Environmental Quality

PAT MCCRORY
Governor

DONALD R. VAN DER VAART
Secretary

MEMORANDUM

TO: ENVIRONMENTAL REVIEW COMMISSION
The Honorable Jimmy Dixon, Co-Chairman
The Honorable Chuck McGrady, Co-Chairman
The Honorable Trudy Wade, Co-Chairman

FROM: Mollie Young, Director of Legislative Affairs, NCDEQ

SUBJECT: Stormwater Practices for TMDL Compliance Report

Pursuant to S.L. 2016-94, section 14.13(i), *"Stormwater treatment practices that have been approved by the Chesapeake Bay Commission for TMDL compliance in the Chesapeake Bay watershed shall be allowed for TMDL compliance in the Jordan Lake and Falls Lake watersheds at the same pollutant removal efficiency value established for each such practice for the Chesapeake Bay watershed. The Department shall report no later than December 1, 2016, to the Environmental Review Commission, the Joint Legislative Oversight Committee on Agriculture and Natural and Economic Resources, and the Fiscal Research Division on the need and desirability of establishing State-specific pollutant removal efficiency values for the stormwater treatment practices allowed by this subsection. If the Department decides to establish State-specific values, it shall incorporate those values into the Nutrient Strategies readoption required by subsection (d) of this section."*

If you have any questions or need additional information, please contact me by phone at (919) 339-9433 or via e-mail at mollie.young@ncdenr.gov.

Cc: Don Van der Vaart, Secretary, NCDEQ
Tom Reeder, Assistant Secretary for Environment, NCDEQ
Tracy Davis, Director of Energy, Mineral, and Land Resources, NCDEQ
Lanier McRee, Fiscal Research Division, NCGA

Report on Stormwater Practices for TMDL Compliance in the Jordan and Falls Lake Watersheds

To fulfill the requirements of Session Law 2016-94, Section 14.13

SECTION 14.13.(i) *Stormwater treatment practices that have been approved by the Chesapeake Bay Commission for TMDL compliance in the Chesapeake Bay watershed shall be allowed for TMDL compliance in the Jordan Lake and Falls Lake watersheds at the same pollutant removal efficiency value established for each such practice for the Chesapeake Bay watershed. The Department shall report no later than December 1, 2016, to the Environmental Review Commission, the Joint Legislative Oversight Committee on Agriculture and Natural and Economic Resources, and the Fiscal Research Division on the need and desirability of establishing State-specific pollutant removal efficiency values for the stormwater treatment practices allowed by this subsection. If the Department decides to establish State-specific values, it shall incorporate those values into the Nutrient Strategies readoption required by subsection (d) of this section.*

December 1, 2016

Prepared by:
North Carolina Division of Energy, Mineral, and Land Resources
Stormwater Permitting Program

Executive Summary

This report covers the following topics:

The key points of this report are:

#1: We already have a state-specific method for crediting the benefits of Stormwater Control Measures (SCMs) that has been developed in cooperation with local stakeholders and researchers. *(Please note that in NC, we use the term "Stormwater Control Measures," or "SCMs," and we will use that terminology in this report.)*

Compared with the Chesapeake Bay stormwater crediting method, the NC methodology for crediting SCMs is simpler and more accurate. For example, research in NC indicates that the type of soil in which SCMs are installed has a crucial impact to their effectiveness and our methodology gives strong weight to soil type, which is not considered in the Chesapeake Bay crediting method. Also, the NC methodology is based on research of SCMs that are designed in accordance with NC standards. NC SCM design standards were developed in cooperation with highly respected researchers at NCSU as well as numerous stakeholders from the development community, local governments and environmental groups.

#2: It is not practical to apply Chesapeake Bay credits to our state because we deal in different "currencies."

The hurdle that is nearly impossible to scale in transferring Chesapeake Bay SCM credits to NC is that we deal in different currencies. The Chesapeake Bay method distills information about SCM type and size to a single "percent reduction;" whereas, in NC, we calculate annual loads of nutrients leaving developing sites. The nutrient load in pounds/acre/year is what EPA requires in reporting progress toward the TMDL. NCDEQ's Nutrient Accounting Tool makes these calculations simple for the user.

