Baltimore Harbor Tidal Nutrients Total Maximum Daily Load Implementation Plan

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MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

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Acronyms

AMT	Automated Modeling Tool
BIBI	Benthic Index of Biotic Integrity
BMP	Best Management Practice
CAST	Chesapeake Assessment Scenario
CBP	Chesapeake Bay Program
CBT	Chesapeake Bay Trust
CIS	Countywide Implementation Strategy
COMAR	Code of Maryland Regulations
CONV	Conversion BMP
CWA	Clean Water Act
EOS	Edge of Stream
EPA	United States Environmental Protection Agency
ESD	Environmental Site Design
GIS	Geographic Information System
HHD	Highway Hydraulics Division
Lbs	Pounds (weight)
MD	Maryland
MDE	Maryland Department of the Environment
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated Biphenyl
PFO	Perfluorooctane Sulfonate
REST	Restoration BMP
ROW	Right-of-Way
SCA	Stream Corridor Assessment
SHA	State Highway Administration
STB	Stream Bed and Bank
SW-WLA	Stormwater Wasteload Allocation
SWAP	Small Watershed Action Plan
SWM	Stormwater Management
TBD	To be determined
TIPP	TMDL Implementation Progress and Planning
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
WIP	Watershed Implementation Plan
WM	Watershed Model
WQSs	Water Quality Standards
Yr	Year

1 Introduction

The Federal Clean Water Act (CWA) of 1972 established requirements for each state to develop programs to address water pollution through:

- Establishment of water quality standards (WQSs)
- Implementation of water quality monitoring programs
- Identification and reporting of impaired waters
- Development of maximum allowable pollutant loads for impaired waters that when met, and not exceeded, will meet WQSs and attain the water's designated use.

WQSs are based on the concept of designating and maintaining specifically defined uses for each waterbody. Under the CWA, the State of Maryland is required to assess and report on the quality of waters throughout the state. Section 303(d) of the CWA requires the State to list its water bodies as "impaired" if applicable WQSs are not met. In such cases, the State must develop a Total Maximum Daily Load (TMDL) for pollutants of concern.

The Maryland Department of the Environment (MDE) develops WQSs, lists qualifying water bodies as impaired, and establishes TMDLs to ensure designated uses are met. Once MDE develops a TMDL document and the U.S. Environmental Protection Agency (EPA) approves it, all jurisdictions with a designated stormwater wasteload allocation (SW-WLA) are required to develop an implementation plan to meet the goals of the TMDL.

The EPA has delegated MDE authority to issue discharge permits within Maryland in accordance with the CWA and corresponding National Pollutant Discharge Elimination System (NPDES) regulations. The MDE issued Maryland State Highway Administration (SHA) an NPDES Municipal Separate Storm Sewer System (MS4) discharge permit on October 9, 2015 (Permit No. 11-DP-3313 MD0068276) that requires compliance with TMDLs, coordination with county MS4 jurisdictions concerning watershed assessments, and development of a TMDL implementation plan for each watershed where SHA has a SW-WLA. The SHA NPDES MS4 permit is available for reference online at the following web address: https://roads.maryland.gov/mdotsha/pages/index.aspx?PageId=336

In accordance with conditions in the NPDES MS4 discharge permit and recommendations described in the MDE documents titled, *General Guidance for Local TMDL SW-WLA Watershed IPs* (MDE, 2022a) and *Guidance for Developing Local Nutrient and Sediment TMDL (Total Maximum Daily Load) Stormwater Wasteload Allocation (SW-WLA) Watershed Implementation Plans (WIPs)* (MDE, 2022b), SHA has prepared this implementation plan to address the total nitrogen (TN) and total phosphorus (TP) SW-WLAs established for SHA in the MDE document titled, *Total Maximum Daily Loads of Nitrogen and Phosphorus for the Baltimore Harbor in Anne Arundel, Baltimore, Carroll, and Howard Counties and Baltimore City, Maryland* that was approved by EPA on December 17, 2007 and revised August 31, 2015 (MDE, 2015).

The primary audience of this implementation plan is SHA as it provides an overview of the strategy to achieve the SW-WLAs assigned in the Baltimore Harbor Tidal nutrient TMDL, which fulfills MS4 permit requirements related to TMDL implementation plans. In addition, this plan

communicates SHA's approach to the public and MDE. Since SHA's jurisdiction lies within county MS4 boundaries, effective coordination is necessary to implement the restoration efforts outlined in this plan. As such, the plan can serve as a tool to engage stakeholders and facilitate the exchange of information on water quality improvements across the impaired watershed.

2 Watershed Description

The TMDL for TN and TP is established for the Patapsco River Mesohaline – PATMH segment (excluding Bodkin Creek), which encompasses the Baltimore Harbor estuary that drains into the Chesapeake Bay. Hereafter this segment will be referred to as the Baltimore Harbor Tidal watershed. The Baltimore Harbor Tidal watershed encompasses 420 square miles within Anne Arundel County, Baltimore County, Baltimore City, Carroll County, and Howard County and includes five Maryland 8-digit watersheds: the Baltimore Harbor Non-Tidal (02130903), Gwynns Falls (02130905), Jones Falls (02130904), Patapsco River Lower North Branch (02130906), and South Branch Patapsco River (02130908) (**Figure 1**). Major tributaries include Brice Falls, Deep Run, Gillis Falls, Gwynns Falls, Jones Falls, North Branch Patapsco River, South Branch Patapsco River, Patapsco River, Piney Branch, Piney Run, Sawmill Creek, and Stony Run.

There are 3,107 lane miles of SHA roadway located within the Baltimore Harbor Tidal watershed. The 8,488 acres of SHA right-of-way (ROW) includes 3,699 acres of impervious surface. The SHA does not have ROW within Baltimore City. The SHA ROW is relatively uniform with land use categorized primarily as roadway and roadway vegetation.

According to the published TMDL report (MDE, 2015), land use within the Baltimore Harbor Tidal watershed is approximately 55% urban lands, 29% forest and other herbaceous growth, 15% mixed agriculture, and 1% water. Municipal and industrial point sources are estimated to be the largest nutrient source category, contributing an estimated 71% and 58% of baseline pollutant loads for TN and TP, respectively (MDE, 2015). The SHA researched potential sources during the development of this implementation plan (see summary in **Table 1** below) and determined 'urban' and 'natural' sources are the most likely types to exist within SHA ROW.

Table 1: Nutrient Sources from Various References

Land Use	Sources
Agriculture	• Chemical Fertilizer • Manure
Urban	• Pet Waste • Lawn Fertilizer • Parking Lot, Roof • Street Runoff
Wastewater	• Municipal • Industrial • Failed Septic Systems • Combined Sewer Overflow/ Sanitary Sewer Overflow • Leaking Sewers
Natural	• Atmospheric Deposition

