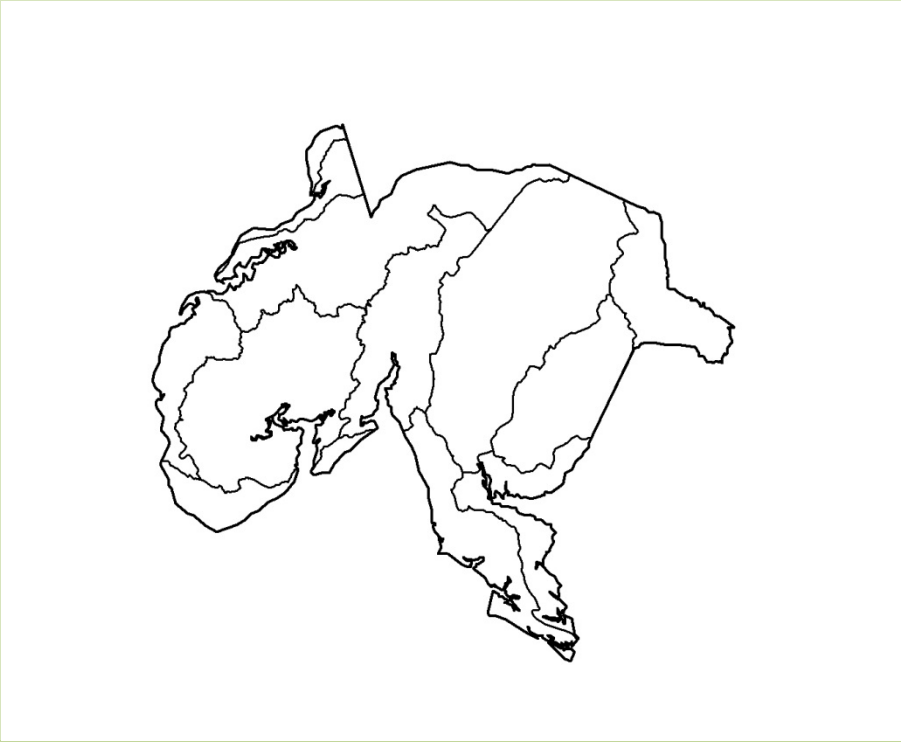
Charles County Municipal Stormwater Restoration Plan

Plan to Achieve Stormwater Waste Load Allocations and Impervious Surface Restoration



Charles County, Maryland

May 2015

Charles County Municipal Stormwater Restoration Plan

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Compliance document for Part IV.E.2.a. and b. of MS4 Discharge Permit #11-DP-3322.

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Prepared For

Charles County, Maryland
Department of Planning and Growth Management
200 Baltimore St.
La Plata, MD 20646

Prepared by

KCI Technologies, Inc.
936 Ridgebrook Road
Sparks, MD 21152

Acknowledgements

This watershed restoration plan was completed as a collaborative effort between the following partners:

Charles County Department of Planning and Growth Management

KCI Technologies, Inc.

The report was authored by the following individuals from KCI Technologies, Inc.:

Susanna Brellis

Mike Pieper

Bill Frost, P.E.

Megan Crunkleton

County staff providing expertise, oversight, and review include:

Karen Wiggen

Charles Rice

Erica Hahn

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For more information pertaining to the Restoration Plan, please contact:

Karen Wiggen, Planner
Charles County Government
Department of Planning and Growth Management
P.O. Box 2150
La Plata, MD 20646
301-645-0683
WiggenK@charlescountymd.gov

And visit us on the web:
www.charlescountymd.gov/watershed

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Appendices

Appendix A – Watershed Restoration Project Master List

Appendix B – Restoration Project Location Maps

List of Acronyms

AFG	Accounting for Growth
BayFAST	Bay Facility Assessment Scenario Tool
BMP	Best Management Practices
CBP	Chesapeake Bay Program
CIP	Capital Improvement Plan
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DEL	Delivered
EOS	Edge of Stream
EPA	U.S. Environmental Protection Agency
ESD	Environmental Site Design
LULC	Land use / Land cover
MAST	Maryland Assessment Scenario Tool
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
SHA	State Highway Administration
SPSC	Step Pool Storm Conveyance
SSO	Sanitary Sewer Overflow
SW to MEP	Stormwater to the Maximum Extent Practicable
SW-WLA	Stormwater Wasteload Allocation
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus

TSS	Total Suspended Solids
WIP	Watershed Implementation Plan
WLA	Wasteload Allocation
WQA	Water Quality Assessment
WWTP	Wastewater treatment plant

1 Introduction and Background

1.1 Purpose

Charles County, along with other large jurisdictions in Maryland, has been operating its municipal separate storm sewer system (MS4) under a National Pollutant Discharge Elimination System (NPDES) permit issued by the Maryland Department of the Environment (MDE). In recent years these permits and other stormwater regulations have been changing rapidly. The County's permit requires compliance with pollutant load limits from both the Chesapeake Bay Total Maximum Daily Load (TMDL) and local TMDLs and restoration of untreated impervious surfaces. The suite of allowable stormwater treatment options has also expanded beyond conventional stormwater best management practices (BMPs) to include alternatives such as street sweeping, catch basin cleaning, stream restoration, and tree planting.

On December 26, 2014, Charles County received a new NPDES MS4 Discharge Permit (11-DP-3322 MD0068365) from MDE that includes requirements for watershed restoration activities, specifically preparation of a restoration plan within the first year of the permit term (Section IV.E.2). To address this requirement, Charles County has developed this Restoration Plan that:

- Demonstrates ways to meet the Total Maximum Daily Load (TMDL) Stormwater Wasteload Allocations (SW-WLAs) approved by U.S. Environmental Protection Agency
- Illustrates a strategy to provide additional stormwater runoff management on impervious acres equal to 20% of the impervious area for which runoff is not currently managed to the Maximum Extent Practicable (MEP)
- Educates and involves residents, businesses, and stakeholders in achieving measurable water quality improvements
- Establishes a reporting framework for annual reporting under the County's MS4 permit
- Provides an evaluation and adaptive management process for developing actions to be taken if permit requirements are not met
- Identifies the funding needed to implement the Restoration Plan

1.2 Plan Development

MDE has prepared several guidance documents to assist municipalities with preparation of TMDL restoration plans. This plan is developed following the guidance detailed in the following documents with modifications as necessary:

- General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan (MDE, 2014d)
- Guidance for Using the Maryland Assessment Scenario Tool (MAST) to Develop Stormwater Wasteload Allocation Implementation Plans for Local Nitrogen, Phosphorus, and Sediment TMDLs (MDE, 2014b)
- Guidance for Developing Stormwater Wasteload Allocation Implementation Plans for Nutrient and Sediment Total Maximum Daily Loads (MDE, 2014e)
- Guidance for Developing a Stormwater Wasteload Allocation Implementation Plan for Bacteria Total Maximum Daily Loads (MDE, May 2014a)
- Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated (MDE, 2014c)
- Draft Maryland Trading and Offset policy and Guidance Manual, Chesapeake Bay Watershed (MDE, 2016)

It is noted that the Restoration Plan is an important first step; however, the MS4 permit calls for an iterative and adaptive plan for implementation. If new methods of stormwater treatment are identified, or better approaches to source control are found, the plans can be extended and updated to take the changes into account. Similarly, if some elements of the plans are not as successful as expected, adaptations and improvements will be incorporated in future updates. Plans may also change if pollutant removal crediting methods are modified in the future.

1.3 Charles County MS4 Permit

Section 402(p) of the Clean Water Act required the Environmental Protection Agency (EPA) to add MS4 discharges to the NPDES permit program. In 2002, EPA directed permit writers to include WLA requirements in NPDES permits, including those for MS4 discharges. Charles County is one of five medium jurisdictions in Maryland that is regulated by a NPDES MS4 Discharge Permit (Section 402(p) of the Water Quality Act of 1987 and NPDES Permit Application Regulations for Storm Water Discharges of November 16, 1990). Charles County's first permit went into effect on May 1, 1997 and the County received its third permit on December 26, 2014 (11-DP-3322 MD0068365). This third permit includes the following new requirements related to Restoration Plans, impervious surface treatment, and TMDLs among others.

Permit Requirements

One objective of this plan is to meet the County's MS4 NPDES permit requirement to restore 20% of the County's impervious surface area that has not already been restored to the MEP per permit section PART IV.E.2.a. Another objective is to develop restoration plans for local TMDLs, specifically each SW-WLA approved by EPA, prior to the effective date of the permit, per permit section PART IV.E.2.b. Plans must be developed within the first year of permit issuance. Charles County's final permit was issued on December 26, 2014 therefore the restoration plans was to be complete by December 26, 2015. An extension was granted by MDE and Charles County's plan is now due on June 30, 2016.

The following specific permit sections and language apply:

PART IV. Standard Permit Conditions

E. Restoration Plans and Total Maximum Daily Loads

2. Restoration Plans

a. Within one year of permit issuance, Charles County shall submit an impervious surface area assessment consistent with the methods described in the MDE document "Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollutant Discharge Elimination System Stormwater Permits" (MDE, June 2011 or subsequent versions). 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, Charles County 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. Equivalent acres restored of impervious surfaces, through new retrofits or the retrofit of pre-2002 structural BMPs [Best Management Practices], shall be

based upon the treatment of the WQv criteria and associated list of practices defined in the 2000 Maryland Stormwater Design Manual. For alternate BMPs, the basis for calculation of equivalent impervious acres restored is based upon the pollutant loads from forested cover.

b. *Within one year of permit issuance, Charles 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, Charles County shall:*

   i. *Include 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;*

   ii. *Provide detailed cost estimates for individual projects, programs, controls, and plan implementation;*

   iii. *Evaluate and track the implementation of restoration plans through monitoring or modeling to document the progress toward meeting established benchmarks, deadlines, and stormwater WLAs; and*

   iv. *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.*

Further, the permit requires continual outreach to the public regarding the development of its watershed assessments and restoration plans and requires public participation in the TMDL process (permit section PART IV.E.3.a-d).

The permit requires an annual progress report presenting the assessment of the NPDES stormwater program based on the fiscal year. A TMDL assessment report including complete descriptions of the analytical methodology used to evaluate the effectiveness of the County's restoration plans and how these plans are working to achieve compliance with EPA approved TMDLs is a component of the annual report. The assessment includes: estimated net change in pollutant load reductions from water quality improvement projects; a comparison of the net change to targets, deadlines, and applicable WLAs; cost data for completed projects; cost estimates for planned projects; and a description of a plan for implementing additional actions if targets, deadlines, and WLAs are not being met (permit section PART IV.E.4.a-e).

In addition to the standard permit conditions described above, the County is also required to address additional programmatic conditions specific to the Chesapeake Bay TMDL as outlined below:

PART VI. Special Programmatic Conditions

A. Chesapeake Bay Restoration by 2025

A Chesapeake Bay TMDL has been developed by the EPA for the six Bay States (Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia) and the District of Columbia. The TMDL describes the level of effort that will be necessary for meeting water quality criteria and restoring the Chesapeake Bay. This permit is requiring compliance with the Chesapeake Bay TMDL through the use of a strategy that calls for the restoration of twenty percent of previously developed impervious land with little or no controls within this five year permit term as described in Maryland's Watershed Implementation Plan. The TMDL is an aggregate of nonpoint sources or the load allocation (LA), and point sources or WLA, and a margin of safety. The State is required to issue NPDES permits to point source discharges that are consistent with the assumptions of any applicable TMDL, including those approved subsequent to permit issuance.

Urban stormwater is defined in the Clean Water Act (CWA) as a point source discharge and will subsequently be a part of Maryland's WLA. The NPDES stormwater permits can play a significant role in regulating pollutants from Maryland's urban sector and in the development of Chesapeake Bay Watershed Implementation Plans. Therefore, Maryland's NPDES stormwater permits issued to Charles County and other municipalities will require coordination with MDE's Watershed Implementation Plan and be used as the regulatory backbone for controlling urban pollutants toward meeting the Chesapeake Bay TMDL by 2025.

1.4 MS4 Permit Coverage

Under previous permits, MDE considered the area within the Charles County Development District as regulated area. MDE now considers the MS4 Permit for Charles County to be the entire county with the exception of lands which have their own NPDES stormwater permits (Figure 1) including federal lands, state highway lands, other state lands, and municipal lands. NPDES regulated industrial facilities are also excluded from the County's permit coverage. MDE notes that the inclusion of private and non-urban land in the MS4 permit is based on the rationale that stormwater management for private property in Maryland is locally administered for plan approval, inspection, and enforcement, and that these facilities are inherently a part of a locality's storm drain system. The County's SW-WLA responsibilities are only for those areas included in the MS4 area, as well as County properties within municipal boundaries.

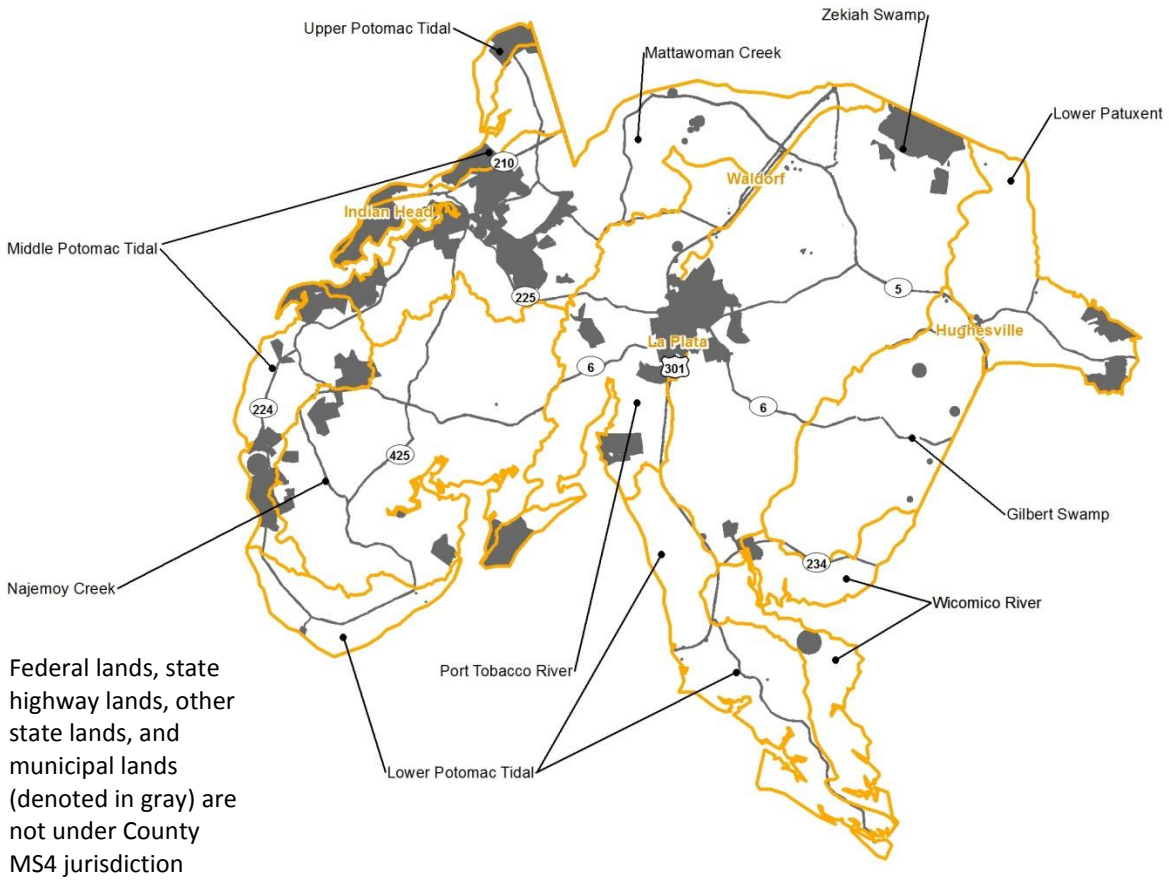

Figure 1. County Watershed and MS4 Permit Area

1.5 Anticipated Growth

Future urban sector growth and the anticipated increase in urban loads that may result are expected to be controlled by two elements: stormwater management to the MEP that is required with new development, and anticipated "Accounting for Growth" policies. This Restoration Plan is developed to treat the reduction required from the initial baseline year load, calibrated to the current Bay model. Based on coordination with MDE, TMDL restoration planning should focus on the untreated and undertreated areas associated with the urban footprint at the time of the TMDL baseline. Future loads and loads potentially added to the urban sector since the baseline year to present are not accounted for here as they are addressed under other programs. MDE has requested in restoration plan development guidance (MDE, 2014d) that jurisdictions begin estimating potential additional loads, therefore estimates are included in section 2.3.2.

1.5.1 Offsetting Loads from Future Growth

Growth and development is expected to occur throughout Charles County, and depending on when and where this growth occurs, pollutant loading from urban stormwater sources may also increase. It is anticipated that new development will make use of Environmental Site Design (ESD) stormwater treatment according to MDE's Stormwater Regulations.

Maryland's 2007 Stormwater Management Act went into effect in October of 2007, with resulting changes to COMAR and the 2000 Maryland Stormwater Design Manual in May of 2009. The most significant changes relative to watershed planning are in regard to implementation of ESD. The 2007 Act defines ESD as "using small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources."

The following section discusses projected land use loads with the application of stormwater BMPs to the maximum extent practicable (SW to the MEP). TMDL modeling efforts to estimate future loads include the application of SW to the MEP to represent ESD treatment for new development in the watershed. SW to the MEP will control 50%, 60%, 90%, and 70% of nitrogen, phosphorus, sediment and bacteria loads, respectively, for new development.

Anticipated "Accounting for Growth" policies will address the residual load (Total Nitrogen (TN): 50%, Total Phosphorus (TP): 40%, Total Suspended Solids (TSS): 10%, and bacteria: 30%) that is potentially uncontrolled by development-based stormwater controls. As required by the State's Watershed Implementation Plan (Bay Restoration Plan) Maryland is developing an Accounting for Growth (AFG) policy that will address the expected increase in the State's pollution load from increases in population growth and new development. While not currently a fully formed policy, the State's plan, as of the *Final Report of the Workgroup on Accounting for Growth in Maryland* (August 2013) focuses on two elements: 1) the strategic allotment of nutrients loads to large wastewater treatment plants, upgraded to the best available technology; and 2) the requirement that all other new loads must be offset by securing pollution credits.

1.5.2 Estimates of Future Growth

As stated in the MDE guidance document General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan, Section 1.h. (MDE, 2014d):

New urban areas that have been developed since TMDL allocations were set imply loads beyond the original SW-WLA (i.e., additional urban footprint within a watershed). This can confound the process of accounting for load reductions to meet the allocations. MDE is working to develop methods to deal with this issue. However, MDE is also recommending that within the SW-WLA implementation plans, local jurisdictions estimate this potential new urban load as the next step in a longer-term process to address the issue.

Therefore, Charles County has developed a basic estimate of increases in loads relative to the Bay TMDL at the Countywide scale, and for the two watersheds with SW-WLA, Mattawoman, and Indian Creek.

To estimate increases in loads over time for TN, TP and TSS, an analysis was completed using a combination of MAST modeled loads and projected loading estimates in addition to estimates based on recent growth patterns. The estimates were completed at the Countywide scale (i.e., sum of all watersheds) and for the Mattawoman Creek watershed. The average percent change in County Phase I MS4 urban land use acres (impervious and pervious acres) was calculated as the average percent change observed between MAST land use acres from 2010 through 2015. There was a 1.7% annual average Countywide increase in County Phase I MS4 urban land use acres observed between 2010 and 2015 (Table 1) and an average annual percent change of 0.8% for Mattawoman Creek (Table 4).

The pace of growth in loads is consistent with growth projections outlined in Charles County's Water Resources Element (WRE) (Charles County, 2011). The WRE is built upon projections developed by Maryland Department of Planning (MDP) in 2008. These projections indicate that County population will reach approximately 204,200 by the year 2030, which follows an annual increase of approximately 1.7 percent per year.

Projected TN, TP, and TSS Edge of Stream (EOS) and Delivered (DEL) loads were calculated by applying the average percent change observed between MAST loading results for County Phase I MS4 urban land (impervious and pervious acres) from 2010 through 2015 to loads of the previous year by watershed and Countywide.

Charles County average percent change in County Phase I MS4 background pollutant loads are shown in Table 2 which ranges from 1.5% to 1.9%. Average percent change in County Phase I MS4 background loads for watersheds with listed local TMDL pollutants are shown in Table 4 with an average percent change of 0.8% for Mattawoman Creek. In this manner, a 1.5% annual increase in TSS-EOS Countywide loads and a 0.8% annual increase in TP-EOS loads in Mattawoman Creek would be expected from 2015 to 2025 if development were to occur at the same rate and be implemented without BMPs. Because new development will implement BMPs under Maryland's stormwater regulations, the resultant loading increases were reduced by 50% for TN, 60% for TP, and 90% for TSS based on the MAST removal rates for nutrients and sediment treated by stormwater treatment to the maximum extent practicable (SW to the MEP). Projected loading with application of SW to the MEP was incorporated in both Bay and local TMDL modeling and is shown in Table 3 and Table 4. These additional loads are cumulative since 2015; for example, 2017 additional land use loads consists of additional loads for 2016 growth and 2017 growth.

Table 1. Charles County Average Annual Percent Change in County Phase I MS4 Urban Land Use Acres

County Phase I MS4 - Urban Land Use Acres	
2010	41,012
2015	44,515
Total % Change	8.5%
Average Annual % Change	1.7%

Table 2. Charles County Average Percent Change in County Phase I MS4 Background Pollutant Loads

No BMP County Phase I MS4 Urban Land Use Loads	TN EOS-lbs/yr	TN DEL-lbs/yr	TP EOS-lbs/yr	TP DEL-lbs/yr	TSS EOS-lbs/yr	TSS DEL-lbs/yr
2010	251,573	190,464	22,530	19,791	6,669,712	7,474,268
2015	272,801	208,247	24,304	21,415	7,159,666	8,061,608
Average % Change	1.7%	1.9%	1.6%	1.6%	1.5%	1.6%

Table 3. Additional Estimated Future Loads for Charles County Bay TMDL

Additional Land Use Loads - With SW to MEP	TN EOS-lbs/yr	TN DEL-lbs/yr	TP EOS-lbs/yr	TP DEL-lbs/yr	TSS EOS-lbs/yr	TSS DEL-lbs/yr
2017 Estimate	4,604	3,889	306	281	21,038	25,340
2019 Estimate	9,207	7,778	613	562	42,076	50,680
2025 Estimate	23,019	19,444	1,531	1,406	105,189	126,699

Additional loads are cumulative since 2015

Table 4. Mattawoman Creek Nutrient Local TMDLs – Estimated Future Increases in Land Use and Pollutant Loads

Year	MS4 Urban Land Use Acres	TN EOS-lbs/yr	TP EOS-lbs/yr
2010	12,173	74,838	6,782
2015	12,681	77,951	7,059
Total % Change	4.2%	4.2%	4.2%
Average Annual % Change	0.8%	0.8%	0.8%
Additional Land Use Loads - With SW to MEP		**TN EOS-lbs/yr**	**TP EOS-lbs/yr**
	2017 Estimate	2,626	176
	2019 Estimate	7,230	482
	2025 Estimate	21,041	1,401

The average percent change in bacteria loads in the Indian Creek watershed was derived based on the number of septic systems in the watershed and the annual average percent increase in septic systems over time, extrapolated forward. Based on septic system GIS data, at the end of 2001, the TMDL baseline year, there were 299 residential dwelling units with septic systems. This number increased to 486 at the end of 2014, the last year data were available, an increase of 187 over the 13 year period (Table 5).

Table 5. Indian Creek Estimated Growth in Septic System Units

Year	New Units	Cumulative Total	Annual Percent Increase
2001	22	298	7.9%
2002	46	344	15.4%
2003	27	371	7.8%
2004	20	391	5.4%
2005	15	406	3.8%
2006	12	418	2.9%
2007	5	423	1.2%
2008	9	432	2.1%
2009	11	443	2.5%
2010	15	458	3.4%
2011	7	465	1.5%
2012	4	469	0.9%
2013	7	477	1.5%
2014	9	486	1.9%

Using a 10 year period from 2004 to 2014, there is an average 2.5% increase per year in new septic systems. Extrapolating the number of units forward to 2025 based on an annual increase of 2.5% results in a total 549 units as of 2019, the end of the current permit term, and 635 by 2025 (Table 6).

Table 6. Estimate Number of New Septic System Units

Year	New Units	Cumulative Total
2015-2019	63	549
2020-2025	86	635

1.6 Impairments, Water Quality, and Land Use/Land Cover

1.6.1 Impairments

Sources of water quality impairments vary across the landscape. The most common impairments in the urban environment are nutrients (nitrogen and phosphorus), sediment, bacteria, and impairment to the biological condition of streams. Impairments can have different implications for management. Impairments that cause a water body to not meet its designated use require the responsible jurisdiction to address the impairment to enable that water body to meet its designated use once again. The mechanism for this in Maryland is through the development and implementation of TMDLs.

1.6.2 Water Quality

Use Designations

Use classes for Maryland streams are defined in the Code of Maryland Regulations (COMAR) 26.08.02.02. For each use class there are several designated uses. Use Class I has the following designated uses: growth and propagation of fish (not trout), other aquatic life and wildlife; water contact sports; leisure activities involving direct contact with surface water; fishing; agricultural water supply; and industrial water supply. Use Class II refers to tidal waters and contains all of the designated uses of Use Class I with the addition of: propagation and harvesting of shellfish; seasonal migratory fish spawning and nursery use; seasonal shallow-water submerged aquatic vegetation use; open-water fish and shellfish use; and seasonal deep-channel refuge use. Use Class III contains all of the designated uses of Use Class I with the addition of the growth and propagation of trout. Use Class IV contains all of the designated uses of Use Class I and is also capable of supporting adult trout for a put-and-take fishery. Use classes with the '-P' suffix contain all of the designated uses of the use class with the addition of public water supply. Therefore, Use Class III-P has the designated uses of Use Class I with the addition of growth and propagation of trout, and public water supply.

The spatial extent for stream and impoundment use classes is defined in COMAR 26.08.02.08. A map of stream and impoundment use class for Charles County is presented in Figure 2. Use Classes within Charles County include Use Class I, Class I-P, and Class II. Use Class I streams within Charles County are defined as: tributaries to the Lower Patuxent River, Potomac River, Mattawoman Creek, Port Tobacco River, Wicomico River, Nanjemoy Creek not designated Use Class II, Zekiah Swamp and all tributaries,

and Gilbert Swamp and all tributaries. The one Use Class I-P stream within Charles County is an unnamed tributary to Zekiah Swamp Run between the confluence with Piney Branch and Stoner Creek. Use Class II streams within Charles County are defined as: Lower Patuxent River and tributaries not designated Use Class I, Potomac River and tributaries not designated Use Class I, Mattawoman Creek and tributaries not designated Use Class I, Port Tobacco River and tributaries not designated Use Class I, Wicomico River and tributaries not designated Use Class I, and Nanjemoy Creek and tributaries not designated Use Class I. There are no Use Class II-P, III, III-P, IV, or IV-P streams in Charles County. Two impoundments in Charles County (Myrtle Grove Lake and Gilbert Run Lake) are listed at Use Class I.

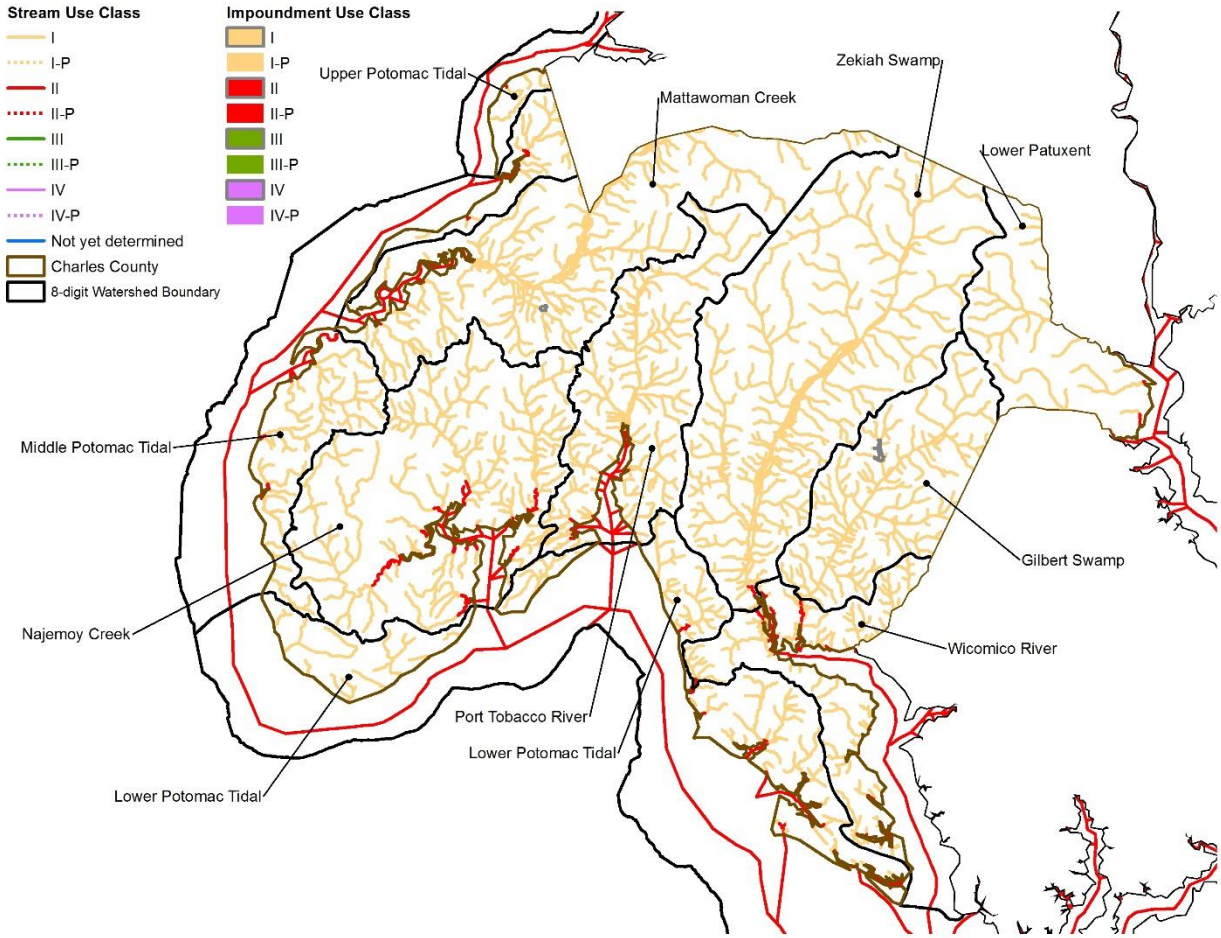

Figure 2. Charles County Stream and Impoundment Designated Use Classes

303(d) Impairments

According to Maryland's final 2014 list of impaired waters (MDE, 2015a), several segments within Charles County are listed for water quality impairments as previously discussed in Section 1.1.2 and shown in Table 13. Charles County contains ten Category 4a stream segments which include those waters that are not meeting their use designation but for which a TMDL has been developed to address impairments. Category 4a waters include four watersheds listed for sediment, seven watersheds listed for phosphorus, seven watersheds listed for nitrogen, one watershed listed for bacteria, and three watersheds listed for PCBs. Category 5 waters, which include those waters that are not meeting their

use designation and require a TMDL, include five watersheds listed for an unknown pollutant (i.e., cause unknown), one watershed listed for chlorides, one watershed listed for low pH, one watershed listed for total suspended solids, one watershed listed for fecal coliform, one watershed listed for enterococcus, and two watersheds listed for PCB in fish tissue.

1.6.3 Biological Condition

The condition of Charles County's watersheds, as indicated by Benthic Index of Biotic Integrity (BIBI) scores, is shown in the following map of Maryland Biological Stream Survey (MBSS) stream monitoring results (Figure 3). While stream conditions vary across the county, degradation is more common where the urban area is more dense or older. This reflects, in part, the history of urban and suburban development prior to effective stormwater management regulations. Stream condition is generally better in the more rural parts of the county, but stream degradation still occurs in these areas as a likely result of large lot development and legacy agricultural impacts. By reducing the adverse effects of stormwater runoff throughout the county, this Restoration Plan should improve the condition of County streams and watersheds over time.

