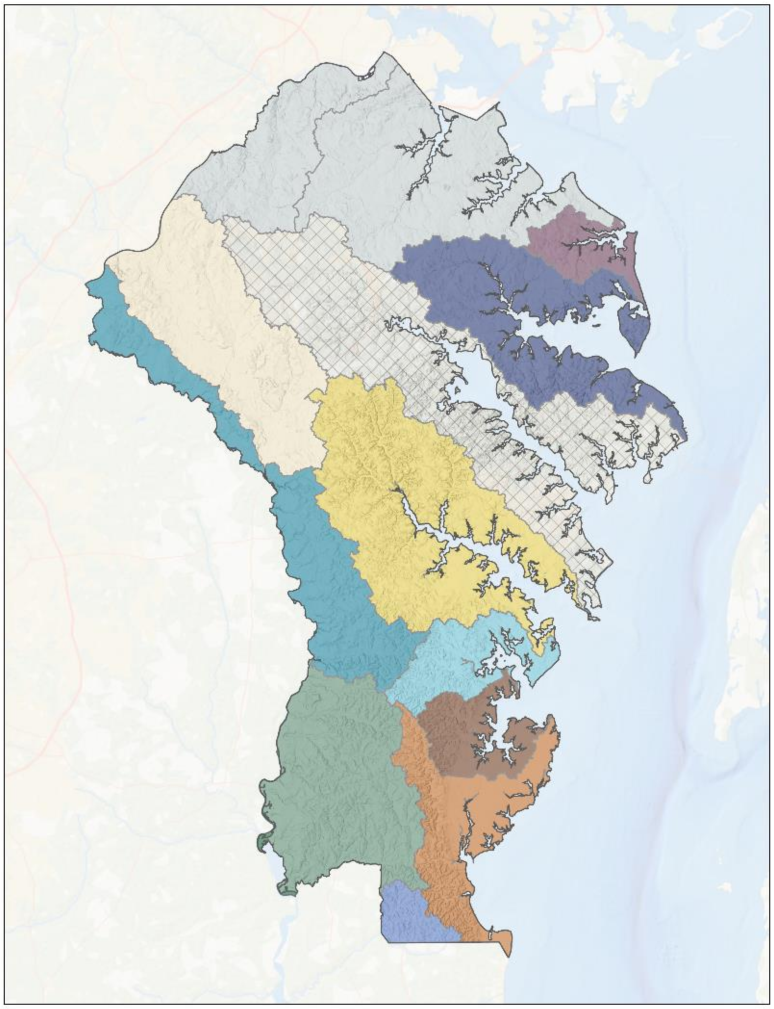
Anne Arundel Countywide TMDL Stormwater Implementation Plan

FY 22 Annual Progress Report - December 2022



Anne Arundel County Bureau of Watershed Protection & Restoration

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FY 22 Annual Progress Report

December 2022

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Bureau of Watershed Protection and Restoration

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I. Definitions of Key Terms

Anne Arundel County Watershed Stewards Academy	A non-profit organization that builds capacity in Anne Arundel County by training Master Watershed Stewards to help neighbors reduce pollution in our local creeks and rivers.
Backcasting	A method developed by Baltimore County and approved by Maryland Department of Environment to 'translate' historical land cover datasets to a format consistent with Phase 6 Chesapeake Bay Watershed Model land cover classes. This allows the most accurate estimation of land cover and loads at the baseline year for each TMDL and ensures baseline loads are not over or underestimated.
Baseline Load	A Baseline load is a pollutant load estimate for each TMDL watershed at baseline year conditions. Baseline loads are estimated as the sum of land use loads minus any reductions from BMPs that were installed in or before the baseline year.
Baseline Year	The baseline year is the bench mark year from which progress in reducing pollutant loads is assessed.
Bay segment	Bay segments are geographical areas of the Chesapeake Bay as defined within the Phase 5 Chesapeake Bay Model.

BMP	A watershed Best Management Practice that is used to reduce and control stormwater and associated pollution.
Chesapeake Bay Program	A regional partnership that directs and conducts the restoration of the Chesapeake Bay.
Chesapeake Bay Conservancy	A non-profit organization that works conserve and restore the natural and cultural resources of the Chesapeake Bay watershed. The Conservancy also develops geospatial datasets such as land cover.
CIP	The Capital Improvement Program of Anne Arundel County Government.
EPA	The United States Environmental Protection Agency.
Interim Programmed Reduction	Load reduction, expressed as either lbs, counts, or percent, which are achieved from BMPs that are under a design contract and have reached the 30% design stage.
MDE	The Maryland Department of the Environment.
MDNR	The Maryland Department of Natural Resources.

MS4	MS4, or Municipal Separate Storm Sewer System, is a conveyance or system of conveyances owned by a state, city, town, village, or other public entity that discharges stormwater to waters of the United States.
National Land Cover Database	Nationwide data on land cover data at a 30m resolution produced by the Multi-Resolution Land Characteristics (MRLC) Consortium.
NPDES	NPDES, or the National Pollutant Discharge Elimination System, is an EPA program that addresses water pollution by regulating point sources that discharge pollutants to waters of the United States.
Planned Reduction	Load reduction, expressed as either lbs, counts, or percent, which are achieved from BMPs that are either not under a design contract or have not yet reached the 30% design stage.
Progress	Progress, in the context of TMDLs, is the cumulative amount of pollutant reduction, measured in lbs, counts, or percent, which the County has achieved to attain a Stormwater Waste Load Allocation for a given pollutant.
Progress Reduction	Cumulative load reductions, expressed as either lbs, counts, or percent, which are achieved via stormwater BMP implementation through the end of the current fiscal year.

SW-WLA

SW-WLA, or a Stormwater Wasteload Allocation, is the maximum load of pollutants originating from the stormwater sector that is allowed to be discharged to waters of the United States.

Target Date

The target date when the Stormwater Wasteload Allocation is expected to be met.

TIPP

TIPP, or the TMDL Implementation Progress and Planning tool, is a planning tool to help estimate baseline loads and reductions from BMPs to meet stormwater waste load allocations. The TIPP tool was created by Maryland Department of the Environment.

TMDL

A TMDL, or Total Maximum Daily Load, is a calculation of the maximum amount of a pollutant that is allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards and support the waterbodies designated uses.

WIP

WIP, or Watershed Implementation Plan, is a roadmap of how a jurisdiction will achieve its waste load allocations.

II. Background

Maryland Department of Environment (MDE) issued NPDES Permit No. 20-DP-3316 to Anne Arundel County on November 5, 2021. Part IV.F of this permit requires Anne Arundel County to submit a Countywide Stormwater Total Maximum Daily Load (TMDL) Implementation Plan (Countywide Plan) that addresses all TMDLs with Stormwater Wasteload Allocations (SW-WLAs) listed in Appendix A within one year of permit issuance. The Countywide Plan represents Anne Arundel County's roadmap to achieve SW-WLAs for each TMDL, and ultimately the progress towards attaining water quality criteria ensuring that each waterbody supports its designated uses. The Countywide Plan must be approved by MDE and must annually document progress toward meeting TMDL SW-WLAs. The Countywide Plan is to be based on the Department's analyses or equivalent, and where applicable, document Anne Arundel County water quality analyses. The plan should include:

- A list of stormwater BMPs, programmatic initiatives, or alternative control practices that will be implemented to reduce pollutants for the TMDL;
- A description of the County's analyses and methods, and how they are comparable with MDE's TMDL analyses; and
- Final implementation dates and benchmarks for meeting the TMDL's applicable stormwater WLA. Once approved by the Department, any new TMDL implementation plan shall be incorporated into the Countywide Plan and subject to the annual progress report requirements under Part IV.F of the permit.

Annual progress toward meeting the TMDL SW-WLAs listed in Appendix A of the permit must be documented in the Countywide Plan and shall include:

- A summary of all completed BMPs, programmatic initiatives, alternative control practices, or other actions implemented for each TMDL stormwater WLA;
- An analysis and table summary of the net pollutant reductions achieved annually and cumulatively for each TMDL stormwater WLA;
- An updated list of proposed BMPs, programmatic initiatives, and alternative control practices, as necessary, to demonstrate adequate progress toward meeting the Department's approved benchmarks and final stormwater WLA implementation dates

III. Introduction

A. Chesapeake Bay TMDL and Progress Modeling Approach

The Chesapeake Bay TMDL was approved on December 29, 2010 and applies to all of Anne Arundel County. On September 15, 2011 MDE finalized its Phase II Load Allocations and on July 2, 2012 Anne Arundel County submitted its Phase II WIP to MDE. Anne Arundel County's Phase II WIP serves as the restoration plan for the SW-WLAs for each impairment addressed by the Chesapeake Bay TMDL.[1] At the time of writing this report, the final date for meeting the Chesapeake Bay TMDL SW-WLA is 2025, as set by the U.S. Environmental Protection Agency (EPA).

Chesapeake Bay TMDL progress load reductions, calculated in lbs and percent, are calculated for all completed restoration projects and County programmatic reductions, using an in-house R script. The script follows MDE's guidance document "Accounting for Stormwater Wasteload Allocation and Impervious Acres Treated; Guidance for National Pollutant Discharge Elimination System Stormwater Permits, August 2014", individual expert panel reports from Chesapeake Bay Program (CBP), and any communications with MDE that clarify or modify existing credit guidance. Phase 5 edge of tide factors were applied to all BMPs, with the exception of street sweeping and catch basin cleaning practices, and stream restorations and shoreline restorations, which were credited under the default rate. From FY23 onwards, the County intends to assess Chesapeake Bay TMDL progress within each Bay segment using the TIPP tool.

B. Local Nutrient and Sediment TMDLs and Progress Modeling Approach

Anne Arundel County has one local nutrient TMDL, and nine local sediment TMDLs. The local nutrient TMDL, "Total Maximum Daily Loads of Nitrogen and Phosphorus for the Baltimore Harbor in Anne Arundel, Baltimore, Carroll and Howard Counties and Baltimore City, Maryland", was approved by EPA in 2007 and revised by MDE in August 2015. The nine local TMDLs, and their approval dates can be found in Table 1. Anne Arundel County established final dates for meeting the SW-WLAs in the individual sediment and nutrient TMDLs, approved by EPA prior to FY19, as 2025 and 2030, respectively. Individual sediment TMDLs approved in FY19 have a target date of 2030 for meeting the SW-WLA. The County began the development of an implementation plan for the Baltimore Harbor Watershed TMDL in FY22 and anticipates submitting a draft plan to MDE for comment by the end of calendar year 2022.

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[1] https://mde.maryland.gov/programs/water/TMDL/TMDLImplementation/Pages/WIPPhaseIICountyDocuments.aspx

Table 1: Anne Arundel County sediment TMDLs

TMDL Watershed	Approval Date of TMDL
Baltimore Harbor, 8 Digit WS 02130903	January, 27, 2022
Little Patuxent River, 8 Digit WS 02131105	September 30, 2011
Upper Patuxent River, 8 Digit WS 02131104	September 30, 2011
Patapsco River Lower North Branch, 8 Digit WS 02130906	September 30, 2011
South River, 8 Digit WS 02131003	September 28, 2017
Other West Chesapeake, 8 Digit WS 02131005	February 9, 2018
Middle Patuxent River, 8 Digit WS 02131102	July 2, 2018
Lower Patuxent River, 8 Digit WS 02131101	July 2, 2018
West River, 8 Digit WS 02131004	April 24, 2019

MDE's TIPP spreadsheet tool was used for all local nutrient and sediment TMDL progress modeling. Land cover data from the National Land Cover Database (NLCD) was used to quantify land cover acreage for each TMDL baseline year (either 1995, 2005, or 2009). NLCD data was used because the Chesapeake Conservancy (CC) land cover data, which reflects 2013/2014 conditions, does not reflect the baseline year land use conditions for each TMDL watershed. MS4 regulated land cover increased in many watersheds between the baseline years and 2013/2014, and therefore, relying on 2013/2014 land cover would inflate baseline year loads. The backcasting method developed by Baltimore County, and approved by MDE, resolves this issue. The backcasting method was applied to NLCD data and makes it consistent with the Phase 6 Chesapeake Bay Watershed Model land cover classes.

Backcasting was achieved by comparing 2013/2014 Chesapeake Conservancy (CC) land cover data, that was modified by MDE, to 2013 NLCD land cover data. Before backcasting, several steps were taken to preprocess both the NLCD and CC data. Firstly, MDE's classification of 'Mixed Open/Agriculture' was disaggregated into 'Mixed Open' and 'Agriculture'. This was achieved by reclassifying 'Mixed Open/Agriculture' to 'Agriculture' where the land cover classification intersected with a parcel having an agricultural assessment. All other occurrences of 'Mixed Open/Agriculture' that did not intersect with a parcel having an agricultural assessment were reclassified as 'Mixed Open'.

NLCD land cover data does not have an 'Impervious' land cover category, but is instead classified as different intensities of 'Developed'. To be consistent with Phase 6 Chesapeake Bay Watershed

Model land cover classes, all NLDC land cover data were reclassified as 'Impervious' if it intersected with the County's impervious land cover dataset. The 2007 County impervious data were used for the backcasting, regardless of the baseline year, as it was the earliest impervious dataset that provided an accurate representation of impervious surfaces in the County. Finally, NLCD data were clipped to the extent of the County MS4-regulated area, removing State, Federal, and any other land that does not fall under the County's jurisdiction.

The backcasting method was conducted for each nutrient and sediment TMDL watershed separately. Each TMDL watershed has a unique fingerprint of land cover classes and acreage, therefore the translation of NLCD land cover classes to CC land cover classes is expected to be unique for each watershed. Using both the 2013/2014 NLCD and CC land cover data, for each NLCD land cover category, the percentage of different CC land cover classes within each NLCD land cover class were summarized. Figure 1 shows the results of this comparison for all TMDL watersheds, and serves as the key with which to 'translate' NLCD data prior to 2014 and make data consistent with the Phase 6 Chesapeake Bay Watershed Model land cover classes. As seen in Figure 1, the NLCD land cover category 'Mixed Forest' in the South River comprises 88.5% of the CC land cover category 'Forest'. In contrast, the NLCD land cover category 'Developed, High Intensity' in the South River comprises 58.6% Turf, 22.8% Tree Canopy over Turf, and 7.3% Impervious.

For each baseline year, the NLCD land cover acreages were multiplied by the percentages of CC land covers presented in Figure 1, thereby transforming the NLCD land cover to CC land cover classes. Backcasted NLCD land cover data for each TMDL watershed is presented in Figure 2. As shown in Figure 2, urban land cover classes increased between 1995 and 2009, indicating the sensitivity of the backcasting method to land cover change and also the necessity of backcasting to make the baseline loads as accurate as possible. For each watershed, backcasted 'Aggregate Impervious' and 'Turf' acres were entered into the TIPP Tool to determine the baseline load. Land cover including 'Tree Canopy over Turf' and 'Tree Canopy over Aggregate Impervious' were added as land cover conversions from 'Turf'. In these cases, 'Tree Canopy over Turf' and 'Tree Canopy over Aggregate Impervious' acres were added to the baseline 'Turf' acres.

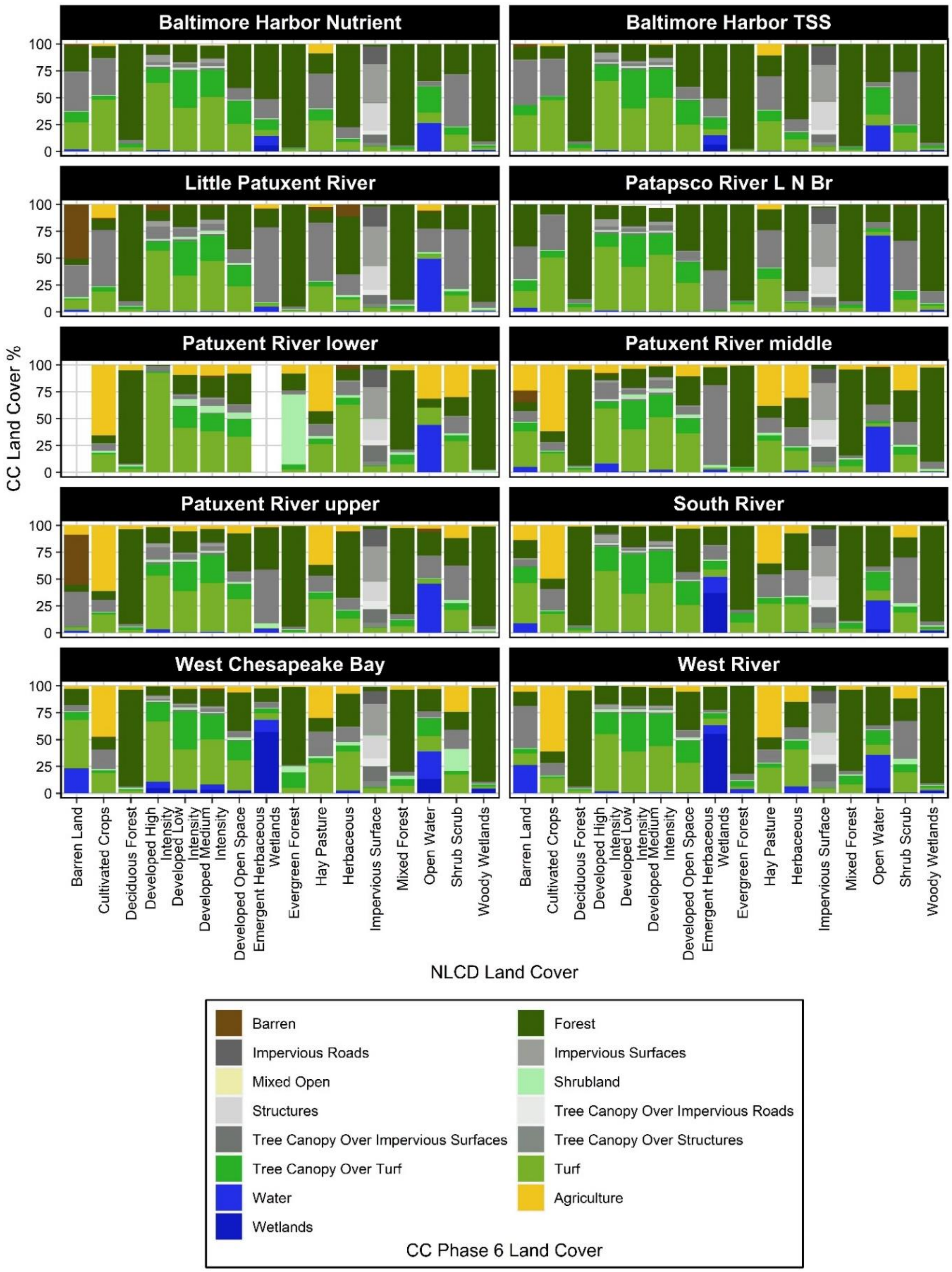

Figure 1: Unique NLCD-CC translations for each Nutrient and Sediment TMDL watershed. These relationships are used as a key to 'translate' NLCD data to Phase 6 Chesapeake Bay Watershed Model land cover classes.

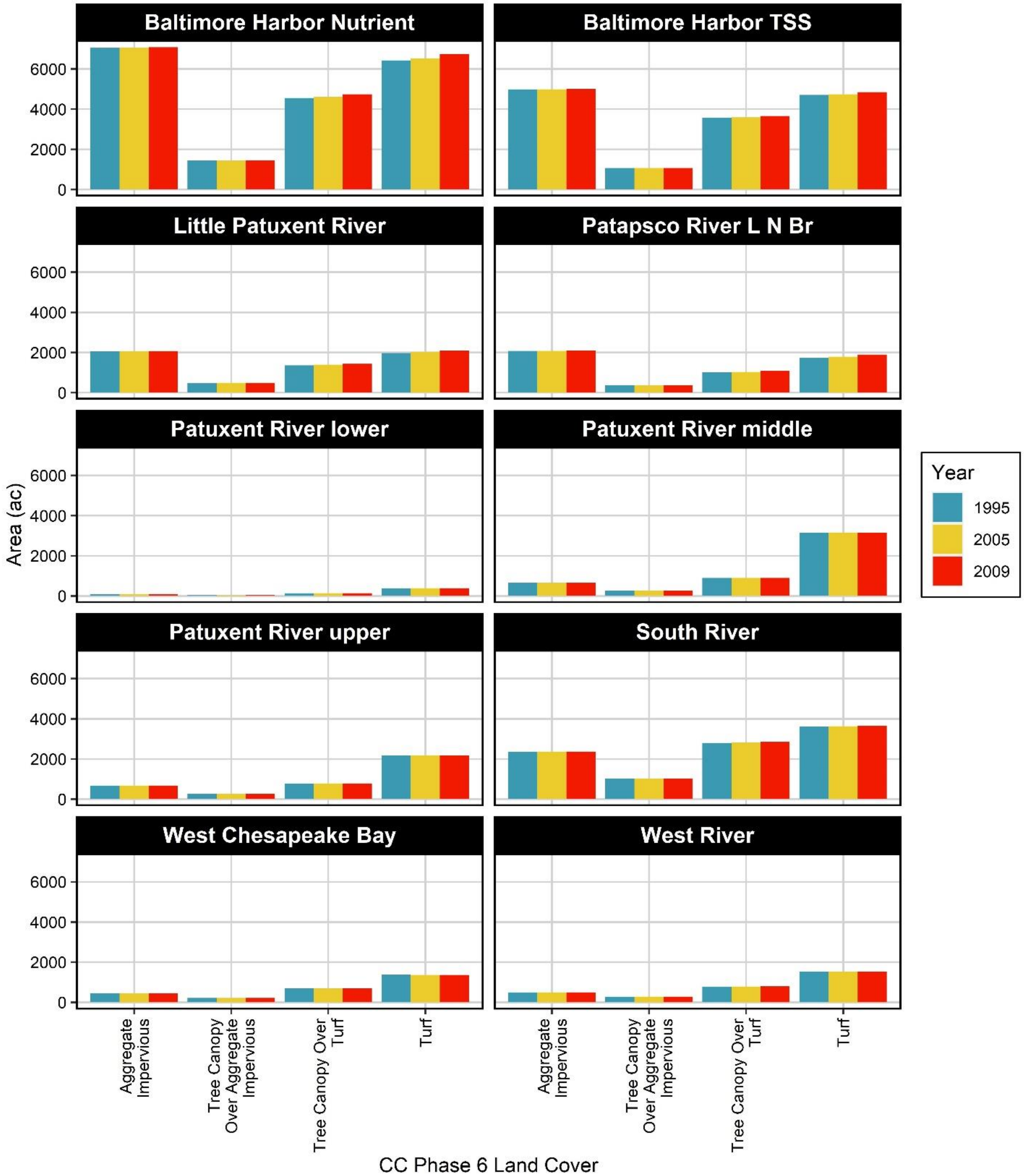

Figure 2: Backcasted MS4 land cover for each Nutrient and Sediment TMDL watershed

C. Bacteria

Anne Arundel County has 19 individual bacteria TMDLs, approved by EPA between November 2005 and August 2011 (Table 2). Pursuant to MDE guidance, compliance for bacteria TMDLs is assessed programmatically by monitoring activities rather than by modeling.

Table 2: Anne Arundel County bacterial TMDLs

TMDL Watershed	Approval Date
Magothy River Mainstem	February 20, 2006
Magothy River/Forked Creek	February 20, 2006
Magothy River/Tar Cove	February 20, 2006
Patapsco River/Furnace Creek	March 10, 2011
Patapsco River/Marley Creek	March 10, 2011
Patapsco River Lower North Branch, 8 Digit WS 02130906	December 3, 2009
Upper Patuxent River, Subsegment of 8 Digit WS 0213114	August 9, 2011
Rhode River/Bear Neck Creek	February 20, 2006
Rhode River/Cadle Creek	February 20, 2006
Severn River Mainstem, Subsegment of 8 Digit WS 02131002	April 10, 2008
Severn River/Mill Creek	April 10, 2008
Severn River/Whitehall & Meredith Creeks	April 10, 2008
South River/Duvall Creek	November 4, 2005
South River, Subsegment of 8 Digit WS 02131003	November 4, 2005
South River/Ramsey Lake	November 4, 2005
South River/Selby Bay	November 4, 2005
W. Chesapeake Bay/Tracy & Rockhold Creeks	February 20, 2006
West River, Subsegment of 8 Digit WS 02131004	February 20, 2006
West River/Parish Creek	February 20, 2006

D. Polychlorinated Biphenyls (PCBs)

Anne Arundel County has a total of six PCB TMDLs, only two of which have SW-WLAs requiring reductions. These two PCB TMDLs, the Baltimore Harbor, Curtis Creek/Bay and Bear Creek portions of the Patapsco River Mesohaline, and the Patuxent River – Tidal Fresh watersheds are shared with other jurisdictions, and were approved by EPA between October 2012 and September 2017 (Table 3). As with Bacteria TMDLs, compliance for PCB TMDLs is assessed programmatically by monitoring activities rather than by modeling.

Table 3: Anne Arundel County PCB TMDLs

TMDL Watershed	Approval Date
Baltimore Harbor, Curtis Creek/Bay, and Bear Creek portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment	October 1, 2012
Patuxent River – Tidal Fresh	September 19, 2017

Approved nutrient, sediment, bacteria and PCB TMDL restoration plans can be found in Appendix A. Draft TMDL restoration plans can be found in Appendix B.

IV. FY 22 BMP Implementation

In Fiscal Year (FY) 22, 9 alternative BMPs, 7 upland BMPs, 19 septic connections to WWTP (within bacterial TMDL watersheds only) were implemented, with 312.6 tons of material collected from annual practices including street sweeping and catch basin cleaning (Table 4).

Table 4: FY 22 BMP implementation in Anne Arundel County

BMP Type	Number/Tons
Infiltration Trench	1
Outfall Stabilization	2
Shoreline Restoration*	5
Step Pool Conveyance System	6
Stream Restoration	2
Septic Connections to WWTP**	19
Street Sweeping***	172.9
Catch Basin Cleaning***	139.7

* Only applicable to the Chesapeake Bay TMDL.

** Number of connections excludes those outside of Bacterial TMDL watersheds.

*** Annual practice totals for FY 22 only. Progress modeling used averages for FY 16-FY 18 and FY 17-FY 18 for street sweeping and catch basin cleaning, respectively.

A summary of interim programmed restoration and planned restoration via future planned BMPs are presented in Appendix C, Appendix D, and Appendix E respectively.

V. Chesapeake Bay TMDL Progress

Anne Arundel County's total nitrogen, total phosphorus, and total suspended sediment target loads (SW-WLAs) for the Chesapeake Bay are 449,641 lbs, 30,147 lbs, and 4,646,000 lbs, respectively, which are required to be achieved by 2025. These SW-WLAs equate to required reductions of 31.6%, 46.7%, and 67.3% for the 2009 baseline loads of nitrogen, phosphorus, and sediment.

In previous NPDES permits, the SW-WLAs and the annual progress the County made in meeting them were reported at the county-level. Within the County's recently issued NPDES permit, county-level SW-WLAs for nitrogen and phosphorus are disaggregated for each Chesapeake Bay Model Phase 5 segment (Bay segment). The SW-WLAs, required reductions, and FY22 progress, expressed as a percentage, in meeting these reductions are presented in Table 5 and Table 6. Sediment SW-WLAs are not presented for each Bay segment as the State of Maryland did not set individual sector targets for sediment within the Chesapeake Bay Phase II Watershed Implementation Plan. Based on experience from the Chesapeake Bay Phase I Watershed Implementation Plan, the State of Maryland expected that reductions in phosphorus would result in concurrent sediment reductions to satisfy the sediment SW-WLA.

Table 5: FY 22 Chesapeake Bay TMDL TN progress for each Bay segment within Anne Arundel County

Bay Segment	Target TN Load (lbs/year)	Required TN Reduction (%)	FY 22 TN Reduction (%)
Upper Chesapeake Bay Mesohaline	1,003	37	0.1
Middle Chesapeake Bay Mesohaline	31,594	36	13.8
Magothy River Mesohaline	71,725	36	8.7
Patapsco River Mesohaline	114,652	35	4.8
Middle Patuxent River Oligohaline	2,843	27	0.0
Upper Patuxent River Tidal Fresh	116,661	15	1.9
Rhode River Mesohaline	7,559	36	11.6
Severn River Mesohaline	72,485	36	4.8
South River Mesohaline	57,140	36	13.7
West River Mesohaline	8,692	36	1.9

Table 6: FY 22 Chesapeake Bay TMDL TP progress for each Bay segment within Anne Arundel County

Segment	Target TP Load (lbs/year)	Required TP Reduction (%)	FY 22 TP Reduction (%)
Upper Chesapeake Bay Mesohaline	66	52	0.2
Middle Chesapeake Bay Mesohaline	2,119	51	38.8
Magothy River Mesohaline	4,954	51	15.3
Patapsco River Mesohaline	8,080	49	9.0
Middle Patuxent River Oligohaline	173	45	0.0
Upper Patuxent River Tidal Fresh	6,498	29	6.9
Rhode River Mesohaline	490	52	58.3
Severn River Mesohaline	5,038	51	9.5
South River Mesohaline	3,986	50	46.8
West River Mesohaline	572	52	11.9

In FY 22, Anne Arundel County's cumulative county-wide reductions of nitrogen, phosphorus, and sediment were 7.2%, 19%, and 119.1%, respectively. These reductions were achieved via restoration BMPs as well as street sweeping (annual average of 193.8 tons removed) and storm drain cleaning (annual average of 174.5 tons removed).

Figure 3 and Figure 4 show the load reduction progress (in tons) for each bay segment, showing the target load and required reduction (with the sum being the baseline load), and the FY22 cumulative progress reduction and interim planned reduction (with the sum being the total implemented and planned load reduction). Figure 3 and Figure 4 help identify where the County needs to expand the current inventory of planned projects to address the SW-WLA in each Bay segment.