Sources: MDE, 2014; EPA, 2010; Hoos et al., 2000; and Schueler, 2011

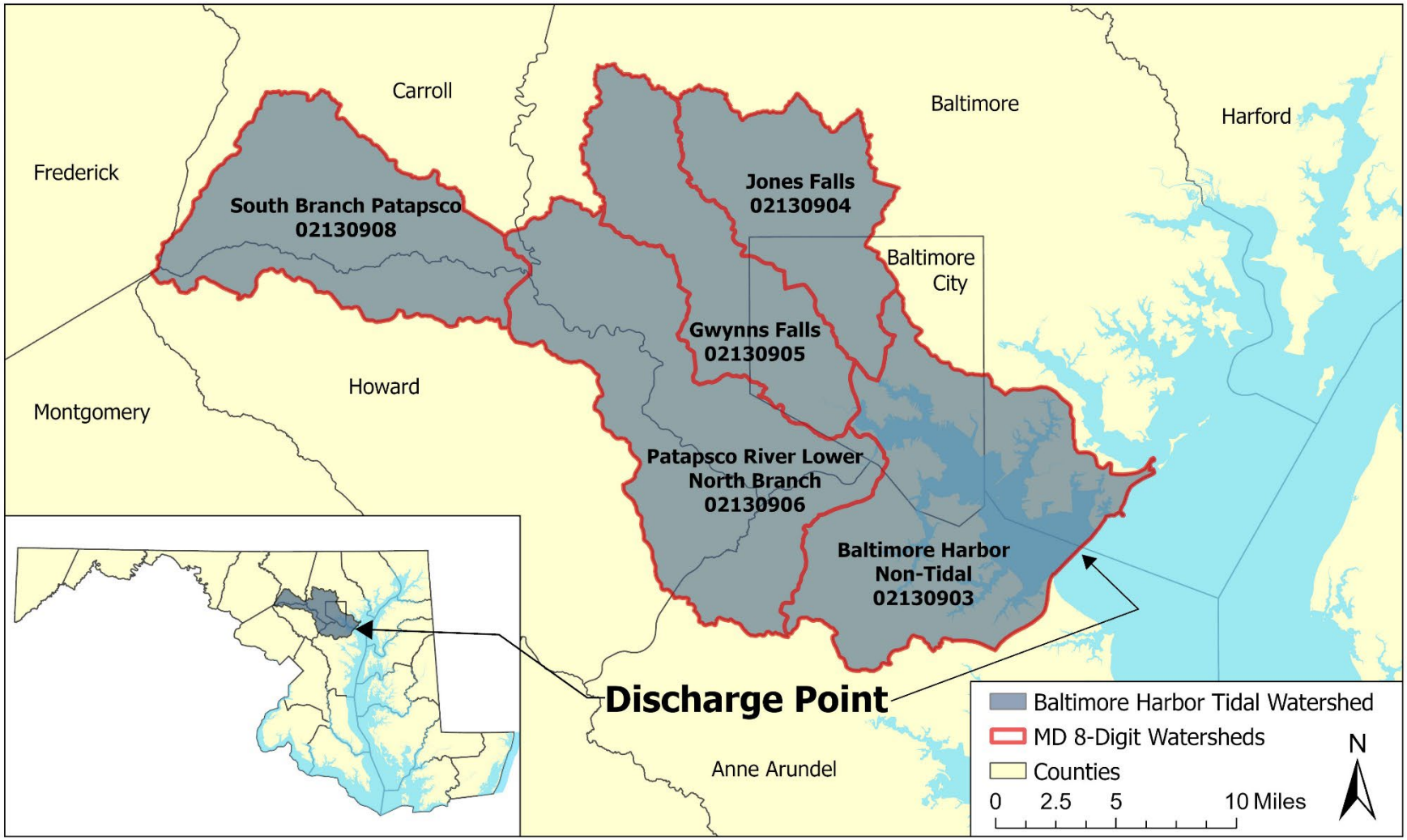

Figure 1: Baltimore Harbor Tidal Watershed

The Maryland WQS stream segment designation for PATMH (excluding Bodkin Creek) is Use II Tidal Waters: Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting (Code of Maryland Regulations [COMAR] 26.08.02.08). Although Use II Tidal Waters are classified as Shellfish Harvesting, there are no areas designated as Shellfish Harvest User areas in the Baltimore Harbor (MDE, 2015). The designated uses for waterways in the Baltimore Harbor Tidal TMDL watershed are: 1) Migratory Spawning and Nursery, 2) Shallow Water Submerged Aquatic Vegetation, 3) Open Water Fish and Shellfish, 4) Seasonal Deep Water Fish and Shellfish, and 5) Deep Channel. An interactive map of Maryland's Designed Use Classifications is available at the following web address: https://mde.maryland.gov/programs/water/tmdl/waterqualitystandards/pages/designatedusesmaps.aspx

The nutrients TMDL for the Baltimore Harbor Tidal was established to reduce excessive algal blooms, that may result in high chlorophyll *a* concentrations, and to maintain the numeric dissolved oxygen criteria for Use II designated uses present in the Harbor. The TMDL document presents descriptions of the numeric dissolved oxygen criteria for designated use subcategories present in the Baltimore Harbor (see Section 2.3.1.; MDE, 2015).

Tier II waters are those that have existing water quality that is significantly better than the water quality standards minimum requirement (MDE, 2021c). There are six Tier II stream segments within the Baltimore Harbor Tidal watershed: five Tier II stream segments within the South Branch Patapsco River watershed which include Gillis Falls 1, Gillis Falls 2, Piney Branch 2 Carroll Co, South Branch Patapsco River 1, and South Branch Patapsco River UT 1; and one Tier II stream segment, Red Run 1, within the Gwynns Falls watershed (COMAR 26.08.02.04-2).

The Baltimore Harbor Tidal is associated with one assessment unit in *Maryland's Final 2024 Integrated Report of Surface Water Quality* (Final 2024 Integrated Report; MDE, 2024): the PATMH segment. Waters within the Baltimore Harbor Tidal are subject to the following impairment types and are not currently meeting WQS as noted in the Final 2024 Integrated Report:

- Chlordane
- Copper
- Cyanide
- Enterococcus
- Impacts to Biological Communities
- Lead in Sediments
- Nitrogen (Total)
- Perfluorooctane Sulfonate (PFOs)
- Phosphorus (Total)
- Polychlorinated Biphenyls (PCBs)
- Sedimentation/Siltation
- Trash
- Zinc in Sediments

3 County Developed Baltimore Harbor Tidal Nutrient TMDL Implementation Plans

As shown in **Figure 1**, the Baltimore Harbor Tidal watershed spans Anne Arundel County, Baltimore County, Baltimore City, Carroll County, and Howard County. This Baltimore Harbor Tidal nutrients TMDL implementation plan may serve as a starting point for open communication with the county jurisdictions and identify opportunities for collaborative future BMP implementation to achieve nutrient load reductions. Each of the county jurisdictions currently holds an NPDES MS4 permit and developed their own Baltimore Harbor Tidal nutrients TMDL implementation plan to address their assigned TN and TP SW-WLAs, thus their BMP implementation and progress complements SHA's load reduction efforts.

The SHA completed a review of TMDL implementation plans published by the county MS4 permittees where SHA has jurisdiction. A summary of these documents is provided in **Table 2** and the section below. Additionally, SHA completed a review of county watershed assessments completed within the Baltimore Harbor Tidal watershed. A summary of the watershed assessments is presented in Section 4.

Each jurisdiction assigned a SW-WLA submits an initial TMDL implementation following EPA approval of the TMDL document. The initial TMDL implementation plan includes lists of potential projects and programs to meet TMDL load reductions, describes analysis and modeling methods, and includes estimated final dates and benchmarks. A new requirement of the county NPDES MS4 permits, issued by MDE in 2021 and 2022, is the development and annual updating of a Countywide TMDL Stormwater Implementation Plan (Countywide Plan) that provides a summary of all completed BMPs implemented for each TMDL SW-WLA, an analysis and table summary of the net pollutant reductions achieved annually and cumulatively for each TMDL SW-WLA, and an updated list of proposed projects and programs needed to meet SW-WLA targets (MDE, 2021e). The Countywide Plan provides an opportunity for permittees to adjust their plan (e.g., planned BMPs, costs, target years) as progress is made or as adaptive management is required. Below are summaries of details regarding each jurisdiction's plans:

Anne Arundel County

Anne Arundel County's Bureau of Watershed Protection and Restoration developed a TMDL implementation plan for the Balmore Harbor Tidal nutrient TMDL titled, *Baltimore Harbor Watershed Nutrient TMDL Restoration Plan* (AA-DPW, 2016a), that was approved by MDE in November 2016. The TMDL restoration plan highlighted the use of stormwater retrofits and outfall enhancement projects to achieve the reductions required by the target years of 2020 for TP and 2030 for TN. The most recent Anne Arundel County Countywide Plan titled, *Anne Arundel Countywide TMDL Stormwater Implementation Plan FY 24 Annual Progress Report* (AA-DPW, 2024), was submitted in December 2024 and updated their Baltimore Harbor Tidal target years to reflect target reductions for both TN and TP would be reached by 2030.

Baltimore County

Baltimore County's Department of Environmental Protection and Sustainability first submitted their implementation plan titled, *Baltimore County TMDL Implementation Plan: Nutrients in*

Baltimore Harbor (BA-EPS, 2016a), to MDE in December 2014 and its revision in December 2016. The plan identified stream restoration, stormwater retrofits, and several other BMPs as strategies to achieve TN and TP reduction requirements by 2025. In December 2024, Baltimore County published their Countywide Plan within their NPDES MS4 Permit 2024 Report titled *Baltimore County National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Permit 2024 Annual Report* (BA-EPS, 2024). In this report, the Baltimore Harbor Tidal nutrients TMDL load reduction target years for TN and TP were updated to 2056 and 2024, respectively. The target reduction for phosphorus was achieved in 2024.

Carroll County

Carroll County's Government Bureau of Resource Management submitted an implementation plan for the Baltimore Harbor Tidal nutrient TMDL to MDE for review in August of 2016, which was ultimately approved in May 2020. Carroll County's implementation plan titled, *Baltimore Harbor Carroll County, Maryland Interim Restoration Plan* (CL-BRM, 2019) specified a focus on stormwater retrofits, streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects as strategies to achieve their TN reduction requirement by 2033 and TP reduction requirement by 2025. In December 2024, Carroll County submitted the *2024 Total Maximum Daily Load Stormwater Implementation Plan Carroll County, Maryland* (CL-BRM, 2024) and based on current progress the load reduction target years for TN and TP were updated to 2050 and 2064, respectively.

Howard County

Howard County's Department of Public Works first developed and submitted their County Implementation Strategy (CIS) to MDE in December 2015. The CIS presented a long-term plan to address the SW-WLAs for all TMDLs approved by the EPA in Howard County as well as achieving impervious restoration treatment goals. The County updated the CIS in December of 2017, titled *Howard County Countywide Implementation Strategy* (HC-DPW, 2017a), highlighting that the majority of planned management strategies include stream restoration, outfall stabilization, and incorporation of BMP retrofits to achieve their TN reduction requirement by 2029 and TP reduction requirement by 2029. The County's most recent Countywide Plan titled, *Countywide TMDL Stormwater Implementation Plan* (HC-DPW, 2024), was submitted to MDE in November 2024. Based on current progress, this report updates the load reduction target years for TN and TP to 2052 and 2029, respectively.

Table 2: Additional Baltimore Harbor Tidal Nutrient TMDL Implementation Plans by Jurisdiction

Jurisdiction	Date TMDL Implementation Plan Initially Submitted to MDE	Date Countywide TMDL Stormwater Implementation Plan Submitted to MDE	Target Year
Anne Arundel County	November 2016	December 2024	TN - 2030 TP - 2030
Baltimore County	December 2016	December 2024	TN - 2056 TP - 2024[1]
Carroll County	August 2016	December 2024	TN - 2050 TP - 2064
Howard County	December 2015	November 2024	TN - 2052 TP - 2029

[1] reduction target has been met

4 Watershed Assessment Evaluations

Each NPDES MS4 permitted county is required to perform detailed assessments of local watersheds within its jurisdiction. These assessments determine current water quality conditions, identify and rank water quality problems, prioritize and rank structural and non-structural improvement projects, and set pollutant reduction benchmarks and deadlines to demonstrate progress toward meeting applicable WQSs. The SHA is not required to duplicate this effort but is required to coordinate with the MS4 permitted jurisdictions to obtain and review their watershed assessments. The SHA uses the information provided in the County watershed assessments to inform its implementation strategies and potential locations for restoration work.

The sections below summarize surface water impairments, watershed assessments completed, TMDL implementation plans developed by MS4 permitted counties within the Baltimore Harbor Tidal watershed. The information is presented by each MD 8-digit watershed within the Baltimore Harbor Tidal watershed: Baltimore Harbor Non-Tidal, Gwynns Falls, Jones Falls, Patapsco River Lower North Branch, and South Branch Patapsco River.

