Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated

Guidance for National Pollutant Discharge Elimination System Stormwater Permits

August 2014

Department of the Environment

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I. Executive Summary

The goals of Maryland's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permits are to control stormwater pollution, improve water quality, and work toward meeting water quality standards. The permits require MS4 jurisdictions to perform watershed assessments and develop restoration plans in order to meet stormwater wasteload allocations (WLAs) included in Environmental Protection Agency (EPA) approved total maximum daily loads (TMDLs). These plans provide a schedule for implementing best management practices (BMPs) to reduce pollution and meet water quality standards. This document provides guidance for determining credits granted for BMP implementation to comply with permit requirements.

The MS4 permits establish two specific requirements for developing restoration plans. The first involves restoration of twenty percent of a jurisdiction's impervious surface area that has little or no stormwater management. The impervious area restoration requirement is part of the strategy in Maryland's Watershed Implementation Plan (WIP) for meeting the Chesapeake Bay TMDL. The second requirement is to develop a schedule for BMP implementation to meet all applicable WLAs. Therefore, BMPs implemented to address these permit conditions will help Maryland meet both Chesapeake Bay and local water quality goals. In order to establish consistent criteria for successful implementation across jurisdictions, this guidance:

- Describes how to establish baseline conditions for impervious area restoration and stormwater WLAs.
- Describes how to apply impervious area restoration credits for BMP implementation.
- Describes how to apply pollutant removal credits for BMP implementation for new development, redevelopment, and restoration.
- Expands the list of traditional water quality practices to offer additional options called "alternative BMPs" that may be used for restoration.

BMP Performance Standards

The information in this guidance will incorporate recent recommendations from the Chesapeake Bay Program (CBP) for nutrient and sediment load credits associated with BMP implementation. In order for permittees to receive proper credit toward Chesapeake Bay TMDLs, restoration activities and reporting need to be consistent with CBP approved practices and efficiencies. This will allow Maryland's MS4 community to be consistent with region-wide efforts to meet the Chesapeake Bay TMDL.

BMP performance can be determined using the CBP approved publication, "Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards" (Schueler and Lane, 2012). This offers a series of pollutant removal adjustor curves (see Appendix A) to determine nutrient and sediment load reductions for BMP implementation. BMPs are classified as runoff reduction (RR) and stormwater treatment (ST) practices as outlined in Table 1.E below.

Table 1.E. Classification of BMPs Used in Maryland[1]	
Runoff Reduction (RR) Practices	**Stormwater Treatment (ST) Practices**
All ESD Practices in Manual[2]: • Alternative Surfaces • Nonstructural Practices • Micro-Scale Practices	Structural Practices in Manual[2] • Wet Ponds • Wetlands • Filtering Practices (ex. Bioretention) • Wet Swales
Structural Practices in Manual[2]: • Infiltration Practices • Bioretention Filters • Dry Swales	
Note: Structural stormwater management practices that do not meet the performance criteria established in the Manual (e.g., dry detention or extended detention ponds, hydrodynamic structures) may not be used to meet restoration requirements.	

1. Schueler and Lane, 2012
2. 2000 Maryland Stormwater Design Manual, Volumes I & II (MDE, 2000)

The criteria for the RR and ST practices noted above are found in the 2000 Maryland Stormwater Design Manual (Manual). MDE used the adjustor curves in Appendix A to develop Table 2.E, below. The table shows pollutant removal rates for RR and ST practices for commonly used runoff depths.

Table 2.E. Removal Rates for ESD/RR and ST Practices

Runoff Depth Treated (inches)	TSS		TP		TN	
	ESD/RR	ST	ESD/RR	ST	ESD/RR	ST
0.00	0%	0%	0%	0%	0%	0%
0.25	40%	37%	38%	29%	32%	19%
0.50	56%	52%	52%	41%	44%	26%
0.75	64%	60%	60%	47%	52%	30%
1.00	70%	66%	66%	52%	57%	33%
1.25	76%	71%	70%	55%	60%	35%
1.50	80%	74%	74%	58%	64%	37%
1.75	83%	77%	77%	61%	66%	39%
2.00	86%	80%	80%	63%	69%	40%
2.25	88%	83%	82%	65%	71%	41%
2.50	90%	85%	85%	66%	72%	42%

Note: Where runoff reduction or ESD practices are used, or other acceptable RR practices predominate, the ESD/RR curves should be used. Otherwise, the stormwater treatment or ST curves should be used.

BMP Implementation and Restoration Credits

The list of practices defined in Chapters 3 and 5 of the Manual (shown in Table 1.E) are considered acceptable water quality treatment BMPs for addressing restoration requirements in MS4 permits. The objective for restoration design is based on treating the water quality volume (WQ_v), or 1 inch of rainfall, using the criteria for BMPs defined in the Manual. Table 2.E may be used to determine pollutant removal rates for a given restoration project based on the runoff depth treated. The 1 inch runoff depth is highlighted in the table as this generally correlates with the WQ_v. Impervious area treatment credits are granted for the total impervious area within the drainage area when the full WQ_v is provided. When less than 1 inch of rainfall is treated, impervious area treatment credit will be based on the proportion of the full WQ_v treated.

Alternative BMPs

In addition to the BMPs identified in the Manual, there are a number of other practices that can provide water quality benefits and many local jurisdictions have data to validate their performance. These practices are called “alternative BMPs” and offer jurisdictions additional options and greater flexibility toward meeting restoration requirements outlined in MS4 permits. The list of acceptable alternative BMPs and their associated pollutant load efficiencies and impervious acre equivalents are provided in Table 3.E. MS4 jurisdictions may use the pollutant reduction efficiencies and impervious acre equivalents for alternative BMPs in Table 3.E to show progress toward meeting the twenty percent impervious area restoration requirement and toward meeting stormwater WLAs.

Reporting and Maintenance

NPDES stormwater permits require that a database be maintained of all stormwater BMPs implemented for new development, redevelopment, and restoration. The Urban BMP database structure is outlined in Appendix B. Data for TMDL and impervious acre credits will be noted for each BMP. The database also contains information regarding inspection and maintenance. Regular maintenance shall occur for all BMPs once every 3 years and each jurisdiction shall implement appropriate actions and document that any deficiencies are rectified. Otherwise, the credits will be removed until proper performance is verified. Therefore, proper reporting and ongoing BMP inspection and maintenance are essential for compliance with NPDES permit requirements.

New Research and CBP Expert Panels

This guidance also incorporates recent recommendations from the CBP expert panels for stream restoration and homeowner BMPs. Other expert panels on shoreline management and illicit discharge are nearing final recommendations and CBP approval. In addition, Maryland’s MS4 community continues to monitor new and innovative approaches for water quality treatment. Restoration in the urban environment offers unique challenges and MDE recognizes the need for flexibility and adaptive management for site specific planning. MDE will work with all MS4 permittees to accommodate new ideas and innovative technology for managing stormwater and improving water quality. As new research and information is developed by the MS4 community, the CBP, and others, MDE will make that information available and periodically update this guidance as needed.

Table 3.E. Alternative Urban BMPs

	Notes	Efficiency Per Acre			Impervious Acre Equivalent
		TN	**TP**	**TSS**	
Mechanical Street Sweeping	High density urban areas where sweeping occurs 2x/month	4%	4%	10%	0.07
Regen/Vacuum Street Sweeping	High density urban areas where sweeping occurs 2x/month	5%	6%	25%	0.13
Reforestation on Pervious Urban	Survival rate of 100 trees/acre or greater; at least 50% of trees have two inch diameter or greater (4.5 ft. above ground)	66%	77%	57%	0.38
Impervious Urban to Pervious	Remove pavement and provide vegetative cover for 95% of area	13%	72%	84%	0.75
Impervious Urban to Forest	Survival rate of 100 trees/acre or greater; at least 50% of trees have two inch diameter or greater (4.5 ft. above ground)	71%	94%	93%	1.00
Regenerative Step Pool Storm Conveyance (SPSC)[1]	Located in dry or ephemeral channels; nutrient removal and impervious area credit is based on runoff depth treated	57%	66%	70%	1.00
		Lbs Reduced / Ton			**Impervious Acre Equivalent**
		TN	**TP**	**TSS**	
Catch Basin Cleaning	High density urban areas; storm drains are routinely maintained	3.5	1.4	420	0.40
Storm Drain Vacuuming	High density urban areas; storm drains are routinely maintained	3.5	1.4	420	0.40
Mechanical Street Sweeping	High density urban areas where sweeping occurs 2x/month	3.5	1.4	420	0.40
Regen/Vacuum Street Sweeping	High density urban areas where sweeping occurs 2x/month	3.5	1.4	420	0.40
		Lbs Reduced / Linear Ft			**Impervious Acre Equivalent**
		TN	**TP**	**TSS**	
Stream Restoration: load reductions for interim rate[2]	Schueler and Stack (2014) specify qualifying conditions and protocols to calculate individual load reductions per project	0.075	0.068	15/45	0.01
Outfall Stabilization	Stabilization or repair of localized areas of erosion below a storm drain outfall; max credit is 2 acres per project	n/a	n/a	n/a	0.01
Shoreline Management [3]	Revised protocols are pending CBP approval	0.075	0.068	137	0.04
		Lbs Reduced / Unit			**Impervious Acre Equivalent**
		TN	**TP**	**TSS**	
Septic Pumping	Pumping system is maintained and verified for annual credit	0[4]	0	0	0.03
Septic Denitrification	Permanent credit for installing enhanced septic denitrification	0[4]	0	0	0.26
Septic Connections to WWTP	Permanent credit for septic system connected to a WWTP	0[4]	0	0	0.39

1. Efficiencies and impervious acre equivalents shown are based on treating 1 inch of rainfall. When less than 1 inch of rainfall is treated, then refer to Table 2 for impervious acre equivalent and Table 6 for nutrient and sediment removal efficiencies.
2. Load reductions are based on current proposal under consideration by CBP. TSS is based on coastal plain and non-coastal plain applications. (Refer to Appendix E, Stream Restoration).
3. Load reductions are based on current proposal under consideration by CBP based on Drescher and Stack (2014). (Refer to Appendix E, Shoreline Management).
4. Actual load reductions shall be reported through local health department. Septic system credits only apply to impervious acre requirements.

II. Maryland's NPDES MS4 Permits and Restoration of Urban Lands

Phase I of the EPA stormwater program was promulgated in 1990 under the Clean Water Act (CWA). This program relies on NPDES permit coverage to address polluted discharges from stormwater runoff from large and medium MS4s. Eleven jurisdictions in Maryland met the criteria for coverage described in the CWA, and each has been permitted under the Phase I NPDES MS4 program since the 1990s. A growing focus on restoring Chesapeake Bay and local water quality concerns has resulted in new Phase I permits that include more stringent requirements toward meeting water quality standards.

More specifically, Part IV.E of these new permits describes requirements to develop restoration plans. These plans must address impervious area restoration and WLAs for meeting approved TMDL limits. Examples of relevant sections of the permit that specify these conditions are highlighted below:

- **Part IV.E. Restoration Plans and Total Maximum Daily Loads**: "In compliance with §402(p)(3)(B)(iii) of the Clean Water Act (CWA), MS4 permits must require stormwater controls to reduce the discharge of pollutants to the maximum extent practicable [MEP]. By regulation at 40 CFR §122.44, BMPs and programs implemented pursuant to this permit must be consistent with applicable WLAs developed under EPA approved TMDLs..."

- **Part IV.E.2.a**: "Within one year of permit issuance, [the local jurisdiction] shall submit an impervious surface area assessment consistent with the methods described in [this guidance] document. Upon approval by MDE, this impervious surface area assessment shall serve as the baseline for the restoration efforts required in this permit.

  By the end of this permit term, [the local jurisdiction] shall commence and complete the implementation of restoration efforts for twenty percent of the County's impervious surface area consistent with the methodology described in the MDE document cited in PART IV.E.2.a. that has not already been restored to the MEP…"

- **Part IV.E.2.b**: "Within one year of permit issuance, [the] County shall submit to MDE for approval a restoration plan for each stormwater WLA approved by EPA prior to the effective date of the permit. The County shall submit restoration plans for subsequent TMDL WLAs within one year of EPA approval. Upon approval by MDE, these restoration plans will be enforceable under this permit. As part of the restoration plans, [the] County shall: …[i]nclude the final date for meeting applicable WLAs and a detailed schedule for implementing all structural and nonstructural water quality improvement projects, enhanced stormwater management programs, and alternative stormwater control initiatives necessary for meeting applicable WLAs…"

<u>Establishing Baselines: Impervious Surface Area Assessment</u>

Jurisdictions will need to determine the total impervious surface area under their responsibility and delineate the portions that are treated to the MEP, partially treated, or untreated and available for retrofit. This assessment will provide the baseline used to calculate the twenty percent restoration requirement. The impervious area assessment is due within one year of the effective date of the permit and remains the same for the rest of the permit term. The following describes the information needed for this assessment:

1. MS4 Regulated Permit Area

All permittees will need to determine the total land area that is regulated under their MS4 permit. Title 40 of the Code of Federal Regulations (CFR), 122.26 (b) (8) defines an MS4 as "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned or operated by a State, city, town, borough, county, parish, district, association, or other public body." The storm drain system within a jurisdiction's boundary is typically a mix of ownership, which includes parts of local, State, and federal systems. Each jurisdiction needs to account for these various entities when defining what it "owns or operates."

Some State and federal properties, certain small municipalities, and industrial facilities regulated under other NPDES stormwater permits and the storm drain systems in these entities may be excluded from a locality's responsibility. However, each MS4 jurisdiction is responsible for any stormwater discharge that passes through its storm drain system. Most NPDES Phase I municipalities already have their storm drain systems mapped in geographic information system (GIS) format. These maps shall be continuously updated and refined as new development and field verification procedures are implemented across the jurisdiction.

2. Land Use Data and Impervious Surface Area

The total impervious surface within a jurisdiction's regulated permit area should be evaluated using the best available land use data that can be generated from the same source from year to year. This will ensure consistent annual analysis regarding acres treated, retrofit goals, and permit compliance. The baseline year for the impervious area assessment shall be 2002, which is the year that the Manual was fully implemented. BMPs designed in compliance with the water quality volume (WQ_v) treatment criteria found in the Manual are considered to provide water quality treatment to the MEP. Therefore, the impervious area draining to BMPs designed and approved in accordance with the Manual is considered treated and does not need to be counted toward restoration requirements.