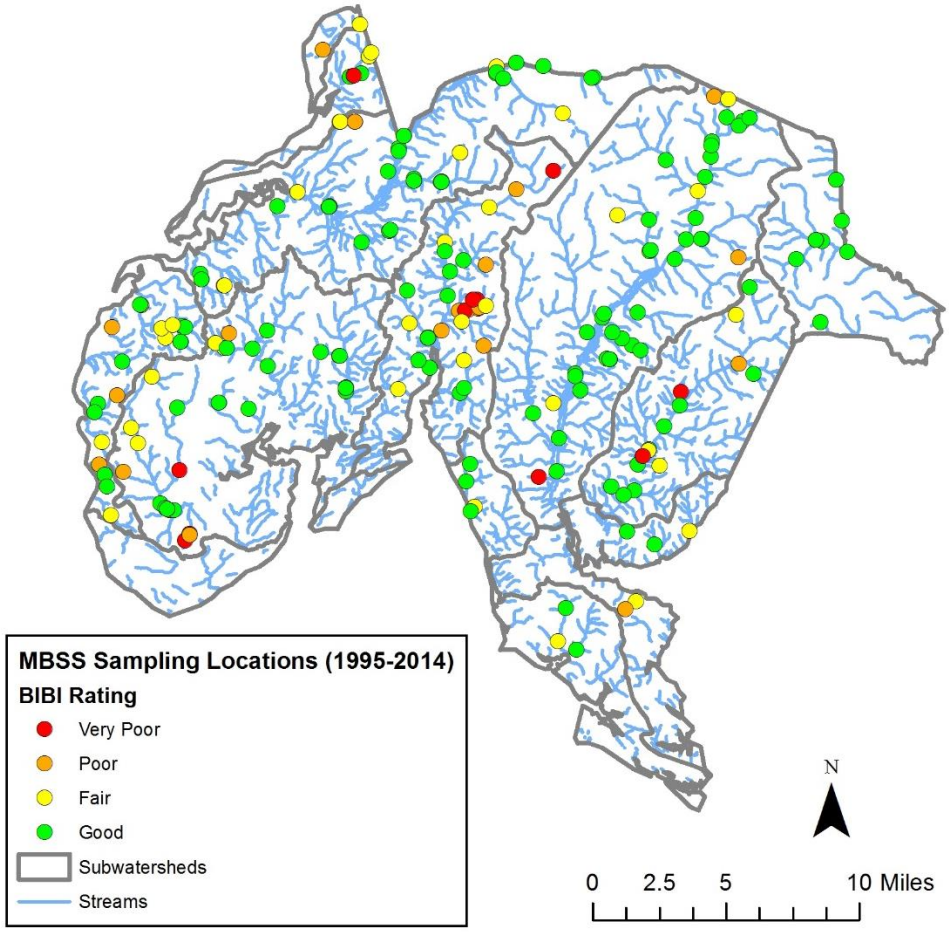

Figure 3. Condition of Charles County streams as indicated by sampling of benthic macroinvertebrate communities at random locations by Maryland DNR (1995 - 2014)

1.6.4 Land Use/Land Cover

The type and density of various land uses can have a dramatic effect on water quality and stream habitat. Forested areas slow stormwater flow and allow water to gradually seep into soils and drain into streams. Vegetation and soils bind nutrients and pollutants found within stormwater—improving water quality as it infiltrates the ground. Developed areas, with a high percentage of impervious surfaces (buildings, paved roads, parking lots, etc.), do not reduce either the volume or flow of stormwater—increasing the amount of pollutants entering streams. Increased stormflow affects stream habitat negatively by increasing bank erosion and decreasing instream and riparian habitat. Agricultural land, if managed incorrectly, can also impair streams with increases nutrients and bacteria.

Land use / land cover (LULC) data from Maryland Department of Planning (MDP, 2010) is presented in Figure 4. Data presented in the figure and tables below were used to characterize the County and show potential pollution sources. These LULC data were not used in the calculations of loads and load reduction, which were based instead on the land-river segment scale from the Chesapeake Bay Program Partnership Watershed Model.

Existing Land Use/Land Cover

According to 2010 LULC data (Table 7), the largest category in Charles County is forest (55.5%) followed by urban, or developed land (24.8%) and agriculture (16.3%). Developed land largely consists of residential (low-density 11.2%, large lot subdivisions (large lot agriculture 1.5%, large lot forest 4.8%, and medium-density 2.9%). Residential areas as a total make up 21.1% of the County.

Land use / land cover data are summarized by watershed in Table 8. The watershed in Charles County with the largest percentage of urban land is Mattawoman Creek (39.5%) followed by Patuxent River Lower (38.9%) and Port Tobacco River (33.0%). The watershed with the least amount of urban land is Wicomico River (7.5%), followed by Potomac River Lower Tidal (12.7%), and Nanjemoy Creek (14.7%). Potomac River Middle and Upper Tidal (72.7% and 72.6%, respectively) are the watersheds with the largest portion of forested land. Wicomico River (35.0%) and Gilbert Swamp (25.9%) are the watersheds with the largest amount of agricultural lands.

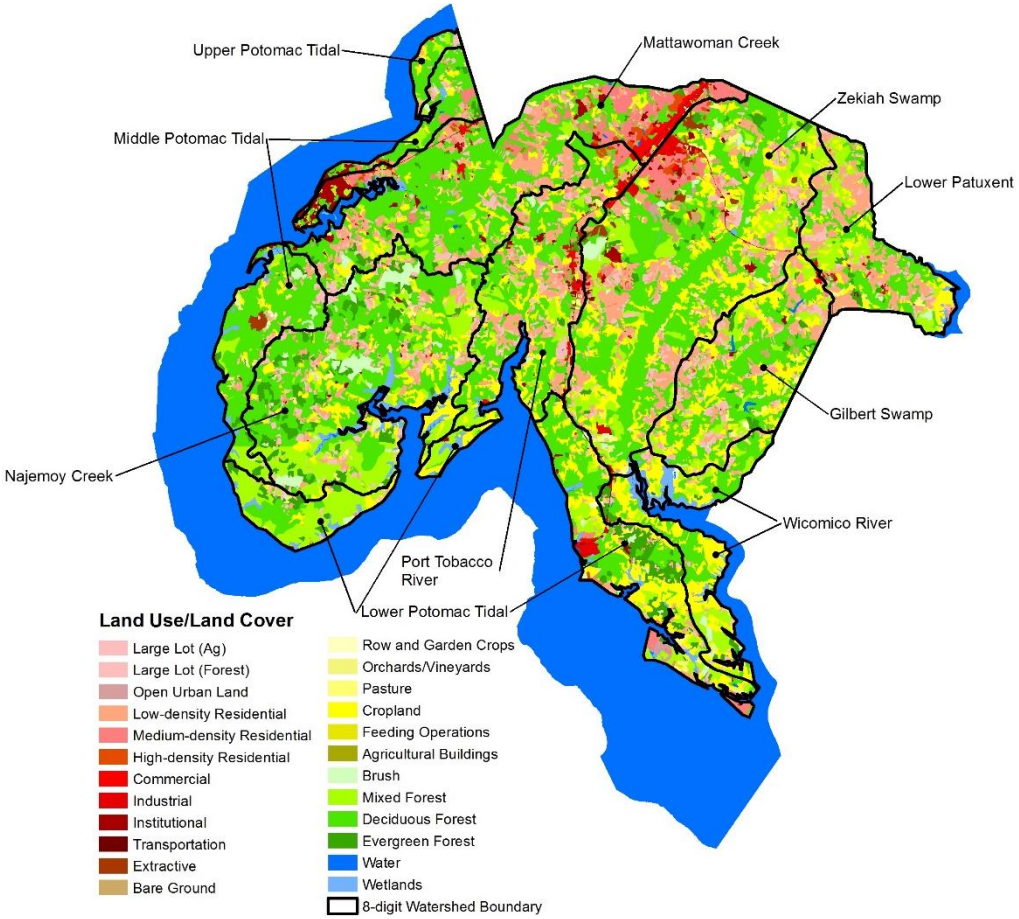

Figure 4. Countywide Land Use/Land Cover (MDP, 2010)

Table 7. Countywide Land Use/Land Cover (MDP, 2010)

Land Use / Land Cover	Acres	Percent
Urban	**73,220.1**	**24.8%**
Large lot subdivision (agriculture)	4,374.9	1.5%
Large lot subdivision (forest)	14,269.1	4.8%
Low-density residential	33,142.3	11.2%
Medium-density residential	8,637.1	2.9%
High-density residential	1,803.2	0.6%
Open urban land	912.7	0.3%
Commercial	3,185.5	1.1%
Industrial	1,234.2	0.4%
Institutional	4,027.2	1.4%
Extractive	1,039.5	0.4%
Transportation	594.4	0.2%
Agriculture	**48,189.4**	**16.3%**
Cropland	43,214.8	14.6%
Pasture	4,009.3	1.4%
Orchards/vineyards/horticulture	72.3	0.0%
Row and garden crops	390.8	0.1%
Feeding operations	390.9	0.1%
Agricultural building	111.4	0.0%
Forest	**163,840.0**	**55.5%**
Deciduous forest	108,565.1	36.8%
Evergreen forest	12,998.2	4.4%
Mixed forest	36,583.4	12.4%
Brush	5,693.3	1.9%
Water	**2,178.9**	**0.7%**
Other	**7,791.2**	**2.6%**
Wetlands	6,419.2	2.2%
Bare ground	1,372.0	0.5%
Total	**295,219.6**	**100.0%**

Table 8. Land Use/Land Cover (MDP, 2010) and Impervious Cover (2011) by Watershed

Watershed	Urban		Agriculture		Forest		Water		Other		Imperviousness	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Gilbert Swamp	6,208.3	25.0%	6,427.1	25.9%	11,800.3	47.5%	204.1	0.8%	217.5	0.9%	1,010.7	4.1
Mattawoman Creek	17,614.5	39.5%	3,275.6	7.3%	22,836.8	51.2%	219.3	0.5%	674.2	1.5%	4,323.5	9.7
Nanjemoy Creek	6,868.1	14.7%	5,791.7	12.4%	32,042.1	68.4%	246.2	0.5%	1,891.1	4.0%	903.3	1.9
Patuxent River Lower	7,009.9	38.9%	2,575.6	14.3%	8,018.7	44.5%	75.8	0.4%	325.0	1.8%	839.8	4.6
Port Tobacco River	9,263.8	33.0%	4,444.1	15.8%	13,977.3	49.8%	100.6	0.4%	304.1	1.1%	1,961.5	7.0
Potomac River L Tidal	3,826.8	12.7%	6,717.3	22.3%	17,698.8	58.7%	675.9	2.2%	1,236.6	4.1%	945.2	3.1
Potomac River M Tidal	3,250.2	16.7%	1,132.8	5.8%	14,145.3	72.7%	353.3	1.8%	587.7	3.0%	621.5	3.2
Potomac River U Tidal	314.9	15.4%	190.6	9.3%	1,486.9	72.6%	44.2	2.2%	10.2	0.5%	48.1	2.3
Wicomico River	1,201.6	7.5%	5,588.8	35.0%	7,212.5	45.2%	234.9	1.5%	1,708.4	10.7%	388.7	2.4
Zekiah Swamp	7,662.1	27.1%	2,045.9	18.5%	4,621.3	53.1%	24.7	0.0%	836.5	1.3%	3,841.5	5.9

1.7 Watershed Planning Approach

This plan is developed within the context of on-going watershed management planning, restoration, and resource protection being conducted by Charles County. Watershed assessments and impervious surface restoration plans have been completed for portions of the County and additional assessments are scheduled for the future.

Information synthesized and incorporated into this plan draws upon the sources listed below with updates and additions where necessary to meet the specific goals of the SW-WLAs and impervious restoration goals.

In addition, the plan draws upon the County's Charles County Phase II Watershed Implementation Plan Strategy (WIP) (LimnoTech, 2013).

1.7.1 Watershed Assessments

This section describes Charles County's watershed-based planning process to address watershed impairments. Charles County initiated its current watershed assessment approach in 2014 with the Port Tobacco Watershed assessment. Table 9 lists the completed watershed assessments and those that are planned. In 2016, Charles County is planning to complete watershed assessments similar to those completed in 2014 and 2015 in Zekiah Swamp, Gilbert Swamp, and Wicomico River watersheds. Data and results from the Port Tobacco, Mattawoman, and Lower Patuxent assessments were completed in time to be available to support this restoration plan. Results, projects, and programs identified in the upcoming assessments will be incorporated into future updates to the plan.

Table 9. Watershed Assessment Schedule

Year	Included County Watersheds	Status
2014	Port Tobacco	Completed 2015
2015	Mattawoman Creek Lower Patuxent River	Completed 2016
2016	Zekiah Swamp Gilbert Run Wicomico River	To be complete 2016
2017	Potomac River Upper Potomac River Middle Potomac River Lower Nanjemoy Creek	To be complete 2017

The following assessments were conducted throughout the watersheds:

- Upland Assessments
- Nutrient Synoptic Survey
- Stream Corridor Assessment

The primary goal of the assessments is to identify impacted, untreated and degraded areas in need of treatment and restoration. A desktop analysis was first conducted to identify those areas that had the highest potential for both impairment and restoration. The evaluation included land use, previous stream assessment results, impervious surface data, stormdrain network mapping, and location and type of existing BMPs.

The upland assessments included both the Neighborhood Source Assessment (NSA) and Hotspot Site Investigations (HSI). Upland pollution sources and restoration opportunities were identified following the methodology detailed in the Center for Watershed Protection's Unified Subwatershed and Site Reconnaissance Manual (CWP, 2004).

Synoptic water quality sampling was performed across the watersheds. Grab samples were collected from each site for laboratory analysis of water quality parameters and stream discharge measurements were collected in order to calculate instantaneous baseflow pollutant loads.

Stream corridor assessments (SCA) were conducted throughout the watersheds, using standard SCA protocols outlined in Stream Corridor Assessment Survey: SCA Survey Protocols (Yetman, 2001). The field team collected information on channel alternation, erosion, exposed utility pipes, drainage pipe outfalls, fish barriers, inadequate buffers, construction in or near the stream, trash dumping, and recorded any unusual conditions. Representative sites were selected at locations representative of each stream segment. The general physical habitat condition was assessed at the representative sites using a modified version of the EPA's Rapid Bioassessment Protocols (Barbour et al., 1999). In addition to the basic SCA set of impacts and assessments, KCI added an inventory of Potential BMP Locations, in which the field crew could identify up to five potential BMP types that could be implemented at any particular location. This reduced the need for additional field visits and property owner coordination. The potential BMP types included outfall stabilization, riparian buffer enhancement or replacement, stream restoration, BMP retrofit, or new stormwater management opportunities. Table 10 displays the number of HSI and NSA sites, synoptic sites, and SCA reaches assessed in each watershed completed to date.

Table 10. Upland Assessment Sites, Synoptic Sites, and SCA Reaches Assessed per Watershed

Year	Watershed	HSI Sites	NSA Sites	Synoptic Sites	SCA Reaches (miles)
2014	Port Tobacco	26	15	47	8
2015	Mattawoman Creek	21	10	51	6
2015	Lower Patuxent	1	4	14	2

Results of the desktop and field watershed assessments were compiled and results were analyzed to determine those specific areas of impairment most in need of restoration. Restoration measures were then developed according to the type and source of impact. The following section presents the methods and results for each restoration measure type which include both structural and non-structural practices and programs:

- Stream restoration;
- Shoreline erosion control;
- Stormwater BMPs;

- Reforestation;
- Environmental site design;
- Street sweeping;
- Inlet cleaning;
- Trash clean-up;
- Homeowner practices (rain barrels, rain gardens, downspout disconnect)

1.7.2 Impervious Surface Restoration Assessment

The County initiated a series of NPDES MS4 Retrofit Studies to specifically identify structural stormwater projects that would result in progress towards meeting the 20% impervious surface restoration goal. Assessments were completed previously in the County's Development District in 2004, 2007 and 2011. More recent assessments were initiated in 2014 in the Mattawoman, Port Tobacco, Nanjemoy, Zekiah, and Potomac River watersheds. In addition the County completed more targeted assessments at a variety of sites, at a variety of scales to further identify projects. These include assessments at several County school properties, in specific neighborhoods and residential subdivisions, at parks and at other Charles County owned properties.

Results of these assessments are included in this restoration plan. These primary sources include:

- Subwatersheds within Charles County Development District (KCI, 2004; KCI, 2007; KCI, 2011)
- Acton-Hamilton Watershed NPDES Watershed Restoration Concept Study (Vista, 2015)
- Stormwater Management Assessments (various school properties) (GMB, 2014a-d)
- Stormwater Management Assessments (Ruth Swann Park) (GMB, 2014e)
- Lower Patuxent River (BayLand, 2014a)
- Countywide Shoreline Management (BayLand, 2014b)
- Mattawoman Creek (Vista, 2015b)
- Port Tobacco River (Vista, 2015c)
- Upper Zekiah Swamp (BayLand, 2015)
- Countywide Retrofit Plan for 20% Treatment (Vista, 2015d)
- Stormwater Management Assessment, Potomac River Watershed Residential Subdivisions (GMB, 2015f)
- Waldorf Urban Development Corridor Concept (70%) SWM Master Plan Report (BAI, 2016)

1.8 Best Management Practices

This section describes the stormwater BMPs that are being used by Charles County currently and are planned for additional implementation.

Many stormwater BMPs address both water quantity and quality, however, some BMPs are more effective at reducing particular pollutants than others. The stormwater practices listed below keep the focus on "green technology" to reduce the impacts of stormwater runoff from impervious surfaces. These BMPs were selected specifically for three reasons: 1) effectiveness for water quality improvement, 2) willingness among the public to adopt, and 3) implementable in multiple facility types without limitations by zoning or other controls.

These practices are consistent with those currently being implemented by Charles County as water quality improvement projects. The County has the technical expertise, operational capacity, and system resources in place to site, design, construct and maintain these practices.

The recommended practices are also consistent with those proposed in the County's Phase II Watershed Implementation Plan (WIP) for the Chesapeake Bay TMDL and in the County's comprehensive watershed planning efforts. Exceptions to this are dry ponds which include dry detention ponds and dry extended detention ponds. These practices are no longer considered for future implementation; however, there are many existing facilities that are still actively treating runoff throughout the County so they are described here as well.

The BMPs in this section are organized into structural practices and operational programs.

1.8.1 Structural Practices

Structural practices are those that have a physical setting, require design and construction to implement, and require maintenance over time to ensure they are functioning properly. Primary examples of structural practices are listed here with brief descriptions.

- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. Rain gardens may be engineered to perform as a bioretention.
- **Bioswales** —An open channel conveyance that functions similarly to bioretention. Unlike other open channel designs, there is additional treatment through filter media and infiltration into the soil.
- **Dry Detention Ponds** – Depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow. MAST modeling includes hydrodynamic structures in this category. These devices are designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.
- **Dry Extended Detention Ponds** - Depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. They are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, allowing additional wet sedimentation to improve treatment effectiveness.
- **Impervious Surface Reduction** - Reducing impervious surfaces to promote infiltration and percolation of runoff storm water. Disconnection of rooftop and non-rooftop runoff, rainwater harvesting (e.g., rain barrels), and sheetflow to conservation areas are credited as impervious surface reduction.
- **Infiltration** — A depression or trench to form a shallow basin where sediment is trapped and stormwater infiltrates into the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil; they are not constructed on poor soils, such as C and D soil types. Yearly inspections to determine if the basin

or trench is still infiltrating runoff are planned. Dry wells, infiltration basins, infiltration trenches, and landscaped infiltration are all examples of this practice type.

- **Outfall Enhancement with Step Pool Storm Conveyance (SPSC)** – The SPSC is designed to stabilize outfalls and provide water quality treatment through pool, subsurface flow, and vegetative uptake. The retrofits promote infiltration and reduce stormwater velocities. This strategy is modeled in MAST as SW to the MEP. Bacteria reductions for this practice are modeled as a sand filter.
- **Permeable Pavement -** Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils or exits via an underdrain.
- **Stream Restoration -** Stream restoration in urban areas is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape of a stream, help improve habitat and water quality conditions in degraded streams.
- **Stormwater Retrofits –** Howard County plans to construct a variety of retrofits throughout the County. Stormwater retrofits may include converting dry ponds, dry extended detention ponds, or wet extended detention ponds into wet pond structures, wetlands, infiltration basins, or decommissioning the pond entirely to install SPSC (step pool storm conveyance).
- **Urban Filtering** - Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit.
- **Urban Tree Plantings** - Urban tree planting is planting trees on urban pervious areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting
- **Vegetated Open Channels** - Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff then releases it at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached pollutants. Until 2002 in Maryland, these practices were generally designed to meet water quantity, not water quality objectives. There is little or no vegetation within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.

1.8.2 Operation and Programmatic Practices

Along with the standard set of structural BMPs listed above, treatment will also be provided through non-structural measures. These include programs that often require on-going implementation to maintain the treatment, load reduction and impervious surface credit. The following strategies are performed through the programs listed below:

Street Sweeping

Street sweeping is an operational program that the County is actively engaged in and will continue to perform. Street sweeping at regular intervals can remove pollutants from the pavement before it can be washed off into the storm drain system and into local waterways by rainfall. According to MDE's guidance document (2014a), mechanical street sweeping at a bi-weekly or twice monthly rate reduces the load on the swept area by TN 4% / TP 4% / TSS 10%. This frequent sweeping of the same street will reduce nitrogen and phosphorus as well as sediment.

Forthcoming crediting guidance from the Chesapeake Bay Program (CBP, 2015) indicates that some credit can be obtained for sweeping at a frequency of at least 10 times per year for mechanical street sweeping; however, the credits are very low at 0.1% for TSS and 0% for TN and TP. Even mechanical sweeping at twice a week (100 times per year) is low in removal rates with 0.7% for TSS and 0% for TN and TP. Use of sweepers with Advanced Sweeping Technology (AST) yields much better removal according to the guidance, at up to TN 4% / TP 10% / TSS 21% for 100 times per year. AST is defined as sweepers classified as either Regenerative-Air Sweepers (RAS) or Vacuum Assisted Sweepers (VAS).

Currently, the County uses mechanical broom sweepers (MBS) for all of its street sweeping. The current frequency and technology used would not receive any credit under either of the guidance and crediting methods mentioned above; therefore the County has used a mass loading approach to calculate removal (Schueler et al., 2015). In this manner the mass of material removed by the sweeping is applied to values for pounds of pollutant reduced per dry ton of swept material to determine the overall removal.

The County will research its current sweeping methods including routes, technology, frequency and cost and potentially seek ways to improve the performance of the technique to obtain credit in the future.

Septic Systems

Septic system maintenance (pump-outs), upgrades and waste water treatment plant connections are methods to reduce impacts from septic systems, especially for nitrogen as septic systems can be a major contributor of nitrogen. Credits for TN, TP and TSS for septic system maintenance are not given for the urban stormwater sector. Pollution removal credits to the County for septic maintenance would fall under the waste water sector and are therefore not accounted for in the restoration plan which focuses on the stormwater sector. Credit for impervious surface restoration and bacteria reduction however, are available for three septic system activities:

Septic Connection. This practice involves abandoning an existing septic system and connecting the wastewater source to public sewer. This reduces the bacteria load from both working and failed systems because the waste is sent into the sewer and treated at a wastewater treatment plant. For impervious area accounting, 0.39 equivalent acres would be credited for each septic system connected to a wastewater treatment plant (WWTP).

Septic Pumping. On average, septic tanks need to be pumped once every three to five years to maintain effectiveness. The pumping of septic tanks is one of several measures that can be implemented to protect soil absorption systems from failure. When septic tanks are pumped and sewage removed, the septic system's capacity to remove pollutants from wastewater is increased. Septic pump-outs, that are part of a regular septic system maintenance program, provide 0.03 equivalent acres of restoration when

a system is maintained and verified annually. However, there is no additional bacteria removal from pumpouts.

Septic Denitrification. This practice involves the replacement of traditional septic systems with more advanced systems that have additional nitrogen removal capabilities. An enhanced septic system can provide further treatment of nitrogen through processes that encourage denitrification of the wastewater. Denitrification systems do not improve bacteria reduction over conventional systems; however when installed to replace a failed conventional system there is a significant improvement. Septic upgrades to install enhanced septic denitrification technologies result in a permanent credit of 0.26 equivalent acres for each upgrade completed.

Pet Waste Outreach

Pet Waste. Failure to clean up after a dog can cause both water quality and public health problems. Pet waste outreach programs include education efforts which increase public recognition about the water quality and health problems from consequences of dog waste. They may also include more active approaches including establishing dog parks and providing bags and disposal facilities in residential common areas.

Pond / Lake Reclassification

Charles County has many lakes, impoundments, reservoirs and amenity ponds that are providing water quality volume reduction and pollution attenuation and treatment and therefore should be credited for impervious surface restoration and pollutant load reduction. The County is currently investigating the steps to achieve impervious surface and pollutant reduction credit for these facilities. Once completed it is likely that the baseline treatment values will be updated as many of the facilities were built before baseline dates.

Homeowner Programs

Rain Barrel Program

Charles County currently operates a rain barrel program and provides financial assistance and incentives for property owners to implement the practice. A rain barrel is a small-scale conservation practice that collects and stores rooftop water runoff for future use to irrigate lawns, gardens and other non-potable water uses. By capturing water from downspouts that would otherwise discharge onto a paved surface, rain barrels can reduce the amount of runoff and pollutants reaching local streams and waterways. It is estimated that during summer months, nearly 40% of household water use is for lawn and garden watering. Using a rain barrel may save the average household up to 1300 gallons of water a year.

The County offers a program to quality residents for a 50% credit on their Watershed Protection and Restoration Fee (WPRF) by installing two rain barrels on their home, totaling 110 gallons of stormwater capture. The credit is good for three years and can be renewed if the system is verified to be operating correctly. Participants are asked to register their rain barrels using the University of Maryland's SMART Tool. http://extension.umd.edu/watershed/smart-tool

Credit for rain barrels is given for pollutant reduction using land use loading rates with treatment percentages following removal curves in MDE guidance (MDE, 2014c). Impervious surface treatment is

based on the square feet and inches of rainfall treated per rain barrel, with a 0.75 factor applied relating rain barrels to impervious surface treatment (Goulet and Schueler, 2014).

Rain Gardens

Charles County is encouraging homeowners to install and maintain rain gardens on their properties to address stormwater runoff. Credit of 50% off the WPRF is given for rain gardens capturing runoff from at least 800 square feet of impervious surface. The pollutant removal rates for this homeowner BMP are dependent on the specific size and volume of the facility compared to the runoff to be treated. Removal rates and impervious treatment are derived from Goulet and Schueler, 2014 and shown in the following section.

1.8.3 Implementation Levels

The County's identified structural projects have been organized in a tiered "Level" system to track their progress from project identification to concept, design, construction and completion. Appendix A includes the full Master list of County projects organized by Level and by watershed. Level 8 projects are considered alternates and lower priority than those identified in levels 2-7 based primarily on factors related to cost per impervious acre treated. Level 9 projects are those identified by KCI in 2015 and 2016 that will need to be added to the full prioritization to determine which projects are most feasible, beneficial and cost effective.

- Level 1 - Completed
- Level 2 – In Construction
- Level 3 – In Full Design
- Level 4 – County Maintenance / Alternative BMP Projects
- Level 5 – Existing SWM Facility Inspection/Upgrades
- Level 6 – Feasibility and Concept Design Projects (County NTP)
- Level 7 – Feasibility and Concept Design Projects (Med. Priority)
- Level 8 - Alternate Feasibility and Concept Design Projects
- Level 9 – Additional Sites Identified in KCI Watershed Assessment

1.8.4 Pollutant Reductions and Impervious Credits

The measured effectiveness and impervious equivalency for each of these practices may be found in Table 11 and Table 12.

Table 11. Typical Pollutant Reductions from Structural and Non-Structural BMPs

BMP	Nitrogen	Phosphorus	Sediment	Bacteria
Bioretention A/B soils	70%	75%	80%	65%
Bioretention C/D soils	25%	45%	55%	65%
Bioswales	70%	75%	80%	-4%
Dry Detention Ponds	5%	10%	10%	60%
Dry Extended Detention Ponds	20%	20%	60%	60%
Impervious Surface Reduction*	-	-	-	-
Infiltration w/ sand, veg.	85%	85%	95%	90%
Infiltration w/o sand, veg.	80%	85%	95%	90%
Outfall Enhancement with SPSC**	50%	60%	90%	70%
Permeable Pavement w/ sand, veg.	80%	80%	85%	58%
Permeable Pavement w/o sand, veg.	75%	80%	85%	-
Rain Barrels	28%	33%	0%	0%
Rain Garden	60%	70%	0%	0%
Septic Systems (pumping, upgrades, connections)	0%	0%	0%	varies
Stream Restoration	0.08 lbs/ linear ft	0.07 lbs/ linear ft	44.88 lbs/ linear ft	-
Street Sweeping	0%	0%	0%	-
Urban Filtering	40%	60%	80%	58%
Urban Tree Plantings*	-	-	-	-

BMP	Nitrogen	Phosphorus	Sediment	Bacteria
Vegetated Open Channels	45%	45%	70%	-
Wet Ponds or Wetlands	20%	45%	60%	84%

Sources: MDE, 2014c; Maryland Assessment Scenario Tool (MAST) documentation; International Stormwater BMP Database, Watershed Treatment Model

* Calculated as a land use change to a lower loading land use

**Outfall enhancement with SPSC modeled as SW to the MEP in MAST for nutrients and sediment and as sand filters for bacteria

Table 12. Impervious Acre Equivalent for Structural and Non-Structural BMPs

BMP	Treatment Unit	Impervious Acre Equivalent*
Bioretention A/B soils	WQv (provided)/WQv (required)	1.00
Bioretention C/D soils	WQv (provided)/WQv (required)	1.00
Bioswales	WQv (provided)/WQv (required)	1.00
Dry Detention Ponds	WQv (provided)/WQv (required)	0.00
Dry Extended Detention Ponds	WQv (provided)/WQv (required)	0.00
Impervious Surface Reduction	Per acre disconnected or removed	0.75
Infiltration	WQv (provided)/WQv (required)	1.00
Outfall Stabilization	WQv (provided)/WQv (required)	0.01
Permeable Pavement	WQv (provided)/WQv (required)	0.75
Rain Barrel	WQv (provided)/WQv (required)	0.75
Rain Garden	WQv (provided)/WQv (required)	1.00
Septic pump-outs	Per unit (annual practice)	0.03
Septic Upgrades (denitrification)	Per unit	0.26
Step Pool Storm Conveyance (SPSC)	WQv (provided)/WQv (required)	1.00
Stream Restoration	Linear foot	0.01
Street Sweeping	Dry ton removed	0.00
Urban Filtering	WQv (provided)/WQv (required)	1.00
Urban Tree Plantings	Acres planted	0.38
Vegetated Open Channels	WQv (provided)/WQv (required)	1.00
Wet Ponds or Wetlands	WQv (provided)/WQv (required)	1.00

Source: MDE, 2014c

*Assuming full 1-inch rainfall treatment, full WQv is provided. Acres of impervious in BMP drainage area is multiplied by the equivalent acres to determine credited acres

2 Local TMDLs

Under the Federal Clean Water Act (CWA), the State of Maryland is required to assess and report on the quality of waters throughout the state. Where Maryland's water quality standards are not fully met, Section 303(d) of the CWA requires the state to list these water bodies as impaired waters. States are then required to estimate the maximum allowable pollutant load, or TMDL, that the listed water body can receive and still meet water quality standards. In this plan, the term 'local TMDL' is used to refer to TMDLs at the smaller 8 or 12-digit watershed scale, and to differentiate between the Chesapeake Bay TMDL which is implemented at the County scale.

Charles County has several watersheds where an EPA-approved quantitative assessment study (the TMDL) has established pollutant loading limits for waterbodies. These loading limits represent a maximum amount of a pollutant that the water body can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant (e.g., point sources or nonpoint sources). Pollutant loads from point and nonpoint sources must be reduced by implementing a variety of control measures. Responsibility for TMDL reductions is divided among various contributing jurisdictions within the area draining to the water body. The TMDL loading targets, or allocations, are also divided among the pollution source categories, which in this case includes non-point sources (termed load allocation or LA) and point sources (termed waste load allocation or WLA). The WLA consists of loads attributable to regulated process water or wastewater treatment and to regulated stormwater. For the purposes of the TMDL and consistent with implementation of the NPDES MS4 permit, stormwater runoff from MS4 areas is considered a point source contribution.

As a requirement of section PART IV.E.2.b of the NPDES MS4 Discharge Permit issued by MDE to Charles County, the County must develop restoration plans for each SW-WLA approved by EPA prior to the effective date of the permit. This applies to all current local TMDLs as well as any new TMDLs approved by EPA. Such new TMDLs could be developed for any watersheds in the County that have listed water quality impairments as shown in Table 13. Several County TMDL watersheds fall within neighboring counties; however, SW-WLAs assigned to jurisdictions outside of Charles County's Phase I MS4, which may also include, Phase II jurisdictions, Maryland State Highway Administration, and other NPDES regulated stormwater are not the responsibility of Charles County and are not addressed in the Restoration Plan. Charles County watershed boundaries and salinity levels of the water (Mesohaline, Oligohaline, and Fresh) are displayed in Figure 5.