There are four 8-digit watersheds with TSS impairments where MDE developed a TMDL – Baltimore Harbor Non-Tidal, Gwynns Falls, Jones Falls, and Patapsco River Lower North Branch. It is important to note that the BMPs implemented to treat TSS impairments will also provide TN and TP reductions that will contribute to reducing the Baltimore Harbor Tidal watershed TN and TP loads.

4.1 Baltimore Harbor Non-Tidal (02130903)

Impaired Surface Waters

Waters within the Baltimore Harbor Non-Tidal watershed are subject to the following impairments, at the tributary scale, as noted in MDE's Final 2024 Integrated Report:

Table 3: Baltimore Harbor Non-Tidal Impaired Surface Waters

Impairment	Water Quality Category
• Total suspended solids (TSS)	4a - still impaired but have a TMDL developed that establishes pollutant loading limits designed to bring the water body back into compliance
• Lack of riparian buffer • Habitat alterations	4c - impaired but not for a conventional pollutant. This includes pollution caused by habitat alteration or flow alteration
• Chloride	5s - impairment is caused by chloride from road salt

Source: MDE, 2024

Watershed Assessments

In 2012, the Baltimore County Department of Environmental Protection and Sustainability published the *Bear Creek/Old Road Bay Small Watershed Action Plan* (Parsons Brinckerhoff, 2012). According to the Action Plan, the Bear Creek watershed is largely a mix of medium to high density residential (17% and 15%, respectively) and industrial (32%) land use with impervious cover representing 29% of the overall watershed. In its Small Watershed Action Plan (SWAP), Baltimore County discusses and provides maps of restoration opportunities in the Bear Creek subwatershed. The types of restoration opportunities identified include downspout redirect, tree planting, street sweeping, parking lot/alley retrofits, and bayscaping (Parsons Brinckerhoff, 2012).

Anne Arundel County's Department of Public Works prepared the *Patapsco Tidal and Bodkin Creek Watershed Assessment* (AA-DPW, 2012). The assessment determined the condition of, and prioritized watershed management activities for, areas within the Baltimore Harbor Non-Tidal watershed. Bodkin Creek watershed is also included in Anne Arundel County's assessment but is not part of the Baltimore Harbor Non-Tidal 8-digit watershed area.
For their watershed assessment, the Anne Arundel County Aquatic Biological Monitoring Program, modeled after the State's Maryland Biological Stream Survey (MBSS), assessed both random and targeted streams within the Patapsco Tidal subwatershed. Activities performed included benthic sample collection, physical habitat assessment, and Rapid Bioassessment Protocol habitat assessment. The overwhelming majority of sites sampled were rated either "poor" or "very poor." Approximately 16% of the streams evaluated in the Patapsco Tidal watershed were classified as "severely degraded" by the Maryland Physical Habitat Index. Three subwatersheds (Cabin Branch 2, Marley Creek 1, and Cabin Branch) were identified as having the highest percentage of stream reaches classified as either "degraded" or "severely degraded."

Anne Arundel County suggested the following BMPs for the Patapsco Tidal watershed:

- *Outfall retrofits* – all major outfalls characterized as impaired
- *Stormwater pond retrofits* – all ponds constructed prior to 2002 with a drainage area greater than 10 acres
- *Stream restoration* – targeting degraded and severely degraded reaches
- *Street Sweeping* – all closed curbed County roads

- *Inlet cleaning* – vacuum cleaning stormwater curb inlets and catch basins
- *Public land reforestation*
- *ESD retrofit to the MEP* – including green roofs, permeable pavement, bioretention, etc.

TMDL Implementation Plans Developed

MDE developed a TMDL to address the TSS impairment in the Baltimore Harbor Non-Tidal watershed that was approved by EPA in January 2022. Jurisdictions within the watershed – Baltimore County and Anne Arundel County – developed TSS TMDL implementation plans that propose BMPs that will treat the required TSS reductions.

The Baltimore County TSS TMDL implementation plan titled, *Baltimore County TMDL Implementation Plan: Sediment in Baltimore Harbor (non-tidal streams)* (BA-EPS, 2023), was submitted to MDE in January 2023 and highlighted management actions such as stream restoration, street sweeping, storm drain cleaning, downspout disconnection, stormwater retrofits, stream buffer reforestation, urban tree canopy, redevelopment, and other BMPs as strategies to achieve their TSS reduction requirement by the target year of 2052.

The Anne Arundel County TSS TMDL implementation plan titled, *Non-tidal Baltimore Harbor Watershed Sediment TMDL Restoration Plan* (LimnoTech, 2022), was submitted to MDE in December 2022 and identified management actions such as stream restoration, street sweeping, storm drain cleaning, land use conversion, stormwater management BMPs as strategies to achieve their TSS reduction requirement by the 2035 target year.

4.2 Gwynns Falls (02130905)

Impaired Surface Waters

Waters within the Gwynns Falls watershed are subject to the following impairments, at the tributary scale, as noted in MDE's Final 2024 Integrated Report:

Table 4: Gwynns Falls Impaired Surface Waters

Impairment	Water Quality Category
• Fecal coliform (bacteria) • TSS	4a - still impaired but have a TMDL developed that establishes pollutant loading limits designed to bring the water body back into compliance
• Habitat alterations	4c - impaired but not for a conventional pollutant. This includes pollution caused by habitat alteration or flow alteration
• Temperature • PCBs in fish tissue • PFOs in fish tissue	5 - impaired waters for which a TMDL is required
• Chloride	5s - impairment is caused by chloride from road salt.

Source: MDE, 2024

Watershed Assessments

The Baltimore County Department of Environmental Protection and Sustainability completed SWAPs for the Gwynns Falls watershed's Upper Gwynns Falls subwatershed (AMT, Inc., 2011) and the Middle Gwynns Falls subwatershed (PB, 2013). Impervious land cover makes up 20% of the Upper Gwynns Falls watershed and 29% of the Middle Gwynns Falls watershed.

For the purposes of planning, Baltimore County selected the following generalized restoration strategies to aid in meeting restoration goals within the Gwynns Falls watershed:

- Using present SWM facilities
- Converting SWM facilities
- SWM retrofits
- Community Reforestation Program
- Stormwater education and outreach
- Stream restoration
- Impervious cover removal
- Street sweeping
- Illicit connection detection/disconnection
- Sanitary sewer consent decree
- Credits for Fertilizer Act of 2011
- Increased State-owned property restoration
- Redevelopment of urban areas
- Reforestation
- Downspout disconnection
- Urban nutrient management

Baltimore County identified numerous potential restoration sites within each subwatershed by conducting neighborhood source assessments, hotspot site investigations, institutional site investigations, and pervious area assessments. The County also identified multiple potential stormwater conversions within each watershed: 28 for the Upper Gwynns Falls watershed (AMT, Inc., 2011) and 15 for the Middle Gwynns Falls watershed (PB, 2013). Detailed information on site locations can be found in the SWAPs.

TMDL Implementation Plans Developed

MDE developed a TMDL to address the TSS impairment in the Gwynns Falls watershed that was approved by EPA in March 2010. The Baltimore County Department of Environmental Protection and Sustainability developed a Gwynn Falls TSS TMDL implementation plan that proposes BMPs that will treat their required TSS reductions. The Baltimore County TSS TMDL implementation plan titled, *Baltimore County TMDL Implementation Plan: Sediment in Gwynns Falls* (BA-EPS, 2016b), was submitted to MDE in December 2016 and highlighted management actions such as stream restoration, street sweeping, storm drain cleaning, downspout disconnection, stormwater retrofits, stream buffer reforestation, urban tree canopy, and other BMPs as strategies to achieve their TSS reduction requirement by the target year of 2025.

Additionally, Baltimore County developed an implementation plan to address the bacteria TMDL in the Gwynns Falls watershed; however, the actions in this plan do not provide nutrient reductions towards the Baltimore Harbor Tidal TMDL.

4.3 Jones Falls (02130904)

Impaired Surface Waters

Waters within the Jones Falls watershed are subject to the following impairments, at the tributary scale, as noted in MDE's Final 2024 Integrated Report:

Table 5: Jones Falls Impaired Surface Waters

Impairment	Water Quality Category
• Fecal coliform (bacteria) • TSS • PCBs in fish tissue (Lake Roland only)	4a - still impaired but have a TMDL developed that establishes pollutant loading limits designed to bring the water body back into compliance
• Habitat alterations	4c - impaired but not for a conventional pollutant. This includes pollution caused by habitat alteration or flow alteration
• Temperature • PCBs in fish tissue • PFOs in fish tissue	5 - impaired waters for which a TMDL is required
• Chloride	5s - impairment is caused by chloride from road salt

Source: MDE, 2024

Watershed Assessments

The Baltimore County Department of Environmental Protection and Sustainability completed SWAPs for the Upper Jones Falls watershed (CWP et al., 2015), the Northeastern Jones Falls watershed (BA-EPS, 2012), and the Lower Jones Falls watershed (CWP, 2008). Impervious land cover comprises 9% of the Upper Jones Falls watershed, 25% of the Northeastern Jones Falls watershed, and 32% of the Lower Jones Falls watershed. Urban impervious and cropland are the land uses responsible for the greatest nitrogen, phosphorus, and sediment loads within the Upper Jones Falls and Northeastern Jones Falls watersheds.

In the Northeastern Jones Falls watershed, 20 of the 22 sites assessed by the County had Benthic Index of Biotic Integrity (BIBI) scores in the "poor" or "very poor" categories. In the Lower Jones Falls watershed, 31 of the 32 sites assessed by Baltimore City and 13 of the 15 sites assessed by the County had BIBI scores in the "poor" or "very poor" categories.