#3: NCDEQ welcomes input on our crediting methods from all stakeholders and will readjust credits if research shows that our credits are not accurate.

NCDEQ is open to any member of the public who wishes to provide data showing that our SCM credits should be updated. We public noticed the NCDEQ SCM Credit Document, which is available on NCDEQ's Stormwater Design Manual web page, from September 30 until October 30, 2016. Staff have made numerous presentations on our SCM crediting practices to professional groups and at workshops. Even though we are currently outside of the public notice period, NCDEQ is happy to consider comments and make updates to this document as the science indicates it is needed.

NC and Chesapeake Bay offer the same stormwater treatment options

Session Law 2016-94 requires that stormwater treatment practices that have been approved by the Chesapeake Bay Commission for TMDL compliance in the Chesapeake Bay watershed shall be allowed for TMDL compliance in the Jordan Lake and Falls Lake watersheds.

In our research, NCDEQ staff have discovered that the Chesapeake Bay Commission is a tristate legislative assembly representing Maryland, Virginia and Pennsylvania. It consists of 21 members who are responsible for identifying the needs of the Bay, listening to constituents and determining actions for better stewardship of the Bay. Its membership consists of 15 legislators, the governors of each state (represented by cabinet members who are directly responsible for managing their states' natural resources) and three citizens. ***While it is an important assembly, the Chesapeake Bay Commission does not approve stormwater treatment practices.***


Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards

Stewart Comstock, Scott Crafton, Randy Greer, Peter Hill, Dave Hirschman, Shoreh Karimpour, Ken Murin, Jennifer Orr, Fred Rose, Sherry Wilkins

Accepted by Urban Stormwater Work Group: **April 30, 2012**
Revised based on Watershed Technical Work Group feedback: **May 29, 2012**
Resubmitted to Watershed Technical Work Group: **July 13, 2012**
Conditionally Approved by Watershed Technical Work Group: **August 1, 2012**
Conditionally Approved by Water Quality Goal Implementation Team: **August 13, 2012**
Errata Correction Approved by USWG: **September 14, 2012**
Resubmitted to WQGIT **September 28, 2012**
Final Approval by WQGIT: **October 9, 2012**
Revised: **January 20, 2015**

Prepared by:
Tom Schueler and Cecilia Lane
Chesapeake Stormwater Network

To meet the presumptive intent of the session law, which we believe is to bring Chesapeake Bay stormwater treatment options and credits to our state, NCDEQ staff referenced the most recent report of the Chesapeake Stormwater Network as the yardstick by which to compare their stormwater options with ours. This report entitled, "Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards," was last updated in January 2015.

The Chesapeake Stormwater Network consulted with an expert panel of engineers and scientists from local and state governments in the Chesapeake Bay region in writing its recommendations. This panel reviewed the available science on the pollutant removal performance and runoff reduction capability of stormwater treatment practices. Each of the six Chesapeake Bay states and Washington, D.C base their state programs on these recommendations to the extent that it is practical within their own boundaries.

Table 1 shows that while it may appear that the Chesapeake Bay states have many more options for treating stormwater that we do in our state, they actually have different and more names for the same stormwater treatment practices that we allow in North Carolina. For example, NCDEQ allows infiltration systems to be any shape and size as long as the stormwater they receive infiltrates in 72 hours or less. We do not separately name them as infiltration basins, infiltration beds, infiltration trenches, dry well/seepage pits and landscape infiltration.