As shown in Table 5 and
Table 6 and in Figure 3 and Figure 4, load reduction progress at the Bay Segment is variable, with some segments having significantly more BMP implementation than others. Likewise, as Figure 3 and Figure 4 indicate, the Interim Planned Reduction in some Bay segments, defined as projects that are currently under design, will not be enough to meet the required reduction. However, the County anticipates that grant funding mechanisms such as the annual 'Full Delivery of Turnkey Water Quality Improvements' and the 'Anne Arundel County Watershed Restoration Grant Program' will be enough to meet the required SW-WLAs in each Bay segment.

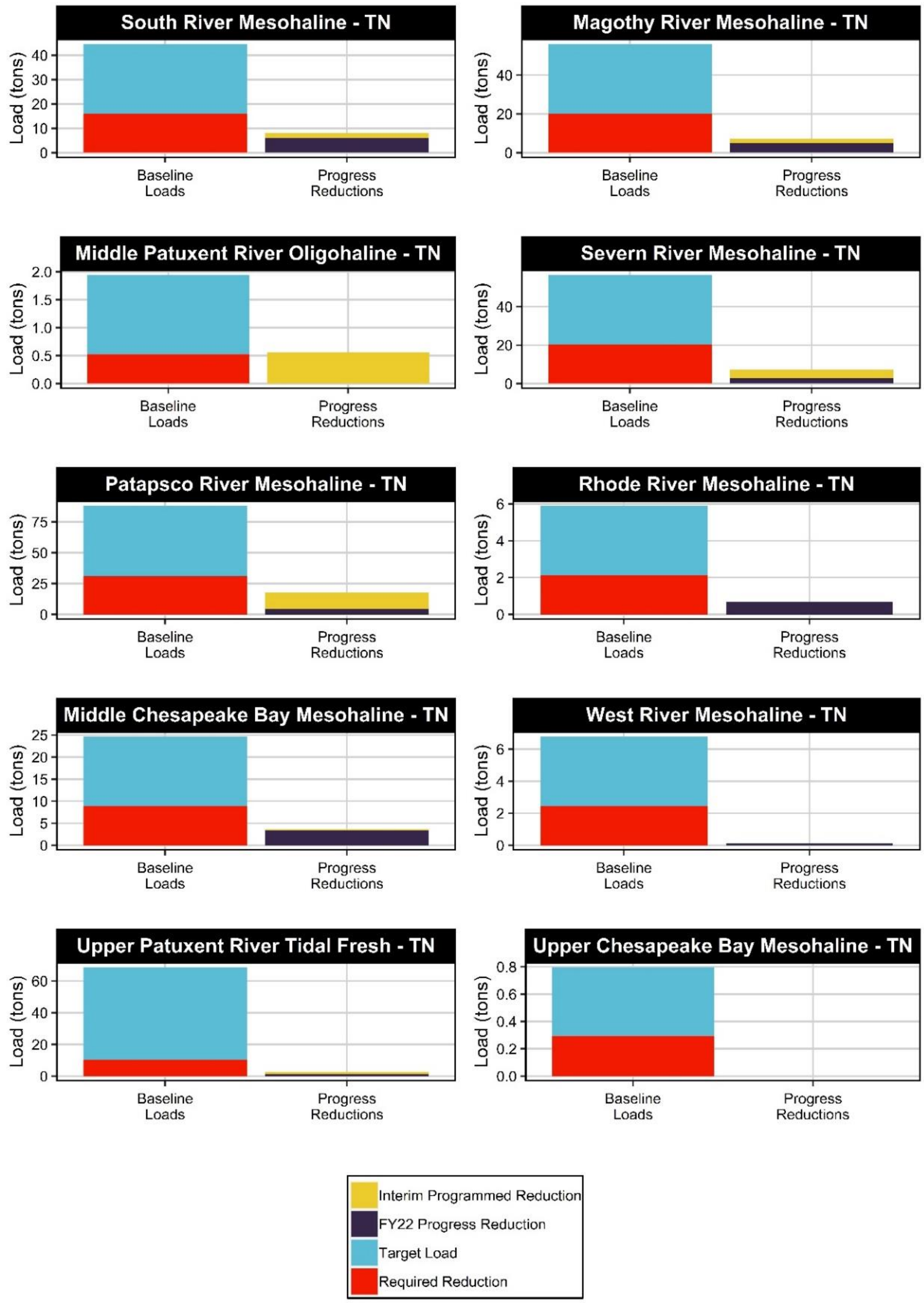

Figure 3: Baseline and progress TN loads for each Bay segment within Anne Arundel County. Where the sum of progress and interim programmed reductions are smaller than the required reductions, the County needs to expand the current inventory of planned projects to address the SW-WLA in each Bay segment.

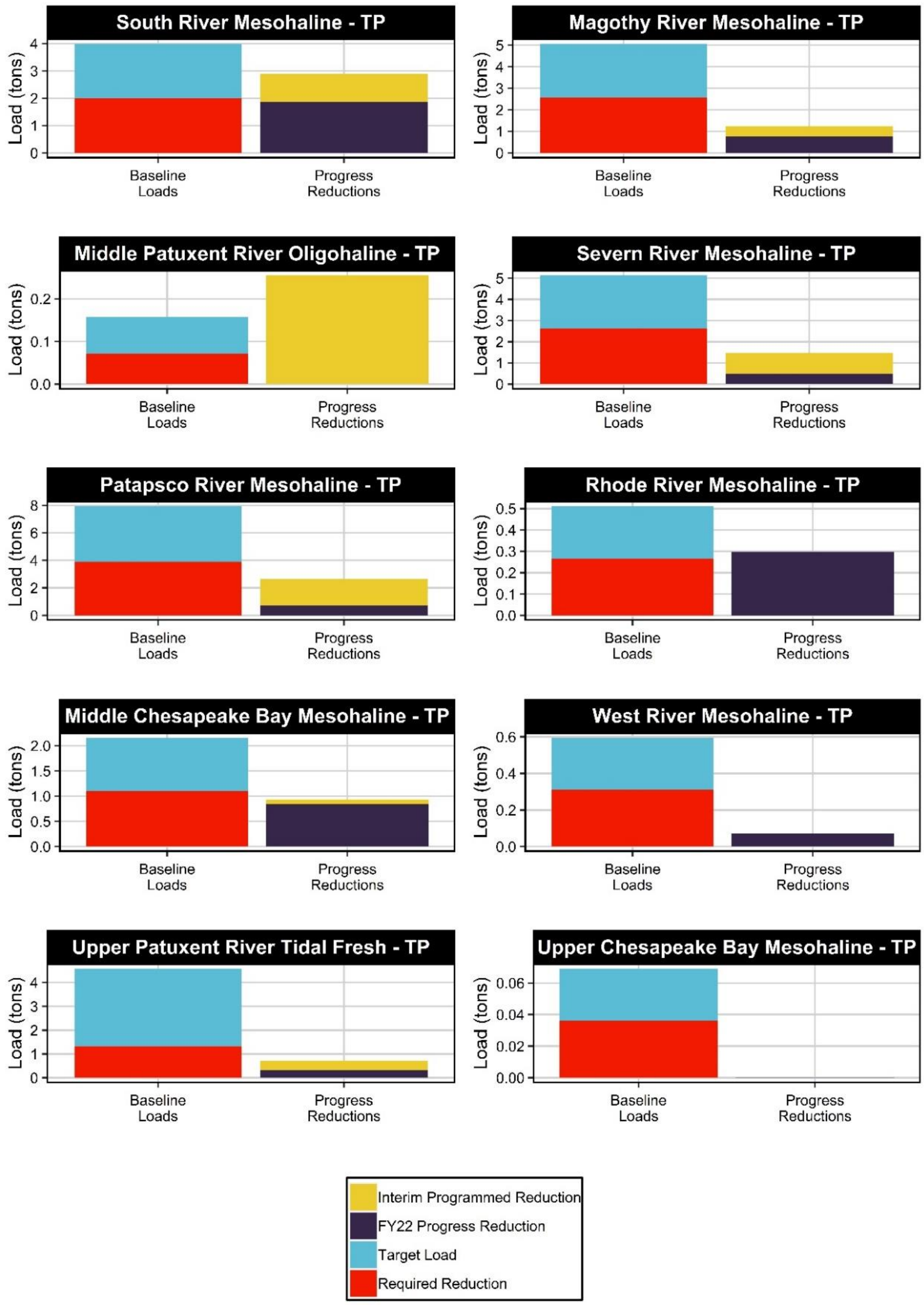

Figure 4: Baseline and progress TP loads for each Bay segment within Anne Arundel County. Where the sum of progress and interim programmed reductions are smaller than the required reductions, the County needs to expand the current inventory of planned projects to address the SW-WLA in each Bay segment.

VI. Local Sediment and Nutrient TMDL Progress

The location of the nine local TMDLs within Anne Arundel County are presented in Figure 5. Each TMDL's nitrogen, phosphorus, and sediment target load (SW-WLAs) is presented in Table 7, along with the completion year, FY 22 progress, FY 22 cumulative progress, and the expected progress by the completion year. Based on the current interim programmed and planned projects (Appendix C and Appendix D), the SW-WLAs for each TMDL are expected to be met for all local sediment and nutrient TMDLs.

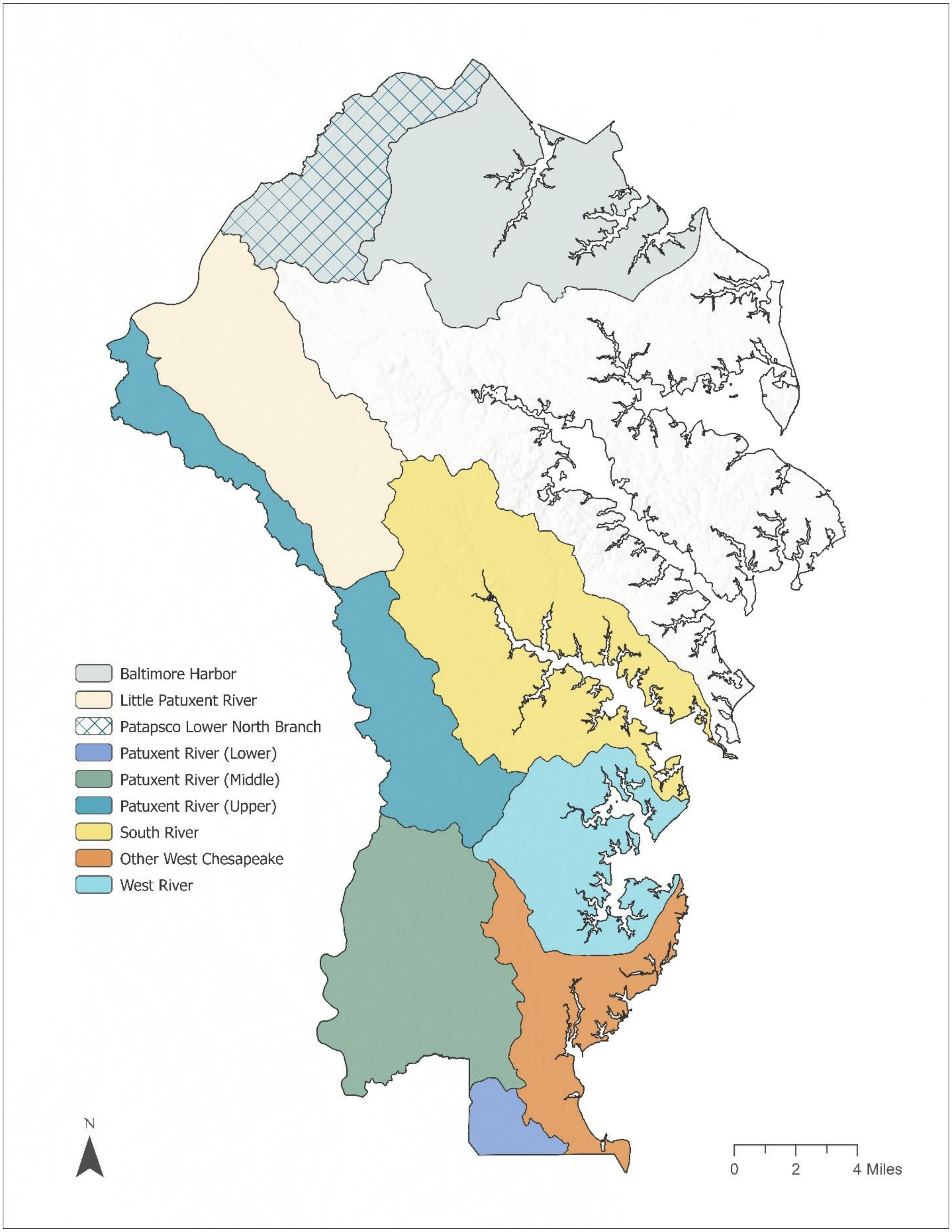

Figure 5: Map of local TSS and nutrient TMDL watersheds

Table 7: Local TSS and nutrient TMDL progress

Watershed	TMDL	Target Load (lbs)	Required Reduction (%)	Completion Year	FY22 Cumulative Progress (%)*	Completion Year Progress (%)*
Baltimore Harbor	TP	18,380.3	15%	2030	6.1%	32.6%
Baltimore Harbor	TN	232,941.4	15%	2030	3.0%	15.8%
Baltimore Harbor	TSS	9,102,809.8	58%	2030	8.5%	58.1%
Little Patuxent	TSS	15,047,258	20.5%	2025	9.5%	34.8%
Lower Patuxent	TSS	767,132.1	61%	2030	0.0%	69.8%
Middle Patuxent	TSS	6,982,285.2	56%	2030	0.2%	57.5%
Upper Patuxent	TSS	11,314,309.7	11.4%	2025	1.8%	11.9%
Patapsco Lower North Branch	TSS	12,960,021	22.2%	2025	6.9%	22.8%
South River	TSS	13,634,211.2	28%	2025	32.1%	66.6%
Other West Chesapeake	TSS	7,363,965.3	33%	2030	1.3%	34.5%
West River	TSS	7,150,213.7	22%	2030	0.7%	24.5%

* Orange shading indicates TMDL compliance has been achieved in FY22. Light green shading indicates TMDL compliance is expected to be met or exceeded by the completion year.

A. Sediment TMDLs

Figure 6 shows the progress, expressed in lbs, in each TMDL watershed, showing the target load and required reduction (with the sum being the baseline load), and the FY22 cumulative progress reduction, interim planned reduction, and planned reduction (with the sum being the total implemented and planned load reduction). Figure 6 helps identify where the County needs to expand the current inventory of planned projects to address the SW-WLA in each TMDL watershed. In watersheds such as South River, the FY 22 progress reduction comprises the greatest amount, whereas others, such as Patapsco Lower North Branch, load reductions equally split between FY 22 progress load reductions, programmed load reductions, and planned load reduction.

Figure 7 shows the breakdown of load reductions by BMP type for FY 22 progress load reductions, programmed load reductions, and planned load reductions. As shown in Figure 7, the majority of load reductions come from stormwater management BMPs and stream restorations. Within the more rural TMDL watersheds, stream restorations make up the bulk of TSS reductions due to limited stormwater management BMP retrofit opportunities.

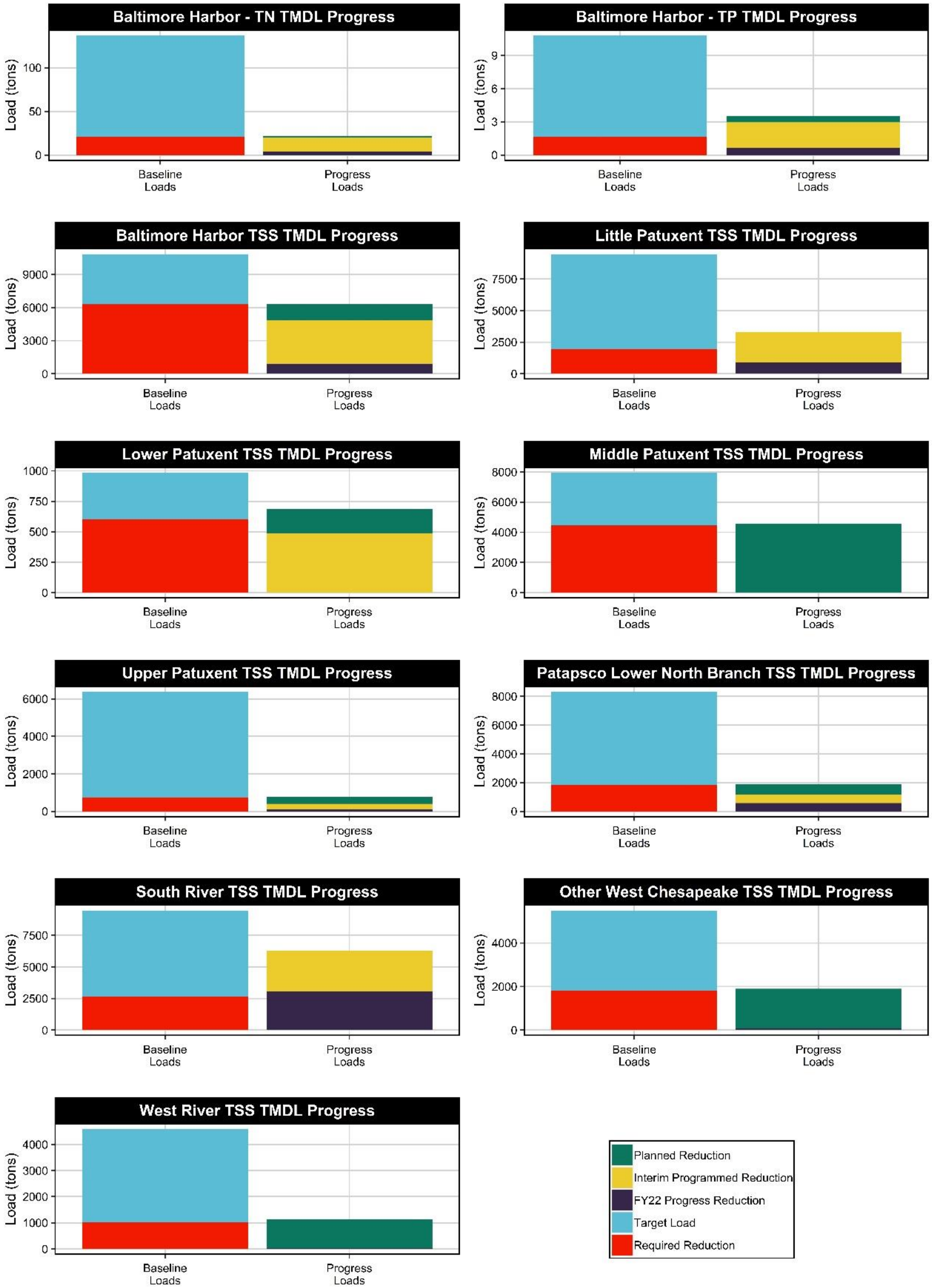

Figure 6: Baseline and progress loads within each TMDL watershed. Where the sum of progress, interim programmed reductions, and planned are smaller than the required reductions, the County needs to expand the current inventory of planned projects to address the SW-WLA in each Bay segment.

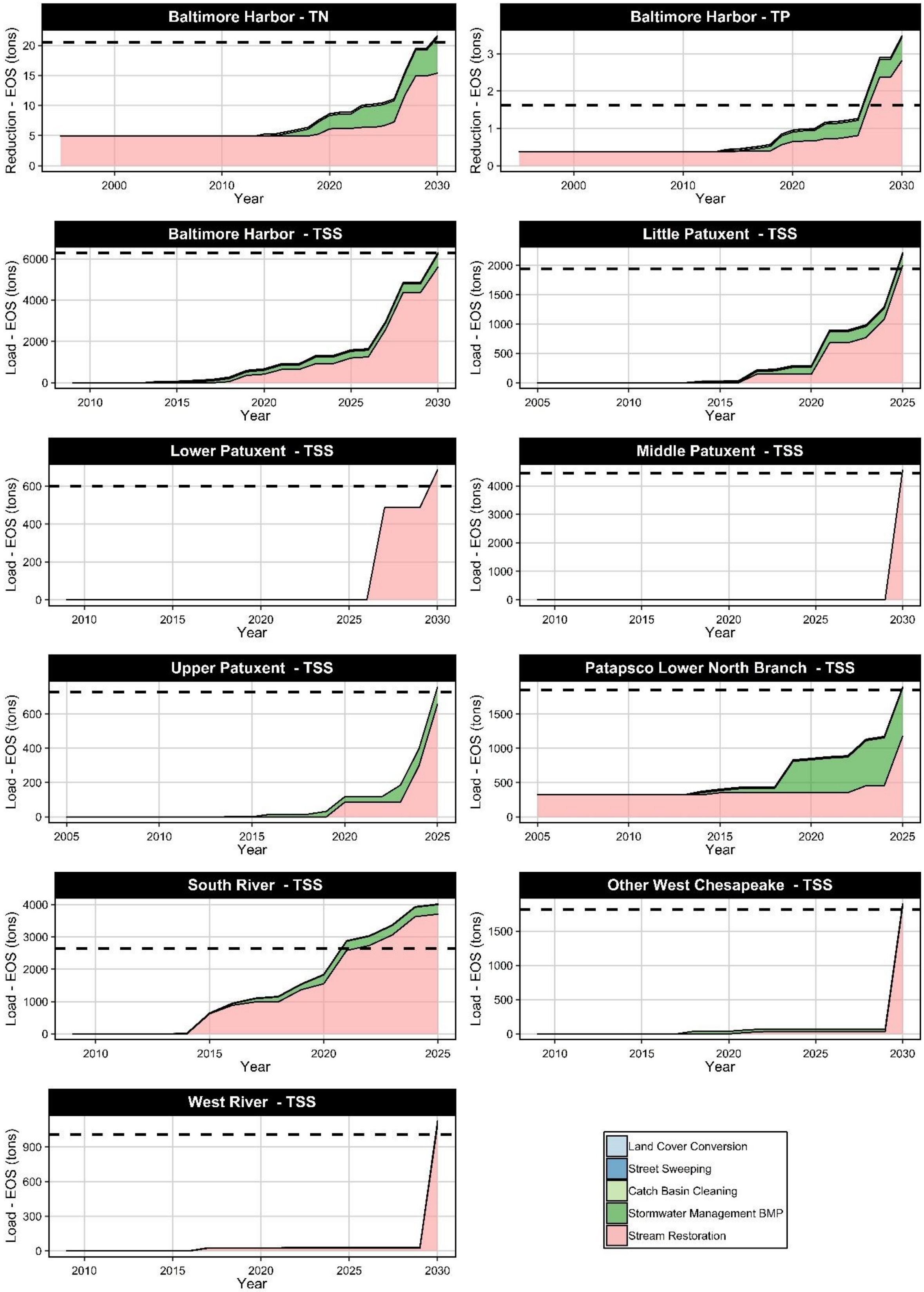

Figure 7: Expected load reductions by BMP type within each TMDL watershed.

1. Baltimore Harbor

The Baltimore Harbor Watershed is situated in the northern portion of the County, and shares political boundaries with Baltimore City, Baltimore, Carroll, and Howard Counties (Figure 8). The Anne Arundel County portion of the Baltimore Harbor watershed is approximately 30,357 acres (47.4 square miles) in area and contains approximately 160.4 total miles of stream reaches.

The target sediment load for the Baltimore Harbor is 9,102,810 pounds per year - a 58% reduction from the baseline by 2030. Current FY 22 progress shows a reduction of 1,843,172 pounds (8.5%). Total interim programmed and planned restoration will result in a further 10,745,078 pounds of reduction, resulting in a total of 58.1% reduction by the completion year (Table 8).

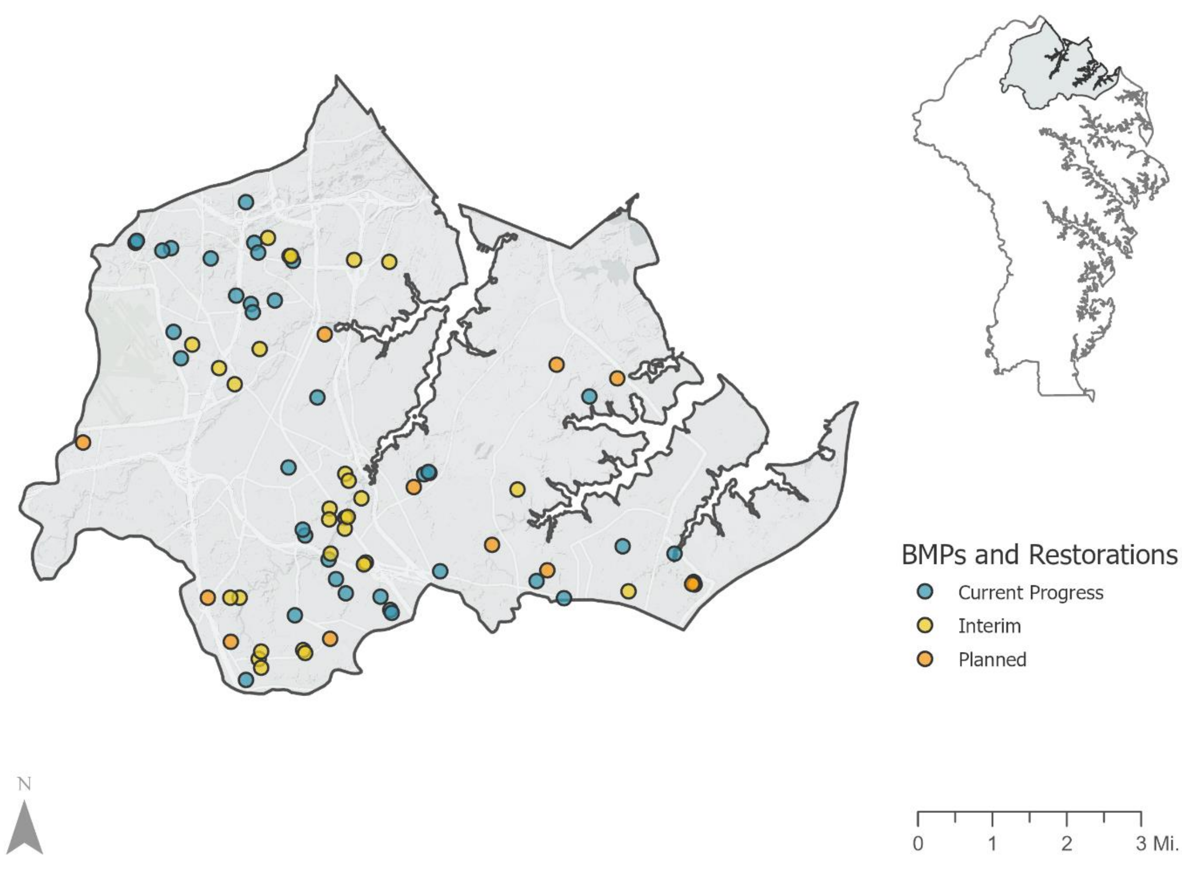

Figure 8: Map of the Baltimore Harbor TSS TMDL watershed

The Baltimore Harbor FY 22 progress reduction (8.5%) was achieved via street sweeping (~60.2 lane miles), storm drain cleaning (~252,066 pounds), 35 stormwater management practices, three land cover conversion BMPs (2.81 acres) and five stream restorations (5,765 linear feet). The interim programmed and planned reduction consists of 22 stormwater management practices and 23 stream restorations (41,875 linear feet) and will achieve compliance with the TMDL. See Appendix C and Appendix D for information on individual projects. Note that there are 6 BMPs providing water quality treatment in this watershed that are not shown in Figure 8. The drainage areas for these BMPs overlap significantly with the Baltimore Harbor TMDL watershed, but their centroids fall outside the boundary used for mapping. These BMP drainage areas are determined from high-resolution QL1 LiDAR, and as such are more accurate than the MD 8-digit watershed boundaries.

The top three projects that provide the greatest sediment reductions in the Baltimore Harbor are:

- BMP0291, a stream restoration that reduces 610,000 lbs of sediment annually;
- BMP0746, a stream restoration that reduces 283,869.2 lbs of sediment annually; and
- BMP0003, Protocol 5 reductions associated with a step-pool conveyance system that reduces 166,454.5 lbs of sediment annually.

Table 8: TMDL summary for Baltimore Harbor TSS

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	21,673,357
FY22 Progress Load (lbs)	19,830,185
FY30 Planned Load (lbs)	9,085,106
FY22 Percent Reduction	8.5%
FY30 Percent Reduction	58.1%
Target TMDL WLA Reduction	58.0%

Anne Arundel County began development of an implementation plan in FY22 to address the sediment load reduction required by the '*Total Maximum Daily Load of Sediment in the Baltimore Harbor Watershed, Baltimore City, Baltimore County, and Anne Arundel County*' that was approved by EPA on January 27, 2022. A copy of the plan is submitted in Appendix B and will be advertised for public comment by the end of calendar year 2022.