For the purposes of planning, Baltimore County has selected the following generalized restoration strategies to aid in meeting restoration goals within the Jones Falls watershed:

- SWM for new development and redevelopment
- Existing SWM facility conversions
- SWM retrofits
- Stream corridor restoration
- Street sweeping and storm drain inlet cleaning
- Illicit connection detection and disconnection program and hotspot remediation
- Sanitary sewer consent decrees

- Downspout disconnection
- Citizen awareness (fertilizer application and pet waste)
- Pervious Area Restoration (reforestation and tree planting)
- Agricultural BMPs (stream protection via fencing and conservation tillage)

Baltimore County identified numerous potential restoration sites within each subwatershed by conducting neighborhood source assessments, hotspot site investigations, institutional site investigations, and pervious area assessments. The County also identified multiple potential stormwater retrofits and conversions within each watershed: 13 in the Upper Jones Falls watershed, 16 in the Northeastern Jones Falls watershed, and 43 in the Lower Jones Falls watershed. Detailed information on site locations can be found in the SWAPs.

TMDL Implementation Plans Developed

MDE developed a TMDL to address the TSS impairment in the Jones Falls watershed that was approved by EPA in September 2011. The Baltimore County Department of Environmental Protection and Sustainability developed a Jones Falls TSS TMDL implementation plan that proposes BMPs that will treat TSS and other nutrient impairments contributing to the Baltimore Harbor Tidal watershed TN and TP loads. The Baltimore County TSS TMDL implementation plan titled, *Baltimore County TMDL Implementation Plan: Sediment in Jones Falls* (BA-EPS, 2016c), was submitted to MDE in December 2016 and highlighted management actions such as stream restoration, street sweeping, storm drain cleaning, downspout disconnection, stormwater retrofits, stream buffer reforestation, upland reforestation, and other BMPs as strategies to achieve their TSS reduction requirement by the target year of 2025.

Additionally, Baltimore County developed TMDL implementation plans to address the bacteria and PCB impairments in the Jones Falls watershed; however, the actions in these plans do not provide nutrient reductions towards the Baltimore Harbor Tidal TMDL.

4.4 Patapsco River Lower North Branch (02130906)

Impaired Surface Waters

Waters within the Patapsco River Lower North Branch watershed are subject to the following impairments, at the tributary scale, as noted in MDE's Final 2024 Integrated Report:

Table 6: Patapsco River Lower North Branch Impaired Surface Waters

Impairment	Water Quality Category
• *Escherichia coli* (bacteria) • TSS	4a - still impaired but have a TMDL developed that establishes pollutant loading limits designed to bring the water body back into compliance
• Habitat alterations	4c - impaired but not for a conventional pollutant. This includes pollution caused by habitat alteration or flow alteration
• Temperature • PFOs in fish tissue	5 - impaired waters for which a TMDL is required
• Chloride	5s - impairment is caused by chloride from road salt

Source: MDE, 2024

Watershed Assessments

The SHA reviewed findings from Baltimore County's 2012 *Lower Patapsco River Small Watershed Action Plan* (Versar et al., 2012); Anne Arundel County's 2011 *Patapsco Non-Tidal Watershed Assessment Comprehensive Summary Report* (KCI/CH2M Hill, 2011); Carroll County's 2016 *Lower North Branch Patapsco River Watershed Characterization Plan* (CL-BRM, 2016); and Howard County's 2012 *Tiber-Hudson & Plumtree Branch Stream Corridor Assessment*, revised in 2016 (S&S Planning and Design, 2016), and 2017 *Patapsco River South Branch and Lower North Branch Watershed Assessment* (AA-DPW, 2017b). These reports discuss specific issues that contribute to overall watershed impairments and identify high priority restoration projects.

Restoration assessments were completed in the Lower Patapsco River watershed, which is the lower portion of the Patapsco River Lower North Branch watershed that is located within Baltimore County. The assessments helped the County prioritize subwatersheds for restoration and identify potential restoration opportunities. Twenty-five existing detention ponds were identified for conversion potential (Versar et al., 2012).

Anne Arundel County completed similar restoration assessments in the Patapsco Non-Tidal watershed, which is the lower portion of the Patapsco River Lower North Branch watershed that is located within the County. The Patapsco Mainstem was identified as the subwatershed with the highest priority for restoration based on the Anne Arundel County's subwatershed restoration assessment.

A very small portion (565 acres) of the Patapsco River Lower North Branch watershed is in Carroll County (CL-BRM, 2016) and includes only a few miles of stream. SHA does not have ROW within Carroll County's portion of the watershed.

Howard County's assessment of the Patapsco River Lower North Branch within Howard County yielded 269 potential projects and 130 concept plans for the top-ranked opportunities (HC-DPW, 2017b).

TMDL Implementation Plans Developed

MDE developed a TMDL to address the TSS impairment in the Patapsco River Lower North Branch watershed that was approved by the EPA in September 2011. Jurisdictions within the Patapsco River Lower North Branch watershed include Baltimore County, Anne Arundel County, Carroll County, and Howard County. Because of the small geographic area of overlap, Carroll County does not have a TSS reduction responsibility. These other three jurisdictions have each developed a Patapsco River Lower North Branch TSS TMDL implementation plan that proposes BMPs that will treat TSS and other nutrient impairments contributing to the Baltimore Harbor Tidal watershed TN and TP loads.

The Baltimore County TSS TMDL implementation plan titled, *Baltimore County TMDL Implementation Plan: Sediment in the Patapsco Lower North Branch* (BA-EPS, 2016), was submitted to MDE in December 2016 and highlighted management actions such as new stormwater BMP, stormwater BMP conversion, urban nutrient management, urban stream restoration, and other BMPs as strategies to achieve their TSS reduction requirement by the target year of 2025. In December 2024, Baltimore County published their annual Countywide TMDL Summary Report within their NPDES MS4 Permit 2024 Report titled *Baltimore County National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Permit 2024 Annual Report* (BA-EPS, 2024) and the target year for TSS reduction was updated to 2057.

The Anne Arundel County TSS TMDL implementation plan titled, *Patapsco River Lower North Branch Sediment TMDL Restoration Plan* (AA-DPW, 2016b), was submitted to MDE in November 2016 and identified bioretention, extended dry ponds, infiltration, inlet cleaning, and other BMPs as strategies to achieve their TSS reduction requirement by the target year of 2025. In December 2024, the County submitted the *Anne Arundel Countywide TMDL Stormwater Implementation Plan FY 24 Annual Progress Report* (AA-DPW, 2024) and the target year for TSS reduction remains 2025.

The Howard County TSS TMDL implementation plan titled, *Howard County Countywide Implementation Strategy* (HC-DPW, 2017a), was submitted to MDE in December 2017 specified new stormwater BMP, stormwater BMP conversion, urban nutrient management, urban stream restoration, outfall stabilization, and other BMPs as strategies to achieve their TSS reduction requirement by the target year of 2025. In their *FY24 Countywide TMDL Stormwater Implementation Plan* (HC-DPW, 2024) the target year was updated to 2029.

Additionally, the counties each developed a TMDL implementation plan to address the bacteria impairment in the Patapsco River Lower North Branch watershed; however, the actions in these plans do not provide nutrient reductions towards the Baltimore Harbor Tidal TMDL.

4.5 South Branch Patapsco River (02130908)

Impaired Surface Waters

Waters within the South Branch Patapsco River watershed are subject to the following impairments, at the tributary scale, as noted in MDE's Final 2024 Integrated Report:

Table 7: South Branch Patapsco River Impaired Surface Waters

Impairment	Water Quality Category
• Impacts to biological communities • Temperature • Chlorophyll-*a* • TP (Piney Run Reservoir only)	5 - impaired waters for which a TMDL is required

Source: MDE, 2024

Watershed Assessments

Carroll County used the findings from its *South Branch Patapsco Watershed Characterization Plan* (CL-BRM, 2016) and *South Branch Patapsco Watershed SCA* (CL-BRM, 2013) to develop the *2019 Baltimore Harbor Carroll County, MD Interim Restoration Plan* (CL-BRM, 2019).

BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements were outlined in the *2019 Baltimore Harbor Carroll County, MD Interim Restoration Plan*.

Howard County's 2017 *Patapsco River South Branch and Lower North Branch Watershed Assessment* (HC-DPW, 2017b) noted that land use within the Howard County portion of the South Branch Patapsco River watershed primarily includes agriculture, residential, and forest. Impervious surfaces within the Howard County portion of the South Branch Patapsco River watershed total 4.8%.

Howard County's assessment of the South Branch Patapsco River yielded 60 potential projects and 15 concept plans for the top-ranked opportunities. Eleven of the concept plans are for stream restoration projects, with two concept plans for tree planting projects, and two concept plans for outfall stabilization projects.

TMDL Implementation Plans Developed

MDE had not yet developed TMDLs for the impairments listed in **Table 7**.

5 Desktop Reviews and Field Investigations

To supplement information from its evaluation of county watershed assessments, SHA utilized Geographic Information Systems (GIS) software and data to review SHA ROW for potential BMP implementation opportunities. The following GIS datasets were referenced during associated BMP viability assessments:

- Aerial imagery
- Street view mapping
- Environmental features delineation such as streams, critical area boundary, wetlands, buffers, floodplain limits
- County data such as utilities, storm drain systems, contour, and topographic mapping
- SHA ROW boundaries
- Current SHA stormwater control and restoration practice locations
- Drainage area boundaries

Sites identified through these desktop reviews were prioritized based on cost-effectiveness. Field investigations were then performed at prioritized sites to document existing site conditions, implementation constraints, and potential restoration credit. **Table 8** and **Appendix A** summarize the number of sites and BMP types that were deemed potentially viable for future implementation to meet the Baltimore Harbor Tidal nutrient TMDLs SW-WLA.