Table 1: Comparison of SCM Terms Between NC and the Chesapeake Bay Area

NC stormwater terms……..	Chesapeake Bay terms for the same practice
Bioretention cell……	bioretention, rain garden and bioswale
Infiltration system……	infiltration basin, infiltration bed, infiltration trench, dry well/seepage pit and landscape infiltration
Permeable pavement……	permeable pavement and porous pavement
Wet pond……	wet pond and retention basin
Stormwater wetland……..	constructed wetland
Sand filter……	constructed filter, sand filter and stormwater filtering system
Rainwater harvesting……	rainwater harvesting and capture and reuse
Green roof……	green roof
Level spreader-filter strip……	sheetflow to filter/open space, sheetflow to conservation area and vegetated filter strip
Disconnected Impervious Surface…...	rooftop disconnection and simple disconnection to amended soils
Pollutant removal swale……..	dry swale
Dry pond……	dry pond

NCDEQ currently does not have minimum design criteria and institutionalized credits for the Regenerative Stormwater Conveyances and Tree Pits (which are both covered in the Chesapeake Bay recommendations), but they are in development and will be completed by June 2017. Until the design criteria and credits for Regenerative Stormwater Conveyances and Tree Pits are approved next summer, anyone wishing to use these practices may present a design plan and proposed amounts of credit to NCDEQ for approval.

NC Credits for Stormwater Control Measures

NCDEQ has worked with a wide array of stakeholders to develop state-specific nutrient credits for SCMs. We believe that NC credits are more defensible and more desirable for our state than the Chesapeake Bay credits because:

1. We have an accurate, simple, automated tool that accounts for the nutrient removal of each SCM on a site specific basis. This tool also gives users the ability to enter and use custom SCMs.
2. We base our credits on the effluent concentrations from SCMs, which award higher credit for treatment of higher density developments, while the more simplistic Chesapeake Bay fixed percentage removal efficiencies approach does not.
3. Our credits are based on continually refined state-specific research and account for the soil type in which the SCM is installed. NCDEQ's credits are explained in the SCM Credit Document.
4. Our credits provide flexibility to under and oversize SCMs and receive appropriate credit, while the Chesapeake Bay does not consider sizing of SCMs.

1. The Tool

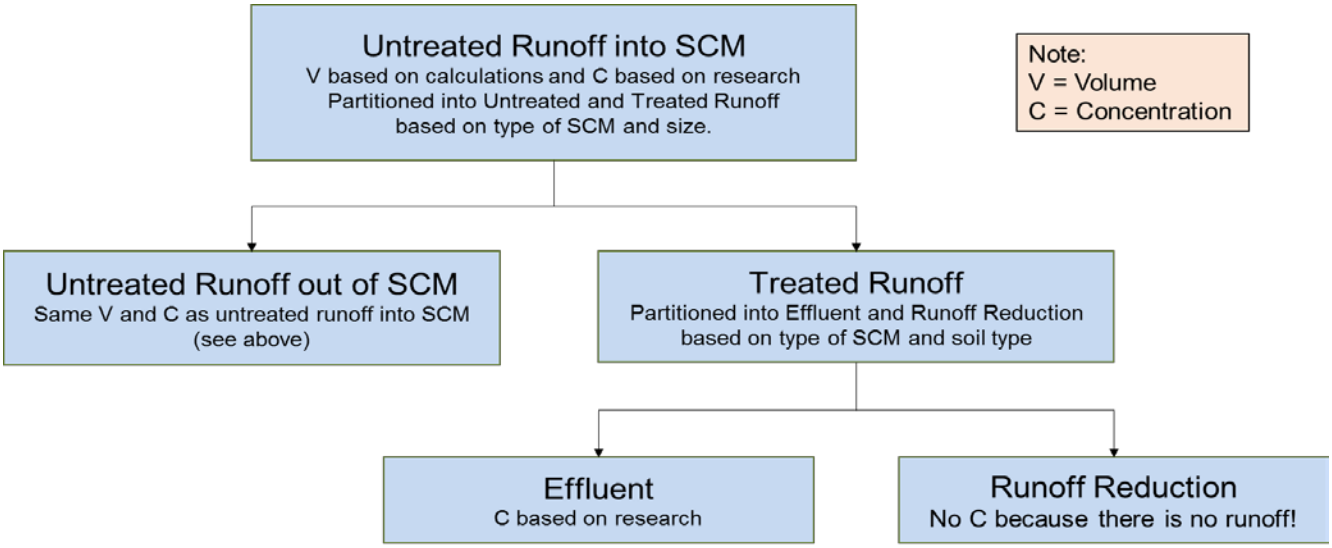
Nutrient credits for SCMs are programmed into the Jordan-Falls Stormwater Nutrient Accounting Tool ("the Tool"), which is available on NCDEQ's Nutrient Crediting and Practices web site. The Tool guides the user through a simple process of entering the drainage area land uses before and after development as well as the types, sizes and drainage areas of the SCMs. Based on the information provided by the user, the tool calculates the nutrient load in pounds/acre/year before development, after development without SCMs, and after development with SCMs. The Tool may also be used to calculate the benefits of adding SCMs to existing developments.