2. Patuxent River (Little Patuxent River, Upper Patuxent River, Middle Patuxent River, and Lower Patuxent River)

a. Little Patuxent

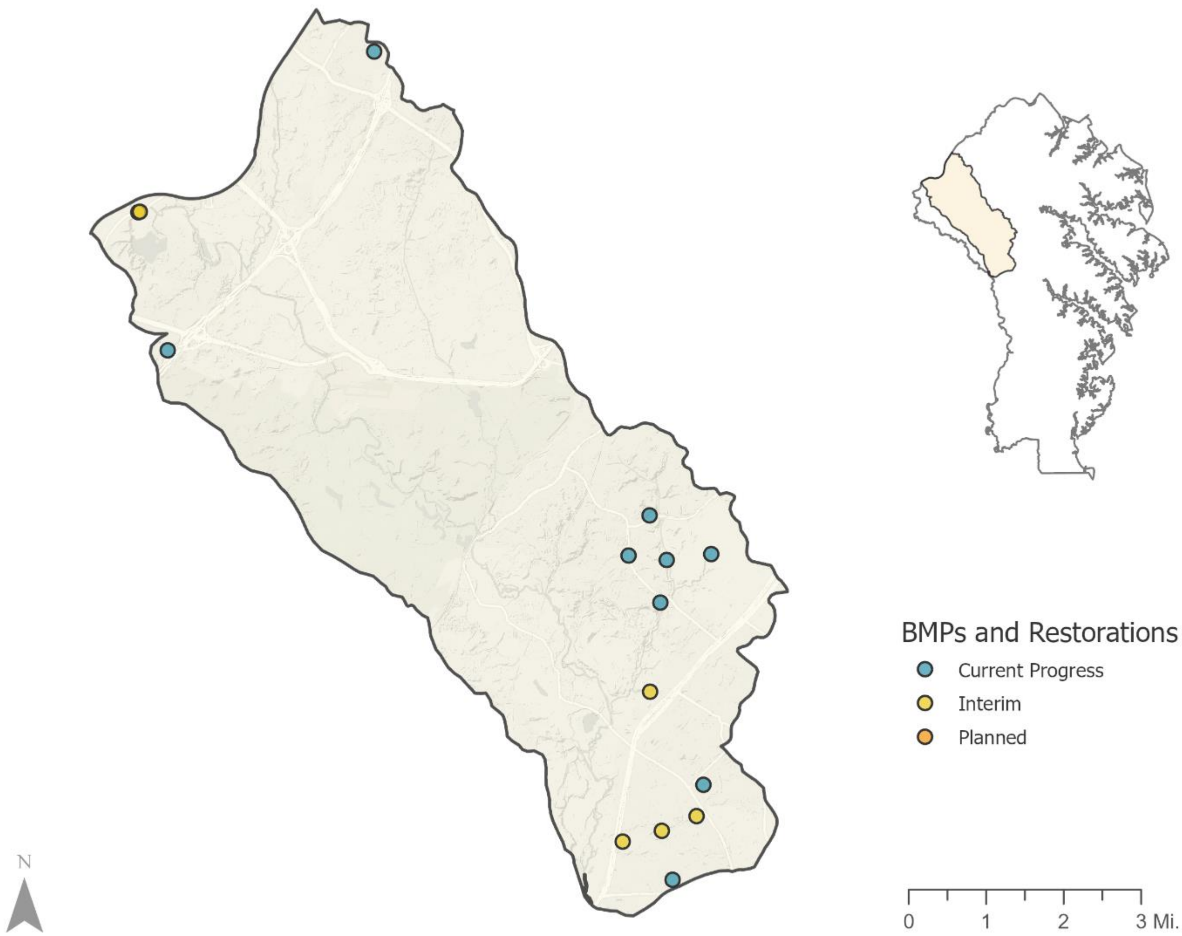

Figure 9: Map of the Little Patuxent River TSS TMDL watershed

The Little Patuxent is situated in the western portion of the County, and shares political boundaries with Howard County (Figure 9). Anne Arundel County's portion of the Little Patuxent watershed is approximately 27,752 acres (43.4 square miles) in area and contains approximately 1,200 total miles of stream reaches.

The target sediment load for the Little Patuxent is 15,047,258 pounds per year - a 20.5% reduction from the baseline by 2025. Current FY 22 progress shows a reduction of 1,798,832 pounds (9.5%).

Total interim programmed restoration will result in a further 4,782,277 pounds of reduction, resulting in a total of 34.77% reduction by the completion year (Table 9).

The Little Patuxent FY 22 progress reduction (9.5%) was achieved via annual street sweeping (~45 lane miles), annual storm drain cleaning (~33,414 pounds), eight stormwater management practices, and four stream restorations (4,221 linear feet). The interim programmed reduction consists of three stormwater management practices and five stream restorations (13,264 linear feet) and will achieve compliance with the TMDL. See Appendix C and Appendix D for information on individual projects. Note that there is one BMP providing water quality treatment in this watershed that is not shown in Figure 9. The drainage areas for this BMP overlaps significantly with the Little Patuxent TMDL watershed, but its centroids falls outside the boundary used for mapping. These BMP drainage areas are determined from high-resolution QL1 LiDAR, and as such are more accurate than the MD 8-digit watershed boundaries.

The top three projects that provide the greatest sediment reductions in the Little Patuxent are:

- BMP0324, a stream restoration that reduces 620,053 lbs of sediment annually;
- BMP0221, a stream restoration that reduces 454,000 lbs of sediment annually; and
- BMP0266, a stream restoration that reduces 250,728 lbs of sediment annually.

Table 9: TMDL summary for Little Patuxent TSS

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	18,927,368
FY22 Progress Load (lbs)	17,128,536
FY30 Planned Load (lbs)	12,346,259
FY22 Percent Reduction	9.5%
FY30 Percent Reduction	34.8%
Target TMDL WLA Reduction	20.5%

b. Upper Patuxent

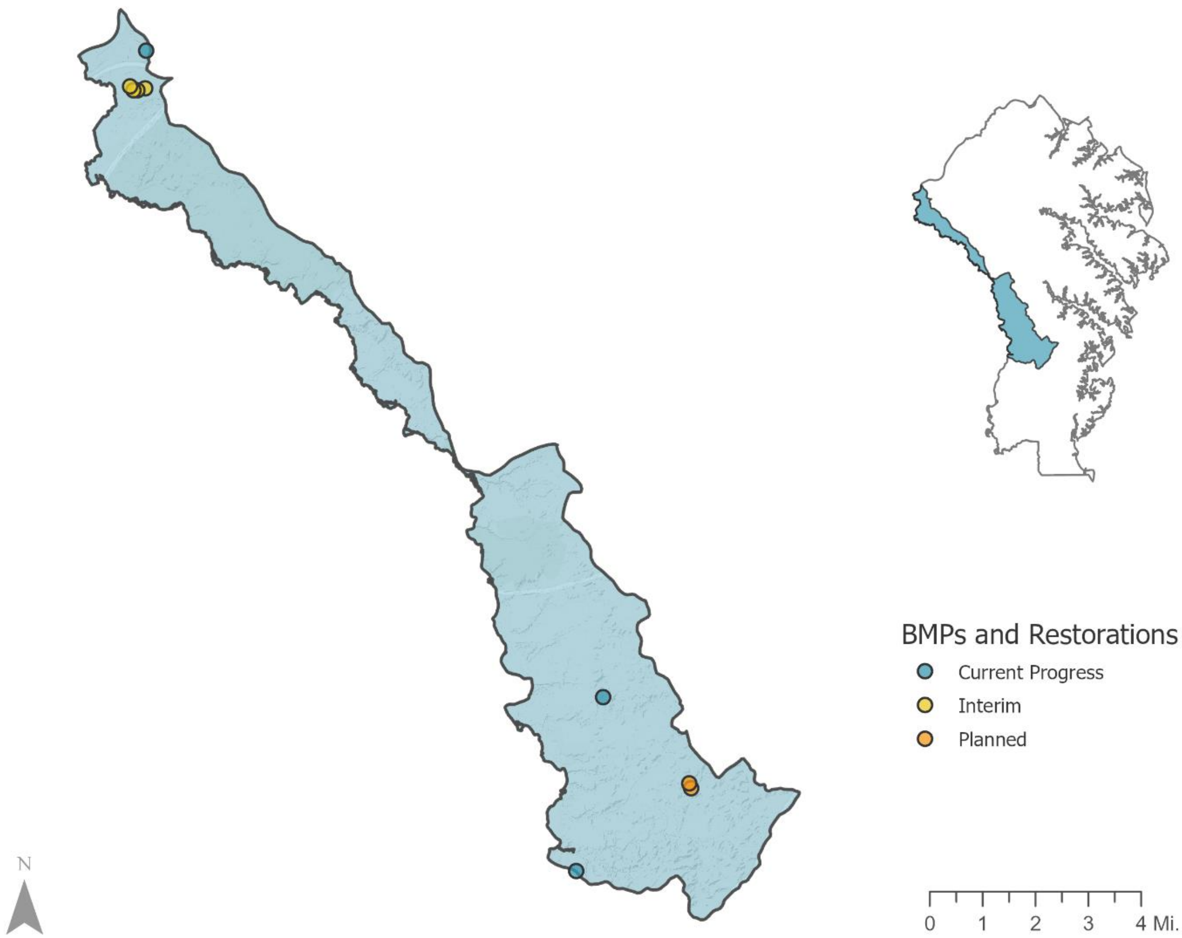

Figure 10:Map of the Upper Patuxent River TSS TMDL watershed

The Upper Patuxent is situated in the western portion of the County, and shares political boundaries with Prince George's County along the Patuxent River and a small portion of Howard County (Figure 10). Anne Arundel County's portion of the Upper Patuxent watershed is approximately 22,420 acres (35.0 square miles) in area and contains approximately 90 total perennial miles of stream reaches.

The target sediment load for the Upper Patuxent is 11,314,310 pounds per year - an 11.4% reduction from the baseline by 2025. Current FY 22 progress shows a reduction of 235,384 pounds (1.84%), with a total interim programmed restoration of 560,777 pounds. Planned restoration will result in a further 719,200 lbs of reduction, resulting in a total of 11.87% reduction by the completion year (Table 10).

The Upper Patuxent FY 22 progress reduction (1.84%) was achieved via annual street sweeping (~0.1 lane miles), annual storm drain cleaning (~1,516 pounds), two stormwater management practices, one stream restoration (236 linear feet) The interim programmed reduction consists of three stormwater management practices and one stream restoration (2,518 linear feet). The planned reduction consists of two stream restorations (2,900 linear feet) and will achieve compliance with the TMDL. See Appendix C and Appendix D for information on individual projects.

The top three projects that provide the greatest sediment reductions in the Upper Patuxent are:

- BMP0289, a stream restoration that reduces 171,500 lbs of sediment annually;
- BMP0197, a stormwater management BMP that reduces 32,808.7 lbs of sediment annually; and
- BMP0068, a stormwater management BMP that reduces 30,279.8 lbs of sediment annually.

Table 10: TMDL summary for Upper Patuxent TSS

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	12,770,101
FY22 Progress Load (lbs)	12,534,717
FY30 Planned Load (lbs)	11,254,740
FY22 Percent Reduction	1.8%
FY25 Percent Reduction	11.9%
Target TMDL WLA Reduction	11.4%

c. Lower Patuxent

The Lower Patuxent is located in the southernmost portion of the county, and shares political boundaries with Calvert County (Figure 11). 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 Anne Arundel County portion of the Lower Patuxent watershed is approximately 3,217 acres (5 square miles) and contains approximately 24.7 miles of streams.

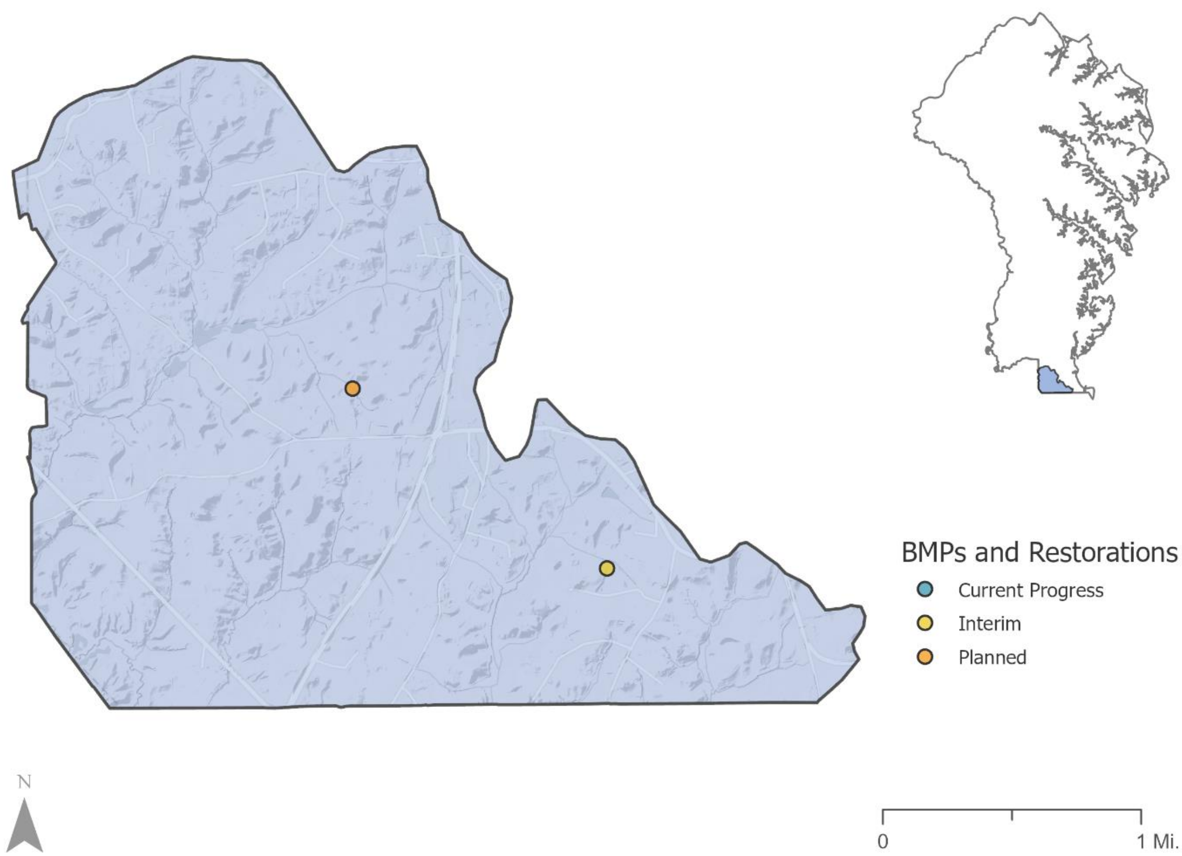

Figure 11: Map of the Lower Patuxent River TSS TMDL watershed

The target sediment load for the Lower Patuxent is 767,132 pounds per year - a 61% reduction from the baseline by 2030. Current FY 22 progress shows a reduction of 0 pounds (0%), with a total interim programmed restoration of 973,878 pounds. Planned restoration will result in a further 398,214 lbs of reduction, resulting in a total of 69.8% reduction by the completion year (Table 11).

The Lower Patuxent interim programmed reduction consists of one stream restoration (2,906 linear feet) that will reduce 973,878 lbs of sediment annually. The planned reduction consists of one stream restoration (1,606 linear feet) that will reduce 398,213.6 lbs of sediment annually and will achieve compliance with the TMDL. See Appendix C and Appendix D for information on individual projects.

Table 11: TMDL summary for Lower Patuxent TSS

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	1,967,005
FY22 Progress Load (lbs)	1,967,005
FY30 Planned Load (lbs)	594,914
FY22 Percent Reduction	0%
FY30 Percent Reduction	69.8%
Target TMDL WLA Reduction	61.0%

d. Middle Patuxent

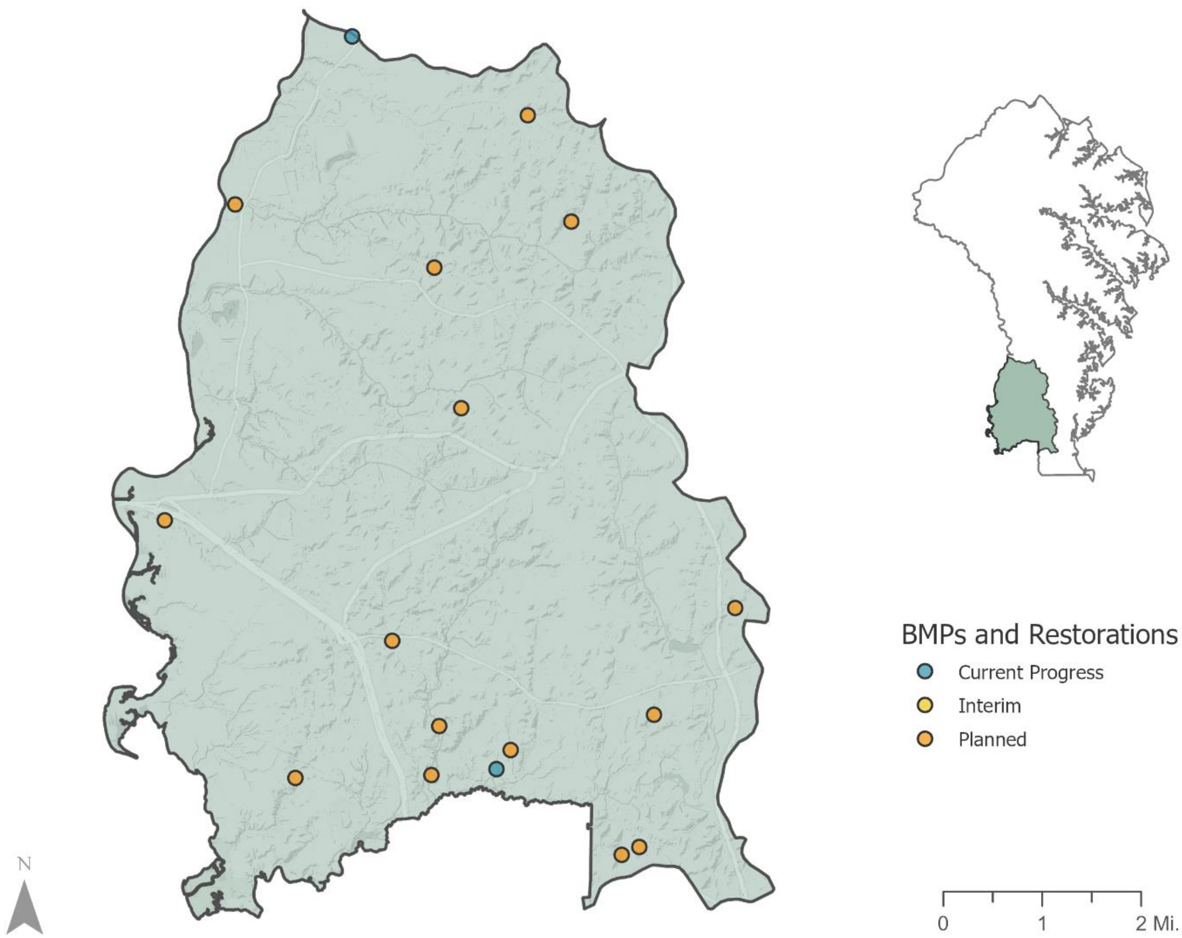

Figure 12: Map of the Middle Patuxent River TSS TMDL watershed

The Middle Patuxent watershed is located in the southwest portion of the county, and 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 (Figure 12). The Anne Arundel County portion of the Middle Patuxent watershed is approximately 26,490 acres (41.4 square miles) and contains approximately 228 miles of streams.

The target sediment load for the Middle Patuxent is 6,982,285 pounds per year - a 56% reduction from the baseline by 2030. Current FY 22 progress shows a reduction of 24,499 pounds (0.15%). Planned restoration will result in a further 9,094,964 lbs of reduction, resulting in a total of 57.47% reduction by the completion year (Table 12).

The Middle Patuxent FY 22 progress reduction (0.15%) was achieved via annual street sweeping (~1.1 lane miles), annual storm drain cleaning (~882 pounds), one stream restoration (2,266 linear feet), and two land use conversion practice (1.5 acres). The planned reduction consists of fifteen stream restorations (36,673 linear feet) and will achieve compliance with the TMDL. See Appendix C and Appendix D for information on individual projects.

The top three projects that provide the greatest sediment reductions in the Middle Patuxent are:

- BMP0779, an outfall stabilization that reduces 19,784.7 lbs of sediment annually;
- BMP0413, a land cover conversion practice that reduces 1,987.9 lbs of sediment annually; and
- BMP0418, a land cover conversion practice that reduces 1,197.3 lbs of sediment annually.

Table 12: TMDL summary for Middle Patuxent TSS

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	15,868,830
FY22 Progress Load (lbs)	15,844,331
FY30 Planned Load (lbs)	6,749,368
FY22 Percent Reduction	0.2%
FY30 Percent Reduction	57.5%
Target TMDL WLA Reduction	56.0%

3. Patapsco River Lower North Branch

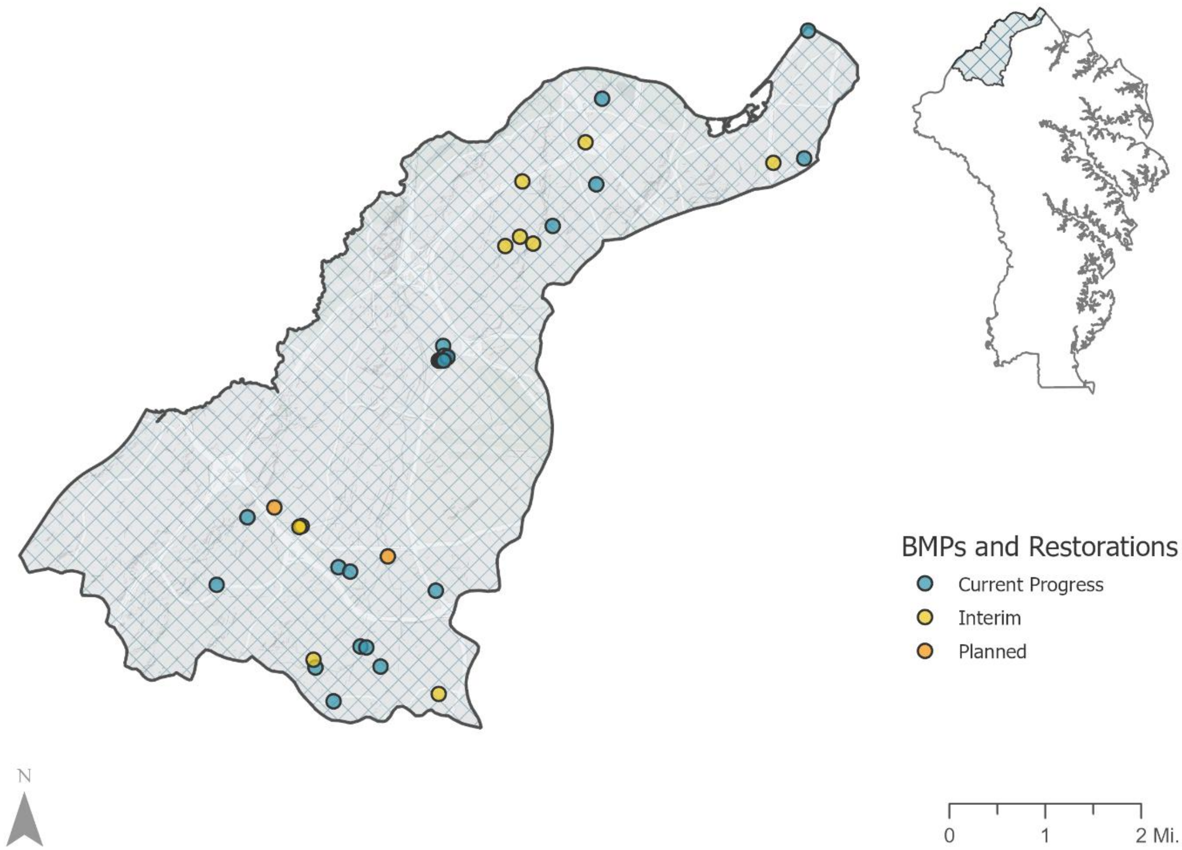

Figure 13: Map of the Patapsco River Lower North Branch TSS TMDL watershed

The Patapsco LNB is situated in the northwestern portion of the County, and shares political boundaries with Howard County along Deep Run and Baltimore County along the mainstem of the Patapsco River (Figure 13). The downstream extent of the watershed borders Baltimore City. Anne Arundel County's portion of the Patapsco LNB watershed is approximately 15,270 acres (23.9 square miles) in area and contains approximately 96 miles of streams.

The target sediment load for the Patapsco LNB is 12,960,021 pounds per year - a 22.2% reduction from the baseline by 2025. Current FY 22 progress shows a reduction of 1,141,663 pounds (6.85%), with a total interim programmed restoration of 1,209,034 pounds. Planned restoration will result in a further 1,442,640.8 lbs of reduction, resulting in a total of 22.77% reduction by the completion year (Table 13).

The Patapsco LNB FY 22 progress reduction (12.23%) was achieved via annual street sweeping (~33.5 lane miles), annual storm drain cleaning (~24,442 pounds), and 23 stormwater management practices and one stream restoration (250 linear feet). The interim programmed reduction consists of three stream restorations (13,118 linear feet), two land use conversions (0.33 acres), and six stormwater management practices. The planned reduction consists of two stream restorations (5,817 linear feet) and will achieve compliance with the TMDL. See Appendix C and Appendix D for information on individual projects.

The top three projects that provide the greatest sediment reductions in the Patapsco Lower North Branch are:

- BMP0198, a stormwater management BMP that reduces 505,990.6 lbs of sediment annually;
- BMP0168, a stormwater management BMP that reduces 129,093.8 lbs of sediment annually; and
- BMP0234, a stormwater management BMP that reduces 105,466.3 lbs of sediment annually.

Table 13: TMDL summary for Patapsco Lower North Branch TSS

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	16,658,125
FY22 Progress Load (lbs)	15,516,462
FY30 Planned Load (lbs)	12,864,787
FY22 Percent Reduction	6.9%
FY25 Percent Reduction	22.8%
Target TMDL WLA Reduction	22.2%

4. South River

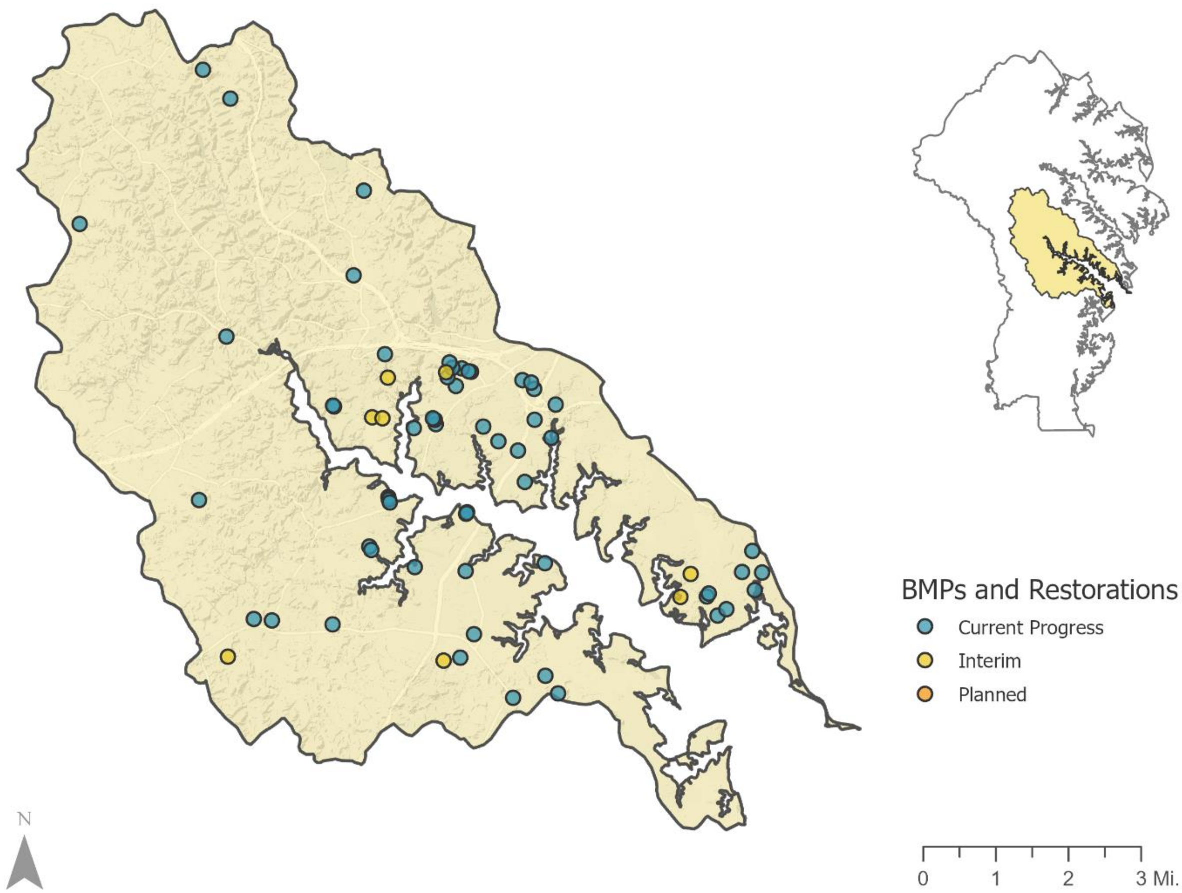

Figure 14:Map of the South River TSS TMDL watershed

The South River is situated in the central portion of the County, and drains directly to the Chesapeake Bay (Figure 14). The watershed comprises approximately 36,514 acres and lies entirely within the County.

In FY22 the County remodeled sediment loads in the South River using MDE's TIPP Sediment Spreadsheet Tool and revised the previously submitted South River Sediment TMDL, Documentation of Attainment Report, to address comments received from MDE on 4.29.2019. The revised plan, *Non-Tidal South River Watershed Sediment TMDL Stormwater Wasteload Allocation Attainment Report (2022)* is submitted in Appendix B.

The target sediment load for the South River is 13,634,211 pounds per year - a 28% reduction from the baseline by 2025. Current FY 22 progress shows a reduction of 6,080,427 pounds (32.11%), achieving compliance with the TMDL. Additionally, there is a total interim programmed restoration of 6,522,954 pounds, resulting in a total reduction of 66.56% by the completion year (Table 14).