Table 8: Potential Sites for Future BMP Implementation

BMP Types	Anne Arundel County	Baltimore County	Carroll County	Howard County	Tidal Watershed Total
Forest Planting	11	4	4	3	22
Grass Swales	0	0	2	8	10
Stream Restoration	18	5	4	4	31

The nutrient reductions associated with the potential sites identified through desktop reviews do not provide enough TN or TP reductions to achieve SHA's TMDL targets. Therefore, additional BMP implementation must be completed in the watershed. Planned implementation for the Baltimore Harbor Tidal nutrients TMDL is described in Section 7.1. Not all planned BMP implementation has an identified location at this time.

6 Modeling Nutrient Loads and Reductions

In 2021, MDE released their TMDL Implementation Progress and Planning (TIPP) spreadsheet tool (MDE, 2021a). The MDE developed the TIPP spreadsheet tool to simplify the load estimating and planning process. The spreadsheet tool estimates load reductions at various points in the watershed planning process, allowing users to assess current progress and future BMP implementation. The spreadsheet uses Chesapeake Bay Program Watershed Model Phase 6 (CBP WM P6) CAST-2017d No Action (No BMP) scenario loading rates with disaggregated Stream Bed and Bank (STB) loads at the county 8-digit watershed scale.

MDE's *Guidance for Developing Local Nutrient and Sediment TMDL SW-WLA WIPs* (MDE, 2022b) requires jurisdictions to use the TIPP tool as their predictive implementation model to

ensure consistency among load reduction calculation methods and results of the tool to accompany submissions of SW-WLA Implementation Plans. However, alternative modeling methods may be employed for planning and subsequent progress reporting to MDE if permitted jurisdictions have specific needs. The SHA submitted a justification report to MDE in May 2023 (*Alternative Modeling Method for TMDL Loads and Load Reductions Justification Report*) which summarized the challenges SHA would experience modeling all nutrient and sediment TMDL responsibilities in the TIPP spreadsheet tool and requested MDE approval for the continued use of SHA's Automated Modeling Tool (AMT). On August 17, 2023, MDE approved SHA's use of the AMT for all local TMDL and Bay TMDL modeling.

The AMT is a script that extracts SHA BMP treatment data from multiple sources and then applies calculations derived from MDE's TIPP and guidance documents to calculate loads and load reductions for each BMP. Although this is a custom model, it replicates current MDE-approved modeling methods, using loading rates and delivery factors from MDE's TIPP and load reduction crediting from MDE's 2021 Accounting Guidance and published CBP BMP protocols. For local TMDL modeling, pollutant loads are based on TIPP loading rates by county 8-digit watersheds for edge of stream (EOS). The SHA's AMT does not support modeling planned BMP implementation at this time, so a combination of modeling using the AMT (baseline and progress loads) and MDE's TIPP spreadsheet tool (planned reductions) was needed for this implementation plan.

As shown in **Figure 1**, SHA has ROW in multiple counties and 8-digit watersheds within the Baltimore Harbor Tidal watershed, so SHA needed to first separate its land use acres and BMP implementation in each county 8-digit watershed. The individual baseline, progress, and planned loads modeled by separate county 8-digit watershed were consolidated by county-Baltimore Harbor Tidal watershed (i.e., Anne Arundel, Baltimore, Carroll, and Howard counties' portions of the Baltimore Harbor Tidal watershed). The SHA TN and TP load reduction targets were calculated using these total baseline loads for the individual county portions of the Tidal watershed and the following formula:

$$\boldsymbol{Reqd\ Reduction}_{\boldsymbol{SHA}} = \boldsymbol{Baseline\ Load}_{\boldsymbol{SHA}} * \boldsymbol{Reqd\ Reduction}\ \%$$

Where:

Reqd Reduction $_{SHA}$ =	Reduction amount required for SHA
Baseline Load $_{SHA}$ =	SHA translated Baseline Load
Reqd Reduction % =	Published percent reduction assigned to SHA NPDES regulated stormwater point source in the TMDL document (i.e., 15%)

The MDE used 1995 baseline conditions and a time-variable, three-dimensional water quality eutrophication model package to develop the Baltimore Harbor Tidal nutrients local TMDL. For this reason, SHA needed to 'translate' its SW-WLAs into a P6-compatible target load while maintaining the original percent reduction required in the MDE TMDL document (15.0%). In order to reflect 1995 baseline conditions in the Baltimore Harbor Tidal watershed, the SHA translated county baseline loads for TN and TP to account for load reductions provided by SHA-owned BMPs built prior to the 1995 TMDL baseline year that are currently functioning as

designed. The 15% TN and TP pollutant load reduction requirements from the TMDL document were applied to the SHA translated baseline loads for each county to calculate the total pounds per year of TN and TP load reductions required for SHA to meet its targets. The required pollutant load reductions were then subtracted from the SHA translated baseline loads, for each county, to calculate the target SW-WLAs in pounds per year.

The SHA does not have accurate land use data available for the 1995 TMDL baseline year, so SHA used best available 2005 land use data in its modeling. The SHA's available land use and impervious area spatial data are based on analysis of aerial imagery dated 2005 and 2011. The SHA has mapped its impervious cover using remote sensing methods, specifically an Esri application called Feature Analyst. Land use source data used for analysis was statewide orthophotography as of 2005 and 2011. The impervious cover layer was overlaid on the land use and clipped to SHA ROW. The pervious and impervious area within SHA ROW is summarized by TMDL watershed – in this case, the 2005 land use data was summarized for each county 8-digit watershed within the Baltimore Harbor Tidal watershed as shown in **Table 9**, below.

For SHA's TMDL modeling, the version of land use and impervious area spatial data used (i.e., 2005 or 2011) is selected based on the baseline year of the TMDL being modeled. TMDLs with a baseline year of 2005 or earlier use SHA land use and impervious area spatial data based on 2005 aerial imagery and TMDLs with a baseline year of 2006 or later use impervious area spatial data based on 2011 aerial imagery. This is likely a conservative approach since it overstates the amount of land area and imperviousness, relative to the TMDL analysis, which will lead to a higher restoration requirement for SHA.

Table 9: 2005 Baseline Land Use Data Inputs

County	8-Digit Watershed	Land Use Type	
		Impervious Road (acres)	Turf (acres)
Anne Arundel	Baltimore Harbor Non-Tidal	822.6	998.4
	Patapsco River Lower North Branch	449.4	825.6
Baltimore	Baltimore Harbor Non-Tidal	120.3	86.0
	Gwynns Falls	564.8	853.1
	Jones Falls	434.7	397.4
	Patapsco River Lower North Branch	505.8	492.2
Carroll	South Branch Patapsco	198.9	337.0
Howard	Patapsco River Lower North Branch	459.5	701.7
	South Branch Patapsco	88.8	149.3

The TIPP spreadsheet contains options to use either specific land use information (i.e., Impervious Road and Impervious Non-Road data) or aggregated impervious land use information. The SHA used a conservative approach, modeling all its impervious ROW acres as "Impervious Road" in both the P6 AMT for baseline and progress scenarios and in MDE's TIPP spreadsheet for planned scenarios. This is considered conservative because SHA impervious area includes areas that could otherwise qualify as "non-road impervious" such as sidewalks, portions of

driveways, and parking areas. The SHA impervious road and turf acres within the Baltimore Harbor Tidal watershed are summarized, by county 8-digit watershed, in **Table 9** and were used as data input into baseline load modeling. The modeled TN and TP baseline loads and reduction targets by county are provided in **Table 10** below with supporting data provided in **Appendix B**.

Table 10: Modeled Baseline Nutrient Loads and Reduction Targets

County	TN (EOS-lbs/yr)				TP (EOS-lbs/yr)			
	Baseline Load	Target Reduction %	Target Load (SW-WLA)	Total Reduction Required	Baseline Load	Target Reduction %	Target Load (SW-WLA)	Total Reduction Required
Anne Arundel	47,805	15.0	40,634	7,171	4,587	15.0	3,899	688
Baltimore	58,351	15.0	49,598	8,753	5,488	15.0	4,664	823
Carroll	9,533	15.0	8,103	1,430	1,218	15.0	1,035	183
Howard	21,045	15.0	17,888	3,157	2,337	15.0	1,986	350

7 Nutrient Pollution Reduction Strategy

Current and future BMP implementation and associated load reductions are presented below.

7.1 BMP Implementation

During the current, administratively continued 2015-2020 MS4 permit term, SHA had success utilizing innovative contracting mechanisms to facilitate large scale, cost-effective BMP design and construction in relatively short time periods. For this reason, SHA intends to primarily use innovative contracting mechanisms to program BMP implementation. The SHA will supplement these strategies with traditional contracting mechanisms to attain the nutrient SW-WLAs. The recommended BMP practices presented in this plan are approved by MDE, described in the 2021 MS4 Accounting Guidance (MDE, 2021b), and included as BMPs in the TIPP tool.

The SHA tracks implementation status against restoration and TMDL goals. Status is based on progress in planning, design, and construction of BMPs. Planned implementation for the Baltimore Harbor Tidal nutrients TMDL consists of BMPs with the project development status categories including: Remediated BMPs, Under Construction, Restoration Project Portfolio, Recommended for Restoration, and To Be Determined (TBD). At the time of developing this implementation plan, there were currently no projects in the planning or design phase. Unit treatment (e.g., impervious and turf acres, acres converted, linear feet) for each type of BMP is grouped based on project status and entered into the TIPP. For planned TIPP modeling, the statuses are grouped further into milestones: Milestone 1, Milestone 2, and Planned, which are the scenario labels used in the TIPP spreadsheet tool for future BMP implementation. Definitions of the project status categories are provided below, organized by the TIPP implementation milestone.

