NON TIDAL PATUXENT RIVER LOWER AND MIDDLE WATERSHEDS

SEDIMENT TMDL RESTORATION PLAN

JANUARY 2020

FINAL

Anne Arundel County WATERSHED Protection & Restoration PROGRAM

NON TIDAL PATUXENT RIVER LOWER AND MIDDLE WATERSHEDS

SEDIMENT TMDL RESTORATION PLAN

JANUARY 2020

FINAL

PREPARED FOR

Anne Arundel County

Department of Public Works

Watershed Protection and Restoration Program

2662 Riva Road, P.O. Box 6675

Annapolis, Maryland 21401

PREPARED BY

LimnoTech

1015 18th Street NW

Suite 900

Washington, DC 20003

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Acronyms

AA	Anne Arundel
AAWSA	Anne Arundel Watershed Stewards Academy
AFG	Accounting For Growth
AHB	Advocates for Herring Bay
BIBI	Benthic Index of Biotic Integrity
BMP	Best Management Practice
BSID	Biological Stressor Identification
CAST	Chesapeake Assessment Scenario Tool
CBP	Chesapeake Bay Program
CIP	Capital Improvement Program
COMAR	Code of Maryland Regulations
CWA	Clean Water Act
DPW	Department of Public Works
EMC	Event Mean Concentration
EOS	Edge of Stream
EOT	Edge of Tide
EPA	Environmental Protection Agency
ESD	Environmentally Sensitive Design
FAP	Financial Assurance Plan
FIBI	Fish Index of Biotic Integrity
GIS	Geographic Information System
H&H	Hydrologic and Hydraulic
LA	Load Allocation
LULC	Land use / Land cover
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MEP	Maximum Extent Practicable
MPHI	Maryland Physical Habitat Index
MS4	Municipal Separate Storm Sewer System
NEIEN	National Environmental Information Exchange Network
NGO	Non-governmental Organization
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometer Turbidity Units

OSDS	On-site Disposal Systems
PHI	Physical Habitat Index
PSU	Primary Sampling Unit
RBP	Rapid Bioassessment Protocol
ROW	Right of Way
SAT	Stream Assessment Tool
SPSC	Step Pool Storm Conveyance
SW-WLA	Stormwater Wasteload Allocation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USGS	United States Geological Survey
WIP	Watershed Implementation Plan
WLA	Waste Load Allocation
WMP6	Watershed Model Phase 6
WMT	Watershed Management Tool
WPRP	Watershed Protection and Restoration Program
WQA	Water Quality Analysis
WQIP	Water Quality Improvement Projects

1 Introduction

1.1 Background and Purpose

The Anne Arundel (AA) County Department of Public Works (DPW) Watershed Protection and Restoration Program (WPRP) is developing restoration plans to address local water quality impairments for which a Total Maximum Daily Load (TMDL) has been established by the Maryland Department of the Environment (MDE) and approved by the U.S. Environmental Protection Agency (EPA). A TMDL establishes a maximum load of a specific single pollutant or stressor that a waterbody can assimilate and still meet water quality standards for its designated use class.

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, CWA Section 303(d) requires the state to list these water bodies as impaired waters. States are then required to develop a TMDL for pollutants of concern for the listed impaired waters. The Non-Tidal Lower and Middle Patuxent River watersheds are listed in Maryland's Integrated Report of Surface Water Quality [303(d) list and 305(b) Report] for sediment pollution. On July 2, 2018 EPA approved sediment (total suspended solids, or TSS) TMDLs for the Non-Tidal Patuxent River Lower and Middle Watersheds. These two TMDLs apply to multiple Counties, and responsibility for reduction of sediment is divided among the multiple contributing jurisdictions. This plan will specifically address Anne Arundel County's responsibility for meeting the stormwater wasteload allocation (SW-WLA) required by the Non-Tidal Patuxent River Lower and Middle sediment TMDLs.

The TMDL loading targets, or allocations, are also divided among the pollution source categories, which includes non-point sources (termed load allocation or LA) and point sources (termed wasteload 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 National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Discharge Permit, stormwater runoff from MS4 areas is considered a point source contribution.

Anne Arundel County's current MS4 permit (11-DP-3316, MD0068306) issued in its final form by the MDE in February of 2014, requires development of restoration plans for each stormwater WLA (SW-WLA) approved by EPA prior to the effective date of the permit (permit section IV.E.2.b). This plan satisfies this permit requirement for the Anne Arundel County SW-WLAs in the Non-Tidal Patuxent River Lower and Middle Watersheds TMDL and provides the loading target, recommended management measures, load reduction estimates, schedule, milestones, cost estimates and funding sources, and the tracking and monitoring approaches to meet the SW-WLAs in the TMDL documents.

It is noted that TMDL restoration plans are an important first step towards achieving the SW-WLAs. 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 restoration 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 into future updates.

Information included in this plan demonstrates that Anne Arundel County expects to meet its sediment SW-WLA for the Non-Tidal Patuxent River Lower and Middle watersheds by 2030. The strategies proposed in the plan will provide treatment to reduce current sediment loads from the urban stormwater sector.

1.2 TMDL Allocated and Planned Loads Summary

The Non-Tidal Patuxent River Lower and Middle Watersheds Restoration Plan (also called the Restoration Plan herein) only addresses loads allocated to Anne Arundel County's point source NPDES-regulated stormwater sediment. Additional SW-WLAs for the Non-Tidal Patuxent River Lower and Middle watersheds TMDLs assigned to other Counties or regulated entities are not the responsibility of Anne Arundel County and will not be addressed in this plan.

The Non-Tidal Patuxent River Lower and Middle watersheds TMDLs require a 61% and 56% reduction, respectively, of sediment loads from 2009 baseline levels to achieve the target SW-WLA for Anne Arundel County NPDES-regulated stormwater. A planning horizon of 2030 is used as the date to achieve these load reductions, with 2021, 2023, 2025, 2027, and 2029 proposed as interim milestones to assess progress.

The Chesapeake Assessment Scenario Tool (CAST) was used to model baseline, progress, and planned loads. CAST, created by the Chesapeake Bay Program (CBP), is a web-based pollutant load estimating tool that calculates pollutant loads and reductions. CAST uses the same modeling approaches as the CBP Watershed Model Phase 6 (WMP6) (CBP, 2017). The 2009 baseline loads and required reductions for Lower and Middle Patuxent are shown in Table 1-1 below. Details of the modeling and load calculations are included in Sections 4 and 5.

Table 1-1: TMDL baseline loads and required reductions

	Lower Patuxent	Middle Patuxent
AA County MS4 2009 Baseline Load	801,324	5,814,345
Reduction Needed to meet AA County MS4 SW-WLA (%)	61%	56%
Reduction Needed to meet AA County MS4 SW-WLA (lbs)	488,808	3,256,033

Based on MDE guidance, growth in the stormwater load since the TMDL baseline year was not accounted for in the development of this plan. From a planning perspective, local TMDLs are considered met when the load reductions associated with 2009 baseline load, coupled with the planned restoration load reductions, exceed the load reduction required.

This section of the plan provides a concise summary of the loads and reductions at important timeline intervals, including the 2009 baseline, 2018 progress, 2025 interim milestone and 2030 final planning intervals (Table 1-2). These terms and dates are used throughout the plan and are explained in more detail in the following sections. They are presented here to assist the reader in understanding the definitions of each and how they were derived, and to summarize the percent reduction required and percent reduction achieved through full implementation of this plan. Sediment loads and WLAs are presented as tons/year in the TMDLs for the Non-Tidal Patuxent River Lower and Middle Watersheds, but will be discussed as pounds/year (lbs/yr) in this Restoration Plan since CAST provides the loads in terms of lbs/yr.

- **2009 Baseline Loads**: These are the baseline level sediment loads from the 2009 conditions in the Non-Tidal Lower and Middle Patuxent watersheds (i.e., 2009 land use loads minus any reductions from BMPs that were installed in 2009 or before). The baseline loads were calculated by running the CAST model with the 2009 Progress BMPs. Baseline TSS loads, in conjunction with the percent load reduction prescribed by the TMDL, were used to calculate the sediment SW-WLA as shown in Table 1-1.
- **2018 Progress Loads and Reductions**: These are the progress loads and load reductions achieved from stormwater best management practice (BMP) implementation through the end of 2018. The 2018 progress load reductions are calculated by modeling the restoration BMP implementation (post 2009 through end of 2018) in CAST. Additionally, reductions from inlet cleaning and street sweeping were calculated outside of CAST and added to the BMP reductions from CAST to calculate the total progress load reductions. The 2018 progress load was then calculated by subtracting the 2018 progress load reductions from the 2009 baseline load.
- **2025 Interim Milestone Goal Planned Loads and Reductions**: These are the planned 2025 loads and reductions that will result from implementation of strategies through 2025. The 2025 planned load reductions are calculated by modeling all the strategies needed to meet the 2030 planned load reductions (based on the SW-WLA targets), and back-calculating the expected progress that will be achieved by 2025. All planned strategies are calculated using CAST. The 2025 planned loads are calculated by subtracting the 2025 planned load reductions from the 2009 baseline load.
- **2030 Planned Loads and Reductions**: These are the planned 2030 loads and reductions that will result from implementation of strategies through 2030 and will meet the TMDL SW-WLAs. The 2030 planned load reductions are calculated using CAST. The 2030 planned loads are calculated by subtracting the 2030 planned load reductions from the 2009 baseline load.

Table 1-2: Summary of the loads and reductions at important timeline intervals

	Lower Patuxent River Sediment (lbs/year)	Middle Patuxent River Sediment (lbs/year)
2009 Baseline Load	801,324	5,814,345
2009-2018 Progress Load Reductions	-18	-366,092
2018 Progress Load	801,306	5,448,253
2018-2025 Planned Load Reductions	-285,151	-1,685,894
2025 Planned Load	516,155	3,762,359
2025-2030 Planned Load Reductions	- 203,679	- 1,204,210
2030 Planned Load	312,476	2,558,149
Required Reduction by 2030 (percent)	61.0	56.0
Planned Progress Reduction by 2030 (percent)	61.0	56.0

1.3 Restoration Plan Elements and Structure

This plan is developed within the context of on-going watershed management planning, restoration, and resource protection being conducted by Anne Arundel County. The County initiated comprehensive

watershed assessment and management plans in 2000 and has completed plans for all of the 12 major watersheds. A comprehensive watershed assessment for the Herring Bay, Middle Patuxent, and Lower Patuxent watershed was completed in 2018. The County also prepared a Phase II Watershed Implementation Plan (WIP) for nitrogen, phosphorus and sediment in 2012 in response to requirements set forth in the Chesapeake Bay TMDL. Information synthesized and incorporated into this Restoration Plan for the Lower and Middle Patuxent watersheds draws upon these sources, with updates and additions where necessary, to meet the specific goals of the TMDL. The TMDL analyses and reports developed by MDE were also used to develop this plan. These primary sources include:

- *Herring Bay, Middle Patuxent, and Lower Patuxent Watershed Assessment Comprehensive Summary Report* (Anne Arundel County, 2018) (hereafter referred to as the "*Middle and Lower Patuxent Watershed Assessment Report"*)
- *Chesapeake Bay TMDL, Phase II Watershed Implementation Plan, Final* (Anne Arundel County, 2012)
- *Total Maximum Daily Load of Sediment in the Non-Tidal Patuxent River Lower Watershed, Anne Arundel, Calvert, Charles, St. Mary's and Prince George's Counties, Maryland* (including supplemental technical memoranda and decision letters) July 2, 2018 (MDE, 2018a)
- *Total Maximum Daily Load of Sediment in the Non-Tidal Patuxent River Middle Watershed, Anne Arundel, Calvert and Prince George's Counties, Maryland* (including supplemental technical memoranda and decision letters) July 2 , 2018 (MDE, 2018b)

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, 2014b)
- *Guidance for Developing Stormwater Wasteload Allocation Implementation Plans for Nutrient and Sediment Total Maximum Daily Loads* (MDE, 2014c)
- *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE, 2014a)

The Non-Tidal Patuxent River Lower and Middle Watersheds Restoration Plan has been prepared in accordance with the EPA's nine essential elements for watershed planning. These elements, commonly called the "a through i criteria" are important for the creation of thorough, robust, and meaningful watershed plans and incorporation of these elements into the plan is of particular importance in receiving funding for implementation. The EPA has clearly stated that to ensure that Section 319-(the EPA Nonpoint Source Management Program[1]) funded projects make progress towards restoring waters impaired by nonpoint source pollution, watershed-based plans that are developed or implemented with Section 319 funds to address 303(d)-listed waters must include at least the nine elements. While the sediment Restoration Plan described herein is focused on Anne Arundel County MS4 point sources, EPA recommends to include these nine elements in all watershed plans because they provide a quantitative framework for the

[1] https://www.epa.gov/nps/319-grant-program-states-and-territories

planning process that leads to water quality improvements and restoration to attain water quality standards.

The Non-Tidal Patuxent River Lower and Middle Watersheds Restoration Plan is organized based on these nine elements. A modification to the order has been incorporated into this plan such that element c., a description of the management measures, is included in the plan as Section 4, before element b., the expected load reductions, which is included in the plan as Section 5. This modified approach makes the plan easier to follow. The letters (a. through i.) are included in the headers of the plan's major sections to indicate to the reader the elements included in that section. The planning elements (summarized below in the order presented by EPA) are:

a. An identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the plan and to achieve any other watershed goals identified in the plan, as discussed in element (b) immediately below. (Section 3 of this Restoration Plan)

b. An estimate of the load reductions expected for the management measures described under element (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time. (Section 5 of this Restoration Plan)

c. A description of the management measures that will need to be implemented to achieve the load reductions estimated under element (b) above as well as to achieve other watershed goals identified in the plan, and an identification of the critical areas in which those measures will be needed to implement this plan. (Section 4 of this Restoration Plan)

d. An estimate of the amount of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. (Section 6 of this Restoration Plan)

e. An information/education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the recommended management measures. (Section 7 of this Restoration Plan)

f. A schedule for implementing the management measures identified in this plan that is reasonably expeditious. (Section 8 of this Restoration Plan)

g. A description of interim, measurable milestones for determining whether management measures or other control actions are being implemented. (Section 8 of this Restoration Plan)

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised. (Section 9 of this Restoration Plan)

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element (h) immediately above. (Section 10 of this Restoration Plan)

The restoration planning efforts described in this document provide a blueprint for the implementation of restoration projects that will result in meeting Anne Arundel County's sediment SW-WLAs, and contribute to meeting water quality standards. Successful implementation of the plan will lead to improvements in local watershed conditions and aquatic health.

2 Watershed Characteristics

The following sections describe the watershed characteristics for the Non-Tidal Lower and Middle Patuxent River watersheds. Figures are included at the end of the section.

2.1 Lower Patuxent

2.1.1 Watershed Delineation

The Lower Patuxent is one of 12 watersheds within Anne Arundel County, Maryland, and is located in the southernmost portion of the county. Anne Arundel County's portion of the watershed shares political boundaries with Calvert County. Only a small portion of the entire Lower Patuxent watershed is located within Anne Arundel County; the rest of the Lower Patuxent watershed extends through Prince George's, Calvert, Charles, and St. Mary's counties until the point of discharge from the Patuxent River into the Chesapeake Bay. The Lower Patuxent watershed is part of the Chesapeake Bay watershed (Figure 2-1, shown at the end of Section 2).

2.1.2 Non-Tidal Lower Patuxent River Subwatersheds

The following information was taken from the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018). The Anne Arundel County portion of the Lower Patuxent watershed is approximately 3,217 acres (5 mi^2) and contains approximately 24.7 miles of streams. The watershed includes the named stream Hall Creek. The watershed is divided into three subwatersheds, which were used as the planning units. Table 2-1 shows the area and length of stream for each subwatershed. Figure 2-2, shown at the end of Section 2, shows the subwatershed delineations for the Lower Patuxent River.

Table 2-1: Lower Patuxent River: subwatershed area and stream length

Subwatershed Code	Subwatershed Name	Drainage Area (acres)	Drainage Area (square miles)	Total Stream Length (miles)
MPC	Hall Creek 1	1,471	2.30	12.4
MPX	Hall Creek 2	933	1.46	6.7
MPY	Hall Creek 3	813	1.27	5.6
Lower Patuxent Total		**3,217**	**5.03**	**24.7**

2.1.3 Land Use/Land Cover

Land use and land cover (LULC) have a significant impact on water quality and stream habitat condition. Undeveloped, forested areas slow the flow of stormwater and allow for infiltration. Vegetation and soil remove some of the nutrients and pollutants found in stormwater, improving the water quality as the stormwater infiltrates. Developed areas with high levels of impervious surface do not slow or filter stormwater. Thus developed areas result in increased flow levels and decreased water quality, both of which degrade the stream habitats through erosion and pollution, respectively. Agricultural land can also impair streams with nutrients and bacteria if not managed properly.

The Lower Patuxent watershed is largely undeveloped, containing mostly forest and agricultural land. Figure 2-3 shows the LULC of the watershed. These data were obtained from the CBP Phase 6 Land Use data set published by the United States Geological Survey (USGS, 2018).

2.1.3.a Existing Land Use/Land Cover

As shown in Table 2-2, the largest LULC category in the Lower Patuxent Watershed is forest (54.64%) followed by mixed open/agriculture (22.10%) and turf (11.86%). Impervious surfaces account for approximately 4.88% (sum of all impervious LULC categories that include roads, surfaces, and structures).

Table 2-2: Lower Patuxent River Land Use/Land Cover

Land Use/Land Cover	Acres	Percent of Watershed
Forest	1,757	54.62%
Mixed Open/Agriculture	711	22.10%
Turf	382	11.87%
Tree Canopy Over Turf	136	4.23%
Shrubland	69	2.14%
Impervious Roads	46	1.43%
Impervious Surfaces	44	1.37%
Structures	26	0.81%
Tree Canopy Over Impervious Surfaces	22	0.68%
Tree Canopy Over Impervious Roads	13	0.40%
Tree Canopy Over Structures	6	0.19%
Barren	4	0.12%
Water	1	0.03%
TOTAL	**3,217**	**100%**

2.1.3.b Impervious Surfaces

Impervious surfaces accelerate and concentrate stormwater runoff, causing significant potential for degradation when the runoff reaches the streams. Stormwater runoff also washes off pollutants accumulated on impervious surfaces, leading to degraded water quality in streams. Areas with lower levels of impervious surfaces tend to correspond with better stream health. Impervious cover is an important factor to consider when determining pollutant loads and other characteristics of stormwater runoff.

Impervious surfaces make up 4.88% of the Lower Patuxent watershed, with little variation between impervious cover among the three subwatersheds, as shown in Table 2-3.

Table 2-3: Lower Patuxent River Percent Impervious

Subwatershed Code	Subwatershed Name	Percent Impervious
MPC	Hall Creek 1	5.3%
MPX	Hall Creek 2	5.6%
MPY	Hall Creek 3	3.4%

As further explained below in Section 4, County-owned impervious areas, and in particular buildings and parking lots, represent opportunities for targeted BMP implementation to control stormwater runoff. A GIS

analysis was conducted to identify these impervious surfaces, utilizing GIS data on County-wide impervious surfaces and public parcels (Figure 2-4). Any surfaces that were already treated by existing BMPs were left out of the impervious surface analysis, as were small buildings (smaller than 2,000 sf) and parking lots (smaller than 1/16th of an acre). These thresholds were set in order to limit potential restoration to areas where retrofit projects would be most practical and cost-effective. A summary of the remaining impervious surfaces are summarized below in Table 2-4.

Table 2-4: Area of County-Owned Buildings and Parking Lots for Potential BMP Implementation in Lower Patuxent River

Buildings	Total Area (sq.ft.)	Number of Buildings
2,000-4,000 sf	0	0
4,000-6,000 sf	0	0
6,000-8,000 sf	7,973	1
TOTAL	**7,973**	**1**
Parking Lots	**Total Area (sq.ft.)**	**Number of Parking Lots**
1/16-1/8 acre	0	0
1/8-1/4 acre	0	0
1/4-1/2 acre	0	0
1/2-1.0 acre	0	0
>1 acre	48,170	1
TOTAL	**48,170**	**1**

2.1.4 Water Quality

2.1.4.a Use Designations

According to water quality standards established by MDE in the Code of Maryland Regulations (COMAR) 26.08.02.08[2], the Non-Tidal Lower Patuxent river and its tributaries are classified as Class I waters. Class I waters are generally designated to support "water contact recreation and protection of non-tidal warm water aquatic life." The more detailed designated uses of Class I waters are shown below in Table 2-5.

Table 2-5: Designated Uses in the Lower Patuxent River and its Tributaries

Designated Use	Lower Patuxent
Growth and propagation of fish (not trout), other aquatic life and wildlife	X
Water contact sports	X
Leisure activities involving direct contact with surface water	X
Fishing	X
Agricultural water supply	X
Industrial water supply	X
Public water supply	X

[2] http://www.dsd.state.md.us/comar/comarhtml/26/26.08.02.08.htm

2.1.4.b 303(d) Impairments

According to Maryland's final 2016 and draft 2018 303(d) list of impaired waters, the Lower Patuxent is impaired by TSS. The water quality impairment of the Patuxent River Middle watershed is caused, in part, by an elevated sediment load beyond a level that the watershed can sustain, thereby causing sediment-related impacts to aquatic life. The sediment impairment was listed in 2014. The impairment is Category 5, which indicates that the waterbody is impaired and a TMDL or water quality analysis (WQA) is needed. Impairments are summarized below in Table 2-6.

Table 2-6: 303(d) Impairments in the Lower Patuxent River and its Tributaries

Watershed	Basin Code	Non-tidal/ Tidal	Designated Use Class	Year Listed	Identified Pollutant	Listing Category
Patuxent River Lower	02131101	Non-Tidal	Class I	2014	TSS	5

2.1.4.c TMDLs

TMDLs are pollutant limits established for waterbodies on Maryland's 303(d) list to help achieve the waterbody's designated use. In order to establish the TMDL, the State estimates the maximum allowable pollutant load that the water body can receive and still meet water quality standards. TMDLs are required by the CWA for waters listed in Category 5. The Lower Patuxent Sediment TMDL was approved on July 2, 2018. The TMDL targets for the Non-Tidal Lower Patuxent River were obtained from the TMDL documentation entitled "Final Technical Memorandum, Point Sources of Sediment in the Non-Tidal Patuxent River Lower Watershed, April 2018" (MDE, 2018c). The watershed loads in the TMDL were modeled using the Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) watershed model 2009 Progress Scenario edge-of-stream (EOS) sediment loads. The TMDL baseline loads, SW-WLAs, and required sediment load percent reduction are summarized in Table 2-7 below. Note that baseline year for the TMDL is 2009. For the Lower Patuxent River Watershed, the County's MS4 regulated area requires a 61% reduction in sediment load.

Table 2-7: Non-Tidal Lower Patuxent River Sediment TMDL WLA for Anne Arundel County

NPDES Regulated Stormwater Sector	Baseline Load (ton/yr)	SW-WLA (ton/yr)	Reduction (%)
Lower Patuxent River, Anne Arundel County Phase I MS4	14	5.5	61

2.1.4.d NPDES

Under section 402(p) of the CWA, the EPA's NPDES permit program is required to include MS4 discharges. Since 2002, NPDES permits have included WLA requirements, including those for MS4 discharges. Anne Arundel County holds a Phase 1 Large Jurisdiction MS4 NPDES permit issued by MDE (11-DP-3316, MD0068306). The County's first permit was issued in 1993. The current fourth permit was issued in 2014.

Section IV.E.2.b of the permit requires the County to develop a restoration plan for any local TMDLs. The restoration plan must be completed within a year of the TMDL approval date. The EPA approved the Sediment TMDL for the Non-Tidal Patuxent River Lower Watershed on July 2, 2018, so the restoration plan must be submitted by July 2, 2019.

