Non-Tidal Patuxent River Lower and Middle Watersheds

2020 Sediment TMDL Annual Assessment Report

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Prepared For

Anne Arundel County
Bureau of Watershed Protection and Restoration
Department of Public Works
2662 Riva Road, MS 7301
Annapolis, Maryland 21401

Prepared By

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

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List of Acronyms

BIBI	Benthic Indices of Biotic Integrity
BMP	Best Management Practices
BSID	Biological Stressor Identification
BWPR	Bureau of Watershed Protection and Restoration
CAST	Chesapeake Assessment Scenario Tool
CBP	Chesapeake Bay Program
COMAR	Code of Maryland Regulations
CWA	Clean Water Act
DPW	Department of Public Works
EOS	Edge of Stream
EOT	Edge of Tide
EPA	United States Environmental Protection Agency
FIBI	Fish Indices of Biotic Integrity
FY	Fiscal Year
LA	Load Allocation
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometer Turbidity Units
PHI	Physical Habitat Index
PSU	Primary Sampling Unity
RBP	Rapid Bioassessment Protocol
SPSC	Step Pool Storm Conveyance
STB	Stream Bed and Bank
SW-WLA	Stormwater Wasteload Allocation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
WLA	Wasteload Allocation
WM	Watershed Model
WQIP	Water Quality Improvement Projects

1 Introduction

1.1 Background

The Anne Arundel County Department of Public Works (DPW) Bureau of Watershed Protection and Restoration (BWPR) has developed and is currently implementing restoration plans to address local water quality impairments for which a Total Maximum Daily Load (TMDL) has been established by the Maryland Department of the Environment (MDE) and approved by the U.S. Environmental Protection Agency (EPA) (MDE, 2011a). A TMDL establishes a maximum load of a specific single pollutant or stressor that a waterbody can assimilate and still meet water quality standards for its designated use class.

Under the Federal Clean Water Act (CWA), the State of Maryland is required to assess and report on the quality of waters throughout the state. Where Maryland's water quality standards are not fully met, CWA Section 303(d) requires the state to list these water bodies as impaired waters. States are then required to develop a TMDL for pollutants of concern for the listed impaired waters. The Non-Tidal Lower and Middle Patuxent River watersheds are listed in Maryland's Integrated Report of Surface Water Quality [303(d) list and 305(b) Report] for sediment pollution. On July 2, 2018 EPA approved sediment (total suspended solids, or TSS) TMDLs for the Non-Tidal Patuxent River Lower and Middle Watersheds. These two TMDLs apply to multiple Counties, and responsibility for reduction of sediment is divided among the multiple contributing jurisdictions. Anne Arundel County BWPR developed a TMDL Restoration Plan for the two 2018 sediment TMDLs, drafted in 2019 and finalized in January of 2020 (Anne Arundel County, 2020) following review and comment from MDE and the general public.

The TMDL loading targets, or allocations, are also divided among the pollution source categories, which includes non-point sources (termed load allocation or LA) and point sources (termed wasteload allocation or WLA). The WLA consists of loads attributable to regulated process water or wastewater treatment, and to regulated stormwater. For the purposes of the TMDL and consistent with implementation of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Discharge Permit, stormwater runoff from MS4 areas is considered a point source contribution.

Anne Arundel County's current MS4 permit (11-DP-3316, MD0068306) issued by MDE in February of 2014 requires the development of restoration plans for each SW-WLA approved by EPA prior to the effective date of the permit (permit section IV.E.2.b), and requires an annual TMDL assessment report to document implementation progress, pollutant load reductions, and program costs (permit section IV.E.4). The *Non-Tidal Patuxent River Lower and Middle Watersheds Sediment TMDL Restoration Plan* (the Restoration Plan) (Anne Arundel County, 2020) satisfied the permit planning requirement and this *2020 Non-Tidal Patuxent River Lower and Middle Watersheds Sediment TMDL Annual Assessment Report* satisfies the progress documentation requirement for fiscal year (FY) 2020.