Milestone 1

- *Remediated BMPs* – Load reduction credit was temporarily removed from the current progress modeling for any 'failed' BMPs (i.e., lapse inspections or failed inspections). Credit will be claimed once proper performance is attained and verified. Load reductions for these projects were modeled in the AMT and are not included in planned TIPP spreadsheets.
- *Under Construction* – Projects that have completed the design phase and are currently under construction; these projects do not have a built date.
- *Restoration Project Portfolio* – As part of the NPDES MS4 permit development process for future permits, MDE requested that SHA provide a comprehensive MEP analysis. In March 2024, SHA prepared and submitted to MDE a comprehensive MEP Analysis that included an MEP Report, Restoration Project Portfolio spreadsheet, and a Physical Capacity Analysis questionnaire (SHA, 2024). The Restoration Project Portfolio summarized SHA's potential restoration projects to be planned, designed, and/or constructed during the next 5-year MS4 permit term. The Restoration Project Portfolio notes that SHA intends to implement several forest planting and outfall stabilization projects; however, the site selection process has not been completed for these BMPs. Specific site locations are not determined for these projects at this time. For the purposes of this implementation plan, it was estimated that some of the forest planting and outfall stabilization projects will be implemented within the Baltimore Harbor Tidal watershed between FY31 through FY34.

Milestone 2

- *Recommended for Restoration* – Project opportunities with specific locations from past desktop reviews as described previously in Section 5 (see also **Table 8**). The SHA identified 31 stream restoration BMP sites (estimated 50,991 linear feet), 22 forest planting (estimated 48 acres), and ten grass swale BMP sites (estimated to treat 13.7 drainage area acres) as potentially viable for implementation within the Baltimore Harbor Tidal watershed. Preliminary investigations will be needed to verify the viability of these sites.

Planned

- *To Be Determined (TBD)* – Additional hypothetical projects needed to achieve the TMDL reduction targets. Where TBD BMPs are needed to achieve the TMDL reduction requirements, SHA will explore the viability of new BMP types recently authorized as generating MS4 impervious area treatment credit and pollutant load reductions in the MDE 2021 MS4 Accounting Guidance (MDE, 2021b) and will leverage established and open-ended Memorandums of Understanding (MOU) with Anne Arundel County, Baltimore County, and Howard County (executed March 2, 2016, September 30, 2016, and July 18, 2016 respectively) to identify opportunities for collaborative BMP implementation, when possible.

7.2 Nutrient Load Reductions

Since the 1995 TMDL Baseline Year, SHA has implemented BMPs that currently function as designed and actively reduce a total of 4,776 TN EOS lbs/yr and 938 TP EOS lbs/yr from the total nutrient baseline loads within the tidal watershed. **Table 11** below summarizes existing treatment provided by SHA-owned BMPs implemented before the 1995 TMDL baseline year, the SHA pollutant load reduction progress from BMPs implemented after the baseline year and between July 1, 1995 and June 30, 2023, and a tentative schedule for future BMP implementation to attain the TP SW-WLAs by the end of FY2036 and the TN SW-WLAs by the end of FY2055. A list of future projects is included in **Appendix A** and represents the planned BMP implementation modeled in the scenarios described in Section 7.1.

Although it is anticipated that TN and TP SW-WLAs in each county will be achieved through various levels of planned implementation, to simplify the planning process, SHA has set each "Target Year", FY2036 for TP and FY2055 for TN, for attainment for all SW-WLAs per county. When setting the Target Years, SHA considered the standard 5-year MS4 permit term, the Maryland Watershed Implementation Plan (WIP) III schedule (e.g., 2% restoration/treatment per year of impervious surfaces not treated as of 2010) for restoration by MS4 permittees, and restoration projects already programmed for upcoming years to meet attainment milestones for SHA's other TMDL SW-WLAs.

Table 12 below shows planned implementation by milestones. Projects associated with Milestone 1 are estimated to be complete by the end of FY2034. Through planned TIPP modeling, the TP SW-WLA for Howard County is anticipated to be achieved through the implementation of Milestone 1 projects. Milestone 2 projects are planned for implementation after FY2034 and before the end of FY2041. Only a portion of Milestone 2 projects are needed to achieve the TP SW-WLAs in Anne Arundel, Baltimore, and Carroll Counties. The TN SW-WLA for Carroll County is anticipated to be achieved through the implementation of Milestone 2 projects. Planned projects are only needed to achieve the TN SW-WLAs for Anne Arundel, Baltimore, and Howard Counties with implementation beginning in FY2042 and continuing through the end of FY2055. **Table 13** presents nutrient reductions after implementation of this plan through the FY2055 Target Year. Full implementation of this plan will meet all SW-WLAs for TN and exceed all SW-WLAs for TP.

Table 11: BMPs Implemented to Date and Planned Implementation Needed to Achieve SW-WLAs

BMP Type	Unit	Baseline				Current Progress				Planned Implementation[1]			
		Anne Arundel	Baltimore	Carroll	Howard	Anne Arundel	Baltimore	Carroll	Howard	Anne Arundel	Baltimore	Carroll	Howard
Structural Stormwater Controls	drainage area acres	344.1	90.7	9.3	40.4	28.8	42.7		12.1			2.7	11.0
Structural Stormwater Control Retrofits	drainage area acres					138.1		20.9	2.9	11.4			
Impervious Surface Removal	acres converted						0.2					0.2	
Forest Planting	acres converted					37.2	60.7	7.7	7.4	136.9	222.9	26.9	86.6
Stream Restoration	linear feet						4,343.0	4,710.0	6,025.0	44,915.9	37,018.2	7,171.2	6,510.9
Outfall Stabilization	linear feet								1,421.0	13,387.5	35,700.0		4,462.5
TN Load Reduction Totals	EOS lbs/yr	1,527.3	643.3	84.3	304.9	1,401.0	1,189.9	677.0	1,507.7	5,799.9	7,566.9	806.7	1,652.3
TP Load Reduction Totals	EOS lbs/yr	188.5	72.8	12.7	42.2	162.4	319.1	134.8	321.4	4,100.4	5,204.8	517.8	854.2

[1] Planned implementation includes BMP implementation associated with Milestone 1, Milestone 2, and Planned scenarios (defined in Section 7.1) and meets the required % reduction for all TN SW-WLAs per county. This level of planned implementation exceeds the required % reduction for all TP SW-WLAs per county.

Table 12: Planned BMP Implementation Load Reductions by Milestone

BMP Type	TN EOS Load Reductions (lbs/yr)				TP EOS Load Reductions (lbs/yr)			
	Anne Arundel	Baltimore	Carroll	Howard	Anne Arundel	Baltimore	Carroll	Howard
Milestone 1								
Structural Stormwater Control Retrofits	80.7	0.0	0.0	0.0	11.5	0.0	0.0	0.0
Impervious Surface Removal	0.0	0.0	2.4	0.0	0.0	0.0	0.4	0.0
Forest Planting	568.8	397.9	130.3	629.8	53.8	46.6	13.7	84.3
Outfall Stabilization	133.9	267.8	0.0	133.9	121.4	242.8	0.0	121.4
Total Load Reduction	783.4	665.6	132.7	763.7	186.7	289.2	14.2	205.6
Milestone 2								
Structural Stormwater Controls	0.0	0.0	29.9	115.1	0.0	0.0	4.5	13.6
Forest Planting	218.2	102.3	106.2	50.0	19.8	14.5	11.5	5.5
Stream Restoration	2,364.6	433.6	537.8	488.3	2,143.9	393.1	487.6	442.7
Total Load Reduction	2,582.8	535.9	673.9	653.4	2,163.7	407.6	503.6	461.9
Planned								
Forest Planting	559.4	1,612.9	0.0	34.4	50.7	199.0	0.0	4.6
Stream Restoration	1,004.1	2,342.8	0.0	0.0	910.4	2,124.2	0.0	0.0
Outfall Stabilization	870.2	2,409.8	0.0	200.8	789.0	2,184.8	0.0	182.1
Total Load Reduction	2,433.7	6,365.5	0.0	235.2	1,750.0	4,508.0	0.0	186.7

Table 13: Overall Plan Summary

BMP Type	TN EOS Load Reductions (lbs/yr)				TP EOS Load Reductions (lbs/yr)			
	Anne Arundel	Baltimore	Carroll	Howard	Anne Arundel	Baltimore	Carroll	Howard
Baseline								
Impairment Baseline Load	47,804.9	58,350.6	9,533.0	21,044.7	4,586.9	5,487.6	1,218.0	2,336.5
Target % Reduction	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Target Load	40,634.2	49,598.0	8,103.0	17,888.0	3,898.9	4,664.5	1,035.3	1,986.0
Total Reduction Required	7,170.7	8,752.6	1,429.9	3,156.7	688.0	823.1	182.7	350.5
Current Progress								
Total Load after Implementation	46,403.9	57,160.7	8,856.0	19,537.1	4,424.5	5,168.5	1,083.2	2,015.1
Implementation % Reduction	2.9%	2.0%	7.1%	7.2%	3.5%	5.8%	11.1%	13.8%
Milestone 1								
Total Load after Implementation	45,620.6	56,495.1	8,723.3	18,773.4	4,237.8	4,879.3	1,069.1	1,809.5
Implementation % Reduction[1]	4.6%	3.2%	8.5%	10.8%	7.6%	11.1%	12.2%	22.6%
Milestone 1 + Milestone 2								
Total Load after Implementation	43,037.7	55,959.2	8,049.4	18,120.0	2,074.1	4,471.7	565.5	1,347.6
Implementation % Reduction[2]	10.0%	4.1%	15.6%	13.9%	54.8%	18.5%	53.6%	42.3%
Milestone 1 + Milestone 2 + Planned								
Total Load after Full Implementation[3]	40,604.0	49,593.7	8,049.4	17,884.8	324.1	-36.3	565.5	1,160.9
Full Implementation % Reduction	15.1%	15.0%	15.6%	15.0%	92.9%	100.7%	53.6%	50.3%

[1]Planned BMP implementation through Milestone 1 exceeds the required TP % reduction for Baltimore and Howard Counties.
[2]Planned BMP implementation through Milestone 2 exceeds the required TP % reduction for Anne Arundel and Carroll Counties and meets the required TN % reduction for Carroll County.
[3]Loads are relative to Baseline Load; negative values indicate reductions are greater than the modeled Baseline Load.