The restoration plan must address the following requirements, as outlined in County's MS4 permit:

- Include the final date for meeting applicable SW-WLAs and a detailed schedule for implementing all structural and non-structural water quality improvement projects, enhanced stormwater management programs, and alternative stormwater control initiatives necessary for meeting applicable SW-WLAs;
- Provide detailed cost estimates for individual projects, programs, controls, and plan implementation;
- Evaluate and track implementation of restoration plans through monitoring or modeling to document the progress toward meeting established benchmarks, deadlines, and SW-WLAs; and
- Develop an ongoing iterative process that continuously implements structural and non-structural restoration projects, program enhancements, new and additional programs, and alternative BMPs where EPA approved TMDL SW-WLAs are not being met according to the benchmarks and deadlines established a part of the County's watershed assessments.

The permit also requires public outreach and involvement in the development of the restoration plan and the rest of the TMDL process (permit section IV.E.3.a-d).

The permit requires an MS4 Annual Report assessing the NPDES stormwater program based on the fiscal year. The MS4 Annual Report must include a TMDL assessment evaluating the effectiveness of the restoration plan in achieving compliance with the EPA approved TMDL. Components of the assessment include estimated net change in pollutant load reductions from water quality improvement projects; a comparison of net change to targets, deadlines, and applicable SW-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 SW-WLAs are not being met (permit section IV.E.4.a-e).

The County's permit also requires restoration of 20% of impervious surface area to the maximum extent practicable (MEP) (Permit section IV.E.2.a). Strategies in this Restoration Plan will contribute to additional treatment of impervious surfaces, but accounting for the contribution of this plan to the County's overall 20% impervious treatment requirement is not included in this report.

2.1.4.e Monitoring

The County has many on-going monitoring programs to assess and track water quality progress within the watershed. These are more fully explained in Section 10.

2.2 Middle Patuxent

2.2.1 Watershed Delineation

The Middle Patuxent watershed is located in the southwest portion of the county. The watershed shares political boundaries with Prince George's County along the Patuxent River to the west, and with Calvert County along Lyons Creek to the south. The Middle Patuxent watershed also lies within the larger Chesapeake Bay watershed, with the Patuxent River discharging into the Chesapeake Bay (Figure 2-1, shown at the end of Section 2).

2.2.2 Non-Tidal Patuxent River Middle Subwatersheds

The following information was taken from the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018). The Middle Patuxent watershed is approximately 26,490 acres (41.4 sq. miles) and contains approximately 228 miles of streams. The watershed includes the named streams including Lyons Creek, Cabin Branch, Ferry Branch, Wilson Owens Branch, and the middle branch of the Patuxent River. The watershed is divided into 33 subwatersheds, which were used as the planning units. Table 2-8 shows the area and length of stream for each subwatershed. Figure 2-2, shown at the end of Section 2, shows the subwatershed delineations for the Middle Patuxent River.

Table 2-8: Middle Patuxent River: subwatershed area and stream length

Subwatershed Code	Subwatershed Name	Drainage Area (Acres)	Drainage Area (square miles)	Total Stream Miles
MP0	Deep Creek	974	1.52	12.1
MP1	Unnamed Tributary	781	1.22	5.5
MP2	Rock Branch 1	1,319	2.06	6.2
MP3	Rock Branch 2	1,316	2.06	9.3
MP4	Ferry Branch 1	1,124	1.76	9.3
MP5	Wilson Owens Branch 3	708	1.11	6.2
MP6	Lyons Creek 10	1,082	1.69	11.0
MP7	Galloway Creek	1,308	2.04	13.5
MP8	Cabin Branch 1	879	1.37	10.6
MP9	Two Run Branch 2	827	1.29	9.2
MPA	Pindell Branch	628	0.98	8.0
MPB	House Creek	237	0.37	5.2
MPD	Wilson Owens Branch 1	527	0.82	3.8
MPE	Wilson Owens Branch 2	645	1.01	5.4
MPF	Lyons Creek 1	734	1.15	6.9
MPG	Lyons Creek 2	394	0.62	4.1
MPH	Lyons Creek 3	743	1.16	4.5
MPI	Lyons Creek 4	655	1.02	4.9
MPJ	Lyons Creek 5	1,065	1.66	7.6
MPK	Lyons Creek 6	466	0.73	2.9
MPL	Lyons Creek 7	427	0.67	3.4
MPM	Lyons Creek 8	316	0.49	3.4
MPN	Lyons Creek 9	357	0.56	3.4
MPO	Ferry Branch 2	1,072	1.68	7.1
MPP	Ferry Branch 3	859	1.34	6.6
MPQ	Cabin Branch 2	645	1.01	6.0
MPR	Cabin Branch 3	488	0.76	4.0
MPS	Cabin Branch 4	828	1.29	5.6
MPT	Cabin Branch 5	547	0.86	4.3
MPU	Unnamed Tributary	1,060	1.66	7.2
MPV	Rock Branch 3	1,665	2.60	12.2

Subwatershed Code	Subwatershed Name	Drainage Area (Acres)	Drainage Area (square miles)	Total Stream Miles
MPW	Two Run Branch 1	730	1.14	7.6
MPZ	Wilson Owens Branch 4	1,167	1.82	10.7
Middle Patuxent Total		**26,573**	**41.52**	**227.7**

2.2.3 Land Use/Land Cover

LULC have a significant impact on water quality and stream habitat condition. Undeveloped, forested areas slow the flow of stormwater and allow for infiltration. Vegetation and soil remove some of the nutrients and pollutants found in stormwater, improving the water quality as the stormwater infiltrates. Developed areas with high levels of impervious surface do not slow or filter stormwater. Thus developed areas result in increased flow levels and decreased water quality, both of which degrade the stream habitats through erosion and pollution respectively. Agricultural land can also impair streams with nutrients and bacteria if not managed properly.

The Middle Patuxent watershed is largely undeveloped, containing mostly forest and agricultural land. The Lower Patuxent watershed is largely undeveloped, containing mostly forest and agricultural land. Figure 2-3 shows the land use/land cover of the watershed. These data were obtained from the CBP Phase 6 Land Use data set published by the United States Geological Survey (USGS, 2018).

2.2.3.a Existing Land Use/Land Cover

As shown in Table 2-9, the largest LULC category in the Middle Patuxent Watershed is forest (50.00%) followed by mixed open/agriculture (27.26%) and turf (12.05%). Impervious surfaces account for approximately 4.82% (sum of all impervious LULC categories that include roads, surfaces, and structures).

Table 2-9: Middle Patuxent River Land Use/Land Cover

Land Use/Land Cover	Acres	Percent of Watershed
Forest	13,286	50.00%
Mixed Open/Agriculture	7,243	27.26%
Turf	3,202	12.05%
Tree Canopy Over Turf	913	3.44%
Impervious Surfaces	439	1.65%
Shrubland	346	1.30%
Impervious Roads	295	1.11%
Water	260	0.98%
Structures	198	0.75%
Tree Canopy Over Impervious Surfaces	188	0.71%
Tree Canopy Over Impervious Roads	110	0.41%
Tree Canopy Over Structures	51	0.19%
Barren	42	0.16%
TOTAL	**26,573**	**100%**

2.2.3.b Impervious Surfaces

Impervious surfaces accelerate and concentrate stormwater runoff, causing significant potential for degradation when the runoff reaches the streams. Stormwater runoff also washes off pollutants accumulated on impervious surfaces, leading to degraded water quality in streams. Areas with lower levels of impervious surfaces tend to correspond with better stream health. Impervious cover is an important factor to consider when determining pollutant loads and other characteristics of stormwater runoff.

Impervious surfaces make up 4.82% of the Middle Patuxent watershed. Impervious coverage ranges from 0.3% in the House Creek subwatershed to 11.5% in the Galloway Creek subwatershed.

Table 2-10: Middle Patuxent River Percent Impervious

Subwatershed Code	Subwatershed Name	Percent Impervious
MP0	Deep Creek	3.9%
MP1	Unnamed Tributary	5.8%
MP2	Rock Branch 1	6.5%
MP3	Rock Branch 2	2.7%
MP4	Ferry Branch 1	3.1%
MP5	Wilson Owens Branch 3	5.2%
MP6	Lyons Creek 10	4.9%
MP7	Galloway Creek	11.5%
MP8	Cabin Branch 1	7.5%
MP9	Two Run Branch 2	1.7%
MPA	Pindell Branch	1.5%
MPB	House Creek	0.3%
MPD	Wilson Owens Branch 1	4.4%
MPE	Wilson Owens Branch 2	4.0%
MPF	Lyons Creek 1	2.4%
MPG	Lyons Creek 2	3.6%
MPH	Lyons Creek 3	7.8%
MPI	Lyons Creek 4	4.5%
MPJ	Lyons Creek 5	4.1%
MPK	Lyons Creek 6	7.2%
MPL	Lyons Creek 7	6.5%
MPM	Lyons Creek 8	8.5%
MPN	Lyons Creek 9	4.4%
MPO	Ferry Branch 2	4.8%
MPP	Ferry Branch 3	3.3%
MPQ	Cabin Branch 2	3.1%
MPR	Cabin Branch 3	2.7%
MPS	Cabin Branch 4	4.2%
MPT	Cabin Branch 5	3.3%
MPU	Unnamed Tributary	4.2%
MPV	Rock Branch 3	4.4%
MPW	Two Run Branch 1	3.1%

MPZ	Wilson Owens Branch 4	8.2%

As further explained below in Section 4, County-owned impervious areas, and in particular buildings and parking lots, represent opportunities for targeted BMP implementation to control stormwater runoff. A GIS analysis was conducted to identify these impervious surfaces, utilizing GIS data on county-wide impervious surfaces and public parcels (Figure 2-4). Any surfaces that were already treated by existing BMPs were left out of the impervious surface analysis, as were small buildings (smaller than 2,000 sf) and parking lots (smaller than 1/16th of an acre). A summary of the remaining impervious surfaces are summarized below in Table 2-11.

Table 2-11: Area of County-Owned Buildings and Parking Lots for Potential BMP Implementation in Middle Patuxent River

Buildings	Total Area (sq.ft.)	Number of Buildings
2,000-4,000 sf	6099	2
4,000-6,000 sf	8488	2
6,000-8,000 sf	6021	1
TOTAL	20608	5
Parking Lots	**Total Area (sq.ft.)**	**Number of Parking Lots**
1/16-1/8 acre	29876	8
1/8-1/4 acre	45802	6
1/4-1/2 acre	13419	1
1/2-1.0 acre	46436	2
>1 acre	0	0
TOTAL	135533	17

2.2.4 Water Quality

2.2.4.a Use Designations

According to water quality standards established by MDE in the Code of Maryland Regulations (COMAR) 26.08.02.08[3], the Non-Tidal Lower Patuxent river and its tributaries are classified as Class I waters. Class I waters are generally designated to support "water contact recreation and protection of non-tidal warm water aquatic life". The more detailed designated uses of Class I waters are shown below in Table 2-12.

Table 2-12: Designated Uses in the Middle Patuxent River and its Tributaries

Designated Use	Middle Patuxent
Growth and propagation of fish (not trout), other aquatic life and wildlife	X
Water contact sports	X
Leisure activities involving direct contact with surface water	X
Fishing	X
Agricultural water supply	X
Industrial water supply	X

[3] http://www.dsd.state.md.us/comar/comarhtml/26/26.08.02.08.htm

2.2.4.b 303(d) Impairments

According to Maryland's final 2016 and draft 2018 303(d) list of impaired waters, the Middle Patuxent is impaired by TSS and sulfates. The water quality impairment of the Patuxent River Middle watershed is caused, in part, by an elevated sediment load beyond a level that the watershed can sustain; thereby causing sediment related impacts to aquatic life. These impairments were listed in 2014. The impairments are Category 5, which indicates that the waterbody is impaired and a TMDL or water quality analysis (WQA) is needed. Impairments are summarized below in Table 2-13.

Table 2-13: 303(d) Impairments in the Middle Patuxent River and its Tributaries

Watershed	Basin Code	Non-tidal/ Tidal	Designated Use Class	Year Listed	Identified Pollutant	Listing Category
Patuxent River Middle	02131102	Non-tidal	Class I	2014	TSS , Sulfates	5

2.2.4.c TMDLs

TMDLs are pollutant limits established for waterbodies on Maryland's 303(d) list to help achieve the waterbody's designated use. In order to establish the TMDL, the State estimates the maximum allowable pollutant load that the water body can receive and still meet water quality standards. TMDLs are required by the CWA for waters listed in Category 5. The Middle Patuxent Sediment TMDL was approved on July 2, 2018.

The TMDL targets for the Non-Tidal Middle Patuxent River were obtained from the TMDL documentation entitled "Final Technical Memorandum, Point Sources of Sediment in the Non-Tidal Patuxent River Middle Watershed, April 2018" (MDE, 2018c). The watershed loads in the TMDL were modeled using the Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) watershed model 2009 Progress Scenario edge-of-stream (EOS) sediment loads. The TMDL baseline loads, SW-WLAs, and required sediment load percent reduction are summarized in Table 2-14 below. Note that baseline year for the TMDL is 2009.

Table 2-14: Non-Tidal Middle Patuxent River Sediment TMDL WLA for Anne Arundel County

NPDES Regulated Stormwater Sector	Baseline Load (ton/yr)	SW-WLA (ton/yr)	Reduction (%)
Middle Patuxent River, Anne Arundel County Phase I MS4	162	71	56

For the Middle Patuxent River Watershed, the County's MS4 regulated area requires a 56% reduction in sediment load.

2.2.4.d NPDES

Under section 402(p) of the Clean Water Act, the EPA's NPDES permit program is required to include MS4 discharges. Since 2002, NPDES permits have included WLA requirements, including those for MS4 discharges. Anne Arundel County holds a Phase 1 Large Jurisdiction MS4 NPDES permit issued by MDE (11-DP-3316, MD0068306). The County's first permit was issued in 1993. The current fourth permit was issued in 2014.

Section IV.E.2.b of the permit requires the County to develop a restoration plan for any local TMDLs. The restoration plan must be completed within a year of the TMDL approval date. The EPA approved the Sediment TMDL for the Non-Tidal Patuxent River Lower Watershed on July 2, 2018, so the restoration plan must be submitted by July 2, 2019.

The restoration plan must address the following requirements, as outlined in County's MS4 permit:

- Include the final date for meeting applicable WLAs and a detailed schedule for implementing all structural and non-structural water quality improvement projects, enhanced stormwater management programs, and alternative stormwater control initiatives necessary for meeting applicable WLAs;
- Provide detailed cost estimates for individual projects, programs, controls, and plan implementation;
- Evaluate and track implementation of restoration plans through monitoring or modeling to document the progress toward meeting established benchmarks, deadlines, and stormwater WLAs; and
- Develop an ongoing iterative process that continuously implements structural and non-structural 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 a part of the County's watershed assessments.

The permit also requires public outreach and involvement in the development of the restoration plan and the rest of the TMDL process (permit section IV.E.3.a-d).

The permit requires an annual report assessing the NPDES Stormwater program based on the fiscal year. The annual report must include a TMDL assessment evaluating the effectiveness of the restoration plan in achieving compliance with the EPA approved TMDL. Components of the assessment include estimated net change in pollutant load reductions from water quality improvement projects; a comparison of 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 IV.E.4.a-e).

The County's permit also requires restoration of 20% of impervious surface area to the maximum extent practicable (MEP) (Permit section IV.E.2.a). Strategies in this Restoration Plan will contribute to additional treatment of impervious surfaces, but accounting for the contribution of this plan to the County's overall 20% impervious treatment requirement is not included in this report.

2.2.4.e Monitoring

The County has many on-going monitoring programs to assess and track water quality progress within the watershed. These are more fully explained in Section 10.

Figure 2-1: Location of the Lower and Middle Patuxent Watersheds Within Anne Arundel County