Figure 1: Cover Page of the Jordan-Falls Stormwater Nutrient Accounting Tool

2. The Fixed Effluent Concentration Approach

The fixed effluent concentration approach is based on the estimation that an SCM's effluent has the same nutrient concentration regardless of the concentration of nutrients in the stormwater that flows into it. Research in our state has shown that this is a far more accurate way to assess the performance of SCMs than percent removal. The Tool has never used simple percent removal rates for SCMs since it was first approved by the Environmental Management Commission in 2011. "Runoff reduction" means total annual runoff volume that is eliminated by infiltration, interception or uptake by plants or rainfall harvesting. "Effluent" means water that is treated and discharged to pipes, swales or waters.

Figure 2: How the Tool Estimates Volumes and Concentrations of Nutrients



The Fixed Effluent Concentration Approach is simple to explain mathematically:

$$\text{Nutrient Load} = [\, V_{untreated} * C_{untreated} + V_{effluent} * C_{effluent} \,] * \text{Conversion Factor}$$

Where:

$V_{untreated}$	=	Annual volume of untreated runoff
$C_{untreated}$	=	Concentration of untreated runoff
$V_{effluent}$	=	Annual volume of effluent
$C_{effluent}$	=	Concentration of nutrients in effluent

*The conversion factor converts (ft^3*mg/year*L) to (pounds/year.*

3. The SCM Credit Document

In cooperation with university researchers and stakeholders, NCDEQ created the SCM Credit Document, which is available on NCDEQ's Stormwater Design Manual web page. The purpose of the SCM Credit Document is to improve the clarity and consistency of the credits awarded for SCMs throughout North Carolina. In the past, credits for SCMs have been listed in each individual chapter of the Stormwater Design Manual. Going forward, NCDEQ is listing SCM credits together in this separate document to facilitate updates as new research becomes available and to facilitate comparisons between different SCMs for the regulated community.

The SCM Credit Document supports all of the stormwater programs throughout the state. The NPDES, Coastal Counties, ORW, HWQ and Water Supply Watershed programs are based on removing an acceptable level of Total Suspended Solids (TSS). The choice of TSS reflects its importance as the number one pollutant in our state as well as a surrogate for removal of other pollutants, like phosphorus and heavy metals. The NSW program is based on achieving low nutrient loadings throughout an entire development site for new development and achieving reductions on existing development as well. All of the stormwater programs allow and encourage runoff volume match (sometimes called "Low Impact Development") as a voluntary alternative to the above goals.

NCDEQ public noticed the draft SCM Credit Document from September 30 until October 30, 2016. We received a number of comments in support of our approach and a handful of suggestions for improvement. The document will be finalized by December 1, 2017.

The centerpiece of the SCM Credit Document is the SCM Credit Table, which contains a row for each type of SCM that is approved for use in NC (15 separate SCMs, and a number allow design variations as well). To illustrate NC SCM crediting, Table 2 shows one row of the table for an SCM known as Disconnected Impervious Surface (DIS). DIS is the practice of directing stormwater from built-upon areas like pavement and roofs to properly sized, sloped and vegetated receiving areas. Each column of Table 2 is explained below.