7.3 Estimated Cost of Planned BMP Implementation

Estimated costs to attain the nutrient SW-WLAs are summarized below in **Table 14**. Cost estimates are based on the median cost per 1lb of TN reduction yielded for SHA compliance from each BMP type during the current, administratively continued 2015-2020 MS4 permit term and do not include BMP inspection and maintenance costs.

Table 14: Estimated Cost of BMP Implementation

BMP Type	Attainment Schedule			Total
	Milestone 1 FY2026 – FY2034	Milestone 2 FY2035 – FY2041	Planned FY2042 – FY2055	
Structural Stormwater Controls	$257,000	$1,990,000	$0	$2,247,000
Structural Stormwater Control Retrofits	$70,000	$0	$0	$70,000
Forest Planting	$10,463,000	$2,888,000	$13,371,000	$26,722,000
Stream Restoration	$0	$33,213,000	$29,066,000	$62,279,000
Outfall Stabilization	$1,829,000	$0	$11,886,000	$13,715,000
Totals	$12,619,000	$38,091,000	$54,323,000	$105,033,000

8 Progress Evaluation Criteria

Progress will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring. Pollutant load modeling is used to estimate future achievement of required load reductions through the planned strategies discussed in Section 7 and will be the method to show that SHA is meeting the nutrient SW-WLAs in the Baltimore Harbor Tidal watershed as implementation progresses.

Planning targets will be re-evaluated against progress and revised to ensure that SHA is on track to meet established goals. Progress assessments are completed annually and reported to MDE with SHA's NPDES MS4 permit annual report.

8.1 Tracking Implementation of Management Measures

Implementation will be measured by determining whether the targets for implementation shown in **Table 12** are achieved according to the target years assigned. The SHA will track BMP implementation by annually fulfilling the requirements outlined in the Annual NPDES MS4 Report as specified in SHA's NPDES MS4 permit (Permit No. 11-DP-3313 MD0068276). The SHA must submit each year a progress report on or before the anniversary date of the permit documenting implementation of the NPDES stormwater program during the prior fiscal year. The permit requirements for annual reporting are described in Part V.A.1 and include executive summaries on stormwater management and stormwater restoration, a narrative summary describing results and analyses of data accumulated throughout the reporting year, the identification or water quality improvements and documentation of attainment and/or progress

toward attainment, and the identification of proposed changes to SHA's program when SW-WLAs are not being met.

The SHA's MS4 data are centralized in a geodatabase that facilitates reporting in MDE's new NPDES schema (Version 2.0, October 2024). Elements of the database include feature classes and associated tables that store and report to MDE SHA's urban BMP restoration projects. The MDE and the Chesapeake Bay Program use the data for larger scale Bay modeling and TMDL compliance tracking. The relevant database features include:

- *AltBMPLine* - stream restoration, outfall stabilization
- *AltBMPPoly* – forest planting, street sweeping, storm drain cleaning, impervious removal
- *BMP* – stormwater BMPs (bioretention, filtering practices, infiltration practices, wet ponds etc.)

8.2 Tracking Load Reductions through Modeling

The SHA will perform modeling annually to evaluate load reductions and progress towards meeting the nutrient SW-WLA goals. The load reductions will be reported in SHA's NPDES MS4 permit annual report, as described above. The SHA will continue to model load reductions for the Baltimore Harbor Tidal watershed using the AMT, as described in Section 6 of this plan. Modeled load reductions of current progress and future implementation will be compared against benchmarks and implementation will be adjusted accordingly.

8.3 Tracking Overall Program Success through Monitoring

In the context of TMDL progress evaluation, SHA considers three primary elements forming the basis for their monitoring program. First is inspection and maintenance of implemented BMPs to ensure they are functional, second and related, are the monitoring terms of United States Army Corps of Engineers (USACE) joint permits for stream restoration projects, and finally BMP effectiveness and watershed assessment monitoring can be used to determine overall program effectiveness. These three elements are described in the following sections.

8.4 BMP Inspection and Maintenance

Maintenance of BMPs is an important step to ensure that implemented practices are functioning properly and are providing the expected benefits, including pollutant load reductions. To this end, SHA has established policies and procedures for regular BMP inspection and maintenance.

The SHA tracks the functionality of all BMPs on a year-to-year basis and immediately removes credit associated with BMPs when they are assigned a failed inspection rating. This ensures that SHA modeling is consistently the best available information for assessing current load reductions provided by BMPs and adaptively managing attainment milestones. Load reduction credit is

added back into the modeling when failing BMPs are remediated. The SHA prioritizes its BMP remediation schedules to align with SW-WLA attainment milestones whenever practicable.

8.5 Joint Permit Stream Restoration Monitoring

Monitoring the stability and success of stream restoration activities is often a requirement of the MDE and USACE joint permit for the Alteration of Floodplain, Waterway, Tidal or Nontidal Wetlands in Maryland. The permit typically requires monitoring several success criteria related to flow classification, vertical and lateral stability, habitat, wetlands (if applicable), and vegetative and invasive species cover during a baseline pre-construction period and for approximately five years after construction is complete. Monitoring ensures that the goals of the project are being met and provides an opportunity to identify and correct issues related to stability, hydrology, and/or biology.

8.6 BMP Effectiveness and Watershed Assessment Monitoring

BMP Effectiveness and Watershed Assessment Monitoring are MS4 permit conditions that use measures of biology, physical condition, and chemical water quality sampling to monitor pre- and post-implementation conditions to detect changes over time in response to the implementation of restoration and water quality treatment BMPs. These two monitoring strategies are included in MDE's *Guidance for Developing Local Nutrient and Sediment TMDL (Total Maximum Daily Load) Stormwater Wasteload Allocation (SW-WLA) Watershed Implementation Plans (WIPs)* (MDE, 2022a) and are referenced as the minimum monitoring strategy to be used for TMDL related progress monitoring. The two elements are further described with more specific detail in the *2021 MS4 Monitoring Guidelines: BMP Effectiveness and Watershed Assessments* (MDE, 2021d).

Starting in FY24, SHA is collaborating with MDE in a Pooled Monitoring Advisory Committee administered by the Chesapeake Bay Trust (CBT) for compliance with the Assessment of Controls, BMP Effectiveness and Watershed Assessment Monitoring conditions of the MS4 permit. An MOU with CBT was executed June 28, 2024.

9 Adaptive Management

The MS4 permit calls for SHA to develop an ongoing, iterative, and adaptive process that continuously evaluates and reassesses BMP implementation when SW-WLAs are not being met according to established benchmarks and deadlines. These activities are collectively referred to as "adaptive management." Adaptive management is a critical component of achieving the SW-WLAs required by SHA's responsibilities of nutrient and sediment TMDLs.

The SHA will follow an adaptive management process guided by the feedback loop shown in **Figure 2** to evaluate implementation of this plan. The feedback loop outlines the cyclical nature of adaptive management and how it might take multiple additional steps to achieve attainment.

Once this implementation plan is reviewed and approved by MDE, SHA will begin implementing the outlined strategies.

The Plan's estimated dates and costs for completion of various projects may change over time, and projects may be substituted based on lessons learned as implementation progresses. If new methods of stormwater treatment are identified, or better approaches to source control are found, the plan can be extended and updated to take these changes into account. Similarly, if some elements of this plan are not as successful as expected, adaptations and improvements will be incorporated in future updates. This plan may also change if pollutant removal crediting methods are modified in the future. The SHA's planning targets are achieved when modeling shows the recommended nutrient load reductions for the TMDL. If target years are not met, SHA will coordinate with MDE and discuss possible response actions and adjust timelines if needed.

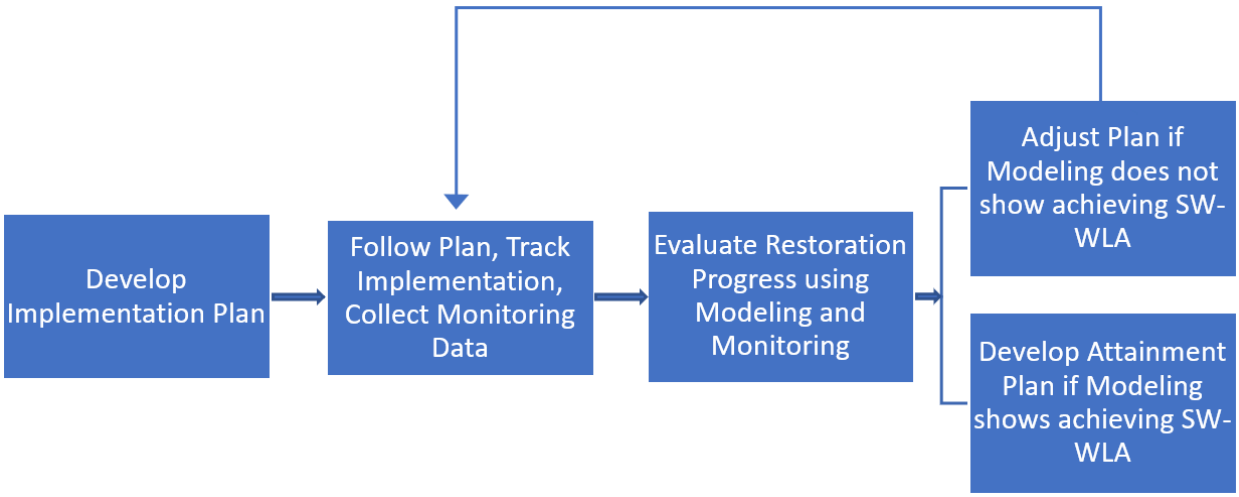

Figure 2: Adaptive Implementation Cycle

Per MDE's guidance (MDE, 2022a), once there is documented achievement of SW-WLAs through modeling, an attainment plan should be developed. The MDE is currently developing an attainment plan guidance that will focus on ensuring SW-WLAs continue to be achieved into the future. The SHA will work with MDE and other MS4 jurisdictions, as appropriate, to develop attainment plans in accordance with forthcoming MDE guidance. It is important to note that even if SHA attains their nutrient SW-WLAs, the actual reduction of the load, meeting water quality standards, and meeting biological criteria is still dependent on other jurisdictions meeting their WLAs as well. There will be a level of collaboration needed between jurisdictions to prevent back-sliding in the Baltimore Harbor Tidal watershed.

