds so that mitigation projects can be placed close to the area of the development. This is accomplished by incorporating the land cost of the property being developed (in terms of dollars per acre) into the offset fee to generate sufficient funds to support flexibility when choosing mitigation options.

Objective 3: Proposed Formulas (cont.)

- **Formula for Scenario C:**

  Neuse River Basin
  Nitrogen Payment = ($94.80/lb N)(#of lbs/year)(30 years)(1.1 AdminCosts)
  Phosphorus Payment = ($62.91/0.10 lb P)(#of lbs/year)(30 years)(1.1 AdminCosts)

  Tar-Pamlico River Basin
  Nitrogen Payment = ($90.21/lb N)(#of lbs/year)(30 years)(1.1 AdminCosts)
  Phosphorus Payment = ($59.77/0.10 lb P)(#of lbs/year)(30 years)(1.1 AdminCosts)

- **Rationale:** Under this scenario, stormwater wetlands are always implemented. Thus, the location of the development (or the land cost per acre) has little impact on the cost of the BMPs. As a result, we recommend a simple formula specification similar to the one for Scenario A.

Objective 4: Expanding NOFPP

- Nutrient offset fees can distort regional development; however, these distortions are likely minor compared with economic and environmental consequences of excess nutrient loading.
- Environmental Question: For each river basin, are nutrients creating sufficient environmental damage that they need to be mitigated?
- A full benefit-cost analysis is beyond the scope of this study; thus, we focus on the existing literature and published studies to provide insights on this issue.

Objective 4: Expanding NOFPP (cont.)

- Other water bodies in North Carolina have historically experienced and continue to experience symptoms of human-induced eutrophication and could, therefore, be considered candidates for geographic extension of the nutrient offset program. These bodies include:
  - Chowan River Basin
  - Jordan and Falls Reservoirs
  - Catawba and Yadkin River Basins

Objective 5:
Evaluate Alternative NOFPP Structures

- The EEP currently operates the NOFFP either through a design-bid-build or a full-delivery process. However, a wide range of alternative structures could be developed to implement a nutrient offset trading system.
- As part of this task we specifically investigated the feasibility of providing nutrient offsets through a regulated trading market.

Objective 5: Alternative Structures (cont.)

- There are many instances where federal and state governments have established trading systems (while maintaining regulatory oversight and supervision) to mitigate pollutants or protect wetlands.

- Examples of such programs include:
  - Tar Pamlico Point Nonpoint Source Trading Program
  - Pennsylvania Nutrient Trading Program
  - U.S. Environmental Protection Agency's (EPA's) SO_2 Emission Allowance
  - Regional Clean Air Incentives Market (RECLAIM)

Objective 5: Alternative Structures (cont.)

Given proper regulatory oversight and supervision …

The Nutrient Offset Program seems well suited for market trading.

Using a private-sector mitigation bank is a proven method for implementing market-based systems.

Private entities in the state have the capabilities to implement such a program.

We were not able to conduct a quantitative analysis, but there is no reason to expect there would be a degradation in cost-effectiveness or timeliness with a market-based system.

Objective 5: Advantages and Disadvantages of a Market-Based Nutrient Trading System

- Advantages
  - supply and demand intersect (i.e., they are in the same cost range)
  - would produce lowest cost
  - would capture changes in cost over time

- Disadvantages
  - more difficult to control placement of mitigation options
  - market may be too thin for regional/county-level markets
  - would not address integrated environmental or equity objectives

Objective 6:
Review of Other Potential Mitigation Efforts

- The Center for Watershed Protection compiled and analyzed national cost data for a variety of structural stormwater retrofit practices, including wet ponds, wetlands, bioretention areas, filtering practices, infiltration practices, and swales.
- This effort produced national average construction costs for a wide range of mitigation practices that were not available for projects based in North Carolina. Additional mitigation projects identified include sand filters, underground sand filters, infiltration practices, and water quality swales.

Objective 6: Review of Other Mitigation Efforts (cont.)

Stormwater Retrofit Practice	Median Cost ($/lb-30 N)[a]	Range ($/lb-30 N)[a]	Median Cost ($/0.10 lb-30 P)[b]	Range ($/0.10lb-30 P)[b]
Wet ponds	$177	$88 to $317	$93	$47 to $168
Wetlands	$110	$55 to $198	$107	$53 to $192
Large bioretention areas	$265	$188 to $433	$174	$125 to $286
Small bioretention areas	$755	$628 to $1,007	$498	$415 to $664
Sand filters	$503	$403 to $553	$332	$266 to $365
Underground sand filters	$1,637	$705 to $1,887	$1,079	$465 to $1,245
Infiltration practices	$240	$160 to $368	—[c]	—[c]
Water quality swales	$550	$308 to $968	$466	$262 to $822

[a] Cost per pound of nitrogen removed per year, in 2006 dollars.

[b] Cost per pound of phosphorus removed per year, in 2006 dollars.

[c] Not computable; pollutant removal benefits not defined within NCDENR, 2005a

Caveats and Future Research

- It was not the purpose of this project to recommend which of the three scenarios (or alternative possible scenarios) the EEP should pursue. That is a public policy decision that requires a more extensive environmental and economic benefit-cost analysis. However, our findings should serve as valuable inputs into the decision-making process.
- As part of this study's analysis, we encountered several issues that may warrant further research. These relate to
  - pollutant removal efficiencies and
  - event-mean-concentrations (EMCs) and land use loading rates.
  - These factors are used in calculating the offsets required of developers and the nutrients mitigated by the EEP.

Summary

- Please send comments to:
  - Michael Gallaher (mpg@rti.org), or
  - Dallas Wood (dwood@rti.org).