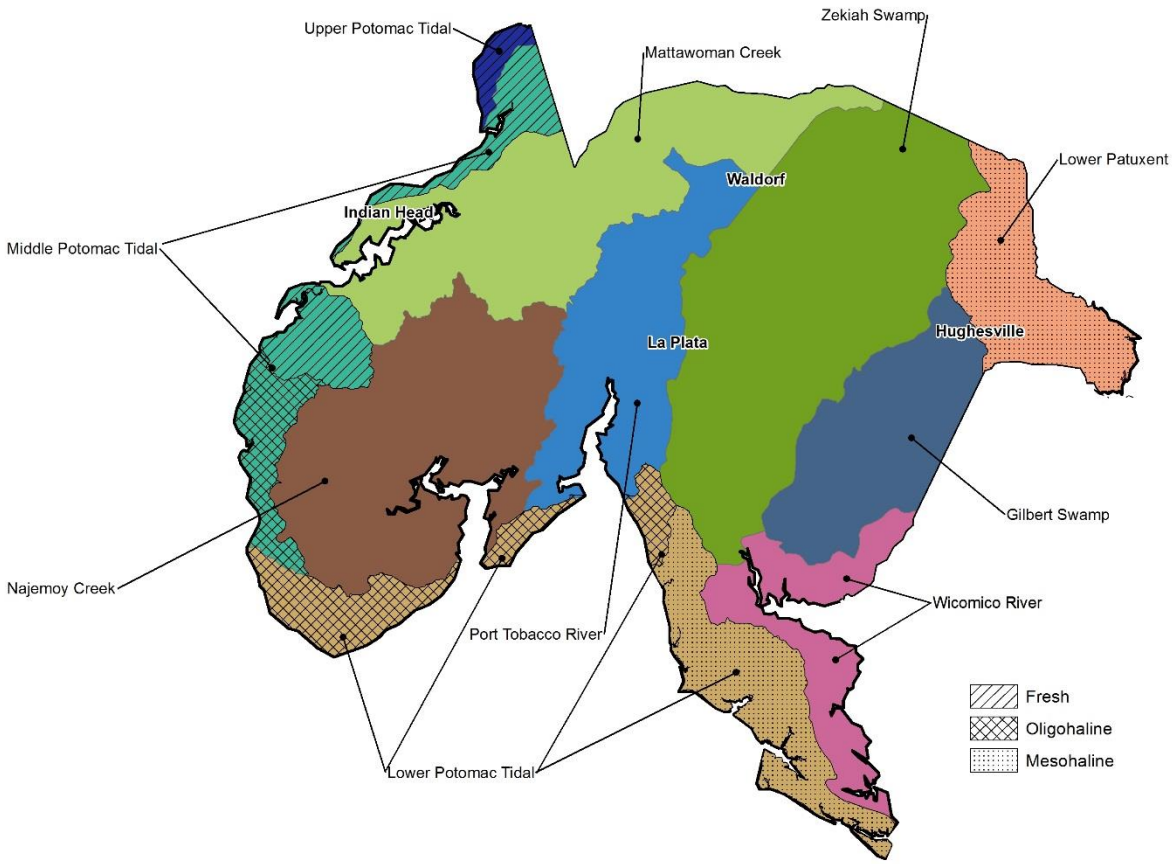

Figure 5: Charles County Watersheds and Salinity Levels

The statuses shown in Table 13 correspond to the following categories used by MDE to describe water quality impairment listings (MDE, 2015a):

- WQA – Category 2; waters meeting the standards for which they have been assessed based on a completed Water Quality Assessment (WQA)
- Insufficient data – Category 3; waters that have insufficient data or information to determine whether any water quality standard is being attained
- TMDL approved – Category 4a; waters that are still impaired have a TMDL developed that establishes pollutant loading limits designed to bring the water body back into compliance.
- Technological remedy – Category 4b; waters that are impaired but for which a technological remedy should correct the impairment.
- Impaired – Category 5; water bodies that may require a TMDL

Table 13. MDE Water Quality Impairment Listings and Status for Charles County (as of October 2015)

Impairment	Applicable Segment	Status	Approval Date
Mercury in Fish Tissue	Lower Patuxent River	WQA	
Chlorpyrifos	Lower Patuxent River	WQA	
PCB in Fish Tissue	Lower Patuxent River	Impaired	
Total Suspended Solids	Lower Patuxent River	Impaired	
Phosphorus	Lower Patuxent River Mesohaline	TMDL approved	2012
Fecal coliform bacteria	**Lower Patuxent River Mesohaline**	**TMDL approved**	**2005**
Nitrogen	Lower Patuxent River Mesohaline	TMDL approved	2012
Total Suspended Solids	Lower Patuxent River Mesohaline	TMDL approved	2012
Oil spill- PAHs	Lower Patuxent River Mesohaline	Technological remedy	
Cause Unknown	Lower Patuxent River Mesohaline	Impaired	
Cause Unknown	Potomac River Middle Tidal	WQA	
Lead	Potomac River Middle Tidal	WQA	
Chromium (total)	Potomac River Middle Tidal	WQA	
Cadmium	Potomac River Middle Tidal	WQA	
Copper	Potomac River Middle Tidal	WQA	
PCB in Fish Tissue	**Potomac River Middle Tidal**	**TMDL approved**	**2008**
PCB in Fish Tissue	**Potomac River Lower Tidal**	**TMDL approved**	**2008**
Fecal coliform	Lower Potomac River Mesohaline	Insufficient data	
Phosphorus	Lower Potomac River Mesohaline	TMDL approved	2012
Nitrogen	Lower Potomac River Mesohaline	TMDL approved	2012
Total Suspended Solids	Lower Potomac River Mesohaline	TMDL approved	2012
Fecal Coliform	Lower Potomac River Mesohaline	Impaired	
Cause Unknown	Lower Potomac River Mesohaline	Impaired	
Total Suspended Solids	Lower Potomac River Oligohaline	Insufficient data	
Nitrogen	Lower Potomac River Oligohaline	TMDL approved	2012
Phosphorus	Lower Potomac River Oligohaline	TMDL approved	2012
Cause Unknown	Lower Potomac River Oligohaline	Impaired	
Cause Unknown	Upper Potomac River Tidal Fresh	WQA	
Total Suspended Solids	Upper Potomac River Tidal Fresh	Insufficient data	
Phosphorus	Upper Potomac River Tidal Fresh	TMDL approved	2012
Nitrogen	Upper Potomac River Tidal Fresh	TMDL approved	2012
Mercury in Fish Tissue	Potomac River Upper Tidal	WQA	
Copper	Potomac River Upper Tidal	WQA	
PCB in Fish Tissue	**Potomac River Upper Tidal**	**TMDL approved**	**2008**
Cause Unknown	Potomac River Upper Tidal	Impaired	
Mercury in Fish Tissue	Wicomico River	WQA	
PCB in Fish Tissue	Wicomico River	WQA	
Cause Unknown	Wicomico River	WQA	
Cause Unknown	Gilbert Swamp	WQA	
Nitrogen	Gilbert Swamp	Insufficient data	

Impairment	Applicable Segment	Status	Approval Date
Lead	Zekiah Swamp	WQA	
Copper	Zekiah Swamp	WQA	
Selenium	Zekiah Swamp	WQA	
Zinc	Zekiah Swamp	WQA	
Cause Unknown	Zekiah Swamp	WQA	
Nitrogen	Zekiah Swamp	Insufficient data	
Phosphorus	Zekiah Swamp	Insufficient data	
Enterococcus	Port Tobacco River	WQA	
Nitrogen	Port Tobacco River Oligohaline	TMDL approved	2012
Phosphorus	Port Tobacco River Oligohaline	TMDL approved	2012
Total Suspended Solids	Port Tobacco River Oligohaline	TMDL approved	2012
Enterococcus	Port Tobacco River	Impaired	
Cause Unknown	Port Tobacco River	Impaired	
Cause Unknown	Nanjemoy Creek	WQA	
Nitrogen	Nanjemoy Creek	TMDL approved	2012
Phosphorus	Nanjemoy Creek	TMDL approved	2012
Total Suspended Solids	Nanjemoy Creek	TMDL approved	2012
Mercury in Fish Tissue	Mattawoman Creek	WQA	
Phosphorus	Mattawoman Creek	Insufficient data	
Total Suspended Solids	Mattawoman Creek	Insufficient data	
Cause Unknown	Mattawoman Creek	Insufficient data	
Low pH	Mattawoman Creek	Impaired	
Chlorides	Mattawoman Creek	Impaired	
PCB in Fish Tissue	Mattawoman Creek	Impaired	
Nitrogen	**Mattawoman Creek**	**TMDL approved**	**2012**
Phosphorus	**Mattawoman Creek**	**TMDL approved**	**2012**

Final approved TMDLs within Charles County with either an individual or aggregate SW-WLA, shown in bold text

Source: Maryland's Final 2014 Integrated Report of Surface Water Quality (MDE, 2015a)

There are currently four final approved TMDLs (Upper, Middle, and Lower Potomac PCB TMDL combined) within Charles County with either an individual or aggregate SW-WLA, shown in bold text in Table 13 above and also shown in Figure 6. Although there are many other TMDLs listed in Table 13, they do not have SW-WLAs assigned to the Charles County NPDES regulated stormwater point source and are therefore not addressed in the Restoration Plan. SW-WLAs assigned to Maryland State Highway Administration and other NPDES regulated stormwater are not the responsibility of Charles County and will not be addressed in this plan.

The final approved TMDLs include the following:

- Mattawoman Creek – Nutrients: Nitrogen and Phosphorus
    - 0214011 – Mattawoman Creek
- Lower Patuxent River (shellfish harvesting areas) – Fecal Coliform Bacteria
    - 021311010887 – Indian Creek

- Tidal Potomac River – PCBs (Polychlorinated Biphenyls)
    - 02140201 – Upper Potomac River
    - 02140102 – Middle Potomac River
    - 02140101 – Lower Potomac River

It is noted that the Lower Patuxent River bacteria TMDL is for the Indian Creek 12-digit subwatershed of Lower Patuxent River Mesohaline watershed. The SW-WLA is only for the Indian Creek portion of this watershed shown by the hatch pattern in the figure below.

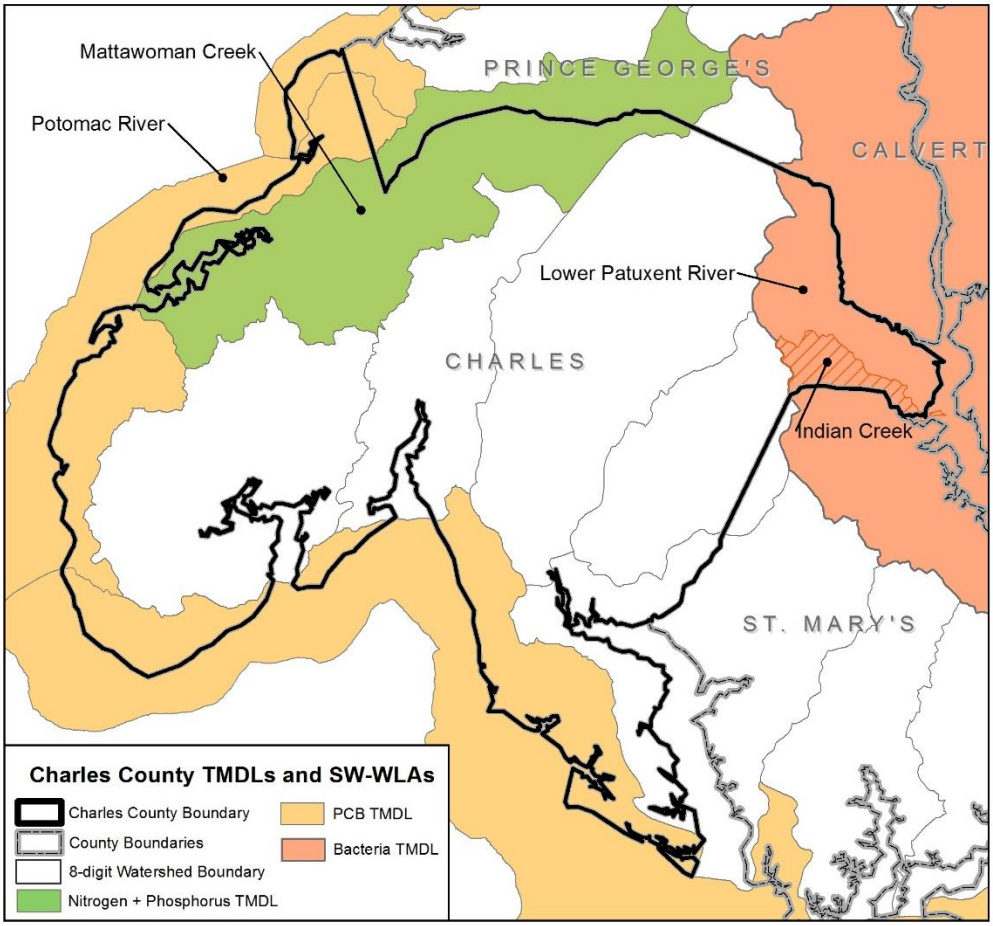

Figure 6: Charles County Local TMDLs with SW-WLAs

2.1 Mattawoman Creek TMDL for Nitrogen and Phosphorus

Mattawoman Creek Nutrients

Mattawoman Creek was first identified in 1996 as being impaired by nutrients and a TMDL for nitrogen and phosphorus was developed in 2004 (MDE, 2004b). The TMDL was approved by USEPA on January 5, 2005 and uses a baseline analysis year of 2000. The TMDL requires a 54% reduction in nitrogen and a 47% reduction in phosphorus from the 2000 baseline loads. The Mattawoman Creek nutrient local TMDL SW-WLAs are for edge of stream annual loads (EOS-lbs/yr). An EOS load is the amount of a pollutant load that is transported from a source to the nearest stream annually.

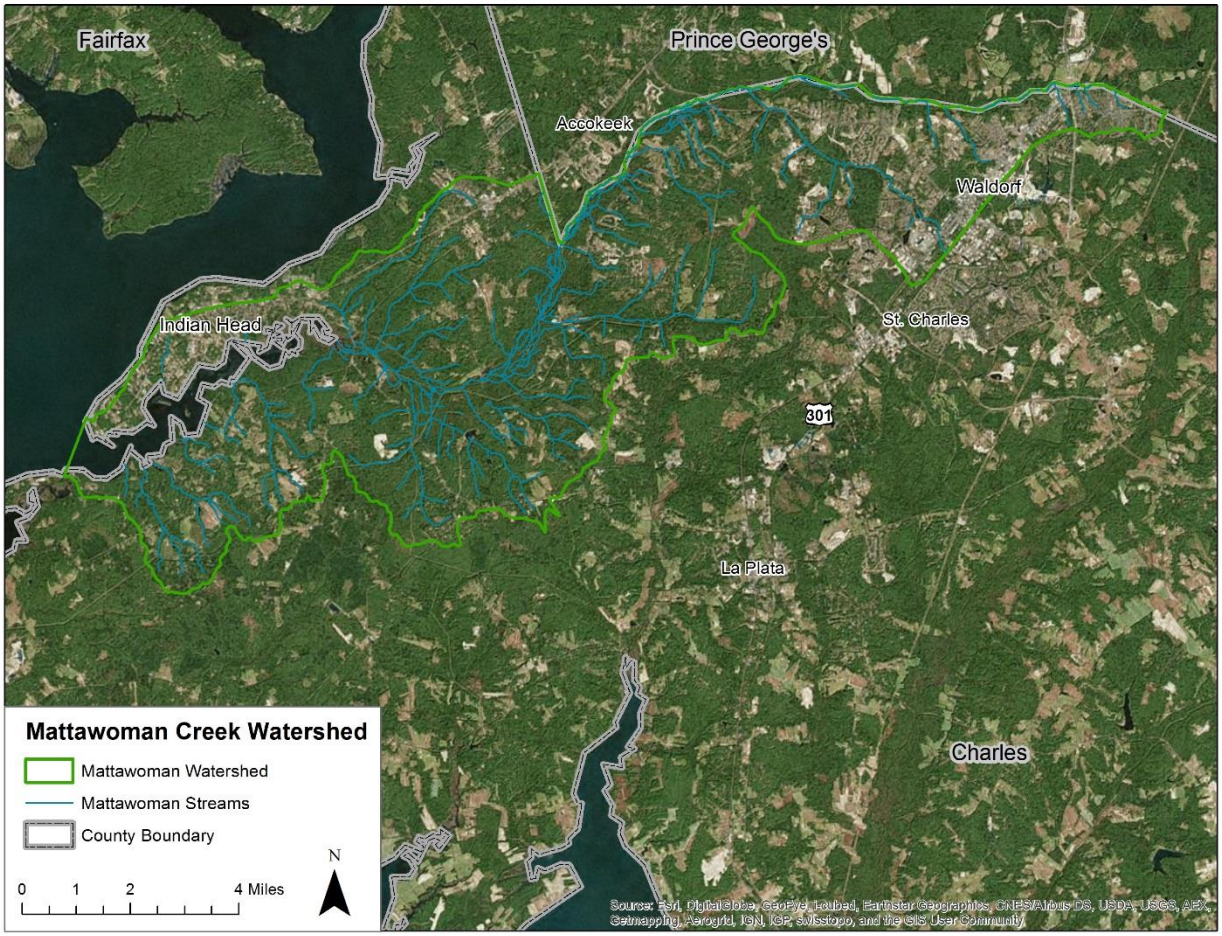

Figure 7: Mattawoman Creek Watershed

2.1.1 Sources

Nutrients are a pollutant of concern as an overabundance can cause algal blooms. Nitrogen is the limiting nutrient in the Chesapeake Bay, with high levels of nitrogen leading to algal blooms which cause decreased water clarity and light attenuation in the bay, as well as rob the bay of dissolved oxygen as algal blooms die and decompose at the bottom of the water column. Phosphorus is the limiting nutrient in freshwater systems and can lead to algal blooms in lakes and reservoirs with the same impacts as

algal blooms in the Chesapeake Bay but also can have an impact on drinking water if the bloom occurs in a reservoir that is used as a water source for municipal drinking water. Sources of nutrients include agricultural runoff, urban stormwater, municipal wastewater treatment plants, phosphorus bound to sediments supplied to the system, and discharge from upstream impoundments.

An approved TMDL exists for nitrogen and phosphorus for Mattawoman Creek. The two largest sources of nitrogen to Mattawoman Creek as identified in the Mattawoman Creek TMDL (MDE, 2004b) are mixed agricultural (39.9%), and urban stormwater (39%). The two largest sources of phosphorus are urban stormwater (48.9%) and mixed agricultural (28.7%). As of 2005, there were four municipal wastewater treatment plants (WWTP) in the Mattawoman Creek watershed (Indian Head WWTP, Lackey High School, Brandywine Receiving Station, and the Lingafelt Residence).

2.1.1 Modeling Approach

A combination of models was used for baseline, progress, and planned pollutant load modeling for Bay and local TMDLs. They are described below. Each BMP provides impervious surface restoration as well as a reduction for nitrogen, phosphorus, and sediment, along with other pollutants.

Section 3.3 presents the suite of practices the County uses for current implementation and/or plans to use to address local TMDL and impervious restoration permit requirements. Section 8 presents information on how progress toward load reductions will be evaluated and how management plans will be adapted on an on-going basis.

MAST and BayFAST

The pollutant loads (i.e., nitrogen, phosphorus, and sediment) for the Bay TMDL baseline and progress scenarios in addition to local TMDL progress scenarios were determined using MAST, which calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program Partnership Watershed Model. MAST, created by Devereux Environmental Consulting for MDE, is a web-based pollutant load estimating tool that streamlines environmental planning. Users specify a geographic area (e.g., County, watershed) and then select BMPs to apply on that area. MAST builds the scenario and provides estimates of pollutant load reductions and allows users to understand which BMPs provide the greatest load reduction benefit and the extent to which these BMPs can be implemented. Based on the scenario outputs, users can refine their BMP choices in their planning. MAST facilitates an iterative process to determine if TMDL allocations are met. Scenarios may be compared to each other, to TMDL allocations, or to the amount of pollutants reduced by current BMP implementation.

MAST estimates of load reductions for point and nonpoint sources include: agriculture, urban, forest, and septic loading. Load reductions are not tied to any single BMP, but rather to a suite of BMPs working in concert to treat the loads. Both MAST and the Watershed Model calculate reductions from all BMPs as a group, much like a treatment train. Reductions are processed in order, with land use change BMPs first, load reduction BMPs next, and BMPs with individual effectiveness values at the end. The overall load reduction can vary depending on which BMPs are implemented.

The baseline pollutant loads for nutrient and sediment local TMDLs were determined using BayFAST (Bay Facility Assessment Scenario Tool). BayFAST functions similarly to MAST but allows users to delineate facility boundaries (e.g., watershed, parcel, drainage area) and alter land use information within the delineated boundary depending on the model year. Local TMDL baseline loads were

calibrated in BayFAST by modeling BMPs installed prior to the TMDL baseline year on top of baseline land use background loads. This ensures that the same set of baseline BMPs are used throughout future progress and planned scenarios. Local TMDL baseline scenario loads are provided in MAST; however, the functionality to edit baseline BMPs in the scenarios is not available.

Both the Watershed Model and MAST/BayFAST provide loads at two different scales: Edge-of-Stream (EOS) and Delivered (DEL). Delivered loads show reductions based on in-stream processes, such as nutrient uptake by algae or other aquatic life. Local TMDL plans focus on reducing load on the land, so EOS estimates are more appropriate and were used for nutrient and sediment modeling analysis.

Removal Rate Curve Equations

Pollutant load reductions for planned projects were calculated using revised removal rate curve equations for runoff reduction (RR) and stormwater treatment (ST) practices prepared by Chesapeake Stormwater Network (Schueler and Lane, 2015). Reductions are calculated based on rainfall treatment, whether noted in project concepts or as an assumption of 1-inch treatment, and removal efficiencies per RR and ST practice (Table 14).

Table 14. Runoff Reduction and Stormwater Treatment Practices Removal Rate Reductions

Practice	Rainfall Treatment	Nitrogen Reduction	Phosphorus Reduction	Sediment Reduction
Runoff Reduction (RR)	1”	60%	70%	75%
Stormwater Treatment (ST)	1”	35%	55%	70%

2.1.2 Reduction Target Derivation

In order to derive the County MS4-specific SW-WLA load reduction targets, MDE’s published baseline values for each local TMDL need to be *disaggregated* and *calibrated* before the percent reduction is applied to calculate the load reduction required.

Some SW-WLAs are developed by MDE as an aggregate load including load contributions from multiple jurisdictions. Aggregate values must be first disaggregated to determine the portion of the load that each jurisdiction is responsible for.

Charles County’s TMDLs were developed by MDE at different periods in time using a variety of models. In order to use current models such as MAST (Maryland Assessment Scenario Tool), which is based on the current version of the Chesapeake Bay Model (v5.3.2), for analysis of load reductions, the baseline load needs to be translated or “calibrated” from the model used to develop the TMDL to the current model. According to the MDE guidance document *Guidance for Using the Maryland Assessment Scenario Tool to Develop Stormwater Wasteload Allocation Implementation Plans for Local Nitrogen, Phosphorus, and Sediment TMDLs* (MDE, 2014b), Section I, baseline nutrient and sediment loads and SW-WLAs must be calibrated to the model used to calculate load reductions:

Because all of Maryland’s approved local nutrient and sediment TMDLs were developed using watershed models other than MAST [Maryland Assessment Scenario Tool], the baseline and target loads from these TMDLs need to be translated into MAST loadings. This adjustment is required to account for potential differences between models. This is a two-step process that involves 1) creating a MAST scenario that

replicates the baseline year of the TMDL, and 2) applying the load reduction percentage from the TMDL to the MAST loading for the baseline year.

The Mattawoman Creek nitrogen and phosphorus aggregate SW-WLAs were disaggregated using the BayFAST (Bay Facility Assessment Scenario Tool) model. BayFAST allows users to specify the watershed and jurisdiction to model; therefore, the results include only Charles County MS4 baseline loads and do not include other municipalities. The results then represent the disaggregated portion of the baseline load.

The baseline model includes County BMPs installed prior to the TMDL baseline year on top of baseline land use background loads. BayFAST functions similarly to MAST; which is described further in Section 3.2: Modeling Approach of this plan, however BayFAST allows users to delineate facility boundaries (e.g., watershed, parcel, drainage area) and alter land use information within the delineated boundary depending on the model year. A table displaying Charles County nutrient local TMDLs in Mattawoman Creek with baseline loads and SW-WLAs calibrated to BayFAST is included in Table 15. The general calibration procedure is as follows:

1. A facility boundary for the Mattawoman Creek 8-digit TMDL watershed within Charles County borders was delineated within BayFAST.
2. All default land use acreages were deleted and regulated pervious and impervious acres were replaced with MAST Local Base County Phase I MS4 urban pervious and impervious acres using the Compare Scenario tool in MAST for the 2000 baseline year of the Mattawoman Creek local TMDL. This approach inherently disaggregates County MS4 loads from the rest of the NPDES regulated area within the watershed.
3. County BMPs installed prior to the TMDL baseline year were then added to the model.
4. The reduction percentage published in the TMDL document was then applied to the calibrated baseline loads modeled in BayFAST to calculate a calibrated reduction in EOS-lbs/yr.
5. A calibrated SW-WLA was calculated by subtracting the calibrated reduction from the BayFAST baseline load.

Calibrated load reductions calculated based on TMDL percent reductions and baseline loads modeled in BayFAST using Charles County Phase I MS4 baseline pervious and impervious land use and baseline treatment are the target reductions used in the Restoration Plan for nutrient local TMDLs. These values are presented in bold in Table 15.

Table 15. Mattawoman Creek (0214011) Disaggregated and Calibrated Local TMDL SW-WLAs and Load Reductions

Baseline Year	WLA Type	Baseline Model[1]	Pollutant	Unit	MDE Published SW-WLA	MDE Published Reduction %[2]	Baseline Loads[3]	Load Reductions[4]	WLA[5]
2000	Aggregate	WASP5.1	Nitrogen	EOS-lbs/yr	46,618	54%	56,526	**30,524**	26,002
2000	Aggregate	WASP5.1	Phosphorus	EOS-lbs/yr	5,213	47%	4,958	**2,330**	2,628

Target load reductions used in the Restoration Plan shown in bold text.

1) Baseline model used to create the TMDL. Water Quality Analysis Simulation Program version 5.1 (WASP5.1).
2) Published WLA and Reduction % from the MDE TMDL Data Center SW WLAs for County Storm Sewer Systems in Charles County and from TMDL documentation.
3) Baseline loads modeled in BayFAST using County BMPs installed prior to the TMDL baseline year on top of baseline land use background load.
4) Calibrated reductions calculated by applying the MDE published percent reduction to the BayFAST calibrated baseline loads.
5) Calibrated WLAs calculated by subtracting the calibrated reduction from the BayFAST calibrated baseline load.

2.1.3 Summary of Findings from 2015 Watershed Assessment

The Mattawoman Creek Watershed Assessment consisted of neighborhood source assessments, hotspot site investigations, nutrient synoptic survey, and stream corridor assessments.

Of the ten neighborhoods assessed, only two neighborhoods were determine to have a high pollution severity rating due to the potential for nutrient, bacteria, sediment, and oil and grease pollution. All other neighborhoods were found to have moderate pollution severity ratings. Opportunities for restoration actions including rain barrels, rain gardens, and downspout disconnections were identified in many of the neighborhoods. Of the 21 hotspot sites investigated, only one site was designated as having a high potential for pollutant discharge and 17 sites were designated as potential hotspots. Opportunities for stormwater BMPs were identified at these sites.

A total of 51 synoptic sites were sampled for water quality and discharge measurements throughout the watershed. One site had DO levels below the COMAR standard, 14 sites had pH values below the minimum threshold, and 5 sites had specific conductivity values exceeding the impairment threshold for Maryland benthic macroinvertebrates.

Nutrients including total nitrogen, nitrate/nitrite, and total phosphorus were generally found to be low and moderate at all sites. Orthophosphate concentrations were found to be excessive at 16 of the sites. Bacteria levels exceeding the standard for water contact recreation were found at 4 sites.

Field crews conducted stream corridor assessments on approximately 6.3 miles of streams. Erosion sites, pipe outfalls, and buffer breaks were the most widespread and frequent problems identified. The majority of points collected were categorized as moderate to minor severity. These assessments helped identify projects throughout the watershed including reforestation, stormwater BMPs, stream restoration, and outfall stabilization projects.

2.1.4 2015 Progress

Charles County maintains a database of stormwater urban BMP facilities and water quality and capital improvement projects (WQIP and CIP) in addition to tracking ESD and operational practices. Current BMP implementation through 2015 in the Mattawoman Creek watershed are shown in Table 16.

Table 16: Current BMP Implementation Through 2015 in the Mattawoman Creek watershed

BMP	Unit	Mattawoman Creek 2015 Current Implementation*
ESD Practices*	impervious acre	51
Inlet Cleaning	# of pipes	183
Street Sweeping	miles swept	101
Wet Pond	acres	84
Underground Storage Chamber	acres	9
Dry Swale	acres	2
Filterra	acres	1
SPSC	acres	23

BMP	Unit	Mattawoman Creek 2015 Current Implementation*
Rain Garden	Acres	0
Septic Connections	connection	21
Septic Pump outs	pump out	163
Septic Upgrades	upgrade	17

*Includes all of the County's ESD BMPs through 2015

Example structural projects implemented to date include the Acton Lane Roadway wet pond, the Bryans Road dry swale, underground storage chamber and Filterra, the Fox Run SPSC, and a wet pond in the Pinefield neighborhood.

Table 17. Mattawoman 2015 Nutrient TMDL Restoration Progress

	TN - EOS lbs/yr	TP - EOS lbs/yr
Baseline and Targets		
2000 Baseline Loads with BMPs	56,526	4,958
Target Percent Reduction	54.0%	47.0%
Calibrated Reduction	30,524	2,330
Calibrated WLA	26,002	2,628
2015 Progress Reductions		
Restoration Reduction (from baseline to 2015)	**1,862**	**643**
Restoration Reduction Percent	**3%**	**13%**
Reduction Remaining for Treatment	**28,662**	**1,687**

2.1.5 Restoration Plan

Stormwater Controls

Planned implementation for the Mattawoman Creek is summarized in Table 18. This represents essentially all of the projects and programs that have been identified for the watershed thus far from the variety of assessment conducted. This includes all of levels 2-9 of the projects identified by Vista, KCI, GMB and other consultants working with Capital Services and Planning and Growth Management.

Table 18: BMP Implementation - Planned Levels

BMP	Unit	Mattawoman
Bioretention	acre	25
Created wetland	acre	1,286
Downspout Disconnection - Homeowner Practice	# of homes participating	581
Rain Barrels - Homeowner Practice	# of homes participating	2,430
Rain Gardens - Homeowner	# of homes	581

BMP	Unit	Mattawoman
Practice	participating	
Dry Swale	acre	22
Filtering Practices	acre	59
Infiltration basin	acre	54
Inlet Cleaning	# of pipes	183
Organic Filter	acre	2
Pond Retrofit	acre	145
Reforestation	acres	31
Sheetflow to Conservation	acre	58
Shoreline Erosion Control	linear feet	0
Step Pool Stormwater Conveyance Systems	acre	831
Stream Restoration	linear feet	10,434
Street Sweeping	miles swept	101
Submerged Gravel Wetland	acre	520
Wet Pond	acre	92

Septic Systems

Mattawoman Creek is largely a sewered watershed with municipal wastewater treating a proportion of the watershed; however Charles County estimates that there are 2,917 septic systems in the Mattawoman Creek watershed, which represents approximately 17% of the systems in the County. A comprehensive septic connection program, connecting a large percentage of Mattawoman systems would be anticipated to meet and exceed septic sector goals for the local TMDL and the extra nitrogen credit could be traded to the stormwater sector. Figure 8 indicates the potential project locations for septic system projects in the County. Charles County is investigating the feasibility of such a program to determine the septic credits needed and the availability of extra credit for stormwater application.

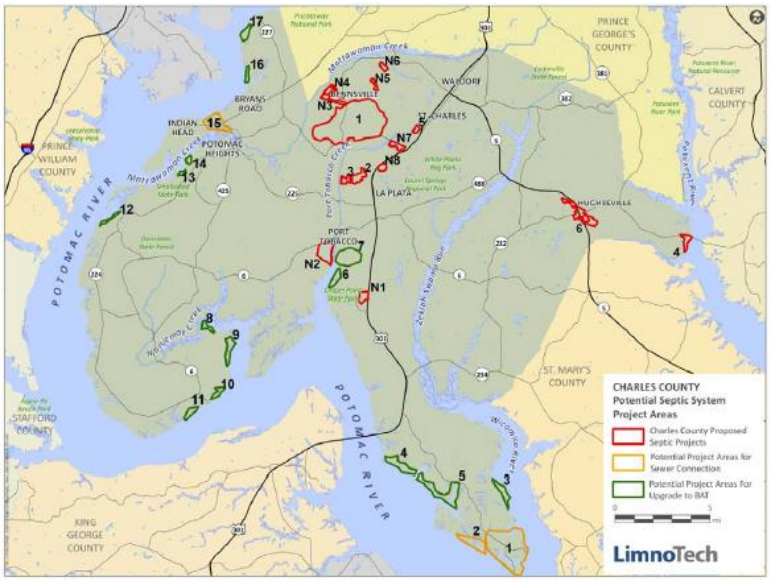

Figure 8. Potential Project Locations for Septic System BMPs (from LimnoTech, 2013)

2.1.6 Load Reductions Expected

Calculation of the load reductions to be achieved through full implementation of the levels 2-9 projects are presented in Table 19 below. This represents a total of 111 structural restoration projects in addition to the operational, programmatic and homeowner activities listed above.