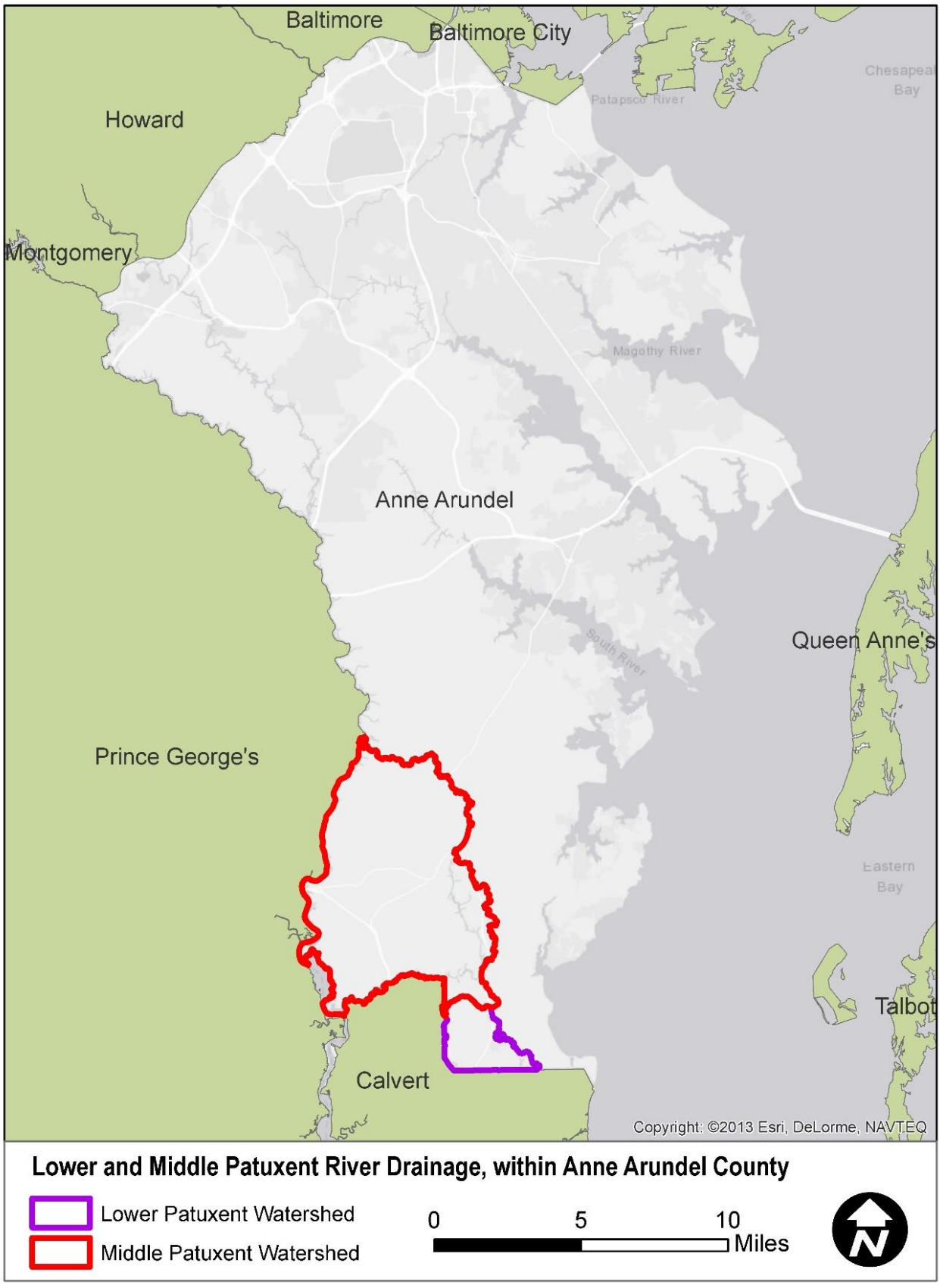


Figure 2-2: Lower and Middle Patuxent Subwatershed Delineations

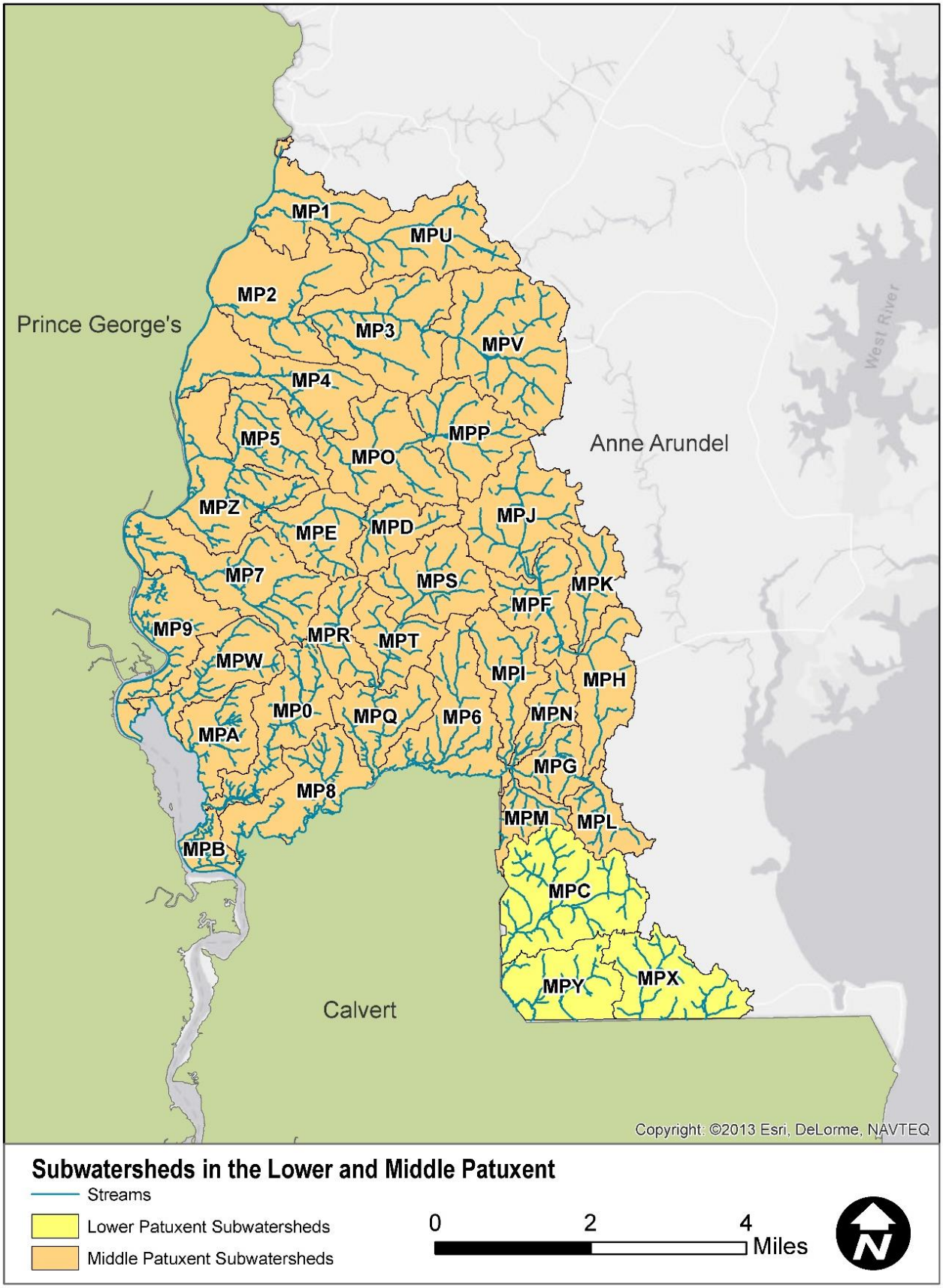


Figure 2-3: Landuse/Landcover in the Lower and Middle Patuxent River Watersheds

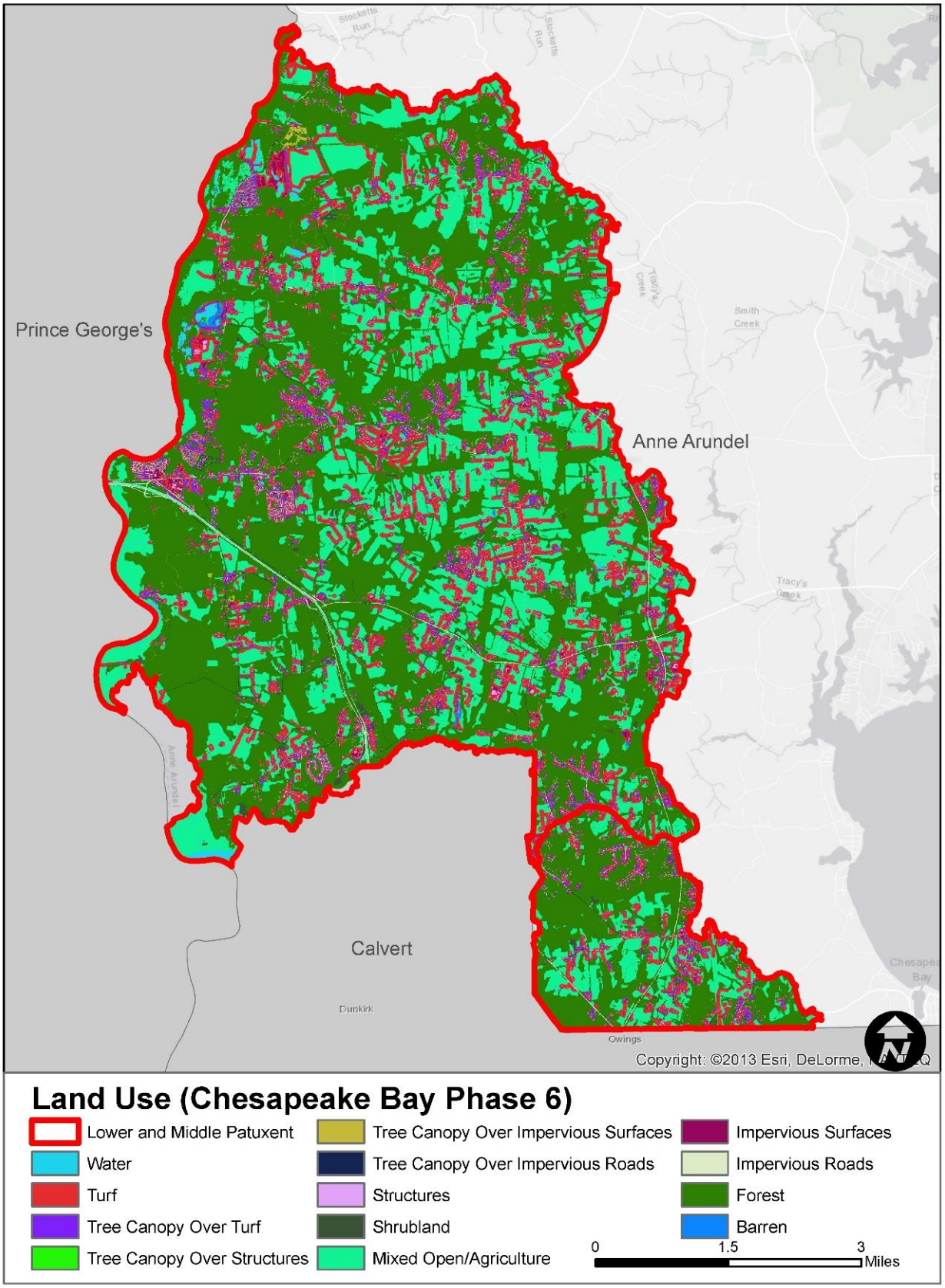
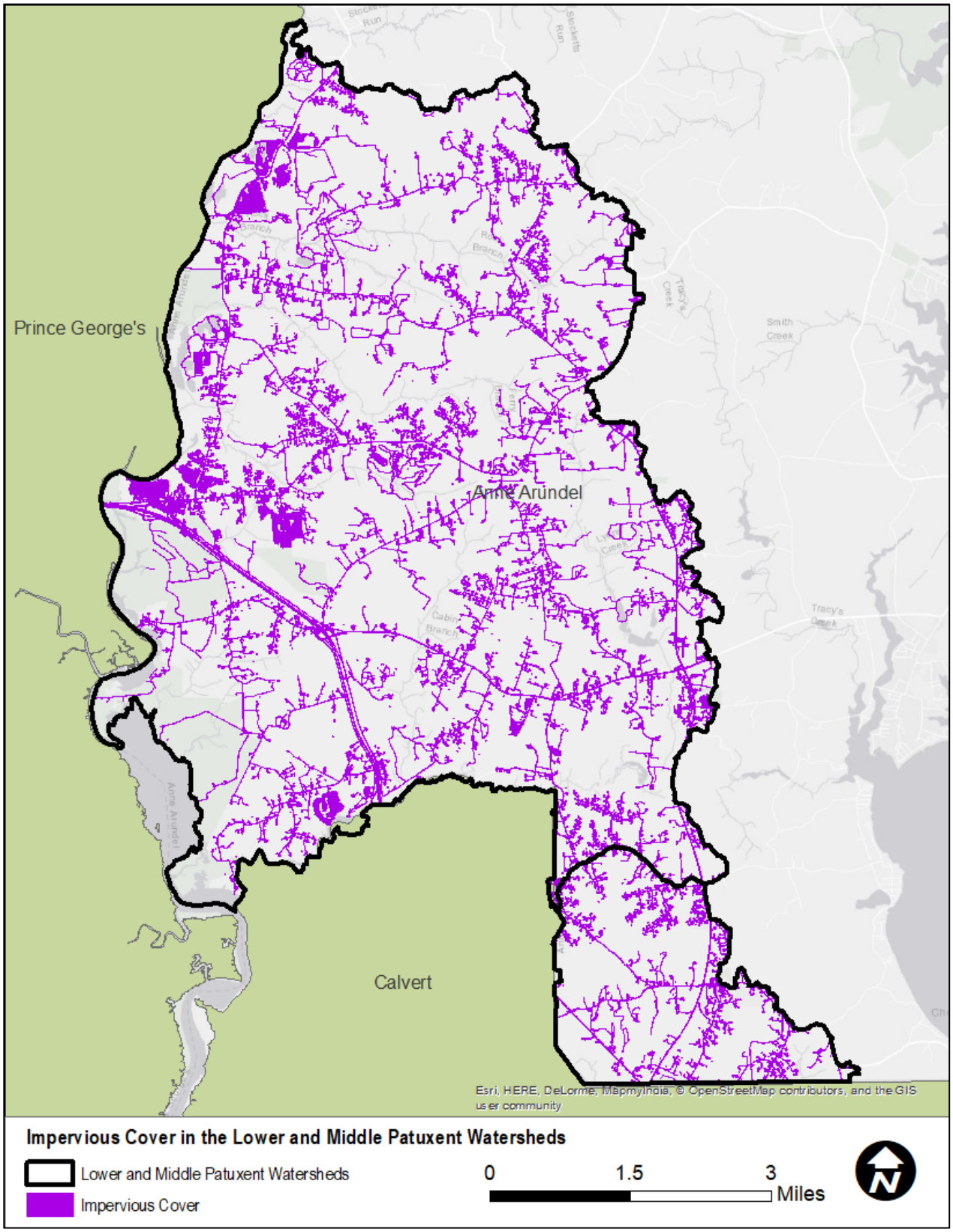


Figure 2-4: Impervious Cover in the Lower and Middle Patuxent River Watersheds



3 Causes and Sources of Impairments

3.1 Impairments

Elevated levels of sediment currently impair the Non-Tidal Lower and Middle Patuxent River watersheds as evident through the 303(d) listings and local TMDL requirement. Sediment is the loose sand, clay, silt and other soil particles that settle at the bottom of a body of water. Sediment from both upland and in-stream sources can impact in-stream habitat by covering and filling gravelly and rocky substrate, which is a preferred substrate habitat for some aquatic organisms (fish and benthic community) and is necessary for some fish species for spawning. Finer clays, silts and sands associated with sediment are more mobile and transient and provide less livable space for more sensitive benthic macroinvertebrate species by filling the interstitial spaces between larger substrate particles in the channel bottom. Increases in sediment loads in channels that cannot adequately transport the load can lead to deposition and aggrading streams. These factors often negatively impact channel flow, causing additional erosion and increases in flooding, particularly if road crossing capacity is limited by sediment accumulation. Suspended sediment in the water column may limit light penetration and prohibit healthy propagation of algae and submerged aquatic vegetation. Suspended sediments can cause gill abrasion in fish and can limit clarity, which impacts aquatic species that rely on sight for feeding. Section 10 discusses the ongoing monitoring that helps assess progress towards reducing the sediment impairments.

3.2 Sources

Sediment can come from soil erosion or from the decomposition of plants and animals. Wind, water and ice help carry these particles to rivers, lakes and streams. While natural erosion produces nearly 30 percent of the total sediment in the United States, accelerated erosion from human use of land accounts for the remaining 70 percent[4]. The 2009 baseline loading rates obtained from CAST are shown in Table 3-1 below for the Lower and Middle Patuxent River Watersheds within Anne Arundel County respectively. The CAST baseline loads (Table 3-2) also show that in the Lower Patuxent watershed, the majority of sediment allocated to the MS4 originates from in-stream sources related to channel erosion (35%), from urban turf (34%), and from impervious land cover (31%). Similarly, in the Middle Patuxent watershed, the majority of sediment allocated to the MS4 originates from in-stream sources related to channel erosion (41%), from urban turf (32%) and from impervious land cover (27%) stormwater runoff.

With respect to impervious land cover, “MS4 Buildings and Other,”, “MS4 Roads,” and “MS4 Tree Canopy over Impervious,” contribute the highest sediment loads per acre of all MS4 land use types (Table 3-1). A comparison of Table 3-1 and Table 3-2 also shows that even though the loading rates for turf areas are lower than the loading rates for impervious areas, turf areas are a large contributor to the overall total sediment load in both watersheds because a very large percentage of the total area is turf (Table 3-3). These results show that impervious areas and stream banks could be targeted for additional sediment reduction through future BMP implementation. Targeting turf areas for additional sediment reduction may not be practical or cost effective given the large contributing areas and low loading rates.

[4] https://cfpub.epa.gov/npstbx/files/ksmo_sediment.pdf

Table 3-1: Acreage and Sediment Loads in the MS4 Area of the Lower and Middle Patuxent River Watershed

Load Source	Lower Patuxent River		Middle Patuxent River	
	Amount[1]	Loading Rate[1]	Amount[1]	Loading Rate[1]
MS4 Buildings and Other	59 acres	2,016 lbs/acre	543 acres	1,527 lbs/acre
MS4 Roads	17 acres	2,016 lbs/acre	128 acres	1,526 lbs/acre
MS4 Tree Canopy over Impervious	47 acres	2,016 lbs/acre	351 acres	1,525 lbs/acre
MS4 Tree Canopy over Turf Grass	63 acres	409 lbs/acre	431 acres	316 lbs/acre
MS4 Turf Grass	372 acres	666 lbs/acre	3403 acres	512 lbs/acre
Stream Bed and Bank	1.1 mile	253,897 lbs/mile	10.1 miles	235,768 lbs/mile

1. Acreage and loading rates are rounded to the nearest integer for ease of presentation. Multiplying these numbers together will produce total loads that are slightly different than those shown in Tables 3-2, 5-3, and 5-4. For total sediment load per load source, refer to those tables.

Table 3-2: Sediment Loads Per Major MS4 Source

Load Source	Lower Patuxent River		Middle Patuxent River	
	Amount (lbs)	Percent of Total	Amount (lbs)	Percent of Total
Impervious[1]	249,585	31%	1,560,765	27%
Turf[2]	273,806	34%	1,879,686	32%
Stream Bed and Bank	277,933	35%	2,373,894	41%

1. Includes “MS4 Buildings and Other”, “MS4 Roads, and “MS4 Tree Canopy over Impervious”
2. Includes “MS4 Tree Canopy over Turf Grass” and “MS4 Turf Grass”

Table 3-3: Percent Impervious and Turf Area in the MS4 Portion of the Lower and Middle Patuxent River

Load Source	MS4 Lower Patuxent River		Middle Patuxent River	
	Amount (acres)	Percent of Total	Amount (acres)	Percent of Total
Impervious	124	22%	1,023	21%
Turf	435	78%	3,835	79%

3.2.1 Urban Stormwater Runoff

The sediment load contribution of urban stormwater and urban nonpoint sources was analyzed in the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018). Figure 3-1 presents the modeled annual total suspended solids runoff load as the relative quantity of sediment contributed from each subwatershed (i.e., lowest to highest). This modeling scenario represents current actual land use conditions and accounts for pollutant load reductions from existing public and privately owned BMPs, all restoration projects performed as part of the County’s Capital Improvement Program (CIP), and disconnected impervious surfaces. The water quality model used for the assessment was based on EPA’s Simple Method (Schueler, 1987) and PLOAD models (EPA, 2001) using event mean concentrations (EMCs) for each LULC type. The results presented here are the sediment associated with runoff, and do not reflect in-stream sources. Model results indicate that runoff from the following LULC categories contribute the

most overall sediment: row crops, pasture and hay, transportation, and commercial and industrial areas. These LULC categories also have the highest sediment loading rates. While large residential developments have a lower sediment loading rate, they make up a significant portion of the watershed (22%) and are therefore also a significant contributor to loads.

Subwatersheds contributing the highest amount of existing sediment loads include MP3, MPV, MPP, and MPJ (all located in Middle Patuxent), and to a lesser extent, subwatersheds MPU, MP2, MPO, MP7, MP0, MPs, MPF, MPI, MP6 (all in Middle Patuxent), and MPY and MPX (in Lower Patuxent).

Management measures targeted in subwatersheds with high existing sediment loads, and with high contributions from the MS4 land use sectors, will be the priority of this Restoration Plan to ensure required reductions are achieved and maintained.

3.2.2 In-stream Sources

Although channel bed and bank erosion occurs naturally as streams work to maintain a state of dynamic equilibrium, excessive erosion can occur due to increased stream discharge and velocity. Increased stream discharge is often associated with development and agricultural activities that increase runoff and encroach on riparian buffers within the watershed. Channel erosion can deliver excessive pollutants, such as sediment and phosphorus, downstream, where water quality can be impacted and important habitat for fish spawning and benthic invertebrates can be degraded. Excessive erosion can also threaten the stability of nearby built infrastructure. The Biological Stressor Identification Analysis (BSID) included in the *Middle and Lower Patuxent Watershed Assessment Report* determined that biological communities in this watershed are likely degraded due to sediment and in-stream habitat related stressors, as well as water quality (Anne Arundel County, 2018). These stressors often result from altered hydrology and increased runoff from impervious area, specifically from channel erosion and subsequent elevated suspended sediment transport through the watershed. Thus, suspended sediment was identified as a probable cause and confirmed the Category 5 listing for TSS as an impairing substance in this watershed.

Approximately 133 miles of streams were assessed and characterized for the Lower and Middle Patuxent Rivers, as described in the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018). Data collected included stream classifications, physical habitat condition assessment, inventory of infrastructure and environmental features, habitat scores, channel geomorphology, road crossing flood potential, bioassessments, and aquatic resource indicators. Within each perennial reach, channel erosion was assessed and scored based on severity. A score of five was considered Moderate impact, a score of seven was considered Severe, and a score of 10 was considered an Extreme condition. A total of 457 erosion locations were cataloged in the Lower and Middle Patuxent watershed with erosion severity rated as moderate, severe, or extreme (Figure 3 2). Erosion impacts were attributed mostly to agricultural runoff and development in the watersheds. In addition to stream erosion, a total of 293 headcuts were inventoried, with an average height of 3.7 feet, and with several reaching as high as 10 feet tall. The information on location of erosion and height of headcut, along with other collected data such as length of erosion, will be used to assess potential stream restoration projects.

An assessment of channel geomorphology utilizing Rosgen Level I geomorphic classifications (Rosgen, 1996) was also developed for each single-threaded, perennial reach throughout the watershed as part of the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018). An assessment of

channel geomorphology is useful to better understand the stability of a stream and its associated behaviors, including channel entrenchment. The Rosgen classification system has four levels. The Level I classification is a geomorphic characterization that groups streams as Types A through G based on aspects of channel geometry, including water surface slope, entrenchment, width/depth ratio, and sinuosity.

The majority of the assessed perennial stream miles in the Lower and Middle Patuxent watershed were Type C (38.2%) or Type G (31.1%) channels. Type C channels exhibit a well-developed floodplain, higher sinuosity, and susceptibility to de-stabilization when flow regimes are altered. Type G channels are unstable, incised "gully" channels with high erosion rates. Type E channels made up 17.7% of assessed stream miles, and are generally stable, low gradient, meandering streams with low width/depth ratios. Type A channels made up 10.7% of assessed stream miles, and have a high slope and are typically found in headwaters in areas with steep slopes. The remaining 2.3% of stream miles were of other types. Because they represent such a small percentage of stream miles, these streams are not discussed further here, but they are discussed in more detail in the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018).

3.3 Anticipated Growth

Future urban sector growth and the anticipated increase in urban loads that may result are expected to be controlled by three elements: stormwater management to the MEP that is required with new development, anticipated MDE "Accounting for Growth" policies, and Anne Arundel County's General Development Plan. This Restoration Plan is developed to achieve the reduction required from the initial (2009) baseline year load, calibrated to the current Bay model. Based on coordination with MDE, TMDL restoration planning is designed to focus on the untreated and undertreated areas associated with the urban footprint at the time of the TMDL baseline. Future load and loads potentially added to the urban sector from the baseline year to present are not accounted for in this plan, as they are addressed under other programs; however, they are discussed here for completeness.

3.3.1 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, 2014b):

> *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.*

The *Anne Arundel County General Development Plan* (Anne Arundel County, 2009) was finalized April 2009 and was adopted in October 2009 (Bill No. 64-09). The next update of the plan, *Plan2040*, is scheduled for completion in 2020. *Plan2040* will capitalize on the County's assets and conserve its critical resources. *Plan 2040* will be divided in to two volumes. Volume I will be the General Development Plan adopted by the County Council and will include the Countywide Vision, an Action Plan of goals, policies and recommendations for each of the Plan elements, a process for new Region Plans, a Concurrency and

Implementation Plan and a plan for measuring the success of *Plan 2040.* Volume II will provide more detail of the regulatory framework for the General Development Plan, background reports and the public engagement process. During the early stages of the *Plan2040* planning process, protection of the natural environment and rural areas as well as revitalization and redevelopment of older communities and maintaining quality of life were identified as the highest priorities. *Plan2040* will identify opportunities to expand protection of the natural environment and conserve land and resources. Anne Arundel County is considered one of the fastest growing counties in the region with 14.6% population growth (427,239 to 489,656 persons) over 1990-2000 compared to 6.9% growth in the Baltimore region and 10.8% growth throughout the State of Maryland (Anne Arundel County, 2009). The population in Anne Arundel County is projected to increase to 564,925 persons by 2025, which is an increase of 15.4% from 2000 data, and to 579,137 persons by 2035, an increase of 18.3% from 2000 data.

There are no major cities or towns located in the Non-Tidal Lower and Middle Patuxent River watersheds. The primary developed areas located in Lower Patuxent are residential properties located in Friendship and Rose Haven or along the major road arteries. The majority of the watershed is forested, followed by agriculture and turf. Additional residential properties may develop as growth occurs throughout the County. Anne Arundel County continues to utilize strategies such as promoting low impact development and implementing stormwater BMPs for water quality treatment. However, increased urban stormwater related loads will inevitably occur as growth continues.

Figure 3-3 depicts sediment loading by subwatershed based on a future conditions modeling scenario with the implementation of projects funded in the County's Capital Improvement Program (CIP) as recommended in the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018) and discussed further in Section 4. This modeling scenario relies on a realistic estimate of future development (informed by legal/physical constraints on development, capacity studies conducted by the County's Office of Planning and Zoning, and expected changes in land use), under the assumption that any future development complies with Environmental Site Design (ESD) to the maximum extent practicable. In general, future sediment loading is projected to be highest in Rock Branch 1 (MP2), Rock Branch 2 (MP3), Rock Branch 3 (MPV), Ferry Branch 3 (MPP), Lyons Creek 5 (MPJ), Galloway Creek (MP7), and Lyons Creek (MP6) subwatersheds.

3.3.2 Offsetting Sediment Loads from Future Growth

Anne Arundel County's new General Development Plan, *Plan2040,* establishes the following vision for the County's natural environment into the future: *Resilient, Environmentally-Sound, and Sustainable Communities – Land use decisions* affecting future growth and *development will recognize the value of, and strive to balance good neighborhood planning, while retaining open space, preserving and restoring forest cover, investing in the health of our rivers and waterways, and increasing the ability of communities to withstand climate change impacts. Agricultural areas will remain important to the character of the County, and efforts to curb stormwater runoff, create living shorelines, and restore oyster populations will contribute to a cleaner and more sustainable environment.*

The land and water conservation framework within Anne Arundel County consists of multiple programs, plans and regulatory measures in place at the federal, State, and County levels for protection of natural resources. Collectively they accomplish much in terms of natural resource preservation, land conservation, and water quality improvements. Growth and development is expected to occur throughout Anne Arundel

County, and depending on when and where this growth occurs, pollutant loading from urban stormwater sources may also increase. *Plan2040* will direct and, in association with programmatic and regulatory measures, will manage future growth in a way that will minimize increases in sediment loading in the Middle and Lower Patuxent watersheds from new development. In addition, Maryland's baseline programs, including the 1991 Forest Conservation Act, 1997 Priority Funding Areas Act, 2007 Stormwater Management Act, 2009 Smart, Green & Growing Planning Legislation, 2010 Sustainable Communities Act, 2011 Best Available Technology Regulation, and the 2012 Sustainable Growth & Agricultural Preservation Act, effectively mitigate the majority of the impacts from new development. Any additional loads will be offset through Maryland's alignment for growth policies and procedures as articulated through Chesapeake Bay milestone achievement. The overriding goal shall be no net growth in loads and Anne Arundel County shall reflect these policies, programs, and implementation as part of its net WLA accounting as stipulated in Part IV.E.4.b.ii of this permit.

It is anticipated that new development will make use of environmentally sensitive design (ESD) stormwater treatment according to MDE's Stormwater Regulations. Further, 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." As such, Anne Arundel County has updated Articles 16 and 17 of the County Code to incorporate the requirements for ESD. Anne Arundel County finalized the *Anne Arundel County Stormwater Management Practices and Procedures Manual* (Anne Arundel County, 2010) to incorporate criteria specific to the County that are not addressed within the Maryland Design Manual. Additionally, a comprehensive review and update to the County's Manual was completed in 2017 and approved by MDE. The update included a new "Temporary Stormwater Management" policy that requires management of the 1-year storm for all construction projects that require grading permits.

Anticipated "Accounting for Growth" policies will address the residual load (TN: 50%, TP: 40%, 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.