1.2 Watershed Description

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

The Middle Patuxent watershed is located in the southwest portion of the county (Figure 1). The watershed shares political boundaries with Prince George's County along the Patuxent River to the west, and with Calvert County along Lyons Creek to the south. The Middle Patuxent watershed also lies within the larger Chesapeake Bay watershed, with the Patuxent River discharging into the Chesapeake Bay. The Middle Patuxent watershed is approximately 26,490 acres (41.4 square miles) and contains approximately 228 miles of streams. The watershed includes the named streams Lyons Creek, Cabin Branch, Ferry Branch, Wilson Owens Branch, and the middle branch of the Patuxent River.

Figure 1: Watershed Location Map

1.3 TMDL Allocation and Planned Loads Summary

This section describes the derivation of the TMDL reduction targets. SW-WLAs in the sediment TMDLs were developed by MDE using the Chesapeake Bay Program Watershed Model Phase 5.3.2 (CBP WM P5.3.2). Baseline, progress, and planned loads were modeled in development of the *Non-Tidal Patuxent River Lower and Middle Watersheds Restoration Plan* (also called the Restoration Plan herein) using CAST (Chesapeake Assessment Scenario Tool) Chesapeake Bay Program Watershed Model Phase 6 (CBP WM P6).

MDE is currently working on a new local TMDL modeling tool that will be available in the future to report progress toward nutrient and sediment load reductions. If completed and available, this new spreadsheet model will be used for FY2021 modeling, likely resulting in changes to the baseline, permit, and progress loads and load reductions in this report.

CAST, created by the Chesapeake Bay Program, is a web-based pollutant load estimation tool that calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program Partnership Watershed Phase 6 Model. Because the TMDL was developed under an older version of the model, the SW-WLA needed to be translated into a CAST-compatible target load. In order to do this, the 2009 baseline sediment loads were re-calculated in CAST by modeling baseline BMPs in non-tidal Lower and Middle Patuxent watersheds on top of baseline land use conditions.

The required percent reduction assigned to the Anne Arundel County Phase I MS4 source for the non-tidal Patuxent River Lower and Middle watersheds (61% and 56% reduction, respectively) in the local TMDLs were then applied to the CAST modeled baseline loads to calculate required sediment reduction. The required sediment reductions were then subtracted from the baseline loads to calculate the target SW-WLA. Sediment loads required for the non-tidal Patuxent River Lower and Middle watersheds Anne Arundel County Phase I MS4 source are shown in Table 1, which compares results presented in the Restoration Plan (P6 with stream bed and bank [STB] loads pro-rated according to the ratio of Anne Arundel County MS4 area to the total area in the watershed) with re-modeled results for the annual assessment (P6 with STB loads disaggregated following calculations provided by the CBP). Section 1.5 contains more details on the modeling specifics.

Table 1: Sediment Loads Required for the Non-Tidal Lower and Middle Patuxent River Local TMDLs

Watershed	Model	2009 Baseline Load (lbs/yr)	Required Reduction %	Required Reductions (lbs/yr)	TMDL Load Allocation (SW-WLA) (lbs/yr)
Lower Patuxent	P6 – pro-rated STB loads	801,324	61%	488,808	312,516
	P6 –disaggregated STB loads	1,708,554	61%	1,042,218	666,336
Middle Patuxent	P6 – pro-rated STB loads	5,814,345	56%	3,256,033	2,558,312
	P6 –disaggregated STB loads	12,426,617	56%	6,958,906	5,467,712

1.4 Planned Reductions

Table 2, provides a concise summary of the loads and reductions at important timeline intervals including the 2009 baseline, 2020 progress, and 2030 final planning intervals. These terms and dates are used throughout the Restoration Plan and explained in more detail in the following sections. They are presented here to assist the reader in understanding the definition of each, how they were derived, and to provide an overall summary demonstrating the percent reduction required and percent reduction achieved through full implementation of this plan. Sediment loads and wasteload allocations are presented as tons/year in the *Total Maximum Daily Load of Sediment in the Non-tidal Patuxent River Lower Watershed, Anne Arundel, Calvert, Charles, Prince George's and Saint Mary's Counties, Maryland* and *Total Maximum Daily Load of Sediment in the Non-Tidal Patuxent River Middle Watershed, Anne Arundel, Calvert, Charles, St. Mary's and Prince George's Counties, Maryland*, but will be discussed as lbs/year in this report. All loads presented below were calculated in CAST.