Table 19. Mattawoman Creek Planned Load Reductions

	TN - EOS lbs/yr	TP - EOS lbs/yr
Planned Reductions (2016 - 2019)		
Planned Reductions Subtotal	**4,145**	**901**
Planned Structural Reductions Level 2-3	4,021	875
Planned Homeowner Reductions	124	26
Planned Reductions (2020 - 2025)		
Planned Reductions Subtotal	**3,404**	**1,106**
Level 4-7	557	160
Level 8	1,436	205
Level 9	1,412	796
Total Reductions		
Reduction (Progress + Planned)	**9,411**	**2,704**
Reduction Percent (Progress + Planned)	**30.8%**	**116.0%**
Reduction Remaining for Treatment	**21,113**	**(374)**

Based on the analysis of load reductions and a comparison to the Mattawoman SW-WLA percent reduction required, the plan is currently estimated to achieve a reduction of 30.8% for TN and 116.0% for TP compared to goals of 54.0% for TN and 47.0% for TP. The plan meets the TP target, but not the TN target. In general TP is treated in higher percentages with stormwater BMPs than TN. A TN reduction of 54.0% is a very aggressive goal.

Charles County will need to explore additional and alternative avenues to meet the TN reductions, which could come from additional structural and programmatic practices, or through intra-jurisdictional cross-sector trading particularly with the septic sector.

If the County were to meet the full TN goal through additional implementation of projects in the stormwater sector it is estimated that another 300 stormwater projects similar to those already identified would be required for a total of over 400 projects.

2.1.7 Cost and End Date of Mattawoman TMDL Restoration

The cost to implement the projects and programs identified currently in the Mattawoman Creek is estimated at over $60 million and is presented here. Based on the estimation above that approximately 300 additional projects may be necessary, which is three times the currently planned implementation, the total cost could escalate to $243 million dollars. To achieve the goal by 2035, funding close to $13.5 million per year would be required.

An alternative approach using intra-jurisdictional credit trading with the septic sector could achieve the overall TMDL goals at a lower cost. The feasibility of such a program is being investigated by the County. To achieve the additional 21,113 lbs/yr that is still required after the initial plan implementation is complete, it is expected that close to 1,103 septic connections would be required. A basic analysis with the number of septics in the watershed (2,917) shows that 38% of the septics would require connection to meet the load reduction goals. At a cost of $42,330 unit cost per septic system connection from the County's Phase II WIP (LimnoTech, 2013) the cost for this scenario would be approximately $46.7 million, still a very large sum, but only about 20% of the projected cost treating the entire load in the stormwater sector. It is also foreseeable that finding enough suitable stormwater projects will simply not be feasible.

Table 20. Mattawoman TMDL Cost as Planned ($ in thousands)

Mattawoman Creek	
2015 Progress Impervious Restoration (Completed Projects)	
Level 1 Completed Projects	$4,341
Planned Impervious Restoration (Projects Funded in Prior FY Budgets)	
Level 2, 3 and 6 Already Funded	$16,340
Planned Impervious Restoration (2016-2019) (Funding FY17 to Dec FY25)	
Levels 3-7	$14,224
Operational Reductions	$17
Septic Reductions	$852
Homeowner Reductions	$1,676
Planned Impervious Restoration (2020-2025) (Funding FY20 to Dec FY25)	
Level 8	$11,227
Level 9	$12,120
Cost Planned (2016 to 2025)	**$40,116**
Cost of TMDL Restoration Complete and Planned	
Cost, Completed and Planned	**$60,797**

2.2 Lower Patuxent Bacteria TMDL (Indian Creek, Charles County, MD)

The Lower Patuxent River TMDL for bacteria was developed in 2004 and approved by USEPA on May 25, 2005. The TMDL addresses fecal coliform impairments for several restricted shellfish harvesting areas (MDE, 2004a). Because the only subwatershed listed in the TMDL within Charles County with a SW-WLA is Indian Creek, the discussion of the TMDL in this plan refers only to the Indian Creek subwatershed. The TMDL requires a 43.94% reduction from the 2001 baseline, based on the baseline and allowable loads of 261.5 and 146.6 bn MPN/day, respectively.

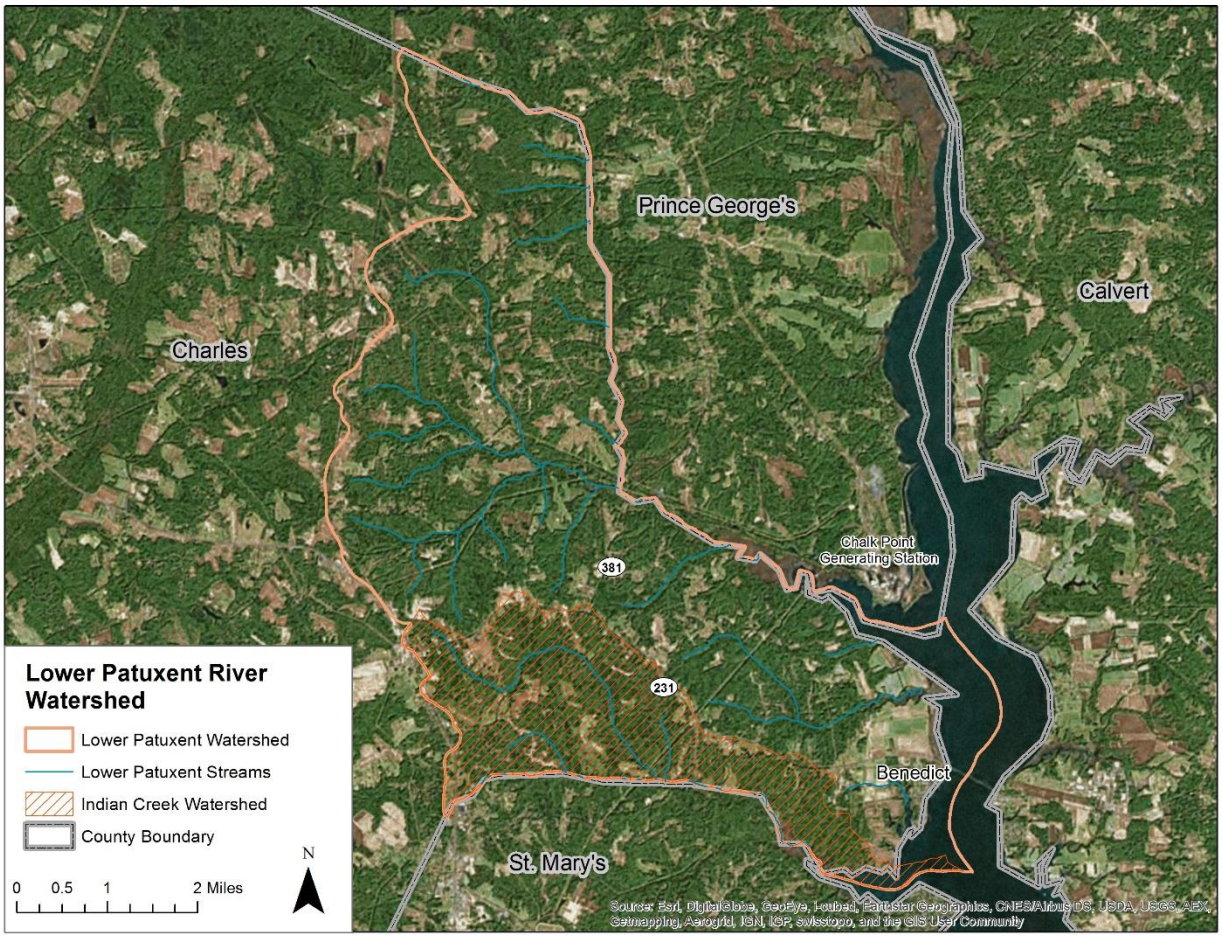

Figure 9: Lower Patuxent River Watershed

2.2.1 Sources

Bacteria are another pollutant of concern. Bacteria in any waters can create a human health hazard and require water contact restrictions in streams, rivers, lakes, and the bay. Bacteria in tidal waters can contaminate shellfish. If detected above the water quality standard, these areas will be closed to shellfish harvesting.

MDE's TMDL analyses categorize bacteria sources into four types: human, domestic pets, wildlife, and livestock. Specific sources for each category are shown in the table below, which has been derived from MDE's stormwater WLA bacteria guidance (MDE, 2014c) and Watershed Protection Techniques Article

17 (Schueler, 2000b) which describes the sources to be addressed for load reduction in an implementation plan, as follows:

Table 21: Bacteria Sources

Sector	MS4 Source	Non-Point Source
Human	Sanitary sewer illicit discharge Sanitary sewer exfiltration Homeless populations	Septic systems Sanitary sewer overflow (SSO) Combined sewer overflow (CSO) Recreational boating
Domestic Pets	Pets, urban areas	Pets, rural areas
Wildlife	Urban wildlife	Non-urban wildlife
Livestock		Agriculture, hobby farms CAFOs

One watershed in Charles County has an approved TMDL for bacteria for shellfish harvesting: the Lower Patuxent River watershed. The Indian Creek watershed is the only affected portion of the Lower Patuxent River within Charles County.

Bacteria Source Tracking (BST) analysis was not performed for this TMDL. Instead, the best available data was used to calculate sources of fecal coliform in the Lower Patuxent River basin. The calculations were based on the following input data and are calculations of watershed loads, not the loads based on instream concentrations used for the TMDL.

- Population, septic systems, and sewer coverage
- Factors for number of dogs and FC production per dog
- Wildlife habitat, density per acre, and FC production per animal
- Livestock census and FC production per animal

The largest sources of bacteria in the Indian Creek watershed were identified as livestock (64.7%) and wildlife (21.6%), followed by pets (12.9%) and human (0.8%). The sources are significant in relation to permit conditions. The TMDL only included domestic pets and urban wildlife as contributors to the SW-WLA subject to the permit. There are no sanitary sewers in the watershed so septic systems are the only human sources. While a priority for reduction, they are not in a different source sector and subject to the NPDES MS4 permit.

The bacteria sources listed as MS4 sources are all diffuse sources which enter the drainage system either through runoff or cross-connections. These sources can be treated either by stormwater BMPs or load reduction strategies. Loads from the non-point source list are either discrete sources which can only be addressed through a load reduction approach or diffuse rural sources that do not flow to storm drains.

2.2.1 Summary of Findings from Lower Patuxent Assessment

The Lower Patuxent Watershed Assessment consisted of neighborhood source assessments, hotspot site investigations, nutrient synoptic survey, and stream corridor assessments.

All of the neighborhoods assessed were found to have a moderate pollution severity rating for the potential for nutrient, bacteria, sediment, and oil and grease pollution. Opportunities for restoration

actions including rain barrels, rain gardens, and downspout disconnections were identified in many of the neighborhoods. One hotspot site was investigated and was determined to be a potential hotspot.

A total of 14 synoptic sites were sampled for water quality and discharge measurements throughout the watershed. Two sites had pH values below the minimum threshold. Nutrients including total nitrogen and nitrate/nitrite were found to be low at all sites. Total phosphorus concentrations were high at 2 sites, moderate at 7 sites, and low at the remaining 3 sites. Orthophosphate was found to be excessive at all sites. Elevated bacteria levels were found at five sites.

Field crews conducted stream corridor assessments on approximately 1.5 miles of streams. Inadequate buffer and erosion were the most widespread and frequent problems identified. Point severity ranged from severe to minor, however no points received a rating of very severe. These assessments helped identify a stream restoration project in the watershed.

2.2.2 Modeling Approach

Bacteria loads were modeled with a spreadsheet analysis. Because of the high variability in loading, sources which are difficult to identify or quantify, unknown processes of die-off or growth, and lack of data, more sophisticated modeling does not provide a significantly better estimate of loads or reductions to justify the additional effort.

The information used in the TMDL to determine source contributions was sufficient to develop a load analysis for Charles County's urbanized area representing the WLA and the rural area representing the LA. Loads from the source categories listed in Table 21 were estimated as follows:

Human Sources

Sanitary sewers: Illicit discharges, exfiltration, and overflows do not exist in the watershed and were not modeled.

Combined sewers: There are no combined sewers in the watershed, so overflows were not modeled.

Homeless population: Because of the low-density suburban nature of the land use in the watershed, it was assumed that loads from the homeless were negligible.

Recreational boating: There are no marinas or locations for boating in the watershed. Loads were assumed to be negligible.

Septic Systems: Sewage for the entire watershed is treated with septic systems. These were modeled with data from Charles County and from the TMDL. Loading estimates were based on the discharge from the septic system leach field, with no attempt to model decay or transport to the receiving water.

Both working and failed systems were modeled. For both, the loads from wastewater generated by the watershed population were required. The loading per person was derived from default data presented in the TMDL source analysis and worked out to 26.5 bn MPN/day.

Population on septic systems was calculated using the County's parcel data. Parcel data was clipped to the Indian Creek watershed, and the year built was used to determine that 325

parcels had the potential to contribute wastewater to septic systems. Population was estimated using data from the TMDL for the entire watershed, including both counties and all urban and rural area. The result was an average of 2.4 people per septic system.

Agricultural and residential parcels consisted of single-family residences. The commercial, institutional, and industrial uses included day care, taverns, and churches with a larger population of users; however, an assumption was made that these facilities would draw from the local population and would not add a significant amount of load from outside the watershed.

Table 22: Baseline Parcels and Population on Septic in 2001

Land Use	Number of Parcels	Population on Septic
Agricultural	13	31
Commercial	10	24
Commercial / Residential	13	31
Institutional	9	22
Industrial	4	10
Residential	268	643
No Data	8	19
TOTAL	**325**	**780**

The overall load of wastewater generated by the population of 780 people was 20,670 bn MPN/day. Discharge was based on an estimate of the number of working and failed systems. Charles County instituted design requirements for separation from groundwater in 1990. Systems built prior to that have a higher chance of failure. The parcel analysis indicated that 170 of the systems in the watershed (52%) were built prior to 1990. For the purposes of the analysis, an assumption was used that 7.5% had failed, consistent with MDE's estimate of failures statewide.

Discharge from working systems was calculated assuming that all were conventional systems, with a reduction rate of log 3.5, or 99.968 percent. Failed systems were assumed to discharge the entire wastewater load. Loads from working systems were 7 bn MP/day and from failed systems, 1,550 bn MPN/day.

Domestic

Pets, Rural Areas. Based on the parcel analysis, there were only a minimal number of dwelling units in rural areas of the watershed, essentially the 13 agricultural parcels. Loads from these sources were not modeled.

Pets, Urban Areas. The parcel analysis showed there were 268 residential parcels in the watershed. Contributions from dogs were the only bacteria sources considered in the TMDL. Using the calculations provided, pet waste contributed 125 bn MPN/day to the watershed load, as follows:

Table 23: Bacteria Loads from Domestic Pets

Parameter	Units	Factor	Calculation
Households	number		268
Dogs/household	percent	41%	110
% walkers	percent	56%	62
% that don't pick up	percent	41%	25
FC / dog	bn MPN/day	5.0	
TOTAL	**bn MPN/day**		**125**

Wildlife

Certain wildlife can be found in urban areas, including raccoons, resident geese, and deer, all of which were part of the TMDL assessment of wildlife loads. Wildlife loads were estimated using the data from the TMDL on species, density per type of habitat, GIS calculations of habitat area, whether the habitat was in urban or rural land use, and production per animal. Results are shown in Table 24 and Table 25.

Table 24: Wildlife Population

Wildlife	Density	Density Units	Habitat	Habitat (ac)		Population	
				Urban	Rural	Urban	Rural
Beaver	4.8	animals/ mile of stream	Tidal and non-tidal regions	1.3	9.1	6	43
Deer	0.047	animals/acre	Entire watershed	1,509.0	2,411.4	71	113
Goose	0.087	animals/acre	Entire watershed	1,509.0	2,411.4	131	210
Duck	0.039	animals/acre	Entire watershed	1,509.0	2,411.4	59	94
Muskrat	2.75	animals/acre	Within 66 feet of streams and ponds	8.4	54.5	23	150
Raccoon	0.07	animals/acre	Within 600 feet of streams and ponds	76.6	495.8	5	35
Wild Turkey	0.01	animals/acre	Entire watershed	1,509.01	2,411.43	15	24

Table 25: Bacteria Loads from Wildlife

Wildlife	Bacteria per Animal (bn MPN/day)	Urban Load (bn MPN/day	Rural Load (bn MPN/day
Beaver	0.25	1.50	10.75
Deer	0.50	35.50	56.50
Goose	2.43	318.33	510.30
Duck	0.034	143.37	228.42
Muskrat	1.00	0.78	5.10
Raccoon	0.093	5.00	35.00
Wild Turkey	0.25	1.40	2.23
	TOTAL	**505.9**	**848.3**

Livestock

The TMDL estimated livestock population based on pro-rating Countywide data to the land use area within Indian Creek. The data were reviewed and visually compared with aerial photography of the watershed. The results of the assessment were that there were no large pastured areas with significant numbers of livestock. An estimate of 20 horses on small hobby farms was used for the livestock loading analysis. This resulted in a small load of less than two bn MPN/day.

Table 26: Bacteria Loads from Livestock

Livestock	Bacteria per Animal (bn MPN/Day)	Percent Confined	% Manure For Washoff	Net Loading Rate	Urban Load (bn MPN/Day	Rural Load (bn MPN/Day
Cows	0.25	20%	40%	3.84	0.0	0.0
Chicken	0.50	85%	10%	2.04E-03	0.0	0.0
Pig	2.43	100%	40%	0.00E+00	0.0	0.0
Sheep	0.034	50%	40%	2.40	0.0	0.0
Horse	1.00	50%	40%	0.08	1.68	0.0
	TOTAL				**1.7**	**0.0**

2.2.3 Reduction Target Derivation

The Indian Creek fecal coliform bacteria SW-WLA is listed on MDE's TMDL data center as an aggregate; however; the SW-WLA is implicitly disaggregated. The SW-WLA for stormwater was estimated in the TMDL by considering the urban land area in the watershed to be the regulated stormwater, and calculating the SW-WLA by pro-rating the allowable load to the urban land. Since the only permitted jurisdiction in the watershed is Charles County, the County's urban land was used for the calculation. This resulted in a pro-rated percentage of 10.6% of the TMDL and a total of 15.6 bn MPN/day for the SW-WLA, shown in the tables below. It should be noted that this method of estimating the SW-WLA includes loads from all sources, including human, domestic pets, wildlife, and livestock as part of the regulated urban load.

Table 27: Indian Creek Land Use Distribution

Land Use	Total Area (ac)	Charles County (ac)	Charles County (%)	St. Mary's County (ac)	St. Mary's County (%)
Non-Urban	5,710.1	3,090.2	39.4%	2,619.8	33.4%
Regulated Urban	829.1	829.1	10.6%		0.0%
Non-regulated Urban	1,309.8		0.0%	1,309.8	16.7%
Total	7,849.0	3,919.4	49.9%	3,929.6	50.1%

Source: TMDL Tables C-2 and C-3

Table 28: Stormwater Waste Load Allocation (WLA) and Load Allocation (LA) (bn MPN/day)

	SW-WLA	LA	TMDL
Charles County	15.6	57.7	73.3
St. Mary's County	0.0	73.4	73.4
Published Total	15.6	131.1	146.7

Source: TMDL Section 4.8

Review of the TMDL modeling shows that the allowable load was derived from the water quality criteria and the current load from monthly monitoring data. As a result, the TMDL computation is based on instream loads calculated from measurements of concentration in the receiving water. Watershed loads, calculated from sources which are not transported and which have not undergone transformation such as die-off are required for restoration analysis.

Watershed loads have been modeled with a spreadsheet analysis. As a result, the load analysis performed for implementation modeling calculates watershed loads and reductions only. These loads cannot be compared to the baseline, WLA, and LA loads in the TMDL.

This approach allows the County to use its best land use and treatment data to develop baseline loads and reduction targets consistent with the baseline TMDL date of 2001. The information used in the TMDL to determine source contributions was sufficient to develop a load analysis for Charles County's urbanized area representing the WLA and the rural area representing the LA.

The modeled load reduction for the bacteria SW-WLA is the target for the Indian Creek bacteria local TMDL. This value is presented in bold in Table 29. The modeling method used for the bacteria TMDL for reductions and planning scenarios is described further in section 3.2.

Table 29. Lower Patuxent River- Indian Creek (021311010887) Disaggregated and Calibrated Local TMDL SW-WLAs and Load Reductions

Baseline Year	WLA Type	Baseline Model[1]	Pollutant	Unit	MDE Published SW-WLA	MDE Published Reduction %[2]	Baseline Loads[3]	Load Reductions[4]	WLA[5]
2001	Individual	Steady state tidal prism	Bacteria	billion MPN/day	15.6	43.94%	3,038	**1,335**	1,703

Target load reductions used in the Restoration Plan shown in bold text.

1) Baseline model used to create the TMDL.
2) Published WLA and Reduction % from the MDE TMDL Data Center SW WLAs for County Storm Sewer Systems in Charles County and from TMDL documentation.
3) Disaggregated baseline loads calculated by development of independent model.
4) Disaggregated load reductions were calculated from the disaggregate baseline loads and reduction %.
5) WLA calculated by subtracting the load reduction from the baseline load.

2.2.4 2015 Progress

Between the baseline year of the TMDL and 2015, two septic systems were upgraded in the Indian Creek watershed, with data showing that one was a new system and one was repaired. Assuming these systems were failed at the time of upgrade, bacteria loadings would have been reduced by 64 bn MPN/day.

2.2.5 Restoration Plan

The implementation approach required by the permit is to meet the SW-WLA by reducing loads from the sources identified in the TMDL: domestic pets and urban wildlife. Livestock, septic systems, and other wildlife are considered non-point sources contributing to the LA and are not regulated by the NPDES permit.

If it is infeasible or impractical to meet the reduction from these sources, additional strategies that address other sectors will be explored. An alternate approach is described in MDE's bacteria TMDL guidance (MDE 2014) which states that the priority is to address human sources due to the greater health risk. Even though the TMDL does not describe any human sources that discharge through the MS4, reducing loads from non-MS4 sources such as septic systems will be an acceptable method of meeting the TMDL requirement.

SW-WLA

Domestic - Pets The planned reduction in pet waste will be accomplished through expanding existing programs to encourage dog owners to clean up after their pets. The goal is to increase awareness through a number of outreach activities targeted to residents in the Indian Creek watershed with the goal of changing the fraction of dog walkers who pick up waste from 60% to 70%.

Wildlife - Urban No programs are planned to address this source. While goose management can be a successful method of reducing bacterial loads, the watershed does not have open water locations such as ponds where the birds congregate and where management practices can be applied easily. Other wildlife species are similarly dispersed and it is not feasible to reduce the population.

LA

Human - Septic Systems Bacteria loads from working systems were not affected by any restoration programs. The projects planned for failed systems are septic system denitrification upgrades, which will bring the systems back to working status, and add additional treatment to reduce nitrogen loads significantly. Upgrades will repair failures to the septic tank structure and the drainfield, allowing the system to reduce bacteria loads as originally designed. It is currently estimated that 24 septic upgrades will provide the level of treatment needed to meet the SW-WLA goals.

Wildlife - Rural No programs are planned to address this source.

Livestock No programs are planned to address this source. There are no areas of pasture where livestock have access to streams for water so off-stream watering or fencing would not reduce livestock pollution. The minimal loads from this source did not justify additional effort for pollutant load reductions.

2.2.1 Load Reductions Expected

The SW-WLA could not be met with the sources discharging to the storm drain system - domestic and wildlife. However, by including septic system upgrades as a restoration strategy, the target percentage reduction from the TMDL can be met. Two upgrades before 2015 provided a small reduction in loading. Upgrades for the estimated remaining failed systems will meet more than the required WLA reduction, along with reducing the priority source from human contributions.

	TMDL Bacteria (bn MPN/day)	Modeled Bacteria (bn MPN/day)
Baseline and Targets		
2001 Baseline Loads with BMPs	261.5	3,038
Target Percent Reduction	43.94%	43.94%
Reduction Required	114.9	1,335
WLA	146.6	1,703
2015 Progress Reductions		
Restoration Reduction (from baseline to 2015)	-	64
Restoration Reduction Percent	-	2.11%
Reduction Remaining for Treatment	-	1,271
Planned Reduction Programs		
Pet Waste Outreach	-	30
Septic System Replacement	-	1,549
Summary		
Reduction (Progress + Planned)	-	1,643
Reduction Percent (Progress + Planned)	-	54.08%
Reduction Remaining for Treatment	-	0

2.2.1 Cost and End Date of Indian Creek TMDL Restoration

The costs to implement projects and programs to meet the Indian Creek TMDL have been estimated based on the implementation described above. Septic system upgrades for 24 systems, at an average of $13,000 per upgrade would total $312,000. A targeted pet waste outreach program using door hangers, a returnable pledge to pick up pet waste, and potentially a give-away of dog waste bags has been preliminarily estimated at $5,000.

The end date for implementation based on the above is expected to occur by 2025.

2.3 Potomac River PCB TMDL

The Potomac River Lower Tidal, Middle Tidal, and Upper Tidal watersheds each have polychlorinated biphenyl (PCB) TMDLs (Haywood and Buchanan, 2007). The TMDL was developed in 2007 and approved by USEPA on October 31, 2007. Figure 10 shows the location of the Potomac River Tidal watershed within Charles County.

2.3.1 Potomac River PCB Disaggregation

The Potomac PCB TMDL presents SW-WLAs for each jurisdiction, therefore no additional disaggregation was required to determine Charles County's allocation.

The EPA requires stormwater discharges to be included in the WLA of a TMDL. The WLA percent reduction for the Lower, Middle, and Upper Potomac River Tidal in Charles County is 5%. This 5% reduction is due to the Margin of Safety (MOS) built into the TMDL calculation. According to the TMDL, "it is expected that the proposed 93% reduction in atmospheric deposition of PCBs will yield the 5% reduction in stormwater loads represented by the MOS" (Haywood and Buchanan, 2007). Consequently, reduction strategies from the stormwater sector in Charles County are not necessary to meet the overall TMDL.

2.3.2 Sources

PCBs are a group of man-made organic chemicals. They were widely used as coolants and lubricants in electrical equipment. New production of PCBs has been banned since 1979 since they have been classified as a probable human carcinogen. While new production has been banned, the compounds are still used in existing equipment and are transported into the environment through inadequate disposal, leaks, fires, and spills. PCBs do not break down easily and bioaccumulate in aquatic environments.

Sources of PCB to the Potomac are grouped into six categories: the non-tidal Potomac River at Chain Bridge, lower basin tributaries, direct drainage, wastewater treatment plants (WWTPs), combined sewer overflows (CSOs), atmospheric deposition to the water surface, and contaminated sites. The WLA portion of the TMDL includes WWTPs, regulated stormwater, and CSOs. As stated previously, 5% MOS reduction is expected to be achieved through the proposed 93% reduction in atmospheric deposition, therefore strategies for PCB reduction will not be addressed in this report.

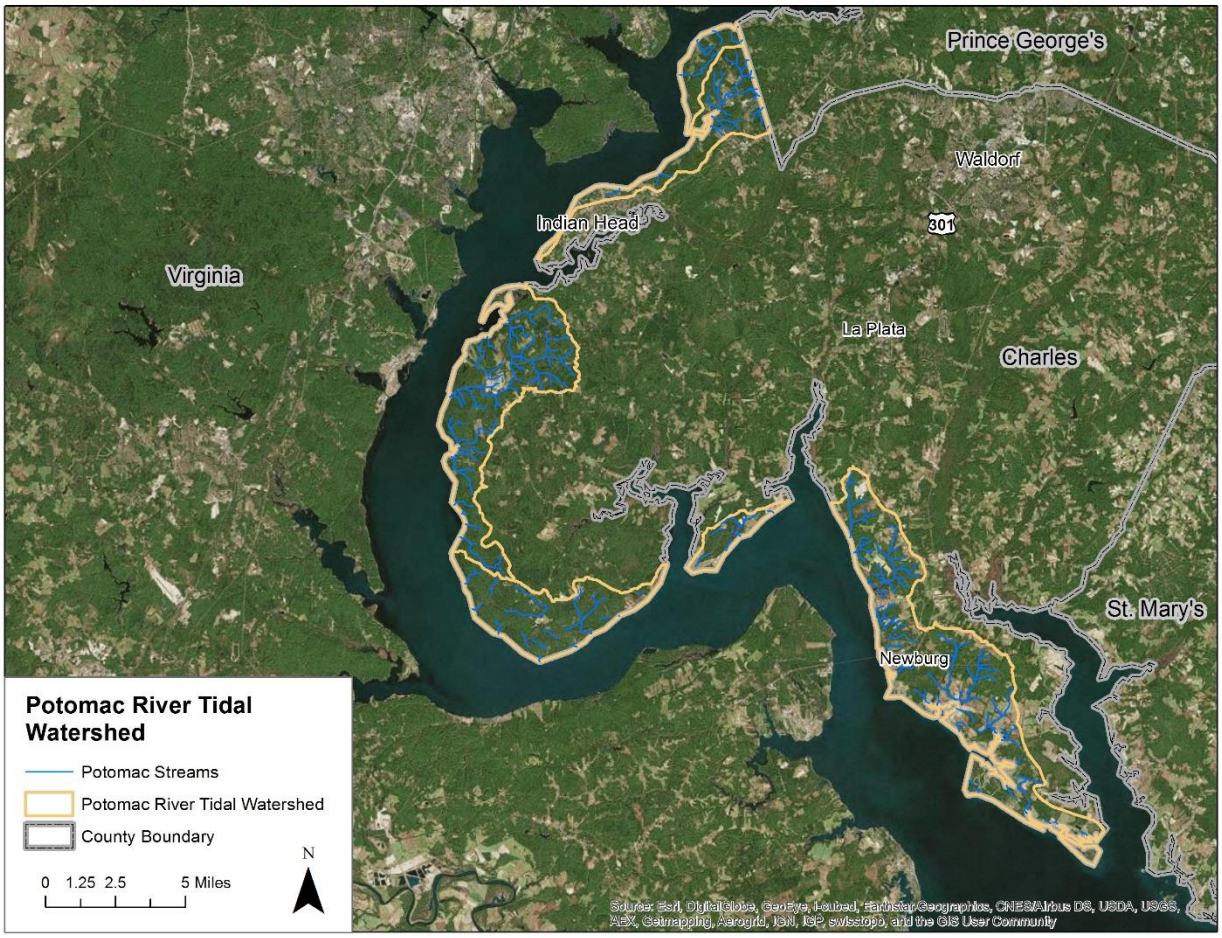

Figure 10. Potomac River Tidal Watershed

Table 30. Tidal Potomac River Upper (02140201), Middle (02140102, and Lower (02140101) Disaggregated and Calibrated Local TMDL SW-WLAs and Load Reductions

Baseline Year	WLA Type	Baseline Model[1]	Pollutant	Unit	MDE Published SW-WLA	MDE Published Reduction %[2]	Baseline Loads[3]	Load Reductions[4]	WLA[5]
2005	Individual	POTPCB	PCBs	grams/yr	12.6	5%	13.2	**0.6**	12.6

Target load reductions used in the Restoration Plan shown in bold text.

1) Baseline model used to create the TMDL. Potomac PCB Model (POTPCB).
2) Published WLA and Reduction % from the MDE TMDL Data Center SW WLAs for County Storm Sewer Systems in Charles County and from TMDL documentation.
3) Baseline load from Table 12 in PCB TMDL (Haywood and Buchanan, 2007).
4) Load reduction from Table 12 in PCB TMDL (Haywood and Buchanan, 2007).
5) WLA from Table 12 in PCB TMDL (Haywood and Buchanan, 2007).

3 Chesapeake Bay TMDL and Impervious Surface Reduction

Charles County's stormwater sector is required by its MS4 NPDES permit to meet the Bay TMDL requirements by completion of the 20% impervious surface restoration; therefore these two programs and goals are described together in this section. The impervious surface restoration is required to be met by the end of the County's permit term in December of 2019, and the Bay TMDL is required to be met by 2025.

3.1 Impervious Restoration

3.1.1 Impervious Surface Analysis

Impervious surfaces concentrate stormwater runoff, accelerating flow rates and directing stormwater to the receiving stream. This accelerated, concentrated runoff can cause stream erosion and habitat degradation. Runoff from impervious surfaces picks up and washes off pollutants and is usually more polluted than runoff generated from pervious areas. In general, undeveloped watersheds with small amounts of impervious cover are more likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover. Impervious cover is a primary factor when determining pollutant characteristics and loadings in stormwater runoff.