Figure 3-1: Modeled Existing Watershed Sediment Loads (Relative)

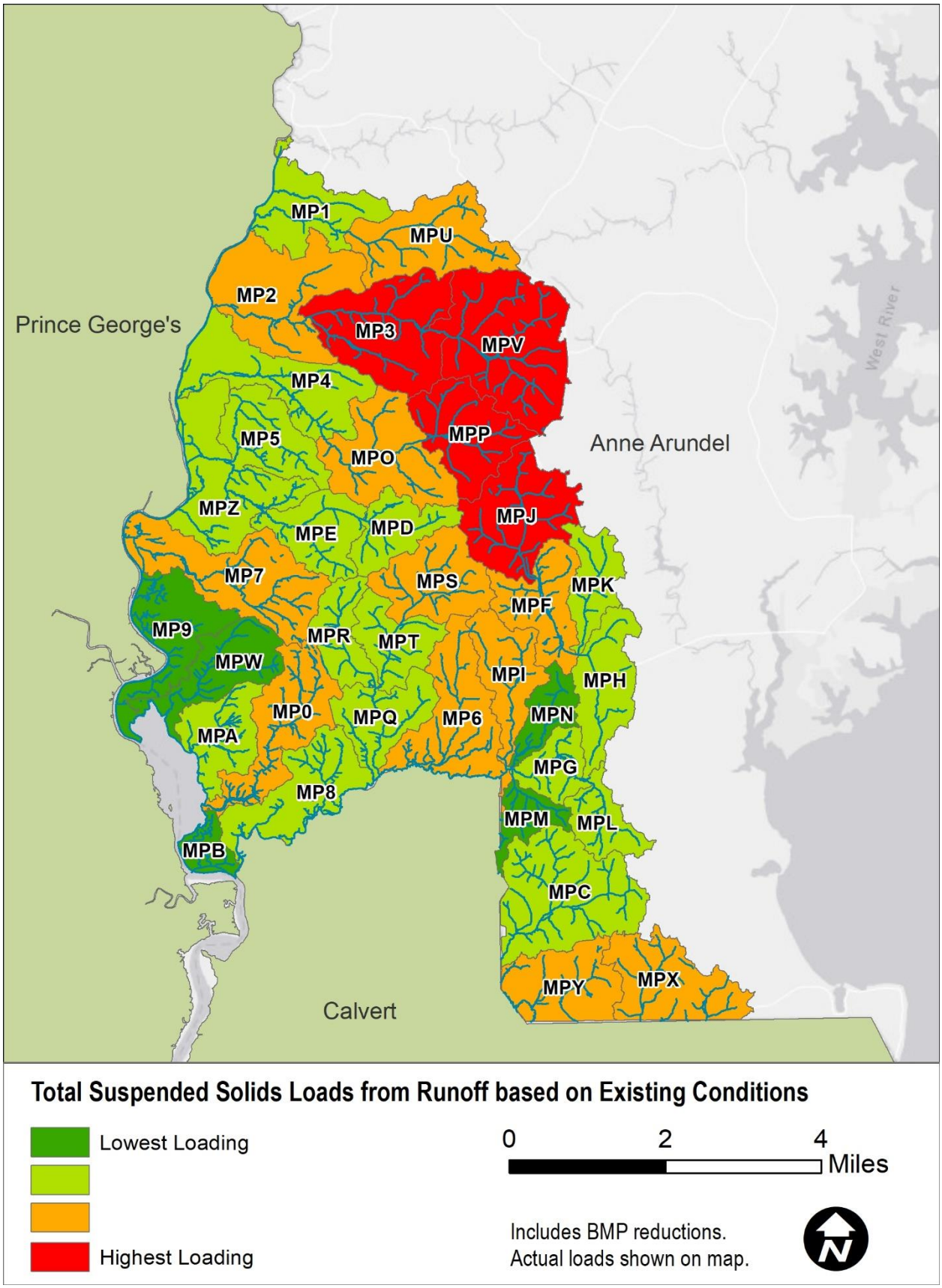


Figure 3-2: Stream Erosion Inventory (Anne Arundel County, 2018)

Map 2.4 - Herring Bay, Middle Patuxent, and Lower Patuxent Watersheds Infrastructure and Environmental Features

SHED CODE	SHED NAME	ACRES
HB0	Rockhold Creek	1964
HB1	Tracys Creek I	1803
HB2	Tracys Creek II	2401
HB3	Jack Creek	229
HB7	Cedarhurst	493
HB8	Deep Creek	833
HB9	Deep Cove Creek	1002
HBB	Chesapeake Bay	157
HBC	Broadwater Creek	452
HBD	Carrs Creek	269
HBF	Parker Creek	448
HBL	Trotts Branch	1372
HBM	Herring Bay	183
HBO	Unnamed Tributary	336
HBP	Herring Bay II	119
HBQ	Unnamed Tributary II	1545
HBR	Herring Bay III	118
HBS	Unnamed Tributary III	317
HBT	Red Lyon Creek	250
HBU	Herrington Harbor	129
HBV	Chesapeake Bay II	244
MP0	Deep Creek	974
MP1	Unnamed Tributary	781
MP2	Rock Branch 1	1319
MP3	Rock Branch 2	1315
MP4	Ferry Branch 1	1124
MP5	Wilson Owens Branch 3	708
MP6	Lyons Creek 10	1082
MP7	Galloway Creek	1308
MP8	Cabin Branch 1	893
MP9	Two Run Branch 2	827
MPA	Pindell Branch	628
MPB	House Creek	237
MPC	Hall Creek 1	1471
MPD	Wilson Owens Branch 1	527
MPE	Wilson Owens Branch 2	645
MPF	Lyons Creek 1	734
MPG	Lyons Creek 2	394
MPH	Lyons Creek 3	743
MPI	Lyons Creek 4	655
MPJ	Lyons Creek 5	1065
MPK	Lyons Creek 6	466
MPL	Lyons Creek 7	427
MPM	Lyons Creek 8	316
MPN	Lyons Creek 9	357
MPO	Ferry Branch 2	1072
MPP	Ferry Branch 3	859
MPQ	Cabin Branch 2	645
MPR	Cabin Branch 3	488
MPS	Cabin Branch 4	828
MPT	Cabin Branch 5	547
MPU	Unnamed Tributary	1060
MPV	Rock Branch 3	1665
MPW	Two Run Branch 1	730
MPX	Hall Creek 2	933
MPY	Hall Creek 3	813
MPZ	Wilson Owens Branch 4	1167

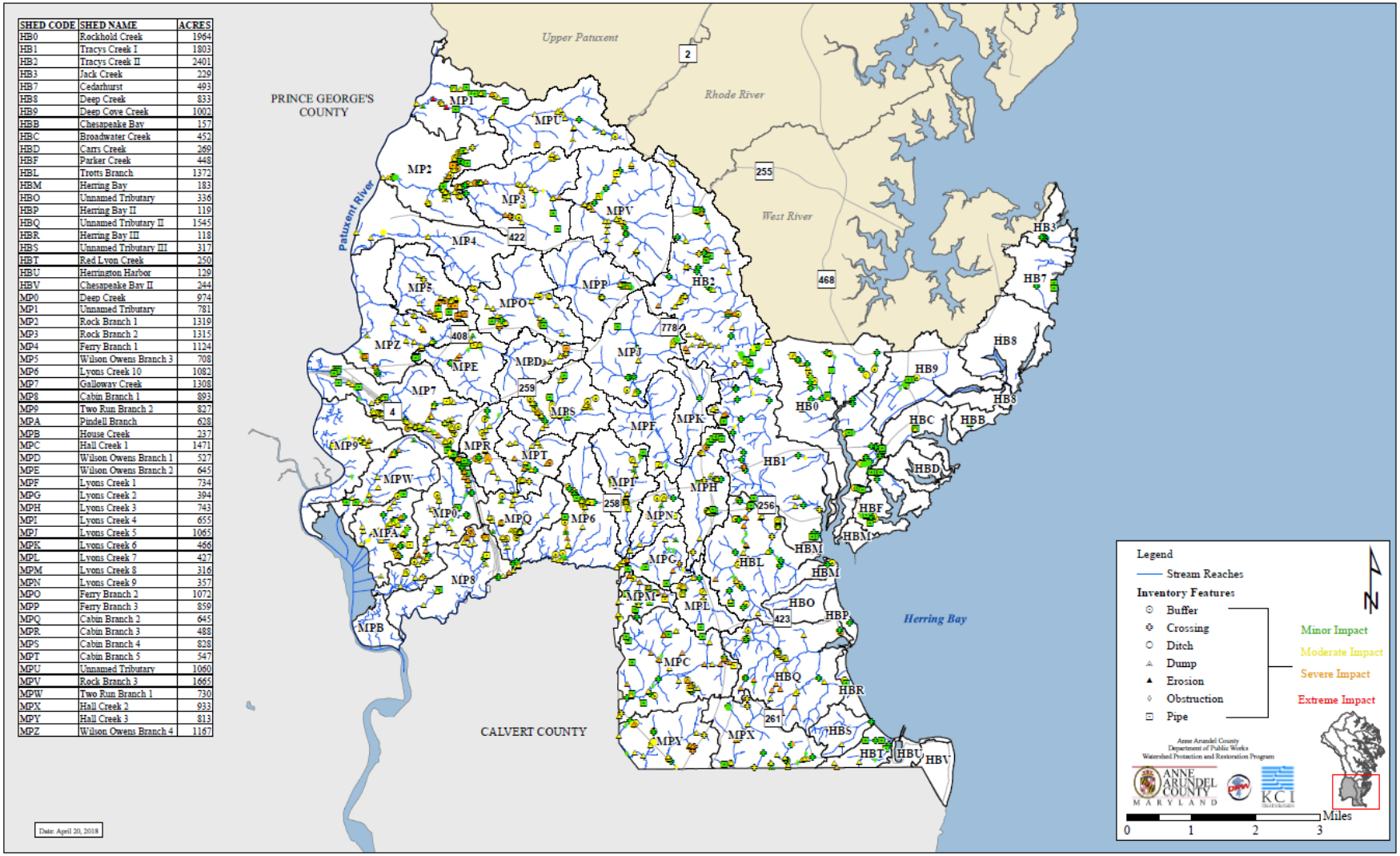
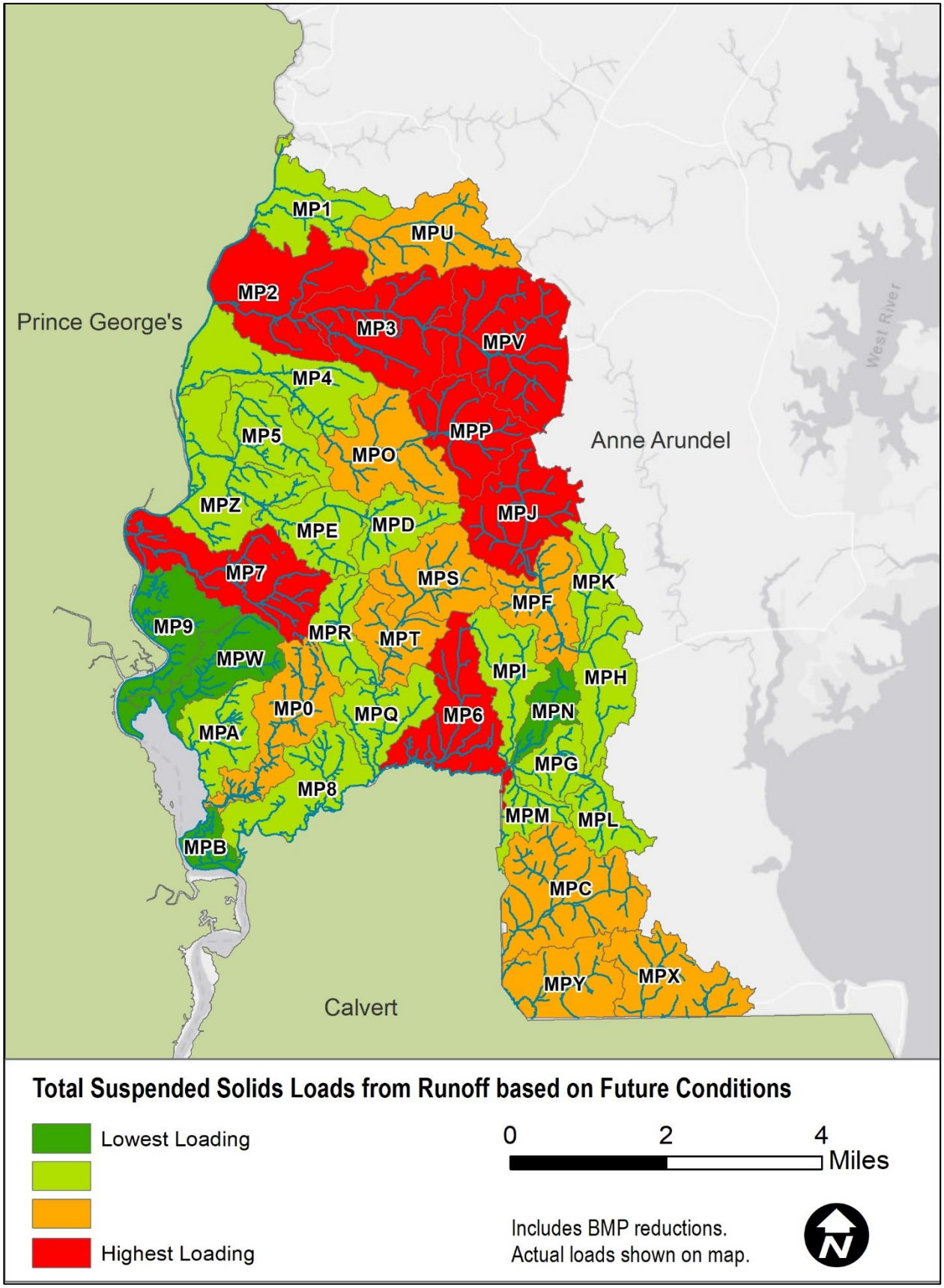


Figure 3-3: Modeled Future Watershed Sediment Loads (Relative)



4 Management Measures

BMPs have been implemented by the County to reduce sediment loads. This section describes the modeling approach and types of BMPs and management measures being implemented in the watershed. Load reductions that result from these measures are discussed in Section 5.

4.1 Modeling Approach

BMPs provide reductions for nitrogen, phosphorus, sediments, and other pollutants. The sediment pollutant loads for the Lower Patuxent and Middle Patuxent watersheds were determined using CAST, a web-based estimator tool that calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program's Watershed Model (CBP, 2017). CAST allows users to specify inputs such as geographic areas, the baseline year, and types of BMPs to create scenarios. CAST can then run these scenarios to determine land use acres and loads applicable to the conditions defined in the scenario. Separate scenarios for implementing restoration projects were created for the Lower Patuxent and Middle Patuxent watersheds. The baseline year for each TMDL is 2009, so the BMPs from the CAST scenario called "2009 Progress" were incorporated into the baseline scenarios.

The loads provided in the Chesapeake Bay Program's Watershed Model are presented at two different scales: Edge-of-Stream (EOS) and Edge-of-Tide (EOT). EOS refers to loads that reach the edge of a small stream, while EOT refers to loads that reach the edge of the tidal portion of the Bay. EOS loads are more appropriate for the watershed restoration plans and were used for all modeling analyses.

All baseline loads and most current and planned source reductions were calculated in CAST. Pollutant load reductions from non-structural maintenance efforts (i.e., street sweeping and inlet cleaning) were calculated outside of CAST, based on the mass of material removed as calculated using the MDE guidance document *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE, 2014). The modeling results were compiled and summarized in a spreadsheet. Current loads (2018 and earlier) were compared to the 2009 baseline loads to determine the percent of sediment reduction already achieved by the existing management measures. To fill the gap between the current sediment reductions and the reduction required by the TMDL SW-WLA, additional source reductions were planned.

The planned source reductions include retrofits of detention structures and large impervious surfaces not currently being managed by a BMP. The acreage potential for these retrofits is limited, so stream restoration is also planned. The total planned load reduction needed to meet each TMDL SW-WLA was then apportioned to various progress checkpoints through 2030.

4.2 Best Management Practices

Many stormwater BMPs can be implemented for both water quantity and water quality purposes; however, the effectiveness of sediment removal can vary between practices. Prior to 2009, the County decided to implement a range of practice types throughout the Lower and Middle Patuxent watersheds. The County has the technical expertise, operational capacity, and system resources in place to site, design, construct, and maintain these practices. These practices are consistent with Maryland's Stormwater Design Manual, and are described below:

- **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.
- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the stormwater 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.
- **Dry Detention Ponds** – Depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow. 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.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff and 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. 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.
- **Filtering Practices** - 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.
- **Swales** – Channels that provide conveyance, water quality treatment, and flow attenuation of stormwater runoff. Swales provide pollutant removal through vegetative filtering, sedimentation, biological uptake, and infiltration into the underlying soil media. Types of swale practices include dry swales, grass swales, wet swales, and bio-swales. Implementation of each is dependent upon site soils, topography, and drainage characteristics.
- **Dry Well** – Excavated pit or structural chamber filled with gravel or stone that provides temporary storage of stormwater runoff from rooftops. The storage area may be constructed as a shallow trench or a deep well. Rooftop runoff is directed to these storage areas and infiltrates into the surrounding soils prior to the next storm event. The pollutant removal capability of dry wells is directly proportional to the amount of runoff that is stored and allowed to infiltrate.

- **Rain Garden** – Shallow, excavated landscape feature or a saucer-shaped depression that temporarily holds runoff for a short period of time. Rain gardens typically consist of an absorbent-planted soil bed, a

mulch layer, and planting materials such as shrubs, grasses, and flowers. An overflow conveyance system is included for bypass of larger storms. These types of practices typically capture runoff from downspouts, roof drains, pipes, swales, or curb openings. The captured runoff temporarily ponds and slowly filters into the soil over 24 to 48 hours.

- **Infiltration Berms** – A mound of earth composed of soil and stone that is placed along the contour of a relatively gentle slope. This practice may be constructed by excavating upslope material to create a depression and storage area above a berm or earth dike. Stormwater runoff flowing downslope to the depressed area filters through the berm in order to maintain sheetflow. Infiltration berms should be used in conjunction with practices that require sheetflow (e.g., sheetflow to buffers) or in a series on steeper slopes to prevent flow concentration.
- **Disconnection of Rooftop Runoff** – Involves directing flow from downspouts onto vegetated areas where it can soak into or filter over the ground. This disconnects the rooftop from the storm drain system and reduces both runoff volume and pollutants delivered to receiving waters. To function well, rooftop disconnection is dependent on several site conditions (e.g., flow path length, soils, slopes).
- **Disconnection of Non-Rooftop Runoff** – Involves directing flow from impervious surfaces onto vegetated areas where it can soak into or filter over the ground. This disconnects these surfaces from the storm drain system, reducing both runoff volume and pollutants delivered to receiving waters. Non-rooftop disconnection is commonly applied to smaller or narrower impervious areas like driveways, open section roads, and small parking lots and is dependent on several site conditions (e.g., permeable flow path length, soils, slopes, compaction) to function well.
- **Sheetflow to Conservation Areas** – Stormwater runoff is effectively treated when flow from developed land is directed to adjacent natural areas where it can soak into or filter over the ground. To function well, this practice is dependent on several site conditions (e.g., buffer size, contributing flow path length, slopes, compaction).
- **Stream Restoration** - Stream restoration is a set of techniques and methods that restores the natural hydrology and landscape of a stream by engineering the stream to reduce stream bank erosion, reconnecting the stream bed to the floodplain, minimizing down-cutting of stream bed, and restoring the aquatic ecosystems.

In addition to the structural BMPs listed above, the County also implements non-structural management measures that are conducted throughout a given year and repeated annually, including:

- **Inlet Cleaning** - Storm drain cleanout practice ranks among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with their NPDES stormwater permits. Sediment reduction credit is based on the mass of material collected (MDE, 2014b).
- **Street sweeping** - This practice uses mechanical or vacuum-assisted sweeper trucks to remove the buildup of pollutants that have been deposited along streets or curbs. The amount of nutrient and sediment reduction associated with this program is dependent on the stream sweeping technology and the frequency of sweeping.

5 Expected Load Reductions

5.1 2009 Baseline Load

SW-WLAs in the sediment TMDL were developed using the Chesapeake Bay Program Watershed Model Phase 5.3.2 (CBP WM P5.3.2) watershed model. Currently, CAST is using a computational framework that is compatible with an updated version of the model: CBP WM P6. Because the TMDL was developed under an older version of the model, the TMDL WLA needed to be translated into a CAST-compatible target load. In order to do this, the 2009 baseline sediment load was re-calculated in CAST by modeling MDE 2009 Progress BMPs in the Lower and Middle Patuxent River Watershed on top of baseline impervious and pervious Anne Arundel County Phase I MS4 acres. To derive the stream loads allocated to the County's urban stormwater sector, the stream bed and bank loads calculated by CAST for each TMDL watershed (which included land from multiple MS4 Counties) were pro-rated according to the ratio of Anne Arundel County MS4 area to total area in the watershed, and then these calculated stream bed and bank loads were assigned to the County's urban stormwater sector. The required reduction percent assigned to the Anne Arundel County Phase I MS4 source from the TMDL document was then applied to the new baseline load to calculate the required sediment reduction expressed as a load. The required sediment reduction load was then subtracted from the new baseline load to calculate the target TMDL SW-WLA. The sediment load requirements for the Lower Patuxent and Middle Patuxent are shown in Table 5-1 and Table 5-2, respectively.

Table 5-1: Anne Arundel County Sediment SW-WLA Reduction Required for the Lower Patuxent Watershed

2009 Baseline Load (lbs/yr)	Required Reduction (%)	Required Reductions (lbs/yr)	TMDL SW-WLA (lbs/yr)
801,324	61%	488,808	312,516

Table 5-2: Anne Arundel County Sediment SW-WLA Reduction Required for the Middle Patuxent Watershed

2009 Baseline Load (lbs/yr)	Required Reduction (%)	Required Reductions (lbs/yr)	TMDL SW-WLA (lbs/yr)
5,814,345	56%	3,256,033	2,558,312

5.2 2018 Progress Load (Current Implementation)

Implemented BMPs are reported to EPA through the National Environmental Information Exchange Network (NEIEN) before being transferred into the CAST dataset. The BMPs in CAST through the year 2009 were used to calculate the baseline conditions. From there, additional source reduction practices implemented after 2009 were incorporated into the calculations to determine the current (2018) loads (i.e., the 2018 Progress Load). For the Lower Patuxent, only street sweeping was performed (Table 5-3).

For the Middle Patuxent watershed, inlet cleaning, stream sweeping, and stream restoration were completed during this time period (Table 5-4). Urban BMPs constructed as part of development or re-development after 2009 were not included in the 2018 Progress scenario because they were required to be implemented to offset the increase in impervious area caused by development or re-development, and therefore should not be counted for additional sediment load reduction credit for the TMDL.

The current BMPs account for only a small percentage of the total sediment load reduction required by the County's TMDL SW-WLA. As shown in Table 5-5, The Lower Patuxent has currently achieved a sediment reduction of 0.002% compared to its 61% target. The Middle Patuxent has currently achieved a 6% sediment reduction compared to its target of 56% (Table 5-6).

Table 5-3: Current BMP Implementation through 2018 for Lower Patuxent

Load Source		EOS Sediment Load (lbs)
CAST Baseline Loads	MS4 Buildings and Other	119,119
	MS4 Roads	34,814
	MS4 Tree Canopy over Impervious	95,653
	MS4 Tree Canopy over Turf Grass	25,795
	MS4 Turf Grass	248,011
	Stream Bed and Bank	277,933
2009 Baseline Load		**801,324**
Current Source Reductions	Inlet Cleaning	-
	Street Sweeping	18
	Stream Restoration	-
2018 Progress Load		**801,306**

Table 5-4: Current BMP Implementation through 2018 for Middle Patuxent

Load Source		EOS Sediment Load (lbs)
CAST Baseline Loads	MS4 Buildings and Other	829,605
	MS4 Roads	195,250
	MS4 Tree Canopy over Impervious	535,910
	MS4 Tree Canopy over Turf Grass	136,423
	MS4 Turf Grass	1,743,263
	Stream Bed and Bank	2,373,894
2009 Baseline Load		**5,814,345**
Current Source Reductions	Inlet Cleaning	236
	Street Sweeping	1,787
	Stream Restoration (1,468 ft.)	364,069
2018 Progress Load		**5,448,253**

Table 5-5: 2018 Progress Reductions Achieved in the Lower Patuxent

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	801,324
2018 Progress Load (lbs)	801,306
Percent Reduction	0.002%
Target TMDL WLA Reduction	61%

Table 5-6: 2018 Progress Reductions Achieved in the Middle Patuxent

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	5,814,345
2018 Progress Load (lbs)	5,448,253
Percent Reduction	6.3%
Target TMDL WLA Reduction	56%

5.3 Planned Implementation

As shown in the previous section, Anne Arundel County must achieve further load reductions to meet its TMDL requirements in these watersheds. The Lower and Middle Patuxent watersheds are located within a more rural portion of Anne Arundel County. A vast majority of the land cover in these two watersheds is either forested or used for agriculture, as previously described in Section 2. Less than 5% of each of the watersheds consist of impervious surfaces, which leaves little opportunity to achieve additional sediment load reductions from managing stormwater runoff from impervious surfaces. Nonetheless, retrofits of existing dry ponds and impervious surfaces are included in this Restoration Plan in both the Lower and Middle Patuxent watersheds. Existing dry ponds in these watersheds will be further evaluated for potential to retrofit into wet ponds or wetlands. This includes three (3) dry ponds in the Middle Patuxent River Watershed and one (1) dry pond in the Lower Patuxent River Watershed. Additionally, the County will evaluate the potential to retrofit available County-owned impervious area associated with buildings and parking lots, as shown in Table 2-4 and Table 2-11 in Section 2. This includes 1.3 and 3.6 acres of impervious area retrofits in the Lower and Middle Patuxent River watersheds, respectively.