- **2009 Baseline Loads**: Baseline levels (i.e., land use loads with baseline best management practices [BMPs]) from 2009 conditions in the non-tidal Patuxent River Lower and Middle watersheds. Baseline loads were used to calculate the stormwater allocated sediment loads, or SW-WLA.
- **2020 Progress Loads and Reductions**: Progress loads and load reductions achieved from stormwater BMP implementation through 2020.
- **2030 Allocated Load**: Allocated loads are calculated from the 2009 baseline levels, calibrated to CBP P6 as noted above, using the following calculation: Lower Patuxent 2030 Allocated Load = 2009 Baseline - (2009 Baseline x 0.61); Middle Patuxent 2030 Allocated Load = 2009 Baseline - (2009 Baseline x 0.56).
- **2030 Planned Loads and Planned Reductions**: Loads and reductions that will result from implementation of the Restoration Plan. The 2030 Planned Loads are calculated from the 2009 Baseline Loads by the following calculation: 2030 Planned Load = 2009 Baseline - 2030 Planned Reduction.

Table 2: Local TMDL Allocated and Planned Loads

	Lower Patuxent River Sediment (lbs/year)	Middle Patuxent River Sediment (lbs/year)
2009 Baseline Loads	1,708,554	12,426,617
2020 Progress Loads	1,708,529	12,422,636
2020 Progress Reductions	25	3,982
TMDL Allocated Loads	666,336	5,467,712
2030 Planned Loads*	1,708,529	12,422,636
2030 Planned Reductions	25	3,982
Required Percent Reduction	61%	56%
Planned Percent Reduction	>0.1%	>0.1%

*It is assumed that stormwater runoff from new development will be treated to the maximum extent practicable to achieve 90% sediment removal and Accounting for Growth policies will address the remaining 10%.

1.5 Modeling Methods

1.5.1 Overview

The baseline, progress, and planned pollutant loads for the non-tidal Patuxent River Lower and Middle watersheds were determined using CAST, which calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program Partnership Phase 6 Watershed Model (CBP WM P6).

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

CAST provides analysis and load output at two different scales: Edge-of-Stream (EOS) and Edge-of-Tide (EOT). Edge-of-tide loads incorporate in-stream processes, such as nutrient uptake by algae or other aquatic life and generally result in lower delivered loads from the upstream source to the receiving water body, which in this case is the Chesapeake Bay. The EOT scale is used in Bay TMDL modeling. This TMDL is for impairments in the freshwater tributary streams; therefore, the County's plan focuses on reducing loads delivered from upland and instream tributary sources. As a result, EOS estimates are more appropriate and are used for the modeling analysis.

The Restoration Plan also used CAST for modeling; however, the plan used a different approach to disaggregate stream bed and bank loads than what is presented in this annual assessment report. To derive the stream loads allocated to the County's urban stormwater sector in the Restoration Plan, the stream bed and bank loads calculated by CAST for each TMDL watershed (which included land from multiple MS4 Counties) were pro-rated according to the ratio of Anne Arundel County MS4 area to total area in the watershed, and then these calculated stream bed and bank loads were assigned to the County's urban stormwater sector. Since the Restoration Plan was completed in January 2020, the Chesapeake Bay Program has provided calculations to the MS4s that disaggregate stream bed and bank nutrient and sediment loads using the same principals used by CAST. This methodology was used in the annual assessment modeling and is described in detail in section 1.5.2 below.