The degree of imperviousness in a watershed also affects aquatic life. There is a strong relationship between watershed impervious cover and the decline of a suite of stream indicators. As imperviousness increases the potential stream quality decreases with most research suggesting that stream quality begins to decline at or around 10 percent imperviousness (Schueler, 1994; CWP, 2003). However, there is considerable variability in the response of stream indicators to impervious cover observed from 5 to 20 percent imperviousness due to historical effects, watershed management, riparian width and vegetative protection, co-occurrence of stressors, and natural biological variation. Because of this variability, one cannot conclude that streams draining low impervious cover will automatically have good habitat conditions and a high quality aquatic life.

Figure 11 shows the distribution of impervious cover within the County using the County's 2011 planimetric impervious surface spatial data. Table 8 presents a summary of the countywide impervious cover totals by watershed and Table 31 presents a summary of impervious cover totals by each NPDES source sector by watershed, both using analysis with the County's 2011 planimetric impervious GIS data.

The total impervious surface acreage for Charles County using 2011 planimetric data is 14,883.9 acres, or 5.0% of the county. Mattawoman Creek is the watershed with the most impervious acres and largest percentage of imperviousness, at 4,323.5, or 9.7% of total watershed area, respectively (Table 8). It is noted too that a most of the impervious cover in the Mattawoman is focused in the upper portion of the watershed in the Waldorf area and along the US Route 301 corridor. The watershed with the lowest impervious percentage is Nanjemoy Creek at 1.9%. Table 31 presents percent impervious cover by watershed and NPDES source sector. The majority of the County's impervious cover is within the County MS4 Phase I source sector (87.6%) with some impervious cover owned by Maryland State Highway Administration (SHA) (8%), within the Federal Phase II MS4 (2.8%), other State-owned property (1.2%), and some regulated industrial facilities (0.4%).

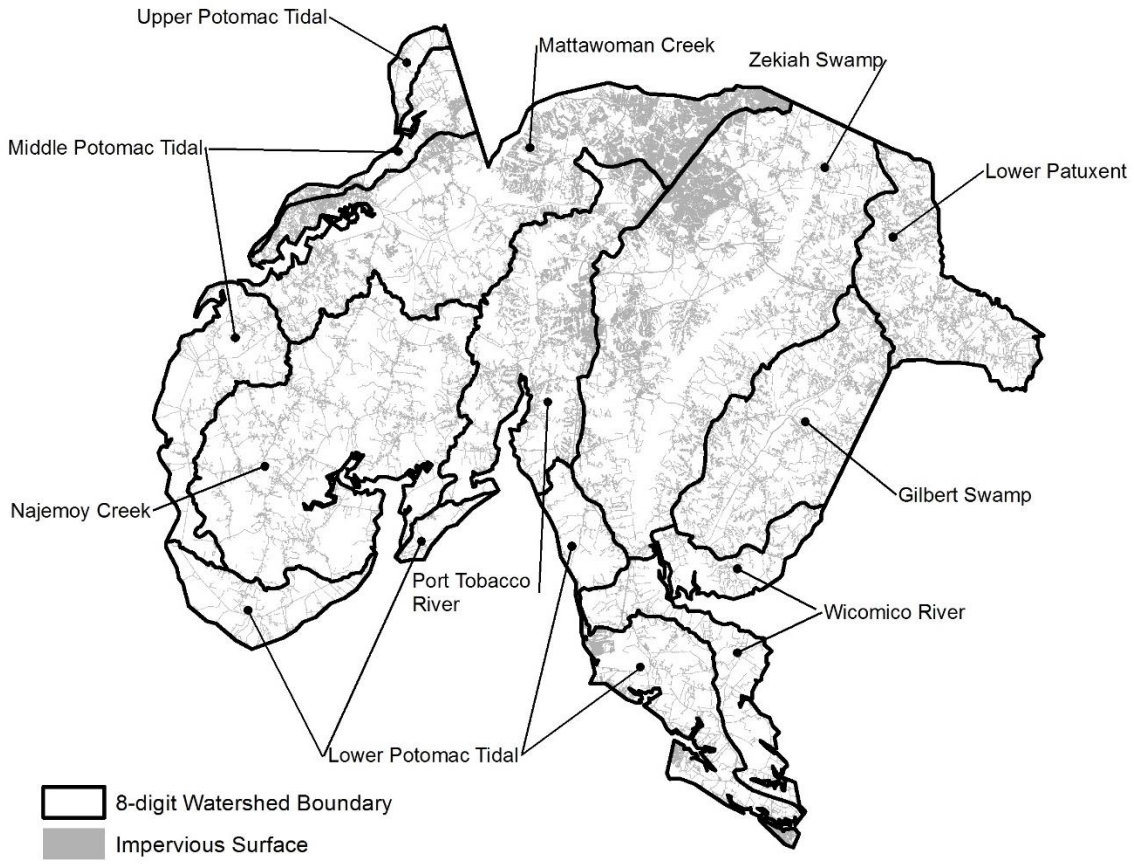

Figure 11. Distribution of impervious cover within Charles County (as of 2011)

Table 31. Percent Impervious Cover by Watershed and NDPES Source Sector

Watershed Name	Total Impervious Acres	County Phase I MS4	Federal Property	Municipal Phase II MS4	Regulated Industrial Facility	SHA Phase I MS4	State Property
Gilbert Swamp	1,010.7	92.9%	0.0%	0%	0.5%	6.4%	0.2%
Mattawoman Creek	4,323.5	83.6%	5.7%	0%	0.6%	8.8%	1.4%
Nanjemoy Creek	903.3	90.4%	0.5%	0%	0.0%	8.4%	0.7%
Patuxent River Lower	839.8	89.9%	0.0%	0%	0.0%	7.2%	2.8%
Port Tobacco River	1,961.5	66.2%	0.4%	22.4%	0.6%	9.5%	0.8%
Potomac River L Tidal	945.2	87.6%	2.9%	0%	0.7%	8.6%	0.2%
Potomac River M Tidal	621.5	64.6%	19.3%	0%	0.0%	11.2%	4.9%
Potomac River U Tidal	48.1	67.3%	32.7%	0%	0.0%	0.0%	0.0%
Wicomico River	388.7	85.0%	0.0%	0%	0.0%	13.3%	1.7%
Zekiah Swamp	3.841.5	85.3%	0.0%	7.9%	0.1%	5.9%	0.8%
Countywide Total	**14,883.9**	**82.6%**	**2.8%**	**5.0%**	**0.4%**	**8.0%**	**1.2%**

3.1.1 20% Impervious Restoration Goal

As a requirement of section PART IV.E.2.a of the NPDES MS4 Discharge Permit issued by MDE to Charles County, the County must conduct an impervious area assessment to define the restoration efforts required under the permit to restore 20% of remaining Countywide baseline impervious acres not already restored to the MEP. The restoration is required to be complete by 2019, the end of the current permit term.

Vista Design, Inc. was contracted by Charles County in May 2013 to complete an impervious surface area assessment, which resulted in the *Stormwater Management by Era and Impervious Surface Area Assessment Report* (Vista, 2015a). Data presented in this section was provided in Vista, 2015a and related GIS files from the impervious surface assessment.

The first step in this process is to determine the County's MS4 area of jurisdiction and the baseline impervious surface area that is treated, untreated, and partially treated. The County's GIS planimetric impervious layer was used as the basis for the analysis. Using this layer in combination with treatment from existing BMPs, the amount of untreated impervious surfaces was obtained and the 20% then applied. Existing BMPs include structural stormwater BMPs and other treatment including rooftop and non-rooftop disconnects.

Impervious accounting methodology is provided here with results at the watershed and County scale presented in Table 32. The impervious analysis was developed at the parcel scale. Each parcel was analyzed independently of others such that more than 65,000 parcels were evaluated individually to create a more accurate assessment. The following stormwater eras and analyses were used to derive the baseline values and 20% treatment target:

- **ERA 0** – Areas undeveloped or outside County jurisdiction – Impervious areas under public ownership other than County ownership and impervious areas regulated under other NPDES stormwater permits, such as Phase II or Industrial, were removed as they are not under County MS4 jurisdiction. Parcels considered "non-county" included the municipal limits of La Plata and Indian Head; however county-owned properties within these municipal limits were included. Other parcels not included are agricultural land, undeveloped forests, and properties assessed but with an improvement value of less than $10,000, owned by the State of Maryland, owned by the Federal Government, or within a preserved area. There were also 45 identified industrial permitted facilities with NPDES permits that were not included.
- **ERA 1** – Prior to 1985 stormwater management was not required at the state level. Some development may have included stormwater design techniques; however development occurring before 1985 is generally considered to not have stormwater adequate management in place, particularly in regards to water quality treatment. Era 1 locations make up a large portion of the County's untreated impervious area baseline.
- **ERA 2** – Between 1985 and 2002 developments were required to implement stormwater BMPs according to the 1982 stormwater management law which required all new development to treat the first 0.5-inches of runoff from impervious surfaces. It has since been determined that the 0.5-inch treatment is not adequate for full water quality treatment therefore these areas are considered partially treated. Therefore these areas make up a portion of the baseline untreated value.
- **ERA 3** – Areas developed after 2002 under Maryland's 2000 Storm-water Design Manual were required to treat the first 1.0-inch of stormwater runoff from impervious surfaces. Areas of rural

development had the same requirement after 2004. Because treatment at the 1.0-inch level is consider to be providing full water quality treatment (treating 100% of the water quality volume or WQv), those areas developed after 2002 are considered fully treated and are part of the baseline treated portion of the County's overall impervious surfaces total.

- **ERA 4** – Areas developed under this era include more recent Environmental Site Design regulations. These areas, like those in era 3, provide treatment for the full water quality volume at the 1.0-inch runoff level and are therefore considered to be fully treated.
- **ERA 6** - Rooftop and Non-Rooftop Impervious Surface Disconnects– An analysis was conducted to determine those impervious areas (rooftops and non-rooftops i.e. roads, driveways parking lots) which drain to vegetative systems and may meet ESD requirements for impervious surface disconnection. These areas, with varying levels of treatment depending on the site conditions, were subtracted from the impervious untreated baseline and added to the treated portion.
- The result of the calculations Countywide yields the impervious acres that are fully treated, partially treated, and not treated.
- Untreated Impervious Area – Following from the impervious treatment analysis, the total acres of treatment were subtracted from the County's total MS4 impervious area and the result is the acres of untreated or partially untreated impervious area.
- 20% Target – A 20% factor was applied to the County's total untreated impervious acres to determine the restoration target.

Charles County's impervious baseline accounting is presented in Table 32 and Table 33. Countywide, the total County MS4 Impervious Area, or the area under Charles County jurisdiction, is 9,941.7 acres. The difference between this value and the total impervious area of 14,883.9 acres is impervious area under other ownership (state lands) and areas regulated by other NPDES permits (MSHA and industrial sites) which totals 4,942.2 acres.

The impervious baseline treated area is 2,893.9 acres and the untreated area is 7,047.8 acres. Applying the 20% factor to the untreated area yields a 20% restoration target of 1,409.6 acres. The levels of treated and untreated impervious area are shown per watershed, however the 20% restoration goal is implemented at the County scale and is therefore not shown at the watershed level.

3.1.1 Impervious Restoration Progress

Charles County has implemented several projects and programs in recent years that can be counted as progress towards the restoration goal. Progress as of 2015 is shown in Table 33.

Table 32. Impervious Accounting Results per Watershed

	Gilbert Swamp	Mattawoman Creek	Nanjemoy Creek	Patuxent River Lower	Port Tobacco River	Potomac River L Tidal	Potomac River M Tidal	Potomac River U Tidal	Wicomico River	Zekiah Swamp	Total
	Impervious Baseline and Target (Impervious Credit Acres)										
Total Impervious Area	**1,010.7**	**4,323.5**	**903.3**	**839.8**	**1,961.5**	**945.2**	**621.5**	**48.1**	**388.7**	**3,841.5**	**14,883.9**
County MS4 Impervious Area	**550.2**	**3,326.4**	**522.9**	**611.9**	**1,202.7**	**443.8**	**286.3**	**34.7**	**160.9**	**2,801.8**	**9,941.7**
Era 1: Pre-1985 Stormwater BMPs	403.3	1,575.3	399.1	397.2	648.2	350.6	198.2	26.4	125.0	1,761.7	5,885.0
Era 2: 1985 - 2002 Stormwater BMPs	58.0	1,123.2	12.7	102.3	300.6	21.3	41.4	3.8	4.1	450.5	2,118.0
Era 3: 2002 - 2013 Stormwater BMPs	27.0	420.9	30.2	65.9	139.2	33.9	13.0	1.2	15.9	428.8	1,175.9
Era 4: ESD Regulations	9.4	64.4	10.5	17.3	54.9	11.3	1.2	0.1	6.5	44.2	219.7
Era 6: Rooftop Disconnect	52.5	142.7	70.5	29.2	59.8	26.6	32.4	3.3	9.3	116.6	543.0
Impervious Baseline Treated	**108.8**	**1,157.3**	**109.2**	**158.8**	**389.2**	**78.5**	**63.9**	**5.6**	**32.4**	**790.1**	**2,893.9**
Impervious Baseline Untreated	**441.4**	**2,169.1**	**413.7**	**453.1**	**813.5**	**365.3**	**222.4**	**29.2**	**128.5**	**2,011.6**	**7,047.8**
20% Restoration Target											**1,409.6**

Table 33. Impervious Restoration 2015 Progress per Watershed

	Gilbert Swamp	Mattawoman Creek	Nanjemoy Creek	Patuxent River Lower	Port Tobacco River	Potomac River L Tidal	Potomac River M Tidal	Potomac River U Tidal	Wicomico River	Zekiah Swamp	Total
Impervious Baseline and Target (Impervious Credit Acres)											
County MS4 Impervious Area	**550.2**	**3,326.4**	**522.9**	**611.9**	**1,202.7**	**443.8**	**286.3**	**34.7**	**160.9**	**2,801.8**	**9,941.7**
Impervious Baseline Treated	**108.8**	**1,157.3**	**109.2**	**158.8**	**389.2**	**78.5**	**63.9**	**5.6**	**32.4**	**790.1**	**2,893.9**
Impervious Baseline Untreated	**441.4**	**2,169.1**	**413.7**	**453.1**	**813.5**	**365.3**	**222.4**	**29.2**	**128.5**	**2,011.6**	**7,047.8**
2015 Progress Impervious Restoration (Impervious Credit Acres)											
2015 Restoration Progress	0.0	50.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	46.3	96.5
Septic Credits	5.2	17.5	6.5	7	16	11.6	2.7	1.6	4.5	12.9	85.4
Total 2015 Progress Restoration	**5.2**	**67.58**	**6.5**	**7.15**	**16**	**11.6**	**2.7**	**1.6**	**4.5**	**48.581**	**181.9**
Remaining Impervious Restoration											**1,222.7**

The table builds on the impervious accounting information included in Table 32 in the previous section, but adds the restoration progress completed between July 1, 2013 and November 2015. Results are provided at the watershed level for informational purposes only and to aid in planning and targeting future restoration efforts, the 20% requirement is to be met at the County scale, not at the watershed scale. The results indicate that the County has 181.9 impervious acres of restoration to apply to its 20% goal, leaving 1,222.7 acres of impervious restoration to be completed by the end of the permit term in December, 2019.

Projects implemented to date have been located in the Mattawoman (6 projects), Zekiah (4 projects) and Lower Patuxent (1 project) Watersheds. These projects were identified in earlier watershed assessments conducted by the County in 2004, 2007 and 2011. The sites are located in the neighborhoods of Pinefield, Bryans Road, Fox Run, Ryon Woods and Carrington. The types of projects include stormwater retrofits to shallow marsh wetland facilities, SPSC, pond retrofits and dry swales.

A full list of completed projects is included in Appendix A.

3.1.2 Planned Impervious Restoration (Scenario 1)

The following describes the level of project implementation and cost that would be required to meet the 20% goal by 2019 fully by completing projects wholly within the stormwater sector (Scenario 1). Subsequent sections will describe the potential for the County to use cross-sector trading with the wastewater sector to ensure compliance by 2019 and still meet the restoration goals.

The County has identified a suite of stormwater projects that if completed can meet the 20% restoration goals. These projects are included in Levels 2-7 of the County's project planning list and represent a total of 90 additional projects to implement before December 2019. The projects are summarized in Table 34 with the levels of planned impervious treatment and the numbers of projects shown. Also shown are the reductions expected from the operational programs.

The projects and programs collectively are expected to treat an additional 1,916.7 impervious acres, which would exceed the 20% goal and result in treatment of 27.2%. When added to the 2015 progress results (181.9 acres) the total impervious treatment planned is 2,098.6 acres or 29.8%.

It is likely that some projects currently identified may not succeed in producing the anticipated level of treatment once the project has done through full design and construction. Additionally, some projects will likely not move forward from concept stages to full design based on additional feasibility analyses.

Additional projects and programs are identified in levels 8 and 9 that can be used if feasibility for those in levels 2-7 deems those projects less desirable or beneficial. Level 8 are projects are those identified by Vista, BayLand and GMB that were not as cost effective (cost per impervious acre treated) than those selected for further development. There are a small number of projects (9) that were also not included in the initial cost benefit analysis and will need to be incorporated fully into the planning. Level 9 projects are those identified by KCI in the watershed assessments in Port Tobacco, Mattawoman and Lower Patuxent watersheds. These projects will also need to be incorporated into the full prioritization and planning process to ultimately select the best projects to move forward with.

Table 34. Scenario 1 - Levels of Planned Stormwater Sector Restoration Required per Watershed to meet 20% Goal

	Gilbert Swamp	Mattawoman Creek	Nanjemoy Creek	Patuxent River Lower	Port Tobacco River	Potomac River L Tidal	Potomac River M Tidal	Potomac River U Tidal	Wicomico River	Zekiah Swamp	Total
Planned Impervious Restoration (2016-2019) (Impervious Credit Acres)											
Level 2 In Construction	0.0 (0)	55.5 (3)	2.9 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (1)	0.0 (0)	0.0 (0)	5.3 (1)	63.7 (6)
Level 3 In Design	0.0 (0)	351.3 (25)	0.0 (0)	18.0 (1)	6.0 (5)	66.2 (3)	0.0 (0)	0.0 (0)	0.0 (0)	226.9 (12)	668.4 (46)
Level 5 Existing SWM Facility Inspection /Upgrade	0.0 (0)	3.3 (2)	0.0 (0)	0.0 (0)	130.3 (5)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	513.0 (9)	646.5 (16)
Level 6 Concept Design High Priority	0.0 (0)	66.6 (12)	0.0 (0)	0.0 (0)	18.4 (2)	82.0 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	166.9 (15)
Level 7 Concept Design Medium Priority	0.0 (0)	15.3 (4)	0.0 (0)	0.0 (0)	21.4 (5)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	36.6 (9)
Levels 2-7 Total	**0.0 (0)**	**491.8 (46)**	**2.9 (1)**	**18.0 (1)**	**176.1 (17)**	**148.2 (4)**	**0.0 (1)**	**0.0 (0)**	**0.0 (0)**	**745.2 (22)**	**1,582.4 (92)**
Operational Reductions	0.0	157.1	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	164.6
Septic Reductions	0.0	17.5	0.0	7.3	4.4	0.0	0.0	0.0	0.0	0.0	29.2
Homeowner Reductions	0.0	39.2	0.0	19.9	81.4	0.0	0.0	0.0	0.0	0.0	140.5
Total Reductions	**0.0**	**705.8**	**2.9**	**45.2**	**269.4**	**148.2**	**0.0**	**0.0**	**0.0**	**745.2**	**1,916.7**

Notes: Total may not match sum of values in the table due to rounding. Implementation for structural projects in Levels 2-7 are listed as Impervious Acres Treated and (Number of Projects). Operational Reductions include street sweeping and inlet cleaning. Septic reductions include upgrades, pump-outs and connections.

3.1.3 Planned Impervious Restoration (Scenario 2)

The County is currently investigating the potential for cross-sector trading in time with the wastewater sector to assist in meeting the 20% restoration goal by 2019. MDE in January 2016 published draft guidance on water quality trading across sectors that for the first time allowed the MS4 sector to participate with the agricultural and wastewater sectors (MDE, 2016). Charles County is interested in, and is exploring the feasibility of trading with credits from its municipal waste water treatment plants that have demonstrated additional capacity under their loading caps.

Currently the draft guidance is under review and comment by many interested parties including municipalities, and there are many details to be sorted out and finalized; however the following trading elements are understood to be a part of the process that would impact the County's intra-jurisdictional trading.

- Point sources (MS4) may participate
- Waste water sector (WWTP) may participate
- Trading could be used for up to half of the County's 20% impervious surface restoration goal
- Trading is preferred to occur with three geographic boundaries (Potomac River Basin, Patuxent River Basin, and Easter Shore/Western Shore Tributary Basins including the Susquahanna
- Delivery factors may apply if trading occurs across the geographic boundaries
- Trading should occur within a priority order
    - Within a local watershed under a TMDL
    - Within the regulated MS4 jurisdiction
    - Within any 8-digit watershed that extends beyond the MS4 boundary
    - Within Maryland Trading Regions (only after the first three priorities have been exhausted)

Currently the guidance calls for a 20 year duration of credits to include two full five year permit terms and a plan to demonstrate how the credits will be maintained for an additional 10 years. The County, and many other MS4 are advocating for "trading in time" or a temporary credit framework allocated on an annual basis. In this manner Charles County could use cross-sector trading to meet its 20% goal in 2019, but continue to implement stormwater sector projects and "pay back" the credit over time.

Scenario 2 includes using currently unused load capacity at the County's Mattawoman WWTP to meet half (10%) of the restoration goal. It is anticipated that trading within a County, among County owned and operated NPDES permits will simplify the transaction. The following describes the preliminary analysis completed to demonstrate the feasibility of this trade.

The County's untreated impervious area is 7,047.8 acres, which results in a 20% goal of 1,409.6 acres, and a 10% goal of 704.8 acres. Using MDE's impervious to loading equivalents (Table 35) we have calculated the loads (TN and TP) required to obtain a range of credits from 1% of the impervious goal, to 10% of the goal (Table 36).

Table 35. Impervious to Pollutant Load Conversion Rates

Parameter	Impervious (lbs/ac/yr)	Forest (lbs/ac/yr)	Delta (lbs/ac/yr)
TN	15.34	3.08	12.26
TP	1.7	0.08	1.62
TSS	0.56	0.03	0.53

The table below also provides a generic cost evaluation associated with each level of crediting between 1 and 10% using an average cost per impervious acre treated in the stormwater sector.

Table 36. Loading Equivalents and Associated Stormwater Sector Costs

Potential Trade Percent	Equivalent Impervious Acres	Cost of Impervious Treatment (Stormwater)	Equivalent TN Credits (lbs/yr)	Equivalent TP Credits (lbs/yr)	Equivalent TSS Credits (lbs/yr)
base numbers	1.00	$50,000	12.26	1.62	0.53
1%	70.48	$3,523,900	864.06	114.17	37.35
2%	140.96	$7,047,800	1728.12	228.35	74.71
3%	211.43	$10,571,700	2592.18	342.52	112.06
4%	281.91	$14,095,600	3456.24	456.70	149.41
5%	352.39	$17,619,500	4320.30	570.87	186.77
6%	422.87	$21,143,400	5184.36	685.05	224.12
7%	493.35	$24,667,300	6048.42	799.22	261.47
8%	563.82	$28,191,200	6912.48	913.39	298.83
9%	634.30	$31,715,100	7776.54	1027.57	336.18
10%	704.78	$35,239,000	8640.60	1141.74	373.53

From this analysis it is determined that to trade a full 10%, the waste water sector would need to have available loading capacity of 8,640.60 lbs/yr of TN, and 1,141.74 lbs/yr of TP. Table 37 presents the annual TN and TP loading and a five year average from 2010-2015. The 'Loading Capacity' indicates the additional capacity that would have been available each year to trade.

Table 37. Mattawoman WWTP Annual Loading Summary

Year	Total Effluent Flow (MGY)	Avg Daily Flow (MGD)	TN Conc. (mg/l) Annual Average	TN Loading (lbs/yr)	TN Loading Capacity (lb/yr)	TP Conc. (mg/l) Annual Average	TP Loading (lbs/yr)	TP Loading Capacity (lb/yr)
Cap				243,645			10,964	
2016*	1,034	11.36	7.29	63,690	179,955	0.06	532	10,432
2015	3,667	10.05	6.68	224,457	19,188	0.08	2,286	8,678
2014	3,979	10.90	4.06	147,286	96,359	0.09	2,969	7,995
2013	3,829	10.49	2.77	91,337	152,308	0.08	2,435	8,529
2012	3,519	9.64	1.88	55,554	188,091	0.08	2,354	8,610
2011	4,115	11.27	1.88	65,403	178,242	0.07	2,440	8,524
2010	3,952	10.83	3.58	133,609	110,036	0.07	2,131	8,833
Average**	3,844	10.53	3.48	119,608	124,037	0.08	2,436	8,528

* data available through March of 2016

** Average of annual values 2010-2015

Finally, the annual loading capacity is converted back to impervious area using the same impervious to load equivalents in Table 35. The results in Table 38 indicate that, on average, there is 14 times the TN capacity to meet the 10% trading limit, and 7.5 times the TP capacity to meet the 10% trading limit.

Table 38. Mattawoman WWTP Annual Impervious Equivalents

Year	TN Loading Capacity (lb/yr)	Impervious Area Equivalent (using TN)	Impervious Acre % Treated (using TN)	TP Loading Capacity (lb/yr)	Impervious Area Equivalent (using TP)	Impervious Acre % Treated (using TP)
2015	19,188	1,565.09	22%	8,678	5,356.79	76%
2014	96,359	7,859.62	112%	7,995	4,935.19	70%
2013	152,308	12,423.18	176%	8,529	5,265.01	75%
2012	188,091	15,341.86	218%	8,610	5,314.82	75%
2011	178,242	14,538.50	206%	8,524	5,261.57	75%
2010	110,036	8,975.20	127%	8,833	5,452.43	77%
Average	124,037	10,117.24	144%	8,528	5,264.30	75%

Additional information is required to determine the level of service and average daily flows to the plant estimated in future years to ensure that even a short-term trade would be feasible. The County's comprehensive plan indicates an existing treatment capacity of 20 MGD (million gallons per day) and 80,000 EDU (equivalent dwelling units). Projections in the plan indicate a total demand in 2040 of 18.869 MGD and 75,477 EDU. A basic estimation using the remaining capacity of 1.131 MGD and the five-year average TN concentration of 3.48 mg/L yields an annual load of just over 200,000 lbs/yr, which is still

well under the 243,645 TN loading cap. Likewise for TP the annual load in 2040 at the expected demand would be 4,598 lbs/yr, still under the loading cap by 6,366 lbs/yr.

Table 39. Estimated Mattawoman WWTP Future Capacity

	5 Year Average	2040
Average Daily Flow	10.530	18.869
Treatment Capacity	20.000	20.000
Available Capacity	9.470	1.131
Total Nitrogen		
TN Concentration (mg/L)	3.48	3.48
TN Load (lbs/yr)	119,608	200,018
2025 Permit Cap on TN Load (lbs/yr)	243,645	243,645
Available TN Load (lbs/yr)	124,037	43,627
Total Phosphorus		
TP Concentration (mg/L)	0.08	0.08
TP Load (lbs/yr)	2,436	4,598
2025 Permit Cap on TP Load (lbs/yr)	10,964	10,964
Available TP Load (lbs/yr)	8,528	6,366

If trading is used under Scenario 2, the County would need to only meet half of the goal by 2019. To reach 10% by the end of 2019, the 2015 progress (181.9 impervious acres) is subtracted from the 10% goal (704.8 impervious acres) to result in a goal of 522.9 impervious acres. This can be accomplished through implementation of the planned operational and programmatic practices which is planned to account for 334.3 impervious acres treated, and by the projects currently under levels 2 and 3, those in construction and full design, respectively. Level 2 is estimated to produce 63.7 acres of impervious treatment, and Level 3 668.4 acres. This would result in a total treatment of 1,066.3 impervious acres which is well over the 522.9 impervious acres goal under this scenario and therefore provides a conservative estimate.

3.1.4 Cost of Impervious Restoration

Under this scenario the County would complete at least 10% of the impervious restoration by December 2019, and continue to develop stormwater projects to pay back the traded credits over a period of time yet to be determined. By trading, the County can spread out the costs of meeting the 20% goal over a longer period of time, while still meeting the overall TMDL goal.

The cost of completed structural projects is $6,514,851 to treat 97 acres of impervious area. This equates to a cost of $67,163 per acre.

Scenario 1

Costs for Scenario 1 are included below in Table 40. Several of the projects have already been funded under previous fiscal year budgets. This includes all of Level 2 (in construction) projects, some Level 3 (in design) projects and one Level 6 concept project. While these projects add to the total cost of meeting the goals, they have been separated so that the additional funding from FY17 forward is understood.

Under this scenario, $32,384,000 in structural project Capital Improvement Plan (CIP) funds are needed to meet the 20% goal with an additional $6,493,000 in costs for the operational and programmatic practices. This CIP cost equates to an annual requirement of $10,795,000 to implement the projects over the next 3 years.

The County's FY17 budget has $10,783,000 allocated in FY17 and $10,950,000 per year allocated in FY18 through FY21.

Based on this analysis, current funding levels for structural CIP projects, termed 'NPDES Retrofit Projects' in the County's FY17 budget should be adequate. However, the additional $6,493,00 is not currently met by the budget.

Scenario 2

If trading is used under Scenario 2 for half of the required 20% restoration, the County would need to implement the projects currently in construction and design (Levels 2 and 3) by the end of 2019. There are currently six projects in construction, and 46 projects in design for a total of 52 projects to implement. As mentioned previously, all Level 2 projects and some Level 3 projects have already been funded so their cost is reported separately. This scenario would incur a cost of $27,900,000 per year moving forward including structural and operational programs. The cost per year of the NPDES Retrofit Projects alone would be $7,135,670 per year ($21,407,000 total). Costs for Scenario 2 are included below in Table 41.

Table 40. Scenario 1 Cost to meet 20% Goal within the Stormwater Sector ($ in thousands)

	Gilbert Swamp	Mattawoman Creek	Nanjemoy Creek	Patuxent River Lower	Port Tobacco River	Potomac River L Tidal	Potomac River M Tidal	Potomac River U Tidal	Wicomico River	Zekiah Swamp	Total
2015 Progress Impervious Restoration (Completed Projects)											
Level 1 Completed Projects	$0	$4,341	$0	$185	$0	$0	$0	$0	$0	$1,989	$6,515
Planned Impervious Restoration (Projects Funded in Prior FY Budgets)											
Level 2, 3 and 6 Already Funded	$0	$16,340	$108		$1,097	$2,194	$928	$0	$0	$3,685	$24,352
Planned Impervious Restoration (2016-2019) (Funding FY19 to Dec FY20)											
Levels 3-7	$0	$14,224	$0	$370	$3,137	$1,427	$0	$0	$0	$13,225	$32,384
Operational Reductions	$0	$17	$0	$0	$1	$0	$0	$0	$0	$0	$18
Septic Reductions	$0	$852	$0	$312	$650	$0	$0	$0	$0	$0	$1,814
Homeowner Reductions	$0	$1,676	$0	$856	$2,129	$0	$0	$0	$0	$0	$4,661
Total Cost	**$0**	**$16,769**	**$0**	**$1,538**	**$5,917**	**$1,427**	**$0**	**$0**	**$0**	**$13,225**	**$38,877**

Table 41. Scenario 2 Cost to meet 20% Goal with 10% Credit from Cross-sector Trading ($ in thousands)

	Gilbert Swamp	Mattawoman Creek	Nanjemoy Creek	Patuxent River Lower	Port Tobacco River	Potomac River L Tidal	Potomac River M Tidal	Potomac River U Tidal	Wicomico River	Zekiah Swamp	Total
2015 Progress Impervious Restoration (Completed Projects)											
Level 1 Completed Projects	$0	$4,341	$0	$185	$0	$0	$0	$0	$0	$1,989	$6,515
Planned Impervious Restoration (Projects Funded in Prior FY Budgets)											
Level 2, 3 and 6 Already Funded	$0	$16,340	$108		$1,097	$2,194	$928	$0	$0	$3,685	$24,352
Planned Impervious Restoration (2016-2019) (Funding FY19 to Dec FY20)											
Level 3	$0	$8,901	$0	$370	$0	$0	$0	$0	$0	$12,136	$21,406
Operational Reductions	$0	$17	$0	$0	$1	$0	$0	$0	$0	$0	$18
Septic Reductions	$0	$852	$0	$312	$650	$0	$0	$0	$0	$0	$1,814
Homeowner Reductions	$0	$1,676	$0	$856	$2,129	$0	$0	$0	$0	$0	$4,661
Total Cost	**$0**	**$11,446**	**$0**	**$1,538**	**$2,780**	**$0**	**$0**	**$0**	**$0**	**$12,136**	**$27,900**

If the remaining 10% is to be paid back through implementation of stormwater projects over a three year period starting in 2020, it is anticipated that the cost differential between the two Scenarios ($10,997,000) would be spread across the 3 year period adding an additional $3,659,000 to FY budgets from FY20-FY22.