The South River FY 22 progress reduction (32.11%) was achieved via annual street sweeping (~20.3 lane miles), annual storm drain cleaning (~50,602 pounds), 39 stormwater management practices, one land use conversion (0.26 acres), and 19 stream restorations (27,945 linear feet), and achieves compliance with the TMDL. The interim programmed reduction consists of seven stream restorations (20,257 linear feet), and two stormwater management practices. See Appendix C and Appendix D for information on individual projects.

The top three projects that provide the greatest sediment reductions in the South River are:

- BMP0286, a stream restoration that reduces 1,327,868.9 lbs of sediment annually;
- BMP0283, a stream restoration that reduces 744,000 lbs of sediment annually; and
- BMP0295, a stream restoration that reduces 653,340.9 lbs of sediment annually.

Table 14: TMDL summary for South River TSS

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	18,936,404
FY22 Progress Load (lbs)	12,855,977
FY30 Planned Load (lbs)	6,333,023
FY22 Percent Reduction	32.1%
FY25 Percent Reduction	66.6%
Target TMDL WLA Reduction	28.0%

5. Other West Chesapeake Bay

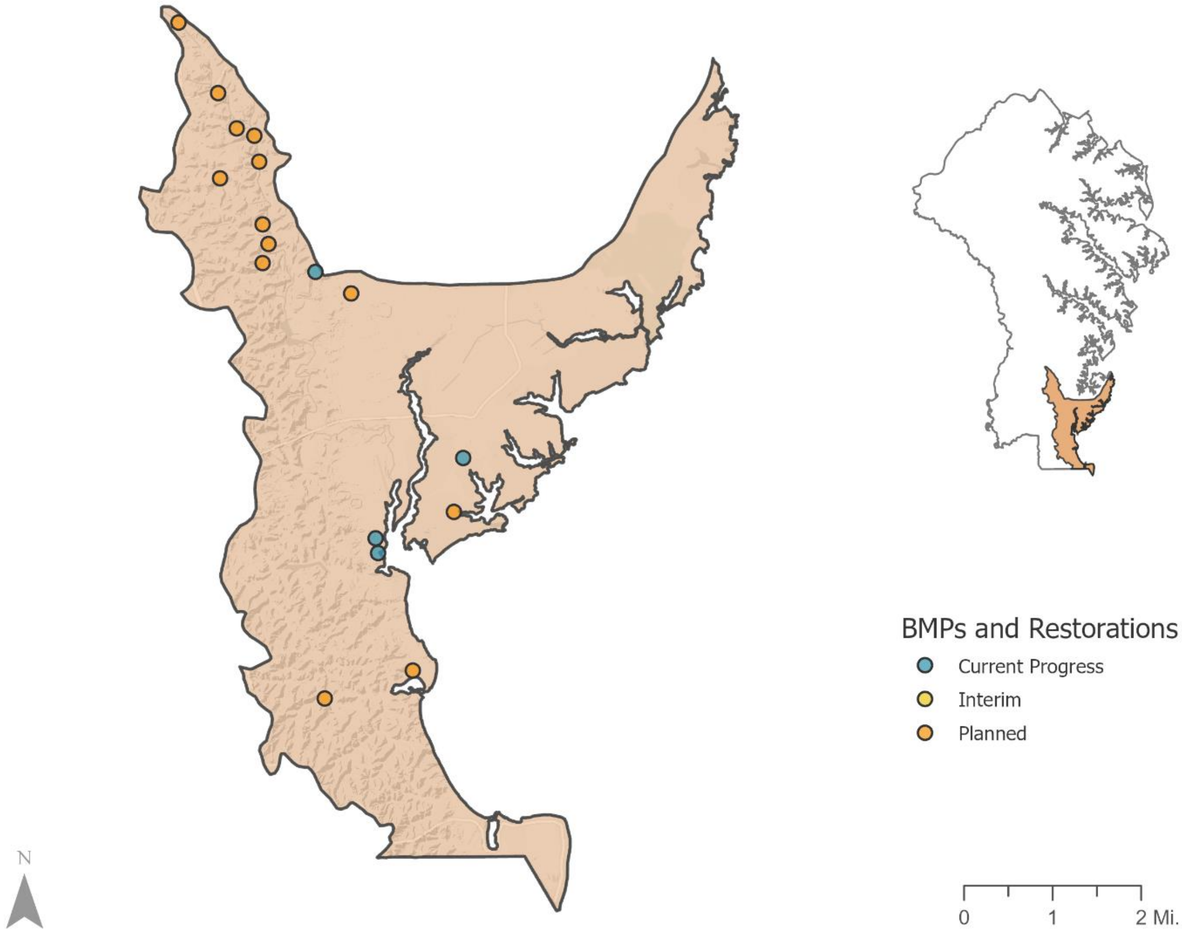

Figure 15: Map of the Other West Chesapeake Bay TSS TMDL watershed

The Other West Chesapeake is situated in the southeastern portion of the County, and shares political boundaries with Calvert County (Figure 15). The Anne Arundel County portion of the Other West Chesapeake watershed is approximately 14,662 acres (22.9 square miles) in area and contains approximately 100 total miles of streams.

The target sediment load for the Other West Chesapeake watershed is 7,363,965 pounds per year - a 33% reduction from the baseline by 2030. Current FY 22 progress shows a reduction of 143,061 pounds (1.3%). Planned restoration will result in a further 3,648,551 lbs of reduction, resulting in a total of 34. 5% reduction by the completion year (Table 15).

The Other West Chesapeake watershed FY 22 progress reduction (1.3%) was achieved via annual street sweeping (~0.1 lane miles), annual storm drain cleaning (~2,114 pounds), two stormwater management practices, and two stream restorations (562 linear feet). The planned reduction consists of 13 stream restorations (14,712 linear feet) and will achieve compliance with the TMDL. See Appendix C and Appendix D for information on individual projects.

The top three projects that provide the greatest sediment reductions in the Other West Chesapeake Bay are:

- BMP0185, a stormwater management BMP that reduces 76,183.5 lbs of sediment annually;
- BMP0320, a stream restoration that reduces 38,312 lbs of sediment annually; and
- BMP0799, a stream restoration that reduces 27,380.5 lbs of sediment annually.

Table 15: TMDL summary for Other West Chesapeake Bay TSS

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	10,990,993
FY22 Progress Load (lbs)	10,847,932
FY30 Planned Load (lbs)	7,199,381
FY22 Percent Reduction	1.3%
FY30 Percent Reduction	34.5%
Target TMDL WLA Reduction	33.0%

6. West River

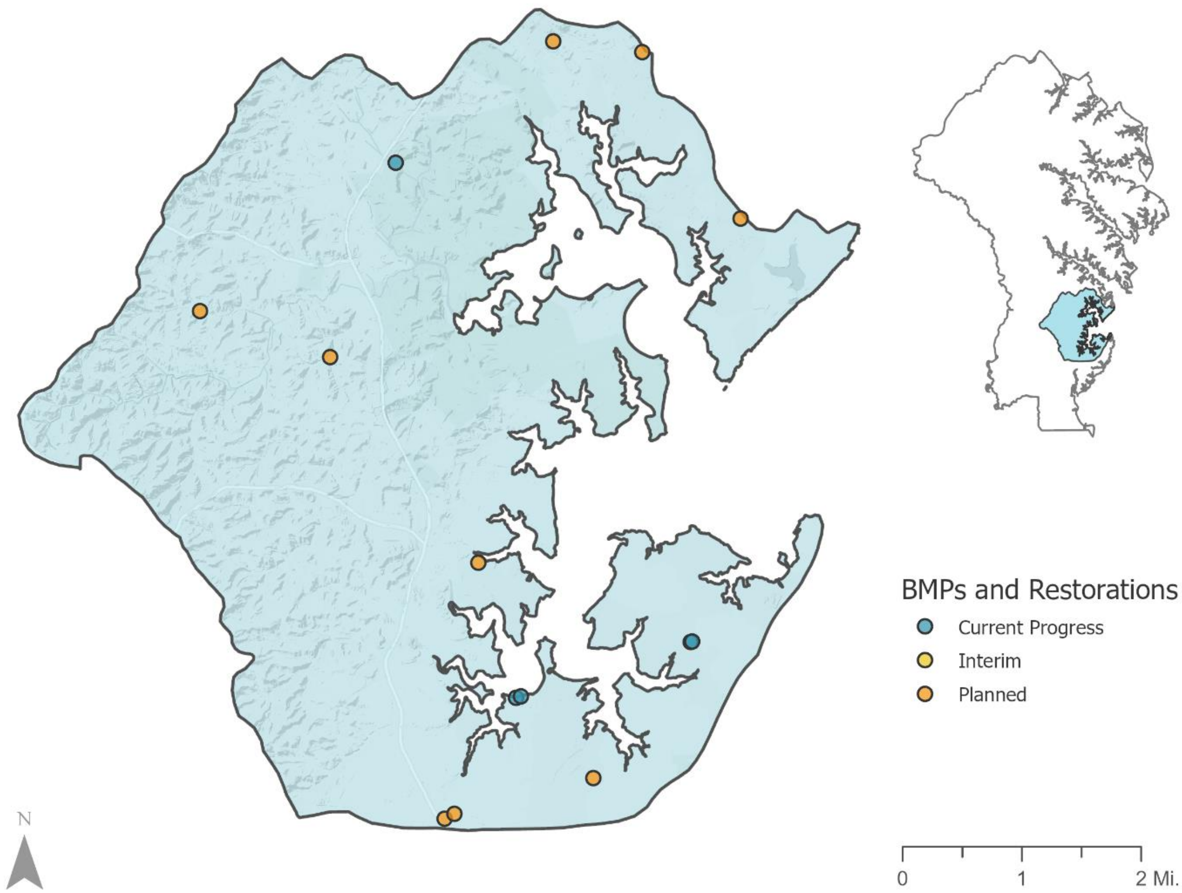

Figure 16: Map of the West River TSS TMDL watershed

The Non-Tidal West River watershed is located in the southeastern part of Anne Arundel County, and consists of two major segments - the West River and the Rhode River (Figure 16). The Non-Tidal West River watershed is approximately 15,623 acres (24.4 square miles) and contains approximately 62 miles of streams, 33 miles of which are perennial streams.

The target sediment load for the West River is 7,150,214 pounds per year - a 22% reduction from the baseline by 2030. Current FY 22 progress shows a reduction of 61,146 pounds (0.7%). Planned restoration will result in a further 2,188,342 lbs of reduction, resulting in a total of 24.54% reduction by the completion year (Table 16).

The West River FY 22 progress reduction (0.7%) was achieved via annual street sweeping (~0.1 lane miles), annual storm drain cleaning (~1,516 pounds), four stormwater management practices, one land use conversion (0.1 acres), and one stream restoration (1,400 linear feet). The planned reduction consists of seven stormwater management practices and two stream restorations (8,600 linear feet) and will achieve compliance with the TMDL. See Appendix C and Appendix D for information on individual projects.

Anne Arundel County submitted a final draft of the sediment restoration plan to MDE on February 22, 2022. The plan was advertised on the County's webpage and the local newspaper for a 30-day public comment period from March 23, 2022 through April 23, 2022. No public comments were received. However, following the closure of the public comment period meetings to discuss the plan were requested by the Arundel Rivers Federation Board of Directors, the Arundel Rivers Federation Staff and the Anne Arundel Soil Conservation District Office. These meetings were held on May 2, May 24 and June 8, 2022 respectively. As a result of those meetings, the Arundel Rivers Federation has offered to provide community outreach to assist the County in engaging with private property owners to facilitate permission and easement acquisition when needed for restoration project implementation. At present, the County is awaiting MDE comments on the final draft plan, submitted on February 22, 2022. Following receipt of MDE comments, the County will revise the plan as appropriate and submit the final plan for approval.

The top three projects that provide the greatest sediment reductions in the West River are:

- BMP0259, a stream restoration that reduces 46,363.9 lbs of sediment annually;
- BMP0725, a stormwater management BMP that reduces 4,551.7 lbs of sediment annually; and
- BMP0069, a stormwater management BMP that reduces 3,772.6 lbs of sediment annually.

Table 16: TMDL summary for West River TSS

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	9,166,941
FY22 Progress Load (lbs)	9,105,794
FY30 Planned Load (lbs)	6,917,452
FY22 Percent Reduction	0.7%
FY30 Percent Reduction	24.5%
Target TMDL WLA Reduction	22.0%

B. Nutrient TMDLs

Required load reductions and progress load reductions for the Baltimore Harbor TN and TP TMDL are presented in Figure 6. Figure 7 shows the breakdown of load reductions by BMP type for FY 22 progress load reductions, programmed load reductions, and planned load reductions. As shown in Figure 7, the majority of load reductions come from stormwater management BMPs and stream restorations.

1. Baltimore Harbor

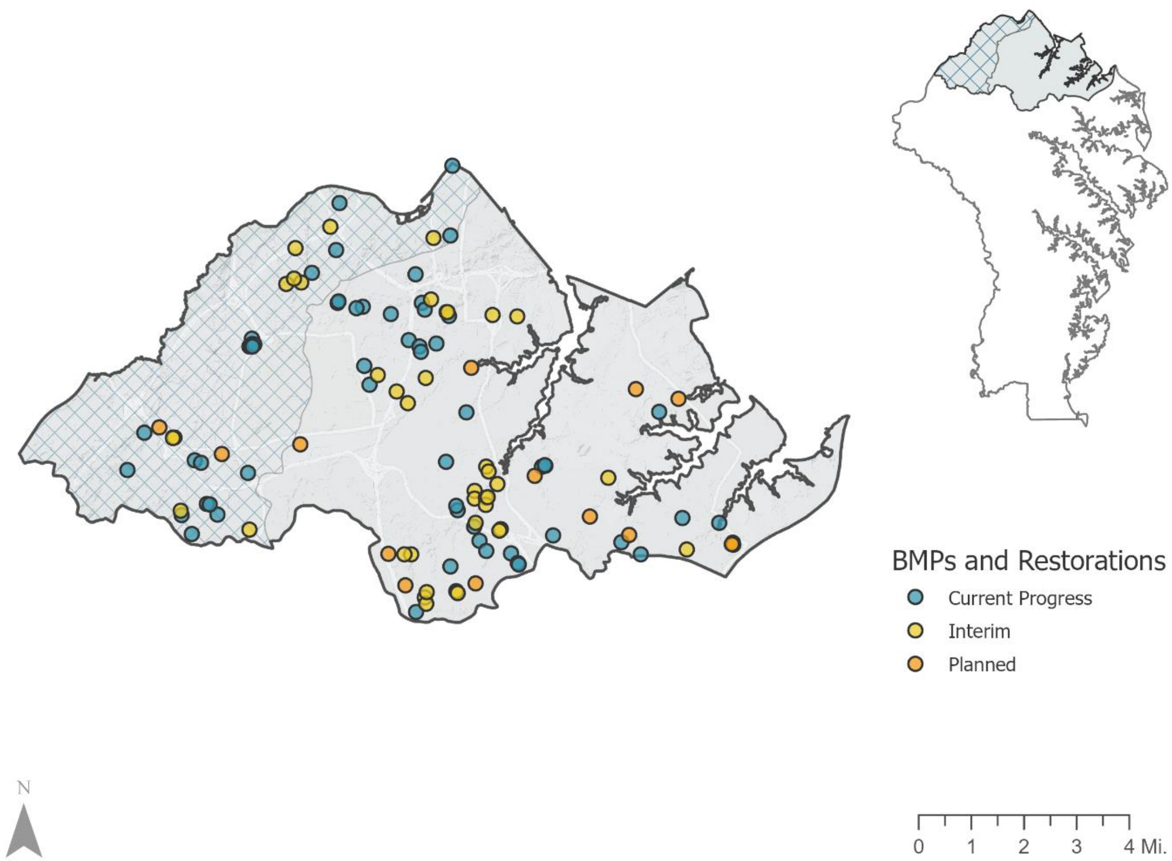

Figure 17: Map of the Baltimore Harbor TN and TP TMDL watershed

The Baltimore Harbor Watershed is situated in the northern portion of the County, and shares political boundaries with Baltimore City, Baltimore, Carroll, and Howard Counties (Figure 17). The Anne Arundel County portion of the Baltimore Harbor watershed is approximately 45,134 acres (70.5 square miles) in area and contains approximately 202 total miles of stream reaches.

The target Total Nitrogen (TN) load for the Baltimore Harbor is 232,941 pounds per year - a 15% reduction from the baseline by 2030. Current FY 22 progress shows a reduction of 8,262 pounds (3.01%), with a total interim programmed restoration of 30,983 pounds. Planned restoration will result in a further 4,105 lbs of reduction, resulting in a total of 15.8% reduction by the completion year (Table 17).

The target Total Phosphorus (TP) load for the Baltimore Harbor is 18,380 pounds per year - a 15% reduction from the baseline by 2030. Current FY 22 progress shows a reduction of 1,317 pounds (6.09%), with a total interim programmed restoration of 4,588 pounds. Planned restoration will result in a further 1,148 lbs of reduction, resulting in a total of 32.62% reduction by the completion year (Table 18).

The Baltimore Harbor FY 22 progress reduction for both TN and TP was achieved via annual street sweeping (~93.7 lane miles), annual storm drain cleaning (~276,508 pounds), 56 stormwater management practices, three land use conversions (2.8 acres), and six stream restorations (6,014 linear feet). The interim programmed reduction consists of 23 stream restorations (45,093 linear feet), two land use conversions (0.33 acres), and 19 stormwater management practices. The planned reduction consists of five stream restorations (12,717 linear feet), and eight stormwater management practices, and will achieve compliance with both the TN and TP TMDLs. See Appendix C and Appendix D for more information on individual projects.

The top three projects that provide the greatest TN reductions in the Baltimore Harbor are:

- BMP0268, a stream restoration that reduces 1,683.2 lbs of TN annually;
- BMP0198, a stormwater management BMP that reduces 972.4 lbs of TN annually; and
- BMP0291, a stream restoration that reduces 696 lbs of TN annually.

The top three projects that provide the greatest TP reductions in the Baltimore Harbor are:

- BMP0291, a stream restoration that reduces 321 lbs of TP annually;
- BMP0268, a stormwater management BMP that reduces 166.7 lbs of TP annually; and
- BMP0198, a stormwater management BMP that reduces 120.1 lbs of TP annually.

Table 17: TMDL summary for Baltimore Harbor TN

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	274,049
FY22 Progress Load (lbs)	265,787
FY30 Planned Load (lbs)	230,699
FY22 Percent Reduction	3.0%
FY30 Percent Reduction	15.8%
Target TMDL WLA Reduction	15.0%

Table 18: TMDL summary for Baltimore Harbor TP

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	21,624
FY22 Progress Load (lbs)	20,306
FY30 Planned Load (lbs)	14,570
FY22 Percent Reduction	6.1%
FY30 Percent Reduction	32.6%
Target TMDL WLA Reduction	15.0%

VII. Bacteria TMDL Progress

The location of the 19 waterways with EPA-approved TMDLs associated with bacteria impairments are presented in Figure 18. Fecal coliforms are identified as the cause of impairment in 15 of the 19 waterways. E. coli and Enterococci are identified as the impairments in the remaining four watersheds (Table 19).

Due to the number of bacteria TMDLs, and because the four source categories (pet waste, wildlife, human, and livestock) were represented in all the impaired waterbodies, Anne Arundel County chose to develop a single consolidated implementation plan to address all 19 bacteria TMDLs.[2]

[2] www.aacounty.org/departments/public-works/wprp/watershed-assessment-and-planning/chesapeake-bay-tmdl/index.html

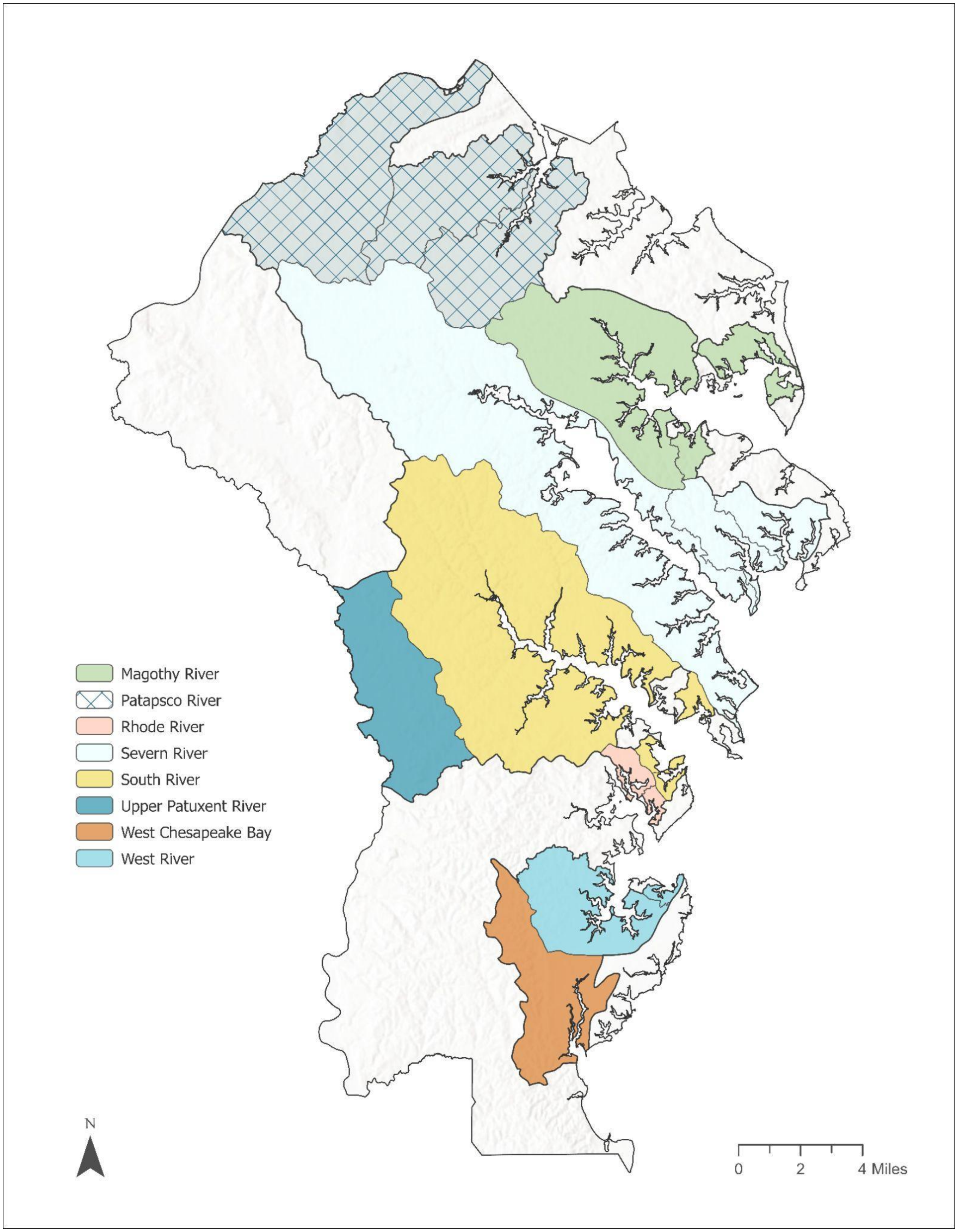

Figure 18:Map of the Bacterial TMDL watersheds in Anne Arundel County

Table 19: List of Bacterial TMDLs in Anne Arundel County

Location	Approval Date	Impairment	% Reduction Required*
Magothy River Mainstem	February 20, 2006	Fecal coliform	12.8
Magothy River/Forked Creek	February 20, 2006	Fecal coliform	26.3
Magothy River/Tar Cove	February 20, 2006	Fecal coliform	0.0
Patapsco River/Furnace Creek	March 10, 2011	Enterococci	77.7
Patapsco River/Marley Creek	March 10, 2011	Enterococci	75.7
Patapsco River Lower North Branch, 8 Digit WS 02130906	December 3, 2009	E. coli	20.7
Upper Patuxent River, Subsegment of 8 Digit WS 0213114	August 9, 2011	E. Coli	22.3
Rhode River/Bear Neck Creek	February 20, 2006	Fecal coliform	43.3
Rhode River/Cadle Creek	February 20, 2006	Fecal coliform	72.2
Severn River Mainstem, Subsegment of 8 Digit WS 02131002	April 10, 2008	Fecal coliform	19.0
Severn River/Mill Creek	April 10, 2008	Fecal coliform	86.0
Severn River/Whitehall & Meredith Creeks	April 10, 2008	Fecal coliform	90.0
South River/Duvall Creek	November 4, 2005	Fecal coliform	45.6
South River, Subsegment of 8 Digit WS 02131003	November 4, 2005	Fecal coliform	29.5
South River/Ramsey Lake	November 4, 2005	Fecal coliform	59.3
South River/Selby Bay	November 4, 2005	Fecal coliform	0.0
W. Chesapeake Bay/Tracy & Rockhold Creeks	February 20, 2006	Fecal coliform	81.6
West River, Subsegment of 8 Digit WS 02131004	February 20, 2006	Fecal coliform	35.3
West River/Parish Creek	February 20, 2006	Fecal coliform	53.1

*Based on the MDE published TMDL documents for bacteria impaired watersheds in Anne Arundel County and Anne Arundel County's *Total Maximum Daily Load Restoration Plan for Bacteria, February 2017.* Percent reductions required for the Patapsco and Upper Patuxent are for the Anne Arundel County portion only.

A. Restoration Strategies

Two restoration strategies are implemented in Anne Arundel County to achieve bacteria TMDL compliance. The first strategy addresses the human sources of bacteria (Tier A strategies) originating from effluent from poorly maintained septic systems, sanitary sewage overflows (SSOs), and illicit discharges of wastewater into storm drains. The second strategy addresses non-human sources of bacteria (Tier B strategies) originating from as pet, wildlife, and livestock excrement.

1. Tier A Strategies

a. Illicit Detection and Elimination

The County's Illicit Discharge Detection and Elimination (IDDE) program requires that approximately 150 outfalls are evaluated each year. In FY 22, the County evaluated a total of 150 outfalls and confirmed four (4) outfalls that had illicit discharge.

b. Sanitary Sewer Overflow Abatement

The County has a program to upgrade the sanitary sewer system to improve its reliability. These upgrades aim to abate SSOs and reduce the discharge of human bacteria to surface water. In FY 22, three (3) sewer pumping station (SPS) upgrade projects were completed in watersheds with a bacteria TMDL. There are currently 16 active SPS upgrade projects in watersheds with a bacteria TMDL that are scheduled to be completed in future fiscal years. In FY22, 51 SSOs were reported throughout the County, with 30 of those occurring within bacteria TMDL watersheds.

c. Septic Retirement

The County aims to retire 20-40 septic systems per year, and replace these systems with connection to the sanitary sewer system. In FY 22, the County retired 19 septic systems in watersheds with a bacteria TMDL. Additionally, 158 denitrification units were installed in bacteria TMDL watersheds in FY22.

d. Monitoring

The County has several bacteria monitoring programs in place to assess impairment in local waterways and to confirm water quality improvements resulting from BMP and programmatic implementation. The County's bacteria monitoring efforts include the following programs:

- Anne Arundel County Department of Health's monitoring of public bathing beaches
- Trend monitoring in the Marley and Furnace Creek watersheds
- Monitoring in two residential communities in conjunction with a pilot pet waste outreach campaign
- Monitoring in the Rhode River/Bear Neck Creek to assess water quality impacts associated with the conversion of the Mayo Water Reclamation Facility from water treatment plant to pumping station
- Bacteria monitoring as part of post-restoration storm and baseflow monitoring at two CIP restoration projects - Furnace Branch and Cowhide Branch - both of which are located in bacteria TMDL watersheds

The County completed the final year of a 3-year bacteria trend monitoring program in Marley and Furnace Creeks in FY22. A Summary report of this 3-year monitoring effort will be completed in early 2023. Based on the findings to date of the 3-year monitoring program, the County will begin an eDNA study of sites in the Marley Creek watershed that exhibited consistently high bacteria counts in an attempt to identify the specific source of the bacteria loads. Trend monitoring can be used to identify bacteria "hotspots" within a waterbody and serves as an initial step precluding microbial source tracking and further geographical source identification. For more information on this and the County's other bacterial monitoring programs, please refer to Appendix F.

Moving forward, the County intends to focus future bacteria reduction efforts in TMDL watersheds where SW-WLAs have not yet been met, to the greatest extent possible. The County understands that current literature suggests that the effectiveness of BMPs to reduce bacteria levels is variable, and largely dependent on site location and BMP type. The County will continue to collaborate with MDE and other jurisdictions to investigate the effectiveness of BMPs to reduce bacteria where such opportunities exist, and will continue to employ effective BMPs in conjunction with other controls to reduce bacteria loads where possible.

For more information regarding Tier A Strategies please refer to Appendix F.

2. Tier B Strategies

a. Stormwater Retrofits

The County has a program to implement new stormwater management practices and retrofit pre-2002 stormwater management facilities. This program concurrently treats stormwater from impervious surfaces and reduces pollutants such as bacteria. A total of 337 projects (including 155 upland BMPs and 182 septic connections) have been completed in watersheds with a bacteria TMDL between 2012 and 2022.

b. Pet Waste Management

The County continued to highlight proper pet waste management practices through its social media outlets, and at community events and presentations throughout FY 22. The County continued to work with a social marketing consultant to refine pet waste outreach messaging that promotes behavioral change and proper pet waste disposal. A pilot campaign was launched in two communities in bacteria TMDL watersheds. To date, the outreach effort has resulted in an online survey, a focus group, and the development of a campaign slogan and various multi-media educational and outreach materials, as well as three virtual presentations to community members. The campaign has also involved the selection of two campaign "spokesdogs" who will serve as the "faces" of the campaign by attending events and appearing on various outreach media. The County continues to make pet waste stations available to interested communities for no cost.