Pollutant load reductions achieved by stream restoration and annual practices (e.g., street sweeping and inlet cleaning) were calculated outside of CAST following MDE's 2020 accounting guidance (MDE, 2020) and Bay Program methods. Stream restoration projects were credited using project specific load reductions calculated using the Bay Program's Protocol method, when available. Planned stream restoration load reductions were modeled using 248 lbs TSS per linear foot. Sediment reduction credit for vacuum-assisted street sweeping were calculated based on a sweeping frequency of 1 pass every two weeks and the annual number of miles swept averaged over the span of the 5-year permit term. Sediment reductions for inlet cleaning were calculated based on the annual aggregate load collected (organic and inorganic material) and averaged over the span of the 5-year permit term.

1.5.2 Stream Bed and Bank Disaggregation

The Phase 6 Chesapeake Bay Program Model provides a separate load source for stream bed and bank loads, while the P5.3.2 model included these stream loads implicitly in the upland load sources. The stream bed and bank load source includes stream loads from streams located in agriculture, natural, MS4, and non-regulated developed land areas, and therefore was disaggregated for a single source sector to determine the stream load attributed to the County's Stormwater sector that should be included under the SW-WLA for these TMDLs.

The stream bed and bank loads were disaggregated using calculations provided by the Chesapeake Bay Program using the same principals used by CAST to calculate the total stream bed and bank load. The calculation for TSS disaggregation is as follows:

TSS STB load = ((Scenario EOS without STB TSS / CAL EOS without STB TSS) * STB base TSS) + (4/3 * Scenario Impervious TSS)

Where:
EOS = edge-of-stream
STB = stream bed and bank load source
TSS = total sediment
CAL = calibration average

This equation is used to calculate the stream bed and bank load for a given scenario outside of CAST. Load reductions associated with stream restoration practices are applied directly to the stream bed and bank loads in CAST. As a result, stream restoration practices are modeled in a spreadsheet outside of CAST and the calculated load reductions are subtracted from the disaggregated stream bed and bank load to determine the total disaggregated stream bed and bank load for a given scenario (i.e. baseline, progress, planned).

1.5.3 Practice Level

This section briefly describes each practice and includes a summary of the typical sediment reductions achieved with each type.

1.5.3.1 Modeled in CAST

- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. Rain gardens may be engineered to perform as a bioretention.
- **Bioswales** —An open channel conveyance that functions similarly to bioretention. Unlike other open channel designs, there is additional treatment through filter media and infiltration into the soil.
- **Dry Detention Ponds** – Depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow. These devices are designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.
- **Dry Extended Detention Ponds** - Depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. They are similar in construction and function to dry detention basins, except

that the duration of detention of stormwater is designed to be longer, allowing additional wet sedimentation to improve treatment effectiveness.

- **Impervious Surface Reduction** - Reducing impervious surfaces to promote infiltration and percolation of runoff storm water. Disconnection of rooftop and non-rooftop runoff, rainwater harvesting (e.g., rain barrels), and sheetflow to conservation areas are examples of impervious surface reduction.
- **Infiltration** — A depression or trench to form a shallow basin where sediment is trapped and stormwater infiltrates into the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil; they are not constructed on poor soils, such as C and D soil types. Yearly inspections to determine if the basin or trench is still infiltrating runoff are planned. Dry wells, infiltration basins, infiltration trenches, and landscaped infiltration are all examples of this practice type.
- **Outfall Enhancement with Step Pool Storm Conveyance (SPSC)** – The SPSC is designed to stabilize outfalls and provide water quality treatment through pool, subsurface flow, and vegetative uptake. All County SPSCs are completed at the end of outfalls, prior to discharging to a perennial stream. The retrofits promote infiltration and reduce stormwater velocities. This strategy is modeled in CAST as filtering practices. Some SPSC sites qualified for Protocol 5 load reductions. Protocol 5 load reductions were added to modeling results outside of CAST when applicable.
- **Stormwater Retrofits –** Stormwater retrofits may include converting dry ponds, dry extended detention ponds, or wet extended detention ponds into wet pond structures, wetlands, infiltration basins, or decommissioning the pond entirely to install SPSC (step pool storm conveyance). Stormwater retrofits were modeled in CAST by calculating the net treatment (retrofit BMP vs. original BMP) for retrofit BMPs of the same CAST BMP type category (e.g., wet pond) within the same land river segment. If a net calculation was not required (i.e., original CAST BMP type category was different than the retrofit CAST BMP type category), the original BMP treatment was removed from the baseline BMPs carried over into progress and planned scenarios and replaced with treatment from the more effective retrofit BMP. This procedure prevents over counting stormwater BMP treatment.
- **Urban Filtering** - Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit.
- **Urban Tree Plantings** - Urban tree planting is planting trees on urban pervious areas at a density that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting
- **Vegetated Open Channels** - Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff then releases it at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached pollutants. Until 2002 in Maryland, these practices were generally designed to meet water quantity, not water quality objectives. There is little or no vegetation within the pooled

area, nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.

The effectiveness for each of these practices are found in Table 3.

Table 3: Typical Sediment Reduction from Stormwater BMPs and Restoration Practices

BMP	Sediment Reduction
Bioretention A/B soils	80%
Bioretention C/D soils	55%
Bioswales	80%
Dry Detention Ponds	10%
Dry Extended Detention Ponds	60%
Impervious Surface Reduction[1]	-
Infiltration	95%
Outfall Enhancement with SPSC[2]	80%
Stream Restoration[3]	248 lbs/linear ft
Urban Filtering	80%
Urban Tree Plantings[1]	-
Vegetated Open Channels	70%
Wet Ponds or Wetlands	60%
Inlet Cleaning – Organic	400 lbs/ton removed
Inlet Cleaning – Inorganic	1,400 lbs/ton removed
Street Sweeping – 1 pass/2 weeks	11%

Sources: MDE, 2020 and CAST documentation

[1] Calculated as a land use change to a lower loading land use

[2] Outfall enhancement with SPSC modeled as filtering practices in CAST

[3] Stream restoration listed with revised interim rate, now termed the 'planning rate'; some stream restoration projects used Bay Program Protocols to calculate load reductions.

1.5.3.2 Modeled using MDE Guidance

Inlet cleaning, street sweeping, and urban stream restoration load reductions are modeled outside of CAST using MDE's 2020 accounting guidance and Bay Program methods. The methods are compatible with Phase 6 of the Bay Model.

- **Inlet Cleaning –** Storm drain cleanout practice ranks among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with NPDES stormwater permits. Nutrient reduction credit is based on the mass of material collected, at the rate of 400 lbs TSS per ton of organic material and 1,400 lbs TSS per ton of inorganic material (MDE, 2020). Data for the mass removed was reported by the County's Bureau of Highways. The total mass of material collected by the inlet cleaning program each year is distributed proportionately across all of the inlets cleaned and then summed at the watershed scale. The County's inlet cleaning program is now at maturity and while amounts of material collected each year may vary, the current level of effort will be maintained in the foreseeable future
- **Street sweeping** — Starting Fiscal Year 2015, Anne Arundel County enhanced their street sweeping program (Anne Arundel County DPW, 2015; Figure 2). This enhanced program targets

impaired watersheds and curbed streets that contribute trash/litter, sediment, nutrients, and other pollutants. Load reductions for this assessment are calculated using the length/area of street swept and 11% reduction efficiency for TSS for street swept every two weeks using vacuum sweepers (MDE, 2020). Data for the curb miles swept and frequency (1 pass/2 weeks) was reported by the County's Bureau of Highways. The County's street sweeping program is now at maturity and while amounts of material collected each year may vary, the current level of effort will be maintained in the foreseeable future.