Figure 3: DIS – A Simple and Cost-Effective SCM

Table 2: SCM Credit Table – Just the Row for DIS

SCM	Role	% Annual Runoff Treated if 100% Sized	% of Treated Runoff to Each Fate			$EMC_{effluent}$ (mg/L)	
			HSG	Runoff Reduction	Effluent	TN	TP
DIS per MDC	Secondary	90	A	65	35	2.44	0.76
			B	50	50		
			C	40	60		
			D	30	70		

Each of the SCMs has a similar row in the SCM Credit Table to indicate how it will be credited by NCDEQ.

- *The **"Role" column** indicates if the SCM is primary or secondary. "Primary SCMs" are more effective at TSS removal and are allowed to stand alone in a drainage area. "Secondary SCMs" are less effective at TSS removal and are usually used with other SCMs.*
- *The **"% Annual Runoff Treated if 100% Sized" column** indicates how much of the total annual runoff is treated by the SCM. This value varies based on the length of time the stormwater stays in the SCM for treatment; the longer the treatment time, the lower this value will be. The values in this column range from 84 to 91 depending on the SCM.*
- *The **'% of Treated Runoff to Each Fate" column** indicates what happens to the water that is treated by the SCM. "Runoff Reduction" means stormwater that is completely removed from the system. "Notice how the % of runoff reduction increases as soil types go from D (clay) to A (sand). This is due to the sandy soil's great effectiveness in infiltrating stormwater.*
- *The **"$EMC_{effluent}$" column** indicates the concentration of nutrients (Total Nitrogen and Total Phosphorus) that would be expected in the effluent. Research at NCSU has shown that this is a much more accurate way to characterize the function of SCMs for nutrient control than percent removal rates (as are used in the Chesapeake Bay area).*

4. Under and Oversized SCMs

After the credit for an SCM has been determined, factors for under or oversizing may be applied if applicable. DIS are not allowed to be undersized due to the risk of erosion, but many other SCMs, like wet ponds and bioretention cells, may be undersized. The Minimum Design Criteria for DIS require that the vegetated receiving area be equivalent to 0.04 times the area draining to it; designers who wish to make the vegetated receiving area larger receive a higher credit for runoff reduction. Figure 4 below shows how this is done for DIS based on soil type (A, B, C or D).

Figure 5 shows how percent sizing interfaces with percent of annual runoff treated for a number of other SCMs, including infiltration systems, wet ponds and stormwater wetlands.

Figure 4: Percent Runoff Reduction for DIS Based on Vegetated Receiving Area Size