The dry pond and impervious area retrofits alone will not be enough to meet the entire required sediment reduction. Stream restoration projects will be evaluated to fill in the gap between the target load and what is achievable with current loads and planned retrofits. To meet the target TMDL SW-WLA reduction, 1,957 feet of stream restoration will be needed in the Lower Patuxent (Table 5-7) and 11,395 feet of stream restoration will be needed in the Middle Patuxent (Table 5-8) to reach the sediment reduction targets.

Inlet cleaning and street sweeping practices are recommended to continue at the current rates.

Table 5-7: Planned BMP Implementation through 2030 for Lower Patuxent

	Load Source	Amount	Unit	EOS Sediment Load (lbs)
Baseline (2009) Load Total				**801,324**
Current (2018) Load Total				**801,306**
Planned Source Reductions	"Plain Old Pond" Retrofits	3.3	acres	2,340
	Impervious Retrofits	1.3	acres	1,154
	Stream Restoration	1,957	feet	485,336
2030 Planned Load (=2018 Progress Load – sum of planned source reductions)				**312,476**
Total Sediment Reduction	Percent Reduction Achieved	61%		
	Target TMDL WLA Reduction	61%		
	Remaining Reduction Required	0%		

Table 5-8: Planned BMP Implementation through 2030 for Middle Patuxent

	Load Source	Amount	Unit	EOS Sediment Load (lbs)
2009 Baseline Load				**5,814,345**
2018 Progress Load				**5,448,253**
Planned Source Reductions	"Plain Old Pond" Retrofits	153	acres	58,692
	Impervious Retrofits	3.6	acres	5,454
	Stream Restoration	11,395	feet	2,825,958
2030 Planned Load (=2018 Progress Load – sum of planned source reductions)				**2,558,149**
Total Sediment Reduction	Percent Reduction Achieved	56%		
	Target TMDL WLA Reduction	56%		
	Remaining Reduction Required	0%		

Feasibility studies of the planned strategies may reveal that some existing structures identified for retrofitting or enhancement may not be feasible candidates for future projects and may be eliminated from consideration. 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. In addition, new technologies are continuously evaluated to determine if the new technologies allow more efficient or effective pollution control.

Section 8 describes the implementation schedule and milestones, Section 9 discusses how progress will be measured, and Section 10 describes the ongoing monitoring efforts that will help evaluate the effectiveness of the implementation on improving water quality.

6 Technical and Financial Assistance Needs

6.1 Technical Needs

Technical assistance to meet the reductions and goals of a TMDL takes on many forms, including MDE assistance to local governments, state and local partner assistance to both MDE and municipalities, and technical consultants contracted to provide support across a wide variety of service areas related to BMP planning and implementation. MDE has provided technical assistance to local governments (and will continue to do so in the future) through training, outreach and tools, providing recommendations on ordinance improvements, technical review and assistance for implementation of BMPs at the local level, and identification of potential financial resources for implementation (MDE, 2014b).

Anne Arundel County DPW contracts with consultants through several contract vehicles, including open-end task-based assignments and full delivery contracts, to provide a variety of technical services. These services, provided by planners, engineers, environmental scientists and geographic information system (GIS) specialists, include watershed assessment and management, stream monitoring, stormwater planning and design, stream restoration design, outfall enhancement, and environmental permitting, among others. The County itself has complementary staff in DPW and other County departments to manage contracts, provide review and approval of planning and design work, conduct assessments, and develop and administer planning and progress tracking tools.

Anne Arundel County has many partners that provide outreach to homeowners and communities in the form of technical assistance, education, and funding for implementation of BMPs within local communities. The Watershed Stewards Academy, further discussed in Section 7, routinely engages and informs the public on reducing pollution sources and employing stormwater/rainscaping retrofits to reduce stormwater impacts.

Technical assistance for public participation and education and for monitoring will also be necessary to fully implement and track progress towards meeting the goals of the local TMDL. These elements are discussed in Sections 7 and 10 of this plan.

6.2 Financial Needs

The total projected cost to implement the County's CIP projects described in this plan for the Lower and Middle Patuxent River watersheds is approximately $1.9M and $12.4M respectively. Table 6-1 and Table 6-2 include a summary of funding needs per BMP type. Project costs are inclusive of all project elements and include design, obtaining land right of way (ROW), construction, and County overhead and administrative costs. The costs are presented based on restoration planning periods out to FY2030. The total cost of the suite of BMPs necessary to meet the TMDL was calculated and then divided proportionally across the milestone periods (Table 6-3).

Table 6-1: Lower Patuxent River Watershed Planned Projects Cost Estimate[1]

Load Source	Amount	Unit	Cost/Unit	Total Cost
"Plain Old Pond" Retrofits	3	acres	$100,000	$330,000
Impervious Retrofits	1	acres	$150,000	$193,332
Stream Restoration	1,957	feet	$923	$1,806,311
Inlet Cleaning[2]	-	lbs removed	$51	$ -
Street sweeping[2]	218	lbs removed	$4	$920
			Total	**$2,330,564**

1. Numbers shown in this table have been rounded.
2. Inlet cleaning and street sweeping are annual activities. The numbers shown here represent the amount and total cost for the period of 2019 through 2030.

Table 6-2: Middle Patuxent River Watershed Planned Projects Cost Estimate[1]

Load Source	Amount	Unit	Cost/Unit	Total Cost
Plain Old Pond Retrofits	153	acres	$100,000	$15,326,919
Impervious Retrofits	4	acres	$150,000	$537,000
Stream Restoration	11,395	feet	$923	$10,517,585
Inlet Cleaning[2]	2,833	lbs removed	$51	$144,050
Street sweeping[2]	21,445	lbs removed	$4	$90,417
Total				**$26,615,971**

1. Numbers shown in this table have been rounded.
2. Inlet cleaning and street sweeping are annual activities. The numbers shown here represent the amount and total cost for the period of 2019 through 2030.

Table 6-3: Planned Projects Cost Estimate Through 2030

Watershed	2021	2023	2025	2027	2029	2030	Total
Lower Patuxent	$582,641	$388,427	$388,427	$388,427	$388,427	$194,214	$2,330,564
Middle Patuxent	$6,653,993	$4,435,995	$4,435,995	$4,435,995	$4,435,995	$2,217,998	$26,615,971

Several sources were used to calculate the cost estimates for each BMP type. Implementation cost of completed projects in the County's geodatabase were used to calculate average cost of stream restoration, plain old pond retrofits, impervious retrofits, inlet cleaning, and street sweeping. King and Hagan (2011) was also consulted for reference.

Non-structural BMP costs for inlet cleaning and street sweeping are based on implementation cost records in the County's geodatabase. Operating costs do not include the purchase and maintenance of street sweeping equipment. Costs for street sweeping and inlet cleaning are included because these activities must continue into the future as part of the planned management measures. The annual costs for these were aggregated over the 18-year (2019-20030) planning period.

6.3 Funding Sources

A major source of funding for the implementation of local stormwater management plans through stormwater management practices and stream and wetland restoration activities is the County's Watershed Protection and Restoration Fee. To comply with forthcoming requirements of the Phase I NPDES MS4 permit, and to support restoration efforts towards reducing pollutant loads required for both the Chesapeake Bay TMDL and local TMDLs throughout Maryland, the State Legislature passed a law in 2012 (House Bill 987) mandating that Maryland's 10 largest jurisdictions (those with Phase I MS4 permits), including Anne Arundel County, develop a Watershed Protection and Restoration Program and establish a Stormwater Remediation Fee. To comply with the State legislation, Anne Arundel County passed legislation in 2013, Bill 2-13.

In 2015, the Maryland Legislature passed Senate Bill 863 (Watershed Protection and Restoration Programs – Revisions) which repealed House Bill 987. Senate Bill 863 removed the *requirement* that jurisdictions adopt the Stormwater Remediation Fee but did still allow for the jurisdictions to adopt and collect the fee. As a replacement of the stormwater remediation fee requirement, jurisdictions are now to develop financial assurance plans, due initially on July 1, 2016, and subsequently every two years, that describe how stormwater runoff will be treated and paid for over the next five years to meet TMDL and impervious surface treatment requirements. Anne Arundel County's initial financial assurance plan was adopted by County Council on July 5, 2016. The most recent update to the County's financial assurance plan will be submitted with their annual NPDES report in February 2019.

The County's Stormwater Remediation Fee, which is termed the 'Watershed Protection and Restoration Fee' (WPRF) is assessed to Anne Arundel County property owners based on the type of property and the amount of impervious surface on their property and is included as a separate line item on the owner's real property tax bill. The fee is structured to provide sufficient funding for projects to meet the pollutant load reduction required by the Chesapeake Bay TMDL and EPA approved individual TMDLs with a SW-WLA, and to meet the impervious surface management requirements, as well as other stormwater obligations set forth in the County's NPDES MS4 Permit. More information on the rate structure can be found at https://www.aacounty.org/departments/public-works/wprp/wprf-rate-information/index.html along with information on the WPRF Credit Program and Appeal Program.

Prior to adoption of the Watershed Protection and Restoration Fee and, as stated in the Anne Arundel County Phase II WIP (Anne Arundel County, 2012), the County's funding capacity to implement urban stormwater restoration/retrofit projects was limited by the County's CIP budget for environmental restoration and water quality improvement projects.

To supplement the WPRF, Anne Arundel County actively pursues grant funding from Federal, State and non-governmental organizations (NGOs) to leverage funding for its restoration projects. The County has also developed a Grant Program to provide funding to local NGOs to facilitate implementation of restoration projects that further the County's ability to meet its regulatory requirements. Anne Arundel County, along with the Chesapeake Bay Trust, fund and administer a County-specific set of grants for restoration practices. They include funding in three categories: Community Planting, Forestry and Forested Land Protection, and Watershed Restoration.

7 Public Participation / Education

7.1 County Outreach Efforts

Anne Arundel County gave numerous public presentations throughout the development of the County's Phase II WIP in order to disseminate information on the Chesapeake Bay TMDL, WIP process, and strategies for meeting the County's assigned pollutant load reductions. In addition to providing a level of understanding to the public, the County uses the presentations as an opportunity to receive input and comment on restoration efforts. Anne Arundel County has a variety of organizations interested in water quality, including Anne Arundel County Commercial Owners; Anne Arundel Watershed Stewards Academy (AAWSA); Anne Arundel County Chamber of Commerce, Environmental Committee; Leadership Anne Arundel; and Chesapeake Environmental Protection Association (Anne Arundel County, 2012).

More recently, the County held two public meetings associated with the development of the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018). The first public meeting was held prior to initiation of fieldwork on September 27, 2016 and presented the goals and methods of the study. The second meeting was held on April 24, 2018 and included presentations of the results of the completed study element. Both meetings solicited feedback from the public. Questions and answer sessions followed each of the presentations. The County solicited public review and comment of the draft watershed assessment report through the April 24, 2018 public meeting and a 30-day public review period, which ran from May 26 through June 26, 2018. The documents are available on the County's website[5].

In order to implement an effective strategy to meet water quality standards and achieve pollutant load reduction, an effort to engage a very broad audience of landowners was a necessity. AAWSA, a non-profit (501(c)(3) environmental organization, was formed through Anne Arundel County Department of Public Works and the County Board of Education's Arlington Echo Outdoor Education Center (Anne Arundel County, 2012). AAWSA's mission is to identify, train, and support citizens to become Master Watershed Stewards who take action with their neighbors to restore local waterways in Anne Arundel County. This program is a unique way to integrate education as a vital element in the AAWSA's role in preservation, conservation and advocacy. There are currently more than 220 certified Master Watershed Stewards representing over 100 communities throughout Anne Arundel County. In 2019 AAWSA installed 964,538 square feet of new-in-the ground projects, provided outreach to 31, 688 County residents, and planted 7,463 native plants and trees.

The AAWSA has extensive resources through the Consortium of Support Professionals, which is composed of over 80 governmental, non-profit and business professionals who provide technical assistance to Master Watershed Stewards. Consortium members are experts in their field of conservation, ecology, government laws, landscape architecture, low impact design, water quality

[5] https://www.aacounty.org/departments/public-works/wprp/watershed-assessment-and-planning/watershed-studies/index.html

monitoring, and watershed assessment, and provide consulting on design and development of watershed restoration projects. The AAWSA is also supported by staff that provides day-to-day guidance to Master Watershed Stewards, connecting Stewards to Anne Arundel County resources, coordinating Stewards certification, post certification professional development, and networking opportunities for Stewards and Consortium of Support Professionals.

The AAWSA has an interactive website (www.aawsa.org) that provides guidance to common water quality problems including information on the following:

- Reduce Your Pollution
    - Practice Bay-Friendly Lawn Care
    - Maintain and Upgrade your Septic System
    - Pick Up Pet Waste
    - Choose Non-Toxic Household Products
    - Maintain your Car and Boat
    - Reduce your Energy Use
- Capture Stormwater
    - Install a Rain Barrel or Cistern
    - Build a Rain Garden
    - Choose to Have Conservation Landscapes
    - Plant Native Trees
    - Direct Water with Swales and Berms
    - Use Permeable Pavers and Pavement
- Clean Up!
    - Invasive Species Removal
    - Dump Site Cleanup
- Conserve and Preserve
    - Land Preservation

These programs and others like them could be more focused on the Non Tidal Lower and Middle Patuxent watersheds.

In addition to the AAWSA, the following organizations have been identified for possible partnerships and education and outreach for the Non Tidal Lower and Middle Patuxent:

- Master Gardeners
- Audubon Society
- Students for the Environment
- Maryland civic associations and service clubs:
    - Maryland Home Builders Assoc.
    - Audubon Naturalist Society of the Central Atlantic States

- Audubon Society of Central Maryland
- Blue Water Baltimore
- Chesapeake Audubon Society
- Chesapeake Bay Program
- Chesapeake Bay Foundation
- Chesapeake Bay Trust
- Chesapeake Ecology Center
- Center for Watershed Protection
- Alliance for the Chesapeake Bay
- Alliance for Sustainable Communities
- Baywise Master Gardeners
- Sierra Club – Maryland Chapter
- Magothy River Association
- Patuxent Riverkeeper
- West/Rhode Riverkeeper
- Nature Conservancy
- Smithsonian Environmental Research Center
- Anne Arundel Community College
- University of Maryland
- University of Maryland Extension
- Volunteer Center for Anne Arundel County

Eligible private property owners in Anne Arundel County also have the opportunity to reduce their stormwater fees by up to 50% for proactive and sustainable uses of stormwater runoff controls. The WPRP Credit Program Policy and Guidance document for Anne Arundel County provides the Department of Public Works the framework and procedures needed to administer the program.

In addition, the WPRP established the WPRF Stormwater Remediation Fee Credit Agreement to provide credit to single-family property owners that have installed small-scale (e.g., under 5,000 sq.ft. land disturbance) stormwater BMP's on their property. Further information and applications for these credit programs is available on the WPRP webpage.

WPRP has developed a comprehensive web-based informational program including a dedicated webpage, Facebook page and Twitter account to provide information to the public. The webpage, www.aarivers.org, offers valuable information on Anne Arundel County watersheds, including an interactive clickable map that displays geographically referenced environmental, utility and land use data in addition to restoration project locations, descriptions, and drainage areas. This outreach platform is also used to notify the public of the opportunity to review and comment on this and other TMDL restoration plans.

7.2 Public Comment Period

Part 4.E.3 of the County's NPDES MS4 permit outlines requirements for public involvement in the development of TMDL restoration plans. The County fulfills these requirements by providing notice in *The Capital* and *Maryland Gazette* newspapers, which serve all of Anne Arundel County, detailing how the public may obtain information on the plan and provide comments. The County makes the reports available for review on the WPRP website at www.aarivers.org and makes copies of the restoration plans available at the County office to parties upon request. The County will provide for a minimum 30-day comment period following submittal of the draft Plan to MDE and will incorporate public comments into the final version of the Plan. The final document will include documentation of the public review period notices and the public comments and responses.

8 Implementation Schedule and Milestones

This section presents the interim milestones, target loads, and activities required to achieve load reduction targets based on a planning horizon of 2030 for achieving the target load reductions. Two-year milestones for 2021, 2023, 2025, 2027, and 2029 are proposed as interim milestones to assess progress towards this target.

8.1 Loading Allocations and Milestone Targets

Progress loads for 2018 and final load requirements for 2030 in the Lower Patuxent and Middle Patuxent are shown in Table 8-2 and Table 8-1, respectively. As discussed in Section 5, some progress has already been made towards reaching the target TMDL WLA. However, large load differences remain between current progress and the 2030 allocated load. Significant load reduction efforts are still needed to achieve the final goal.

Table 8-1: Lower Patuxent Planning and Target Loads

Load	Sediment Load (lbs/yr)
2009 Baseline Load	801,324
2018 Progress Load	801,306
2030 TMDL Allocated Load	312,516
Percent Reduction between 2009 Baseline and 2030 Loads	61%

Table 8-2: Middle Patuxent Planning and Target Loads

Load	Sediment Load (lbs/yr)
2009 Baseline Load	5,814,345
2018 Progress Load	5,448,253
2030 TMDL Allocated Load	2,558,312
Percent Reduction between 2009 Baseline and 2030 Loads	56%

8.2 Implementation Milestones

To meet the final SW-WLAs and the interim milestones, implementation of programs and BMPs must keep pace and meet planned implementation targets. Table 8-3 and Table 8-4 outline the progress necessary to stay on track with the sediment reduction goals in Lower Patuxent and Middle Patuxent watershed respectively. Note that the large load reduction in 2027 reflects the County's current CIP project implementation plan and Financial Assurance Plan (FAP). The load reductions detailed are not BMP specific and may result from any of the dry pond retrofits, impervious retrofits, or stream

restoration projects planned. Beginning in 2021, the County will have milestones every two years until the Restoration Plan is complete in 2030.

Feasibility studies of the planned strategies may reveal that some existing structures identified for retrofitting or enhancement may not be feasible candidates for future projects and may be eliminated from consideration. 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 a suite of solutions based on those results. In addition, new technologies are continuously evaluated to determine if the they allow more efficient or effective pollution control.

Table 8-3: Planned Progress from 2019 to 2030 for the Lower Patuxent

Progress Year	Period Load Reduction (lbs)	Period End Load (lbs)	Total Percent Reduction from 2009 Baseline Load
2021	81,472	719,834	10%
2023	81,472	638,362	20%
2025	81,472	556,891	31%
2027	122,207	434,683	46%
2029	81,472	353,212	56%
2030	40,736	312,476	61%

Table 8-4: Planned Progress from 2019 to 2030 for the Middle Patuxent

Progress Year	Period Load Reduction (lbs)	Period End Load (lbs)	Total Percent Reduction from 2009 Baseline Load
2021	481,684	4,966,569	14.58%
2023	481,684	4,484,885	22.87%
2025	481,684	4,003,201	31.15%
2027	722,526	3,280,675	43.58%
2029	481,684	2,798,991	51.86%
2030	240,842	2,558,149	56.00%

8.3 Implementation Priorities

To meet the load reduction milestones outlined in the previous sections, implementation will be planned based on prioritization analyses presented in the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018). Subwatersheds in the Lower and Middle Patuxent River watersheds were prioritized for restoration/retrofit project selection potential using three separate prioritization models. The models integrated historical environmental data, current stream assessment monitoring data, drainage area characteristics, and watershed modeling results into indicators of watershed condition and need. The indicators are combined into the three models:

- Stream Reach Restoration
- Subwatershed Restoration
- Subwatershed Preservation

The models were designed to operate at three management scales: the individual stream reach scale; the parcel scale; and the subwatershed scale. Additionally, the models differentiated between identification of restoration opportunities for the degraded portions of the watershed (reach and subwatershed scale), and identification of preservation opportunities for high quality sensitive areas that could be subject to additional stressors in future scenarios (subwatershed and parcel scale). For the purpose of this Restoration Plan, prioritization results for stream reach restoration and subwatershed restoration are presented below to address in-stream sources and urban stormwater runoff, respectively.

8.3.1 Stream Reach Restoration

The stream restoration prioritization uses a suite of indicators that are weighted and then combined into a final relative rating for each perennial reach as identified in the Physical Habitat Condition Assessment in the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018). The suite of stream restoration indicators were grouped into five categories, including indicators to rate stream habitat, stream morphology, land cover, infrastructure, and hydrology and hydraulics.

In the Middle Patuxent watershed, 402 perennial reaches were assessed using these indicators. Of these, a total of 27 reaches were rated as “High” priority for restoration, 111 reaches were rated as “Medium High,” 188 reaches were rated as “Medium,” and 76 were rated as “Low.”

In the Lower Patuxent watershed, 60 perennial reaches were assessed. Of these, one reach was rated as “High” priority for restoration, 29 reaches were rated as “Medium High,” 20 reaches were rated as “Medium,” and 10 were rated as “Low.”

A map of the stream reach prioritization was included in the *Middle and Lower Patuxent Watershed Assessment Report*, and is included at the end of Section 8 in this report as Figure 8-1.

8.3.2 Subwatershed Restoration

Similar to the stream restoration assessment, the subwatershed assessment in the *Middle and Lower Patuxent Watershed Assessment Report* used a collection of restoration indicators that were weighted and combined to assign a single rating to each subwatershed. Restoration indicators fell into one of six categories: stream ecology; TMDL impairments; On-site Disposal Systems (OSDS); BMPs; Hydrologic and Hydraulic (H&H) Modeling; Water Quality; and Landscape.

In the Middle Patuxent watershed, only four of the 33 subwatersheds were rated as a “High” priority for restoration. Ten subwatersheds were assessed to be “Medium High” on the prioritization scale for restoration needs, while 12 subwatersheds were assessed to be “Medium” priority. Finally, seven subwatersheds were assessed to be “Low” priorities.

In the Middle Patuxent watershed, two of the three subwatersheds were rated as a “High” priority for restoration and one was rated as “Medium High.”

A map of the subwatershed restoration prioritization was included in the *Middle and Lower Patuxent Watershed Assessment Report*, and is included at the end of Section 8 in this report as Figure 8-2. Table 8-5 and Table 8-6 below show the prioritization of subwatersheds in a tabular format.

Table 8-5: Subwatershed Priority for Restoration

Subwatershed Code	Subwatershed Name	Priority for Restoration
MP7	Galloway Creek	High
MPE	Wilson Owens Branch 2	High
MPL	Lyons Creek 7	High
MPM	Lyons Creek 8	High
MPX	Hall Creek 2	High
MPY	Hall Creek 3	High
MP0	Deep Creek	Medium High
MP6	Lyons Creek 10	Medium High
MP8	Cabin Branch 1	Medium High
MPC	Hall Creek 1	Medium High
MPD	Wilson Owens Branch 1	Medium High
MPI	Lyons Creek 4	Medium High
MPK	Lyons Creek 6	Medium High
MPP	Ferry Branch 3	Medium High
MPS	Cabin Branch 4	Medium High
MPT	Cabin Branch 5	Medium High
MPV	Rock Branch 3	Medium High
MP3	Rock Branch 2	Medium
MP5	Wilson Owens Branch 3	Medium
MPB	House Creek	Medium
MPF	Lyons Creek 1	Medium
MPG	Lyons Creek 2	Medium
MPH	Lyons Creek 3	Medium
MPJ	Lyons Creek 5	Medium
MPN	Lyons Creek 9	Medium
MPO	Ferry Branch 2	Medium
MPQ	Cabin Branch 2	Medium
MPR	Cabin Branch 3	Medium
MPU	Unnamed Tributary	Medium
MP1	Unnamed Tributary	Low
MP2	Rock Branch 1	Low
MP4	Ferry Branch 1	Low
MP9	Two Run Branch 2	Low
MPA	Pindell Branch	Low
MPW	Two Run Branch 1	Low
MPZ	Wilson Owens Branch 4	Low

Table 8-6: Subwatershed Restoration Assessment Results

Rating	Number of Subwatersheds	Percent of Subwatersheds
High	6	17%
Medium High	11	31%
Medium	12	33%
Low	7	19%
Total	36	100%

8.3.3 Subwatershed Preservation

The subwatershed preservation assessment in the *Middle and Lower Patuxent Watershed Assessment Report* used a collection of preservation indicators that were weighted and combined into a single rating for each subwatershed for consideration for preservation activities. Restoration indicators fell into one of five categories: stream ecology; future departure of water quality conditions; soils; landscape; and aquatic living resources.