- **Urban Stream Restoration** – Stream restoration in urban areas is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape of a stream, helping to improve habitat and water quality conditions in degraded streams. These projects were modeled outside of CAST using load reductions at the rate of 248 lbs TSS per linear foot (MDE, 2020) for older projects that pre-dated full adoption of the Bay Program's protocol methods, and for future projects where a planning rate is appropriate for use before the full design is complete and protocol calculations are developed. Project specific load reductions calculated using the Bay Program's Protocol method were used when available.

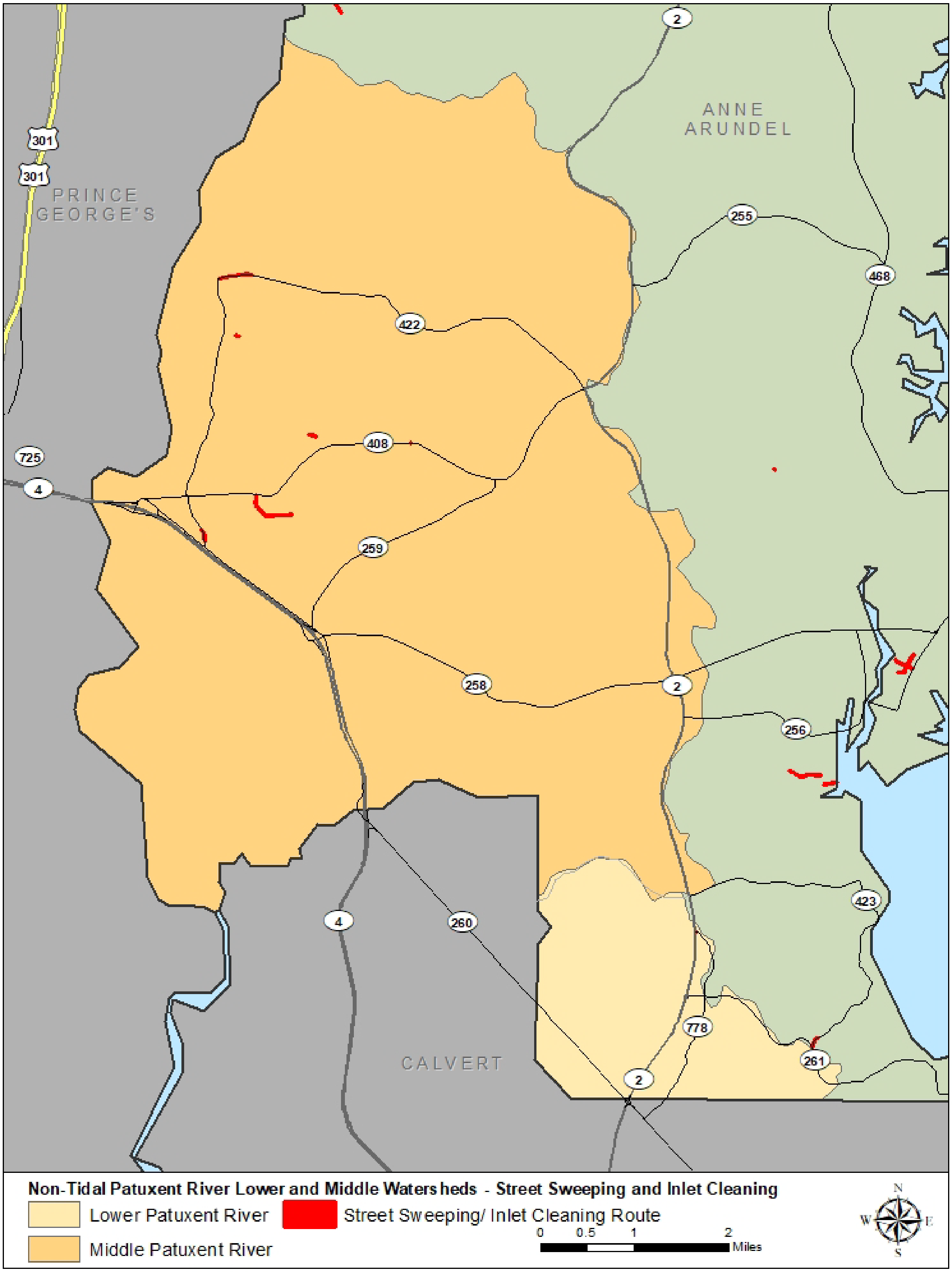

Figure 2: Street Sweeping Routes in the Non-Tidal Patuxent River Lower and Middle Watersheds

2 2020 Progress Summary

The following section summarizes the County's implementation efforts, the resulting load reductions achieved, and the costs of program implementation.