It is expected that the County may receive an additional 10-20% treatment requirement in the next MS4 permit cycle set to begin in January 2020. Using current cost estimates and assuming that half of the $38,877,000 would be needed for the additional 10% then an additional $19,438,500 would be needed from FY20 to FY24. Under Scenario 1 these costs would be incurred after the initial 20% restoration is met; however in Scenario 2 they would overlap in FY20 to FY22. Overall however the annual costs in Scenario 2 are more evenly distributed. The analysis does not include an accounting for inflation, nor does it account for the idea that as the easier and most cost effective projects are completed, that the relative cost of restoration in the future, on a dollar per impervious acre basis, may go up. A cost comparison of the two scenarios per FY is presented in Table 42.

Table 42. Impervious Restoration Cost Summary

		Scenario 1 – Stormwater Sector Only			Scenario 2 – Credit Trading for 10%			
		NPDES Retrofit	Operational	Total	NPDES Retrofit	Operational	Credit Pay-back	Total
20% Goal	FY17	$ 10,794,670	$2,164,330	$12,959,000	$7,135,667	$2,164,330		$9,299,997
	FY18	$ 10,794,670	$2,164,330	$12,959,000	$7,135,667	$2,164,330		$9,299,997
	FY19	$ 10,794,670	$2,164,330	$12,959,000	$7,135,667	$2,164,330		$9,299,997
New 10% Goal	FY20	$ 3,238,400	$ 649,300	$3,887,700	$3,238,400	$649,300	$3,659,000	$7,546,700
	FY21	$ 3,238,400	$649,300	$3,887,700	$3,238,400	$649,300	$3,659,000	$7,546,700
	FY22	$ 3,238,400	$649,300	$3,887,700	$3,238,400	$649,300	$3,659,000	$7,546,700
	FY23	$ 3,238,400	$649,300	$3,887,700	$3,238,400	$649,300		$3,887,700
	FY24	$ 3,238,400	$649,300	$3,887,700	$3,238,400	$649,300		$3,887,700
			Total	$58,315,500			Total	$58,315,490

3.2 Chesapeake Bay TMDL for Nitrogen and Phosphorus

The Chesapeake Bay TMDL, established by the EPA (EPA, 2010), sets pollution limits for nitrogen, phosphorus, and sediment in the Chesapeake Bay Watershed. Total limits set in the Bay TMDL for the states of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia are "185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year—a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment" (EPA, 2010). The TMDL also sets "rigorous accountability measures" for state compliance.

3.2.1 Sources

Nutrients are a pollutant of concern as an overabundance can cause algal blooms. Nitrogen is the limiting nutrient in the Chesapeake Bay, with high levels of nitrogen leading to algal blooms which cause decreased water clarity and light attenuation in the bay, as well as rob the bay of dissolved oxygen as algal blooms die and decompose at the bottom of the water column. Phosphorus is the limiting nutrient in freshwater systems and can lead to algal blooms in lakes and reservoirs with the same impacts as algal blooms in the Chesapeake Bay but also can have an impact on drinking water if the bloom occurs in a reservoir that is used as a water source for municipal drinking water. Sources of nutrients include agricultural runoff, urban stormwater, municipal wastewater treatment plants, phosphorus bound to sediments supplied to the system, and discharge from upstream impoundments.

3.2.2 Modeling Approach

A combination of models was used for baseline, progress, and planned pollutant load modeling for Bay and local TMDLs. They are described below. Each BMP provides impervious surface restoration as well as a reduction for nitrogen, phosphorus, and sediment, along with other pollutants.

Section 3.3 presents the suite of practices the County uses for current implementation and/or plans to use to address local TMDL and impervious restoration permit requirements. Section 8 presents information on how progress toward load reductions will be evaluated and how management plans will be adapted on an on-going basis.

MAST and BayFAST

The pollutant loads (i.e., nitrogen, phosphorus, and sediment) for the Bay TMDL baseline and progress scenarios in addition to local TMDL progress scenarios were determined using MAST, which calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program Partnership Watershed Model. MAST, created by Devereux Environmental Consulting for MDE, is a web-based pollutant load estimating tool that streamlines environmental planning. Users specify a geographic area (e.g., County, watershed) and then select BMPs to apply on that area. MAST builds the scenario and provides estimates of pollutant load reductions and allows users to understand which BMPs provide the greatest load reduction benefit and the extent to which these BMPs can be implemented. Based on the scenario outputs, users can refine their BMP choices in their planning. MAST facilitates an iterative process to determine if TMDL allocations are met. Scenarios may be compared to each other, to TMDL allocations, or to the amount of pollutants reduced by current BMP implementation.

MAST estimates of load reductions for point and nonpoint sources include: agriculture, urban, forest, and septic loading. Load reductions are not tied to any single BMP, but rather to a suite of BMPs working

in concert to treat the loads. Both MAST and the Watershed Model calculate reductions from all BMPs as a group, much like a treatment train. Reductions are processed in order, with land use change BMPs first, load reduction BMPs next, and BMPs with individual effectiveness values at the end. The overall load reduction can vary depending on which BMPs are implemented.

The baseline pollutant loads for nutrient and sediment local TMDLs were determined using BayFAST (Bay Facility Assessment Scenario Tool). BayFAST functions similarly to MAST but allows users to delineate facility boundaries (e.g., watershed, parcel, drainage area) and alter land use information within the delineated boundary depending on the model year. Local TMDL baseline loads were calibrated in BayFAST by modeling BMPs installed prior to the TMDL baseline year on top of baseline land use background loads. This ensures that the same set of baseline BMPs are used throughout future progress and planned scenarios. Local TMDL baseline scenario loads are provided in MAST; however, the functionality to edit baseline BMPs in the scenarios is not available.

Both the Watershed Model and MAST/BayFAST provide loads at two different scales: Edge-of-Stream (EOS) and Delivered (DEL). Delivered loads show reductions based on in-stream processes, such as nutrient uptake by algae or other aquatic life. Local TMDL plans focus on reducing load on the land, so EOS estimates are more appropriate and were used for nutrient and sediment modeling analysis.

Removal Rate Curve Equations

Pollutant load reductions for planned projects were calculated using revised removal rate curve equations for runoff reduction (RR) and stormwater treatment (ST) practices prepared by Chesapeake Stormwater Network (Schueler and Lane, 2015). Reductions are calculated based on rainfall treatment, whether noted in project concepts or as an assumption of 1-inch treatment, and removal efficiencies per RR and ST practice (Table 43).

Table 43. Runoff Reduction and Stormwater Treatment Practices Removal Rate Reductions

Practice	Rainfall Treatment	Nitrogen Reduction	Phosphorus Reduction	Sediment Reduction
Runoff Reduction (RR)	1”	60%	70%	75%
Stormwater Treatment (ST)	1”	35%	55%	70%

3.2.3 Baseline and Target Loads

The County’s MS4 permit is requiring compliance with the Chesapeake Bay TMDL for the stormwater sector through the use of the 20% impervious surface treatment strategy, as described in greater detail in the following section. The strategies provided in this plan to meet local TMDL reduction targets have been modeled in order to calculate potential progress toward meeting the Bay TMDL nutrient and sediment reduction goals. It is anticipated that the County may receive another 10-20% requirement in the following permit term if the goals are not met.

provides a concise summary of Charles County's portions of target edge of stream (EOS) and delivered (DEL) reductions towards the Chesapeake Bay TMDL and 2010 baseline and 2025 allocated loads. These terms and dates are used throughout the plan and explained in more detail in the following sections. They are presented here to assist the reader in understanding the definitions of each, how they were derived, and to provide an overall summary demonstrating the percent reduction required through full implementation of this plan. Planned loads and percent reduction achieved through this plan are discussed in Section 4: Expected Load Reductions and Impervious Treatment.

- **TN, TP, TSS:** Total Nitrogen, Total Phosphorus, Total Suspended Sediment. As specified in the Bay TMDL, if the phosphorus target is met, the sediment target will be met.
- **EOS lbs/yr and DEL lbs/yr:** An EOS load is the amount of a pollutant load that is transported from a source to the nearest stream annually while a DEL load is the amount of a pollutant load that is transported to the tidal waters of the Chesapeake Bay annually. DEL loads are generally less than EOS loads due to losses during transport from streams to the Bay.
- **Calibrated 2010 Baseline Load**: Baseline levels (i.e., land use loads with baseline BMPs) from 2010 conditions in the Charles County MS4 source sector using the Maryland Assessment Scenario Tool (MAST) Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) model. Baseline loads were used to calibrate the Bay TMDL nitrogen and phosphorus SW-WLAs.
- **Target Percent Reduction**: Percent reductions assigned to Charles County Phase I MS4 stormwater sector (http://wlat.mde.state.md.us/ByMS4.aspx). If TP target is met, TSS target will be met.
- **Calibrated Target Reduction:** Target reduction calibrated to MAST CBP v.5.3.2 by multiplying the reduction percent published by the 2010 baseline load. If TP target is met, TSS target will be met.
- **Calibrated TMDL WLA**: Allocated loads are calculated from the 2010 baseline levels, calibrated to CBP P5.3.2 as noted above, using the following calculation: 2010 Baseline – (2010 Baseline x Target Percent Reduction); or, 2010 Baseline x (1 – Target Percent Reduction).

Table 44. Charles County Chesapeake Bay TMDL Baseline and Target Loads

Baseline and Target	TN-EOS lbs/yr	TN-DEL lbs/yr	TP-EOS lbs/yr	TP-DEL lbs/yr	TSS-EOS lbs/yr	TSS-DEL lbs/yr
Calibrated 2010 Baseline Load	235,070	178,693	20,037	17,690	5,739,174	6,477,189
Target Percent Reduction	18.19%	20.24%	37.70%	38.26%	-	-
Calibrated Target Reduction	42,759	36,167	7,554	6,768	-	-
Calibrated Bay TMDL WLA	192,311	142,526	12,483	10,922	-	-

3.2.1 Chesapeake Bay TMDL Progress

2015 Progress results are shown in Table 45. As mentioned in previous plan sections, Charles County is meeting its Bay TMDL responsibilities through the 20% impervious surface restoration; therefore the Bay TMDL targets and reductions shown here are for informational purposes only.

Projects implemented to date have been located in the Mattawoman (6 projects), Zekiah (4 projects) and Lower Patuxent (1 project) Watersheds. These projects were identified in earlier watershed assessments conducted by the County in 2004, 2007 and 2011. The sites are located in the neighborhoods of Pinefield, Bryans Road, Fox Run, Ryon Woods and Carrington. The types of projects include stormwater retrofits to shallow marsh wetland facilities, SPSC, pond retrofits and dry swales.

Table 45. Bay TMDL 2015 Progress Reductions Achieved

	TN-EOS lbs/yr	TN-DEL lbs/yr	TP-EOS lbs/yr	TP-DEL lbs/yr	TSS-EOS lbs/yr	TSS-DEL lbs/yr
Baseline Loads and Target Reductions						
Calibrated 2010 Baseline Load	235,070	178,693	20,037	17,690	5,739,174	6,477,189
Target Percent Reduction	18.19%	20.24%	37.70%	38.26%	-	-
Calibrated Target Reduction	42,759	36,167	7,554	6,768	-	-
Calibrated Bay TMDL WLA	192,311	142,526	12,483	10,922	-	-
2015 Progress Reductions						
Structural Reductions	471	296	78	62	30,757	33,058
Operational Reductions	1,976	1,157	765	615	235,875	209,536
ESD Reductions	349	223	79	60	34,375	28,274
Restoration Reductions (from baseline to 2015)	2,796	1,676	921	737	301,007	270,867
Restoration Reduction Percent	1.2%	0.9%	4.6%	4.2%		
Reduction Remaining for Treatment	39,963	34,491	6,633	6,031		

3.2.2 Bay TMDL Restoration

The structural projects listed in Appendix A in addition to operational practices (street sweeping, inlet cleaning) and homeowner practices (rain barrels, rain gardens) make up the primary programs to be implemented for meeting the Bay TMDL goals by 2025. A detail of the projects, from Level 2 through 9 is included in Table 46. The projects are divided into Structural BMPs, ESD practices, and Alternate MS4 BMPs.

There are 245 projects total including the 11 projects already completed. This includes the 52 projects (Level 2 and 3) to be implemented by 2019 for the 20% restoration, plus 40 additional projects in Levels 4-7, 65 level 8 projects, and 77 level 9 projects.

Table 46. Number of Projects Per Type Per Level and Planning Period

BMP Type	Unit	2015 Progress	Planned Restoration										Total
			2016-2019				2020-2025						
			Level 2	Level 3	Program matic	Total	Level 5	Level 6	Level 7	Level 8 and 9	Program matic	Total	
Structural BMPs													
Bioretention	DA (ac)			10.0		**10.0**		0.6	4.3	31.2		**36.0**	**46.0**
Bioswale	DA (ac)			6.5		**6.5**		2.0				**2.0**	**8.5**
Created Wetland	DA (ac)			496.2		**496.2**		731.4	39.3	60.8		**831.5**	**1,327.7**
Dry Pond Conversion to Bioretention	DA (ac)			8.9		**8.9**						**0.0**	**8.9**
Dry Pond Conversion to Constructed Wetland	DA (ac)			21.8		**21.8**						**0.0**	**21.8**
Dry Swale	DA (ac)	6.3				**0.0**	256.8		13.4	541.9		**812.1**	**818.4**
Existing Grass Swale	DA (ac)					**0.0**		3.0				**3.0**	**3.0**
Existing Pond	DA (ac)			8.4		**8.4**						**0.0**	**8.4**
Filterra	DA (ac)	0.6		1.3		**1.3**				1.5		**1.5**	**3.4**
Grass Swale	DA (ac)			16.2		**16.2**				0.7		**0.7**	**16.9**
In Stream Storage	DA (ac)	33.7				**0.0**						**0.0**	**33.7**
Infiltration Basin	DA (ac)					**0.0**				54.1		**54.1**	**54.1**
Organic Filter	DA (ac)			2.1		**2.1**						**0.0**	**2.1**
Pond Reclassification	DA (ac)					**0.0**	1,073.1		42.4			**1,115.5**	**1,115.5**
Pond Retrofit	DA (ac)			43.4		**43.4**	142.8			195.0		**337.8**	**381.2**
Shallow Marsh	DA (ac)	172.4				**0.0**						**0.0**	**172.4**
StormFilter	DA (ac)					**0.0**				31.3		**31.3**	**31.3**
Stormwater Wetland	DA (ac)					**0.0**				93.2		**93.2**	**93.2**
Stream Restoration	Linear Feet					**0**				43,525		**43,525**	**43,525**
Submerged Gravel Wetland	DA (ac)		237.9	333.4		**571.3**		262.9	22.9	183.2		**469.0**	**1,040.3**
Tree Planting	DA (ac)					**0.0**				114.6		**114.6**	**114.6**

BMP Type	Unit	2015 Progress	Planned Restoration										Total
			2016-2019				2020-2025						
			Level 2	Level 3	Program matic	Total	Level 5	Level 6	Level 7	Level 8 and 9	Program matic	Total	
Underground Infiltration	DA (ac)					**0.0**				18.4		**18.4**	**18.4**
Underground Storage Chamber	DA (ac)	9.1				**0.0**						**0.0**	**9.1**
Wet Pond	DA (ac)	83.5		92.2		**92.2**		75.1		54.1		**129.2**	**304.9**
Wet Swale	DA (ac)			9.9		**9.9**				42.8		**42.8**	**52.7**
Environmental Site Design Practices													
Rainwater Harvesting	DA (ac)			2.0		**2.0**						**0.0**	**2.0**
Sheetflow to Conservation Areas	DA (ac)					**0.0**		52.6	37.9	5.7		**96.2**	**96.2**
SWM Facility Inspection/Upgrade	DA (ac)					**0.0**	1,805.4					**1,805.4**	**1,805.4**
Downspout Disconnection	No. Disconnects				1,322	**1,322**						**0**	**1,322**
Rain Barrels	No. Barrels				9,065	**9,065**						**0**	**9,065**
Rain Garden	DA (ac)	0.2		1.0	3.6	**4.5**				2.8		**2.8**	**7.5**
Alternative MS4 BMPs													
Shoreline Management	Linear Feet					**0.0**				5,898		**5,898**	**5,898**
Shoreline Restoration	Linear Feet			1,488		**1,488**		2,050		7,159		**9,209**	**10,697**
Step Pool Storm Conveyance	DA (ac)	23.1	163.2	39.3		**202.5**				667.3		**667.3**	**892.9**
Septic Connections	No. of Connections	23.0				**0.0**						**0.0**	**23.0**
Septic Pump Outs	No. of Pump Outs/year	1,093			1,093	**1,093**					1,093	**0.0**	**2,186**
Septic Upgrades	No. Upgrades	168			75	**75**					112	**0**	**243**
Storm Drain Vacuuming	No. Pipes/year	247			247	**247**					247	**0**	**494**
Street Sweeping	Miles Swept/year	193.2			193	**193.2**					193.2	**0.0**	**386.4**

Level: 1- Completed; 2- Construction; 3- Full Design; 5- Existing SWM Upgrades; 6- 7 Concept, 8 and 9 sites identified

3.2.3 Load Reductions Expected

When all of the County's structural restoration projects (Levels 2-9) are included in addition to the operational practices and homeowner practices, the resulting loading reduction exceeds the required TP reductions (and TSS by default). Total nitrogen is projected to be at 57.5% of the goal reduction with 27,419 lbs/yr reduced.

Table 47. Bay TMDL Reductions Expected – Full Implementation

	TN-EOS	TN-DEL	TP-EOS	TP-DEL	TSS-EOS	TSS-DEL
	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
Baseline and Targets						
Calibrated 2010 Baseline Load	235,070	178,693	20,037	17,690	5,739,174	6,477,189
Target Percent Reduction	18.19%	20.24%	37.70%	38.26%	-	-
Calibrated Target Reduction	42,759	36,167	7,554	6,768	-	-
Calibrated Bay TMDL WLA	192,311	142,526	12,483	10,922	-	-
2015 Progress Reduction Summary						
Restoration Reductions (from baseline to 2015)	2,796	1,676	921	737	301,007	270,867
Reduction Remaining for Treatment	39,963	34,491	6,633	6,031		
Planned Reductions (2016- 2019)						
Level 2-3	6,705	4,070	1,591	1,300	625,189	599,505
Level 4-7	7,942	6,725	1,276	1145	665,506	728,060
Homeowner Reductions	199	143	42	37	-	-
Planned Reductions (2020 - 2025)						
Level 8	4,341	3,359	1,823	1,663	1,756,969	1,773,211
Level 9	5,436	4,826	2,853	2,692	941,084	918,958
Total Reductions						
Reduction (Progress + Planned)	27,419	20,799	8,506	7,574	4,289,755	4,290,601
Reduction Percent (Progress + Planned)	64.1%	57.5%	112.6%	111.9%		
Reduction Remaining for Treatment	15,340	15,368	(952)	(806)		
Reduction Percent Remaining	35.9%	42.5%	0%	0%		

3.2.4 Additional Reductions

Charles County will investigate additional projects and strategies to meet the remaining TN load reduction by 2025. This could include additional water quality trades, particularly with the waste water (septic) sector, which through connections, upgrades and pump outs may have credits available to the MS4 sector before 2025.

3.2.5 Cost of Bay TMDL Restoration

The total cost of the Bay TMDL implementation proposed thus far is presented in Table 48. The cost for levels 8 and 9 are added to the projects and programs that were identified for the 2016-2025 period to estimate a total cost for the planned projects and programs of $106,216,000. Per year this breaks down to $11,801,778 per year for 9 years. Adding in the cost of projects completed thus far and those that have already been funded by the County in previous fiscal years, the total cost is $137,083,000.

The TMDL plan, as drafted does not currently meet the full TN Bay reduction required in the SW-WLA. If the County were to meet the remaining load reductions through stormwater projects similar to those described in this plan the estimated cost of the additional treatment would be $43,8365,882. This is based on a cost per lb of TN removed with the Level 8 and 9 projects which is $2,852 per lb.

Factoring in this additional cost to meet the TN requirement with the cost to implement the projects in this plan, the total to be incurred is estimated at $150,051,882 or $16,672,431 per year over the 9 year period from 2017 to 2025. This level of funding far exceeds that required to meet the 20% impervious surface restoration.

Table 48. Bay TMDL Cost ($ in thousands)

	Gilbert Swamp	Mattawoman Creek	Nanjemoy Creek	Patuxent River Lower	Port Tobacco River	Potomac River L Tidal	Potomac River M Tidal	Potomac River U Tidal	Wicomico River	Zekiah Swamp	Total
2015 Progress Impervious Restoration (Completed Projects)											
Level 1 Completed Projects	$0	$4,341	$0	$185	$0	$0	$0	$0	$0	$1,989	$6,515
Planned Impervious Restoration (Projects Funded in Prior FY Budgets)											
Level 2, 3 and 6 Already Funded	$0	$16,340	$108		$1,097	$2,194	$928	$0	$0	$3,685	$24,352
Planned Impervious Restoration (2016-2019) (Funding FY17 to Dec FY25)											
Levels 3-7	$0	$14,224	$0	$370	$3,137	$1,427	$0	$0	$0	$13,225	$32,384
Operational Reductions	$0	$17	$0	$0	$1	$0	$0	$0	$0	$0	$18
Septic Reductions	$0	$852	$0	$312	$650	$0	$0	$0	$0	$0	$1,814
Homeowner Reductions	$0	$1,676	$0	$856	$2,129	$0	$0	$0	$0	$0	$4,661
Planned Impervious Restoration (2020-2025) (Funding FY20 to Dec FY25)											
Level 8	$0	$11,227	$4,747	$4,333	$1,989	$701	$3,489	$0	$179	$7,947	$34,612
Level 9	$0	$12,120	$0	$2,488	$18,119	$0	$0	$0	$0	$0	$32,727
Total Cost Planned (2016 to 2025)	**$0**	**$40,116**	**$4,747**	**$8,359**	**$26,025**	**$2,128**	**$3,489**	**$0**	**$179**	**$21,172**	**$106,216**
Full Cost of TMDL Restoration Complete and Planned											
Total Cost, Completed and Planned	**$0**	**$60,797**	**$4,855**	**$8,544**	**$27,122**	**$4,322**	**$4,417**	**$0**	**$179**	**$26,846**	**$137,083**

4 Implementation, Evaluation and Monitoring

Progress evaluation will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring.

4.1 Implementation

4.1.1 Prioritization

Watershed Scale

To implement watershed restoration activities thoughtfully, priorities are set at two scales. First, resources are allocated at the watershed scale and then projects within each watershed are evaluated relative to each other and to operational and programmatic programs to determine the most effective methods to move forward with.

The County will prioritize activities in local TMDL watersheds in order to meet local TMDL requirements for restoration. These include the Mattawoman Creek and Indian Creek watersheds. Watersheds with higher amounts and percentages of impervious surface are also priorities. These include Mattawoman Creek at 9.7% impervious, Port Tobacco River at 7.0% impervious, and Zekiah Swamp at 5.9% impervious with most of the activity in Zekiah in the upper portions of the watershed in and around Waldorf.

As noted in previous sections, the Mattawoman Creek is a high priority watershed for the County due to several factors including the diverse, high quality ecosystem. The Mattawoman Creek has ranked 8th out of 137 watersheds in Maryland for freshwater stream biodiversity and is home to six stream animal RTE species (Interagency Mattawoman Ecosystem Management Task Force. 2012). The Mattawoman Creek local nutrient TMDL has very aggressive load reduction requirements, particularly for nitrogen, therefore the County will have to make restoration in the watershed a priority over other watersheds with no SW-WLA or TMDL defined, and over watersheds not currently listed on the state's impaired waters list.

Project Scale

To support the County's resource allocation and decision making process, a prioritization is developed for each subwatershed as part of the watershed assessment process for the projects identified. The results indicate which projects are the most beneficial and cost effective that should move forward to full implementation. Results can be found in each watershed assessment report. The method is described here briefly.

The prioritization involves a matrix made up of a series of parameters, or metrics, which evaluated each proposed project and allowed for discrimination between the projects. Each metric is scored for each project, either qualitatively or quantitatively as appropriate. Weighting factors were applied to metrics that were deemed the most critical, and the sum of the weighted scores determined the highest priority projects to implement.

The approach includes scoring and ranking of the project benefits, constraints and costs. Including factors of feasibility and cost is necessary because the potential exists for the most beneficial project to also be relatively less feasible. It might be the most expensive project, have limited access, utility conflicts, or require disturbance to natural resources. A series of candidate metrics was developed for

each of the three categories: Benefits, Constraints, and Cost. Metrics evaluated by the project team are listed in Table 49 with a brief description of each.

Table 49: Prioritization Metrics

Metric	Description
Project Benefits	
Pollutant Removal	TN, TP, and TSS removed (lb) based on modeling
Groundwater Recharge	Amount of recharge based on level of expected infiltration
Channel Protection	Based on proposed level of quantity control and downstream stability
Channel Stabilization	Level of channel stabilization provided will be dependent on channel condition and type of project
Water/Stream Temperature	Does project reduce receiving water temperature?
Instream Habitat Improvement	Does project provide or improve instream habitat?
Riparian Habitat Improvement	Does project provide or improve riparian habitat?
Wetland Habitat Improvement	Does project provide or improve wetland habitat?
Fish Passage	Does project reduce or eliminate barriers to fish passage?
Public Visibility/Education/Outreach	Is project in close proximity to public places?
Community Aesthetic Improvement	Does the project improve community appearance?
Combined Benefit	Are there multiple projects in close proximity that together provide a larger cumulative benefit?
Impervious Area Treated	Area of impervious surface treated (acres)
Proximity to MS4	Does the project receive MS4 drainage?
Project Constraints	
Access	Are there constraints to access – mature trees, infrastructure, steep slopes?
Permitting	Are there significant permitting issues – wetland/forest disturbance?
Maintenance Requirements	What is the level of maintenance involved – frequency, expense, equipment?
Ownership	Is ownership of the parcels involved held publicly or privately? Are private owners cooperative?
Adjacent Land Use	Are adjacent properties compatible with the type of potential project?
Design/Construction	Do the site layout, topography, elevations allow for a design that maximizes benefit and is constructible?
Existing Utility Conflicts	Are there existing underground or overhear utilities conflicting with the design? Are the private or public?
Project Cost	
Total Life Cycle Cost	Total life cycle cost of the project
Cost per Impervious Area Treated	Total cost of the project divided by the impervious area treated, dollars per acre
Cost per Pollutant Removed	Total cost of the project divided by the amount of pollutant removed, dollars per lb of TP, TN, TSS

Projects identified under Capital Services program to meet the 20% impervious restoration goal have use the cost per impervious acre treated metric to evaluate projects. As the County moves forward into additional implementation the full set of projects will be prioritized together to develop a more complete restoration prioritization method.

Structural projects will also be evaluated against the cost of operational programs. For example, the septic pump-out program in the first full year of implementation (FY2015) is credited with 24.93 impervious acres restored at 0.03 acres/pump out. The cost per pump-out is $3,885 per impervious acre restored, far less than that achieved through traditional structural stormwater practices.

4.1.2 Project Implementation

Charles County has an implementation process in place through on-call design contracts. The County has three engineering firms on this on-call contract to complete the design and engineering, permitting, construction phase and monitoring elements of structural stormwater BMP and retrofit projects including all of the project types identified in the current round of watershed assessments.

The County seeks to partner with local watershed groups and watershed restoration and monitoring programs to implement its plan. Watershed groups, such as the Mattawoman Watershed Society, and the Port Tobacco River Conservancy will be instrumental in achieving the goal of healthy watersheds. The County is working on an agreement with the Maryland State Highway Administration for potential shared TMDL restoration projects.

The County looks for opportunities to work with technical assistance and financial providers such as the Chesapeake Bay Trust Forestry Grant. The County leverages capital projects being completed by other County agencies and departments to determine if the projects can provide restoration credit. Examples include sewer connection projects, Acton Lane and Stavor's Road improvements, Old Washington Road redevelopment. The County is working with the school system and has identified several restoration opportunities that are moving forward to full design at these sites.

4.2 Tracking Implementation of Management Measures

Implementation will be measured by determining whether the targets for implementation shown in previous sections are maintained according to schedule.

4.2.1 Plan Review and Adaptation

Feasibility studies of the planned strategies may reveal that some existing structures or sites identified for retrofitting or enhancement may not be feasible candidates for future projects and may be eliminated from consideration. Since many restoration projects will need to be done on private property, lack of approval by private property owners may also impact the number and types of projects that can be accomplished. The County will take an adaptive management approach and will reevaluate treatment needs as feasibility studies progress. The County will continue to track the overall effectiveness of the various BMP strategies and will adapt the suite of solutions based on the results. New technologies are continuously evaluated to determine if the new technologies allow more efficient or effective pollution control. The County will also continue to monitor changes in regulations and policy that could impact the program.

4.2.2 Two-Year Milestone Reporting

As a part of the federal Chesapeake Bay Accountability Framework and in support of Maryland's BayStat accountability system, the County is required to report to MDE two-year milestones representing near-term commitments and progress towards achieving load reduction goals for the Bay TMDL. These efforts will also support local TMDL planning and tracking at the County level.

Milestones are reported in two forms: Programmatic and BMP Implementation. Programmatic milestones identify the anticipated establishment or enhancement of the institutional means that support and enable implementation. Examples of Programmatic milestones include projected funding, enhancement of existing programs and resources, and the establishment of new programs and studies. The milestone period for Programmatic covers two calendar years – for example, the period for 2014 - 2015 was from January 1, 2014 through December 31, 2015. BMP Implementation milestones are a quantitative account of various types of restoration activities (e.g., structural BMPs, stream restoration, maintenance efforts), which have geo-located coordinates. The period for BMP implementation milestones differs from the Programmatic milestones period and covers two state fiscal years – for example, the period for 2014 – 2015 is from July 1, 2013 through June 30, 2015. Planned BMP Implementation milestones reported to MDE include the action (e.g., BMP type), proposed restoration over the 2-year milestone period (e.g., area treated, length restored), actual rate of implementation over 1 year, and percent progress.

The Programmatic and BMP Implementation milestone submittal and reporting process follows an iterative approach and includes three separate submittals to MDE. The first is an initial milestone submittal to MDE by January 31st of the first milestone calendar year (e.g., 2014), followed by an interim milestone progress report submittal by January 31st of the second milestone calendar year (e.g., 2015), and concluding with a final milestone progress submittal by January 31st of the start of the subsequent milestone period (e.g., 2016).

4.2.3 Annual NPDES Reporting

As a requirement of the NPDES permit, the County must submit annually a progress report demonstrating the implementation of the NPDES stormwater program based on the fiscal year. If the County's annual report does not demonstrate compliance with their permit and show progress toward meeting WLAs, the County must implement BMP and program modifications within 12 months.

The annual report includes the following – items in bold font directly relate to elements of the load reduction evaluation criteria:

- The status of implementing the components of the stormwater management program that are established as permit conditions including:
  - i. Source Identification
  - **ii. Stormwater Management**
  - iii. Erosion and Sediment Control
  - iv. Illicit Discharge Detection and Elimination
  - v. Litter and Floatables
  - vi. Property Management and Maintenance
  - vii. Public Education
  - viii. Watershed Assessment
  - **ix. Restoration Plans**
  - **x. TMDL Compliance**
  - xi. Assessment of Controls; and,
  - xii. Program Funding
- **A narrative summary describing the results and analyses of data, including monitoring data that is accumulated throughout the reporting year**
- Expenditures for the reporting period and the proposed budget for the upcoming year

- A summary describing the number and nature of enforcement actions, inspections, and public education programs
- **The identification of water quality improvements and documentation of attainment and/or progress toward attainment of benchmarks and applicable WLAs developed under EPA approved TMDLs; and,**
- **The identification of any proposed changes to the County's program when WLAs are not being met**
- Attachment A – The County is required to complete a database containing the following information:
  - i. Storm drain system mapping
  - **ii. Urban BMP locations**
  - iii. Impervious surfaces
  - **iv. Water quality improvement project locations**
  - **v. Monitoring site locations**
  - **vi. Chemical monitoring results**
  - **vii. Pollutant load reductions**
  - **viii. Biological and habitat monitoring**
  - ix. Illicit discharge detection and elimination activities
  - x. Erosion and sediment control, and **stormwater program information**
  - xi. Grading permit information
  - xii. Fiscal analyses – cost of NPDES related implementation

4.2.4 SMART Tool

The County uses the SMART Tool (Stormwater Management and Restoration Tracker) to gather information from individual homeowners and watershed organizations completing small scale restoration projects. The SMART Tool, operated by the University of Maryland Extension, is an on-line resource for outreach and education for homeowner based practices, particularly rain barrels and rain gardens, two practices that the County is encouraging through financial incentives. The tool allows users report the installation of their stormwater practice and to become "SMART Certified". The tool will allow the County to track implementation progress of homeowner based programs.