In the Middle Patuxent watershed, 10 subwatersheds were rated to be "High" priority for preservation, eight subwatersheds were rated "Medium High," 10 subwatersheds were rated "Medium," and five were rated "Low" priority for preservation. In the Lower Patuxent watershed, no subwatersheds were rated to be "High" or "Medium High," one subwatershed was rated "Medium," and two were rated "Low" priority for preservation.

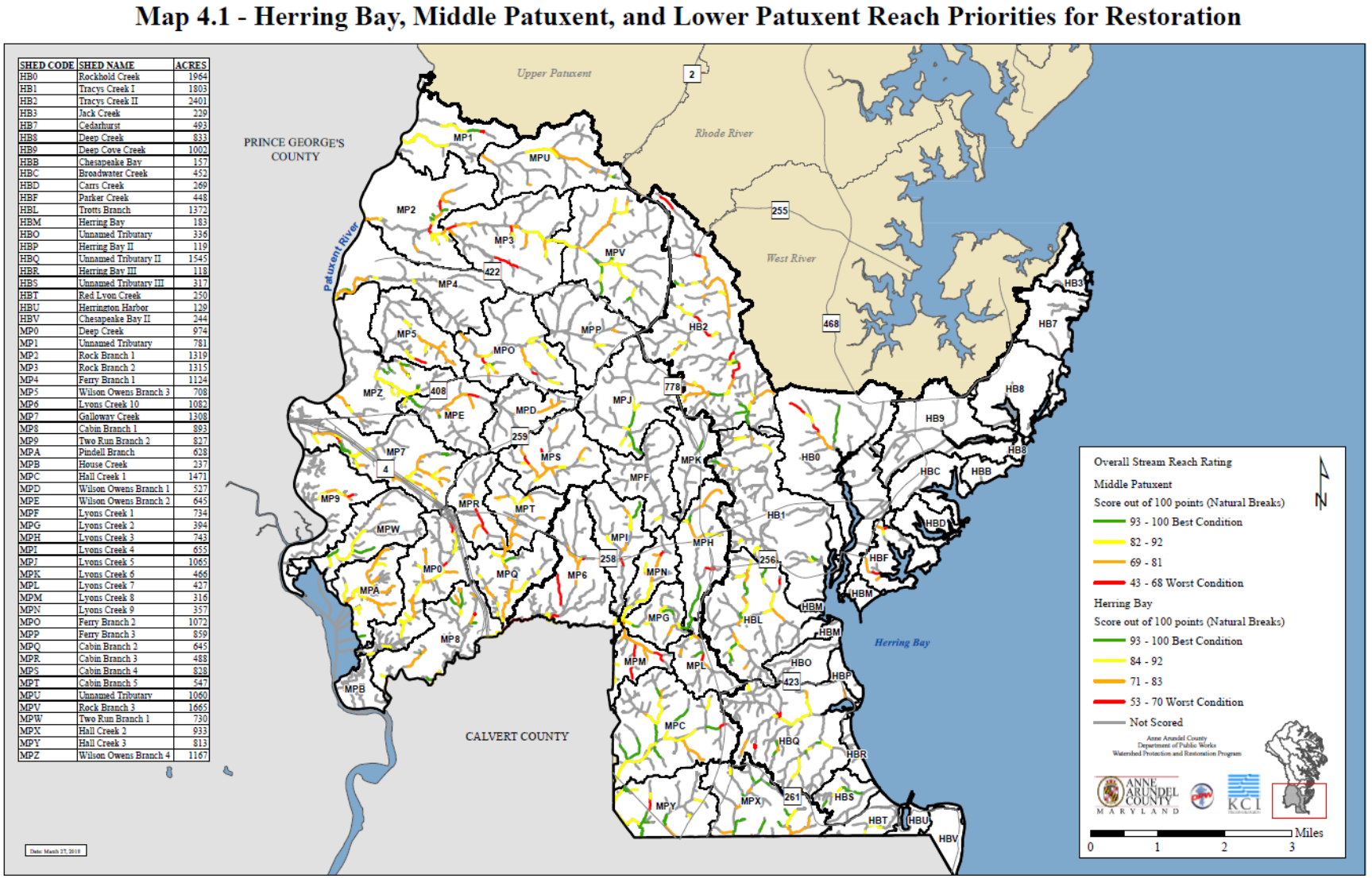
A map of the subwatershed preservation prioritization was included in the *Middle and Lower Patuxent Watershed Assessment Report*, and is included at the end of Section 8 in this report as Figure 8-3.

8.4 Implementation Strategy

Following the adoption of its Stormwater Remediation Fee in 2013, Anne Arundel County developed a six-year Capital Improvement Program (CIP) in FY14 that created a Watershed Protection and Restoration Program (WPRP) class of projects to implement those restoration projects identified in the County's Phase II WIP and applicable individual TMDLs for achieving SW-WLAs. Funding for this class of projects averages $74M annually. Projects in the WPRP class are identified and prioritized through a planning level assessment.

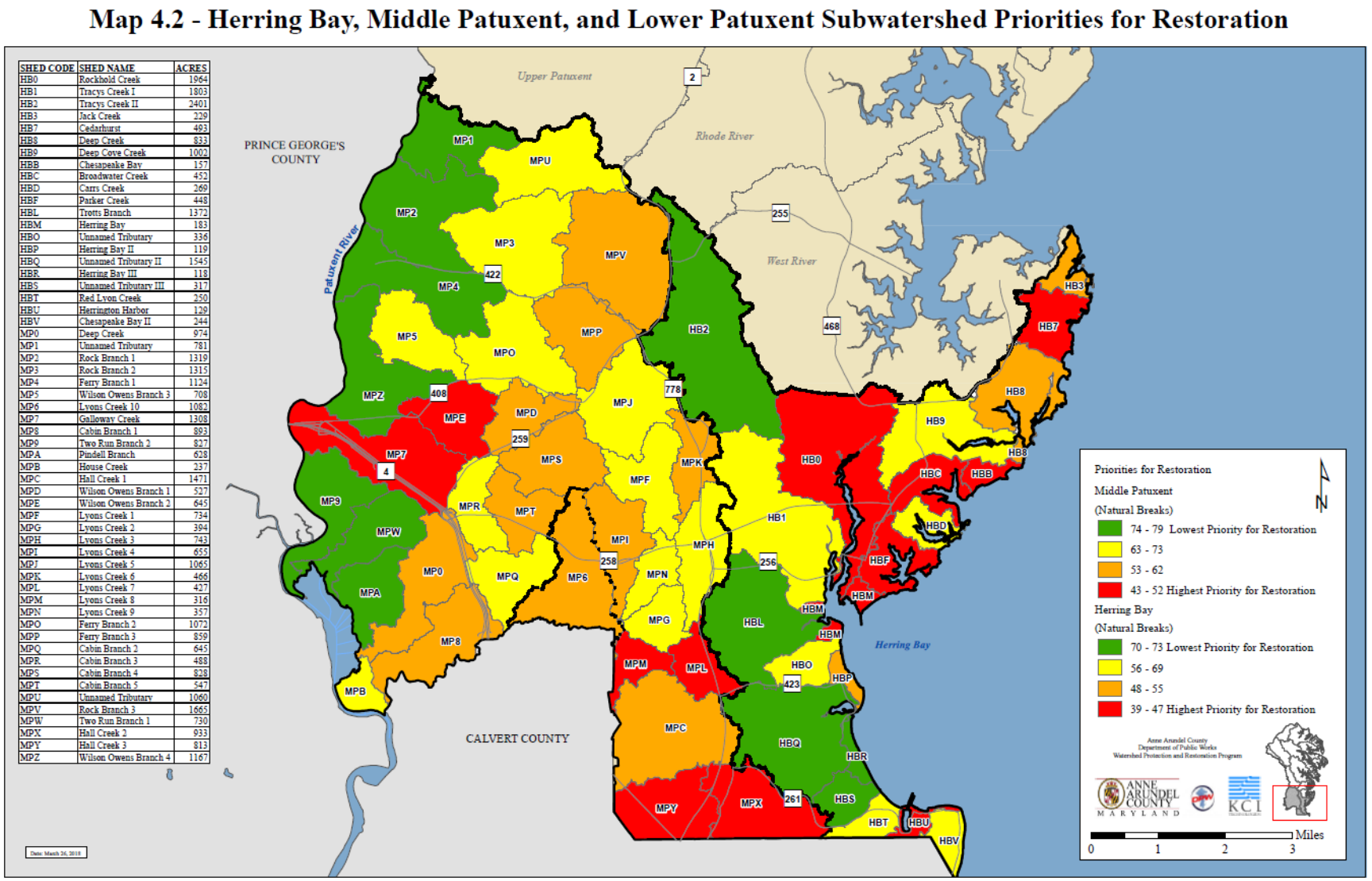
The MS4 permit calls for an iterative and adaptive plan for implementation. As WPRP projects are funded, more detailed feasibility and constructability assessments are conducted. These assessments may result in adaptations and updates to the Restoration Plan if projects previously thought to be feasible are in fact not feasible. The assessment may also result in the identification of additional and/or new opportunities. As these feasibility assessments are completed, the County incorporates these findings into its modeling, re-assesses anticipated load reductions, and adapts it implementation program and CIP accordingly. Additionally, the County will reassess and modify its restoration strategy as BMP technologies and efficiencies change, programs mature, credit trading is enacted, and new regulations are put into place.

Figure 8-1: Stream Reach Priorities for Restoration (Anne Arundel County, 2018)



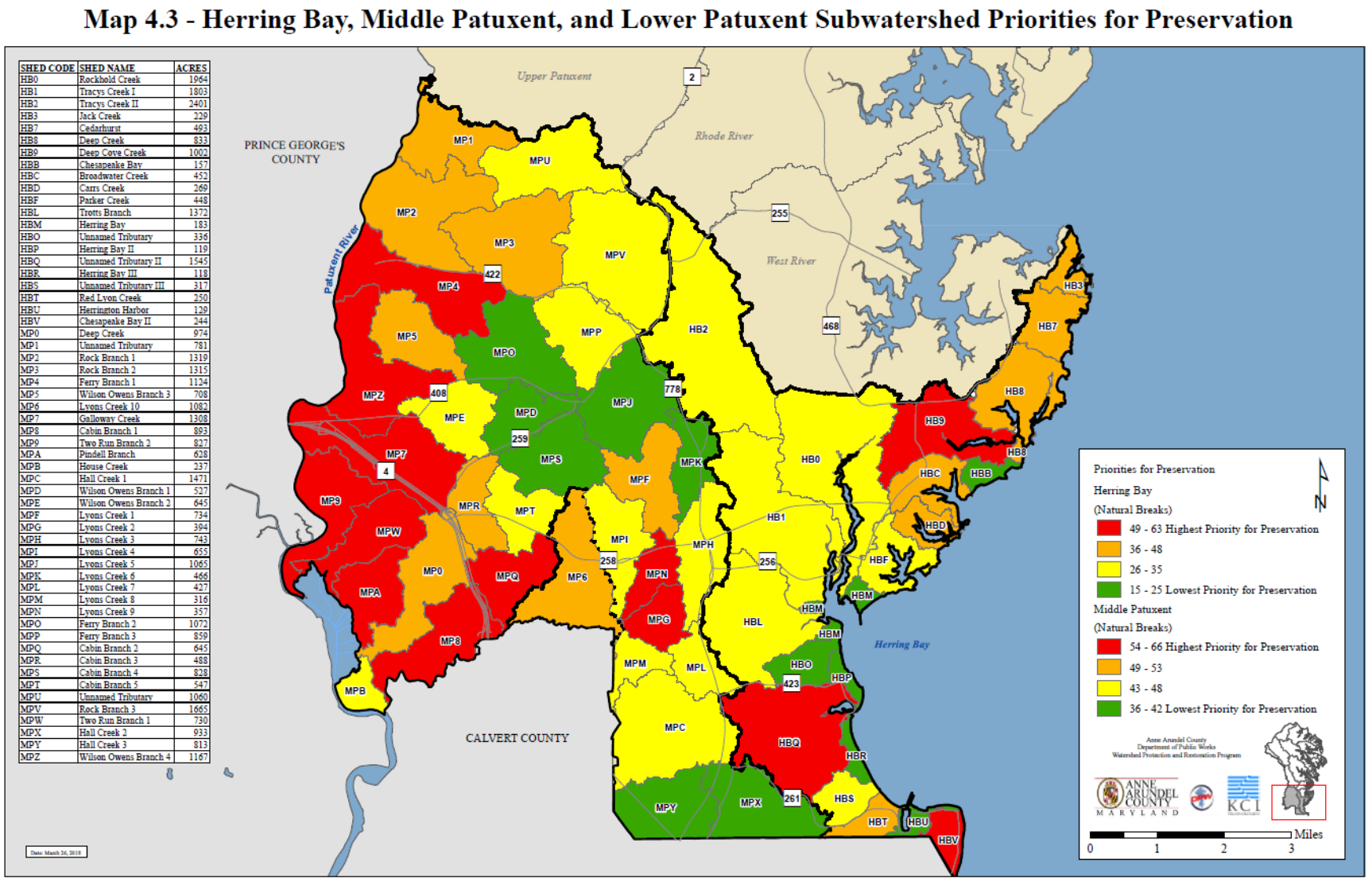
SHED CODE	SHED NAME	ACRES
HB0	Rockhold Creek	1964
HB1	Tracys Creek I	1803
HB2	Tracys Creek II	2401
HB3	Jack Creek	229
HB7	Cedarhurst	493
HB8	Deep Creek	833
HB9	Deep Cove Creek	1002
HBB	Chesapeake Bay	157
HBC	Broadwater Creek	452
HBD	Carrs Creek	269
HBF	Parker Creek	448
HBL	Trotts Branch	1372
HBM	Herring Bay	183
HBO	Unnamed Tributary	336
HBP	Herring Bay II	119
HBQ	Unnamed Tributary II	1545
HBR	Herring Bay III	118
HBS	Unnamed Tributary III	317
HBT	Red Lyon Creek	250
HBU	Herrington Harbor	129
HBV	Chesapeake Bay II	244
MP0	Deep Creek	974
MP1	Unnamed Tributary	781
MP2	Rock Branch 1	1319
MP3	Rock Branch 2	1315
MP4	Ferry Branch 1	1124
MP5	Wilson Owens Branch 3	708
MP6	Lyons Creek 10	1082
MP7	Galloway Creek	1308
MP8	Cabin Branch 1	893
MP9	Two Run Branch 2	827
MPA	Pindell Branch	628
MPB	House Creek	237
MPC	Hall Creek 1	1471
MPD	Wilson Owens Branch 1	527
MPE	Wilson Owens Branch 2	645
MPF	Lyons Creek 1	734
MPG	Lyons Creek 2	394
MPH	Lyons Creek 3	743
MPI	Lyons Creek 4	655
MPJ	Lyons Creek 5	1065
MPK	Lyons Creek 6	466
MPL	Lyons Creek 7	427
MPM	Lyons Creek 8	316
MPN	Lyons Creek 9	357
MPO	Ferry Branch 2	1072
MPP	Ferry Branch 3	859
MPQ	Cabin Branch 2	645
MPR	Cabin Branch 3	488
MPS	Cabin Branch 4	828
MPT	Cabin Branch 5	547
MPU	Unnamed Tributary	1060
MPV	Rock Branch 3	1665
MPW	Two Run Branch 1	730
MPX	Hall Creek 2	933
MPY	Hall Creek 3	813
MPZ	Wilson Owens Branch 4	1167

Figure 8-2: Subwatershed Priorities for Restoration (Anne Arundel County, 2018)



SHED CODE	SHED NAME	ACRES
HB0	Rockhold Creek	1964
HB1	Tracys Creek I	1803
HB2	Tracys Creek II	2401
HB3	Jack Creek	229
HB7	Cedarhurst	493
HB8	Deep Creek	833
HB9	Deep Cove Creek	1002
HBB	Chesapeake Bay	157
HBC	Broadwater Creek	452
HBD	Carrs Creek	269
HBF	Parker Creek	448
HBL	Trotts Branch	1372
HBM	Herring Bay	183
HBO	Unnamed Tributary	336
HBP	Herring Bay II	119
HBQ	Unnamed Tributary II	1545
HBR	Herring Bay III	118
HBS	Unnamed Tributary III	317
HBT	Red Lyon Creek	250
HBU	Herrington Harbor	129
HBV	Chesapeake Bay II	244
MP0	Deep Creek	974
MP1	Unnamed Tributary	781
MP2	Rock Branch 1	1319
MP3	Rock Branch 2	1315
MP4	Ferry Branch 1	1124
MP5	Wilson Owens Branch 3	708
MP6	Lyons Creek 10	1082
MP7	Galloway Creek	1308
MP8	Cabin Branch 1	893
MP9	Two Run Branch 2	827
MPA	Pindell Branch	628
MPB	House Creek	237
MPC	Hall Creek 1	1471
MPD	Wilson Owens Branch 1	527
MPE	Wilson Owens Branch 2	645
MPF	Lyons Creek 1	734
MPG	Lyons Creek 2	394
MPH	Lyons Creek 3	743
MPI	Lyons Creek 4	655
MPJ	Lyons Creek 5	1065
MPK	Lyons Creek 6	466
MPL	Lyons Creek 7	427
MPM	Lyons Creek 8	316
MPN	Lyons Creek 9	357
MPO	Ferry Branch 2	1072
MPP	Ferry Branch 3	859
MPQ	Cabin Branch 2	645
MPR	Cabin Branch 3	488
MPS	Cabin Branch 4	828
MPT	Cabin Branch 5	547
MPU	Unnamed Tributary	1060
MPV	Rock Branch 3	1665
MPW	Two Run Branch 1	730
MPX	Hall Creek 2	933
MPY	Hall Creek 3	813
MPZ	Wilson Owens Branch 4	1167

Figure 8-3: Subwatershed Priorities for Preservation (Anne Arundel County, 2018)



SHED CODE	SHED NAME	ACRES
HB0	Rockhold Creek	1964
HB1	Tracys Creek I	1803
HB2	Tracys Creek II	2401
HB3	Jack Creek	229
HB7	Cedarhurst	493
HB8	Deep Creek	833
HB9	Deep Cove Creek	1002
HBB	Chesapeake Bay	157
HBC	Broadwater Creek	452
HBD	Carrs Creek	269
HBF	Parker Creek	448
HBL	Trotts Branch	1372
HBM	Herring Bay	183
HBO	Unnamed Tributary	336
HBP	Herring Bay II	119
HBQ	Unnamed Tributary II	1545
HBR	Herring Bay III	118
HBS	Unnamed Tributary III	317
HBT	Red Lyon Creek	250
HBU	Herrington Harbor	129
HBV	Chesapeake Bay II	244
MP0	Deep Creek	974
MP1	Unnamed Tributary	781
MP2	Rock Branch 1	1319
MP3	Rock Branch 2	1315
MP4	Ferry Branch 1	1124
MP5	Wilson Owens Branch 3	708
MP6	Lyons Creek 10	1082
MP7	Galloway Creek	1308
MP8	Cabin Branch 1	893
MP9	Two Run Branch 2	827
MPA	Pindell Branch	628
MPB	House Creek	237
MPC	Hall Creek 1	1471
MPD	Wilson Owens Branch 1	527
MPE	Wilson Owens Branch 2	645
MPF	Lyons Creek 1	734
MPG	Lyons Creek 2	394
MPH	Lyons Creek 3	743
MPI	Lyons Creek 4	655
MPJ	Lyons Creek 5	1065
MPK	Lyons Creek 6	466
MPL	Lyons Creek 7	427
MPM	Lyons Creek 8	316
MPN	Lyons Creek 9	357
MPO	Ferry Branch 2	1072
MPP	Ferry Branch 3	859
MPQ	Cabin Branch 2	645
MPR	Cabin Branch 3	488
MPS	Cabin Branch 4	828
MPT	Cabin Branch 5	547
MPU	Unnamed Tributary	1060
MPV	Rock Branch 3	1665
MPW	Two Run Branch 1	730
MPX	Hall Creek 2	933
MPY	Hall Creek 3	813
MPZ	Wilson Owens Branch 4	1167

9 Load Reduction Evaluation Criteria

Adaptive management is a critical component of achieving the SW-WLAs required by the Non-Tidal Patuxent Lower and Middle Sediment TMDL. As presented in Section 8 of this plan, the County has established implementation and load reduction targets at specific intervals between current progress and the 2030 end date to provide interim planning targets and to serve as a vehicle for assessing progress toward the load reduction targets. The interim milestone dates are 2021, 2023, 2025, 2027, and 2029.

Progress 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. Planning targets will be re-evaluated against progress and revised to ensure that Anne Arundel County is on track to meet established goals. Progress assessments are completed annually and reported to MDE with the County's MS4 Annual Report.

9.1 Tracking Implementation of Management Measures

Implementation will be measured by determining whether the targets for implementation shown in Table 8-3 and Table 8-4 are maintained according to the milestone schedule. Anne Arundel County manages a comprehensive system for adding and tracking projects and accounting for new programs. New BMPs constructed through new development and redevelopment projects are entered into the County's BMP database and NPDES MS4 geodatabase as they come on-line. WPRP is responsible for implementing and tracking Water Quality Improvement Projects (WQIP; i.e., restoration and retrofit projects and programs). Additional internal County groups including Bureau of Highway Road Operation Division, which is responsible for maintenance efforts (i.e., street sweeping and inlet cleaning), report back to WPRP. The County is also capturing and tracking projects implemented by the AAWSA through the WPRP-Chesapeake Bay Trust Restoration Grant Program.

9.1.1 Two-Year Milestone Reporting

As a part of the federal Chesapeake Bay Accountability Framework, the County is required to report to MDE on two-year milestones, which represent 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 were previously 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 Milestones covers two calendar years – for example, the period for 2018 -2019 is from January 1, 2018 through December 31, 2019. Following the development of MDE's NPDES MS4 geodatabase as a reporting vehicle for BMP Implementation, 2-Year BMP Implementation milestone reports are no longer required to be submitted.

9.1.2 Annual NPDES Reporting

As a requirement of the NPDES permit described in Section 2.4.4, on or before the anniversary date of the current permit, the County must submit a progress report demonstrating implementation of the NPDES stormwater program based on the fiscal year. If the County's MS4 Annual Report does not demonstrate compliance with their permit and show progress toward meeting SW-WLAs, the County must implement BMP and program modifications within 12 months. The MS4 Annual Report includes the following (items in bold font directly relate to elements of the load reduction evaluation criteria):

a. 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

b. A narrative summary describing the results and analyses of data, including monitoring data that is accumulated throughout the reporting year

c. Expenditures for the reporting period and the proposed budget for the upcoming year

d. A summary describing the number and nature of enforcement actions, inspections, and public education programs

e. 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,

f. The identification of proposed changes to the County's program when WLAs are not being met

g. 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

Elements of the database, following MDE's current schema (version 1.2, May 2017), include feature classes and associated tables that store and report to MDE the County's restoration projects. MDE and the Bay Program use the data for larger scale Bay modeling and TMDL compliance tracking. The relevant database features include:

- AltBMPLine - stream restoration, shoreline restoration, outfalls
- AltBMPPoint – septic system practices (pump-out, upgrades, connections)
- AltBMPPoly – tree planting, street sweeping, inlet cleaning, impervious removal
- RestBMP – stormwater BMPs (SPSC, bioretention, wet ponds etc.)

9.1.3 Annual Assessment Report

Anne Arundel County produces an Annual Assessment Report to assess progress for each County-TMDL that has a completed and final restoration plan in place. The reports include implementation and load reduction summaries for the projects and programs completed in the current reporting year, and also compiled for the full restoration period from the baseline through the current reporting year. Comparisons are made to the planned implementation targets to determine if the County is on track. Costs of program implementation are reported. For sediment TMDLs, a section is dedicated to reporting County water quality and biomonitoring results from the Countywide Biomonitoring Program and from any relevant targeted restoration monitoring sites. The annual progress assessment reports are submitted to MDE with the County's MS4 Annual Report in February of each year.