For more information regarding Tier B Strategies please refer to Appendix F.

B. Magothy River (Mainstem, Forked Creek, and Tar Cove)

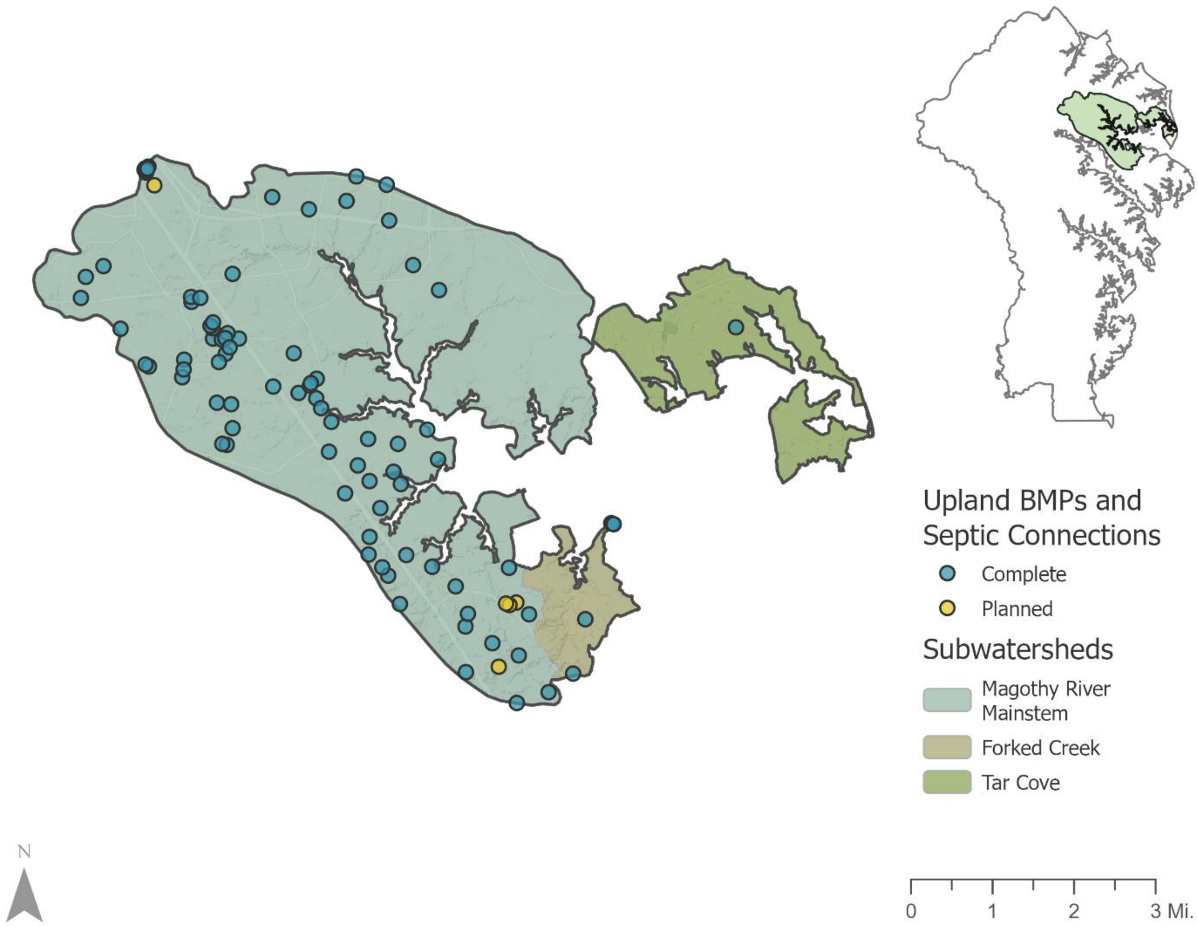

Figure 19: Map of the Magothy River Bacterial TMDL watershed

The Magothy River Watershed is located in the northeastern portion of the County near Pasadena and Severna Park (Figure 19). The Magothy River flows southeast into the Chesapeake Bay near Gibson Island. Forked Creek is a small tidal creek located along the south shoreline of the river near its mouth and has a mainstem approximately 2.5 miles long. Tar Cove is on the opposite (north) shoreline, adjacent to Sillery Bay. The primary land use category in all three watersheds is residential. All three watersheds are impaired by fecal coliforms.

<u>Upland Restoration BMPs and Septic Connections in the Magothy River:</u>

Magothy Mainstem:	82 complete, 5 planned
Forked Creek:	5 complete
Tar Cove:	1 complete

C. Patapsco River (Patapsco Lower North Branch, Furnace Creek, and Marley Creek)

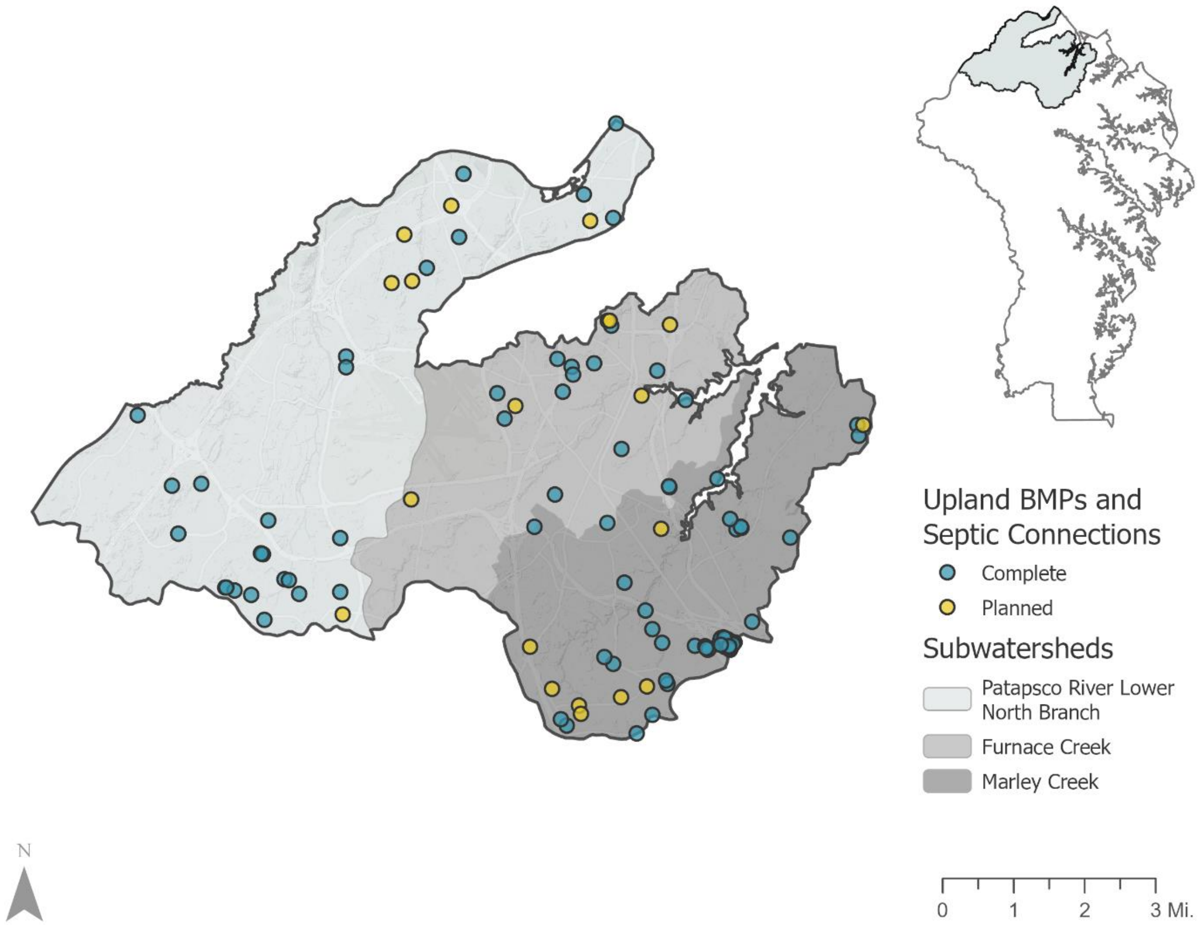

Figure 20: Map of the Patapsco River Bacterial TMDL watershed

Anne Arundel County's portion of the Patapsco Lower North Branch (LNB) watershed is approximately 15,270 acres (23.9 square miles) in area and contains approximately 96 miles of streams (Figure 20). The Patapsco River LNB is generally non-tidal, and is one of two bacteria TMDL watersheds impaired by E. coli.

Furnace Creek and Marley Creek are tidal creeks in the northern portion of the County, a few miles east of Baltimore-Washington International airport. These two watersheds are similar in size (8,579 acres for Furnace Creek, 8,737 acres for Marley Creek), and are highly urbanized with much residential development. The Marley Creek and Furnace Creek watersheds are both impaired by enterococci.

Upland Restoration BMPs and Septic Connections in the Patapsco River:

Lower North Branch:	27 complete, 6 planned
Furnace Creek:	14 complete, 6 planned
Marley Creek:	59 complete, 8 planned

D. Upper Patuxent River

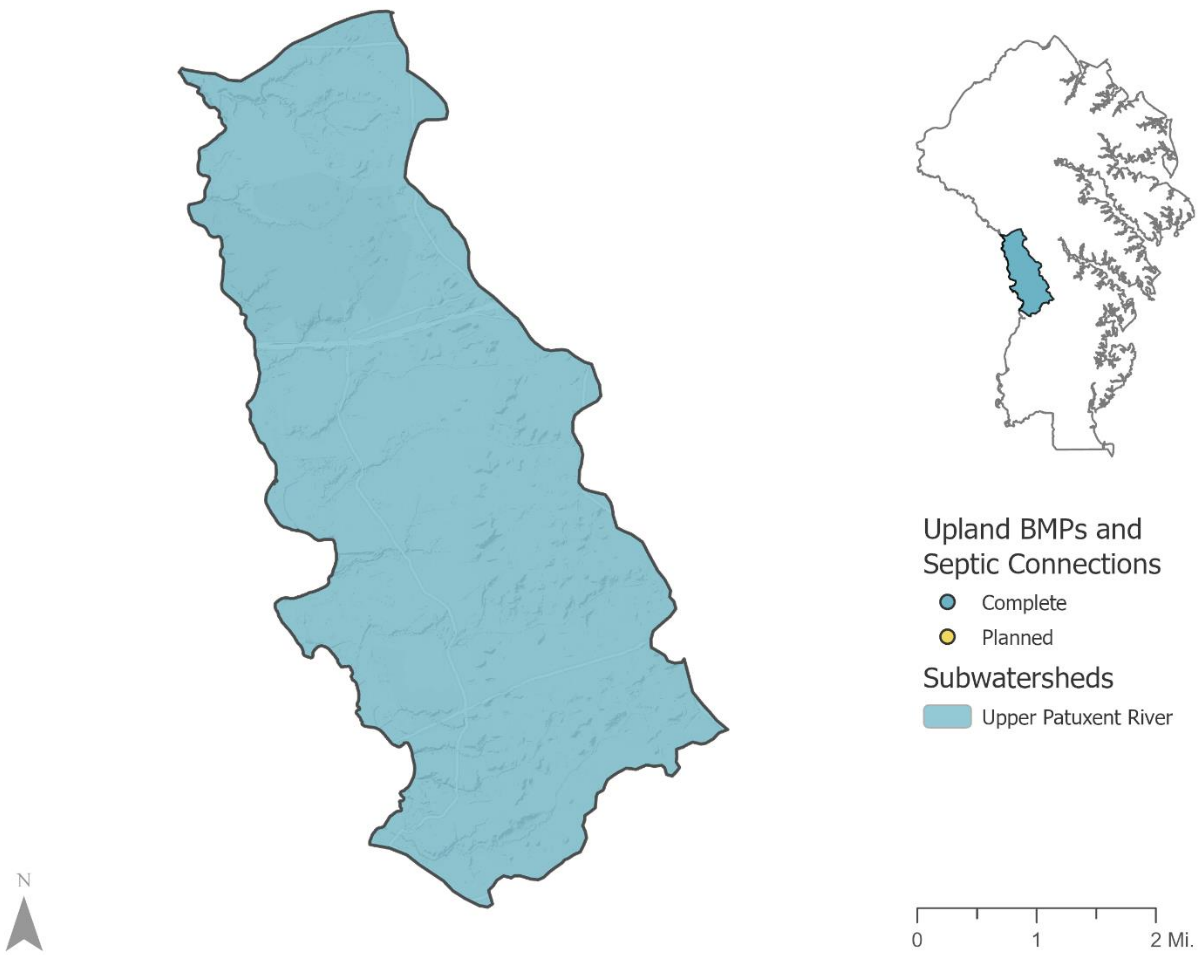

Figure 21: Map of the Upper Patuxent River Bacterial TMDL watershed

The Upper Patuxent is situated in the western portion of the County (Figure 21). Anne Arundel County's portion of the Upper Patuxent watershed is approximately 22,420 acres (35.0 square miles) in area and contains approximately 90 total miles of perennial stream. The Upper Patuxent Watershed is one of two bacteria watersheds that are impaired by E. coli. No upland projects have been completed or planned.

E. Rhode River (Bear Neck Creek and Cadle Creek)

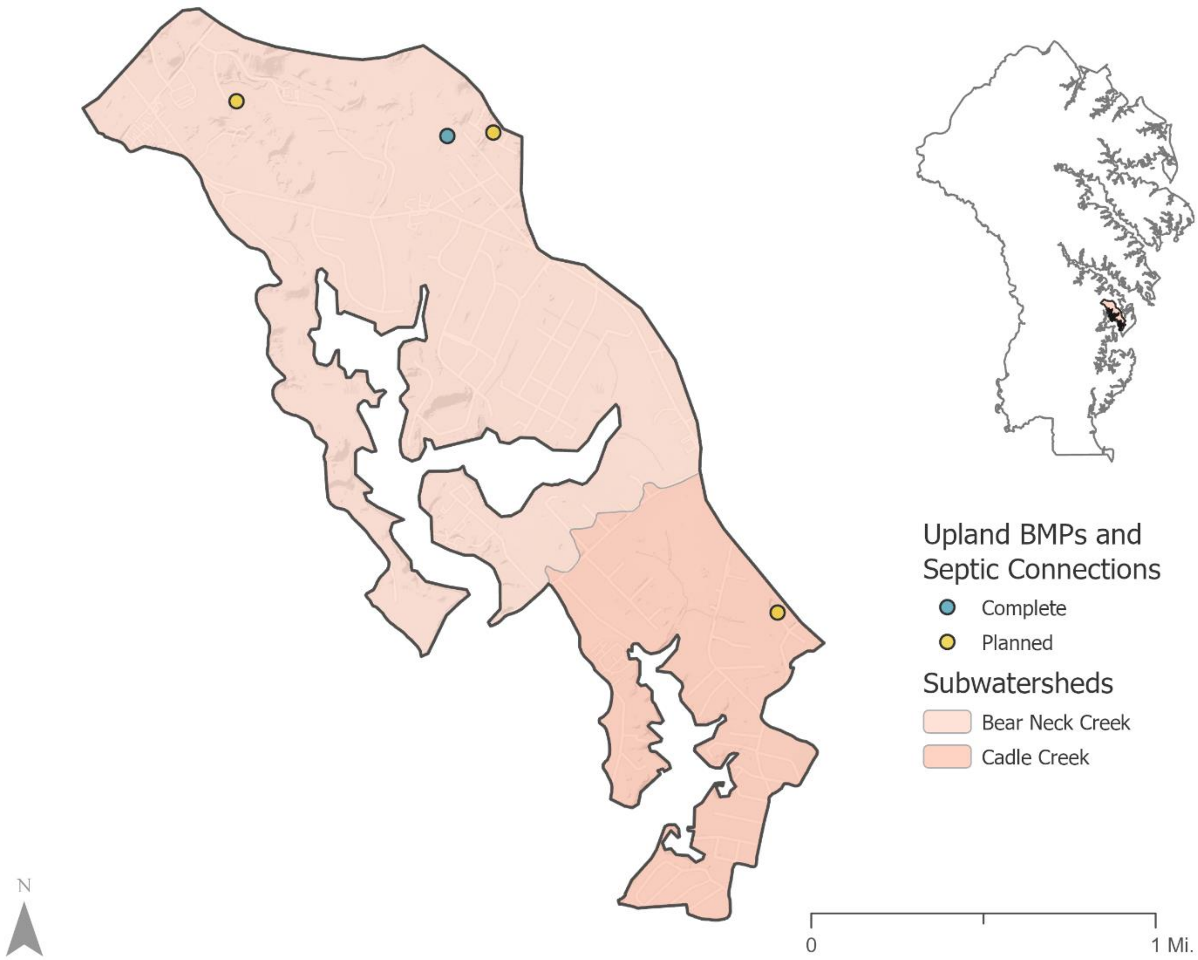

Figure 22: Map of the Rhode River Bacterial TMDL watershed

Bear Neck Creek and Cadle Creek are located in the Rhode River Watershed, in the southeastern part of Anne Arundel County (Figure 22). The Bear Neck Creek Watershed is 880 acres with 50 percent of its land use being residential, mainly consisting of the community of Mayo. The Cadle Creek Watershed is 320 acres, with approximately 70 percent of the land use is residential and 20 percent is impervious.

<u>Upland Restoration BMPs and Septic Connections in the Rhode River:</u>

Bear Neck Creek:	1 complete; 2 planned
Cadle Creek:	1 planned

F. Severn River (Mainstem, Mill Creek, and Whitehall and Meredith Creeks)

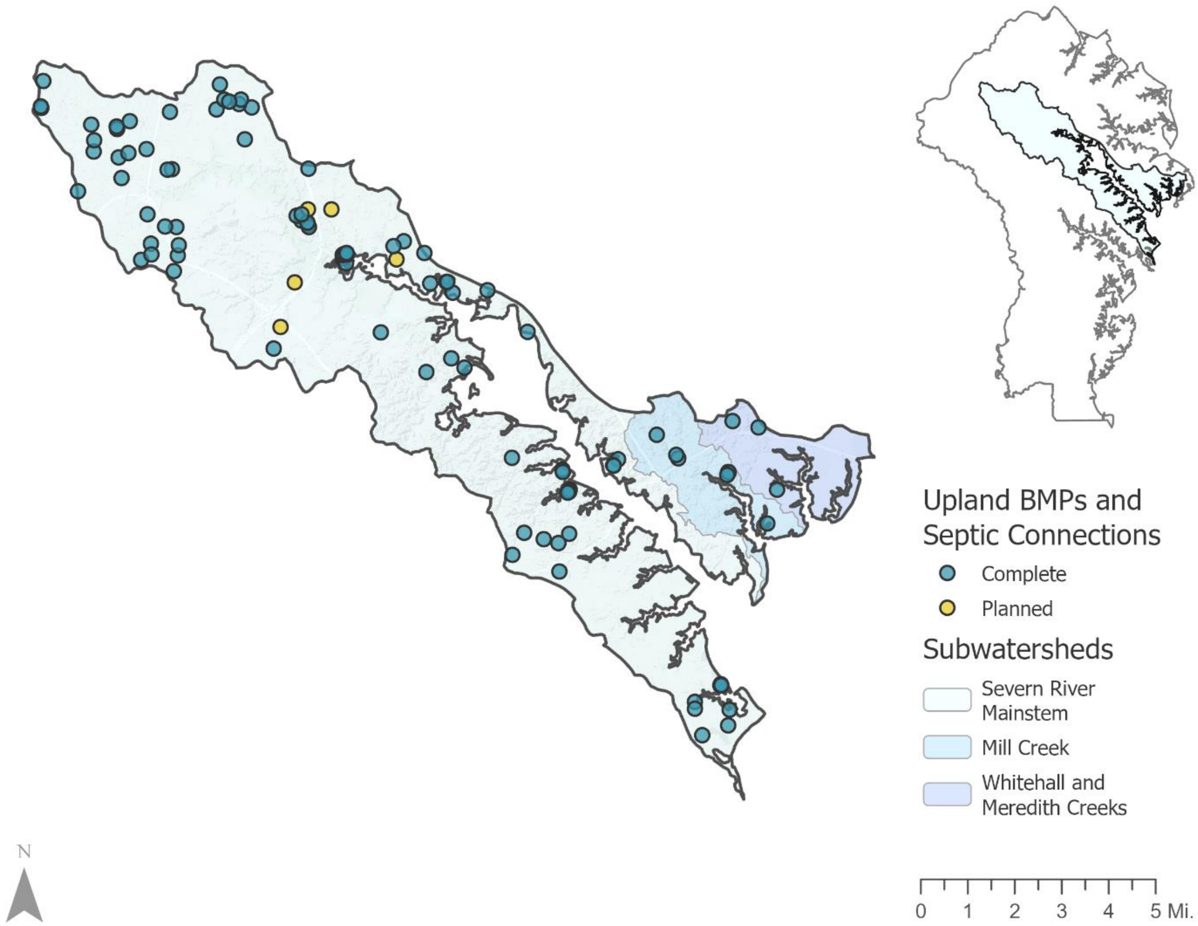

Figure 23:Map of the Severn River Bacterial TMDL watershed

The Severn River Mainstem flows from northwest to southeast across the center of the County, from the community of Severn at the headwaters to the city of Annapolis near the mouth (Figure 23). The total watershed area is 37,011 acres, and the dominant land uses are residential at 44 percent and forested at 35 percent. Mill Creek, Whitehall Creek, and Meredith Creek are all located a few miles northeast of the Severn River's mouth and discharge into the Chesapeake Bay just west of the Bay Bridge.

Upland Restoration BMPs and Septic Connections in the Severn River:

Severn Mainstem:	84 complete, 5 planned
Mill Creek:	7 complete
Whitehall and Meredith:	5 complete

G. South River (Mainstem, Duvall Creek, Ramsey Lake, Selby Bay)

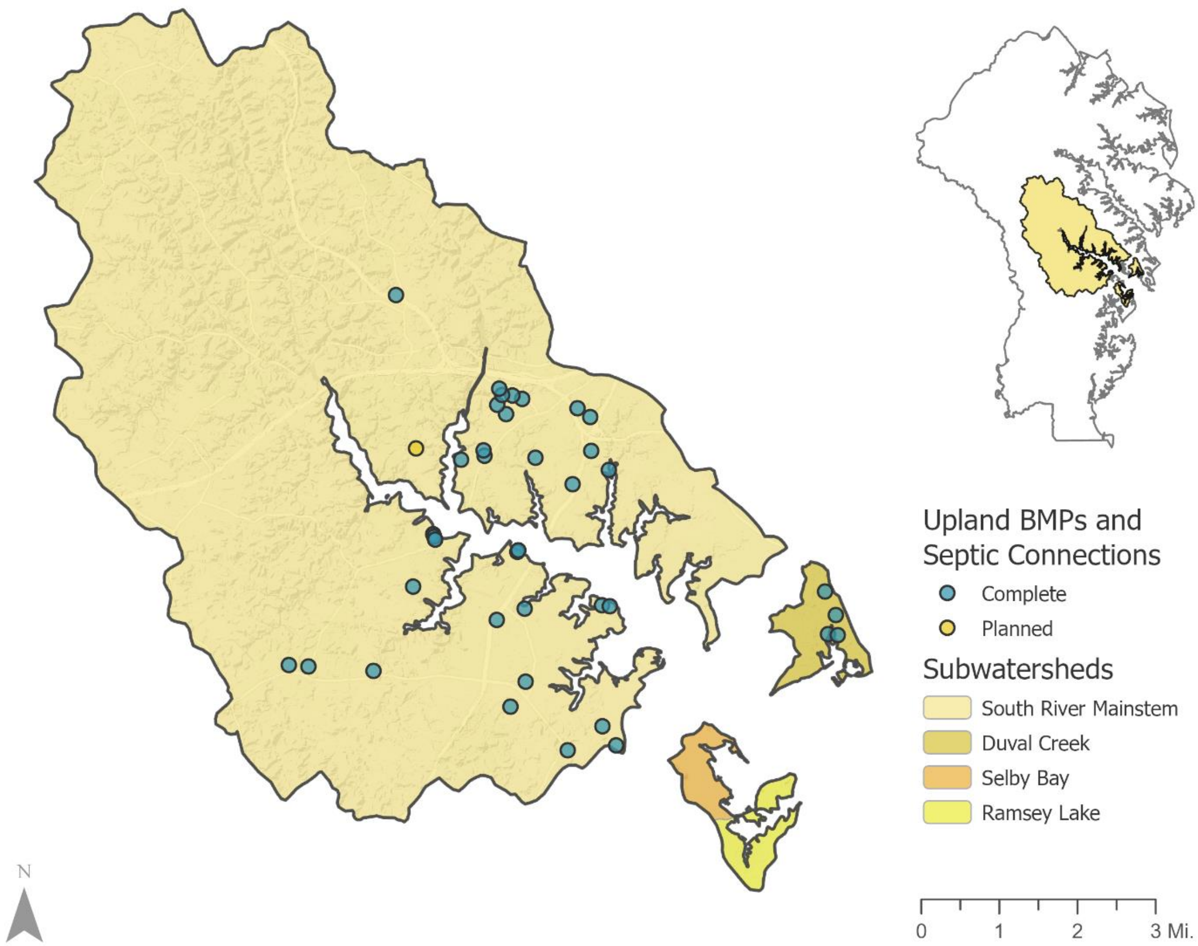

Figure 24: Map of the South River Bacterial TMDL watershed

The South River Watershed has four impaired waterways with approved bacteria TMDLs: the South River Mainstem, Duvall Creek, Ramsey Lake, and Selby Bay (Figure 24). The South River is located immediately south of the Severn River in the central portion of the County. Like the Severn, it flows from northwest to southeast. The headwaters are near the town of Crownsville. The mouth, where it discharges to the Chesapeake Bay, is near Thomas Point Park. Duvall Creek, Ramsey Lake, and Selby Bay are small embayments near the mouth of the South River.

<u>Upland Restoration BMPs and Septic Connections in the South River:</u>

South River:	34 complete, 1 planned
Duval Creek:	4 complete
Selby Bay and Ramsey Lake:	None

H. West Chesapeake Bay (Tracy and Rockhold Creeks)

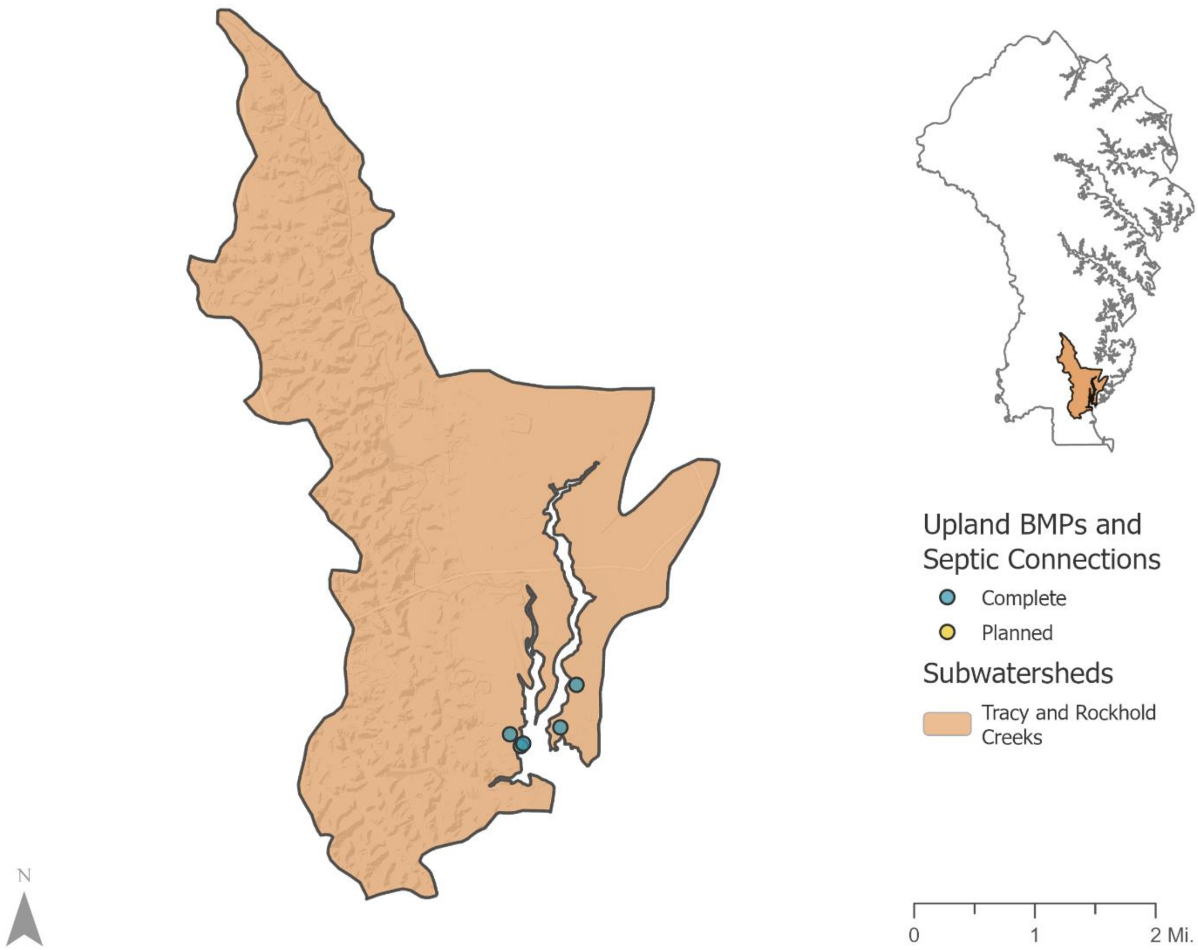

Figure 25:Map of the Other West Chesapeake Bay Bacterial TMDL watershed

Tracy and Rockhold Creeks, situated in the southeastern portion of the County (Figure 25), have a combined watershed area of 7,962 acres, about half of which is forest.