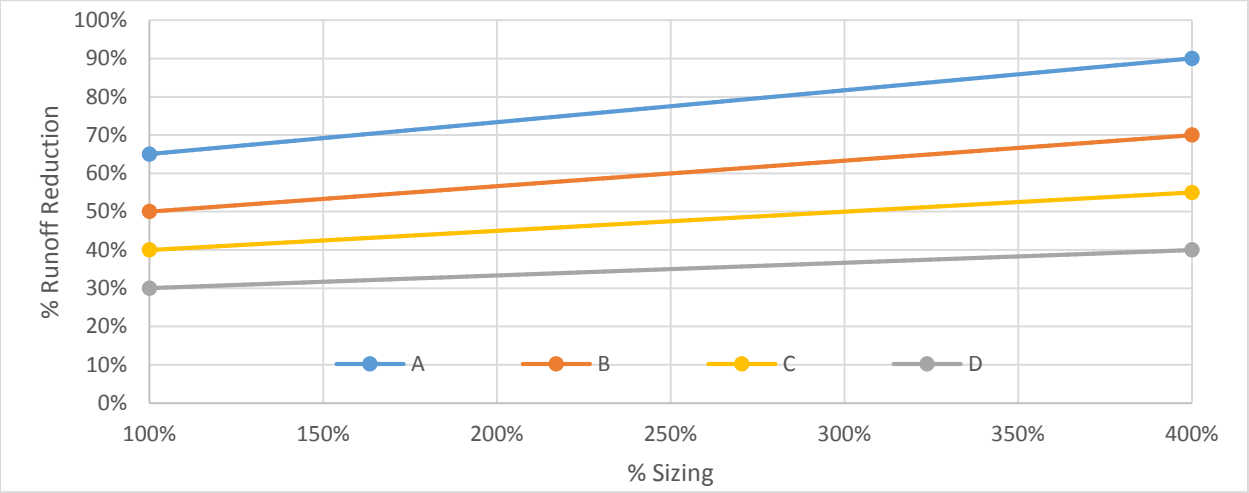
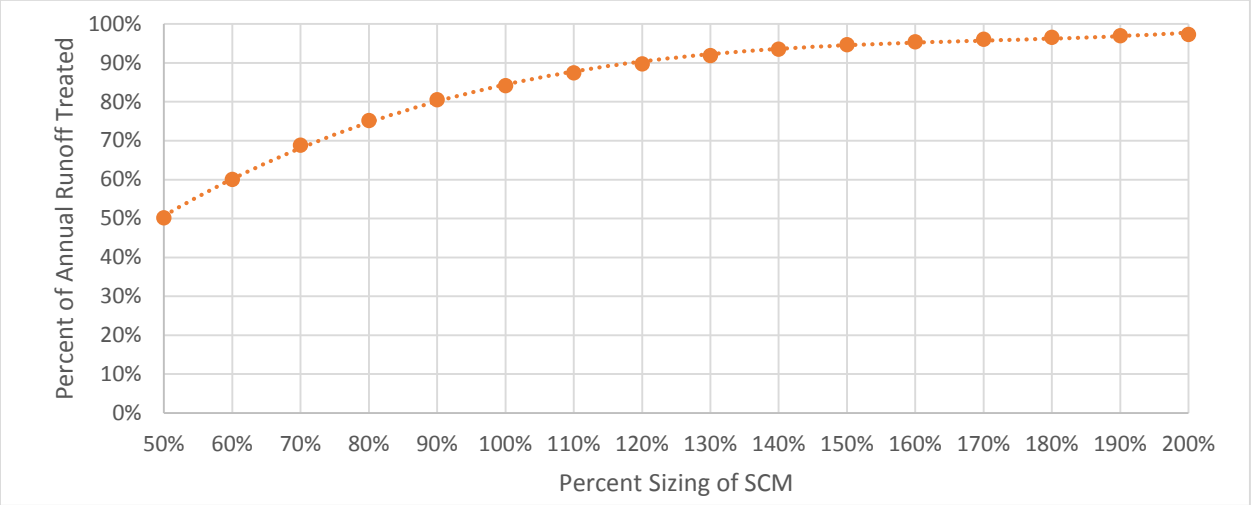


Figure 5: Sizing versus Runoff Treated for Infiltration, Wet Ponds, and Stormwater Wetlands



All of the above data is already programmed into the Tool for easy use. Designers also have the option of entering a "custom SCM," where they enter the type of SCM and the total amount of annual runoff treated, % Effluent and % Runoff Reduction." In addition, designers are also welcome to provide their own calculations based on the SCM Credit Document or other scientific research for the SCMs they design. The Tool is incorporated into the Jordan New Development Rules (currently suspended for local governments) and the Falls New Development Model Program (this is a model approved by the EMC but LGs can propose other methods in their programs).

Current Chesapeake Bay Credits for Stormwater Control Measures

The SCM credits in the Chesapeake Bay recommendations are fundamentally problematic to apply in NC because:

1. They simplify all SCMs into just two categories: runoff reduction or stormwater treatment. The NC approach, as explained above, is much more accurate. In addition, the Chesapeake Bay crediting approach does not account for soil type, a very important factor in runoff reduction.
2. The credits for the Chesapeake Bay vary from state to state.