The SHA will continue to communicate with MDE, particularly its Water and Science Administration, Watershed Protection, Restoration, and Planning Program (WPRPP), on an as-needed basis to address TMDL-related questions or MDE requests for program modifications. The SHA will continue to address issues or concerns presented in MDE's review of the SHA

Coordinated TMDL implementation plan and associated SW-WLA attainment progress reported with MS4 permit annual reports and will make appropriate programmatic adjustments.

10 Public Engagement

In accordance with conditions in its NPDES MS4 permit, SHA will provide notice to the public, in a regional newspaper and on SHA's webpage, outlining how the public may obtain information on the development of this implementation plan and opportunities for comment. The SHA will accept and address comments from the public for a minimum of 30 days from the date of its notice to the public and prior to finalizing this implementation plan and submitting to MDE for approval. **Appendix C** provides documentation of material comments received and SHA responses. Upon approval by MDE, this implementation plan will be accessible online for public reference, along with all other SHA individual watershed IPs approved by MDE, at the following web address:
https://roads.maryland.gov/mdotsha/pages/index.aspx?PageId=336

The SHA will continuously accept and address comments from the public and other stakeholders. Comments can be emailed directly to the SHA Office of Environmental Design, Water Programs Division at wpd@mdot.maryland.gov.

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Appendix A

List of Potentially Viable BMPs

County / 8 Digit Watershed Name	Construction Purpose	MDE BMP Description	Unit	Treatment	Status	Projected Implementation Year
Anne Arundel / Baltimore Harbor Non-Tidal	CONV	Retention Pond (Wet Pond)	Acres	11.4	Under Construction	2025
Baltimore / Gwynns Falls	REST	Outfall Stabilization	Linear Feet	1,785.0	Restoration Project Portfolio	2031
Baltimore / Gwynns Falls	REST	Forest Planting	Acres	15.9	Restoration Project Portfolio	2032
Anne Arundel / Baltimore Harbor Non-Tidal	REST	Outfall Stabilization	Linear Feet	1,785.0	Restoration Project Portfolio	2033
Howard / Patapsco River Lower North Branch	REST	Outfall Stabilization	Linear Feet	1,785.0	Restoration Project Portfolio	2033
Anne Arundel / Baltimore Harbor Non-Tidal	REST	Forest Planting	Acres	15.9	Restoration Project Portfolio	2034
Baltimore / Patapsco River Lower North Branch	REST	Outfall Stabilization	Linear Feet	1,785.0	Restoration Project Portfolio	2034
Anne Arundel / Baltimore Harbor Non-Tidal	REST	Forest Planting	Acres	6.8	Recommended for Restoration	TBD
Anne Arundel / Baltimore Harbor Non-Tidal	REST	Stream Restoration	Linear Feet	5,622.3	Recommended for Restoration	TBD
Anne Arundel / Patapsco River Lower North Branch	REST	Forest Planting	Acres	14.7	Recommended for Restoration	TBD
Anne Arundel / Patapsco River Lower North Branch	REST	Stream Restoration	Linear Feet	25,906.1	Recommended for Restoration	TBD
Baltimore / Baltimore Harbor Non-Tidal	REST	Forest Planting	Acres	1.4	Recommended for Restoration	TBD
Baltimore / Gwynns Falls	REST	Forest Planting	Acres	7.2	Recommended for Restoration	TBD
Baltimore / Jones Falls	REST	Stream Restoration	Linear Feet	1,209.7	Recommended for Restoration	TBD
Baltimore / Patapsco River Lower North Branch	REST	Forest Planting	Acres	3.1	Recommended for Restoration	TBD
Baltimore / Patapsco River Lower North Branch	REST	Stream Restoration	Linear Feet	4,571.0	Recommended for Restoration	TBD

County / 8 Digit Watershed Name	Construction Purpose	MDE BMP Description	Unit	Treatment	Status	Projected Implementation Year
Carroll / South Branch Patapsco	REST	Forest Planting	Acres	9.8	Recommended for Restoration	TBD
Carroll / South Branch Patapsco	REST	Grass Swales	Acres	2.7	Recommended for Restoration	TBD
Carroll / South Branch Patapsco	REST	Stream Restoration	Linear Feet	7,171.2	Recommended for Restoration	TBD
Howard / Patapsco River Lower North Branch	REST	Forest Planting	Acres	1.7	Recommended for Restoration	TBD
Howard / Patapsco River Lower North Branch	REST	Grass Swales	Acres	1.37	Recommended for Restoration	TBD
Howard / Patapsco River Lower North Branch	REST	Stream Restoration	Linear Feet	1,424.9	Recommended for Restoration	TBD
Howard / South Branch Patapsco	REST	Forest Planting	Acres	3.3	Recommended for Restoration	TBD
Howard / South Branch Patapsco	REST	Grass Swales	Acres	9.59	Recommended for Restoration	TBD
Howard / South Branch Patapsco	REST	Stream Restoration	Linear Feet	5,086.0	Recommended for Restoration	TBD
Anne Arundel / Baltimore Harbor Non-Tidal	REST	Forest Planting	Acres	5.3	TBD	TBD
Anne Arundel / Baltimore Harbor Non-Tidal	REST	Outfall Stabilization	Linear Feet	7,140.0	TBD	TBD
Anne Arundel / Baltimore Harbor Non-Tidal	REST	Stream Restoration	Linear Feet	8,925.0	TBD	TBD
Anne Arundel / Patapsco River Lower North Branch	REST	Forest Planting	Acres	49.7	TBD	TBD
Anne Arundel / Patapsco River Lower North Branch	REST	Outfall Stabilization	Linear Feet	4,462.5	TBD	TBD
Anne Arundel / Patapsco River Lower North Branch	REST	Stream Restoration	Linear Feet	4,462.5	TBD	TBD
Baltimore / Baltimore Harbor Non-Tidal	REST	Forest Planting	Acres	20.3	TBD	TBD
Baltimore / Gwynns Falls	REST	Forest Planting	Acres	44.5	TBD	TBD
Baltimore / Gwynns Falls	REST	Outfall Stabilization	Linear Feet	11,602.5	TBD	TBD

County / 8 Digit Watershed Name	Construction Purpose	MDE BMP Description	Unit	Treatment	Status	Projected Implementation Year
Baltimore / Gwynns Falls	REST	Stream Restoration	Linear Feet	13,387.5	TBD	TBD
Baltimore / Jones Falls	REST	Forest Planting	Acres	46.2	TBD	TBD
Baltimore / Jones Falls	REST	Outfall Stabilization	Linear Feet	8,925.0	TBD	TBD
Baltimore / Jones Falls	REST	Stream Restoration	Linear Feet	8,925.0	TBD	TBD
Baltimore / Patapsco River Lower North Branch	REST	Forest Planting	Acres	61.2	TBD	TBD
Baltimore / Patapsco River Lower North Branch	REST	Outfall Stabilization	Linear Feet	11,602.5	TBD	TBD
Baltimore / Patapsco River Lower North Branch	REST	Stream Restoration	Linear Feet	8,925.0	TBD	TBD
Howard / Patapsco River Lower North Branch	REST	Forest Planting	Acres	4.0	TBD	TBD
Howard / Patapsco River Lower North Branch	REST	Outfall Stabilization	Linear Feet	2,677.5	TBD	TBD

Appendix B
Baltimore Harbor Tidal TIPP Spreadsheets

See Attached Excel File for P6 AMT Modeling and Progress Summary:

1. BaltHarborTidal_P6AMT_AllSummary_2025.03.25_forMDE.xlsx

See Attached Baltimore Harbor Tidal TIPP Excel Files for Planned BMPs:

TN Target

1. AACo_Baltimore Harbor_TIPP_PlannedBMPs_20250318.xlsm
2. AACo_Patapsco River L N Br_TIPP_PlannedBMPs_20250318.xlsm
3. BaCo_Baltimore Harbor_TIPP_PlannedBMPs_20250318.xlsm
4. BaCo_Gwynns Falls_TIPP_PlannedBMPs_20250318.xlsm
5. BaCo_Jones Falls_TIPP_PlannedBMPs_20250318.xlsm
6. BaCo_Patapsco River L N Br_TIPP_PlannedBMPs_20250318.xlsm
7. CrCo_S Branch Patapsco_TIPP_PlannedBMPs_20250318.xlsm
8. HoCo_Patapsco River L N Br_TIPP_PlannedBMPs_20250318.xlsm
9. HoCo_S Branch Patapsco_TIPP_PlannedBMPs_20250318.xlsm

TP Target

1. AACo_Baltimore Harbor_TIPP_PlannedBMPs_20250318_TPtarget.xlsm
2. AACo_Patapsco River L N Br_TIPP_PlannedBMPs_20250318_TPtarget.xlsm
3. BaCo_Baltimore Harbor_TIPP_PlannedBMPs_20250318_TPtarget.xlsm
4. BaCo_Gwynns Falls_TIPP_PlannedBMPs_20250318_TPtarget.xlsm
5. BaCo_Jones Falls_TIPP_PlannedBMPs_20250318_TPtarget.xlsm
6. BaCo_Patapsco River L N Br_TIPP_20250318_TPtarget.xlsm
7. CrCo_S Branch Patapsco_TIPP_20250318_TPtarget.xlsm
8. HoCo_Patapsco River L N Br_TIPP_20250318_TPtarget.xlsm
9. HoCo_S Branch Patapsco_TIPP_20250318_TPtarget.xlsm
10. TP TMDLs within Balt Harbor Tidal_20250318.xlsx

Appendix C

Public Comment Period Documentation