3. Urban BMPs

a. Existing BMPs: All jurisdictions have been required to develop and maintain an urban BMP database that identifies all existing stormwater facilities within each jurisdiction along with design, construction, and inspection information. This database and field inspections should be used to verify the level of water quality treatment provided for an existing facility. The following guidelines should be used to determine the level of water quality treatment provided by existing stormwater facilities:

- BMPs constructed according to the Manual for new development after the baseline year of 2002 provide acceptable water quality treatment. The impervious areas draining to these facilities do not need to be counted toward impervious area restoration.

- BMPs implemented for new development after 2002 may not be used for credit toward impervious area restoration.
- The impervious area draining to BMPs implemented for restoration or redevelopment between 2002 and the beginning of the permit term may be subtracted from the baseline.
- Some BMPs implemented prior to 2002 may provide some water quality treatment. These include wet ponds, wetlands, and infiltration facilities. In these cases, the original design parameters for each facility are needed to verify the level of treatment provided. The impervious area treated is based on the volume provided in relation to the WQ_v (i.e., runoff from 1 inch of rainfall). For example, if a BMP was designed to treat a half inch of rainfall, the amount of impervious area treated is 50% of the actual impervious area draining to the facility.
- Stormwater detention facilities designed for flood control do not provide water quality treatment. The impervious area draining to these BMPs must count toward the baseline.
- BMPs where plans, design specifications, and complete maintenance records are not available are not considered to provide acceptable water quality treatment. Impervious areas draining to these structures must count toward the baseline.

A useful tool for an initial assessment is the Stormwater Management by Era approach documented by MDE in 2009. The approach considers four distinct regulatory eras where stormwater management requirements correlate with a certain level of BMP performance. These eras are as follows:

- Prior to 1985. Stormwater management regulations came into effect after this era. Any development constructed in this time period is most likely untreated (unless retrofits were constructed in later years).
- Between 1985 and 2002. BMPs implemented during this time addressed flood control; however, individual BMP design criteria shall be used to verify whether water quality is provided.
- Between 2002 and 2010. The Manual was fully implemented during this era.
- Post-2010. Environmental site design (ESD) to the MEP is required. Any development project that complied with State regulations in the third and fourth eras is considered to have acceptable water quality treatment.

This approach was used in the development of Maryland's WIP for meeting Chesapeake Bay TMDLs. It can be valuable for local planning and for targeting potential areas suitable for retrofitting. However, the Stormwater Management by Era approach should not be used for estimating BMP pollutant removal efficiencies when documentation and record keeping is missing for existing BMPs. A comprehensive BMP inventory is required of all local stormwater programs and shall include updated information on inspection and maintenance activities.

b. BMP Maintenance and Verification: All BMPs must be verified, inspected, and maintained according to State stormwater management regulations and CBP reporting and verification procedures. According to the Code of Maryland Regulations (COMAR) for stormwater management, preventative maintenance of all ESD and structural stormwater management measures is required to ensure proper function. Regular inspections shall occur once every 3 years and each jurisdiction shall implement appropriate actions and document that any deficiencies are rectified. The BMP database (see Appendix B) will need to specify the last inspection date and whether the facility has been properly maintained. A "failed" designation assigned to any BMP indicates that the facility is not functioning as designed. This is described in the BMP Implementation and Restoration Credit section of this document.

In the 2014 memo to the CBP's Urban Stormwater Workgroup, "Final Recommended Guidance for Verification of Urban Stormwater BMPs," Schueler and Goulet emphasize the need for regular inspection and maintenance. This will ensure that BMPs perform as designed. In order for BMPs to qualify for pollutant removal rates and to take credit toward the Chesapeake Bay TMDL, the information in the BMP Implementation and Restoration Credit section of this document must be provided.

4. Impervious Surfaces in Rural Areas

Many rural roads and residential subdivisions have open vegetated drainage systems, impervious area disconnections, and sheetflow to conservation areas that filter and infiltrate stormwater runoff. Each jurisdiction should conduct a systematic review of existing rural roads and subdivisions to determine the extent of water quality treatment already provided. This review will also aid in identifying opportunities for retrofitting.

Land use designation can help in selecting areas that may already be adequately managed. For example, public roads and residential subdivisions in predominantly rural areas with low population densities (e.g., one or less dwelling unit per three acres) may have water quality design features equivalent to those defined in the Manual. Typically, areas that are less than fifteen percent impervious can meet ESD requirements according to the criteria for nonstructural practices in the Manual. These practices include rooftop disconnect, non-rooftop disconnect, and sheetflow to conservation areas. If a jurisdiction can document where conditions meet the Manual's criteria and adequate management is provided, then the impervious acres in these areas can be excluded from the baseline. Table 1 below provides guidelines for determining whether rural impervious areas provide acceptable water quality treatment.

Table 1. Rural Impervious Area and Water Quality Treatment	
Considered Treated	**Considered Not Treated***
Areas that are zoned rural residential with 1 house or less per 3 acres and meets the disconnection or sheetflow to conservation criteria in the Manual	Rural residential cluster development with 1 house or more per 3 acres
Open section roads that meet the disconnection or sheetflow to conservation area criteria in the Manual	Rural areas that drain directly to closed storm drain system infrastructure, including curbs, inlets, and storm drain outfalls
Open section roads with swales that meet the grass swale criteria in the Manual	Buildings and parking associated with commercial, industrial, and agricultural areas: includes wineries and produce markets

* Unless specific practices are documented in the jurisdiction's urban BMP database

A desktop GIS analysis is a good way to initially identify these areas. This allows a quick review of zoning, imperviousness, disconnection, sheetflow, grass swales, and slopes. These data may then be used to determine whether rural impervious areas are adequately treated with ESD based on the criteria in the Manual. Additional field investigation is necessary to validate the desktop analysis and to document the types and extent of ESD practices. This can be accomplished by conducting a representative field survey of the area being claimed as having nonstructural or micro-scale ESD practices. The survey and GIS analysis shall be submitted to MDE for approval. For areas that a jurisdiction wants to submit to the CBP for BMP stormwater credit, actual BMP point-of-investigation, type of BMP, drainage area delineation, water quality treatment (defined in inches of rainfall treated), inspection and maintenance status, and other fields required in the urban BMP database (See Appendix B) will need to be provided.

5. Total Impervious Acres Not Treated to the MEP

A jurisdiction's total impervious area that has not already been treated or restored to the MEP is subject to the twenty percent restoration requirement. The analysis performed according to Section II. 1 – 4, above, shall be used to determine the baseline impervious acres not treated. This can be done by subtracting the total impervious area considered treated from a jurisdiction's total impervious area. The resulting area will serve as the baseline for determining the twenty percent impervious surface area required to be restored to the MEP as described in Part IV.E.2.a of the permit.

The impervious area baseline number established under Part IV.E.2.a of the permit will not change for the entire permit term. Any changes to this number shall be reported and justified as part of the reapplication process and reported in the fourth year annual report. This information will be considered and discussed as part of the negotiation process during the next cycle of permit issuance.

Establishing Baselines: Stormwater WLAs

The permit conditions specified in Part IV.E. above outline the activities required to show compliance with applicable WLAs. In general, the year in which the monitoring data were gathered to support the TMDL should be used as the year to establish stormwater baseline loads. This becomes the starting point where compliance with the targeted load reductions will be measured. Local stormwater program and restoration efforts implemented after the baseline year, along with the associated pollutant load reductions, can then be measured against the stormwater WLAs to determine if benchmarks are being met. A searchable database of WLAs from Maryland's EPA-approved TMDLs is available through MDE's TMDL Stormwater Toolkit website at:

http://www.mde.maryland.gov/PROGRAMS/WATER/TMDL/DATACENTER/Pages/index.aspx

The database provides basic information about each NPDES MS4 jurisdiction and relevant WLAs. This includes individual pollutants, wasteload allocations, reduction percentages, recommendations for determining baseline year, and links to applicable TMDL documents and watershed maps. The website also has detailed, step-by-step instructions on disaggregating stormwater WLAs where numerous MS4s are grouped under one allocation. Additional guidance is being developed by MDE regarding stormwater WLA plan implementation, PCBs, bacteria, trash, and mercury stormwater TMDLs. MDE's website will be updated as available. All of this information may be accessed through the TMDL Stormwater Toolkit link.

MS4 jurisdictions will develop restoration plans that establish BMP implementation schedules and a final date for achieving the targeted WLAs. Computer models may be useful tools for showing how program implementation is making progress toward meeting WLAs. Appendix C of this document provides a list of websites containing documentation on the use of various models. In addition, Appendix C tabulates the pollutant loading rates applied for different land uses in the Chesapeake Bay Watershed Model (CBWM). MS4 jurisdictions may use these loading rates to calculate baseline stormwater loads for the Bay TMDL.

Establishing Baselines: Phase II MS4 Permits

The baseline analysis described above is intended to address permit requirements for Phase I MS4 jurisdictions in Maryland. MDE is currently negotiating with EPA on permit language for Phase II general permits that will also require impervious area restoration. Phase II jurisdictions may use the methodology described above and use 2002 as the baseline year for determining the impervious surface area subject to restoration requirements.

The current Phase II general permit does not require impervious area restoration. Therefore, these jurisdictions have never received credit for restoration activities completed prior to the new permit term. Because MDE has encouraged Phase II jurisdictions to begin restoration efforts, any BMP implemented after 2006 for restoration or redevelopment may be used for impervious area restoration credit to meet the new permit requirements.

III. BMP Implementation and Restoration Credits

The previous section describes how to calculate baseline impervious area restoration requirements and identifies tools for determining WLAs. Once baselines are established, jurisdictions must develop restoration plans that provide a schedule for BMP implementation and track impervious area treatment and pollutant reduction targets. The BMPs listed in Chapters 3 and 5 of the Manual may be used for restoration and the pollutant load reductions are provided by the CBP (Schueler and Lane, 2012). This section describes the credits granted for implementing these BMPs to meet impervious area restoration and nutrient and sediment reduction goals.

Credit for Impervious Acres Treated

The water quality objective for impervious area restoration is based on treating the WQ_v (1 inch of rainfall) using BMPs defined in the Manual. Because of numerous constraints inherent in the urban environment, meeting the design standards specified in the Manual may not always be achievable. In these cases, retrofit opportunities that achieve less than the WQ_v should be pursued where they make sense. Applying impervious area treatment credit for these projects will be based on the proportion of the full WQ_v treated.

Where stormwater retrofits provide water quality treatment for existing unmanaged urban areas, impervious area restoration credit can be applied as follows:

1. Individual Project Credit

Retrofits shall be credited according to the following criteria:

- An acre for acre impervious credit will be given when a BMP is designed to provide treatment for the full WQ_v (1 inch of rainfall); or
- A proportional acreage of credit will be given when less than the WQ_v is provided: (percent of the WQ_v achieved) x (drainage area impervious acres).

Table 2. Retrofit of a Dry Detention Pond Constructed in 1985	
Scenario 1: Original design	2 and 10 year peak management
Impervious acre drainage area	15 acres, (no water quality; no credit)
Scenario 2: Retrofit design	1 inch, (full WQ_v)
Impervious acre credit	15 acre credit
Scenario 3: Retrofit design	0.5 inch
Impervious acre credit	7.5 acre credit (50% of WQ_v * 15 acres)

Table 2 offers three scenarios regarding how credit may be allowed for existing BMPs that are retrofitted. Scenario 1 is a detention pond that was originally designed for flood control and provides no water quality treatment. The 15 acres of impervious area would be included in the baseline impervious area that needs restoration as discussed in the previous section. A jurisdiction may use this opportunity to retrofit the pond by creating an acceptable water quality practice such as a wet pond or wetland. Scenario 2 shows the pond retrofit provides the full

WQ_v and credit is allowed for all 15 acres of impervious area draining to the facility. Scenario 3 assumes that only a portion of the WQ_v can be provided, or, 0.5 inches of treatment. In this case, the credit granted will be 50% of the total watershed impervious area, which is 7.5 acres.

2. Incentive for Extra Credit

There will be instances where BMP retrofits provide treatment of more than 1 inch of rainfall. The amount of impervious area credited for these projects needs to be consistent with known BMP pollutant removal efficiencies. The BMP removal rate adjustor curves developed by Schueler and Lane (2012) show a linear relationship between runoff managed and pollutant removal efficiencies for runoff depths less than 1 inch (see Appendix A). However, for BMPs treating more than 1 inch, the pollutant removal rates decrease to one quarter of the linear rate shown for depths below 1 inch. Therefore, the impervious acre credit given is not one for one when more than 1 inch of rainfall is treated.

Using the BMP adjustor curve relationships (Schueler and Lane, 2012), Table 3 was developed to show the amount of impervious acre credit granted based on inches of rainfall treated. The credit will increase by 0.1 acres for every 0.4 inches treated above 1 inch. For treatment less than 1 inch, the credit granted is consistent with the individual project credit described above.

Table 3. Impervious Acre Credit for Treatment Above and Below 1 Inch of Rainfall

Rainfall Depth Treated (inches)	Impervious Acre Credit per Acre of Watershed Impervious Area	Impervious Acre Credit per 50 Acres of Watershed Impervious Area
0.5	0.5	25
0.75	0.75	37.5
1.0	1	50
1.4	1.1	55
1.8	1.2	60
2.2	1.3	65
2.6	1.4	70

3. Redevelopment and Impervious Acre Credit

Any project that meets or exceeds the regulatory requirements for redevelopment may be used to claim credit toward impervious acre treatment requirements and pollutant reductions. This applies to redevelopment projects dating back to the beginning of the permit term. In 2000, State regulations required treatment for twenty percent of existing impervious areas within the project limit of disturbance (LOD). In 2010, the requirement changed to fifty percent. Table 4 shows that the impervious acre credit granted for an individual project is based on the regulations in place at the time. Additional credit may be granted for any unmanaged existing impervious areas that are treated above the twenty or fifty percent requirements. Further, when additional volume above the WQ_v is provided, additional credit for impervious acres treated will be credited according to the watershed implementation credit described in Section III.2 and shown in Table 3.

Table 4. Impervious Acre Credit for Redevelopment			
Existing Impervious Area within LOD	State Regulations: 2000 (20% I) or 2010 (50% I)	Treatment Requirements (acres)	Impervious Acre Credit (full WQ_v provided)
5	2000	1	1
10	2000	2	2
5	2010	2.5	2.5
10	2010	5	5

There may be cases where a redevelopment project has an increase in impervious area. The increase will need to meet new development requirements and will not receive credit toward restoration. However, projects that have less than 40% existing impervious area will be regulated as new development, and the formerly unmanaged impervious areas may be credited toward impervious acre restoration.