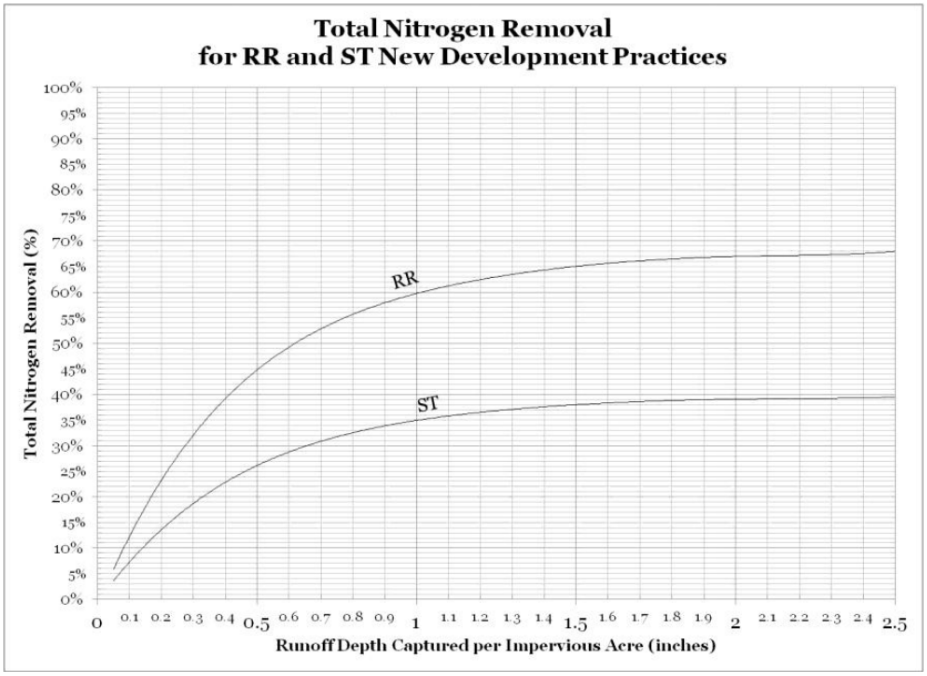
1. Oversimplification of SCM Performance Estimates

The Chesapeake Stormwater Network's report entitled, "Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards," categorizes the SCMs broadly as either stormwater treatment practices (ST) or runoff reduction practices (RR). SCMs that achieve at least a 25% reduction of the annual runoff volume are classified as RR, and earn a higher net removal rate. Wet ponds, wetlands and sand filters that have less runoff reduction are classified as ST (Table 3). The pollutant removal rate must be determined using the stormwater treatment curve (Figure 6) to determine the percent removal of Total Nitrogen associated with the SCM (there is a separate curve for Total Phosphorus that is not included in this report for the sake of brevity.) This is in contrast to NCDEQ's Tool, which performs a precise calculation of how much of the runoff is treated as Effluent versus Runoff Reduction based on type of SCM and the soil in which it is installed.

Table 3: Chesapeake Bay SCMs: Stormwater Treatment or Runoff Reduction?

Runoff Reduction	Stormwater Treatment
Bioretention/Rain Garden Riparian Buffer Restoration Rooftop Disconnection Sheetflow to Filter Strip Regenerative Stormwater Conveyance Dry Swale Expanded Tree Pits Grass Channels Green Roof Bioswale Infiltration Permeable Pavement Rainwater Harvesting	Constructed Wetlands Filtering Practices Wet Ponds Wet Swale

Figure 6: SCM Removal Rate Adjustor Curves for Total Nitrogen



2. Variation from State to State in the Chesapeake Bay

The Chesapeake Bay watershed spans more than **64,000 square miles**. It encompasses parts of six states—Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia—and the entire District of Columbia. Almost 18 million people live in the Chesapeake Bay watershed. NC spans more than **53,000 square miles** and has a population of almost 10 million people.

The Chesapeake Bay states have not uniformly adopted all of the recommendations of the Chesapeake Stormwater Network's report entitled, "Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards. In addition, each state has different minimum design criteria for SCMs so it is very difficult to draw a clear line between design and performance.

Comparison of Credits: NCDEQ versus Chesapeake Bay

It is not possible to say that the NCDEQ method is always more or less generous than the Chesapeake Bay recommendations. For some types, sizes and soil types, NCDEQ provides more generous estimations of performance than the Chesapeake Bay recommendations. For others, the Chesapeake Bay recommendations are more generous. NCDEQ's fixed effluent concentration method awards progressively greater reductions the higher the percent built-upon area of the site.