Upland Restoration BMPs and Septic Connections in the West Chesapeake Bay:
Tracy and Rockhold Creeks: 6 complete

I. West River (Mainstem and Parish Creek)

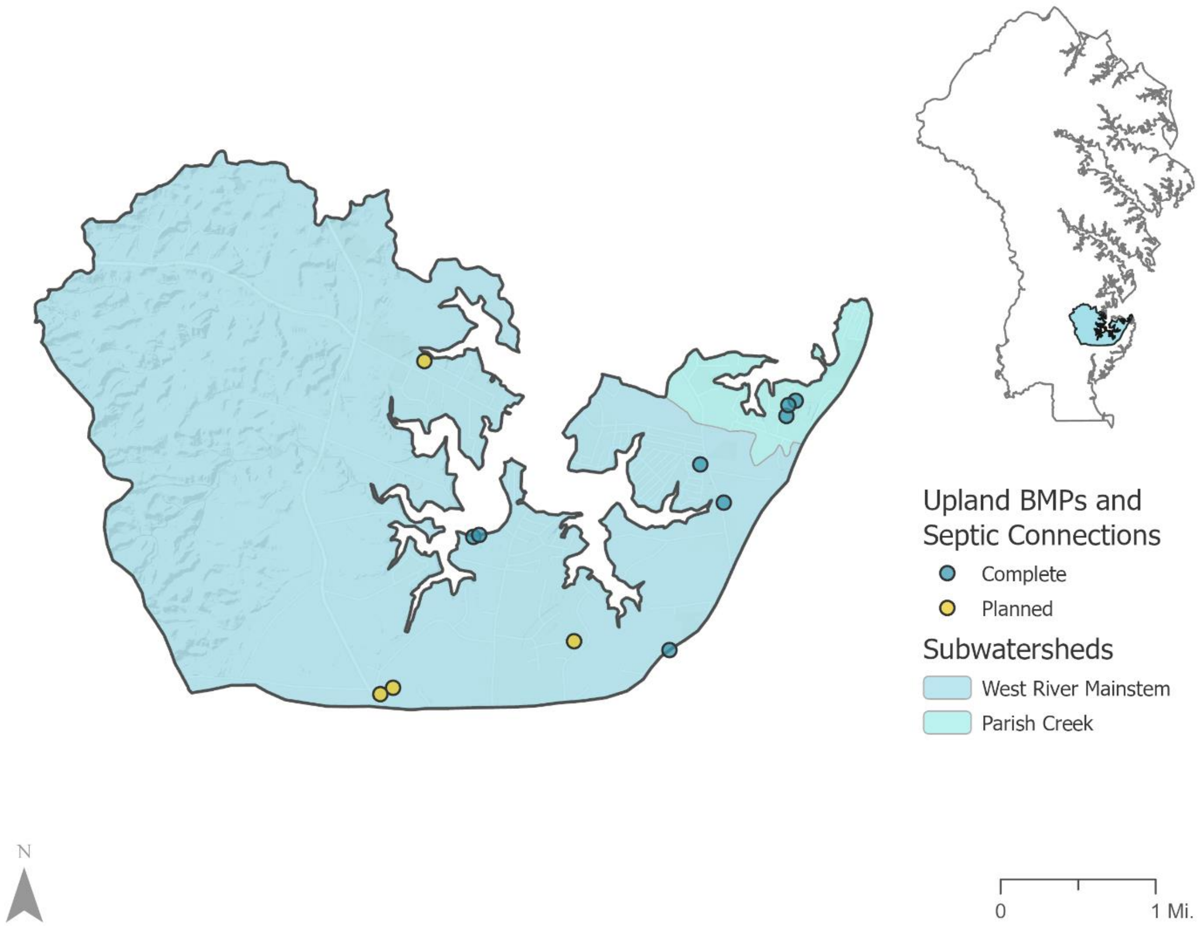

Figure 26:Map of the West River Bacterial TMDL watershed

The West River is a tidal estuary and river system in the southeast portion of the County near the town of Galesville (Figure 26). Parish Creek is a small estuary east of the West River, near the town of Shadyside. Parish Creek drains an area of 324 acres.

<u>Upland Restoration BMPs and Septic Connections in the West River:</u>

West River: 5 complete; 4 planned

Parish Creek: 3 complete

VIII. PCB TMDL Progress

The location of the two PCB TMDLs within Anne Arundel County are presented in Figure 27.

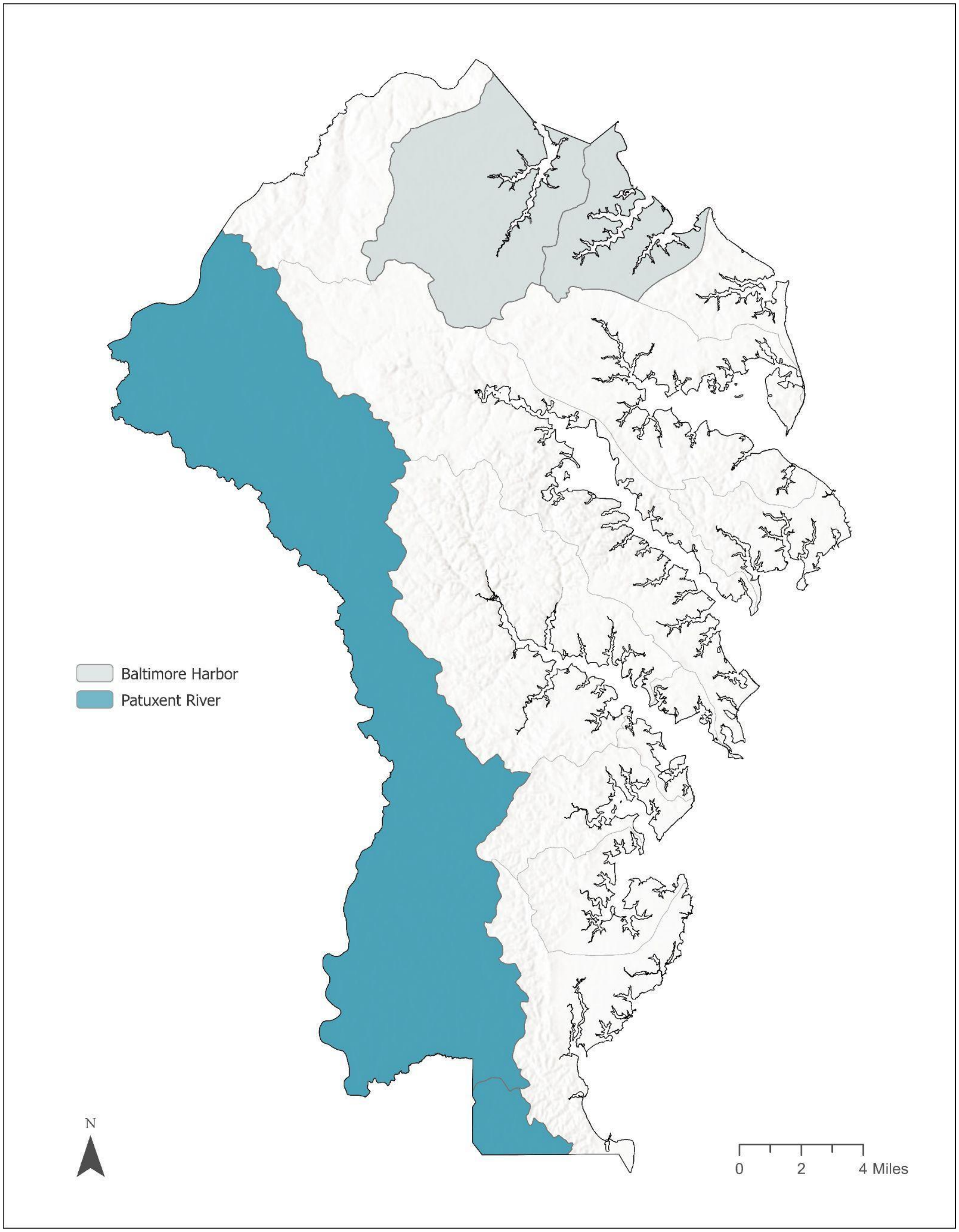

Figure 27:Map of the PCB TMDL watersheds in Anne Arundel County

A. Baltimore Harbor

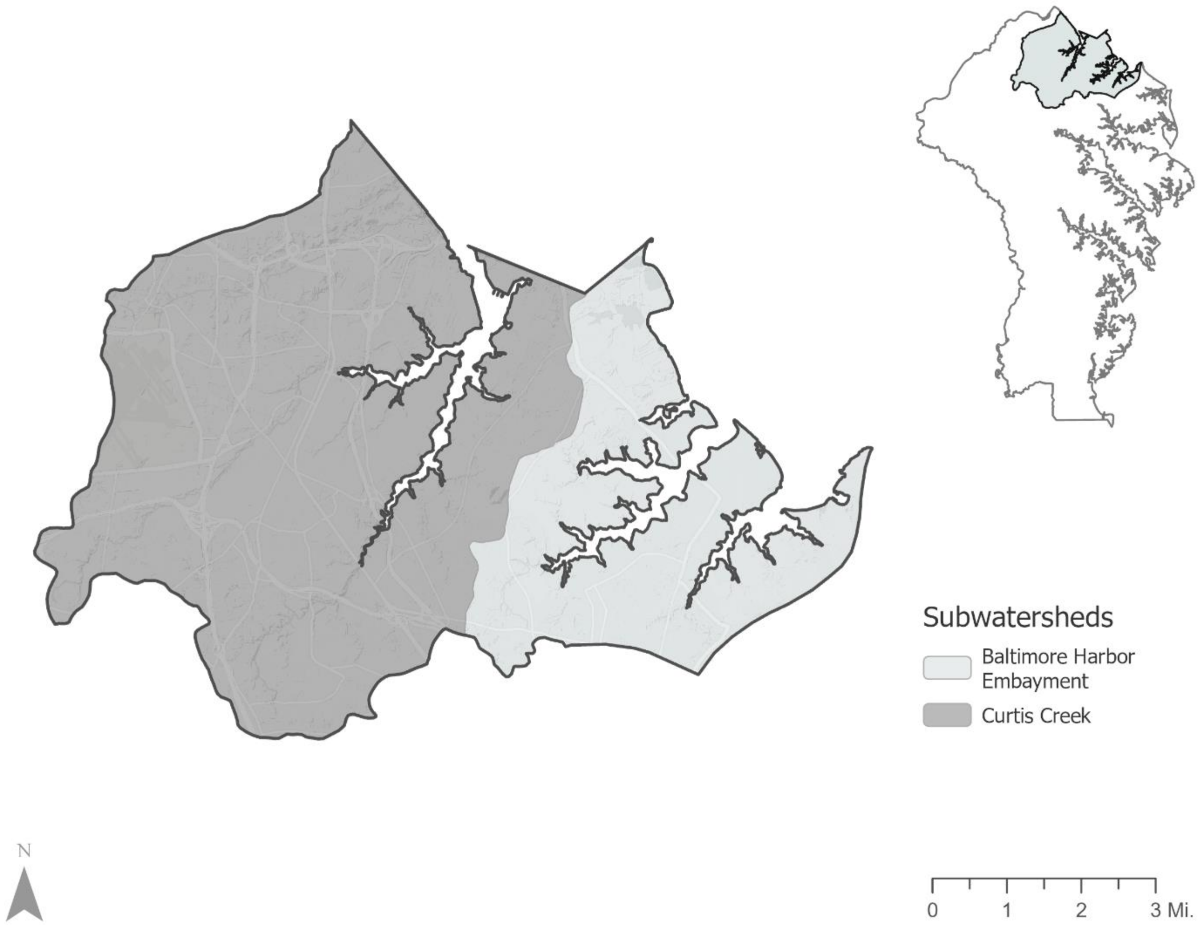

Figure 28:Map of the Baltimore Harbor PCB TMDL watershed

In 2012, the EPA approved a TMDL for Polychlorinated Biphenyls (PCBs) for the Baltimore Harbor, Curtis Creek/Bay, and Bear Creek portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment (Figure 28). The PCB TMDL addresses PCBs in fish tissue for the Baltimore Harbor Embayment, and PCBs in fish tissue and sediment for Curtis and Bear Creeks. The percent required reduction in PCBs by 2025 is 93.5% for Curtis Creek and 91.1% for Baltimore Harbor. The County's actions towards implementation to date are as follows:

- 2016 - The County submitted its Baltimore Harbor and Curtis Creek/Bay Polychlorinated Biphenyls (PCB) TMDL Restoration Plan as part of the County's 2016 MS4 Annual Report

- 2019 – The County completed the development of a targeted PCB Action Strategy.

- Spring 2020 - Following completion of the action strategy the County engaged in collaboration with MDE's Integrated Water Planning Program staff, and University of Maryland, Baltimore County (UMBC) staff, to develop a trackback-style monitoring strategy utilizing passive samplers to measure time-integrated freely dissolved PCB water column concentration to further investigate watershed sources of PCB. An agreement was reached in which MDE would provide funding for field personnel, while UMBC would provide training, materials and analysis towards the monitoring effort.

- Fall 2020 - Phase 1 of the monitoring effort began in September 2020 with the deployment of passive surface water PCB sampling devices at 17 locations within the Baltimore Harbor PCB TMDL watershed, as well as two reference locations outside of the TMDL watershed. In November 2020, sediment grab samples were also collected at each of the 19 sites and in early December 2020, the passive samplers were retrieved. During FY 22 analysis of both surface water and sediment was conducted by UMBC staff. The results of the Phase I monitoring are presented in the *PCB Source Tracking in Anne Arundel County, January 12, 2022* report included in Appendix G.

- Spring 2022 - Based on the results of the 2020 monitoring, a Phase II sampling plan was finalized in May 2022 in an effort to further determine geographic sources of PCBs. Phase II monitoring entails combinations of standard water column passive sampling, stream bed sediment sampling, pore water sampling, short time passive sampling and suspended sediment sampling (using sediment traps) at 12 sites. Phase II sampling will be a collaborative effort between the County, UMBC, and MDE while sample analysis will be conducted by UMBC. Details of the Phase II monitoring plan are presented in Proposal for PCB Source Tracking in Anne Arundel County – Phase 2, May 2022 included in Appendix G.

- Summer 2022 – Phase II sampling began in July 2022 and will conclude in fall 2022.

B. Patuxent River

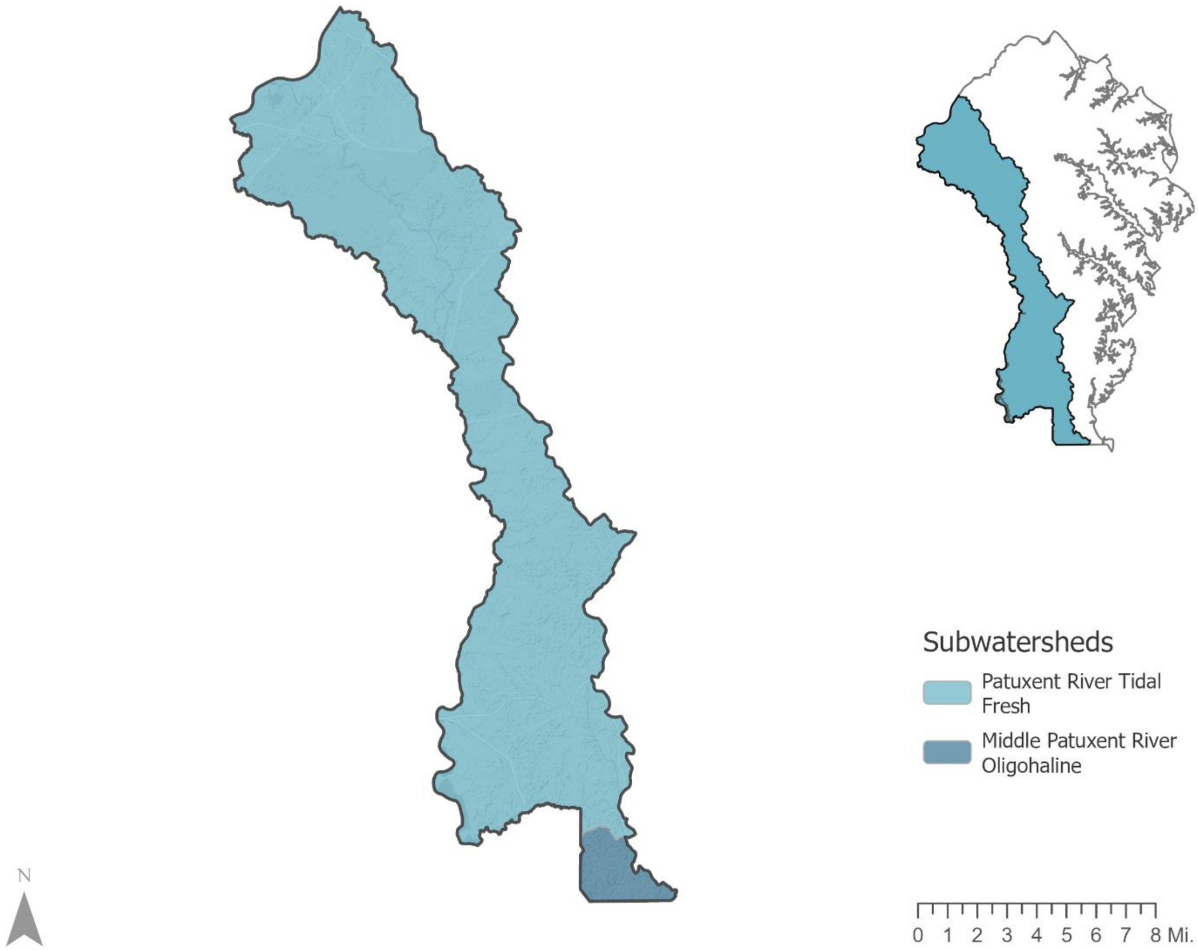

Figure 29:Map of the Patuxent River PCB TMDL watershed

The Total Maximum Daily Load of Polychlorinated Biphenyls in the Patuxent River Mesohaline, Oligohaline and Tidal Fresh Chesapeake Bay Segments was approved by EPA September 19, 2017 and requires a 99.9 % reduction in PCB loads (Figure 29). In 2020, Anne Arundel County submitted a draft restoration plan for the Tidal Fresh portion of the watershed that lies within the boundary of Anne Arundel County for MDE review. Subsequent comments and responses to those comments occurred from November 2020 through July 2021.

It is anticipated and generally understood that a 99.9% reduction in PCB loading may not be feasible given the current limited understanding of PCB sources, the ubiquitous presence of PCBs in watershed soils, and the limitations of stormwater systems to control PCB loading. Therefore, MDE is looking to local jurisdictions to document annual progress on PCB source tracking and programmatic implementation. Initiation of source tracking along with programmatic strategies identified within the plan will initiate PCB load reductions and demonstrate progress towards the goal. The plan will be reviewed and potentially revised annually based on monitoring results and implementation and load reduction progress. Per MDE guidance, completion of the plan was put on hold until MDE provided guidance on PCB monitoring. MDE published this guidance August 2022. The County is currently reviewing that guidance and will update the plan accordingly. Once the plan is updated to take into consideration the new State guidance, the County will submit a final draft to MDE and at the same time advertise the draft plan for a 30-day public comment period. Following receipt of comments, The County will revise the plan as appropriate and submit the final plan to MDE for approval.

During FY 22, at the encouragement of MDE, the County initiated a multijurisdictional collaboration with Howard County, Montgomery County and Prince Georges County and Maryland State Highway (SHA) all of whom are subject to the Total Maximum Daily Load of Polychlorinated Biphenyls in the Patuxent River Mesohaline, Oligohaline and Tidal Fresh Chesapeake Bay Segments. An initial meeting was held virtually on October 21, 2021 to discuss interest in collaborating on, and participating in, a watershed based PCB source tracking monitoring program. Participants at that meeting expressed interest, but acknowledged that additional discussion was needed before a commitment could be made. On October 29, 2021 MDE hosted a virtual meeting to discuss PCB source tracking monitoring guidance at which time MDE recommended that local jurisdictions defer any further discussion or action until MDE issued its final PCB Monitoring Guidance.

IX. Adaptive Management Strategy

A. Overview

Anne Arundel County's strategy for making progress toward meeting SW WLAs is achieved through an adaptive management process that involves both quantitative assessment strategies (TIPP modeling and impairment monitoring) and qualitative assessment strategies (programmatic). The adaptive management process includes evaluating multiple aspects of the TMDL implementation process to incorporate new information and to refine benchmarks and milestones and to identify deficiencies. The County evaluates its implementation progress annually to identify and incorporate improvements. Progress is reported in the County's Countywide TMDL Stormwater Implementation Plan Annual Report as part of the County's MS4 Annual report submittal.

B. Countywide Management Strategy

The foundation for the County's restoration program was set forth in the County's Phase II Watershed Implementation Plan (WIP) in 2012 in response to the Chesapeake Bay TMDL following MDE's allocation of stormwater loads for nitrogen, phosphorus and sediment on September 15, 2011. The County's Phase II WIP identified programs, policies and practice, and established a commitment to implementation that ensures achievement of the nitrogen, phosphorus and sediment load reductions assigned to the County. The County's Phase II WIP set forth a strategy for implementation that identified statutory authority, capital projects, funding mechanisms and timelines for achieving its allocated loads using nitrogen as the keystone nutrient. The County's Phase II WIP was developed in consultation with and through coordination among the multiple stakeholders that comprised the Anne Arundel County WIP Team. The County adopted an edge of stream strategy to pursue load reductions associated with stormwater sector. The majority of the nutrient and sediment load reduction throughout the County's watersheds is anticipated to be achieved through implementation of this strategy as well as through execution of TMDL implementation/restoration plans. Further, this strategy is critical to restoring the functional capacity, efficiency, and overall health of the County's headwater streams with the goal of achieving stormwater wasteload allocations (SW-WLAs) and ultimately delisting impaired waterbodies.

1. Quantifiable SW-WLA Load Reduction Tools

Anne Arundel County's primary tool for achieving quantifiable SW-WLA reductions is its 6-Year Capital Improvement Program (CIP). Restoration projects are identified and included in the CIP budget each fiscal year. The CIP includes projects budgeted for design and construction for the current fiscal year and projects programmed for the following 5 fiscal years. Projects programmed into the CIP budget were initially identified through comprehensive assessments of all of the County's watersheds. In developing these assessments, the County prioritized all watersheds as high, medium, low and very low for restoration and for preservation. To date the majority of the restoration projects identified in the County's Phase II WIP have been implemented. These projects are broadly classified as stream restoration projects, stormwater management retrofits, shoreline restoration and storm drain infrastructure maintenance and repair. In addition to restoration projects implemented through its CIP Program the County has established a WPRP Restoration Grant Program that provides funding for NGO restoration projects.

2. Qualitative SW-WLA Load Reduction Tools

Anne Arundel County has several programs and strategies in place to assist in making further progress toward achieving SW-WLAs. These programs are considered "qualitative" because their benefits to load reduction are not easily quantifiable.

a. Stormwater Fee Credit Program

The County encourages property owners to install BMPs to manage stormwater. Eligible property owners have the opportunity to reduce their Watershed Protection and Restoration Fee (WPRF) assessments by up to 50% for proactive and sustainable uses of stormwater runoff controls. In addition, the BWPR established a 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.

The Program's Goals are to encourage practices that proactively and sustainably manage runoff on private property and support BWPR's goal to minimize the impact of land development on water resources.

b. BMP Preventative Maintenance and Inspection Program

The County conducts preventative maintenance inspections, according to COMAR 26.17.02, of all ESD treatment systems, structural stormwater management facilities, and stable stormwater conveyance and capacity to receiving waters, at least on a triennial basis. Documentation identifying the ESD systems and structural stormwater management facilities inspected, the number of maintenance inspections, follow-up inspections, the enforcement actions used to ensure compliance, the maintenance inspection schedules, and any other relevant information is submitted in the County's MS4 annual report. Preventative maintenance inspection responsibility is split between DPW and I&P staff, with I&P staff responsible for the vast majority (approximately 95%) of facility inspections. Within DPW, achieving the required triennial inspections involves identifying those facilities due for inspections and implementing a minimum inspection rate per month to ensure all required inspections are achieved. I&P staff utilize a similar protocol for identifying facilities to be inspected in any given year with a focus on those facilities on cycle for their triennial inspection. The State and County Stormwater Management Codes require preventive maintenance inspections once during the first year of operation and every three years thereafter for all stormwater management facilities. In addition to these inspections, the County's stormwater management inspection staff performs numerous site visits in response to property owners requesting guidance, to obtain permission for site access in some situations, and to follow up on required maintenance activities. The inspection staff also review previously issued and current correction notices to confirm and ensure compliance. When additional action is required to bring a facility into compliance, additional Phase I enforcement notices are issued as appropriate. The County's inspection process include issuance of correction notices and Phase 1, 2, and 3 violation notices. Additional information relating to inspection and enforcement activities is provided annually in the SWM table of the MS4 Geodatabase, submitted with each NPDES MS4 Annual Report.

Alternative BMP inspections are compiled into a single table in the MS4 Geodatabase (AltBMPInspections). Among these are records for programmatic inspections associated with annual BMP practices (vacuum street sweeping, inlet and catch basin cleaning, and septic pumpouts), imagery reviews for shoreline stabilizations, site inspections for stream restorations, and septic system upgrade (SEPD) inspections which are conducted via a service provider visit from MDE's Best Available Technology Management Network (BATMN). SEPD inspection results are housed in MDEs BATMN database. Lastly, restoration stormwater BMPs are also subject to maintenance inspection to ensure their efficacy within the landscape.

c. Public Outreach and Education Program

The County maintains an aggressive public outreach and education program using social media platforms and in person events to engage its citizenry in addressing the impacts of stormwater. Additionally, the County founded and supports the Anne Arundel Watershed Stewards Academy to train Master Watershed Stewards to provide community outreach, education and engagement as well as to implement large and small-scale restoration projects and BMPs. The public outreach and education program achievements, and the WSA achievements, are annually documented in the County's NPDES MS4 Annual Report.

d. Effective land use decision implementation

Numerous land use plans drive management decisions in Anne Arundel County related to water quality.

- Plan2040 is the General is the General Development Plan for Anne Arundel County. It sets the policy framework to protect the natural environment, shape development of the built environment, provide public services to promote healthy communities, and support a diverse, resilient economy.
- Region Plans are community-driven land use documents that build on Plan2040 in smaller areas. Region Plans evaluate community assets and needs, present a shared vision for the next 20 years, and make specific recommendations about planned land use, zoning, environmental protection, transportation improvements, public facilities, and community design.
- Green Infrastructure Master Plan guides voluntary actions to conserve a network of connected natural areas and to add trees and green spaces in underserved communities. Conservation of green infrastructure supports public health, recreation, wildlife, and water quality. The Plan includes a goal of conserving 5,000 acres of open space by 2030.
- The Environment Article, Title 9, Subtitle 5 of the Annotated Code of Maryland, requires each county to develop water supply and sewerage systems in accordance with a county master plan that specifies the extent, adequacy, sizing, staging, and other characteristics of such facilities so that they are in compliance with State laws relating to water pollution, environmental protection, and land use. The plan is required to be updated every 3 years. The most recent Water and Sewer Master Plan was adopted and enacted in June 2022.

e. IDDE Program

Through this Program, the County works to identify and eliminate potentially polluting non-stormwater discharges to the storm drain system.

C. Progress Assessment Methods

Anne Arundel County uses impairment specific methods to monitor progress toward achieving SW-WLAs. Modelling is used to determine progress for sediment and nutrient TMDLs while monitoring is used to determine progress for bacteria and PCB TMDLs.

Impairment	Modeling Method	Monitoring Method
Sediment & Nutrient	TMDL Implementation Progress planning (TIPP)	
Bacteria		Trend, Source Tracking
PCB		Track Back

1. Modeling Method

Anne Arundel County uses the TIPP model to assess and track progress toward meeting nutrient and sediment TMDLs. The TIPP model was developed by MDE in 2021 and functions as a calculator to estimate pollutant loads and to evaluate progress and implementation scenarios. As noted in Guidance for Developing Local Nutrient and Sediment TMDL SW-WLA watershed implementation plans, MDE requires jurisdictions to use this tool for consistency among load reduction calculation methodologies and ease of reporting progress. The TIPP model estimates load reduction at various points in the watershed planning process, allowing users to assess current progress and future BMP implementation. Land use specific loading rates are multiplied by an amount, which may be acres or systems depending of the load source, to calculate loads coming off the land. The land use loading rates used in this model are Chesapeake Bay Phase 6 CAST-Watershed Model No Action (No BMP) scenario loading rates aggregated at the 8-digit watershed scale by county and include streambed and bank (STB) loads determined by a variation of the method used to determine STB load in the MDE 2021 MS4 Accounting Guidance document. Theses loads account for inconsistencies in load distribution between the Phase 5 and 6 model.

The TIPP model estimates load reductions for nitrogen, phosphorus and total suspended solids at two different scales: Edge-of-stream (EOS) and Edge-of-tide EOT). EOS loads are calculated using the methods and BMP efficiencies recommended by the expert panels approved by the Chesapeake Bay Program. The EOS scale is used for local TMDL modeling and the County's implementation plans. The EOT scale incorporates in-stream uptake, processing, and transport that affects nutrient and sediment loads from the upstream source to the receiving water body. EOT loads in the model are calculated using Chesapeake Bay Phase 6 Watershed Model No Action scenario delivery factors at the Maryland 8-digit watershed scale. Land use is a critical factor in models used to assess TMDL compliance. Land cover data from the National Land Cover Database (NLCD) is used to quantify land cover acreage. Because NLCD land cover classifications are inconsistent with the Phase 6 Chesapeake Bay Watershed Model land cover classes, the back-casting method developed by Baltimore County (*Back-casting Land Cover Approved Methodology, Version 06.04.2021*) is applied to NLCD data used within the TMDL progress modeling.