Credit for Pollutant Removal Efficiencies and WLAs

The CBP has approved the publication, "Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards" (Schueler and Lane, 2012). This will establish consistent reporting and crediting of BMP implementation across the Chesapeake Bay watershed. The document provides a series of BMP removal rate adjustor curves (see Appendix A). The curves are used to determine pollutant removal rates for two basic classifications of BMPs. These include runoff reduction (RR) and more traditional stormwater treatment (ST) practices as outlined in Table 5 below. The adjustor curves are used to determine pollutant removal rates based on the runoff depth treated and whether RR or ST practices are used for treatment. The discussion below will explain how the curves are used for determining pollutant removal efficiencies for new development, redevelopment, and retrofit projects.

Table 5. Classification of BMPs Used in Maryland[1]	
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All ESD Practices in Manual[2]: • Alternative Surfaces • Nonstructural Practices • Micro-Scale Practices	Structural Practices in Manual[2] • Wet Ponds • Wetlands • Filtering Practices (ex. Bioretention) • Wet Swales
Structural Practices in Manual[2]: • Infiltration Practices • Bioretention Filters • Dry Swales	
Note: Structural stormwater management practices that do not meet the performance criteria established in the Manual (e.g., dry detention or extended detention ponds, hydrodynamic structures) may not be used to meet restoration requirements.	

1. Schueler and Lane, 2012
2. 2000 Maryland Stormwater Design Manual, Volumes I & II

1. New Development

New development projects designed to meet Maryland's current regulatory requirements will mimic the natural hydrology of forested conditions. BMPs implemented to meet new development requirements may not be used for credit toward stormwater WLAs. However, local governments are required to report data for new development, redevelopment, and restoration projects on MDE's Urban BMP database so that net pollutant loads will be calculated in the Chesapeake Bay Watershed Model (CBWM). The discussion below will provide guidance on the proper reporting of urban BMP data.

Current Maryland regulations require that ESD be used to the MEP to reduce the runoff from new development and replicate the hydrologic characteristics of forested conditions. To meet this requirement on a new development project, ESD practices must be used either exclusively or, where necessary, in combination with structural practices to provide sufficient treatment and reduce the volume of runoff from the 1-year, 24-hour design storm. For new development projects, this standard is based on the median value of the 1-year storm for Maryland, or 2.7 inches of rainfall.

As discussed above, pollutant removal rates found in the BMP curves are a function of the type of practices used and the runoff depth treated per impervious acre. Along with these charts, Schueler and Lane (2012) provide a simple equation to calculate runoff depth based on each state's specific engineering parameters:

$$Q = \frac{(12 \times EP)}{IA}$$

where: Q = runoff depth treated per impervious acre (inches)
EP = state-specific engineering parameter (acre-feet); either ESD_v or WQ_v
IA = impervious area (acres)

However, this equation does not always reflect Maryland's runoff reduction requirements where meeting the ESD to the MEP mandate results in little to no runoff from a site. To correct for this, MDE has determined that the runoff depth treated per impervious acre where the ESD to the MEP standard is met is equal to the impervious surface runoff from 2.7 inches of rainfall. This is equivalent to the maximum value used on the BMP curves, or 2.5 inches. Also, the ESD to the MEP mandate means that for the majority of projects, ESD (or RR) practices will be the predominant type used. For new development projects meeting the ESD to the MEP standard, the maximum runoff depth treated, or 2.5 inches shall be used in conjunction with the ESD/RR curves to determine pollutant removal rates. Figure 1 below shows pollutant removal rates for ESD to the MEP, 2.5 inches of runoff treated, according to Table 6 shown on the next page.

Figure 1. Pollutant Removal Rates for ESD to the MEP:

- ***Sediment - 90%***
- ***Total Phosphorus - 85%***
- ***Total Nitrogen - 72%***

There may be situations (e.g., quantity control waivers, direct discharges to tidal waters) where the stormwater management design for a new development project does not meet the ESD to the MEP mandate. When this occurs, the pollutant removal curves are still used to determine individual pollutant removal rates. However, the runoff volume (Q) treated per impervious acre is determined using the ratio of the rainfall treated by the design (P_{design}) to the rainfall target (P_E) to determine ESD goals using the following:

$$Q = \left(\frac{P_{design}}{P_E}\right) \times 2.5\ inches$$

where: Q = runoff depth treated per impervious acre (inches)
P_{design} = the rainfall treated by stormwater management practices (inches)
P_E = the rainfall target used to size ESD practices

The BMP removal rate adjustor curves in Appendix A were used to develop Table 6 below which shows removal rates for commonly used runoff depths for ease of reporting.

Table 6. Removal Rates for ESD/RR and ST Practices

Runoff Depth Treated (inches)	TSS		TP		TN	
	ESD/RR	ST	ESD/RR	ST	ESD/RR	ST
0.00	0%	0%	0%	0%	0%	0%
0.25	40%	37%	38%	29%	32%	19%
0.50	56%	52%	52%	41%	44%	26%
0.75	64%	60%	60%	47%	52%	30%
*1.00**	70%	66%	66%	52%	57%	33%
1.25	76%	71%	70%	55%	60%	35%
1.50	80%	74%	74%	58%	64%	37%
1.75	83%	77%	77%	61%	66%	39%
2.00	86%	80%	80%	63%	69%	40%
2.25	88%	83%	82%	65%	71%	41%
2.50	90%	85%	85%	66%	72%	42%

NOTE: Where runoff reduction or ESD practices are used, or other acceptable RR practices predominate, the ESD/RR curves should be used. Otherwise, the stormwater treatment or ST curves should be used.

***Typical scenario for redevelopment projects treating 50% of existing surface area.**

2. Redevelopment

The current standard for redevelopment is either to remove impervious cover or to capture and treat the runoff from 1 inch of rainfall from at least fifty percent of the existing impervious area within the project LOD. For most redevelopment designs, the resultant runoff depth should be close to 1 inch for fifty percent of the existing impervious area. Table 6 can be used to determine pollutant removal rates based on runoff depth for ease of reporting. The credit granted toward impervious area restoration requirements is based on the regulatory requirements at the time of the project as discussed in Section II.3 (see Table 4).

3. Retrofitting/Restoration

A common strategy for meeting restoration requirements is to upgrade or retrofit pre-2002 BMPs to current standards. Similarly, ESD and/or structural BMPs that meet the water quality criteria in the Manual may be constructed in urban areas to provide treatment where previously none existed. The design standards for either of these options are based on the treatment of the WQ_v criteria using the associated list of practices defined in Chapters 3 and 5 of the Manual. Similar to redevelopment, Table 6 may be used to determine pollutant removal rates for a given retrofit design based on the runoff depth treated. The 1 inch runoff depth is highlighted in Table 6 to show pollutant removal rates for typical retrofit or redevelopment projects using either RR or ST practices.

Urban Filter Strips and Homeowner BMPs

The CBP recently approved two additional stormwater BMPs for reducing pollutants to Chesapeake Bay. Approval of urban filter strips is based on the report, “Recommendations of the Expert Panel to Define Removal Rates for Urban Filter Strips and Stream Buffer Upgrade Practices” (Law, 2014). Approval of the homeowner BMP credit is documented in the memo “Background on the Crediting Protocols for Nutrient Reduction Associated with Installation of Homeowner BMPs” (Schueler and Goulet, 2014b). These BMPs are already recognized in Maryland as ESD practices. Therefore, when designed in accordance with the Manual, these practices may be used to meet restoration requirements. For example, urban filter strips must be designed according to the impervious area disconnection or sheetflow to buffer practices in the Manual. In addition, homeowner BMPs must meet the design standards for rain barrels or rain gardens. Impervious acre credit is based on the proportion of 1 inch of rainfall treated as described in Table 2. Stormwater WLA credit is based on the runoff depth treated for RR (or ESD) according to Table 6.

Individual homeowner practices capture a small amount of runoff, however, implementation over a large scale will involve numerous practices. For ease of reporting, a local jurisdiction may chose to report these small practices over a regional or watershed scale. In this way, the aggregate acres treated of numerous homeowner BMPs over a larger region can be reported. The impervious area treated is based on 1 inch of treatment over the area reported. Localities need to maintain records for individual practices and track and verify them over time in order to maintain credit toward Chesapeake Bay and local TMDL requirements.

Reporting Requirements

Municipal NPDES stormwater permits require that a database be maintained for all BMPs implemented for new development, redevelopment, and restoration. In addition, the impervious acres treated shall be calculated from the approved plans for each restoration or redevelopment project and recorded in the database. BMP drainage areas shall be GIS-mapped as line, point, or polygon shape files and linked to the database. The GIS mapping of these BMPs shall be used by localities to demonstrate how the twenty percent impervious cover restoration requirement is being met and to prevent the double reporting of structural BMPs.

Currently permittees are required to submit databases to MDE that conform to Attachment A (Annual Report Databases) of their NPDES MS4 permit. More recently, there have been significant changes to both Maryland's stormwater management program (e.g., ESD) and the CBP reporting requirements. Recognizing these changes, MDE is developing a geodatabase to more efficiently collect and organize the information submitted as part of the NPDES MS4 annual reporting. When this geodatabase is complete, MDE will provide a users' guide with specific instructions on the reporting and use of the database. Until this geodatabase is implemented, Table B.1 in Appendix B, *Urban Best Management Practices (BMPs) Associated with GIS Coverage*, may be used to submit this information to MDE. The reporting structure in Appendix B also provides BMP classification codes that shall be used for reporting.

IV. Alternative BMP Credits

The list of practices defined in Chapters 3 and 5 of the Manual are considered acceptable water quality treatment BMPs for addressing restoration requirements in MS4 permits. In addition to these BMPs, there are a number of other practices that can provide water quality benefits and many local jurisdictions have data to validate their performance. These practices are called "alternative BMPs" and offer jurisdictions additional options and greater flexibility toward meeting restoration requirements outlined in MS4 permits. The list of acceptable alternative BMPs and their associated pollutant load reductions and impervious acre equivalents are shown below in Table 7.

MDE has developed a method for relating the reduction in pollutant loads from alternative BMPs into an equivalent impervious acre. This method is described and example calculations are provided in Appendix D. The results are tabulated in Table 7, under the "Impervious Acre Equivalent" column for each alternative BMP. This conversion method may be used for new alternative BMPs not found in this document for calculating impervious acre equivalencies, when the practice is approved by MDE and/or the CBP. Additional information on how nutrient and sediment load reductions were established for alternative BMPs is described in Appendix E.

MS4 jurisdictions may use the pollutant reduction efficiencies and impervious acre equivalents in Table 7, Alternative Urban BMPs, to show progress toward meeting the twenty percent impervious area restoration requirement and toward meeting stormwater WLAs. Similar to other practices implemented for restoration, alternative BMPs shall be recorded in the stormwater BMP database in accordance with Appendix B. The appropriate abbreviations for coding are also located in Appendix B. All BMPs need to be GIS-mapped as point, line, or polygon shape files and linked to the restoration database.

The database also contains information regarding inspection and maintenance. Regular maintenance shall occur for all BMPs once every 3 years and each jurisdiction shall implement appropriate actions and document that any deficiencies are rectified. Otherwise, the credits will be removed until proper performance is verified. Therefore, proper reporting and ongoing BMP inspection and maintenance are essential for all restoration activities for compliance with NPDES permit requirements.

Table 7. Alternative Urban BMPs

	Notes	Efficiency Per Acre			Impervious Acre Equivalent
		TN	TP	TSS	
Mechanical Street Sweeping	High density urban areas where sweeping occurs 2x/month	4%	4%	10%	0.07
Regen/Vacuum Street Sweeping	High density urban areas where sweeping occurs 2x/month	5%	6%	25%	0.13
Reforestation on Pervious Urban	Survival rate of 100 trees/acre or greater; at least 50% of trees have two inch diameter or greater (4.5 ft. above ground)	66%	77%	57%	0.38
Impervious Urban to Pervious	Remove pavement and provide vegetative cover for 95% of area	13%	72%	84%	0.75
Impervious Urban to Forest	Survival rate of 100 trees/acre or greater; at least 50% of trees have two inch diameter or greater (4.5 ft. above ground)	71%	94%	93%	1.00
Regenerative Step Pool Storm Conveyance (SPSC)[1]	Located in dry or ephemeral channels; nutrient removal and impervious area credit is based on runoff depth treated	57%	66%	70%	1.00
		Lbs Reduced / Ton			**Impervious Acre Equivalent**
		TN	**TP**	**TSS**	
Catch Basin Cleaning	High density urban areas; storm drains are routinely maintained	3.5	1.4	420	0.40
Storm Drain Vacuuming	High density urban areas; storm drains are routinely maintained	3.5	1.4	420	0.40
Mechanical Street Sweeping	High density urban areas where sweeping occurs 2x/month	3.5	1.4	420	0.40
Regen/Vacuum Street Sweeping	High density urban areas where sweeping occurs 2x/month	3.5	1.4	420	0.40
		Lbs Reduced / Linear Ft			**Impervious Acre Equivalent**
		TN	**TP**	**TSS**	
Stream Restoration: load reductions for interim rate[2]	Schueler and Stack (2014) specify qualifying conditions and protocols to calculate individual load reductions per project	0.075	0.068	15/45	0.01
Outfall Stabilization	Stabilization or repair of localized areas of erosion below a storm drain outfall; max credit is 2 acres per project	n/a	n/a	n/a	0.01
Shoreline Management [3]	Revised protocols are pending CBP approval	0.075	0.068	137	0.04
		Lbs Reduced / Unit			**Impervious Acre Equivalent**
		TN	**TP**	**TSS**	
Septic Pumping	Pumping system is maintained and verified for annual credit	0[4]	0	0	0.03
Septic Denitrification	Permanent credit for installing enhanced septic denitrification	0[4]	0	0	0.26
Septic Connections to WWTP	Permanent credit for septic system connected to a WWTP	0[4]	0	0	0.39

1. Efficiencies and impervious acre equivalents shown are based on treating 1 inch of rainfall. When less than 1 inch of rainfall is treated, then refer to Table 2 for impervious acre equivalent and Table 6 for nutrient and sediment removal efficiencies.
2. Load reductions shown are based on current proposal under consideration by CBP. TSS is based on coastal plain and non-coastal plain applications. (Refer to Appendix E, Stream Restoration).
3. Load reductions shown are based on current proposal under consideration by CBP based on Drescher and Stack (2014). (Refer to Appendix E, Shoreline Management).
4. Actual load reductions shall be reported through local health department. Septic system credits only apply to impervious acre requirements.