9.1.4 Financial Assurance Plan Reporting

The County's Financial Assurance Plan (FAP) outlines the County's financial ability to meet its local and Chesapeake Bay TMDL obligations and is another mechanism of reporting to MDE. The FAP demonstrates the County's ability to fund projects that will reduce pollutants of concern and make measureable progress towards improving water quality. Anne Arundel County's first FAP was submitted to MDE in July of 2016, and an updated version was submitted in February of 2019.

9.2 Estimating Load Reductions

The County performs modeling annually to evaluate load reductions and progress towards meeting SW-WLA goals. The load reductions are reported in the County's "Annual Assessment Reports" as described above and in the County's MS4 Annual Report. Modeled baseline and current loads are reported in the NPDES geodatabase in the "LocalStormwaterWatershedAssessment" table. The progress assessments

contribute to ongoing re-evaluation of management plans, and adapting 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 for the Lower and Middle Patuxent River using CAST to maintain consistency with the model framework used to develop the Restoration Plan and initial progress loads.

9.3 Tracking Overall Program Success through Monitoring

Overall program success will be evaluated using trends identified through the long term monitoring program described below in Section 10. TMDL compliance status will be evaluated to determine if the Restoration Plan needs to be updated. If it is found during the evaluation of BMP implementation and load reductions that the milestone targets are no longer being met, a revision of the plan may be necessary.

9.4 Best Management Practices Inspection and Maintenance

Anne Arundel County has established policies and procedures in place for stormwater management facility inspection, maintenance and enforcement.

9.4.1 Background

Both the State and County SWM Codes require maintenance inspections be performed on all SWM practices during the first year of operation and every three years thereafter. The first year of operation inspections are performed by the Environmental Control Inspectors before Certificates of Completion are issued for the grading permits under which the practices were constructed. The three-year maintenance inspections are the responsibility of the WPRP inspection staff.

9.4.2 Phase 1 Inspection and Enforcement

Phase 1 reflects the first time a SWM practice receives a three-year maintenance inspection and maintenance is required. Using the proper Maintenance Inspection Checklists, the Inspector performs the required three-year maintenance inspection, indicating on the Checklist boxes if maintenance is required, not required or the item is non-applicable. The information on the completed Checklist will serve to comply with the inspection requirements of COMAR 26.17.02.11 and is used to complete a Phase 1 Correction Notice issued in the field or mailed to the property owner. The Phase 1 Correction Notices are prepared using the I&P standard computerized inspection report software. They include a detailed description of the maintenance required and the compliance date by which the required maintenance is to be completed. If necessary, Phase 1 Correction Notices can be completed by hand using the standard Environmental Programs Inspection Report Form. Phase 1 Correction Notices contain the proper contact information. The Urban BMP geodatabase is updated to document when a three-year Maintenance Inspection is performed. For monthly reporting purposes, all re-inspections are recorded as inspections and not as facilities inspected or as new correction notices issued. Depending on the degree of maintenance required, a Compliance Schedule may be appropriate. All proposed Compliance Schedules must be authorized by the WPRP Supervisor.

9.4.3 Phase 2 Inspection and Enforcement

Phase 2 reflects situations where Phase 1 Enforcement was not successful in obtaining compliance. Phase 2 Enforcement consists of a formal Phase 2 Violation Notice in the form of a certified letter to the property owner or responsible party. The Phase 2 Violation Notice is prepared by the WPRP Inspector using the appropriate form letter, reviewed by the WPRP Supervisor/Environmental Code Administrator as appropriate, and signed by the WPRP Supervisor. The Phase 2 Notice establishes final compliance dates for the completion of the required maintenance. The final compliance dates may reflect agreed upon Compliance Schedules as authorized by the WPRP Supervisor.

9.4.4 Phase 3 Inspection and Enforcement

Phase 3 reflects situations where Phase 2 Enforcement was not successful in obtaining compliance. Phase 3 enforcement consists of a legal referral to the Office of Law for the enforcement of the Private Inspection and Maintenance Agreement recorded against the deed for the property in question. The referral is prepared by the Environmental Code Administrator using the records associated with the violation.

10 Monitoring

Official monitoring for Integrated Report assessments and impairment status is the responsibility of the State; however, the County has many on-going monitoring programs that supplement the State's efforts.

To determine the specific parameters to be monitored for tracking progress, one must understand the approach used for the initial listing. The Lower and Middle Patuxent River was originally listed for sediments in 1996 as a suspended sediment listing. In 2002, the State began listing biological impairments on the Integrated Report, at the 8-digit scale, based on a percentage of stream miles degraded and whether they differ significantly from a reference condition watershed (<10% stream miles degraded). The biological listing is based on Benthic and Fish Indices of Biotic Integrity (BIBI/FIBI) results from wadeable streams from assessments conducted by the Maryland Department of Natural Resources (MDNR) Maryland Biological Stream Survey (MBSS). The Lower and Middle Patuxent River watershed was listed for biological community impairment in 2002.

MDE then utilized its Biological Stressor Identification (BSID) process to identify the probable or most likely causes of poor biological conditions. For sediment specifically, the BSID identified that 'altered habitat, and increased runoff from residential and historical agricultural landscapes have resulted in changes to stream geomorphology and subsequent elevated suspended sediment in the watershed.' Overall, the results indicated flow/sediment and in-stream habitat related stressors as the primary stressors causing impacts to biological communities.

Based on the results of the BSID, MDE replaced the biological impairment listing with a listing for total suspended solids (TSS). The 2014 final and 2018 draft Integrated Reports lists 'Habitat Evaluation' as the indicator, and 'Anthropogenic Land Use Changes' as the source. It is noted that the *Decision Methodology for Solids for the April 2002 Water Quality Inventory* (MDE, 2012) makes a specific distinction between two different, although related 'sediment' impairment types in free flowing streams:

1. **TSS**: The first type is an impact to water clarity with impairment due to TSS using turbidity measured in Nephelometer Turbidity Units (NTUs). Although numeric criteria have not been established in Maryland for TSS, MDE uses a threshold for turbidity (a measurement of water clarity) of a maximum of 150 NTUs and maximum monthly average of 50 NTU as stated in Maryland COMAR regulations (26.08.02.03-3). Turbidity also may not exceed levels detrimental to aquatic life in Class I designated waters.
2. **Sedimentation / siltation**: The second type is an impact related to erosional and depositional impacts in wadeable streams. The measures used are biocriteria and the criteria for Class I streams (the protection of aquatic life and growth and propagation of fish (other than trout) and other aquatic life).

Since two types of sediment impairments are identified in the IRs, monitoring of both water clarity and sedimentation should be incorporated into monitoring programs to track changes in the watershed condition over time. The WPRP has several on-going monitoring programs that target measures of water clarity and sedimentation. These programs are described below.

10.1 Countywide Biological Monitoring

In 2004, a Countywide Biological Monitoring and Assessment Program for Anne Arundel County was developed to assess the biological condition of the County's streams at multiple scales (i.e., site specific, primary sampling unit (PSU), and countywide). Under Round 1 and 2 of the Countywide Biological Monitoring and Assessment program, biology (i.e., benthic macroinvertebrates) and stream habitat, as well as geomorphological and water quality parameters, were assessed at approximately 240 sites throughout the entire County over a five-year period using a probabilistic, rotating-basin design. Round 1 of the County's Biological Monitoring and Assessment Program occurred between 2004 and 2008, and Round 2 took place between 2009 and 2013. Round 3, which began in 2017 and will be completed in 2021, added fish sampling, water quality grab samples, and expanded the number of sites to 400 over the five-year period.

The biological monitoring program's stated goals are applicable at three scales; Countywide, Watershed wide, and Stream-specific, and include the following components.

- Status: describe the overall stream condition
- Trends: how has the overall stream condition changed over time
- Problem identification/prioritization: identify the impaired and most degraded streams
- Stressor-response relationships: identify anthropogenic stressors and their biological response
- Evaluation of environmental management activities: monitor the success of implemented programs and restoration/retrofit projects

The Middle and Lower Patuxent River watersheds include five PSUs. Four PSUs—Rock Branch, Ferry Branch, Cabin Branch, and Lyons Creek—are in the Middle Patuxent, while Hall Creek is the single PSU found in the Lower Patuxent. Ten sampling sites were sampled in each PSU in each round of sampling. Methodologies follow those used by MBSS for the biological sampling and habitat evaluations have included both MBSS's Physical Habitat Index (MPHI) and the EPA's Rapid Bioassessment Protocol (RBP) metrics. In-situ water quality measures are also collected at each site, along with a geomorphic evaluation utilizing cross-sections, particle substrate analysis using pebble counts, and measures of channel slope.

Following these procedures, the County is collecting several parameters related to water clarity and sediment deposition at each site.

- Water Quality Measures and Observations
    - Turbidity (measured), observations of general water clarity and color
- Biological Measures
    - Benthic macroinvertebrates (benthic index of biotic integrity - BIBI)

- Fish (fish index of biotic integrity - FIBI)

- Habitat Measures
  - General: bar formation and substrate, presence/absence of substrate type
  - PHI: epibenthic substrate, instream habitat
  - RBP: epifaunal substrate /available cover, pool substrate characterization, sediment deposition, channel alteration
- Geomorphic Measures
  - Particle size analysis using modified Wolman pebble counts at ten transects proportioned by channel bed features

Results summarized at the PSU scale with mean BIBI and habitat ratings (PHI and RBP) are presented in Table 10-1 (Anne Arundel County, 2004-2018). Overall, for the Middle Patuxent, BIBI conditions for three of four PSUs increased from Poor to Fair, although only one PSU (Cabin Branch) had an average BIBI score difference that was statistically different in Round 2 compared to Round 1. Habitat conditions were mixed, but in line with observed biological conditions. Lyons Creek had significantly increased habitat score averages for both the PHI and RBP while Ferry Branch had significant score decreases. When all scores were averaged across the entire Middle Patuxent watershed area, BIBI conditions showed an increase from Poor to Fair while habitat scores remained the same between rounds. For the single PSU in the Lower Patuxent watershed, BIBI conditions did not change between Rounds 1 and 2, with the BIBI average remaining in the Poor range. The PHI average score improved from Degraded to Partially Degraded, but the difference in these average scores was not statistically significant despite the change in qualitative condition category. RPB conditions remained the same between Rounds.

Table 10-1: Countywide Biological Monitoring Results for the Lower and Middle Patuxent Watersheds

PSU Name/ *Watershed Segment*	PSU Code	PSU Drainage Area (acres)	Year Sampled		BIBI Rating		PHI Rating		RBP Rating	
			R1	R2	R1	R2	R1	R2	R1	R2
Hall Creek	24	3,168	2006	2012	P	P	D	PD	PS	PS
Lower Patuxent	---	---	---	---	***P***	***P***	***D***	***PD***	***PS***	***PS***
Rock Branch	20	6,131	2008	2009	P	F	PD	PD	PS	PS
Ferry Branch	21	8,038	2004	2010	F	P	MD	PD↓	C	PS↓
Cabin Branch	23	6,443	2008	2013	P	F↑	PD	PD	PS	PS
Lyons Creek	22	6,152	2005	2013	P	F	D	PD↑	PS	S↑
Middle Patuxent	---	---	---	---	***P***	***F***	***PD***	***PD***	***PS***	***PS***

BIBI Ratings: G = Good, F = Fair, P = Poor, VP = Very Poor
PHI Ratings: MD = Minimally Degraded, PD = Partially Degraded, D = Degraded, SD = Severely Degraded
RBP Ratings: C = Comparable, S = Supporting, PS = Partially Supporting, NS = Non-Supporting
Differences marked with and up or down arrow were statistically significant from R1 to R2.

10.2 Restoration Monitoring

To evaluate management activities, the County uses assessment methods similar to the Countywide program (biological monitoring, water chemistry sampling, physical habitat, geomorphic evaluation) to assess baseline and post-restoration conditions for select stream, wetland and stormwater restoration and retrofit sites. In addition, these techniques are utilized to meet several NPDES MS4 permit monitoring requirements, particularly related to Assessment of Controls and Watershed Restoration Assessment.

10.3 Watershed Assessments Monitoring

In 2000, Anne Arundel County initiated a series of systematic and comprehensive watershed assessments and management plans for restoration and protection across the County. The plans are developed within a regulatory context that includes NPDES MS4 requirements, local TMDLs and Watershed Implementation Plans for the Chesapeake Bay TMDL, Maryland Stormwater Regulations and the Water Resources Element of the County's General Development Plan.

Biological monitoring is a component of the characterization and prioritization process within the watershed management plans. The biological monitoring data is primarily utilized in the County's Watershed Management Tool (WMT) and Stream Assessment Tool (SAT), which were developed and maintained by the WPRP. Within this program, sampling sites are selected using a targeted approach with the goal of having at least one, and sometimes two, sites located within each subwatershed planning unit in order to examine the relationships between land use and ecological conditions downstream. Monitoring components include benthic macroinvertebrate community sampling, *in situ* water chemistry measurements, and instream and riparian physical habitat condition assessments. Water quality grab sampling and detailed geomorphic assessments have been included for some watershed studies, but not as routine monitoring components.

Biological monitoring in support of the *Middle and Lower Patuxent Watershed Assessment Report* (Anne Arundel County, 2018) was completed in 2013 and 2016. A full description of the results of this monitoring is too lengthy to describe in this report, but this monitoring program is noted because the associated BIBI and PHI data can be used as additional baseline data points to track changes over time. The County continues to reevaluate its monitoring programs as the state of the science progresses, as the understanding of water quality and ecological interactions are improved, and as regulatory programs are added or modified.

11 References

Anne Arundel County, 2004-2018. Biological Monitoring Reports. Last accessed 05/13/2019 at https://www.aacounty.org/departments/public-works/wprp/ecological-assessment-and-evaluation/biological-monitoring/biological-monitoring-reports/index.html.

Anne Arundel County, 2009. General Development Plan. Adopted October 19, 2009; Bill No. 64-09. Annapolis, MD.

Anne Arundel County, 2010. Stormwater Management Practices and Procedures Manual. Revised November 22, 2010; updated February 1, 2012. Annapolis, MD.

Anne Arundel County, 2012. Anne Arundel County Government Chesapeake Bay TMDL Phase II Watershed Implementation Plan – July 2, 2012. Annapolis, MD.

Anne Arundel County, 2018. Herring Bay, Middle Patuxent, and Lower Patuxent Watershed Assessment Comprehensive Summary Report. Prepared by KCI Technologies, Inc. for Anne Arundel County Watershed Assessment and Planning Program, Annapolis, MD.

CBP, 2017. Chesapeake Assessment and Scenario Tool (CAST) Version 2017d. Chesapeake Bay Program Office, Last accessed 05/13/2019 at http://cast.chesapeakebay.net.

EPA, 2001. PLOAD version 3.0. An ArcView GIS Tool to Calculate Nonpoint Sources of Pollution in Watershed and Stormwater Projects. Users Manual.

King and Hagan, 2001. Costs of Stormwater Management Practices In Maryland Counties. Technical Report Series No. TS-626-11 of the University of Maryland Center for Environmental Science.

MDE, 2012. Decision Methodology for Solids For the April 2002 Water Quality Inventory. Last accessed 05/15/2019 at https://mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/AM_Solids_2012.pdf

MDE, 2014a. Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated – Guidance for National Pollutant Discharge Elimination System Stormwater Permits. Maryland Department of the Environment. August 2014. Baltimore, MD.

MDE, 2014b. General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan. Maryland Department of the Environment. October 2014. Baltimore, MD.

MDE, 2014c. Guidance for Developing Stormwater Wasteload Allocation (SW-WLA) Implementation Plans for Nutrient and Sediment Total Maximum Daily Loads. Maryland Department of the Environment. November 2014. Baltimore, MD.

MDE, 2014d. National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Discharge Permit 11-DP-3316 MD0068306. February 2014. Anne Arundel County, MD.

MDE, 2018a. Total Maximum Daily Load of Sediment in the Non-Tidal Patuxent River Lower Watershed, Anne Arundel, Calvert, Charles, St. Mary's and Prince George's Counties, Maryland (including supplement technical memoranda and decision letters). July 2018. Baltimore, MD.

MDE, 2018b. Total Maximum Daily Load of Sediment in the Non-Tidal Patuxent River Middle Watershed, Anne Arundel, Calvert, Charles, St. Mary's and Prince George's Counties, Maryland (including supplement technical memoranda and decision letters). July 2018. Baltimore, MD.

MDE, 2018c. Final Technical Memorandum, Point Sources of Sediment in the Non-Tidal Patuxent River Lower Watershed. April 2018. Baltimore, MD.

Rosgen, 1996. Rosgen, D.L. and H.L. Silvey. 1996. Applied River Morphology. Wildland Hydrology Books.

Schueler, 1987. Controlling urban runoff: a practical manual for planning and designing urban BMPs. Metropolitan Washington Council of Governments. Washington, DC

USGS, 2018. Chesapeake Bay Program Phase 6 Land Use Data Set. Last accessed 05/13/2019 at https://chesapeake.usgs.gov/phase6/map/

Appendix A: Public Comments

The *Non-Tidal Patuxent River Lower and Middle Watersheds Sediment TMDL Draft Restoration Plan, Anne Arundel County, Maryland* was posted on the County's web page and advertised for public comment in the *Maryland Gazette* and *The Capital* newspapers from July 6, 2019 to August 9, 2019. Comments were received from the Chesapeake Bay Foundation and the Maryland Department of the Environment. Comments received, and Anne Arundel County's response to those comments, are included in this appendix. Also included are the Notice of Public Comment and *The Capital* newspaper posting.

Notice of Public Comment
Non-Tidal Patuxent River Lower and Middle Watersheds Sediment TMDL Restoration Plan
Anne Arundel County Department of Public Works
Watershed Protection and Restoration Program

General information
Public comment period begins: July 6, 2019
Public comment period ends: 4:00 p.m. on August 9, 2019

WPRP contact person:
Ginger Ellis
2662 Riva Road, MS#7409
Annapolis, MD 21401
Fax: 410-222-7059
E-mail: pwelli16@aacounty.org

The Anne Arundel County Department of Public Works (DPW) Watershed Protection and Restoration Program (WPRP) is developing restoration plans to address local water quality impairments for which a Total Maximum Daily Load (TMDL) has been established by the Maryland Department of the Environment (MDE) and approved by the U.S. Environmental Protection Agency (EPA). A TMDL establishes a maximum load of a specific single pollutant or stressor that a waterbody can assimilate and still meet water quality standards for its designated use class.

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, CWA Section 303(d) requires the state to list these water bodies as impaired waters. States are then required to develop a TMDL for pollutants of concern for the listed impaired waters. The Non-Tidal Lower and Middle Patuxent River watersheds are listed in Maryland's Integrated Report of Surface Water Quality [303(d) list and 305(b) Report] for sediment pollution. On July 2, 2018 EPA approved sediment (total suspended solids, or TSS) TMDLs for the Non-Tidal Patuxent River Lower and Middle Watersheds. These two TMDLs apply to multiple Counties, and responsibility for reduction of sediment is divided among the multiple contributing jurisdictions. This plan will specifically address Anne Arundel County's responsibility for meeting the stormwater wasteload allocation (SW-WLA) required by the Non-Tidal Patuxent River Lower and Middle sediment TMDLs.

WPRP invites comments from the public on Anne Arundel County's proposed Sediment TMDL Restoration Plan.

The draft "Non-Tidal Patuxent River Lower and Middle Watersheds Sediment TMDL Restoration Plan" is available for review on the Anne Arundel County Watershed Protection and Restoration Program's website at http://www.aarivers.org and can be inspected at the physical address listed above.

Only written comments will be accepted, no phone calls accepted. The public comment period will end at 4:00 p.m. on August 9, 2019. Written comments should include the name, address, and telephone number of the person submitting the comments and should be mailed to WPRP Attn: Ginger Ellis 2662 Riva Road, MS#7409, Annapolis, MD 21401, faxed to WPRP Attn: Ginger Ellis at 410-222-7059, or e-mailed to pwelli16@aacounty.org.

LEGAL NOTICES

Notice of Public Comment
Non-Tidal Patuxent River Lower and Middle Watersheds Sediment TMDL Restoration Plan
Anne Arundel County Department of Public Works
Watershed Protection and Restoration Program

General information
Public comment period begins: July 6, 2019
Public comment period ends: 4:00 p.m. on August 9, 2019
WPRP contact person:
Ginger Ellis
2662 Riva Road, MS#7409 Annapolis, MD 21401
Fax: 410-222-7059
E-mail: pwelli16@aacounty.org

The Anne Arundel County Department of Public Works (DPW) Watershed Protection and Restoration Program (WPRP) is developing restoration plans to address local water quality impairments for which a Total Maximum Daily Load (TMDL) has been established by the Maryland Department of the Environment (MDE) and approved by the U.S. Environmental Protection Agency (EPA). A TMDL establishes a maximum load of a specific single pollutant or stressor that a waterbody can assimilate and still meet water quality standards for its designated use class.

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, CWA Section 303(d) requires the state to list these water bodies as impaired waters. States are then required to develop a TMDL for pollutants of concern for the listed impaired waters. The Non-Tidal Lower and Middle Patuxent River watersheds are listed in Maryland's Integrated Report of Surface Water Quality [303(d) list and 305(b) Report] for sediment pollution. On July 2, 2018 EPA approved sediment (total suspended solids, or TSS) TMDLs for the Non-Tidal Patuxent River Lower and Middle Watersheds. These two TMDLs apply to multiple Counties, and responsibility for reduction of sediment is divided among the multiple contributing jurisdictions. This plan will specifically address Anne Arundel County's responsibility for meeting the stormwater wasteload allocation (SW-WLA) required by the Non-Tidal Patuxent River Lower and Middle sediment TMDLs.

WPRP invites comments from the public on Anne Arundel County's proposed Sediment TMDL Restoration Plan.

The draft "Non-Tidal Patuxent River Lower and Middle Watersheds Sediment TMDL Restoration Plan" is available for review on the Anne Arundel County Watershed Protection and Restoration Program's website at http://www.aarivers.org and can be inspected at the physical address listed above.

Only written comments will be accepted, no phone calls accepted. The public comment period will end at 4:00 p.m. on August 9, 2019. Written comments should include the name, address, and telephone number of the person submitting the comments and should be mailed to WPRP Attn: Ginger Ellis 2662 Riva Road, MS#7409, Annapolis, MD 21401, faxed to WPRP Attn: Ginger Ellis at 410-222-7059, or e-mailed to pwelli16@aacounty.org.

NOTICE

OF APPOINTMENT NOTICE TO CREDITORS
NOTICE TO UNKNOWN HEIRS TO ALL PERSONS INTERESTED IN THE ESTATE OF
GRACE ESTELLE OWEN

Notice is given that: **DOUGLAS OWEN** whose address is 1976 VALLEY ROAD ANNAPOLIS, MD 21401 was on June 25th, 2019 appointed personal representative(s) of the estate of **GRACE ESTELLE OWEN** who died on June 7th, 2019 with a will and codicil(s).

Further information can be obtained by reviewing the estate file in the office of the Register of Wills or by contacting the personal representative.

All persons having any objection to the appointment shall file their objections with the Register of Wills on or before December 25th, 2019

All persons having claims against the Decedent must serve their claims on the undersigned personal representative or file them with the Register of Wills with a copy to the undersigned on or before the earlier of the following dates:

(1) Six months from the date of the decedent's death, except if the decedent died before October 1, 1992, nine months from the date of the decedent's death; or

(2) Two months after the personal representative mails or otherwise delivers to the creditor a copy of this published notice or other written notice, notifying the creditor that the claim will be barred unless the creditor presents the claims within two months from the mailing or other delivery of the notice. A claim not presented or filed on or before that date, or any extension provided by law, is unenforceable thereafter. Claim forms may be obtained from the Register of Wills.