4.3 Best Management Practices Inspection and Maintenance

Charles County conducts triennial inspections of stormwater BMPs as required by its MS4 NPDES permit. These inspections and the subsequent maintenance ensure that the BMPs are in good condition and functioning as they were designed. Recent improvements to the County's program include an increase in the number of full time inspectors in FY2016, the use of a digital mobile inspection and reporting platform, use of a rapid BMP inspection protocol, development of a residential BMP inspection program, and an alternative BMP inspection program for alternative practices such as shoreline stabilization and stream restoration. Results of the County's inspections will continue to be submitted annually to MDE with the MS4 NPDES annual report.

4.4 Estimating Load Reductions

Progress assessments are scheduled by the Chesapeake Bay Program for 2017 and 2021. Multiple lines of evidence including: several models, monitoring data, and the most recent science on BMP effectiveness and water quality response will be evaluated in the assessments. The milestones and

progress assessments will contribute to regular reassessment of management plans, and adaptation of responses accordingly as technologies and efficiencies change, programs mature, credit trading is enacted, and regulations are put in place. The County will model load reductions in BayFAST / MAST at the interim (2016, 2018) and milestone (2017, 2019) years, which equates to about once a year at minimum.

Results of the modeling, coupled with a compilation of impervious surface treatment totals for the period will be used to evaluate load reduction and impervious surface credits towards reaching the restoration goals.

4.5 Monitoring

Official monitoring for impairment status is the responsibility of the State; however the County utilizes a variety of monitoring programs to monitor progress towards its NPDES responsibilities and TMDL goals.

The County conducts monitoring under its MS4 NPDES permit that includes several outcomes. The Acton/Hamilton long term monitoring site is monitoring for chemical, biological and physical parameters including chemical analysis of wet weather events. The site is downstream of watershed restoration projects that have been focused on the Acton/Hamilton watershed and the monitoring is established to detect changes over time as restoration progresses. Monitoring is also conducted in the Tributary to Piney Branch watershed to determine the effectiveness of the state's 2000 Stormwater Management Design Manual relative to the channel protection volume criteria. The physical and geomorphic monitoring is determining the effectiveness of the design criteria in maintaining stable receiving stream channels.

The United States Geological Survey (USGS) is operating a stream gage (#0165800) on the Mattawoman Creek located near Pomonkey, MD and downstream of Old Womans Run. The site monitors stream flow as well as temperature, pH, specific conductivity, dissolved oxygen, and turbidity. Data from this site represent a long term record to compare over time as additional restoration activities come on line.

The USGS Chesapeake Bay Nontidal Network (NTN) currently includes the Mattawoman Creek. The NTN quantifies nutrient and sediment loads in the nontidal rivers of the Chesapeake Bay watershed. The loads are defined as the mass of nutrient or sediment passing a monitored location per unit time. The NTN estimates changes over time (trends) in sediment and nutrient loads, in a manner that compensates for any concurrent trend in stream discharge. Trends estimated in this manner can indicate changes in the watershed, such as the effects of best management practices that cannot be attributed primarily to climatic fluctuation. This program is currently funded by the Chesapeake Bay Program's Long-term Status and Trends Network and the USGS Priority Ecosystem Program.

The County will investigate the application of a bacteria monitoring program in the Indian Creek watershed. The TMDL is based on two sampling points located in the estuary, which is problematic since the estuary receives drainage from both Charles and St. Mary's Counties and from multiple land use types, making is difficult to determine the specific source of the pollutant. The County will investigate regular monitoring at the three main tributaries draining Charles County's portion of the watershed. Monitoring sites at the downstream ends of these drainages before confluences with Indian Creek itself may help to determine the full extent of the bacteria loading from the watershed, will assist in targeting restoration actions spatially, and can be used to monitor progress over time. The County will also

investigate use of Bacteria Source Tracking (BST) methods to determine more specifically the source of the load – human, wildlife, or livestock.

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APPENDIX A – WATERSHED RESTORATION PROJECT MASTER LIST

Planning Level	Watershed	Project ID	Name	Water Quality Facility Type	Drainage Area (ac)/ Length (ft)	Imperv-ious Acreage	Pervious Acreage	Current Impervious Acres Treated	Imperv-ious Credit Acres	Runoff Dept Treated (inches)	Load Removal						Total Cost
											TN EOS lbs/yr	TN DEL lbs/yr	TP EOS lbs/yr	TP DEL lbs/yr	TSS EOS lbs/yr	TSS DEL lbs/yr	
1- Completed	Lower Patuxent	VCI 140021	Historic Benedict Village	Rain Garden	0.20	0.15	0.05	0.00	0.15	1.00	0.8	0.8	0.1	0.1	33.3	33.3	TBD
1- Completed	Mattawoman	40021	Acton Lane Roadway	Wet Pond	32.51	17.39	15.12	9.39	8.00	1.00	51.5	28.5	8.7	6.9	3,694.7	3,252.0	$318,300
1- Completed	Mattawoman	09-0078	Bryans Road	Filterra	0.58	0.58	0.00	0.00	0.58	1.00	1.5	0.8	0.4	0.3	209.4	184.3	
1- Completed	Mattawoman	09-0078	Bryans Road	Dry Swale	1.61	0.73	0.88	0.00	0.73	1.00	6.3	3.5	0.9	0.7	332.8	292.9	
1- Completed	Mattawoman	09-0078	Bryans Road	Underground Storage Chamber	9.10	8.92	0.18	0.00	8.92	1.00						0.0	$1,711,629
1- Completed	Mattawoman	11-0102	Fox Run	Step Pool Storm Conveyance	23.14	9.51	13.63	0.00	9.51	1.00	52.6	29.1	9.6	7.6	4,160.5	3,662.0	$1,091,710
1- Completed	Mattawoman	09-0111	Pinefield Pond	Wet Pond	51.00	22.30	28.70	0.00	22.34	1.00	116.9	64.6	22.0	17.5	9,601.3	8,450.9	$1,219,630
1- Completed	Zekiah	AMT-06-0034	NPDES: Carrington - Brown Elementary School	Shallow Marsh	75.53	30.88	44.65	0.00	25.33	0.82	147.2	102.7	25.4	20.4	9,342.6	12,615.2	$1,464,000
1- Completed	Zekiah	AMT-06-0036	NPDES: Carrington - Homeowner's Association	In Stream Storage	33.67	18.60	15.07	0.00	3.00	0.04	2.8	2.0	0.3	0.2	82.8	111.8	$201,610
1- Completed	Zekiah	AMT-06-0035	NPDES: Carrington - Middleton Elementary School	Shallow Marsh / In Stream Storage	96.91	31.10	65.81	0.00	17.00	0.28	77.7	54.2	9.0	7.2	2,878.9	3,887.3	$201,610
1- Completed	Zekiah	VIS-11-0099	NPDES: Ryon Woods	Dry Swale	4.66	1.38	3.28	0.00	0.95	0.69	13.7	9.6	1.4	1.1	420.6	567.9	$121,862
2- In Construction	Mattawoman	VIS-P-8	Holly Tree	Step Pool Storm Conveyance	106.63	49.22	57.41	20.92	28.30	1.00	229.9	127.1	43.7	34.8	17,727.1	15,603.1	$1,746,700
2- In Construction	Mattawoman	VIS-P-7	Tanglewood	Step Pool Storm Conveyance	56.55	21.46	35.09	9.49	11.97	1.00	120.6	66.7	21.7	17.3	8,699.2	7,656.9	$1,310,410
2- In Construction	Mattawoman	WTB-1	Temi Drive	Submerged Gravel Wetland	40.01	15.20	24.81	0.00	15.20	1.00	90.1	49.8	15.9	12.7	6,811.1	5,995.0	$1,114,300
2- In Construction	Nanjemoy	14-0006	10th District VFD	Submerged Gravel Wetland	5.43	2.87	2.56	0.00	2.87	1.00	12.8	12.3	2.6	2.5	1,057.9	1,023.1	$107,830
2- In Construction	Potomac- Middle	12-0095	Potomac Height HOA	Various	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	$927,759
2- In Construction	Zekiah	VIS-12-0067	White Plains	Submerged Gravel Wetland	192.50	45.42	147.08	0.00	5.25	0.12	73.5	51.3	7.0	5.6	2,014.1	2,719.6	$737,530
3- Full Design	Lower Patuxent	SH-9	Benedict Ave	Shoreline Restoration	450.00				18.00		34.0	34.0	31.0	31.0	62,000.0	62,000.0	$369,563
3- Full Design	Mattawoman	VIS-P-1	Acton-Hamilton Regional	Submerged Gravel Wetland/Created Wetland	286.56	101.62	184.95	44.19	13.70	0.57	1,394.2	770.5	213.2	169.7	77,645.1	68,342.2	$2,976,960
3- Full Design	Mattawoman	VIS-P-1A	Acton-Hamilton Regional	Created Wetland	443.44	157.24	286.19	68.39	21.20	0.57	807.2	446.1	168.0	133.7	73,208.2	64,436.9	
3- Full Design	Mattawoman	VIS-P-3	Brookside Pl	Filterra/SPSC Facility	1.27	0.83	0.44	0.00	0.83	1.00	4.6	2.5	1.2	1.0	565.1	497.4	$160,304
3- Full Design	Mattawoman	VIS-P-6	Charles County Plaza	Submerged Gravel Wetland	23.06	19.90	3.16	1.26	18.64	1.00	56.0	30.9	14.8	11.8	6,899.1	6,072.5	$790,096
3- Full Design	Mattawoman	GMB-Henson-SWM-01	JC Parks Elementary/ Matthew Henson Middle Schools	Constructed Wetland	28.95	9.81	19.14	0.00	9.81	1.00	27.9	15.4	3.4	2.7	1,098.8	967.1	$1,097,280
3- Full Design	Mattawoman	GMB-Lackey-SWM-01	Lackey High School	Grass Swale	7.30	0.56	6.74	0.00	0.56	1.00	0.9	0.5	0.1	0.1	22.5	19.8	$1,238,560
3- Full Design	Mattawoman	GMB-Lackey-SWM-02	Lackey High School	Grass Swale	8.88	0.59	8.29	0.00	0.59	1.00	0.9	0.5	0.1	0.1	21.5	18.9	
3- Full Design	Mattawoman	GMB-Lackey-SWM-03	Lackey High School	Bioswale	1.31	0.88	0.43	0.00	0.88	1.00	4.6	2.6	0.6	0.4	183.0	161.1	
3- Full Design	Mattawoman	GMB-Lackey-SWM-04	Lackey High School	Submerged Gravel Wetland	4.88	3.96	0.92	0.00	3.96	1.00	24.8	13.7	3.0	2.4	976.5	859.5	
3- Full Design	Mattawoman	GMB-Lackey-SWM-05	Lackey High School	Bioswale	0.95	0.46	0.49	0.00	0.46	1.00	1.8	1.0	0.2	0.2	71.2	62.7	
3- Full Design	Mattawoman	GMB-Lackey-SWM-06	Lackey High School	Existing Pond	8.44	7.09	1.35	0.00	7.09	1.52	22.9	12.6	2.8	2.2	901.9	793.9	
3- Full Design	Mattawoman	GMB-Lackey-SWM-07	Lackey High School	Submerged Gravel Wetland	2.65	0.82	1.83	0.00	0.82	1.00	2.2	1.2	0.3	0.2	85.9	75.6	
3- Full Design	Mattawoman	GMB-Lackey-SWM-08	Lackey High School	Submerged Gravel Wetland	2.85	1.05	1.80	0.00	1.05	1.00	3.2	1.8	0.4	0.3	125.6	110.5	
3- Full Design	Mattawoman	VIS-C-9	Laurel Branch- Apple Creek	SPSC/Stream Restoration	39.29	6.40	32.89	0.01	6.39	1.00	79.1	43.7	10.5	8.4	4,060.6	3,574.1	$967,566
3- Full Design	Mattawoman	VIS-C-22	Laurel Branch- Poplar Court	Wet Pond	92.21	12.22	79.99	0.00	12.22	1.00	192.3	106.3	23.0	18.3	8,676.3	7,636.8	$1,231,051
3- Full Design	Mattawoman	GMB-Mattawoman/ Berry WS 1A	Mattawoman Middle/Berry Elementary Schools	Dry Pond Conversion to Constructed Wetland	21.80	6.75	15.05	0.00	6.75	1.00	48.1	26.6	7.7	6.1	3,239.6	2,851.5	$0
3- Full Design	Mattawoman	GMB-Mattawoman/ Berry WS 1B	Mattawoman Middle/Berry Elementary Schools	Wet Swale/Bioswale	3.45	0.26	3.19	0.00	0.26	1.00	7.1	3.9	0.8	0.6	263.3	231.8	$0
3- Full Design	Mattawoman	GMB-Mattawoman/ Berry WS 2	Mattawoman Middle/Berry Elementary Schools	Dry Pond Conversion to Bioretention	8.90	5.45	3.45	0.00	5.45	1.00	36.6	20.2	6.1	4.9	2,306.0	2,029.7	$1,123,680
3- Full Design	Mattawoman	VIS-P-2	Meadow Ln	Pond Retrofit	5.41	2.45	2.96	0.75	1.70	1.00	6.8	3.8	1.7	1.4	796.3	700.9	$555,460
3- Full Design	Mattawoman	VIS-13-0013	Pinefield Drainage Improvements	Storm Drain Vacuuming					94.00		822.5	454.6	329.0	261.8	98,700.0	86,874.4	$1,359,220

Planning Level	Watershed	Project ID	Name	Water Quality Facility Type	Drainage Area (ac)/ Length (ft)	Imperv-ious Acreage	Pervious Acreage	Current Impervious Acres Treated	Imperv-ious Credit Acres	Runoff Dept Treated (inches)	Load Removal						Total Cost
											TN EOS lbs/yr	TN DEL lbs/yr	TP EOS lbs/yr	TP DEL lbs/yr	TSS EOS lbs/yr	TSS DEL lbs/yr	
3- Full Design	Mattawoman	NGO-1	Stavors Road Design Improvements	Submerged Gravel Wetland	11.56	3.96	7.60	1.00	2.64	1.25	27.1	15.0	4.6	3.7	1,934.9	1,703.1	$294,925
3- Full Design	Mattawoman	WURC-Matt	Waldorf Urban Development Corridor	Various	126.11				140.98		779.8	431.0	184.6	146.9	46.6	41.0	$7,775,618
3- Full Design	Mattawoman	VIS-P-4	Westdale Ct 1	Bioretention	2.21	1.22	0.99	0.61	0.61	1.00	4.9	2.7	1.1	0.9	444.6	391.3	$300,152
3- Full Design	Mattawoman	VIS-P-5	Westdale Ct 2	Organic Filter	1.01	0.67	0.34	0.33	0.34	1.00	2.3	1.3	0.5	0.4	225.8	198.7	$54,770
3- Full Design	Mattawoman	VIS-P-5A	Westdale Ct 3	Organic Filter	1.11	0.69	0.42	0.34	0.35	1.00	2.5	1.4	0.6	0.5	244.5	215.2	$54,770
3- Full Design	Port Tobacco	GMB-SWM-02	McDonough High School	Bioswale	0.82	0.32	0.50	0.00	0.32	1.56	1.8	1.8	0.2	0.2	42.9	42.9	$1,097,280
3- Full Design	Port Tobacco	GMB-SWM-03	McDonough High School	Submerged Gravel Wetland	1.80	0.69	1.11	0.00	0.69	1.61	2.2	2.2	0.3	0.3	85.9	85.9	$0
3- Full Design	Port Tobacco	GMB-SWM-04	McDonough High School	Bioretention- Expand	1.74	1.58	0.16	0.00	1.58	0.10	11.0	11.0	1.3	1.3	432.0	432.0	$0
3- Full Design	Port Tobacco	GMB-SWM-05	McDonough High School	Rainwater Harvesting	1.97	1.60	0.37	0.00	1.60	0.23	30.3	30.3	2.3	2.3	596.8	596.8	$0
3- Full Design	Port Tobacco	GMB-SWM-06	McDonough High School	Bioretention	2.97	1.81	1.16	0.00	1.81	0.64	8.7	8.7	1.1	1.1	341.5	341.5	$0
3- Full Design	Potomac- Lower	PRLT	Piccowaxen Middle / Thomas Higdon Elementary Schools	Pond Retrofit	8.68	2.92	5.76	0.00	2.92	1.00	19.3	19.3	3.2	3.2	1,930.4	1,930.4	$1,047,540
3- Full Design	Potomac- Lower	PRLT	Piccowaxen Middle / Thomas Higdon Elementary Schools	Pond Retrofit	29.27	3.78	25.49	0.00	3.78	1.00	61.0	61.0	7.2	7.2	3,865.4	3,865.4	$0
3- Full Design	Potomac- Lower	SH-5	Swan Point	Shoreline Restoration	1,488.00				59.50		112.0	112.0	101.0	101.0	204,000.0	204,000.0	$1,146,500
3- Full Design	Zekiah		John Hanson Middle School	Created Wetland	6.47	1.52	4.95	0.00	1.52	1.00	13.9	9.7	2.0	1.6	701.6	947.4	$95,636
3- Full Design	Zekiah		John Hanson Middle School	Created Wetland	5.21	2.78	2.43	0.00	2.78	1.00	12.3	8.6	2.5	2.0	977.3	1,319.6	$150,045
3- Full Design	Zekiah		John Hanson Middle School	Rain Garden	0.95	0.95	0.00	0.00	0.95	1.00	2.5	1.7	0.7	0.6	295.6	399.1	$143,797
3- Full Design	Zekiah		John Hanson Middle School	Wet Swale	6.47	1.32	5.15	0.00	1.32	1.00	13.8	9.6	1.9	1.5	648.5	875.7	$82,792
3- Full Design	Zekiah		JP Ryon	Created Wetland	8.72	4.09	4.63	0.00	4.09	1.00	20.2	14.1	4.0	3.2	1,486.5	2,007.2	$848,580
3- Full Design	Zekiah		NPDES: Public Works Campus	Rain Garden			0.00		0.00			0.0		0.0		0.0	
3- Full Design	Zekiah		NPDES: Public Works Campus	Step Pool Storm Conveyance			0.00		29.50		278.2	194.2	82.6	66.4	27,400.0	36,997.8	$1,200,768
3- Full Design	Zekiah		TC Martin Elementary School	Created Wetland	3.41	0.41	3.00	0.00	0.41	1.00	7.1	5.0	0.8	0.6	266.1	359.3	
3- Full Design	Zekiah		TC Martin Elementary School	Bioretention	0.57	0.57	0.00	0.00	0.57	1.00	2.6	1.8	0.6	0.5	190.1	256.7	$898,320
3- Full Design	Zekiah		TC Martin Elementary School	Bioswale	3.40	0.64	2.76	0.00	0.64	1.00	7.2	5.0	1.0	0.8	326.6	441.0	
3- Full Design	Zekiah		TC Martin Elementary School	Bioretention	2.46	1.26	1.20	0.00	1.26	1.00	9.9	6.9	1.5	1.2	479.6	647.6	
3- Full Design	Zekiah	WURC-Zek	Waldorf Urban Development Corridor	Various	188.12				190.46		1,169.7	816.4	277.0	222.6	69.9	94.4	$11,663,427
5- Existing SWM Upgrades	Mattawoman	VIS-B	Hess Court	Pond Retrofit	7.29	2.68	4.61	1.34	1.34	1.00	12.8	7.1	1.8	1.4	729.6	642.2	$94,440
5- Existing SWM Upgrades	Mattawoman	VIS-A	Wimbrell Court	Pond Retrofit	11.83	3.63	8.20	1.71	1.92	1.00	21.5	11.9	2.9	2.3	1,130.4	995.0	$135,317
5- Existing SWM Upgrades	Port Tobacco	VIS-PTR-C-1A	Dorchester Lower	Dry Swale	256.78	74.25	182.53	37.16	37.09	1.00	39.9	39.9	4.5	4.5	1,061.0	1,061.0	$454,458
5- Existing SWM Upgrades	Port Tobacco	VIS-PTR-C-1B	Dorchester Lower	Pond Reclassification							529.6	529.6	84.4	84.4	27,734.7	27,734.7	$0
5- Existing SWM Upgrades	Port Tobacco	VIS-PTR-C-10	Preference Pond	Pond Reclassification	251.79	28.89	222.90	3.21	13.80	1.00	491.7	491.7	58.1	58.1	16,906.0	16,906.0	$45,675
5- Existing SWM Upgrades	Port Tobacco	VIS-PTR-C-14	Upper Dorcester	Pond Reclassification	99.89	28.61	71.28	15.52	13.09	1.00	417.9	417.9	30.2	30.2	5,524.9	5,524.9	$72,150
5- Existing SWM Upgrades	Port Tobacco	VIS-PTR-C-3	White Plains Lake	Pond Reclassification	721.38	136.44	584.94	70.16	66.28	1.00	1,442.5	1,442.5	196.7	196.7	61,010.7	61,010.7	$79,175
5- Existing SWM Upgrades	Zekiah	SWM-04	Henry Ford Circle Pond	SWM Facility Inspection/Upgrade	294.90	123.00	171.90	38.60	57.10	1.00	258.9	180.7	29.8	23.9	17,600.0	23,765.0	$265,500
5- Existing SWM Upgrades	Zekiah	RC-6*	Huntington Lake	SWM Facility Inspection/Upgrade	120.42	30.76	89.66	0.29	30.47	1.00	260.3	181.7	38.7	31.1	13,621.8	18,393.3	$42,000

Planning Level	Watershed	Project ID	Name	Water Quality Facility Type	Drainage Area (ac)/ Length (ft)	Imperv-ious Acreage	Pervious Acreage	Current Impervious Acres Treated	Imperv-ious Credit Acres	Runoff Dept Treated (inches)	Load Removal						Total Cost
											TN EOS lbs/yr	TN DEL lbs/yr	TP EOS lbs/yr	TP DEL lbs/yr	TSS EOS lbs/yr	TSS DEL lbs/yr	
5- Existing SWM Upgrades	Zekiah	SWM-05	Industrial Park Pond	SWM Facility Inspection/Upgrade	114.30	57.39	56.91	22.99	27.20	1.00	103.6	72.3	13.0	10.4	7,800.0	10,532.2	$184,375
5- Existing SWM Upgrades	Zekiah	RC-5*	Lambeth Hill Lake	SWM Facility Inspection/Upgrade	133.36	38.53	94.83	2.90	35.63	1.00	284.4	198.5	43.6	35.0	15,466.1	20,883.6	$42,000
5- Existing SWM Upgrades	Zekiah	RC-1*	Post Office Lake	SWM Facility Inspection/Upgrade	477.28	182.38	294.90	0.00	182.38	1.00	1,075.2	750.4	190.4	153.0	70,370.3	95,019.9	$42,000
5- Existing SWM Upgrades	Zekiah	RC-8*	Sheffield/St. Martin's Drive	SWM Facility Inspection/Upgrade	172.35	60.15	112.20	46.90	13.25	1.00	259.4	181.0	29.3	23.5	9,304.0	12,563.0	$42,000
5- Existing SWM Upgrades	Zekiah	SWM-09	St. Paul Drive	SWM Facility Inspection/Upgrade	95.90	28.88	67.02	6.22	13.90	1.00	75.5	52.7	7.6	6.1	4,400.0	5,941.3	$184,375
5- Existing SWM Upgrades	Zekiah	RC-2*	Wakefield Lake	SWM Facility Inspection/Upgrade	349.57	137.93	211.64	0.00	137.93	1.00	790.4	551.6	142.0	114.1	52,693.8	71,151.6	$42,000
5- Existing SWM Upgrades	Zekiah	SWM-01	White Oak Village Pond	Pond Retrofit	123.70	30.97	92.73	8.41	15.10	1.00	95.7	66.8	9.1	7.3	5,200.0	7,021.5	$245,500
6- Concept	Mattawoman	VIS-C-5	AMF Waldorf Lanes	Submerged Gravel Wetland	3.47	2.88	0.59	0.11	2.77	1.00	8.2	4.5	2.2	1.8	951.8	837.8	$180,333
6- Concept	Mattawoman	VIS-C-16	Constitution Hills- Hale Court	Sheetflow to Conservation Areas	37.94	12.19	25.75	0.52	11.67	1.00	79.7	44.0	13.3	10.6	5,194.9	4,572.5	$120,141
6- Concept	Mattawoman	GMB-Smallwood-SWM-01	General Smallwood Middle School	Submerged Gravel Wetland	2.17	0.97	1.20	0.00	0.97	1.00	3.5	1.9	0.4	0.3	138.6	122.0	$1,089,240
6- Concept	Mattawoman	GMB-Smallwood-SWM-02	General Smallwood Middle School	Bioswale	1.97	0.96	1.01	0.00	0.96	1.00	3.8	2.1	0.5	0.4	147.7	130.0	
6- Concept	Mattawoman	GMB-Smallwood-SWM-03	General Smallwood Middle School	Bioretention	0.56	0.40	0.16	0.00	0.40	1.00	2.2	1.2	0.3	0.2	88.2	77.7	
6- Concept	Mattawoman	GMB-Smallwood-SWM-04	General Smallwood Middle School	Submerged Gravel Wetland	2.48	1.23	1.25	0.00	1.23	1.00	4.8	2.7	0.6	0.5	191.0	168.1	
6- Concept	Mattawoman	GMB-Smallwood-SWM-05	General Smallwood Middle School	Submerged Gravel Wetland	2.77	1.84	0.93	0.00	1.84	1.00	9.5	5.3	1.2	0.9	375.5	330.5	
6- Concept	Mattawoman	GMB-Smallwood-SWM-06	General Smallwood Middle School	Existing Grass Swale	3.02	0.12	2.90	0.00	0.12	1.00	0.1	0.1	0.0	0.0	3.5	3.1	
6- Concept	Mattawoman	VIS-C-6	Grinder/Old Washington Rd	Wet Pond/Impervious Removal	75.05	40.06	34.99	12.53	21.75	1.00	154.8	85.6	31.8	25.3	12,881.3	11,337.9	$378,840
6- Concept	Mattawoman	VIS-C-29	Ruth B Swann Park	Created Wetland/SPSC/SGW/SR	731.38	144.63	586.75	53.65	20.51	0.51	150.9	83.4	80.5	64.1	20,256.4	17,829.4	$3,019,830
6- Concept	Mattawoman	VIS-C-8	Verizon Pond	Submerged Gravel Wetland	3.22	2.42	0.80	0.31	2.09	0.99	7.1	3.9	1.7	1.4	735.3	647.2	$223,688
6- Concept	Mattawoman	VIS-C-2	Wexford Village- Murre Court	Sheetflow to Conservation Areas	14.63	4.51	10.12	2.26	2.26	1.00	23.1	12.8	3.0	2.4	950.2	836.4	$113,095
6- Concept	Port Tobacco	VIS-PTR-C-11	Talbot Street	Submerged Gravel Wetland	8.12	5.70	2.42	0.00	5.70	1.00	32.6	32.6	5.8	5.8	1,763.2	1,763.2	$592,518
6- Concept	Port Tobacco	VIS-PTR-C-8	Warren Drive	Submerged Gravel Wetland	240.66	15.18	225.48	2.52	12.66	1.00	798.3	798.3	61.6	61.6	14,048.4	14,048.4	$922,965
6- Concept	Potomac- Lower	SH-4	NPDES: Clifton	Shoreline Restoration	2,050.00				82.00		154.0	154.0	139.0	139.0	280,000.0	280,000.0	$1,427,313
7- Concept	Mattawoman	VIS-C-23	Pinefield Center	Submerged Gravel Wetland	7.21	5.46	1.75	0.45	5.01	1.00	16.7	9.2	4.2	3.3	1,823.6	1,605.1	$365,434
7- Concept	Mattawoman	VIS-C-25	Shoppers Ditch	Submerged Gravel Wetland	7.03	5.98	1.05	2.89	3.09	1.00	16.7	9.2	4.5	3.6	1,976.6	1,739.8	$175,718
7- Concept	Mattawoman	VIS-C-24	Shoppers Parking	Bioretention Islands	4.29	3.98	0.31	1.99	1.99	1.00	10.4	5.7	3.0	2.4	1,305.3	1,148.9	$137,703
7- Concept	Mattawoman	VIS-C-7	Walmart Pond	Dry Swale/Bioretention Islands	13.40	9.89	3.51	4.72	5.17	1.00	31.0	17.1	7.8	6.2	3,379.8	2,974.9	$378,840
7- Concept	Port Tobacco	VIS-PTR-C-4	Espirit Place	Sheetflow to Conservation Areas	24.82	12.18	12.64	6.09	6.09	1.00	42.0	42.0	5.0	5.0	1,188.1	1,188.1	$100,250
7- Concept	Port Tobacco	VIS-PTR-C-9	Pheasant Farms Entrance	Created Wetland	39.25	5.58	33.67	0.10	5.48	1.00	77.3	77.3	9.7	9.7	2,887.6	2,887.6	$330,870
7- Concept	Port Tobacco	VIS-PTR-C-4A	Southwinds Drive	Sheetflow to Conservation Areas							27.4	27.4	3.2	3.2	773.4	773.4	$100,250
7- Concept	Port Tobacco	VIS-PTR-C-5	Theodore Green Blvd	Submerged Gravel Wetland	8.64	6.65	1.99	1.72	4.93	1.00	35.3	35.3	6.6	6.6	2,021.5	2,021.5	$329,665
7- Concept	Port Tobacco	VIS-PTR-C-12	Wilton Court	Sheetflow to Conservation Areas	13.10	9.89	3.21	5.04	4.85	1.00	93.0	93.0	8.5	8.5	1,870.3	1,870.3	$108,878
8- Concept	Lower Patuxent	Benedict-1	Benedict Rain Garden	Rain Garden	0.50	0.50	0.00	0.00	0.50	1.00	5.5	5.5	0.6	0.6	0.2	0.2	$2,045,894
8- Concept	Lower Patuxent		Benedict Reforestation	Tree Planting	1.48				1.48		19.8	19.8	2.0	2.0	0.5	0.5	$200,625
8- Concept	Lower Patuxent	BAY_LP_SEC_1		Shoreline Management	450.00				18.00		33.8	33.8	30.6	30.6	61,650.0	61,650.0	$40,125
8- Concept	Lower Patuxent	BAY_LP_SEC_2		Shoreline Management	3,016.00				120.64		226.2	226.2	205.1	205.1	413,192.0	413,192.0	$2,045,894
8- Concept	Mattawoman	VIS-C-10	Athens Place	StormFilter	5.56	2.30	3.26	1.15	1.15	1.00	5.1	2.8	1.0	0.8	403.5	355.2	$124,133