Modeling methodologies may change in the future because of updated versions of the Bay Model, which could change loading rates, or because of crediting changes directed by MDE or Expert Panels, that would affect load reduction calculations or BMP percent efficiencies. The TIPP model was originally developed by MDE, and if information is updated in the model MDE will release a new version of the model. Revised components of the updated version will then be incorporated into the County's TIPP workbooks. The County will stay up –to-date on decisions impacting local TMDL pollutant modeling and will revise TMDL implementation plans as necessary.

2. Monitoring Methods (Bacteria)

a. Trend Monitoring

Anne Arundel County assesses and tracks progress toward meeting Bacteria SW-WLAs using multiple monitoring approaches: trend monitoring, hot spot monitoring and IDDE monitoring. Anne Arundel County currently has 19 individual bacteria TMDL watersheds. Fifteen (15) of those watersheds are listed with fecal coliform as the impairment indicator based on USE II water quality standards. The TMDLs for these 15 watersheds were established using data from MDE monitoring stations in shellfish harvesting areas. The remaining four (4) TMDL waterbodies are designated as recreational USE I, with E. coli listed as the impairment indicator for two watersheds and enterococci listed as the impairment indicator for two watersheds.

The County established a trend monitoring program for bacteria in two of its 19 bacteria TMDL watersheds. The decision to monitor bacteria in these two watersheds was based on several factors:

- MDE guidance suggesting that jurisdictions establish monitoring stations in non-shellfish waters
- Multiple TMDL watersheds with the same impairment indicator
- Watersheds located entirely within County boundaries

Multiple monitoring locations were identified within each TMDL watershed. The number of sites to be monitored was determined based on:

- Cost
- Ability of field crew to collect samples and transfer them to a lab within the sample hold criteria
- Ability to identify distinct geographic locations (hot spots) contributing to bacteria loads

Monitoring Site selection within each watershed was determined using a desktop analysis of each watershed. The decision that the most downstream trend monitoring site be the MDE monitoring site location used to establish the TMDL. Sites were chosen to allow segmentation of the watershed to facilitate identification of potential hotspots and/or identification of land use differences contributing to bacteria loads. Following desktop site selection, sites were visited by field teams to ensure that they met surface water bacteria sampling criteria and were accessible by foot, wadeable, and safe to sample.

Monthly grab samples were collected at locations in each of the monitored watersheds. Samples were collected at roughly the same date/time every month and were delivered to a laboratory within 6 hours after the first sample was collected during each sampling event. This follows MDE's guidance for bacteria trend monitoring.

The general procedures conducted at each location during each sampling event were as follows:

- Calibrate the multi-parameter sonde (first location each day at a minimum)
- Note conditions of the site and record field observations in the field log.
- Take GPS reading and record coordinates (first sampling event only at each site).
- Take photograph(s) to document field conditions. Identify point of entry to the monitoring station and sample collection (collection point).
- Note conditions that may affect quality of sample (e.g. shallow depth and soft stream bed that prevent sampling without water fouling).
- Collect a surface water sample and test for residual chlorine (first sampling event only at each site).
- Collect surface water sample for bacteria analysis.
- Use a multi-parameter sonde to collect field measurements and record the results on the field data collection sheet.
- Enter date and time of collection on sample container and COC, and place sample in cooler with ice.
- Decontaminate equipment.

b. Laboratory Analysis

- Samples delivered to lab no later than 6 hours after initial collection**.**
- Sample analysis was conducted by a Maryland State-certified Water Quality Lab using IDESS Enterolert (ASTM Method #D6503-99) for the presence of enterococci bacteria, and results reported in Most Probable Number (MNP) per 100 ml.
- Samples diluted to allow for reporting of actual bacteria counts.
- Results reported in Most Probable Number (MPM) per 100 ml.

c. Hotspot Monitoring

Sites presenting high bacteria sampling results are considered potential hotspots and worthy of further investigation and monitoring. Sites with consistently high bacteria counts during the first phase of trend monitoring trigger additional monitoring. Sites are sampled again using a more focused sampling strategy including, when determined feasible' Microbial Source Tracking (MST). In tandem with the hotspot monitoring a more focused and refined desktop analysis is performed to identify and track down potential bacteria sources.

Bacteria monitoring strategies (e.g. number and location of sampling sites, sampling frequency) are specific to individual watersheds and sources and may vary from watershed to watershed. Once monitoring begins to show declines in bacteria concentrations Anne Arundel County will begin to develop more specific planning horizons and monitoring plans (e.g., moving to weekly or biweekly sampling).

3. Monitoring Methods (PCB)

a. PCB Source Tracking

Anne Arundel County has begun to assess and track progress toward meeting PCB SW-WLAs using a source tracking strategy. Anne Arundel County currently has stormwater WLAs for three drainages under two individual PCB TMDLs. The TMDLs were established using fish tissue and sediment PCB concentration data from MDE's monitoring program.

Anne Arundel County performed an extensive GIS-centric desktop analysis to identify potential PCB sources within the Curtis Bay and Baltimore Harbor segments of the "Baltimore Harbor, Curtis

Creek/Bay, and Bear Creek Portions of Patapsco River Mesohaline Tidal Chesapeake Bay Segment" TMDL area. A subwatershed was chosen for PCB source tracking based on the results of the desktop analysis. Initial monitoring locations were also identified using desktop analysis and then field verified for accessibility and monitoring feasibility.

The initial phase of PCB monitoring entailed the use of passive samplers for water column concentration and sediment grabs for sediment and pore water concentrations at 15 non-tidal locations (including two reference sites) and two tidal locations. Passive samplers were left in place between 82 to 96 days to allow for equilibration before retrieval. Sediment samples were composited from three grabs (left, right, and center channel) at each location. PCB analysis was performed at the congener level based on USEPA SW846 method 8082A. Results of the initial phase of monitoring showed two tributaries as primary sources of PCBs. A second phase of monitoring was then devised to further investigate these two tributaries in an attempt to narrow down the ultimate source(s) of PCBs. In addition to water column and sediment sampling, the second phase of monitoring also included sediment porewater sampling using passive samplers, and sampling of suspended sediments at select stormwater outfalls.

The methods used in the desktop analysis, sample collection, and laboratory analysis are MDE-approved and are proposed for future PCB source tracking studies in other PCB TMDL watersheds..

4. Monitoring Methods (Countywide Biological)

In 2004, a Countywide Biological Monitoring and Assessment Program (CWBMP) 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). The CWBMP is based on the Maryland Department of Natural Resources' Maryland Biological Stream Survey, scaled down to a County level. The program is structured such that all major watersheds of the County are sampled in a 5-year period or Round, using a rotating basin design. In a rotating basin design, a subset of watershed areas are assessed each year, which rotate annually until the entire County is sampled.

Sampling locations within each subwatershed are pre-determined using a probability-based, stratified random sampling design. Habitat evaluations include both MBSS's Physical Habitat Index (MPHI) and the EPA's Rapid Bioassessment Protocol (RBP) metrics. In-situ water quality measures are collected at each site, along with a geomorphic evaluation utilizing cross-sections, particle substrate analysis using pebble counts, and measures of channel slope. Beginning with Round 3 (2017), fish community assessment and a water chemistry grab sample were added to the CWBMP activities. Please review the program design document and other quality assurance documents for additional information that fully document the Program's design: www.aacounty.org/departments/public-works/wprp/ecological-assessment-and-evaluation/biological-monitoring/.

The CWBMP stated goals are applicable at three scales; Countywide, Primary Sampling Unit, 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

Round 1 of the CWBMP occurred between 2004 and 2008, and Round 2 took place between 2009 and 2013. 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 3, which began in 2017 and was completed in 2021, added fish sampling and water quality grab samples, and expanded the number of sites to 400 over the five-year period. Round 4, beginning in 2023 will continue the Round 3 methodology with adjustment to meet the monitoring criteria required by the County's NPDES MS4 Permit as set forth in MDE's *2021 MS4 Monitoring Guidelines for BMP Effectiveness and Watershed Assessments* (MDE 2021).

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. As stated previously, fish sample and a water chemistry grab sample were added to the assessment activities for Round 3.

The County will begin the CWBMP Round 4 in 2023 and plans to utilize Generalized Random Tessellation Stratified (GRTS) on Maryland DNR's MBSS version of the National Hydrography Dataset (NHD) 1:24,000 stream layer for site selection. In Round 4, eight sites will be sampled per PSU, per the Round 3 design power analysis. Up to five (5) PSUs will be sampled each year for five (5) years to complete the Countywide assessment and, thus, complete the Round. For each PSU all eight sites will be sampled in the same year.

A focus of the ongoing watershed biological assessment is to obtain additional data to determine watershed conditions for purposes of supporting further listing/de-listing decisions. MDE published the *Delisting Methodology for Biological Assessments in Maryland's Integrated Report* (MDE, 2021) which outlines the monitoring and biocriteria requirements for a waterbody to be de-listed from the 303(d) list. In general, to consider a waterbody for delisting, that waterbody must have at least two sampling events with IBI scores of 3.0 or greater for both fish and benthos. The CWBMP will provide data points that can be used to support listing/delisting decisions.

5. Monitoring Methods (Targeted Biological)

To evaluate management activities, the County uses CWBMP assessment methods (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. Although this monitoring utilizes the same methods and procedures as the CWBMP, the sites are not randomly selected. There are two general approaches to site selection in the targeted work. Some sites are on restored reaches that the County tracks to see how the stream benthic community changes over time in response to the restoration. The other group of sites, varying in number from year to year, is established on reaches planned for future restoration work. The intent is to create a baseline of biological conditions to justify project implementation by providing permitting agencies evidence that biological and habitat impairments exist within a reach of interest. The County also samples one site within a minimally disturbed stream reach to use as a reference reach.

D. Tracking Progress and Implementation of Additional Management Measures

The County measures progress by determining whether the targets for load reductions are being met according the milestone schedules set for the County's TMDL Implementation/Restoration Plans. Anne Arundel County tracks progress through modeling and in situ monitoring, as discussed above; and also manages a comprehensive system for adding and tracking projects and accounting for programmatic (qualitative) initiatives. New BMPs, retrofits and restoration projects constructed through the County's CIP program, and new development and redevelopment projects are entered into the County's BMP database and NPDES MS4 geodatabase as they come on-line. Additional County entities including the Bureau of Highways, Road Operation Division, which is responsible for maintenance efforts including street sweeping and inlet cleaning, report progress on management practices that are also tracked in County geodatabases. The County also captures and tracks projects implemented through the County's Restoration Grant Program by NGOs and the Watershed Stewards Academy. Annual progress is reported by the County via the NPDES MS4 Report and associated MS4 Geodatabase which serves as the overarching reporting mechanism for all stormwater management reporting.

1. Annual NPDES MS4 Reporting

The County's NPDES MS4 Permit requires the County submit an annual progress report demonstrating implementation of the Permit requirements based on the fiscal year. If the County's MS4 Annual Report does not demonstrate compliance with the permit terms and show progress toward meeting SW-WLAs, the County must implement BMP and program modifications within 12 months.

2. Annual TMDL Progress Reporting

Anne Arundel County's NPDES MS4 Permit also requires the County to submit an annual Countywide TMDL Stormwater Implementation Plan to assess and report progress for each County TMDL that has a completed and final Implementation Plan in place. The report includes implementation and load reduction summaries for the projects and programs completed in the current reporting year, as well as cumulative progress achieved from the TMDL baseline year. Comparisons are made to the planned implementation targets to determine if the County is on track to achieve its SW-WLAs.

E. Decision Making Timeframe

The Annual MS4 and TMDL progress assessments along with monitoring results contribute to ongoing re-evaluation of implementation/restoration plans, programs and management strategies. The County adapts and responds accordingly as technologies and efficiencies change, programs mature, credit trading is enacted, and regulations are put in place. When changes to the County's management approach for achieving SW-WLAs are determined necessary those changes will be documented through updates to individual TMDL Implementation Plans. Figure 30 below shows the decision making process that triggers future management actions.

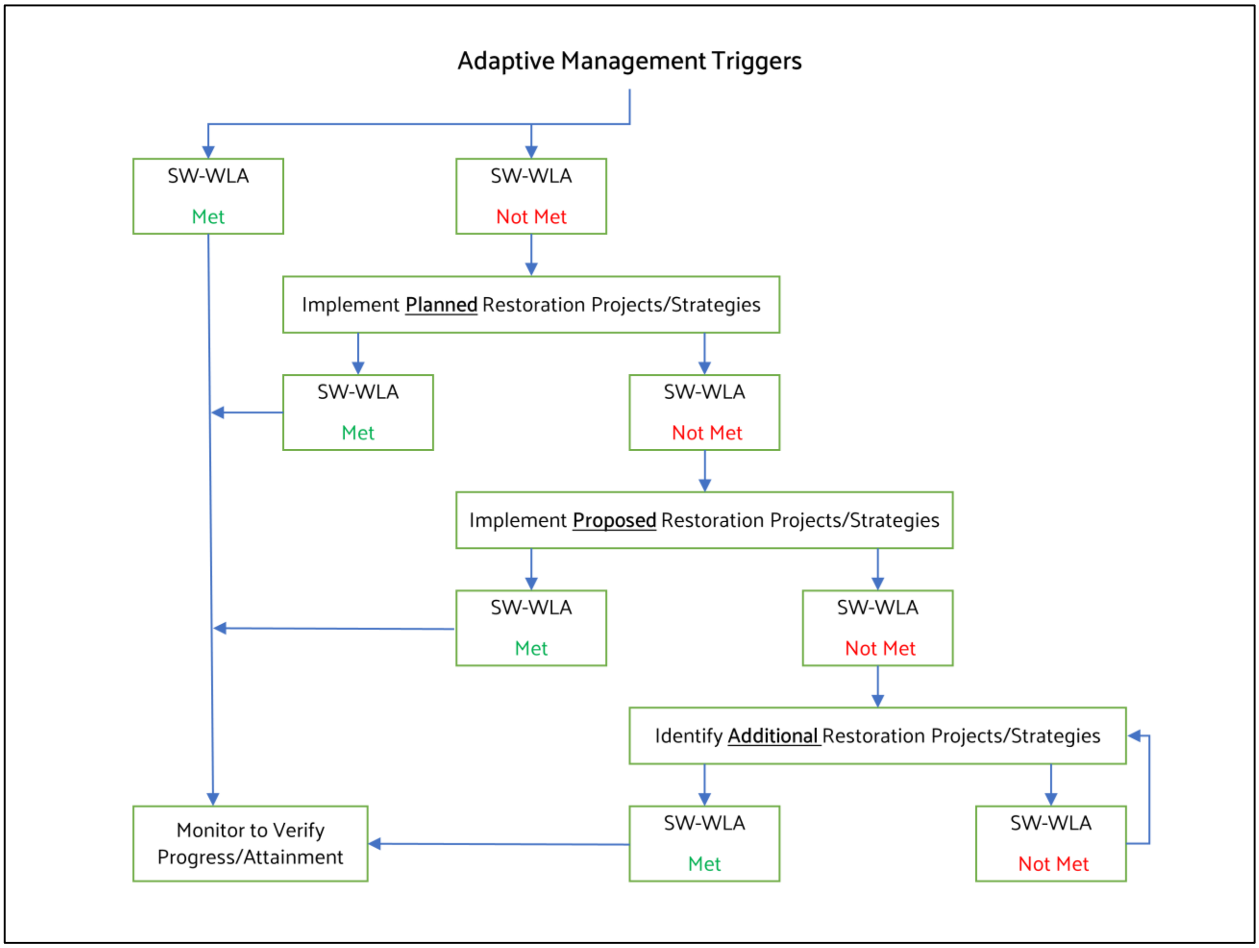

Figure 30. Adaptive Management Decision Diagram

F. Potential Management Options

If it is determined through modeling and in situ monitoring that sufficient progress is not being made the County will identify and pursue additional management strategies. Such management strategies could include, but are not limited to:

- Provide incentives for restoration project implementation in watersheds where monitored or modeled load reductions are lagging behind schedule.
- Implement projects that address multiple impairments.
- Implement projects for which additional funding can be leveraged.
- Continue to refine BMP inspection rate protocols while enhancing staff abilities to more efficiently inspect stormwater management facilities through the development/implementation of an inspection application for field tablets.
- Re-evaluate watershed assessments to identify additional opportunities for restoration or preservation implementation and/or to refocus programmatic initiatives.

X. Appendices

Appendix A Approved Restoration Plans

See documents provided in 'ApprovedRestorationPlans.zip'

Appendix B Draft Restoration Plans

See documents provided in 'DraftRestorationPlans.zip'

Appendix C Current and Programmed BMPs

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - Nutrient	Land Cover Conversion	7.5	0.7	-	BMP0414	Implemented
Baltimore Harbor - Nutrient	Land Cover Conversion	1.2	0.1	-	BMP0416	Implemented
Baltimore Harbor - Nutrient	Land Cover Conversion	0.7	0.1	-	BMP0420	Implemented
Baltimore Harbor - Nutrient	Land Cover Conversion	0.3	0.0	-	BMP0774	Programmed
Baltimore Harbor - Nutrient	Land Cover Conversion	4.2	0.4	-	BMP0775	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	18.8	17.0	-	BMP0257	Implemented
Baltimore Harbor - Nutrient	Stream Restoration	1,683.2	166.7	-	BMP0268	Implemented
Baltimore Harbor - Nutrient	Stream Restoration	696.0	321.0	-	BMP0291	Implemented
Baltimore Harbor - Nutrient	Stream Restoration	33.0	29.9	-	BMP0294	Implemented
Baltimore Harbor - Nutrient	Stream Restoration	158.8	32.1	-	BMP0746	Implemented
Baltimore Harbor - Nutrient	Stream Restoration	5.6	1.4	-	BMP0196	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	112.9	26.7	-	BMP0281	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	59.4	13.8	-	BMP0298	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	1,250.3	89.0	-	BMP0299	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	212.0	60.1	-	BMP0300	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	1,171.0	171.3	-	BMP0304	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	230.2	22.1	-	BMP0305	Programmed

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - Nutrient	Stream Restoration	161.7	23.8	-	BMP0306	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	11.4	3.0	-	BMP0307	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	683.5	48.6	-	BMP0308	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	366.8	17.0	-	BMP0309	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	222.8	26.0	-	BMP0310	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	155.9	17.7	-	BMP0311	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	51.6	5.6	-	BMP0312	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	2,738.0	1,095.9	-	BMP0314	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	42.0	38.1	-	BMP0327	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	922.0	87.4	-	BMP0468	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	9,819.0	756.0	-	BMP0472	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	8,245.0	1,512.5	-	BMP0475	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	532.0	123.0	-	BMP0770	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	19.9	18.0	-	BMP0773	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	225.9	40.0	-	BMP0777	Programmed
Baltimore Harbor - Nutrient	Stream Restoration	5.4	0.9	-	BMP0778	Programmed
Baltimore Harbor - Nutrient	SWM BMP	1.9	0.2	-	BMP0003	Implemented
Baltimore Harbor - Nutrient	SWM BMP	189.8	87.4	-	BMP0003 - P5	Implemented
Baltimore Harbor - Nutrient	SWM BMP	26.6	3.4	-	BMP0010	Implemented
Baltimore Harbor - Nutrient	SWM BMP	62.3	7.9	-	BMP0050	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - Nutrient	SWM BMP	34.2	3.3	-	BMP0057	Implemented
Baltimore Harbor - Nutrient	SWM BMP	37.8	4.9	-	BMP0058	Implemented
Baltimore Harbor - Nutrient	SWM BMP	230.9	22.0	-	BMP0063	Implemented
Baltimore Harbor - Nutrient	SWM BMP	78.1	7.4	-	BMP0064	Implemented
Baltimore Harbor - Nutrient	SWM BMP	47.0	6.1	-	BMP0065	Implemented
Baltimore Harbor - Nutrient	SWM BMP	6.2	0.8	-	BMP0067	Implemented
Baltimore Harbor - Nutrient	SWM BMP	68.2	6.5	-	BMP0071	Implemented
Baltimore Harbor - Nutrient	SWM BMP	2.2	0.2	-	BMP0080	Implemented
Baltimore Harbor - Nutrient	SWM BMP	2.8	0.3	-	BMP0081	Implemented
Baltimore Harbor - Nutrient	SWM BMP	2.0	0.2	-	BMP0082	Implemented
Baltimore Harbor - Nutrient	SWM BMP	37.9	4.8	-	BMP0088	Implemented
Baltimore Harbor - Nutrient	SWM BMP	75.0	9.6	-	BMP0089	Implemented
Baltimore Harbor - Nutrient	SWM BMP	14.7	1.9	-	BMP0090	Implemented
Baltimore Harbor - Nutrient	SWM BMP	23.9	2.3	-	BMP0094	Implemented
Baltimore Harbor - Nutrient	SWM BMP	38.1	4.9	-	BMP0095	Implemented
Baltimore Harbor - Nutrient	SWM BMP	4.2	0.5	-	BMP0096	Implemented
Baltimore Harbor - Nutrient	SWM BMP	42.7	4.2	-	BMP0099	Implemented
Baltimore Harbor - Nutrient	SWM BMP	111.3	14.2	-	BMP0100	Implemented
Baltimore Harbor - Nutrient	SWM BMP	132.8	12.6	-	BMP0101	Implemented
Baltimore Harbor - Nutrient	SWM BMP	65.2	8.2	-	BMP0102	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - Nutrient	SWM BMP	135.7	13.0	-	BMP0121	Implemented
Baltimore Harbor - Nutrient	SWM BMP	146.1	14.1	-	BMP0122	Implemented
Baltimore Harbor - Nutrient	SWM BMP	151.7	19.6	-	BMP0124	Implemented
Baltimore Harbor - Nutrient	SWM BMP	111.8	10.7	-	BMP0125	Implemented
Baltimore Harbor - Nutrient	SWM BMP	45.5	4.2	-	BMP0127	Implemented
Baltimore Harbor - Nutrient	SWM BMP	158.6	20.4	-	BMP0129	Implemented
Baltimore Harbor - Nutrient	SWM BMP	84.9	8.1	-	BMP0133	Implemented
Baltimore Harbor - Nutrient	SWM BMP	198.1	25.5	-	BMP0139	Implemented
Baltimore Harbor - Nutrient	SWM BMP	0.4	0.1	-	BMP0145	Implemented
Baltimore Harbor - Nutrient	SWM BMP	34.4	4.5	-	BMP0149	Implemented
Baltimore Harbor - Nutrient	SWM BMP	5.0	0.4	-	BMP0150	Implemented
Baltimore Harbor - Nutrient	SWM BMP	9.6	0.9	-	BMP0151	Implemented
Baltimore Harbor - Nutrient	SWM BMP	4.7	0.4	-	BMP0152	Implemented
Baltimore Harbor - Nutrient	SWM BMP	13.4	1.2	-	BMP0153	Implemented
Baltimore Harbor - Nutrient	SWM BMP	9.2	0.8	-	BMP0154	Implemented
Baltimore Harbor - Nutrient	SWM BMP	14.4	1.3	-	BMP0155	Implemented
Baltimore Harbor - Nutrient	SWM BMP	0.4	0.0	-	BMP0156	Implemented
Baltimore Harbor - Nutrient	SWM BMP	331.2	42.9	-	BMP0168	Implemented
Baltimore Harbor - Nutrient	SWM BMP	11.1	1.4	-	BMP0171	Implemented
Baltimore Harbor - Nutrient	SWM BMP	136.3	17.4	-	BMP0172	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - Nutrient	SWM BMP	148.9	14.2	-	BMP0173	Implemented
Baltimore Harbor - Nutrient	SWM BMP	54.4	6.7	-	BMP0174	Implemented
Baltimore Harbor - Nutrient	SWM BMP	210.9	19.7	-	BMP0175	Implemented
Baltimore Harbor - Nutrient	SWM BMP	60.4	5.6	-	BMP0176	Implemented
Baltimore Harbor - Nutrient	SWM BMP	21.4	2.6	-	BMP0177	Implemented
Baltimore Harbor - Nutrient	SWM BMP	5.5	0.5	-	BMP0192	Implemented
Baltimore Harbor - Nutrient	SWM BMP	972.4	120.1	-	BMP0198	Implemented
Baltimore Harbor - Nutrient	SWM BMP	177.7	22.9	-	BMP0229	Implemented
Baltimore Harbor - Nutrient	SWM BMP	38.1	4.9	-	BMP0231	Implemented
Baltimore Harbor - Nutrient	SWM BMP	104.9	13.4	-	BMP0232	Implemented
Baltimore Harbor - Nutrient	SWM BMP	185.1	22.7	-	BMP0234	Implemented
Baltimore Harbor - Nutrient	SWM BMP	53.1	6.7	-	BMP0243	Implemented
Baltimore Harbor - Nutrient	SWM BMP	77.7	7.4	-	BMP0244	Implemented
Baltimore Harbor - Nutrient	SWM BMP	70.2	9.0	-	BMP0006	Programmed
Baltimore Harbor - Nutrient	SWM BMP	338.9	42.9	-	BMP0066	Programmed
Baltimore Harbor - Nutrient	SWM BMP	75.6	7.2	-	BMP0079	Programmed
Baltimore Harbor - Nutrient	SWM BMP	167.1	21.0	-	BMP0098	Programmed
Baltimore Harbor - Nutrient	SWM BMP	77.2	7.3	-	BMP0103	Programmed
Baltimore Harbor - Nutrient	SWM BMP	103.8	9.8	-	BMP0105	Programmed
Baltimore Harbor - Nutrient	SWM BMP	133.5	12.4	-	BMP0135	Programmed

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - Nutrient	SWM BMP	101.1	12.9	-	BMP0136	Programmed
Baltimore Harbor - Nutrient	SWM BMP	219.1	27.2	-	BMP0167	Programmed
Baltimore Harbor - Nutrient	SWM BMP	314.1	29.9	-	BMP0170	Programmed
Baltimore Harbor - Nutrient	SWM BMP	35.5	4.4	-	BMP0183	Programmed
Baltimore Harbor - Nutrient	SWM BMP	112.7	14.5	-	BMP0184	Programmed
Baltimore Harbor - Nutrient	SWM BMP	96.1	9.5	-	BMP0196	Programmed
Baltimore Harbor - Nutrient	SWM BMP	1.9	0.2	-	BMP0230	Programmed
Baltimore Harbor - Nutrient	SWM BMP	67.0	8.5	-	BMP0246	Programmed
Baltimore Harbor - Nutrient	SWM BMP	89.4	11.4	-	BMP0421	Programmed
Baltimore Harbor - Nutrient	SWM BMP	103.2	13.2	-	BMP0422	Programmed
Baltimore Harbor - Nutrient	SWM BMP	1,512.8	137.0	-	BMP0727	Programmed
Baltimore Harbor - Nutrient	SWM BMP	115.9	11.2	-	BMP0789	Programmed
Baltimore Harbor - TSS	Land Cover Conversion	-	-	114.8	BMP0414	Implemented
Baltimore Harbor - TSS	Land Cover Conversion	-	-	242.5	BMP0416	Implemented
Baltimore Harbor - TSS	Land Cover Conversion	-	-	111.1	BMP0420	Implemented
Baltimore Harbor - TSS	Stream Restoration	-	-	166,454.5	BMP0003	Implemented
Baltimore Harbor - TSS	Stream Restoration	-	-	113,700.0	BMP0268	Implemented
Baltimore Harbor - TSS	Stream Restoration	-	-	610,000.0	BMP0291	Implemented
Baltimore Harbor - TSS	Stream Restoration	-	-	109,120.0	BMP0294	Implemented
Baltimore Harbor - TSS	Stream Restoration	-	-	283,869.2	BMP0746	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - TSS	Stream Restoration	-	-	17,600.0	BMP0196	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	356,068.7	BMP0281	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	70,200.0	BMP0298	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	1,071,800.0	BMP0299	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	493,000.0	BMP0300	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	245,240.0	BMP0304	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	91,230.0	BMP0305	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	86,640.0	BMP0306	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	6,710.0	BMP0307	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	20,880.0	BMP0308	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	7,140.0	BMP0309	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	71,770.0	BMP0310	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	123,430.0	BMP0311	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	33,070.0	BMP0312	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	2,048,019.0	BMP0314	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	74,303.0	BMP0468	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	2,203,742.0	BMP0475	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	296,000.0	BMP0770	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	135,000.0	BMP0777	Programmed
Baltimore Harbor - TSS	Stream Restoration	-	-	3,667.7	BMP0778	Programmed

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - TSS	SWM BMP	-	-	202.0	BMP0003	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	5,609.3	BMP0010	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	13,435.8	BMP0050	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	7,482.6	BMP0058	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	29,881.2	BMP0063	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	10,272.8	BMP0064	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	8,911.5	BMP0065	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	368.7	BMP0080	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	467.3	BMP0081	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	332.3	BMP0082	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	13,496.4	BMP0089	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	2,933.1	BMP0090	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	3,041.7	BMP0094	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	7,810.4	BMP0095	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	4,786.1	BMP0099	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	17,819.3	BMP0101	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	14,988.0	BMP0102	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	15,926.1	BMP0121	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	16,703.2	BMP0122	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	29,123.2	BMP0124	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - TSS	SWM BMP	-	-	14,314.0	BMP0125	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	6,643.5	BMP0127	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	10,093.4	BMP0133	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	39,137.5	BMP0139	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	53.9	BMP0145	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	5,596.9	BMP0149	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	2,229.3	BMP0171	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	28,723.3	BMP0172	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	18,921.2	BMP0173	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	17,333.1	BMP0174	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	30,873.5	BMP0175	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	2.7	BMP0177	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	702.1	BMP0192	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	34,547.3	BMP0229	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	7,974.3	BMP0231	Implemented
Baltimore Harbor - TSS	SWM BMP	-	-	76,152.7	BMP0066	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	9,818.3	BMP0079	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	10,488.3	BMP0103	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	13,672.3	BMP0105	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	21,001.7	BMP0136	Programmed