Impervious Acre Treatment Credits

Impervious area treatment credits can be calculated by multiplying an alternative BMP's unit measure (i.e., acre, ton, linear feet, and number of facilities) by the impervious acre equivalency found in Table 7. Impervious area treatment credits for street sweeping, regenerative step pool storm conveyance (SPSC), reforestation on pervious, impervious urban to pervious, and impervious urban to forest use acres of implementation as the unit measure. Below are several example calculations for translating these alternative BMPs using acres of implementation and the equivalencies found in Table 7 for determining impervious acres treated for MS4 reporting requirements.

Practice	Acres	Imp. Acre Equivalent	Imp. Acre Credit
Mechanical street sweeping	100	0.07	7
Reforestation on pervious	100	0.62	62
Impervious urban to pervious	100	0.75	75
Impervious urban to forest	100	1.00	100

Impervious area treatment credits for catch basin cleaning, storm drain vacuuming, mechanical and vacuum street sweeping use tons of dry material as the unit measure. Below are a couple of example calculations for translating these alternative BMPs using tons of dry material and the equivalencies found in Table 7 for determining impervious acres treated for MS4 reporting requirements.

Practice	Tons	Imp. Acre Equivalent	Imp. Acre Credit
Catch basin cleaning	10	0.40	4
Storm drain vacuuming	10	0.40	4

Impervious area treatment credits for stream restoration and shoreline stabilization can use linear feet as the unit measure. Below are a couple of example calculations for translating these alternative BMPs using linear feet of implementation and the equivalencies found in Table 7 for determining impervious acres treated for MS4 reporting requirements.

Practice	Linear Feet	Imp. Acre Equivalent	Imp. Acre Credit
Stream Restoration	1,000	0.01	10
Shoreline Stabilization	1,000	0.04	40

Impervious area treatment credits for septic pumping, denitrification, and connections to waste water treatment plants (WWTP) can use the number of facilities improved as the unit measure. Below are several example calculations for translating these alternative BMPs using the number of facilities improved and the equivalencies found in Table 7 for determining impervious acres treated for MS4 reporting requirements.

Practice	No. Facilities	Imp. Acre Equivalent	Imp. Acre Credit
Septic pumping	10	0.03	0.3
Septic denitrification	10	0.26	2.6
Septic connections to WWTP	10	0.39	3.9

Pollutant Load Reductions

Pollutant load reductions for alternative BMPs can be calculated by multiplying the CBP urban pollutant load by the efficiency for each practice or by using the pounds (lbs) reduced for each practice found in Table 7. Pollutant load reductions associated with street sweeping, regenerative step pool storm conveyance (SPSC), reforestation on pervious urban, impervious urban to pervious, and impervious urban to forest are determined by using the efficiency rate for each practice. Example calculations are provided below to show how to determine pollutant load reductions for these alternative BMPs. In the example, the acres of practice implementation, (10 acres) is multiplied by pollutant loads per pound per acre to determine total nutrient and sediment loads. The loading rates shown below are based on the CBWM 5.3.2 model and discussed further in Appendix C.

Practice	Acres	Pollutant Load lbs/Acre			Total Pollutant Load (lbs)		
		TN	TP	TSS (tons)	TN	TP	TSS (tons)
Mechanical street sweeping	10	11.7	0.68	0.18	117	6.8	1.8
Impervious urban to pervious	10	11.7	0.68	0.18	117	6.8	1.8

The total pollutant loads calculated above, are then multiplied by the efficiencies for the alternative BMP. The examples below show how the total pollutant load reductions are determined for mechanical street sweeping and converting impervious urban to pervious.

Practice	Alt. BMP Efficiency			Pol. Load Reduc. (lbs)		
	TN	TP	TSS (tons)	TN	TP	TSS (tons)
Mechanical street sweeping	4%	4%	10%	4.68	0.27	0.18
Impervious urban to pervious	13%	72%	84%	15.21	4.89	1.51

Pollutant load reductions for catch basin cleaning, storm drain vacuuming, and street sweeping can be calculated by multiplying the pounds reduced per unit measurement, or in this case, tons of material removed. Example calculations are provided below to show how to determine pollutant load reductions.

Practice	Tons	lbs Reduced/Tons			Pol. Load Reduc. (lbs)		
		TN	TP	TSS	TN	TP	TSS
Storm drain vacuuming	10	3.5	1.4	420	35	14	4,200
Mechanical street sweeping	10	3.5	1.4	420	35	14	4,200

Pollutant load reductions for stream restoration and shoreline management can be calculated by multiplying the pounds reduced by linear feet of implementation. For stream restoration, the load reductions for TSS are based on whether a project is in the coastal plain or non-coastal plain. Example calculations are provided below for stream restoration (non-coastal plain) and shoreline management.

Practice	Linear feet	lbs Reduced/Lin. Ft.			Pol. Load Reduc. (lbs)		
		TN	TP	TSS	TN	TP	TSS
Stream restoration	1,000	0.075	0.068	44.9	75	68	44,900
Shoreline management	1,000	0.075	0.068	137	75	68	137,000

Future Alternative BMPs: New Technology/Innovative Practices

MDE recognizes that new and innovative approaches to stormwater management are being developed on a continuous basis. The policies and procedures for the approval of new and innovative technologies may be found on MDE's website. These shall be followed for all jurisdictions interested in pursuing new practices or products either for approval as an acceptable BMP for new development and redevelopment or for use in retrofit applications.

Innovative practices that are not approved under the Manual nor have an MDE or CBP assigned pollution removal efficiency can be used to offer jurisdictions additional options toward watershed restoration activities. Similar to other alternative BMPs in this document, MDE can approve certain practices when proper documentation and monitoring are provided to verify pollutant removal efficiencies. In these cases, MDE's approval for using these practices to meet local NPDES MS4 permit restoration requirements is subject to the following:

1. The use of any innovative practice or technology is subject to local jurisdictional approval;

2. Any jurisdiction requesting approval of an innovative stormwater practice for retrofitting must submit to MDE documentation demonstrating practice effectiveness. At a minimum, this documentation must include:

   a. Clear representations of the specific pollutant removal efficiencies for the device in a typical mode of use and under conditions that would be expected normally within the jurisdiction.

   b. Pollutant removal efficiencies must be supported using one or more of the following:

      i. Monitoring data collected under typical field conditions using a methodology consistent with the Technology Acceptance Reciprocity Partnership (TARP) Protocol[1], or other nationally recognized protocol that meets the standards described in MDE's Alternative/Innovative Technology Review Checklist (MDE, 2014a);
      ii. Monitoring studies conducted by the MS4 jurisdiction and approved by MDE; or
      iii. Review and approval of the practice by EPA or CBP.

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[1] Technology Acceptance Reciprocity Partnership (TARP) Protocol, New Jersey Center for Applied Technology, 2003

c. Product specifications, installation requirements, and operation and maintenance procedures;

d. Hydraulic performance specifications (e.g., treatment volume, throughput, etc.);

e. References and examples of actual installations of the product;

f. Minimum and recommended maintenance requirements for the product and any components;

g. Discussion of any special licensing, hauling, or access requirements, and safety issues associated with the operation and maintenance of the product; and

h. Proof that the product or practice has been submitted to the CBP Water Quality Goal Implementation Team (WQGIT) or Urban Stormwater Work Group (USWG) for consideration as an EPA-recognized stormwater BMP.

3. If credit is sought under an MS4 jurisdiction's Watershed Implementation Plan (WIP) or MS4 permit, the product or practice must be documented in that jurisdiction's TMDL implementation plan;

4. All practices must be maintained in accordance with State requirements as defined in the Code of Maryland Regulations (COMAR) 26.17.02;

5. The local jurisdiction is responsible for determining the appropriate impervious area reduction for restoration efforts for the specific product or practice based on the methodology described in Appendix D of this document; and

6. If formal documentation listed in Section 2.b above is absent, MDE reserves the right to establish interim pollutant removal efficiencies based on the supporting documentation provided by the vendor. These interim efficiencies will be recognized for a period not to exceed two years, after which the practice will be disallowed as an acceptable stormwater retrofit BMP.

MDE will evaluate all information and approve any credit toward meeting pollutant reduction targets under established TMDLs and impervious area treatment requirements.

V. Compliance with MS4 Permit Requirements

In Section II of this guidance, some of the permit language related to impervious area restoration and WLA requirements was highlighted. Requirements include providing a schedule for BMP implementation to show progress toward meeting restoration goals and establishing a final date for meeting stormwater WLAs. The information submitted by permittees to address these requirements is enforceable under each permit. When implementation schedules cannot be met, the permit requires that an iterative process be developed to show how benchmarks and deadlines will be addressed. In addition, the permit requires that continual outreach to the public be provided to incorporate any relevant ideas into water quality improvement programs. All reasonable efforts shall be made by MS4 jurisdictions to keep established benchmarks and deadlines on schedule. Examples of permit language that address these matters are outlined below:

- **Part IV.E.2.b. Restoration Plans**: "Develop an ongoing, iterative process that continuously implements structural and nonstructural restoration projects, program enhancements, new and additional programs, and alternative BMPs where EPA approved TMDL stormwater WLAs are not being met according to the benchmarks and deadlines established as part of the County's watershed assessments…"

- **Part IV.E.3. Public Participation:** "[The] County shall provide continual outreach to the public regarding the development of its watershed assessments and restoration plans. Additionally, the County shall allow for public participation in the TMDL process, solicit input, and incorporate any relevant ideas and program improvements that can aid in achieving TMDLs and water quality standards..."

- **Part IV.E.4. TMDL Compliance**: "[The] County shall evaluate and document its progress toward meeting all applicable stormwater WLAs included in EPA approved TMDLs. An annual TMDL assessment report with tables shall be submitted to MDE. This assessment shall include complete descriptions of the analytical methodology used to evaluate the effectiveness of the County's restoration plans and how these plans are working toward achieving compliance with EPA approved TMDLs. [The] County shall further provide:

  …[e]stimated net change in pollutant load reductions from all completed structural and nonstructural water quality improvement projects, enhanced stormwater management programs, and alternative stormwater control initiatives; ...[a] description of a plan for implementing additional watershed restoration actions that can be enforced when benchmarks, deadlines, and applicable stormwater WLAs are not being met or when projected funding is inadequate."

Showing compliance with the twenty percent impervious area restoration requirement involves the following activities:

1. Developing an impervious area assessment and determining baseline impervious area that is not already treated to the MEP.
2. Establishing a schedule for BMP implementation that shows compliance with impervious area restoration requirements by the end of the permit term.

3. Tabulating progress toward meeting impervious area restoration requirements in annual reports.
4. Completing twenty percent impervious area restoration by the end of the permit term.
5. Inspecting and maintaining all BMPs.

Showing compliance with TMDL WLAs, involves the following activities:

1. Determining the baseline load for the specific pollutant and determining the percent reduction required to meet the allowable WLA.
2. Developing restoration plans that identify water quality improvement projects and tabulating the expected pollution reductions from these BMPs.
3. Developing a schedule for BMP implementation that identifies a final date for meeting required WLAs.
4. Facilitating public participation and coordination activities to improve implementation efforts.
5. Comparing cumulative load reductions for all restoration efforts to required WLAs associated with each TMDL.
6. Comparing implementation schedules with target dates for meeting TMDLs and evaluating implementation progress. Providing updates in annual reports.
7. Inspecting and maintaining all BMPs.

As noted in Part IV.E.2.b, MS4 jurisdictions are required to "continuously implement[s] structural and nonstructural restoration projects, program enhancements, new and additional programs, and alternative BMPs…" Additional program requirements such as illicit discharge elimination, erosion and sediment control programs, implementation of the Stormwater Management Act for all new and redevelopment construction, public education and participation initiatives, BMP inspection and maintenance, property management, and monitoring efforts will collectively contribute to the watershed restoration goals intended in the permit. In this way, watershed restoration will be achieved through successful implementation of water quality BMPs in conjunction with other required programs to comply with the permit.

With respect to permit compliance, MS4 jurisdictions are required to continuously re-evaluate, fine tune, and adjust restoration efforts when established benchmarks cannot be met. Remaining on schedule to accomplish all permit conditions while continuously looking for opportunities to improve these efforts becomes a delicate balance. MS4 jurisdictions should carefully identify any delays in implementation schedules and provide a remedial action plan for current and future projects in order to facilitate restoration and improve program implementation. MDE will consider the level of restoration achieved and compare to implementation schedules and required benchmarks to determine compliance with permit requirements.

Successful restoration requires that BMPs function properly to ensure that the expected water quality improvements are achieved. Therefore, BMP inspection and routine maintenance need to be conducted in order for MS4 jurisdictions to claim credit. Further, to receive proper credit toward the Chesapeake Bay TMDL, MDE will need to report BMP data using CBP approved rates, reporting procedures, and BMP verification requirements (Schueler and Goulet, 2014a). Otherwise, the credits will be removed until proper performance is verified. Therefore, BMP inspection, maintenance, and verification are essential for compliance with NPDES permit requirements. MDE will evaluate permit compliance based on the success of implementation and ongoing maintenance and whether these activities are performed to the MEP.

VI. Conclusion

The purpose of this guidance is to standardize procedures, methods, and reporting requirements for the work performed by MS4 jurisdictions to meet NPDES permit requirements for impervious area restoration and TMDL goals. In order for permittees to receive proper credit toward Chesapeake Bay TMDL efforts, restoration activities and reporting need to be consistent with CBP approved practices, efficiencies, and expert panel recommendations. The CBP has various expert workgroups and committees that continuously evaluate science, technology, and field research on BMP implementation. MDE has participated in several of these expert panels to ensure that this guidance reflects the current recommendations of the CBP for watershed restoration. In this way, restoration in Maryland will be consistent with region-wide efforts to meet the water quality goals established in the Chesapeake Bay TMDL.

A significant amount of information provided in this document was generated from research and monitoring performed by MS4 jurisdictions in Maryland. This guidance should be considered a starting point from which restoration should be performed and reported. However, MS4 jurisdictions are encouraged to continue to explore innovative practices and new solutions to improve water quality. When monitoring data exist to support additional credits for new practices, MS4 jurisdictions may submit that information to MDE for consideration. MDE will work closely with CBP workgroups to determine a credit system that is equitable and consistent with other activities in the Chesapeake Bay region. As new technology, innovative practices, and monitoring and research offer additional information, MDE will make that information available and periodically update this guidance as needed.