Planning Level	Watershed	Project ID	Name	Water Quality Facility Type	Drainage Area (ac)/ Length (ft)	Imperv-ious Acreage	Pervious Acreage	Current Impervious Acres Treated	Imperv-ious Credit Acres	Runoff Dept Treated (inches)	Load Removal						Total Cost
											TN EOS lbs/yr	TN DEL lbs/yr	TP EOS lbs/yr	TP DEL lbs/yr	TSS EOS lbs/yr	TSS DEL lbs/yr	
8- Concept	Mattawoman	VIS-C-11	Berry Hill Manor	SPSC/Stream Restoration	300.19	41.98	258.21	29.33	12.65	1.00	502.3	277.6	52.7	41.9	16,038.8	14,117.1	$2,691,340
8- Concept	Mattawoman	VIS-C-12	Bonnie Lane	Step Pool Storm Conveyance	60.39	11.45	48.94	0.20	11.25	1.00	122.8	67.9	16.7	13.3	6,096.6	5,366.1	$1,091,125
8- Concept	Mattawoman	VIS-C-28	Bridle Path	Step Pool Storm Conveyance	93.33	11.26	82.07	0.00	11.26	1.00	185.7	102.6	21.3	17.0	7,217.9	6,353.1	$895,475
8- Concept	Mattawoman	VIS-C-13	Butte Place	StormFilter	12.24	4.76	7.48	2.37	2.39	1.00	11.1	6.1	2.1	1.7	829.5	730.1	$144,003
8- Concept	Mattawoman	VIS-C-14	Community Drive	Submerged Gravel Wetland	16.27	4.79	11.48	2.39	2.40	1.00	25.9	14.3	2.8	2.2	913.3	803.9	$175,115
8- Concept	Mattawoman	VIS-C-15	Holiday Inn Express	Submerged Gravel Wetland	1.50	1.14	0.36	0.57	0.57	1.00	3.5	1.9	0.9	0.7	390.1	343.4	$149,425
8- Concept	Mattawoman	VIS-C-18	Lacrosse Pond	StormFilter	13.48	5.77	7.71	2.88	2.89	1.00	12.4	6.9	2.6	2.1	1,005.4	884.9	$195,588
8- Concept	Mattawoman	VIS-C-19	Lombard Pond	Submerged Gravel Wetland	22.52	8.79	13.73	4.40	4.39	1.00	36.2	20.0	4.4	3.5	1,472.2	1,295.8	$313,808
8- Concept	Mattawoman	VIS-C-20	Marbella Stream	SPSC/Stream Restoration	136.62	66.63	69.99	18.37	48.26	1.00	294.3	162.7	58.3	46.4	23,781.1	20,931.8	$2,731,575
8- Concept	Mattawoman	VIS-C-1	Merganser Court	Sheetflow to Conservation Areas	5.72	2.10	3.62	1.05	1.05	1.00	7.5	4.1	1.2	1.0	386.5	340.2	$101,853
8- Concept	Mattawoman	VIS-C-21	Pembrooke Square	Submerged Gravel Wetland	75.57	39.45	36.12	14.25	23.08	1.00	146.4	80.9	27.2	21.6	10,398.7	9,152.8	$673,335
8- Concept	Mattawoman	GMB-Potomac-BMP-1	Potomac Library	Submerged Gravel Wetland	3.65	1.29	2.36	0.00	1.29	1.00	6.6	3.6	0.6	0.5	158.8	139.8	$87,714
8- Concept	Mattawoman	GMB-Potomac-BMP-2	Potomac Library	Submerged Gravel Wetland	0.52	0.47	0.05	0.00	0.47	1.00	5.6	3.1	0.5	0.4	135.7	119.4	$41,992
8- Concept	Mattawoman	GMB-Potomac-BMP-3	Potomac Library	Submerged Gravel Wetland	0.47	0.42	0.05	0.00	0.42	1.00	5.0	2.8	0.4	0.3	120.0	105.6	$41,141
8- Concept	Mattawoman	GMB-Potomac-BMP-4	Potomac Library	Grass Swale	0.72	0.36	0.36	0.00	0.36	1.00	2.5	1.4	0.2	0.2	60.2	53.0	$17,050
8- Concept	Mattawoman	GMB-RuthSwann-AltB	Ruth B Swann Park	Submerged Gravel Wetland	10.80	10.80	0.00	0.00	10.80	1.00	28.8	15.9	8.3	6.6	3,899.8	3,432.6	$651,114
8- Concept	Mattawoman	VIS-C-26	Silverleaf Street	Dry Swale	9.00	1.81	7.19	0.00	1.81	1.00	18.4	10.2	2.5	2.0	938.5	826.1	$132,965
8- Concept	Mattawoman	VIS-C-17	St. Patricks Drive	Submerged Gravel Wetland	3.81	2.71	1.10	0.00	2.71	1.00	8.8	4.9	2.2	1.8	935.7	823.6	$175,718
8- Concept	Mattawoman	VIS-C-27	Thomas Road	Step Pool Storm Conveyance	12.51	3.48	9.03	0.00	3.48	1.00	25.9	14.3	4.1	3.3	1,560.2	1,373.3	$400,120
8- Concept	Mattawoman	VIS-C-4	Westdale Dr	SPSC/Stream Restoration	19.20	5.22	13.98	0.85	4.37	1.00	29.4	16.2	4.6	3.7	1,831.9	1,612.4	$392,890
8- Concept	Nanjemoy	SWM-03	Friendship Park	Bioretention	2.31	1.28	1.03	0.00	1.30	1.02	10.2	9.8	1.4	1.4	800.0	773.7	$97,605
8- Concept	Nanjemoy	SWM-09	Glasgow Lane	Step Pool Storm Conveyance	13.61	1.90	11.71	0.95	1.50	1.29	80.9	77.8	5.0	4.9	2,200.0	2,127.6	$305,938
8- Concept	Nanjemoy	SR-10	Gordon Place	Stream Restoration	400.00				4.00		30.0	28.8	27.2	26.5	6,000.0	5,802.4	$361,000
8- Concept	Nanjemoy	SR-09	Gunston Road	Stream Restoration	375.00				3.80		28.1	27.0	25.5	24.8	5,800.0	5,609.0	$325,938
8- Concept	Nanjemoy	SR-08	Mason Springs Road	Stream Restoration	400.00				4.00		30.0	28.8	27.2	26.5	6,000.0	5,802.4	$361,000
8- Concept	Nanjemoy	SH-2	NPDES: Friendship Farm Park	Shoreline Restoration	1,987.00				79.50		149.0	143.2	135.0	131.4	272,000.0	263,043.0	$1,106,759
8- Concept	Nanjemoy	SH-2	NPDES: Friendship Farm Park	Shoreline Restoration	2,518.00				100.70		189.0	181.7	171.0	166.5	344,000.0	332,672.1	$1,577,842
8- Concept	Nanjemoy	SWM-08	Pisgah United Methodist	Bioretention	3.70	0.70	3.00	0.00	0.80	1.14	16.7	16.1	1.5	1.5	0.4	0.4	$74,710
8- Concept	Nanjemoy	SWM-01	Port Tobacco Road 1	Step Pool Storm Conveyance	8.46	2.42	6.04	0.00	2.10	0.87	61.1	58.7	4.3	4.2	2,000.0	1,934.1	$453,605
8- Concept	Nanjemoy	SH-3	Walters Landing Road	Shoreline Restoration	120.00				4.80		9.0	8.7	8.0	7.8	16,000.0	15,473.1	$82,840
8- Concept	Port Tobacco	VIS-PTR-C-7A	Coastal Blvd	Submerged Gravel Wetland	22.95	3.00	19.95	0.00	3.00	1.00	57.8	57.8	4.5	4.5	952.5	952.5	$219,073
8- Concept	Port Tobacco	VIS-PTR-C-7B	Coastal Blvd	Wet Swale							31.4	31.4	3.7	3.7	1,084.6	1,084.6	$0
8- Concept	Port Tobacco	VIS-PTR-C-13A	Eller Street	Wet Swale	42.76	3.41	39.35	0.03	3.38	1.00	67.6	67.6	7.6	7.6	2,100.4	2,100.4	$268,248
8- Concept	Port Tobacco	VIS-PTR-C-13B	Eller Street	Submerged Gravel Wetland							142.6	142.6	11.5	11.5	2,673.2	2,673.2	$377,033
8- Concept	Port Tobacco	VIS-PTR-C-2	Red Horse Court	Underground Infiltration	18.36	7.51	10.85	3.76	3.75	1.00	60.2	60.2	14.6	14.6	5,343.3	5,343.3	$741,713
8- Concept	Port Tobacco	VIS-PTR-C-6A	Tate Street	Submerged Gravel Wetland	19.45	4.55	14.90	0.04	4.51	1.00	60.3	60.3	6.2	6.2	1,553.3	1,553.3	$382,853
8- Concept	Port Tobacco	VIS-PTR-C-6B	Tate Street	Wet Swale							15.5	15.5	2.0	2.0	644.4	644.4	
8- Concept	Potomac- Lower	SH-6	Porter Road	Shoreline Restoration	1,007.00				40.30		76.0	76.0	68.0	68.0	138,000.0	138,000.0	$701,124
8- Concept	Potomac- Middle	SR-04	Amherst Road	Stream Restoration	300.00				3.00		22.5	22.5	20.4	20.4	4,600.0	4,600.0	$255,750
8- Concept	Potomac- Middle	SR-07	Bryans Crossing	Stream Restoration	2,100.00				21.00		157.5	157.5	142.8	142.8	32,000.0	32,000.0	$1,338,725
8- Concept	Potomac- Middle	SR-01	Riverside Road	Stream Restoration	400.00				4.30		35.2	35.2	27.6	27.6	6,200.0	6,200.0	$385,100
8- Concept	Potomac- Middle	SH-1	Ruth B. Swann	Shoreline Restoration	1,208.00				48.30		91.0	91.0	82.0	82.0	166,000.0	166,000.0	$793,656
8- Concept	Potomac- Middle	SWM-07	South Hampton Ponds	Pond Retrofit	48.17	14.15			7.20		148.7	148.7	15.5	15.5	8,800.0	8,800.0	$715,770
8- Concept	Wicomico	SH-8	Charleston Estates	Shoreline Restoration	319.00				12.80		24.0	24.0	22.0	22.0	44,000.0	44,000.0	$178,758
8- Concept	Zekiah	SR-06	Bryan Meadows Lane	Stream Restoration	700.00				7.00		52.5	36.6	47.6	38.3	10,600.0	14,313.0	$583,925
8- Concept	Zekiah	SR-07	Bryantown Road	Stream Restoration	1,700.00				17.00		127.5	89.0	115.6	92.9	25,800.0	34,837.3	$1,194,250
8- Concept	Zekiah	SWM-15	CC Public School Admin	Stormwater Wetland	7.90	4.30	3.60	0.00	4.30	1.00	34.0	23.7	4.5	3.6	2,800.0	3,780.8	$411,000
8- Concept	Zekiah	SWM-16	CCPublic School Annex	Stormwater Wetland	3.10	1.74	1.36	0.00	1.70	0.98	13.7	9.6	1.8	1.4	1,200.0	1,620.3	$245,500
8- Concept	Zekiah	SR-01	Idlewood Trailer Park	Stream Restoration	260.00				2.70		20.3	14.2	18.4	14.8	4,200.0	5,671.2	$222,010
8- Concept	Zekiah	SWM-13	La Plata High School	Stormwater Wetland	46.10	16.06	30.04	0.68	13.40	0.88	184.2	128.6	19.1	15.3	10,800.0	14,583.1	$514,250
8- Concept	Zekiah	SWM-03	Lakewood Estates Pond	Pond Retrofit	47.30	8.82	38.48	4.58	4.30	1.01	35.8	25.0	3.1	2.5	1,600.0	2,160.5	$293,750
8- Concept	Zekiah	SWM-12	Malcolm Elementary	Rain Garden	2.30	2.00	0.30	0.00	2.00	1.00	19.4	13.5	2.3	1.8	1,200.0	1,620.3	$137,300
8- Concept	Zekiah	SR-02	Meadow Creek Lane 1	Stream Restoration	1,950.00				19.50		146.3	102.1	132.6	106.6	29,600.0	39,968.4	$1,374,875

Planning Level	Watershed	Project ID	Name	Water Quality Facility Type	Drainage Area (ac)/ Length (ft)	Imperv-ious Acreage	Pervious Acreage	Current Impervious Acres Treated	Imperv-ious Credit Acres	Runoff Dept Treated (inches)	Load Removal						Total Cost
											TN EOS lbs/yr	TN DEL lbs/yr	TP EOS lbs/yr	TP DEL lbs/yr	TSS EOS lbs/yr	TSS DEL lbs/yr	
8- Concept	Zekiah	SR-03	Meadow Creek Lane 2	Stream Restoration	500.00				5.00		37.5	26.2	34.0	27.3	7,600.0	10,262.2	$401,250
8- Concept	Zekiah	SR-04	Poplar Hill Road	Stream Restoration	320.00				3.20		24.0	16.8	21.8	17.5	4,800.0	6,481.4	$272,800
8- Concept	Zekiah	SWM-14	Radio Station Road	Submerged Gravel Wetland	5.70	3.97	1.73	0.00	4.00	1.01	44.2	30.8	4.8	3.9	2,600.0	3,510.7	$274,600
8- Concept	Zekiah	SR-05	St. Charles Community	Stream Restoration	1,000.00				10.00		75.0	52.3	68.0	54.6	15,200.0	20,524.3	$752,500
8- Concept	Zekiah	SR-08	St. Charles Parkway	Stream Restoration	475.00				4.80		35.6	24.8	32.3	26.0	7,200.0	9,722.0	$436,790
8- Concept	Zekiah	SWM-11	Thomas Stone High School	Stormwater Wetland	36.10	15.56	20.54	8.53	7.20	1.01	31.8	22.2	3.7	3.0	2,200.0	2,970.6	$391,000
8- Concept	Zekiah	SWM-08	Vest Lane	Pond Retrofit	99.50	11.30	88.20	5.57	8.60	0.99	95.6	66.7	26.1	21.0	7,400.0	9,992.1	$441,000
9- Planning	Lower Patuxent	KCI-LP_SR_1		Stream Restoration	3,442.53				34.43		258.2	258.2	234.1	234.1	51,638.0	51,638.0	$2,375,863
9- Planning	Lower Patuxent	KCI-LP_SWM_1		Filterra	1.50	0.72	0.78	0.00	0.05	0.05	0.4	0.4	0.1	0.1	34.4	34.4	$12,394
9- Planning	Lower Patuxent	KCI-LP_SWM_2		Bioretention	0.08	0.06	0.02	0.00	1.19	1.75	0.4	0.4	0.1	0.1	25.6	25.6	$21,851
9- Planning	Lower Patuxent	KCI-LP_SWM_3		Bioretention	0.67	0.46	0.21	0.00	1.04	1.15	2.9	2.9	0.5	0.5	196.7	196.7	$156,839
9- Planning	Mattawoman	KCI-MW_BMP_1		Bioretention	0.14	0.12	0.02	0.00	1.14	1.55	0.7	0.4	0.2	0.2	52.0	45.8	$27,357
9- Planning	Mattawoman	KCI-MW_BMP_10		Created Wetland	32.96	6.79	26.17	0.00	0.81	0.81	65.7	36.3	9.0	7.2	3,590.5	3,160.3	$385,450
9- Planning	Mattawoman	KCI-MW_BMP_11		Created Wetland	10.58	4.11	6.47	0.00	1.09	1.35	25.5	14.1	4.6	3.7	1,954.5	1,720.3	$314,682
9- Planning	Mattawoman	KCI-MW_BMP_12		Wet Pond	24.83	7.35	17.48	0.00	1.06	1.24	57.4	31.7	9.1	7.2	3,772.8	3,320.8	$548,985
9- Planning	Mattawoman	KCI-MW_BMP_13		Created Wetland	0.21	0.16	0.06	0.00	1.40	2.60	0.6	0.3	0.1	0.1	66.8	58.8	$15,294
9- Planning	Mattawoman	KCI-MW_BMP_14		Infiltration Basin	36.94	14.45	22.49	0.00	0.77	0.77	130.8	72.3	17.4	13.8	6,298.2	5,543.6	$784,202
9- Planning	Mattawoman	KCI-MW_BMP_15		Infiltration Basin	3.92	1.36	2.56	0.00	1.40	2.60	17.1	9.5	2.1	1.7	767.6	675.6	$134,887
9- Planning	Mattawoman	KCI-MW_BMP_16		Wet Pond	2.51	1.02	1.49	0.00	1.30	2.20	6.4	3.5	1.2	1.0	502.0	441.9	$93,390
9- Planning	Mattawoman	KCI-MW_BMP_17		Infiltration Basin	13.19	4.31	8.88	0.00	1.13	1.51	54.4	30.1	6.7	5.3	2,368.8	2,085.0	$344,161
9- Planning	Mattawoman	KCI-MW_BMP_18		Step Pool Storm Conveyance	5.91	1.83	4.08	0.00	0.83	0.31	7.2	4.0	1.2	1.0	487.0	428.7	$68,063
9- Planning	Mattawoman	KCI-MW_BMP_2		Bioretention	0.26	0.20	0.06	0.00	1.03	1.12	1.2	0.7	0.2	0.2	81.9	72.1	$40,526
9- Planning	Mattawoman	KCI-MW_BMP_3		Bioretention	0.05	0.04	0.01	0.00	0.94	0.94	0.2	0.1	0.1	0.1	16.7	14.7	$8,082
9- Planning	Mattawoman	KCI-MW_BMP_4		Bioretention	6.71	3.26	3.45	0.00	1.04	1.18	27.7	15.3	4.1	3.3	1,519.1	1,337.1	$683,087
9- Planning	Mattawoman	KCI-MW_BMP_5		Wet Pond	5.92	2.56	3.36	0.00	0.82	0.82	12.7	7.0	2.4	1.9	1,034.8	910.8	$147,198
9- Planning	Mattawoman	KCI-MW_BMP_6		Created Wetland	17.09	5.31	11.78	0.00	1.04	1.16	39.1	21.6	6.3	5.0	2,643.1	2,326.4	$389,611
9- Planning	Mattawoman	KCI-MW_BMP_7		Bioretention	1.99	1.79	0.20	0.00	1.00	1.00	8.8	4.9	1.8	1.4	704.3	619.9	$359,036
9- Planning	Mattawoman	KCI-MW_BMP_8		Wet Pond	1.83	1.22	0.61	0.00	1.16	1.64	4.9	2.7	1.1	0.9	520.4	458.0	$99,664
9- Planning	Mattawoman	KCI-MW_BMP_9		Wet Pond	1.43	1.14	0.29	0.00	1.01	1.05	3.7	2.0	0.9	0.7	432.5	380.7	$81,313
9- Planning	Mattawoman	KCI-MW_SR_1		Stream Restoration	1,731.62				17.32		129.9	71.8	117.7	93.7	25,974.2	22,862.2	$1,195,074
9- Planning	Mattawoman	KCI-MW_SR_2		Stream Restoration	946.00				9.46		71.0	39.2	64.3	51.2	14,190.0	12,489.8	$653,108
9- Planning	Mattawoman	KCI-MW_SR_3		Stream Restoration	5,564.19				55.64		417.3	230.6	378.4	301.1	83,462.9	73,462.9	$3,840,126
9- Planning	Mattawoman	KCI-MW_SR_4		Stream Restoration	1,984.19				19.84		148.8	82.2	134.9	107.4	29,762.9	26,196.9	$1,369,392
9- Planning	Mattawoman	KCI-MW_SR_5		Stream Restoration	208.00				2.08		15.6	8.6	14.1	11.3	3,120.0	2,746.2	$143,551
9- Planning	Mattawoman	KCI-MW_TP_1		Reforestation	1.87	0.00	1.87	0.00	0.71		7.1	3.9	0.5	0.4	81.4	71.6	$22,562
9- Planning	Mattawoman	KCI-MW_TP_10		Reforestation	0.93	0.00	0.93	0.00	0.35		3.5	1.9	0.2	0.2	40.3	35.5	$11,164
9- Planning	Mattawoman	KCI-MW_TP_11		Reforestation	0.55	0.00	0.55	0.00	0.21		2.1	1.2	0.2	0.2	24.0	21.1	$6,649
9- Planning	Mattawoman	KCI-MW_TP_12		Reforestation	0.25	0.00	0.25	0.00	0.10		1.0	0.6	0.1	0.1	11.1	9.8	$3,065
9- Planning	Mattawoman	KCI-MW_TP_13		Reforestation	1.94	0.00	1.94	0.00	0.74		7.3	4.0	0.5	0.4	84.1	74.0	$23,320
9- Planning	Mattawoman	KCI-MW_TP_14		Reforestation	0.23	0.00	0.23	0.00	0.09		0.9	0.5	0.1	0.1	9.9	8.7	$2,744
9- Planning	Mattawoman	KCI-MW_TP_15		Reforestation	0.43	0.00	0.43	0.00	0.16		1.7	0.9	0.1	0.1	18.8	16.5	$5,202
9- Planning	Mattawoman	KCI-MW_TP_16		Reforestation	3.28	0.00	3.28	0.00	1.25		12.3	6.8	0.8	0.6	142.5	125.4	$39,499
9- Planning	Mattawoman	KCI-MW_TP_17		Reforestation	0.40	0.00	0.40	0.00	0.15		1.5	0.8	0.1	0.1	17.4	15.3	$4,835
9- Planning	Mattawoman	KCI-MW_TP_18		Reforestation	0.66	0.00	0.66	0.00	0.25		2.5	1.4	0.2	0.2	28.7	25.3	$7,962
9- Planning	Mattawoman	KCI-MW_TP_19		Reforestation	0.76	0.00	0.76	0.00	0.29		2.8	1.5	0.2	0.2	33.1	29.1	$9,158
9- Planning	Mattawoman	KCI-MW_TP_2		Reforestation	0.86	0.00	0.86	0.00	0.33		3.2	1.8	0.2	0.2	37.6	33.1	$10,418
9- Planning	Mattawoman	KCI-MW_TP_20		Reforestation	1.39	0.00	1.39	0.00	0.53		5.3	2.9	0.3	0.2	60.6	53.3	$16,809
9- Planning	Mattawoman	KCI-MW_TP_21		Reforestation	6.46	0.00	6.46	0.00	2.45		24.4	13.5	1.5	1.2	280.6	247.0	$77,799
9- Planning	Mattawoman	KCI-MW_TP_3		Reforestation	0.70	0.00	0.70	0.00	0.27		2.6	1.4	0.2	0.2	30.6	26.9	$8,484
9- Planning	Mattawoman	KCI-MW_TP_4		Reforestation	0.28	0.00	0.28	0.00	0.11		1.1	0.6	0.1	0.1	12.3	10.8	$3,399
9- Planning	Mattawoman	KCI-MW_TP_5		Reforestation	1.76	0.00	1.76	0.00	0.67		6.6	3.6	0.4	0.3	76.3	67.2	$21,164
9- Planning	Mattawoman	KCI-MW_TP_6		Reforestation	3.05	0.00	3.05	0.00	1.16		11.5	6.4	0.7	0.6	132.6	116.7	$36,751
9- Planning	Mattawoman	KCI-MW_TP_7		Reforestation	1.55	0.00	1.55	0.00	0.59		5.8	3.2	0.4	0.3	67.3	59.2	$18,641
9- Planning	Mattawoman	KCI-MW_TP_8		Reforestation	1.41	0.00	1.41	0.00	0.54		5.3	2.9	0.3	0.2	61.5	54.1	$17,048
9- Planning	Mattawoman	KCI-MW_TP_9		Reforestation	2.16	0.00	2.16	0.00	0.82		8.2	4.5	0.5	0.4	94.1	82.8	$26,078

Planning Level	Watershed	Project ID	Name	Water Quality Facility Type	Drainage Area (ac)/ Length (ft)	Imperv-ious Acreage	Pervious Acreage	Current Impervious Acres Treated	Imperv-ious Credit Acres	Runoff Dept Treated (inches)	Load Removal						Total Cost
											TN EOS lbs/yr	TN DEL lbs/yr	TP EOS lbs/yr	TP DEL lbs/yr	TSS EOS lbs/yr	TSS DEL lbs/yr	
9- Planning	Port Tobacco	KCI-PT_SEC_1		Shoreline Management	2,432.00				97.28		182.4	182.4	165.4	165.4	333,184.0	333,184.0	$910,714
9- Planning	Port Tobacco	KCI-PT_SR_1		Stream Restoration	2,828.00				28.28		212.1	212.1	192.3	192.3	42,420.0	42,420.0	$1,951,744
9- Planning	Port Tobacco	KCI-PT_SR_2		Stream Restoration	3,843.00				38.43		288.2	288.2	261.3	261.3	57,645.0	57,645.0	$2,652,246
9- Planning	Port Tobacco	KCI-PT_SR_3		Stream Restoration	800.00				8.00		60.0	60.0	261.3	261.3	57,645.0	57,645.0	$552,120
9- Planning	Port Tobacco	KCI-PT_SR_4		Stream Restoration	170.00				1.70		12.8	12.8	11.6	11.6	2,550.0	2,550.0	$117,326
9- Planning	Port Tobacco	KCI-PT_SR_5		Stream Restoration	3,190.00				31.90		239.3	239.3	216.9	216.9	47,850.0	47,850.0	$2,201,579
9- Planning	Port Tobacco	KCI-PT_SR_6		Stream Restoration	3,976.00				39.76		298.2	298.2	270.4	270.4	59,640.0	59,640.0	$2,744,036
9- Planning	Port Tobacco	KCI-PT_SR_7		Stream Restoration	418.00				4.18		31.4	31.4	28.4	28.4	6,270.0	6,270.0	$288,483
9- Planning	Port Tobacco	KCI-PT_SR_8		Stream Restoration	744.00				7.44		55.8	55.8	50.6	50.6	11,160.0	11,160.0	$513,472
9- Planning	Port Tobacco	KCI-PT_SR_9		Stream Restoration	2,800.00				28.00		210.0	210.0	190.4	190.4	42,000.0	42,000.0	$1,932,420
9- Planning	Port Tobacco	KCI-PT_SWM_1		SPSC Priority; Bioretention secondary	10.80	5.23	5.57	0.00	3.71	0.71	22.2	22.2	4.4	4.4	1,554.2	1,554.2	$233,850
9- Planning	Port Tobacco	KCI-PT_SWM_10		Bioretention	0.94	0.46	0.48	0.00	0.44	0.97	3.7	3.7	0.6	0.6	162.9	162.9	$89,024
9- Planning	Port Tobacco	KCI-PT_SWM_11		Bioretention	0.28	0.16	0.12	0.00	0.08	0.49	0.8	0.8	0.2	0.2	40.8	40.8	$15,776
9- Planning	Port Tobacco	KCI-PT_SWM_12		Bioretention	0.29	0.27	0.02	0.00	0.06	0.23	0.6	0.6	0.1	0.1	37.3	37.3	$12,628
9- Planning	Port Tobacco	KCI-PT_SWM_13		Step Pool Storm Conveyance	6.23	4.00	2.23	0.00	3.32	0.83	14.3	14.3	3.3	3.3	1,181.9	1,181.9	$254,642
9- Planning	Port Tobacco	KCI-PT_SWM_2		Bioretention	1.06	0.40	0.66	0.00	0.36	0.89	2.3	2.3	0.4	0.4	139.1	139.1	$71,642
9- Planning	Port Tobacco	KCI-PT_SWM_3		Bioretention	12.69	1.84	10.85	0.00	0.17	0.09	5.0	5.0	0.6	0.6	187.0	187.0	$33,150
9- Planning	Port Tobacco	KCI-PT_SWM_4		Dry Swale	127.85	8.85	118.99	0.00	6.77	0.77	409.3	409.3	31.6	31.6	7,495.7	7,495.7	$319,405
9- Planning	Port Tobacco	KCI-PT_SWM_5		Dry Swale	71.64	5.19	66.45	0.00	5.19	1.00	250.5	250.5	19.5	19.5	4,649.1	4,649.1	$244,823
9- Planning	Port Tobacco	KCI-PT_SWM_6		Dry Swale	137.32	17.70	119.62	0.00	17.70	1.00	489.1	489.1	43.3	43.3	10,959.3	10,959.3	$834,693
9- Planning	Port Tobacco	KCI-PT_SWM_7		Dry Swale	54.82	4.84	49.99	0.00	4.84	1.00	192.7	192.7	15.6	15.6	3,786.5	3,786.5	$228,146
9- Planning	Port Tobacco	KCI-PT_SWM_8		Wet Pond	17.60	2.25	15.35	0.00	0.72	0.32	20.5	20.5	2.4	2.4	729.2	729.2	$50,406
9- Planning	Port Tobacco	KCI-PT_SWM_9		Dry Swale	141.29	14.79	126.50	0.00	14.79	1.00	499.3	499.3	41.9	41.9	10,372.1	10,372.1	$697,519
9- Planning	Port Tobacco	KCI-PT_TP_1		Reforestation	1.96	0.00	1.96	0.00	0.75	0.00	7.4	7.4	0.5	0.5	68.3	68.3	$23,668
9- Planning	Port Tobacco	KCI-PT_TP_2		Reforestation	0.93	0.00	0.93	0.00	0.35	0.00	3.5	3.5	0.2	0.2	32.2	32.2	$11,150
9- Planning	Port Tobacco	KCI-PT_TP_3		Reforestation	10.95	0.00	10.95	0.00	4.16	0.00	41.3	41.3	2.6	2.6	381.2	381.2	$131,961
9- Planning	Port Tobacco	KCI-PT_TP_4		Reforestation	0.75	0.00	0.75	0.00	0.28	0.00	2.8	2.8	0.2	0.2	26.0	26.0	$9,024
9- Planning	Port Tobacco	KCI-PT_TP_5		Reforestation	57.84	0.00	57.84	0.00	21.98	0.00	218.1	218.1	13.9	13.9	2,013.2	2,013.2	$696,973
9- Planning	Port Tobacco	KCI-PT_TP_6		Reforestation	9.80	0.00	9.80	0.00	3.72	0.00	37.0	37.0	2.3	2.3	341.0	341.0	$118,038

Projects with multiple BMP types have total project cost only listed in one line item- costs for projects with no cost listed are included in separate line.

APPENDIX B – RESTORATION PROJECT LOCATION MAPS

Charles County Restoration Project Locations

NPDES Projects

Level

- 1- Completed
- 2- In Construction
- 3- Full Design
- 5- Existing SWM Facility Inspection/ Upgrades
- 6- Feasibility and Concept Design (County NTP)
- 7- Feasibility and Concept Design (Medium Priority)
- 8- Alternate Feasibility and Concept Design
- 9- Additional Sites Identified in KCI Watershed Assessment

Indian Creek Watershed

County Boundaries

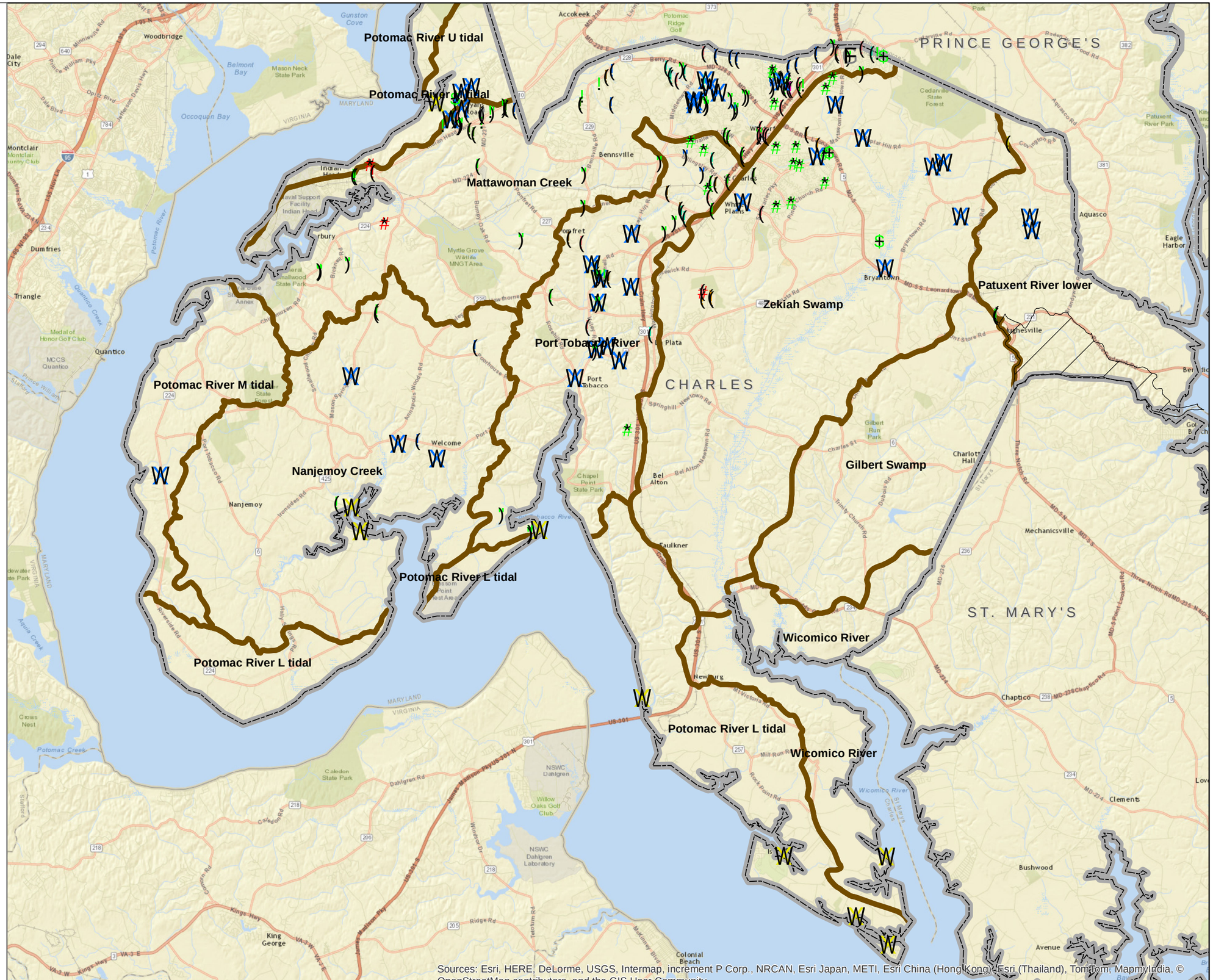
Subwatershed

0 1 2 4 Miles

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Charles County Restoration Project Locations

Facility Type

- Bioretention
- Created Wetlands
- Dry Swale
- ESD
- Filtering Practice
- Filterra
- Organic Filter
- Pond Reclassification
- Pond Retrofit
- Rain Garden
- SPSC
- Sheetflow to Conservation
- Shoreline Restoration
- Storm Drain Cleaning
- Stormwater Wetland
- Stream Restoration
- Submerged Gravel Wetlands
- Underground Storage Chamber
- Various
- Wet Pond
- Wet Pond/Impervious Removal
- Tree Planting
- Indian Creek Watershed
- County Boundaries
- Subwatershed

0 1 2 4 Miles