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Baltimore Harbor - TSS	SWM BMP	-	-	8,477.9	BMP0183	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	23,174.8	BMP0184	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	12,209.9	BMP0196	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	439.2	BMP0230	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	14,439.4	BMP0246	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	18,678.1	BMP0421	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	20,804.7	BMP0422	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	190,633.3	BMP0727	Programmed
Baltimore Harbor - TSS	SWM BMP	-	-	1,447.8	BMP0789	Programmed
Little Patuxent	Stream Restoration	-	-	454,000.0	BMP0221	Implemented
Little Patuxent	Stream Restoration	-	-	250,728.0	BMP0266	Implemented
Little Patuxent	Stream Restoration	-	-	37,200.0	BMP0267	Implemented
Little Patuxent	Stream Restoration	-	-	620,053.0	BMP0324	Implemented
Little Patuxent	Stream Restoration	-	-	624,464.0	BMP0292	Programmed
Little Patuxent	Stream Restoration	-	-	1,623,584.8	BMP0301	Programmed
Little Patuxent	Stream Restoration	-	-	1,825,740.0	BMP0317	Programmed
Little Patuxent	Stream Restoration	-	-	178,580.0	BMP0783	Programmed
Little Patuxent	Stream Restoration	-	-	529,220.0	BMP0784	Programmed
Little Patuxent	SWM BMP	-	-	3,022.4	BMP0053	Implemented
Little Patuxent	SWM BMP	-	-	6,044.2	BMP0067	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Little Patuxent	SWM BMP	-	-	371.4	BMP0068	Implemented
Little Patuxent	SWM BMP	-	-	83,539.8	BMP0110	Implemented
Little Patuxent	SWM BMP	-	-	16,728.2	BMP0169	Implemented
Little Patuxent	SWM BMP	-	-	9,813.7	BMP0179	Implemented
Little Patuxent	SWM BMP	-	-	120,730.1	BMP0197	Implemented
Little Patuxent	SWM BMP	-	-	141,896.5	BMP0221	Implemented
Little Patuxent	SWM BMP	-	-	80.0	BMP0226	Programmed
Little Patuxent	SWM BMP	-	-	340.0	BMP0722	Programmed
Little Patuxent	SWM BMP	-	-	268.2	BMP0723	Programmed
Lower Patuxent	Stream Restoration	-	-	973,878.0	BMP0782	Programmed
Middle Patuxent	Land Cover Conversion	-	-	1,987.9	BMP0413	Implemented
Middle Patuxent	Land Cover Conversion	-	-	1,197.3	BMP0418	Implemented
Middle Patuxent	Stream Restoration	-	-	19,784.7	BMP0779	Implemented
Other West Chesapeake	Stream Restoration	-	-	38,312.0	BMP0320	Implemented
Other West Chesapeake	Stream Restoration	-	-	27,380.5	BMP0799	Implemented
Other West Chesapeake	SWM BMP	-	-	76,183.5	BMP0185	Implemented
Other West Chesapeake	SWM BMP	-	-	165.9	BMP0780	Implemented
Patapsco Lower North Branch	Land Cover Conversion	-	-	169.4	BMP0774	Programmed
Patapsco Lower North Branch	Land Cover Conversion	-	-	772.2	BMP0775	Programmed
Patapsco Lower North Branch	Stream Restoration	-	-	62,000.0	BMP0257	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Patapsco Lower North Branch	Stream Restoration	-	-	138,880.0	BMP0327	Programmed
Patapsco Lower North Branch	Stream Restoration	-	-	643,076.0	BMP0472	Programmed
Patapsco Lower North Branch	Stream Restoration	-	-	65,720.0	BMP0773	Programmed
Patapsco Lower North Branch	SWM BMP	-	-	9,049.0	BMP0057	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	2,536.4	BMP0067	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	17,490.3	BMP0071	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	16,128.3	BMP0088	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	3,099.0	BMP0089	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	2,117.3	BMP0096	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	48,271.2	BMP0100	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	63,734.4	BMP0129	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	1,758.0	BMP0150	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	3,161.4	BMP0151	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	1,631.9	BMP0152	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	4,693.0	BMP0153	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	2,938.7	BMP0154	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	5,064.8	BMP0155	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	147.5	BMP0156	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	129,093.8	BMP0168	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	17,678.8	BMP0176	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Patapsco Lower North Branch	SWM BMP	-	-	10,871.9	BMP0177	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	505,990.6	BMP0198	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	45,477.7	BMP0232	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	105,466.3	BMP0234	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	23,222.9	BMP0243	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	20,155.0	BMP0244	Implemented
Patapsco Lower North Branch	SWM BMP	-	-	28,740.1	BMP0006	Programmed
Patapsco Lower North Branch	SWM BMP	-	-	77,788.4	BMP0098	Programmed
Patapsco Lower North Branch	SWM BMP	-	-	39,746.5	BMP0135	Programmed
Patapsco Lower North Branch	SWM BMP	-	-	107,291.3	BMP0167	Programmed
Patapsco Lower North Branch	SWM BMP	-	-	82,510.0	BMP0170	Programmed
Patapsco Lower North Branch	SWM BMP	-	-	24,340.1	BMP0789	Programmed
South River	Land Cover Conversion	-	-	889.4	BMP0417	Implemented
South River	Stream Restoration	-	-	377,814.2	BMP0240	Implemented
South River	Stream Restoration	-	-	272,800.0	BMP0258	Implemented
South River	Stream Restoration	-	-	205,096.0	BMP0260	Implemented
South River	Stream Restoration	-	-	157,976.0	BMP0261	Implemented
South River	Stream Restoration	-	-	74,400.0	BMP0262	Implemented
South River	Stream Restoration	-	-	274,784.0	BMP0265	Implemented
South River	Stream Restoration	-	-	99,200.0	BMP0276	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
South River	Stream Restoration	-	-	173,600.0	BMP0282	Implemented
South River	Stream Restoration	-	-	744,000.0	BMP0283	Implemented
South River	Stream Restoration	-	-	1,327,868.9	BMP0286	Implemented
South River	Stream Restoration	-	-	653,340.9	BMP0295	Implemented
South River	Stream Restoration	-	-	123,455.3	BMP0313	Implemented
South River	Stream Restoration	-	-	72,664.0	BMP0316	Implemented
South River	Stream Restoration	-	-	184,361.0	BMP0318	Implemented
South River	Stream Restoration	-	-	200,299.3	BMP0319	Implemented
South River	Stream Restoration	-	-	160,185.2	BMP0321	Implemented
South River	Stream Restoration	-	-	74,400.0	BMP0323	Implemented
South River	Stream Restoration	-	-	275,409.8	BMP0329	Implemented
South River	Stream Restoration	-	-	19,672.1	BMP0330	Implemented
South River	Stream Restoration	-	-	341,892.9	BMP0328	Programmed
South River	Stream Restoration	-	-	309,607.4	BMP0454	Programmed
South River	Stream Restoration	-	-	140,403.4	BMP0464	Programmed
South River	Stream Restoration	-	-	3,324,000.0	BMP0480	Programmed
South River	Stream Restoration	-	-	1,240,000.0	BMP0482	Programmed
South River	Stream Restoration	-	-	991,195.6	BMP0740	Programmed
South River	Stream Restoration	-	-	159,849.0	BMP0800	Programmed
South River	SWM BMP	-	-	8,518.4	BMP0023	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
South River	SWM BMP	-	-	3,222.6	BMP0028	Implemented
South River	SWM BMP	-	-	4,651.1	BMP0036	Implemented
South River	SWM BMP	-	-	4,196.6	BMP0037	Implemented
South River	SWM BMP	-	-	25,189.5	BMP0038	Implemented
South River	SWM BMP	-	-	4,549.7	BMP0043	Implemented
South River	SWM BMP	-	-	5,317.9	BMP0045	Implemented
South River	SWM BMP	-	-	11,471.8	BMP0051	Implemented
South River	SWM BMP	-	-	517.9	BMP0055	Implemented
South River	SWM BMP	-	-	3,566.8	BMP0061	Implemented
South River	SWM BMP	-	-	5,492.7	BMP0062	Implemented
South River	SWM BMP	-	-	5,143.8	BMP0069	Implemented
South River	SWM BMP	-	-	13,525.1	BMP0073	Implemented
South River	SWM BMP	-	-	8,940.1	BMP0074	Implemented
South River	SWM BMP	-	-	826.0	BMP0076	Implemented
South River	SWM BMP	-	-	230.1	BMP0077	Implemented
South River	SWM BMP	-	-	457.9	BMP0078	Implemented
South River	SWM BMP	-	-	80,056.3	BMP0097	Implemented
South River	SWM BMP	-	-	26,261.3	BMP0108	Implemented
South River	SWM BMP	-	-	795.5	BMP0111	Implemented
South River	SWM BMP	-	-	17,439.5	BMP0123	Implemented

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
South River	SWM BMP	-	-	1,264.2	BMP0137	Implemented
South River	SWM BMP	-	-	66,231.9	BMP0138	Implemented
South River	SWM BMP	-	-	3,387.2	BMP0162	Implemented
South River	SWM BMP	-	-	21,732.7	BMP0163	Implemented
South River	SWM BMP	-	-	16,756.7	BMP0165	Implemented
South River	SWM BMP	-	-	191.6	BMP0180	Implemented
South River	SWM BMP	-	-	649.6	BMP0181	Implemented
South River	SWM BMP	-	-	842.8	BMP0182	Implemented
South River	SWM BMP	-	-	1,390.9	BMP0211	Implemented
South River	SWM BMP	-	-	1,462.6	BMP0218	Implemented
South River	SWM BMP	-	-	8,168.6	BMP0222	Implemented
South River	SWM BMP	-	-	753.4	BMP0233	Implemented
South River	SWM BMP	-	-	1,546.6	BMP0239	Implemented
South River	SWM BMP	-	-	3,800.5	BMP0240	Implemented
South River	SWM BMP	-	-	3,542.9	BMP0242	Implemented
South River	SWM BMP	-	-	210,119.6	BMP0245	Implemented
South River	SWM BMP	-	-	1,444.8	BMP0443	Implemented
South River	SWM BMP	-	-	887.4	BMP0724	Implemented
South River	SWM BMP	-	-	10,551.2	BMP0721	Programmed
South River	SWM BMP	-	-	5,454.4	BMP0800	Programmed

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	BMP ID	Scenario
Upper Patuxent	Stream Restoration	-	-	171,500.0	BMP0289	Implemented
Upper Patuxent	Stream Restoration	-	-	425,400.0	BMP0292	Programmed
Upper Patuxent	SWM BMP	-	-	30,279.8	BMP0068	Implemented
Upper Patuxent	SWM BMP	-	-	32,808.7	BMP0197	Implemented
Upper Patuxent	SWM BMP	-	-	83,986.0	BMP0226	Programmed
Upper Patuxent	SWM BMP	-	-	31,535.7	BMP0227	Programmed
Upper Patuxent	SWM BMP	-	-	19,855.2	BMP0228	Programmed
West River	Land Cover Conversion	-	-	532.7	BMP0415	Implemented
West River	Stream Restoration	-	-	46,363.9	BMP0259	Implemented
West River	SWM BMP	-	-	2,604.4	BMP0020	Implemented
West River	SWM BMP	-	-	3,772.6	BMP0069	Implemented
West River	SWM BMP	-	-	4,551.7	BMP0725	Implemented
West River	SWM BMP	-	-	2,551.4	BMP0726	Implemented

Appendix D Planned BMPs

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	Scenario
Baltimore Harbor - Nutrient	SWM BMP	789.4	71.0	-	Planned
Baltimore Harbor - Nutrient	SWM BMP	600.7	54.7	-	Planned
Baltimore Harbor - Nutrient	SWM BMP	502.5	43.5	-	Planned
Baltimore Harbor - Nutrient	SWM BMP	341.4	31.4	-	Planned
Baltimore Harbor - Nutrient	SWM BMP	316.8	28.8	-	Planned
Baltimore Harbor - Nutrient	SWM BMP	255.5	23.4	-	Planned
Baltimore Harbor - Nutrient	SWM BMP	240.5	21.1	-	Planned
Baltimore Harbor - Nutrient	SWM BMP	104.6	9.4	-	Planned
Baltimore Harbor - Nutrient	Stream Restoration	330.0	299.2	-	Planned
Baltimore Harbor - Nutrient	Stream Restoration	157.5	142.8	-	Planned
Baltimore Harbor - Nutrient	Stream Restoration	255.0	231.2	-	Planned
Baltimore Harbor - Nutrient	Stream Restoration	146.8	133.1	-	Planned
Baltimore Harbor - Nutrient	Stream Restoration	64.5	58.5	-	Planned
Baltimore Harbor - TSS	SWM BMP	-	-	103,636.4	Planned
Baltimore Harbor - TSS	SWM BMP	-	-	73,124.3	Planned
Baltimore Harbor - TSS	SWM BMP	-	-	79,212.8	Planned
Baltimore Harbor - TSS	SWM BMP	-	-	39,070.0	Planned
Baltimore Harbor - TSS	SWM BMP	-	-	38,833.3	Planned
Baltimore Harbor - TSS	SWM BMP	-	-	30,086.8	Planned
Baltimore Harbor - TSS	SWM BMP	-	-	35,486.7	Planned
Baltimore Harbor - TSS	SWM BMP	-	-	13,479.3	Planned
Baltimore Harbor - TSS	Stream Restoration	-	-	1,091,200.0	Planned
Baltimore Harbor - TSS	Stream Restoration	-	-	520,800.0	Planned
Baltimore Harbor - TSS	Stream Restoration	-	-	843,200.0	Planned
Lower Patuxent	Stream Restoration	-	-	398,213.6	Planned
Middle Patuxent	Stream Restoration	-	-	655,960.0	Planned

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	Scenario
Middle Patuxent	Stream Restoration	-	-	491,412.0	Planned
Middle Patuxent	Stream Restoration	-	-	904,158.4	Planned
Middle Patuxent	Stream Restoration	-	-	701,220.0	Planned
Middle Patuxent	Stream Restoration	-	-	886,451.2	Planned
Middle Patuxent	Stream Restoration	-	-	896,024.0	Planned
Middle Patuxent	Stream Restoration	-	-	758,855.2	Planned
Middle Patuxent	Stream Restoration	-	-	356,549.6	Planned
Middle Patuxent	Stream Restoration	-	-	460,188.8	Planned
Middle Patuxent	Stream Restoration	-	-	536,399.2	Planned
Middle Patuxent	Stream Restoration	-	-	490,568.8	Planned
Middle Patuxent	Stream Restoration	-	-	329,294.4	Planned
Middle Patuxent	Stream Restoration	-	-	483,079.2	Planned
Middle Patuxent	Stream Restoration	-	-	408,406.4	Planned
Middle Patuxent	Stream Restoration	-	-	736,396.3	Planned
Other West Chesapeake	Stream Restoration	-	-	173,228.0	Planned
Other West Chesapeake	Stream Restoration	-	-	62,644.8	Planned
Other West Chesapeake	Stream Restoration	-	-	206,088.0	Planned
Other West Chesapeake	Stream Restoration	-	-	112,765.6	Planned
Other West Chesapeake	Stream Restoration	-	-	419,864.0	Planned
Other West Chesapeake	Stream Restoration	-	-	448,111.2	Planned
Other West Chesapeake	Stream Restoration	-	-	332,320.0	Planned
Other West Chesapeake	Stream Restoration	-	-	386,532.8	Planned
Other West Chesapeake	Stream Restoration	-	-	257,771.2	Planned
Other West Chesapeake	Stream Restoration	-	-	235,525.6	Planned
Other West Chesapeake	Stream Restoration	-	-	440,596.8	Planned
Other West Chesapeake	Stream Restoration	-	-	223,448.0	Planned
Other West Chesapeake	Stream Restoration	-	-	349,655.2	Planned
Patapsco Lower North Branch	Stream Restoration	-	-	485,311.2	Planned
Patapsco Lower North Branch	Stream Restoration	-	-	957,329.6	Planned

Watershed	Type	TN (lbs)	TP (lbs)	TSS (lbs)	Scenario
Upper Patuxent	Stream Restoration	-	-	421,600.0	Planned
Upper Patuxent	Stream Restoration	-	-	297,600.0	Planned
West River	SWM BMP	-	-	12,452.6	Planned
West River	SWM BMP	-	-	2,389.3	Planned
West River	SWM BMP	-	-	14,797.7	Planned
West River	SWM BMP	-	-	10,398.4	Planned
West River	SWM BMP	-	-	10,985.6	Planned
West River	SWM BMP	-	-	1,587.3	Planned
West River	SWM BMP	-	-	2,931.1	Planned
West River	Stream Restoration	-	-	843,200.0	Planned
West River	Stream Restoration	-	-	1,289,600.0	Planned

Appendix E TIPP Tool Spreadsheets

See documents provided in 'AACountyFY22TIPPSpreadsheets.zip'

Appendix F Bacterial TMDL Supporting Documents

See documents provided in 'BacterialTMDLDocuments.zip'

Appendix G PCB TMDL Supporting Documents

See documents provided in 'PCBTMDLDocuments.zip'

Appendix H Response to MDE Comments: FY2021 Countywide Stormwater TMDL Implementation Plan

Anne Arundel FY2021 Countywide Stormwater TMDL Implementation Plan
Response to MDE Comments (8.28.2022)

Required Edits:

1. MDE requests that the purpose of the document be elaborated upon. The document does state it is the fulfillment of the permit requirements, but it also represents the jurisdiction's plan to achieve the applicable wasteload allocations and ultimately make progress towards attaining water quality criteria and waterbody designated uses.

Response: The following language has been added to section II on p. 1 to address this comment "*The Countywide Plan represents Anne Arundel County's roadmap to achieve SW-WLAs for each TMDL, and ultimately the progress towards attaining water quality criteria ensuring that each waterbody supports its designated uses*".

2. On page 2, MDE requests that the County clarify the reasoning for using the 2014 Accounting Guidance/Phase 5 Chesapeake Bay Watershed Model to estimate Bay TMDL progress and clarify its timeframe for moving toward using the most recent science (i.e., P6 and 2021 Acct Guidance) and the TIPP tool. The updated version of TIPP allows for modeling Bay TMDL progress.

Response: The following language has been added to p. 2 to address this comment – "*From FY23 onwards, the County intends to assess Chesapeake Bay TMDL progress within each Bay segment using the TIPP tool.*"

3. MDE requests that the maps included in the Countywide Report be based on restoration needs by watershed ("zones" determined and documented in Watershed Characterization documents or other documents) and show the locations of historic and planned implementation work in relation to those zones.

Response: Maps have been updated to include BMPs that have been implemented (FY22 progress), those that are under a design contract (interim planned progress), and those that are in a conceptual design stage (planned).

4. MDE requests the County develop a list of implementation projects that are (1) driving large reductions, (2) specific BMP types, (3) in high-densities to achieve specific local goals, etc. Please include a running list. South River may be a good candidate for such sites, since this watershed has implemented the full extent of the TSS TMDL SW-WLA model.

Response: For each TMDL summary, a list is now provided that documents the top three BMPs that provide the greatest reductions, noting their IDs, their BMP type, and their reductions.

5. MDE requests the County update the PCB TMDL Progress Section (page 41) to indicate the following: "Spring 2022 - Results of the 2020 sampling will be used to determine Phase II sampling locations in a focused effort to identify geographic sources of PCBs. A plan for Phase II monitoring will be developed after MDE issues its final guidance on PCB TMDL monitoring in 2022". This will accurately reflect the fact that the County has a contract in place with UMBC to conduct Phase II monitoring starting in August and MDE will be providing field support.

Response: The following language has been included in the FY22 Countywide Plan on Page 51. *"Based on the results of the 2020 monitoring, a Phase II sampling plan was finalized in May 2022 in an effort to further determine geographic sources of PCBs. Phase II monitoring will entail combinations of standard water column passive sampling, stream bed sediment sampling, pore water sampling, short time passive sampling and suspended sediment sampling (using sediment traps) at 12 sites. Phase II sampling will be a collaborative effort between the County, UMBC, and MDE while sample analysis will be conducted by UMBC. Sampling began in July 2022 and will conclude in fall 2022. Details of the Phase II monitoring plan are presented in Proposal for PCB Source Tracking in Anne Arundel County – Phase 2, May 2022 included in Appendix G."*

6. MDE requests that Figure 1 have a caption to explain what the schematic illustrates and its utility for planning. It is not clear if the County is comparing the NLCD and the Phase 6 model. Perhaps this could be done as a land cover time series.

Response: The caption of Figure 1 has been amended to – "*Figure 1: Unique NLCD-CC translations for each Nutrient and Sediment TMDL watershed. These relationships are used as a key to 'translate' NLCD data to Phase 6 Chesapeake Bay Watershed Model land cover classes.*" The following text has been added to p. 3 to address this comment - "*NLCD data was used as the 2013/2014 Chesapeake Conservancy (CC) land cover data, which was provided with the TIPP tool by MDE, does not reflect the baseline year land use conditions for each TMDL watershed. MS4 regulated land cover increased in many watersheds between the baseline years and 2013/2014,* *and therefore, relying on 2013/2014 land cover would inflate baseline year loads. The backcasting method developed by Baltimore County, and approved by MDE, resolves this issue. The backcasting method was applied to NLCD data and makes it consistent with the Phase 6 Chesapeake Bay Watershed Model land cover classes*." Likewise, the following text has been p. 4 – "*Figure 1 shows the results of this comparison for all TMDL watersheds, and serves as the key with which to 'translate' NLCD data prior to 2014 and make data consistent with the Phase 6 Chesapeake Bay Watershed Model land cover classes*." and "*As shown in Figure 2, urban land cover classes increased between 1995 and 2009, indicating the sensitivity of the backcasting method to land cover change and also the necessity of backcasting to make the baseline loads as accurate as possible*."

7. MDE requests that the header on Table 1 read "Approval Date of TMDL" since the implementation plans have approval dates as well.

Response: The header of Table 1 has been updated.

8. MDE requests that sections related to Bacteria TMDLs be revised per MDE's new Bacteria Guidance document as the County sees appropriate.

Response: In 2017 the County developed a consolidated restoration plan to address all 19 of its Bacteria TMDLs. With the issuance in February 2022 of MDE's *Guidance for Developing Bacteria TMDL Stormwater Wasteload Allocation Watershed Implementation Plans*, the County plans to update the 2017 plan to better align with MDE's new guidance.

9. The activities discussed in the third paragraph of "Section VI.A.2. Tier B Strategies", are conservation practices. MDE requests further information about these practices and their direct link to bacteria reductions.

Response: The following text has been added to Section VII A. (Section VI.A in FY 2021 plan) on Page 39 to address this comment - *"The County understands that current literature suggests that the effectiveness of BMPs to reduce bacteria levels in variable, and largely dependent on site location and BMP type. The County will continue to collaborate with MDE and other jurisdictions to investigate the effectiveness of BMPs to reduce bacteria where such opportunities exist, and will continue to employ effective BMPs to reduce bacteria loads where possible."*

10. MDE requests a caption elaborating on what Figure 4 demonstrates and its utility for planning.

Response: The following text has been added to p. 10 to address this comment – "*Figure 3 and Figure 4, show the load reduction progress, expressed in lbs., in each bay segment, showing the target load and required reduction (with the sum being the baseline load), and the FY22 cumulative progress reduction and interim planned reduction (with the sum being the total implemented and planned load reduction). Figure 3 and Figure 4 help identify where the County needs to expand the* *current inventory of planned projects to address the SW-WLA in each Bay segment. A*". Likewise, all relevant Figure captions now include the text – "*Where the sum of progress and interim programmed reductions are smaller than the required reductions, the County needs to expand the current inventory of planned projects to address the SW-WLA in each…*"

11. MDE requests that the Index of biotic integrity, or biological sampling in general, be mentioned in the AR as a component of future planning efforts.

Response: Anne Arundel County will provide biological monitoring data, including the required habitat metrics, to MDE in future Annual Report submittals. These data are required and will be provided per Part IV.G.2.b of the NPDES MS4 Permit issued on November 5, 2021. These data will not be provided as a component of the Countywide TMDL Plan update.

12. MDE requests that TIPP spreadsheets be included in the AR submission to allow MDE to check for consistency in modeling.

Response: TIPP modeling spreadsheets will be included in the FY22 Annual Report as an appendix.

Recommended Edits:

1. MDE recommends placing a "quick-key" at the beginning of the Countywide Report that briefly *defines* the term "progress" (e.g. units, quantitative metrics, etc.) with regard to each watershed implementation plan.

Response: The County has added a section called "I. Definitions of Key Terms" to address this comment. Likewise, the following language was added to p. 2 - "*Chesapeake Bay TMDL progress load reductions, calculated in lbs. and percent…*" and on p. 9 – "*The SW-WLAs, required reductions, and FY22 progress, expressed as a percentage, in meeting these reductions are presented in Table 5 and Table 6.*"

2. MDE believes that how the TMDL implementation plans are framed is important to consider for explanatory purposes about why the work is required by the Permit. Therefore, MDE recommends that the County consider reorganizing the plans based on watershed. The watershed is the overarching resource being conserved, organizing the Countywide Report based on impairment mostly follows a legal framework.

Response: The County will keep this in mind and investigate reorganizing the plan in future years.

3. MDE recommends that the County clarify what the "Interim Programmed Reduction" is, which is mentioned on Figure 4, page 11.

Response: The County has added a section called "I. Definitions of Key Terms" to address this comment.

4. On page 14, MDE recommends that the summaries of watershed progress information be included in table format rather than paragraph.

Response: The County has included summary table for each TMDL.

5. MDE recommends that the County include information on why certain plans have still not been approved, e.g., still waiting on forthcoming guidance from MDE.

Response: Language has been added to the FY22 Countywide Plan regarding the two plans that have not been approved by MDE. Those two plans are the West River Sediment TMDL Restoration Plan and the Patuxent River Watershed PCB Restoration Plan.

6. On pages 2-4, MDE recommends that the County briefly explain the utility of backcasting to planning, i.e. why the methodology was chosen.

Response: The county added the following text on p. 3 to address this comment – "*NLCD data was used as the 2013/2014 Chesapeake Conservancy (CC) land cover data, which was provided with the TIPP tool by MDE, does not reflect the baseline year land use conditions for each TMDL watershed. MS4 regulated land cover increased in many watersheds between the baseline years and 2013/2014, and therefore, relying on 2013/2014 land cover would inflate baseline year loads. The backcasting method developed by Baltimore County, and approved by MDE, resolves this issue. The backcasting method was applied to NLCD data and makes it consistent with the Phase 6 Chesapeake Bay Watershed Model land cover classes.*"

7. MDE recommends that the County discuss the relative progress of each AR Fiscal Year (FY) in relation to preceding years and planned years.

Response: The County would like to refer MDE to Figure 7, which has been added to the FY22 report.

8. MDE recommends that the County address the following: (1) How will subwatershed management planning fit into the larger implementation strategy, and (2) how could this be a feature of each watershed map?

Response: The County uses watershed management planning and watershed assessments to inform its Countywide Stormwater TMDL Implementation Plan. The County's watershed management plans identify and prioritize areas for both restoration and preservation to further the County's ability to reduce stormwater loads. The County included maps in this year's Countywide Stormwater TMDL Implementation Plan that include BMPs that have been implemented (FY22 progress), those that are under a design contract (interim planned progress), and those that are in a conceptual design stage (planned).

9. For "Section VI Bacteria TMDLs Progress", MDE recommends that the County consider an outline form instead of narrative presentation, especially for Annual Reports.

Response: Section VII (previously Section VI in the FY2021 plan) has been changed from a text format to an outline format.

10. MDE recommends that the County discuss the role of water quality trend monitoring stations in TMDL implementation and planning as a relevant element of "Section VI.A.1. Tier A Strategies".

Response: A discussion of the County's various bacteria monitoring programs has been added on page 39 as Section VII.A.1.d.

11. With regard to "Section VI.A.3. Monitoring", MDE recommends that the County discuss options for bacteria reductions using BMPs.

Response: The County understands that current literature suggests that the effectiveness of BMPs to reduce bacteria is variable, and largely dependent on site location and BMP type. The County will continue to collaborate with MDE and other jurisdictions to investigate the effectiveness of BMPs to reduce bacteria where such opportunities exist, and will continue to employ effective BMPs in conjunction with other controls to reduce bacteria loads where possible.

12. MDE recommends that the County use bullets to highlight collaboration in Section VII.B.

Response: This section has been revised in the FY 2022 plan to utilize bullets to highlight progress and collaboration.

13. In Section VII.A, MDE encourages the County to enhance the discussion of the positive benefits of implementing TMDLs to improve the status of fishery resources (e.g. sportfish, subsistence fishing areas, shellfish beds, etc.). The County is encouraged to quantify these goals.

Response: Section VII.A. discusses progress made toward meeting the Baltimore Harbor PCB TMDL. Inclusion of a discussion of the positive benefits of implementing PCB TMDLs to improve the status of fishery resources is more appropriate to a TMDL Implementation Plan. The County will include such a discussion when it updates its Baltimore Harbor PCB TMDL Restoration Plan.

14. In Section VI.A.3, MDE encourages the County to increase discussion of the benefits of implementing TMDLs to improve the status of beaches. The County is encouraged to quantify these goals.

Response: The County intends to update its Bacteria TMDL Implementation Plan beginning in 2023 and will expand the discussion of how implementing strategies to reduce bacteria levels will improve the status of bathing beaches at that time.