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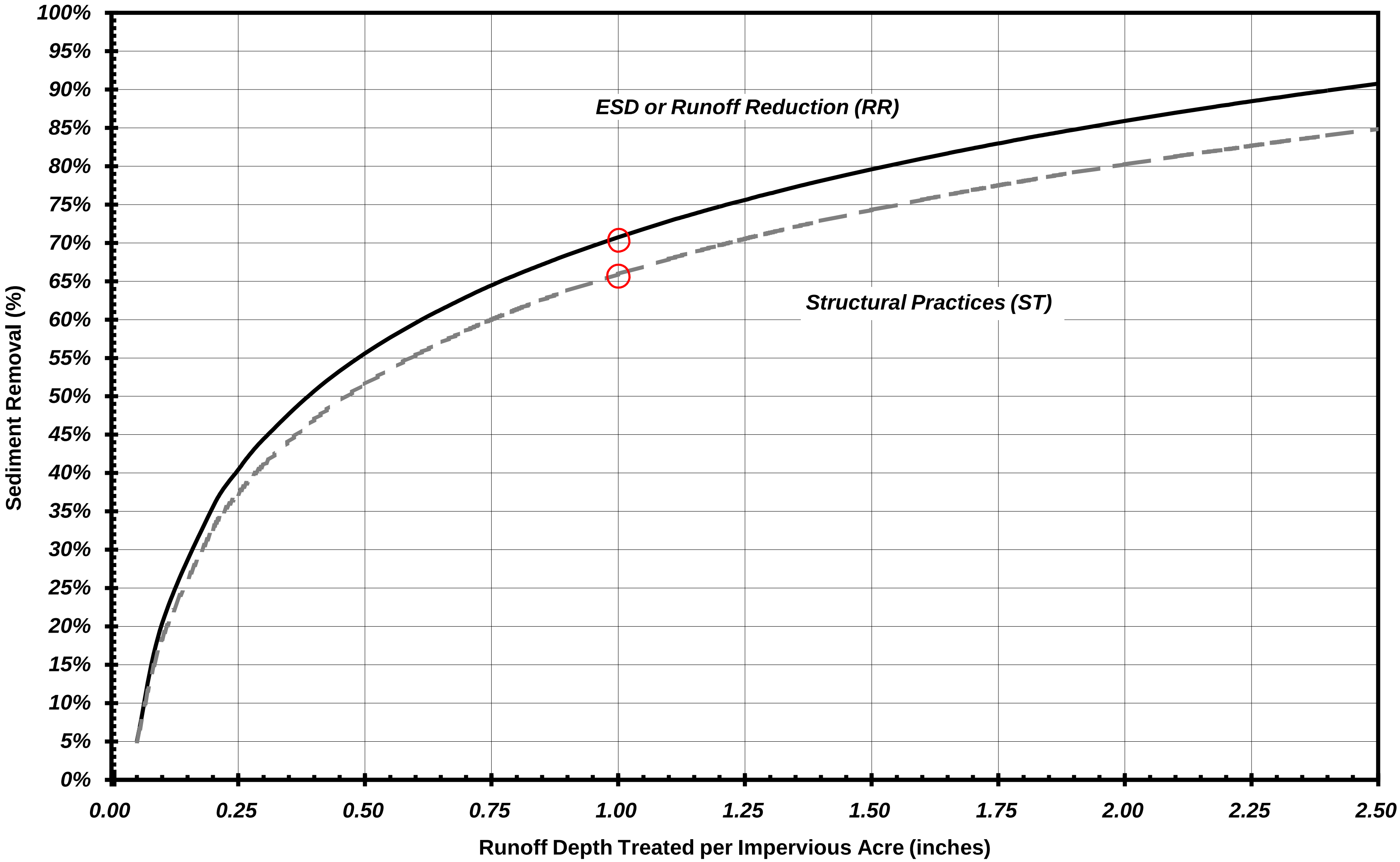
Appendix A - BMP Removal Rate Adjustor Curves (Schueler and Lane, 2012)

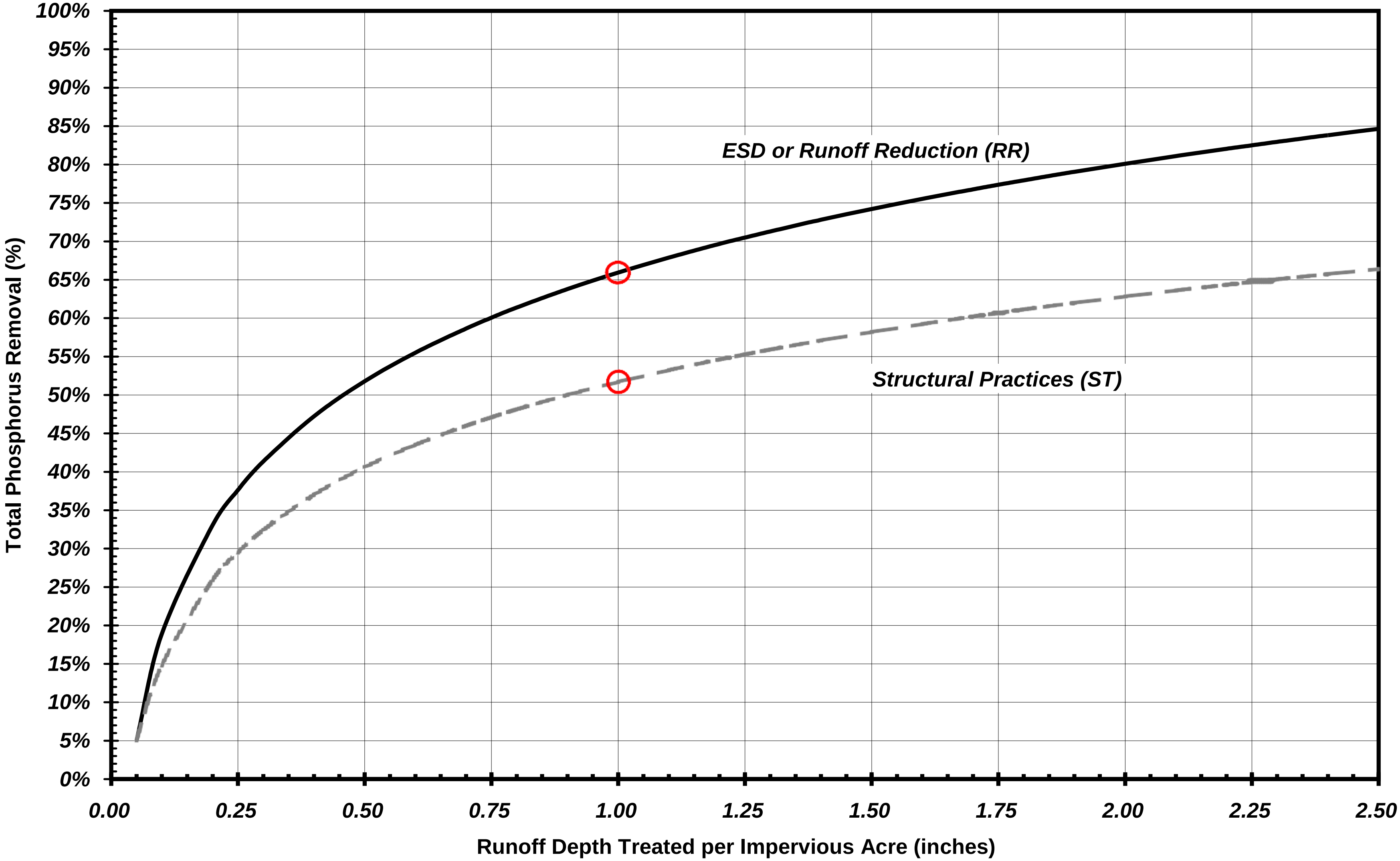
Sediment Removal

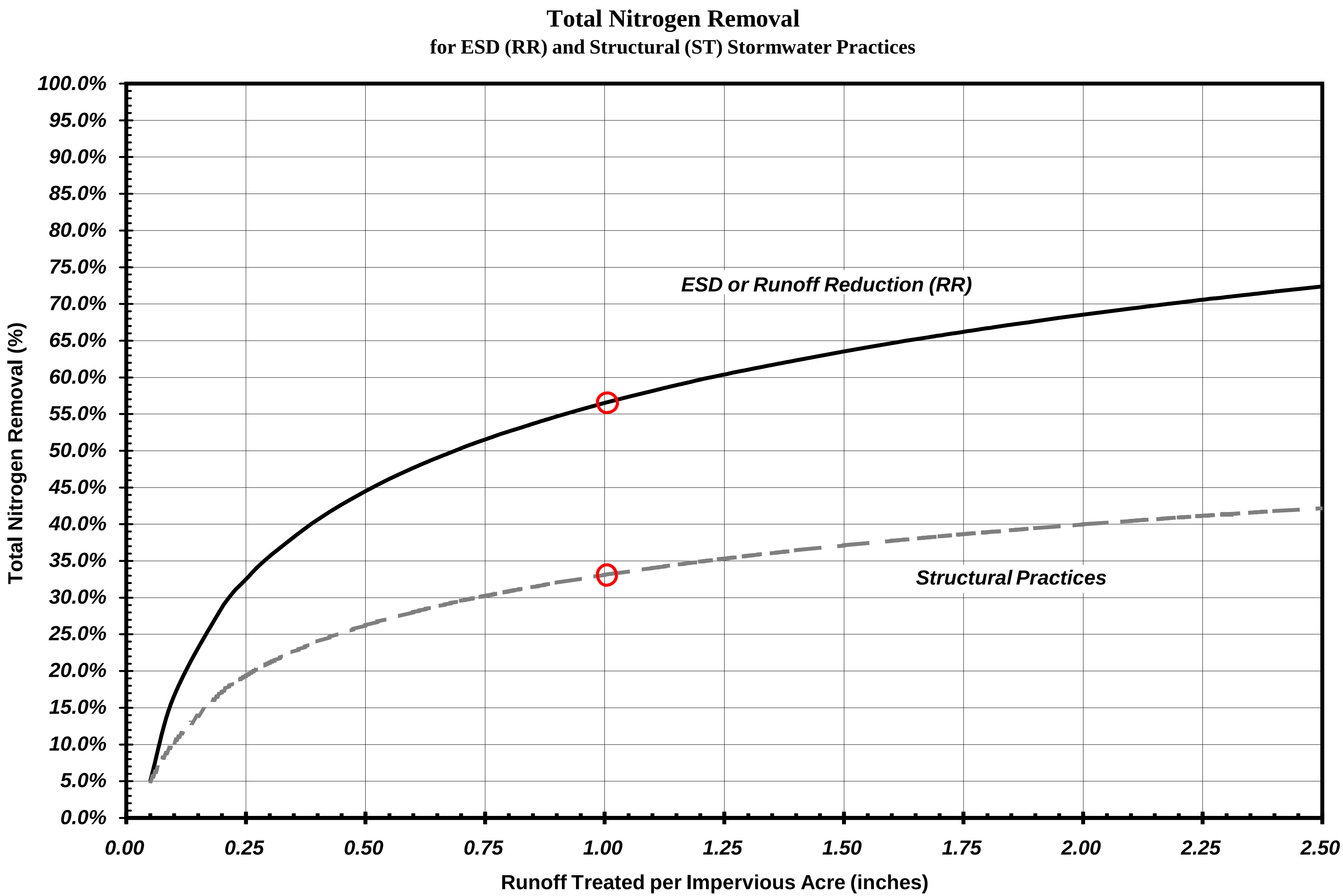
for ESD (RR) and Structural (ST) Stormwater Practices



Total Phosphorus Removal

for ESD (RR) and Structural (ST) Stormwater Practices





Total Nitrogen Removal
for ESD (RR) and Structural (ST) Stormwater Practices
100.0%
95.0%
90.0%
85.0%
80.0%
75.0%
70.0%
65.0%
60.0%
55.0%
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
Total Nitrogen Removal (%)
ESD or Runoff Reduction (RR)
Structural Practices
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Runoff Treated per Impervious Acre (inches)

Appendix B – BMP Data Reporting and Codes

Reporting Requirements: Prior to this guidance, permittees were required to submit databases to MDE that conformed to Attachment A (Annual Report Databases) of their NPDES MS4 permit. More recently, there have been significant changes to both Maryland's stormwater management program (e.g., ESD) and the CBP reporting requirements. Recognizing these changes, MDE is developing a geodatabase to more efficiently collect and organize the information submitted as part of the NPDES MS4 annual reporting. When this geodatabase is complete, MDE will provide a user guide with specific instruction on the reporting and use of the database. Until this geodatabase is implemented, Table B.1 below, *Urban Best Management Practices (BMPs) Associated with GIS Coverage*, should be used to submit this information to MDE.

The BMP database will tabulate a list of all BMPs within a jurisdiction. However, the ESD to the MEP mandate requires numerous ESD practices to be installed throughout a site in order to meet stormwater requirements. In these cases, local jurisdictions may enter the system of ESD practices by specifying the number and type of BMPs used to meet the target rainfall requirements (PE_REQ). This data may be entered in the NUM_BMPS and ESD_MEP fields shown below.