DOUGLAS OWEN, Personal Representative,
ESTATE # 98140
True Test Copy
LAUREN M. PARKER, Register of Wills
for Anne Arundel County Circuit
Courthouse - Church Circle P.O. Box 2368
Annapolis, MD 21404-2368
21404-2368 MARYLAND GAZETTE:
CAP 7/6, 7/13, 7/20/2019 - 6360591

CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

Ginger Ellis, Planning Administrator
2662 Riva Road, MS#7409
Annapolis, MD 21401
Sent via Email: pwelli16@aacounty.org

August 9, 2019

Re: Non-Tidal Patuxent River Lower and Middle Watersheds Sediment TMDL Restoration Plan

Dear Ms. Ellis,

Thank you for the opportunity to comment on the Department's TMDL Restoration Plan for the non-tidal Patuxent River Lower and Middle Watersheds. The Chesapeake Bay Foundation (CBF) and our over 19,000 Anne Arundel members are vitally interested in the health and quality of Anne Arundel rivers, streams, and the Chesapeake Bay. We appreciate the County's work drafting this restoration plan and ongoing efforts to improve water quality in the County.

CBF is concerned that the draft restoration plan currently does not address growth in sediment loads from the stormwater sector. Without identifying and offsetting loads from growth, CBF does not believe it is possible to obtain the load reductions required under the TMDL for these two watersheds. Growth in sediments loads slows the overall progress in load reductions from the Municipal Separate Storm Sewer System (MS4) permit activities. According to our analysis, as detailed below, the identified Best Management Practices in the County's capital improvement fund will not achieve the required load reductions for these two watersheds.

The Maryland Department of the Environment approved the Total Maximum Daily Load (TMDL) for sediment load reduction for the Middle and Lower Patuxent Non-tidal river basins, requiring over 487,000 pounds of sediment reduction per year for the Lower Patuxent watershed and over 2.89 Million pounds of sediment reduction per year for the Middle Patuxent portions of the watershed in Anne Arundel County by 2030. Based on MDE guidance, growth in the stormwater load since 2009 baseline was not accounted for in the development of the county's restoration plan. Section 3.3 of the plan – "Anticipated Growth" relies on stormwater management to the Maximum Extent Practicable (MEP) on new development as well as stating that MDE's "Accounting for Growth Policies" will address growth. However, as demonstrated through Chesapeake Assessment Scenario Tool (CAST) calculations and due to increasing severity of precipitation events, application of stormwater management regulations to new development does not fully avoid or offset the increased sediment loads. Further, MDE did not adopt any accounting for growth policy in the Phase III Watershed Implementation Plan (WIP) and Chesapeake Bay Program intends to only

attach an appendix to each state Phase III WIP document outlining an optional accounting for growth convention using projected 2025 land use[1]. CBF recommends that the County use the Chesapeake Bay Program information to develop an offset program that would account for the increased sediment loads from growth.

Without accounting for and offsetting growth, the County's efforts in restoration can be overcome by new loads. On Table 1-2 of the restoration plan, initial CAST baseline and 2018 progress run comparisons for the Anne Arundel county portions of these two watersheds show 9-year cumulative reductions as only 18 lbs./year for the Lower Patuxent and 366,092 lbs./year for the Middle Patuxent. This suggests that some progress was made in load reductions despite growth in the Middle Patuxent, but that growth has essentially erased any progress in the Lower Patuxent from stormwater Best Management Practices (BMPs).

If this rate of progress were to continue till 2030 without either significant controls on the growth of new impervious surfaces or significant increases in the implementation of stormwater BMP's, the Middle Patuxent would take 71 years to reach the TMDL waste load allocation (WLA) and the Lower Patuxent would take nearly a quarter million years!

The breakdown of land uses in each watershed is similar, with 50-54% Forest, 22-27% Agriculture, 12% Turf, 6% Tree canopy/Shrubland and about 2% Impervious surface. Some sub-watersheds have as much as 16% imperviousness. CAST baseline assessment of sediment load sources from 2009 land use determine 35-41% of the loads come from instream channel erosion, 32-34% from urban turf and 27-31% from impervious cover.

Load source reduction opportunities identified in the plan through retrofit or treatment of buildings, roads, turf and stream restoration are 678,000 pounds for the Lower Patuxent and over 5 million pounds for the Middle Patuxent. Only county-owned buildings and roads were analyzed for impervious surface retrofits. Given the high percentage of loads from urban turf and other impervious cover, CBF would recommend including strategies for reductions from private land as well. The County has an active Watershed Stewards program that can help identify and education private landowners, as well as a Watershed Protection and Restoration Program that can provide credits on stormwater fees to participating landowners. These programs should be leveraged to implement load reductions on private lands.

Tables 5-7 and 5-8 identify planned BMP Implementation that would deliver 312,000 pounds reduction in the Lower Patuxent and 2.558 Million pounds for the Middle Patuxent. These BMPs would still leave the Lower Patuxent 175,000 pounds short of the goal and the Middle Patuxent short 330,000 pounds by 2030. Given this shortfall from BMP implementation, and without specific offsets for growth, CBF has no confidence that the final TMDL load reduction will actually be met.

Stream reach analysis used to prioritize stream restoration actions appears to be based on physical and biological characteristics of the stream, not contribution of sediment loads to the non-tidal lower and Middle Patuxent watersheds. While stream biological criteria are important,

[1] The Use of Land Policy BMPs in the Phase III Watershed Implementation Plans, memo dated 7/16/2019 from the Chesapeake Bay Program Management Board

they should be secondary to load reduction when considering the cost-effectiveness of practices under the auspices of a TMDL. Moreover, CBF strongly discourages the use of stream restoration as a stand-alone practice without first accomplishing source control on the impervious surfaces upstream which are causing the increased flooding flows and scour that make streams a source of sediment rather than a sink. CBF recommends implementation of a "treatment train" approach that ensures upstream sources are addressed before stream restoration, and also prioritizing the stream reach based on the contribution of sediment loads to the two watersheds.

Section 6.3 of the plan identified funding sources for implementation. This section fails to quantify any revenue projections from the county's watershed protection and restoration fee and public grants meant to augment that revenue sufficient to provide assurance that the $29 Million total projected cost of stormwater BMPs would be built, let alone maintained into the future. The plan should identify what percent of the county's $74 million annual revenue will be dedicated to these local sediment TMDLs.

We appreciate the County's dedication to improving and protecting local water quality and the Chesapeake Bay. Thank you again for the opportunity to comment on this draft restoration plan, and please do not hesitate to reach out with any questions or concerns regarding these comments.

Sincerely,

Doug Myers
Maryland Senior Scientist
DMyers@cbf.org

PARA-GRAPH	CBF COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	ANNE ARUNDEL COUNTY RESPONSE	CHANGES MADE TO THE REPORT
1	Thank you for the opportunity to comment on the Department's TMDL Restoration Plan for the non-tidal Patuxent River Lower and Middle Watersheds. The Chesapeake Bay Foundation (CBF) and our over 19,000 Anne Arundel members are vitally interested in the health and quality of Anne Arundel rivers, streams, and the Chesapeake Bay. We appreciate the County's work drafting this restoration plan and ongoing efforts to improve water quality in the County.	n/a	n/a	None
2	CBF is concerned that the draft restoration plan currently does not address growth in sediment loads from the stormwater sector. Without identifying and offsetting loads from growth, CBF does not believe it is possible to obtain the load reductions required under the TMDL for these two watersheds. Growth in sediments loads slows the overall progress in load reductions from the Municipal Separate Storm Sewer System (MS4) permit activities. According to our analysis, as detailed below, the identified Best Management Practices in the County's capital improvement fund will not achieve the required load reductions for these two watersheds.	n/a	See responses below	None

PARA-GRAPH	CBF COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	ANNE ARUNDEL COUNTY RESPONSE	CHANGES MADE TO THE REPORT
3	The Maryland Department of the Environment approved the Total Maximum Daily Load (TMDL) for sediment load reduction for the Middle and Lower Patuxent Nontidal river basins, requiring over 487,000 pounds of sediment reduction per year for the Lower Patuxent watershed and over 2.89 Million pounds of sediment reduction per year for the Middle Patuxent portions of the watershed in Anne Arundel County by 2030. Based on MDE guidance, growth in the stormwater load since 2009 baseline was not accounted for in the development of the county's restoration plan. Section 3.3 of the plan – "Anticipated Growth" relies on stormwater management to the Maximum Extent Practicable (MEP) on new development as well as stating that MDE's "Accounting for Growth Policies" will address growth. However, as demonstrated through Chesapeake Assessment Scenario Tool (CAST) calculations and due to increasing severity of precipitation events, application of stormwater management regulations to new development does not fully avoid or offset the increased sediment loads. Further, MDE did not adopt any accounting for growth policy in the Phase III Watershed Implementation Plan (WIP) and Chesapeake Bay Program intends to only attach an appendix to each state Phase III WIP document outlining an optional accounting for growth convention using projected 2025 land use[1]. CBF recommends that the County use the Chesapeake Bay Program information to develop an offset program that would account for the increased sediment loads from growth.	Section 3.3	Although the State of Maryland has established a nutrient trading program, it has yet to determine the specific nitrogen offsets for growth. When nitrogen offets for growth are determined Anne Arundel County wil work in concert with MDE to develop a program to address and account for increased loads as a result of growth. Currently, Anne Arundel County has land conservation and preservation programs in place and growth management programs that limit the impacts of growth that are not otherwise achieved through current stormwater management regulations and technologies.	Revisions to section 3.3, 3.3.1, 3.3.2

PARA-GRAPH	CBF COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	ANNE ARUNDEL COUNTY RESPONSE	CHANGES MADE TO THE REPORT
4	Without accounting for and offsetting growth, the County's efforts in restoration can be overcome by new loads. On Table 1-2 of the restoration plan, initial CAST baseline and 2018 progress run comparisons for the Anne Arundel county portions of these two watersheds show 9-year cumulative reductions as only 18 lbs./year for the Lower Patuxent and 366,092 lbs./year for the Middle Patuxent. This suggests that some progress was made in load reductions despite growth in the Middle Patuxent, but that growth has essentially erased any progress in the Lower Patuxent from stormwater Best Management Practices (BMPs).	Section 1-2, table 1-2	The 2009-2018 Progress Load reductions shown in Table 1-2 show the load reductions from only the BMPs that the County has implemented above and beyond the regulatory BMPs that were constructed to reduce sediment from growth in the County. This table cannot be used to assess whether sediment from growth has been sufficiently addressed by BMPs. The County is committed to increasing implementation in the future per Section 5.3 of the report in order to achieve the sediment load reduction required.	None
5	If this rate of progress were to continue till 2030 without either significant controls on the growth of new impervious surfaces or significant increases in the implementation of stormwater BMP's, the Middle Patuxent would take 71 years to reach the TMDL waste load allocation (WLA) and the Lower Patuxent would take nearly a quarter million years!	Section 1-2, table 1-2	The 2018-2025 and 2025-2030 planned load reductions shown in Table 1-2 will address the required sediment TMDL load reductions in 12 years. The historic rate of progress should not be used to predict attainment of the WLAs. Anne Arundel County is in the process of updting its General Development Plan. A major focus of that plan will be the establishing land use goals, policies and strategies that address manage growth in the context of achieving TMDL WLA attanment.	None

PARA-GRAPH	CBF COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	ANNE ARUNDEL COUNTY RESPONSE	CHANGES MADE TO THE REPORT
6	The breakdown of land uses in each watershed is similar, with 50-54% Forest, 22-27% Agriculture, 12% Turf, 6% Tree canopy/Shrubland and about 2% Impervious surface. Some sub-watersheds have as much as 16% imperviousness. CAST baseline assessment of sediment load sources from 2009 land use determine 35-41% of the loads come from instream channel erosion, 32-34% from urban turf and 27-31% from impervious cover.	Breakdown of landuse can be found in Section 2.1.3, table 2-3; and Section 2.2.3, table 2-9 and table 2-10. Breakdown of sediment sources can be found in Section 3.2.1, table 3.2	Max imperviousness by sub-watershed is 11.5% (MP7, Galloway Creek). Other statements in this paragraph are correct.	None

PARA-GRAPH	CBF COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	ANNE ARUNDEL COUNTY RESPONSE	CHANGES MADE TO THE REPORT
7	Load source reduction opportunities identified in the plan through retrofit or treatment of buildings, roads, turf and stream restoration are 678,000 pounds for the Lower Patuxent and over 5 million pounds for the Middle Patuxent. Only county-owned buildings and roads were analyzed for impervious surface retrofits. Given the high percentage of loads from urban turf and other impervious cover, CBF would recommend including strategies for reductions from private land as well. The County has an active Watershed Stewards program that can help identify and education private landowners, as well as a Watershed Protection and Restoration Program that can provide credits on stormwater fees to participating landowners. These programs should be leveraged to implement load reductions on private lands.	Section 5-3, tables 5-7 and 5-8	Implementation on county-owned buildings and roads provides the most reliable return on investment and reasonable assurence of long term management and maintenance. Regarding strategies for private property, the County parnters with the Anne Arundel Watershed Stewards Academy (AAWSA). This partnership has been and continues to be highly successful at educating and engaging private landowners. In 2019 AAWSA installed 964,538 square feet of new-in-the ground projects, provided outreach to 31, 688 County residents, and planted 7,463 native plants and trees. Eligible private property owners in Anne Arundel County have the opportunity to reduce their stormwater fees by up to 50% for proactive and sustainable uses of stormwater runoff controls. The WPRP Credit Program Policy and Guidance document for Anne Arundel County provides the Department of Public Works the framework and procedures needed to administer the program. In addition, the WPRP established the WPRF Stormwater Remediation Fee Credit Agreement to provide credit to single-family property owners that have installed small-scale (e.g., under 5,000 Sq.ft land disturbance) stormwater BMP's on their property. Further information and applications for these credit programs is available on the WPRP webpage.	Additional text in Section 7.1

PARA-GRAPH	CBF COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	ANNE ARUNDEL COUNTY RESPONSE	CHANGES MADE TO THE REPORT
8	Tables 5-7 and 5-8 identify planned BMP Implementation that would deliver 312,000 pounds reduction in the Lower Patuxent and 2.558 Million pounds for the Middle Patuxent. These BMPs would still leave the Lower Patuxent 175,000 pounds short of the goal and the Middle Patuxent short 330,000 pounds by 2030. Given this shortfall from BMP implementation, and without specific offsets for growth, CBF has no confidence that the final TMDL load reduction will actually be met.	Section 5-3, tables 5-7 and 5-8	Tables 5-7 and 5-8 have been misinterpreted. These tables show that the **end loads** will be 312,476 and 2.558 million pounds in the Lower Patuxent and Middle Patuxent respectively. The total **load reduction** will be 488,830 pounds (2,340+1,154+485,336) and 2.890 Million pounds 58,692+5,454+2,825,958) respectively. These reductions will meet the required TMDL load reduction.	None
9	Stream reach analysis used to prioritize stream restoration actions appears to be based on physical and biological characteristics of the stream, not contribution of sediment loads to the non-tidal lower and Middle Patuxent watersheds. While stream biological criteria are important, they should be secondary to load reduction when considering the cost-effectiveness of practices under the auspices of a TMDL. Moreover, CBF strongly discourages the use of stream restoration as a stand-alone practice without first accomplishing source control on the impervious surfaces upstream which are causing the increased flooding flows and scour that make streams a source of sediment rather than a sink. CBF recommends implementation of a "treatment train" approach that ensures upstream sources are addressed before stream restoration, and also prioritizing the stream reach based on the contribution of sediment loads to the two watersheds.	Section 3.2.2	During the implementation phase of the TMDL restoration plan, the County will assess in further detail which streams and associated uplands areas to target for restoration. The restoration plan simply provides an assessment of the overall stream length and uplands area that should be restored in order to reduce sediment loads.	None

PARA-GRAPH	CBF COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	ANNE ARUNDEL COUNTY RESPONSE	CHANGES MADE TO THE REPORT
10	Section 6.3 of the plan identified funding sources for implementation. This section fails to quantify any revenue projections from the county's watershed protection and restoration fee and public grants meant to augment that revenue sufficient to provide assurance that the $29 Million total projected cost of stormwater BMPs would be built, let alone maintained into the future. The plan should identify what percent of the county's $74 million annual revenue will be dedicated to these local sediment TMDLs.	Section 6.3	The County does and will use funding from its dedicated (i.e., watershed fee) and opportunistic (e.g., grants) funding sources to fund the capital construction costs of the BMPs identified in Tables 6-1 and 6-2 over the course of the schedule identified in Table 6-3, as well as to fund continued operations and maintenance over the life of the BMP.	None
11	We appreciate the County's dedication to improving and protecting local water quality and the Chesapeake Bay. Thank you again for the opportunity to comment on this draft restoration plan, and please do not hesitate to reach out with any questions or concerns regarding these comments.	n/a	n/a	None

Maryland
Department of
the Environment

Larry Hogan, Governor
Boyd K. Rutherford, Lt. Governor

Ben Grumbles, Secretary
Horacio Tablada, Deputy Secretary

October 2, 2019

To: Anne Arundel County Department of Public Works, Watershed Protection and Restoration Program
From: Maryland Department of the Environment (MDE) – Integrated Water Planning Program (IWPP)
Subject: Approval of Anne Arundel County's Stormwater Wasteload Allocation (SW-WLA) Watershed Implementation Plan (WIP) for the Total Suspended Solids (TSS) impairment of Patuxent River Lower and Middle Watersheds

The Anne Arundel County SW-WLA implementation plan was initially submitted in June 2019 and is of sufficient quality to warrant MDE approval.

MDE's IWPP reviewed the plan for both its technical merits and watershed planning components. The comments the IWPP has provided below are minor; they address minor technical details of the modeling that the County conducted and programmatic issues. These need to be addressed because they affect potential implementation strategies and the tracking of pollutant load reductions in comparison to target reductions.

Below are specific points that demonstrate why this plan is of sufficient quality to the IWPP:

- The County has provided reasonable end-dates for achieving the SW-WLA
- The County has provided detailed cost estimates for implementation
- The County used scientifically defensible modeling tools for estimating the watershed baseline load
- The modeled baseline year is consistent with baseline conditions in the applicable total maximum daily load (TMDL)
- The County used SW-WLA reduction percentages rather than absolute loading targets from the TMDL in its implementation modeling to set loading targets in terms of its own modeling system
- The County outlined specific best management practices (BMPs) and the amounts of these control measures they plan to implement to meet the required loading reduction
- The County used scientifically defensible BMP reduction efficiencies in modeling the expected pollutant load reductions
- The County outlined a timeframe for achievement of the required pollutant load reduction
- The County discussed the mechanisms that it will employ for tracking progress towards the required load reductions

- The County's implementation plan incorporates elements of adaptive management, indicating that it will use water quality monitoring data to assess the effectiveness of implemented practices and adjust implementation strategies if data do not indicate positive trends

There is no information withheld from this plan at this point that should warrant it as being unacceptable per the IWPP's criteria for evaluation. However, the IWPP requests that comments provided to Anne Arundel County in an email dated September 3, 2019 and subsequently discussed on the conference call with the IWPP and Anne Arundel County officials on September 3, 2019 be responded to before March 3, 2020. The comments are enumerated below.

MDE IWPP Comments on NT Lower and Middle Patuxent River Sediment TMDL WIP

1. Number the pages and check the figure/table numbers.
2. With regard to Section 1.3, MDE IWPP encourages the County to consider the "a through i" criteria of the 319 grant planning process as a guideline for the local TMDL WIP development process, and not a steadfast requirement of local TMDL WIPs. MDE IWPP stresses that the utility of local TMDL WIPs should be primarily for the County to develop a path forward to improve water quality in their jurisdiction. The requirements for local TMDL WIPs are intentionally looser than other elements of 319 plans and other MS4 reporting processes to encourage the County to take ownership of the contents of the plan and the planning process.
3. MDE IWPP requests that Table 22 be mapped; MDE IWPP considers spatial analysis and subsequent mapped illustrations of planning details the preferred methodology for displaying environmental conditions and planning goals.
4. MDE IWPP commends Anne Arundel County on its development of Figure 22, this is a great starting point for beginning to prioritize information.
5. In Section 3.3.1, when discussing future growth, the County should consider what management decisions will need to be made in the face of land use changes; and include these in a "decision tree analysis" so planning questions can be paired with the collection of quantitative data.
6. MDE IWPP requests the County illustrate in a tabular format all of the priorities (i.e. cuts of information/data) that were used to generate Figure 82. This is an excellent component of the plan, but needs to be made accessible/understandable for those unfamiliar with the modeling.
7. MDE requests that the County describe what information besides BMP data (Figure 32) enables the transition from Figure 31 to Figure 33.
8. Section 8 and Section 9 need to be woven throughout the plan in a way to demonstrate how the County plans to measure, monitor and report on existing and future risk from sediment sources.

NUMBER	MDE COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	COUNTY RESPONSE	Report Changes
1	Number the pages and check the figure/table numbers.	Second page of plan	The pages are numbered. Roman numeral (ii) on page 2 shouldn't be there and will be removed. All other page numbers, figure and table numbers were checked and are correct.	Removed roman number on page 2
2	With regard to Section 1.3, MDE IWPP encourages the County to consider the “a through i” criteria of the 319 grant planning process as a guideline for the local TMDL WIP development process, and not a steadfast requirement of local TMDL WIPs. MDE IWPP stresses that the utility of local TMDL WIPs should be primarily for the County to develop a path forward to improve water quality in their jurisdiction. The requirements for local TMDL WIPs are intentionally looser than other elements of 319 plans and other MS4 reporting processes to encourage the County to take ownership of the contents of the plan and the planning process.	p.5	Thanks for providing additional context regarding the "a through i" criteria. The County included this information in the restoration plan to demonstrate compliance with the EPA's nine essential elements for watershed planning, and to pre-position the County for 319 grant funding. However, the restoration plan goes beyond just addressing those criteria. The County has evaluated and considered how implementation of this TMDL fits into its overall County watershed restoration program. The restoration plan has incorporated elements of the County's ongoing restoration efforts to ensure that it fits in with the County's existing restoration program.	None

NUMBER	MDE COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	COUNTY RESPONSE	Report Changes
3	MDE IWPP requests that Table 22 be mapped; MDE IWPP considers spatial analysis and subsequent mapped illustrations of planning details the preferred methodology for displaying environmental conditions and planning goals.	p.7	The existing Figure 2-3 in the report shows the landuse information from Table 2-2 and Table 2-9.	None
4	MDE IWPP commends Anne Arundel County on its development of Figure 22, this is a great starting point for beginning to prioritize information.	p.18	no response required	none
5	In Section 3.3.1, when discussing future growth, the County should consider what management decisions will need to be made in the face of land use changes; and include these in a "decision tree analysis" so planning questions can be paired with the collection of quantitative data.	p.24-25	The County will include additional language to address future growth. The County will also add a discussion of existing and planned programs such as land conservation and preservation programs and growth management plans and strategies that address the impacts of growth that are not otherwise achieved through current stormwater management regulations and technologies.	Added text to Section 3.3, 3.3.1, and 3.3.2
6	MDE IWPP requests the County illustrate in a tabular format all of the priorities (i.e. cuts of information/data) that were used to generate Figure 82. This is an excellent component of the plan, but needs to be made accessible/understandable for those unfamiliar with the modeling.	p.47	This table will be added to the report.	Added new tables 8-5 and 8-6
7	MDE requests that the County describe what information besides BMP data (Figure 32) enables the transition from Figure 31 to Figure 33.	p.26-28	Figure 3.2 is a stand-alone figure and not related to Figures 3.1 and 3.3. The County will edit the text to more fully describe these figures.	Added text in section 3.2.1 and 3.3.1

NUMBER	MDE COMMENT	PAGE/SECTION IN THE RESTORATION PLAN	COUNTY RESPONSE	Report Changes
8	Section 8 and Section 9 need to be woven throughout the plan in a way to demonstrate how the County plans to measure, monitor and report on existing and future risk from sediment sources.	p.42 and on	The County will add cross-references to scheduling, priorities, monitoring and tracking throughout the plan where relevant	Cross-references are included in sections 2.1.4, 2.2.4, 3.1, 5.3