Below are some examples of how the crediting methods compare:

Example 1: Infiltration systems and permeable pavement systems that infiltrate stormwater are credited with an 84% annual runoff reduction by NCDEQ if they are designed to manage the runoff from the one-inch storm (this will correspond to an 84% removal of nutrients as well). This is in contrast to only a 60% credit in the Chesapeake Bay recommendations.

Example 2: For constructed wetlands, NCDEQ's credits are usually higher than the Chesapeake Bay's credits. Based on studies in our state, NCSU researchers have found that even though wetlands often do not infiltrate a lot of stormwater, the wetland plants bring about a significant amount of evapotranspiration; often more than the 35% total nitrogen removal rate per the Chesapeake Bay recommendations.

Example 3: In the Chesapeake Bay recommendations, rooftop disconnection is considered to be a runoff reduction SCM and therefore is awarded 60% credit for TN removal. In contrast, NCDEQ provides a differing level of runoff reduction credit based on the size and soil type of the vegetated area that receives the runoff. A minimally sized disconnected impervious surface in a clay soil will only reduce about 30% of the runoff because infiltration is limited in this soil type. However, if the size of the vegetated receiving area is doubled and the device is located in a sandy soil, NCDEQ provides a runoff reduction credit of 73%. NCDEQ bases its credits entirely on recent research conducted in NC.

The hurdle that is nearly impossible to scale in transferring Chesapeake Bay recommendations to North Carolina is that we deal in different currencies. The Chesapeake Bay experts distill information about SCM type and size to a single "percent reduction," a method that we have not been using in North Carolina in favor of calculating annual loads of nutrients leaving developing sites. NCDEQ's approach is more accurate and has been developed in cooperation with our highly respected researchers at NCSU as well as numerous stakeholders from the development community, local governments and environmental groups. Also, the nutrient load in pounds/acre/year is what EPA requires in reporting progress toward NC's Nutrient Management Strategies.

NCDEQ is open to any member of the public who wishes to provide data showing that our SCM credits should be updated. We public noticed the NCDEQ SCM Credit Document from September 30 until October 30, 2016. Staff have made numerous presentations on our SCM crediting practices to professional groups and at workshops. Even though we are currently outside of the public notice period, NCDEQ is happy to consider comments and make updates to this document as the science indicates it is needed.

Conclusions and Recommendations

Based upon the aforementioned reasons, NCDEQ believes that the Chesapeake Bay recommendations should not be implemented in North Carolina as our state specific research and methodologies (NCDEQ's SCM Nutrient Crediting Document) are more appropriate for assessing the treatment provided by North Carolina SCMs, including providing more nutrient credits as built upon area increases, consideration of soil type in SCM function, the more accurate assessment of runoff reduction by SCMs and the reliance on research conducted in North Carolina. *Per S.L. 2016-94, these State-specific values shall be incorporated into the Nutrient Strategies rules readoption process.*

References and Links

To read more about NCDEQ's SCM Credits and Design, please see:

NCDEQ SCM Credit Document, which is available on NCDEQ's Stormwater Design Manual web page:
https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/stormwater-bmp-manual

NCDEQ Minimum Design Criteria for SCMs:
https://ncdenr.s3.amazonaws.com/s3fs-public/Energy%20Mineral%20and%20Land%20Resources/Stormwater/BMP%20Manual/Chapter%2026%20July%2019%2C%202016.pdf

To read more about the Chesapeake Bay recommendations for SCM credits, please see:

"Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards:"
http://chesapeakestormwater.net/wp-content/uploads/dlm_uploads/2012/10/Final-CBP-Approved-Expert-Panel-Report-on-Stormwater-Performance-Standards-LONG_012015.pdf

Fact sheet on efficiency calculations:
http://chesapeakestormwater.net/wp-content/uploads/dlm_uploads/2015/06/U2.-New-and-Redevelopment-Practices-Fact-Sheet-in-Chesapeake-Bay-Watershed.pdf

2009 BMP definitions and effectiveness:
http://archive.chesapeakebay.net/pubs/BMP_ASSESSMENT_REPORT.pdf