B.1. Urban Best Management Practices (BMPs) Associated with GIS Coverage

Column Name	Data Type	Size	Description
YEAR	NUMBER	4	Annual report year
MDE_STRU_ID	TEXT	8	Unique structure ID[1]
MD_NORTH	NUMBER	8	Maryland grid coordinate (NAD 83 meters) Northing
MD_EAST	NUMBER	8	Maryland grid coordinate (NAD 83 meters) Easting
WATERSHED8DGT	NUMBER	20	Maryland 8-digit hydrologic unit code
WATERSHED12DGT	NUMBER	20	USGS 12-digit hydrologic unit code
STRU_NAME	TEXT	60	Name of structure
BMP_CLASS	TEXT	1	BMP classification category (see list of BMPs: E, S, or A)
BMP_TYPE	TEXT	4	Type of BMP structure (see list of BMPs: enter code) [2]
NUM_BMPS	NUMBER	4	Number of all BMPs used to meet PE_REQ
ESD_MEP	TEXT	75	Type of all BMPs used to meet PE_REQ
LAND_USE	NUMBER	3	Predominant land use[3]
PERMIT_NO	TEXT	10	Unique permit number
ADDRESS	TEXT	50	Structure address
CITY	TEXT	15	Structure address
STATE	TEXT	2	Structure address
ZIP	NUMBER	10	Structure address
ON_OFF_SITE	TEXT	3	On or offsite structure
CON_PURPOSE	TEXT	4	New development (NEWD), Redevelopment (REDE), or Restoration (REST)
DRAIN_AREA	NUMBER	8	Structure drainage area (acres)[4]
IMP_ACRES	NUMBER	8	Structure impervious drainage area (acres)[4]
TOT_DRAIN	NUMBER	8	Total site area (acres)
PE_REQ	NUMBER	4	P_E required[5]
PE_ADR	NUMBER	4	P_E addressed[6]

IMP_ACRES_REST	NUMBER	4	Equals IMP_ACRES when PE_ADR = 1 inch (for restoration only)
RCN_PRE	NUMBER	2	Runoff curve number (weighted)[7]
RCN_POST	NUMBER	2	Runoff curve number (weighted)[7]
RCN_WOODS	NUMBER	2	Runoff curve number (weighted)[7]
APPR_DATE	DATE/TIME	8	Permit approval date
BUILT_DATE	DATE/TIME	8	As Built completion date
GEN_COMNT	TEXT	60	General comments
ADDITIONAL DATA REQUIREMENTS FOR ALL ALTERNATIVE BMPS			
TN_RED	NUMBER	12	Total load reduced after restoration (lbs)
TP_RED	NUMBER	12	Total load reduced after restoration (lbs)
TSS_RED	NUMBER	12	Total load reduced after restoration (lbs)
TN_LOAD	NUMBER	12	Load before restoration (lbs)
TP_LOAD	NUMBER	12	Load before restoration (lbs)
TSS_LOAD	NUMBER	12	Load before restoration (lbs)
PROJECT_LENGTH	NUMBER	6	For stream restoration, shoreline stabilization, or outfall stab in feet
ACRES_SWEPT	NUMBER	6	Acres swept for street sweeping
TIMES_SWEPT	NUMBER	6	Number of times per year area is swept
ACRES_PLANTED	NUMBER	6	Acres of trees planted on urban impervious (IMPF)
ACRES_PLANTED	NUMBER	6	Acres of trees planted on pervious (FPU)
IMPERV_ACR_REM	NUMBER	6	Impervious acres removed to pervious land (IMPP)
EQ_IMP_ACRES	NUMBER	6	Equivalent impervious acres treated by alternative BMP (see Table 7)
ADDITIONAL DATA REQUIREMENTS FOR STREAM RESTORATION			
NAME_OF_PROJECT	TEXT	25	Name of project
DESCR_OF_PROJECT	TEXT	75	Brief description of project
PERCENT_IMPERV	NUMBER	6	Watershed percent imperviousness
TSS_LOAD	NUMBER	12	Watershed TSS load before restoration (lbs/year)
TN_LOAD	NUMBER	12	Watershed TN load before restoration (lbs/year)
TP_LOAD	NUMBER	12	Watershed TP load before restoration (lbs/year)
PROTOCOL(S) OR INTERIM RATE	TEXT	8	Protocol 1 (P1), Protocol 2 (P2), Protocol 3 (P3); or interim rate (IR)
TSS_RED_P1	NUMBER	10	TSS load reduction (lbs/year) for P1
TN_RED_P1	NUMBER	10	TN load reduction (lbs/year) for P1
TP_RED_P1	NUMBER	10	TP load reduction (lbs/year) for P1
PRELENGTH_LT	NUMBER	10	Left side pre-restoration stream length connected to floodplain where bank height ratio is 1.0 or less
PRELENGTH_RT	NUMBER	10	Right side pre-restoration stream length connected to floodplain where bank height ratio is 1.0 or less
PREWIDTH_LT	NUMBER	10	The left side pre-restoration stream width taken from the thalweg to the edge of connected side of stream, as indicated by bank height ratio of 1.0 or less
PREWIDTH_RT	NUMBER	10	The right side pre-restoration stream width taken from the thalweg to the edge of connected side of stream, as indicated by bank height ratio of 1.0 or less
POSTLENGTH_LT	NUMBER	10	Left side post restoration stream length connected to floodplain where bank height ratio is 1.0 or less
POSTLENGTH_RT	NUMBER	10	Right side post restoration stream length connected to floodplain where bank height ratio is 1.0 or less
POSTWIDTH_LT	NUMBER	10	The left side post restoration stream width taken from the thalweg to the edge of connected side of stream, as indicated by bank height ratio

			of 1.0 or less
POSTWIDTH_RT	NUMBER	10	The right side post restoration stream width taken from the thalweg to the edge of connected side of stream, as indicated by bank height ratio of 1.0 or less
TSS_RED_P2	NUMBER	10	TSS load reduction (lbs/year) for P2
TN_RED_P2	NUMBER	10	TN load reduction (lbs/year) for P2
TP_RED_P2	NUMBER	10	TP load reduction (lbs/year) for P2
UP_DRAIN_AREA	NUMBER	6	Upstream area draining to stream restoration project
FP_WETLAND_AREA	NUMBER	6	Area (acres) of floodplain/wetland connected to stream
RATIO_FP_UPDA	NUMBER	3	Ratio of FP_WETLAND_AREA to UP_DRAIN_AREA
TSS_EFF_P3	NUMBER	10	TSS loading rate reduction efficiency (percent) for P3
TN_EFF_P3	NUMBER	10	TN loading rate reduction efficiency (percent) for P3
TP_EFF_P3	NUMBER	10	TP loading rate reduction efficiency (percent) for P3
TSS_RED_P3	NUMBER	10	TSS load reduction (lbs/year) for P3
TN_RED_P3	NUMBER	10	TN load reduction (lbs/year) for P3
TP_RED_P3	NUMBER	10	TP load reduction (lbs/year) for P3
TSS_RED_IR	NUMBER	10	TSS load reduction (lbs/year) for IR
TN_RED_IR	NUMBER	10	TN load reduction (lbs/year) for IR
TP_RED_IR	NUMBER	10	TP load reduction (lbs/year) for IR
REASON FOR USING INTERIM RATE	TEXT	75	Brief explanation of why interim rate was used in place of protocols
INSPECTION/MAINTENANCE DATA REQUIRED FOR ALL NEW, REDEVELOPMENT, RETROFIT, AND ALTERNATIVE BMPS			
BMP_STATUS	TEXT	4	Pass/Fail
LAST_INSP_DATE	DATE/TIME	8	Last inspection date
MAIN_DATE	DATE	8	Last date maintenance was performed
REINSP_STATUS	DATE/TIME	4	Pass/Fail
REINSP_DATA	DATE/TIME	4	Reporting Year
REPORTING YEAR	TEXT	8	Date last change made to this record
GEN_COMNT	TEXT	60	General comments

MDE Approved BMP Classifications

ESD BMPs		
Category	Code	Code Description
Alternative Surfaces (A)		
E	AGRE	Green Roof – Extensive
E	AGRI	Green Roof – Intensive
E	APRP	Permeable Pavements
E	ARTF	Reinforced Turf
Nonstructural Techniques (N)		
E	NDRR	Disconnection of Rooftop Runoff
E	NDNR	Disconnection of Non-Rooftop Runoff
E	NSCA	Sheetflow to Conservation Areas
Micro-Scale Practices (M)		
E	MRWH	Rainwater Harvesting
E	MSGW	Submerged Gravel Wetlands
E	MILS	Landscape Infiltration
E	MIBR	Infiltration Berms
E	MIDW	Dry Wells
E	MMBR	Micro-Bioretention

E	MRNG	Rain Gardens
E	MSWG	Grass Swale
E	MSWW	Wet Swale
E	MSWB	Bio-Swale
E	MENF	Enhanced Filters
Structural BMPs		
Ponds (P)		
S	PWED	Extended Detention Structure, Wet
S	PWET	Retention Pond (Wet Pond)
S	PMPS	Multiple Pond System
S	PPKT	Pocket Pond
S	PMED	Micropool Extended Detention Pond
Wetlands (W)		
S	WSHW	Shallow Marsh
S	WEDW	ED – Wetland
S	WPWS	Wet Pond – Wetland
S	WPKT	Pocket Wetland
Infiltration (I)		
S	IBAS	Infiltration Basin
S	ITRN	Infiltration Trench
Filtering Systems (F)		
S	FBIO	Bioretention
S	FSND	Sand Filter
S	FUND	Underground Filter
S	FPER	Perimeter (Sand) Filter
S	FORG	Organic Filter (Peat Filter)
S	FBIO	Bioretention
Open Channels (O)		
S	ODSW	Dry Swale
S	OWSW	Wet Swale
Other Practices (X)		
S	XDPD	Detention Structure (Dry Pond)
S	XDED	Extended Detention Structure, Dry
S	XFLD	Flood Management Area
S	XOGS	Oil Grit Separator
S	XOTH	Other

MDE Approved Alternative BMP Classifications

Alt. BMPs (A)	Code	Code Description
A	MSS	Mechanical Street Sweeping
A	VSS	Regenerative/Vacuum Street Sweeping
A	IMPP	Impervious Surface Elimination (to pervious)
A	IMPF	Impervious Surface Elimination (to forest)
A	FPU	Planting Trees or Forestation on Pervious Urban
A	CBC	Catch Basin Cleaning
A	SDV	Storm Drain Vacuuming
A	STRE	Stream Restoration
A	OUT	Outfall Stabilization
A	SPSC	Regenerative Step Pool Storm Conveyance
A	SHST	Shoreline Management
A	SEPP	Septic Pumping
A	SEPD	Septic Denitrification

A	SEPC	Septic Connections to WWTP

Notes:

1. Use unique structure identification codes listed below
2. For ESD to MEP, enter the most predominant BMP type
3. Use Maryland Office of Planning (MDP) land use codes listed below
4. GIS shapefile required
5. Rainfall target (from Table 5.3, Design Manual pp.5.21-22) used to determine ESD goals and size practices (for new development or redevelopment). If practice is for restoration, then PE_REQ is 1inch.
6. Rainfall addressed (using both ESD techniques and practices, and structural practices) by the BMPs within the drainage area
7. Optional - information should be submitted if available

Unique Structure Identification Codes: Each stormwater best management structure or water quality improvement project will need a unique identification code. For management of these data statewide it is necessary that these codes also indicate the jurisdiction where they are implemented. Please use the County, City, or State abbreviations listed below as part of each structure's unique identification code.

Jurisdiction	Code
Anne Arundel County	AA
Baltimore City	BC
Baltimore County	BA
Carroll County	CA
Charles County	CH
Frederick County	FR
Harford County	HA
Howard County	HO
Prince George's County	PG
Montgomery County	MO
Maryland State Highway Administration	SHA

MDP Land Use/Land Cover

10 Urban Built-up

- **11 Low Density Residential** – Detached single family/duplex dwelling units, yards, and associated areas. Areas of more than 90 percent single family/duplex dwelling units, with lot sizes less than five acres but at least one-half acres (0.2 dwelling units/acre to 2 dwelling units/acre).

- **12 Medium Density Residential** – Detached single family/duplex, attached single unit row housing, yards, and associated areas. Areas of more than 90 percent single family/duplex units and attached single unit row housing, with lot sizes of less than one-half acre but at least one-eighth acre (2 dwelling units/acre to 8 dwelling units/acre).

- **13 High Density Residential** – Attached single unit row housing, garden apartments, high rise apartments/condominiums, mobile home and trailer parks. Areas of more than 90 percent high density residential units, with more than 8 dwelling units/acre.

- **14 Commercial** – Retail and wholesale services. Areas used primarily for the sale of products and services, including associated yards and parking areas.

- **15 Industrial** – Manufacturing and industrial parks, including associated warehouses, storage yards, research laboratories, and parking areas.

- **16 Institutional –** Elementary and secondary schools, middle schools, junior and senior high schools, public and private colleges and universities, military installations (built-up areas only, including buildings and storage, training, and similar areas) churches and health facilities, correctional facilities, and government offices and facilities that are clearly separable from the surrounding land cover.

- **17 Extractive –** Surface mining operations, including sand and gravel pits, quarries, coal surface mines, and deep coal mines. Status of activity (active vs. abandoned) is not distinguished.

- **18 Open Urban Land –** Urban areas whose use does not require structures, or urban areas where non-conforming uses characterized by open land have become isolated. Included are golf courses, parks, recreation areas (except associated with schools or other institutions), cemeteries, and entrapped agricultural and undeveloped land within urban areas.

- **191 Large Lot Subdivision (Agriculture) –** Residential subdivisions with lot sizes less than 20 acres but at least 5 acres, with a dominant land cover of open fields or pasture.

- **192 Large Lot Subdivision (Forest)** - Residential subdivisions with lot sizes less than 20 acres but at least 5 acres, with a dominant land cover of deciduous, evergreen or mixed forest.

20 Agriculture

- **21 Cropland –** Field and forage crops.

- **22 Pasture –** Land used for pasture, both permanent and rotated: grass.

- **23 Orchards/Vineyards/Horticulture –** Areas of intensively managed commercial bush and tree crops, including areas used for fruit production, vineyards, sod and seed farms, nurseries, and green houses.

- **24 Feeding Operations –** Cattle or hog feeding lots, poultry houses, and holding lots for animals, and commercial fishing areas (including oyster beds).

- **241 Feeding Operations –** Cattle or hog feeding lots, poultry houses, and holding lots for animals.

- **242 Agricultural Building –** Breeding and training facilities, storage facilities, built-up areas associated with a farmstead, small farm ponds, and commercial fishing areas.

- **25 Row and Garden Crops –** Intensively managed track and vegetable farms and associated areas.

40 Forest

- **41 Deciduous Forest –** Forested areas in which the trees characteristically lose their leaves at the end of the growing season. Included are such species as oak, hickory, aspen, sycamore, birch, yellow poplar, elm, maple, and cypress.

- **42 Evergreen Forest** - Forested areas in which the trees are characterized by persistent foliage throughout the year. Included are such species as white pine, pond pine, hemlock, southern white cedar, and red pine.

- **43 Mixed Forest –** Forested areas in which neither deciduous or evergreen species dominate, but in which there is a combination of both types.

- **44 Brush –** Areas that do not produce timber or other wood products but may have cut-over timber stands, abandoned agriculture fields, or pasture. These areas are characterized by vegetation types such as sumac, vines, rose, brambles, and tree seedlings.

50 Water – Rivers, waterways, reservoirs, ponds, bays, estuaries, and ocean.

60 Wetlands – Forested and non-forested wetlands, including tidal flats, tidal and non-tidal marshes, and upland swamps and wet areas.

70 Barren Land

- **71 Beaches –** Extensive shoreline areas of sand and gravel accumulation, with no vegetative cover or other land use.

- **72 Bare Exposed Rock –** Areas of bedrock exposure, scarps, and other natural accumulations of rock without vegetative cover.

- **73 Bare Ground –** Areas of exposed ground caused naturally, by construction, or other cultural processes.

80 Transportation - Transportation features include major highways, light rail or metro stations and large "Park N Ride" lots, generally over ten acres in size. Major highways were defined a those appearing on the State Highway maps as Controlled Access Highways or Primary Highways.

Appendix C - Stormwater Models and Weblinks

1. Model Selection

Computer models can aid local jurisdictions in establishing stormwater baseline pollutant loads, planning restoration work, and showing progress toward meeting WLAs. Maryland's Assessment and Scenario Tool (MAST) developed for the CBP and the Hydrological Simulation Program -- Fortran (HSPF), the Stormwater Management Model (SWMM), and spreadsheet versions like the Watershed Treatment Model (WTM) are acceptable for use by Maryland's NPDES localities. MAST is the only model that relates directly to the CBP model and where pollutant removal credits may be assured under the Bay's TMDL.

Other models and results can be compared to the Chesapeake Bay Watershed Model (CBWM) for compliance with NPDES stormwater permit requirements. While different models may generate different baseline pollutant loads, the reductions from implementing water quality improvement projects will be the same because they will all be based on the approved set of CBP urban BMPs and pollutant reduction efficiencies. As a result, all models will be comparable on a percent reduction basis as long as one model is consistently used throughout the permit term. Websites with documentation on the use of various models are listed below.

Maryland Assessment and Scenario Tool:
http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Documents/Webinars/April/WIP_Webinar_2011-04-13_MAST.pdf

Hydrological Simulation Program -- Fortran:
http://water.usgs.gov/software/HSPF/

Stormwater Management Model:
http://www.epa.gov/ednnrmrl/models/swmm/index.htm

Watershed Treatment Model:
http://www.stormwatercenter.net/monitoring%20and%20assessment/WTM_Users_Notes.htm

The BayFAST Tool:
http://www.bayfast.org

2. CBP Loading Rates

In order to develop greater consistency among the models and actual stormwater WLAs, MDE recommends that MS4s use the same urban pollutant loads that were used to develop the Bay TMDL and Maryland's WIPs. For example, CBWM version 5.3.2 pollutant loads were used for the development of Maryland's Phase II WIP. The pollutant loads for nutrients and sediment in version5.3.2 are shown in Table A.1 below.

Table A.1 CBP Annual Urban Runoff Loads Per Acre, Version 5.3.2			
Parameter	**Urban Impervious**	**Urban Pervious**	**Weighted All Urban**
TN (lbs)	15.3	10.8	11.7
TP (lbs)	1.69	0.43	0.68
TSS (tons)	0.44	0.07	0.18
Source: CBWM version 5.3.2, Maryland Statewide average urban loading rates without BMPs provided by MDE, Science Service Administration, Jeff White, 2014b.			

For ease in modeling, Maryland used a weighted pollutant load average for all CBP urban land covers (impervious high density, impervious low density, pervious high density, and pervious low density) in developing its WIPs. Jurisdictions may use these same pollutant loads along with land use data to calculate stormwater wasteloads being discharged from municipal storm drain systems.

Appendix D – Alternative BMPs and Equivalent Impervious Acres

While structural BMPs have a clearly defined drainage area and imperviousness, the task of relating an impervious area controlled by alternative stormwater management practices such as street sweeping, reforestation, and stream restoration becomes more difficult. Alternative stormwater management practices, however, do provide significant pollutant load reductions and should receive a credit toward NPDES impervious acre restoration requirements. MDE has developed a method for relating the reduction in pollutant loads from alternative practices into an equivalent impervious acre.

Table D.1 Pollutant Loads for Impervious and Forest Cover

Parameter	Impervious (lbs/acre/yr)	Forest (lbs/acre/yr)	Delta (lbs/acre/yr)
TN	10.85	3.16	7.69
TP	2.04	0.13	1.91
TSS (tons)	0.46	0.03	0.43

Source: CBWM version 5.3.0, Maryland statewide average urban loading rates without BMPs provided by the Science Services Administration, MDE, 2011.

This approach is based on the pollutant loads associated with runoff from an acre of impervious land cover and an acre of forest. The CBWM estimates that the TN load in runoff from an impervious acre is 10.85 lbs annually while the load from an acre of forest is 3.16 lbs annually. The difference between the two land covers is 7.69 lbs of TN per year. The Delta for TP and TSS loads are also shown in Table D.1. These differences can be used to set a level of implementation that alternative practices would need to meet to mimic forest conditions.

Example 1. Alternative BMPs Used for Impervious Areas

Some alternative BMPs, like street sweeping, are almost exclusively implemented on impervious surface areas, e.g., roads and parking lots. In these instances, the pollutant load (runoff) from impervious surfaces, the approved BMP efficiencies for street sweeping, and a unit rate of implementation (1 acre), can be used to calculate a pollutant load reduction in lbs (Table D.2). If the Delta between impervious and forest land cover is divided into the lbs reduced as a result of street sweeping, then an equivalent impervious acre conversion factor can be derived. Because Chesapeake Bay's TMDLs are based on TN, TP, and TSS, the equivalent impervious acre analyses for all three pollutants are averaged together to determine a single weighted equivalent impervious acre conversion factor of 0.07 (Table D.3).

Table D.2 Estimated Pollutant Load Reductions from Mechanical Street Sweeping

Parameter	Implementation Units	Urban Impervious (lbs/acre/yr)	Reduction Efficiency	Pollutant Load Reduction (lbs/acre/yr)
TN	1 acre	10.85	4%	0.43
TP	1 acre	2.04	4%	0.08
TSS (tons)	1 acre	0.46	10%	0.05

Table D.3 Equivalent Impervious Acre Analyses for Street Sweeping				
Parameter	**Implementation Units**	**Treatment Delta (lbs)**	**BMP Load Reduction (lbs)**	**Impervious Acre Conversion Factor**
TN	1 acre	7.69	0.43	0.06
TP	1 acre	1.91	0.08	0.04
TSS (tons)	1 acre	0.43	0.05	0.12
Average for Nutrients and Sediment:				0.07

Examples are presented in Table D.4 using the equivalent impervious acre conversion factor for street sweeping, or 0.07, along with various drainage areas, e.g., 2, 50, and 100 acres, to calculate an equivalent impervious acre. An equivalent impervious acre analysis has been conducted by MDE for each alternative stormwater management practice and is presented in the main guidance document in Table 7, Alternative Urban BMPs.

Table D.4 An Equivalent Impervious Acre		
Implementation Units	**Conversion Factor for Street Sweeping**	**Impervious Acre Equivalent**
2 acres	0.07	0.14
50 acres	0.07	3.5
100 acre	0.07	7.0

Example 2. Alternative BMPs Used in Pervious Urban Areas

Some BMPs are exclusively used in pervious urban areas. For example, this includes the reforestation of previously grassed areas. In these cases, the urban pollutant load for pervious urban is used. The following example shows how MDE derived an equivalent impervious acre conversion factor for the reforestation of pervious urban areas.

Table D.5 Estimated Pollutant Load Reductions for Reforestation on Pervious Urban				
Parameter	**Implementation Units**	**Urban Pervious (lbs/acre/yr)**	**Reduction Efficiency**	**Pollutant Load Reduction (lbs/acre/yr)**
TN	1 acre	9.43	66%	6.22
TP	1 acre	0.57	77%	0.44
TSS (tons)	1 acre	0.07	57%	0.40

In this example, runoff load is based solely on urban pervious runoff. Next, using the BMP efficiencies for reforestation and a unit rate of implementation (1 acre), a pollutant load reduction in pounds can be determined as shown in Table D.5. The Delta between impervious and forest land cover is divided into the lbs reduced as a result of reforestation so that an equivalent impervious acre ratio can be derived. By adding the TN, TP, and TSS impervious acre conversion factors together and then dividing by 3, a weighted equivalent impervious acre of 0.38 is calculated, see Table D.6. This means that for every acre of reforestation on pervious urban land cover, a jurisdiction may take 0.38 acres of impervious acre credit.

Table D.6 Equivalent Impervious Acre Analyses for Reforestation of Pervious Urban Acres				
Parameter	**Implementation Units**	**Treatment Delta (lbs)**	**BMP Load Reduction (lbs)**	**Impervious Acre Conversion Factor**
TN	1 acre	7.69	6.22	0.81
TP	1 acre	1.91	0.44	0.23
TSS (tons)	1 acre	0.43	0.40	0.09
Average for Nutrients and Sediment:				0.38

CBP 5.3.0 vs. 5.3.2 Urban Pollutant Loads

The equivalent impervious acre rates in this guidance were derived in the early part of 2011 from CBWM 5.3.0, see Table D.7. Since that time, version 5.3.2 established new pollutant loads and are now being used in model scenario runs and assessments. MDE believes that the equivalent impervious acre rates and credits developed under 5.3.0 remain valid for numerous reasons, even with the introduction of the new 5.3.2 loads.

Table D.7 CBP Annual Urban Runoff Loads Per Acre, Version 5.3.0 vs. 5.3.2						
Parameter	**Urban Impervious**		**Urban Pervious**		**Weighted All Urban**	
	5.3.0	**5.3.2**	**5.3.0**	**5.3.2**	**5.3.0**	**5.3.2**
TN (lbs)	10.85	15.3	9.43	10.8	9.96	11.7
TP (lbs)	2.04	1.69	0.57	0.43	0.97	0.68
TSS (tons)	0.46	0.44	0.07	0.07	0.18	0.18
Source: CBWM version 5.3.2, Maryland statewide average urban loading rates without BMPs provided by Jeff White, Science Services Administration, MDE, 2014.						

First, while TN rates have gone up by 15% in version 5.3.2, TP is now 30% less and TSS is exactly the same as CBWM version 5.3.0. Because all three parameters are averaged together in developing the equivalent impervious acre rates, the weighted average of all three in 5.3.2 is only a 5% difference from the weighted 5.3.0 average. MDE does not believe that this change is significant enough to recalculate impervious acre equivalencies, which local governments have been using since 2011.

Another important benefit of maintaining consistent equivalent impervious acre credits is that MDE can provide a higher level of predictability to local governments in the assessment and implementation of practices for meeting MS4 permit requirements. If further science and information on urban runoff loads are used to significantly alter pollutant loading rates for TN, TP, and TSS in future CBP watershed modeling, MDE may recalculate the equivalent impervious acre rates found in this guidance for alternative BMPs.

Appendix E – Alternative BMPs and Pollutant Load Reductions

Pollutant Load Reductions and Alternative BMPs

The impervious area equivalents and associated efficiencies for all alternative BMPs are identified in Table 7 of this document. Supplemental information on how nutrient and sediment load reductions were established for alternative BMPs is provided below. The pollutant load reduction rates for each practice may be used to show progress toward WLA goals.

1. Street Sweeping

MS4 jurisdictions are required to implement maintenance programs that reduce pollutants associated with activities on County-owned properties. Street sweeping is commonly used for this purpose. This practice uses mechanical or vacuum-assisted sweeper trucks to remove the buildup of pollutants that have been deposited along streets or curbs.

The pollutant load reductions only apply to an enhanced street sweeping program where the streets are located in commercial, industrial, central business district, or high density residential neighborhoods that are swept on a regular basis, e.g., twice per month. Areas for the dewatering of and permanent disposal of materials collected from street sweeping, catch basin cleaning, and other similar activities must be located so that discharges back to surface or ground waters do not occur. Localities can use either the mass loading or street lane methods described below to calculate the projected load reductions associated with street sweeping.

a. **Mass Loading Approach**: For the mass loading approach, the street debris collected is measured in tons at the landfill or acceptable disposal location and converted to pounds. Before calculating pollutant load reductions, a "dry mass" of the material swept must be determined. This can be done by multiplying the total pounds of material swept by 70%. The pounds of total nitrogen (TN) and total phosphorus (TP) can be calculated by multiplying the total dry mass in pounds by 0.0025 and 0.001, respectively. Because a majority of the material swept is much larger in size than that which is measured by total suspended solids (TSS) sampling, an additional calculation is needed to determine an accurate TSS reduction rate. This can be done by multiplying the dry mass weight in pounds by 30% to reflect the fraction of material that represents TSS particle size (Law et al., 2008).

b. **Street Lane Approach**: For the street lane approach, a jurisdiction shall report the number of lane miles swept during the course of the year. The following formula is used to convert lane miles swept into acres:

$$\frac{\text{(miles swept)} \times \text{(5,280 ft/mile)} \times \text{(lane width ft)}}{\text{43,560 ft}^2\text{/acre}}$$

The total acres swept is multiplied by the annual nutrient and sediment load for impervious surfaces, or 10.85 lbs/acre for TN, 2.04 lbs/acre for TP, and 0.46 tons/acre for TSS to arrive at a baseline load. The baseline load can be multiplied by the pollutant removal efficiencies shown in Table E.1 to determine the load reduction associated with street sweeping.

The sediment and nutrient reductions are based on the sweeping technology in use, with lower reductions for mechanical sweeping and higher reductions for vacuum-assisted or regenerative air sweeping technologies. Street sweeping is an annual BMP that will need to be updated yearly based on program implementation rates. To get credit toward the Chesapeake Bay TMDL, the MS4 jurisdiction shall report either the tons of debris removed (mass loading approach) or the number of acres swept (street lane approach). This information may also be used for showing progress toward local TMDLs.

Table E.1. Street Sweeping Pollutant Removal Efficiencies

Method	TN	TP	TSS
Mechanical	4%	4%	10%
Regenerative/Vacuum	5%	6%	25%

(CBP Street Sweeping Efficiencies, 2011)

2. Catch Basin Cleaning and Storm Drain Vacuuming

Typically, catch basin cleaning and storm drain vacuuming are activities associated with a jurisdiction's storm drain system maintenance program. This involves performing routine cleanouts on targeted infrastructure with high sediment accumulation rates. Catch basin cleaning is an annual BMP that must be updated yearly based on program implementation rates. The projected nutrient reduction associated with storm drain cleanout programs is calculated using the mass loading approach described for street sweeping.

3. Impervious Surface Elimination

Eliminating impervious surfaces and replacing them with vegetation will improve urban hydrology and water quality. A stormwater WLA credit for this practice is based on the pollutant load reduction expected when land cover is converted from impervious to pervious or forest based on CBWM loading rates for these land uses. Two scenarios are shown in Table E.2. One is the conversion of urban impervious to pervious, and the other is the conversion of urban impervious to forest. The difference in pollutant loads between land covers can be used to calculate pollutant load reduction credits.

Table E.2 Pollutant Reduction Associated with Impervious Surface Elimination
(Adapted from CBWM, Version 5.3.0, 2011)

Conversion from	TN (lbs/acre/yr)	TP (lbs/acre/yr)	TSS (tons/acre/yr)
Urban Impervious	10.85	2.04	0.44
Pervious	9.43	0.57	0.07
Efficiency	13%	72%	84%
Conversion from	**TN (lbs/acre/yr)**	**TP (lbs/acre/yr)**	**TSS (tons/acre/yr)**
Urban Impervious	10.85	2.04	0.44
Forest	3.16	0.13	0.03
Efficiency	71%	94%	93%

4. Tree Planting and Reforestation

Tree planting and reforestation activities provide water quality benefits. To claim these credits a survival rate of 100 trees per acre or greater is necessary with at least 50% of the trees having a diameter of two inches or greater at 4.5 feet above ground level (Maryland Department of Natural Resources, 2009). Because contiguous one-acre parcels are difficult to locate in the urban setting, an aggregate of smaller sites may be used. However, a minimum of 0.25 acre parcels may be aggregated as long as the required survival rates are maintained.

A stormwater WLA credit for this practice is based on the pollutant load reduction expected when land cover is converted from urban to forest based on CBWM loading rates for these land uses. Examples of the expected pollutant reduction for converting urban pervious and impervious land cover to forest are shown in Table E.3. To get stormwater WLA credit toward the Chesapeake Bay and local TMDLs, the MS4 jurisdiction must report acres of trees planted.

Table E.3 Tree Planting and Reforestation Pollutant Load Reduction
(Adapted from CBWM, Version 5.3.0, 2011)

Conversion from	TN (lbs/acre/yr)	TP (lbs/acre/yr)	TSS (tons/acre/yr)
Urban Pervious	9.43	0.57	0.07
Forest	3.16	0.13	0.03
Efficiency	66%	77%	57%
Conversion from	**TN (lbs/acre/yr)**	**TP (lbs/acre/yr)**	**TSS (tons/acre/yr)**
Urban Impervious	10.85	2.04	0.44
Forest	3.16	0.13	0.03
Efficiency	71%	94%	93%

5. Regenerative Step Pool Storm Conveyance

Regenerative Step Pool Storm Conveyance (SPSC) practices have been used for retrofitting unstable and degraded stormwater conveyance channels. The Anne Arundel County SPSC design guidelines (2012) defines this practice as “open-channel conveyance structures that convert, through attenuation ponds and a sand seepage filter, surface storm flow to shallow groundwater flow.” When these practices are used in ephemeral or dry channels as retrofits to capture the runoff from one inch of rainfall, the pollutant removal efficiencies from the most similar BMP type may be used. Because these practices apply to dry conveyance channels, they are located in small drainage areas (e.g., 10 acres). The SPSC performs very similar to a filtration practice, therefore, the pollutant removal efficiencies for micro-bioretention can be applied to the drainage area treated (See Table 6 for appropriate efficiencies based on runoff depth treated for a given application). This is consistent with recommendations in Schueler and Stack (2014) for this practice. An impervious acre credit will be granted based on the proportion of the full water quality volume treated, as described in Table 2. When these practices are implemented as part of a stream restoration project, the procedures for crediting and reporting shall be done according to the stream restoration protocols described below.

6. Stream Restoration

a. **Impervious Area Equivalent**: The impervious area equivalent for stream restoration was originally developed using the Spring Branch efficiency data (approved by the CBP in 2003). Using the method described in Appendix D, MDE calculated an impervious acre credit of 0.01 acres per linear foot of restoration (noted in Table 7). MDE believes that this is a fair credit, as stream restoration should not be considered a substitute for providing adequate attenuation of untreated impervious area in the upland. Therefore, the impervious acre credit of 1.0 acre per 100 linear feet of stream channel will remain.

   Outfall stabilization typically entails the repair of localized areas of erosion below a storm drain pipe and often involves exposed infrastructure. Most outfall stabilization activities do not fit the qualifying conditions of a stream restoration project (as noted in Appendix F) because there are insufficient data available to provide allowable nutrient and sediment removal rates. However, MDE will allow these projects to take credit toward impervious area restoration according to the credit of 1 acre per 100 linear feet of the project. The maximum credit granted for these projects is 2 acres.

b. **New Pollutant Load Reduction Efficiencies**: New pollutant removal credits for stream restoration are described in the CBP approved document "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects" (Schueler and Stack, 2014). This report describes four protocols for defining pollutant load reductions for stream restoration projects. The protocols allow individual project credit toward nutrient and sediment removal through the use of field data and specific calculations. This replaces the former policy of accepting a universal removal rate for all stream restoration projects.

   MDE recommends that the procedures outlined in Schueler and Stack (2014) should be followed for calculating nutrient and sediment load reductions for individual projects. However, MS4 jurisdictions may propose an alternative approach for calculating credit under the protocols. Any MS4 jurisdiction interested in pursuing alternative monitoring or technical procedures to calculate credit under each of the protocols should submit a formal proposal for MDE review and comment.

   Schueler and Stack (2014) provide a literature review, references, and the scientific basis behind the protocols. The design examples provided in the report shall be referenced by all MS4 jurisdictions in order to calculate nutrient and sediment removal credits for individual projects.

c. **Using the Revised Interim Rate for Current Projects and Planning**: In the past, the CBP had approved a universal removal rate for stream restoration based on the Spring Branch studies (Baltimore County Department of Environmental Protection and Sustainability, 2008). This allowed jurisdictions to use a simple calculation to determine nutrient load reductions for any stream restoration project. Schueler and Stack (2014) may be referenced for a historic overview of the universal stream restoration rate and a discussion involving recent revisions. Table E.4 provides the "revised interim rate" which is scheduled for final voting by the CBP WQGIT on August 11, 2014. After the final voting by CBP, MDE will advise MS4 jurisdictions on the status of the approval.

Table E.4 Stream Restoration Revised Interim Removal Rates per Linear Foot (lb/ft/yr)				
Source	**TN**	**TP**	**TSS[1]**	
			Coastal Plain	Non-Coastal Plain
Revised Interim Rate	0.075	0.068	15.1	44.9

[1] The TSS removal rates are based on whether a project is located in the coastal plain or non-coastal plain. Schueler and Stack (2014) provides a discussion of the TSS removal rate and application of a sediment delivery ratio based on the location of the project. The TSS removal rates shown above were derived by multiplying 248 lb/ft/yr by the average CBWM (version 5.3.2) sediment delivery ratio for projects located in the coastal plain (0.061) and non-coastal plain (0.181).

The revised interim removal rates may be used by local programs for assessing stormwater WLA credit for stream restoration under certain conditions. Some projects may be too far along in the design and planning process to undergo the full evaluation using the procedures outlined in Schueler and Stack (2014). MDE supports allowing projects to proceed without delay (provided that they satisfy all regulatory requirements) and will allow the revised interim rate in Table E.4 to be used for calculating stormwater WLA credit for new stream restoration projects through the end of 2015. MS4 jurisdictions may also use removal rates in Table E.4 to quickly estimate load reductions during the planning phase for future projects. The revised interim rate may also be used for historic projects that meet all of the qualifying conditions described in Schueler and Stack (2014).

After 2015, site specific data must be used to calculate credit according to the protocols outlined in Schueler and Stack (2014). Use of the interim rate in combination with the protocols is not allowed. The interim rate may only be used after 2015 based on exceptional circumstances when compiling the data needed for the protocols may not be practical in order to keep project implementation on schedule. However, the long term use of the interim rate will be limited.

d. Regulatory Authorization of Projects: Page 5 of Schueler and Stack (2014) provides the following disclaimer: "The Panel recognizes that stream restoration projects as defined in this report may be subject to authorization and associated requirements from federal, State, and local agencies. The recommendations in this report are not intended to supersede any other requirements or standards mandated by other government authorities. Consequently, some stream restoration projects may conflict with other regulatory requirements and may not be suitable or authorized in certain locations."

Each State has a regulatory process to address any activity that may result in stream, wetland, floodplain or waterway impacts. MDE's review process evaluates each project on a case by case basis for impacts associated with flooding, adjacent property owners, impacts to high functioning portions of the stream and wetland/floodplain ecosystem, and other regulatory considerations. Stream restoration efforts should focus on areas of severe degradation and demonstrate potential benefits to the stream ecosystem.

The calculation procedures under the protocols will typically yield a higher credit for highly degraded channels that do not have access to the floodplain. Work performed in streams that already have access to the floodplain may only receive a relatively small credit. Impacts to streams that have floodplain connection or other high functions will be cause for further regulatory review resulting in possible re-design or denial of an authorization. Early coordination with regulatory agencies is strongly encouraged.

e. Reporting: All MS4 jurisdictions are required to submit a BMP database that includes the information specified in Appendix B (Urban BMP Database) of this document. In the case of stream restoration, there are more specific data reporting elements. These data are described in Schueler and Stack (2014) and also incorporated in the Urban BMP Database in Appendix B.

In addition to the data reporting specified in Appendix B, a short report shall be submitted to show the work behind the calculation procedures. Each protocol has certain limitations with respect to the maximum stormwater WLA credit that may be granted. This information shall be noted in the report.

7. Shoreline Management

Shoreline practices apply to the Chesapeake and Atlantic Coastal Bays and tidal rivers. MDE and Maryland's Chesapeake and Coastal Bays Critical Area Protection Program encourage the use of nonstructural practices or living shorelines. These include tidal marsh creation and beach nourishment. Structural practices include stone revetments, breakwaters, and groins. Further information on the design and construction of these practices can be found in MDE's "Shoreline Erosion Control Guidelines for Waterfront Property Owners" (MDE, 2008).

The Maryland Department of Natural Resources (DNR) provides a website tool, Maryland Shorelines Online (MSO), to determine shoreline erosion rates. Using this computer-driven tool and some field measurements, the volume of soil lost can be estimated for an unprotected shoreline. The nutrient composition of eroding banks along the Bay shoreline is documented in the study, "Eroding Bank Nutrient Verification Study for the Lower Chesapeake Bay" (Ibison et al, 1992).

Baltimore County used the MSO tool and the results from Ibison (1992) to estimate the pounds retained for 23 shoreline restoration projects, both structural and nonstructural. MDE analyzed these data to establish nutrient and sediment removal rates that are applicable for use in other jurisdictions (Table E.5). Because many factors affect shoreline erosion and pollutant reduction varies, a median analysis was used to prevent the influence of data extremes.

Table E.5 can be used to determine credit for stormwater WLAs based on the linear feet of practice implementation. The Baltimore County estimates shown in Table E.5 have been approved by MDE in the past to determine credit for shoreline management practices for MS4 jurisdictions in Maryland. However, currently, the CBP is pending final approval of the report, "Recommendations of the Expert Panel to Define Removal Rates for Shoreline Management Projects" (Drescher and Stack, 2014). The report proposes a new default rate as is shown in Table E.5 and currently under consideration by CBP. If these recommendations are officially accepted by CBP, jurisdictions must use the new default rate and protocols established in Drescher and Stack (2014). The default values in Table E.5 may only be used for one year after the report is approved by CBP, unless an exception is granted by MDE on a case by case basis. After that time, Table E.5 may only be used for planning and budgeting purposes.

Table E.5 Annual Shoreline Management Credits

Practice Type	TN (lbs/linear ft)	TP (lbs/linear ft)	TSS (lbs/linear ft)
Baltimore County Estimate	0.16	0.11	451
Drescher and Stack (2014)[1]	0.075	0.068	137

[1] These rates are currently under consideration by CBP. If approved, local jurisdictions should use the rates in Drescher and Stack. MDE will advise local jurisdictions on the status of CBP approvals and final voting.

8. Nutrient Management

In 2011, Maryland passed a new law that significantly regulates the rate, timing, and application of fertilizers to urban turf grass (Annotated Code of Maryland §§ 6-201 - 6-224). Maryland's lawn fertilizer law is designed to reduce nutrients from entering local water resources and Chesapeake Bay from a variety of urban sources including golf courses, parks, recreation areas, athletic fields, businesses and, hundreds of thousands of urban and suburban lawns. Because the law regulates the amount of TN and TP in fertilizers sold in the State, every jurisdiction will benefit from reduced fertilizer content. The Maryland Department of Agriculture (MDA) tracks non-farm fertilizer sales data, and this information along with fertilizer content information will be used by the CBP to calculate nutrient reductions (CBP, 2013). MS4 jurisdictions will receive stormwater WLA credit for these reductions automatically through future CBP model runs and reduced nutrient WLAs.

9. Septic Systems

Septic Systems are considered a nonpoint source load allocation (LA) in the CBP model. When describing pollutant sectors the CBP will sometimes refer to an urban load, which is a combination of stormwater WLAs and septic system LAs. Because these two sources are often interconnected, localities can investigate opportunities to improve septic system discharges in urban areas for achieving pollutant load reductions to meet established TMDLs. Septic system pumping is considered an annual BMP and information will need to be updated annually to receive credit beyond one year. Enhanced denitrification and connection to WWTPs are considered permanent BMPs when documentation is available to confirm these upgrades are maintained.

Jurisdictions may not double count credits for reductions for septic system upgrades. Therefore, the load reductions associated with this practice may not be used to show progress toward MS4 stormwater WLA goals. This is because these numbers are already reported through local health department procedures. For this reason, Table 7 provides impervious acre credits only for septic systems.

10. Illicit Discharge Detection and Elimination

A recent draft version of the report “Recommendations of the Expert Panel to Define Removal Rates for the Elimination of Discovered Nutrient Discharges from Grey Infrastructure” has been submitted to CBP for consideration as a new BMP. The report provides a series of protocols to calculate nutrient reduction credit for various infrastructure related discharges when these problems are identified and corrected. The status of the report is pending stakeholder review and comment. If this report becomes final, MDE will advise local MS4 jurisdictions and provide direction regarding how the new protocols may be used for determining and reporting credits.

11. Other BMPs for Consideration

Maryland's MS4 jurisdictions have requested that additional BMPs be considered as acceptable options for restoration. Some of these include education, sub-soiling, trash removal, pet waste management, floodplain restoration, river bank stabilization, and bio-reactor carbon filter. However, sufficient data are not available to establish credits for these practices. MDE will consider these and any other option proposed by MS4 jurisdictions if monitoring data documenting pollutant removal capability and performance criteria are submitted for approval. Routine inspection and maintenance procedures also need to be established to ensure long term performance for these practices. MDE will work with the MS4 community and the CBP to determine the proper credit for these or other options where sufficient data justify their use as an acceptable water quality practice.