2.1 Implementation Results

Project implementation information extracted from CAST for the 2009 Progress Scenario used to develop Baseline loads is presented in Table 4. Implementation up through the end of FY2020 is detailed in Table 5 and Table 6. Information on completed projects and programs is gleaned primarily from the County's MS4 geodatabase. All 2020 implementation is included in the database. In 2018 the County completed a comprehensive record review of stormwater BMPs. The County's MS4 Geodatabase has been updated to incorporate the results of the review.

No restoration projects were completed during FY2020, however annual practices were continued.

Inlet Cleaning

One inlet was cleaned using storm drain vacuuming in the Lower Patuxent in FY2020, removing a total of 37 pounds (0.02 tons) of material. Three inlets were cleaned in the Middle Patuxent, removing a total of 5,335 pounds (2.67 tons) of material. Estimated cost per watershed was determine using the average cost per pound of material removed.

Street Sweeping

Building upon on the County's enhanced street sweeping program, 0.95 curb miles were swept in the watershed during FY2020. The total mass of material collected by the street sweeping program during the same time was 1.76 tons. Total mass reported for FY2020 is the average of annual mass removed for FY2016 through FY2020. It is noted that while average mass of material collected is presented here and in the following tables to demonstrate implementation levels, load reduction calculations are based on curb miles swept and frequency.

The total cost of the practices and programs implemented in FY2020 is $8,127.

Table 4: Baseline BMP Implementation

BMP	Unit	Lower Patuxent River 2009 Baseline	Middle Patuxent River 2009 Baseline
Structural Permanent Practices			
Bioretention	acre	0.0	1.79
Bioswale	acre	0.10	2.60
Dry Pond	acre	1.81	16.10
Dry Extended Detention Pond	acre	0.0	38.21
Filtering Practices	acre	3.47	29.95
Impervious Surface Reduction	acre	0.0	0.22
Infiltration Practices	acre	4.37	158.96
Runoff Reduction Performance Standard	acre	0.97	74.54

BMP	Unit	Lower Patuxent River 2009 Baseline	Middle Patuxent River 2009 Baseline
Stormwater Treatment Performance Standard	acre	34.41	314.52
Urban Tree Planting	acre	0.01	2.30
Wet Ponds and Wetlands	acre	0.0	336.56

Table 5: Current BMP Implementation through FY2020 for the Lower Patuxent Watershed

BMP	Unit	CY2010 - FY2019 Restoration[2]	FY2020 Restoration[2]	FY2020 Progress[3]	FY2020 Restoration Cost[4]
Structural Permanent Practices					
Bioretention	acre	0	0	0	
Dry Ponds	acre	0	0	0	
Extended Detention Dry Ponds	acre	0	0	0	
Impervious Surface Reduction	acre	0	0	0	
Infiltration	acre	0	0	0	
Stormwater Retrofits[1]	acre	0	0	0	
Vegetated Open Channels	acre	0	0	0	
Wet Ponds or Wetlands	acre	0	0	0	
Urban Stream Restoration	linear ft	0	0	0	
Outfall Enhancement with SPSC	acre	0	0	0	
Annual Practices					
Inlet Cleaning[5]	Inlets/yr	NA	1	1	$43
Street Sweeping[6]	lbs /yr	NA	35	35	$18
				Total FY2020 Cost	$61

Source: BWPR urban BMP, WQIP and MDE MS4 FY20 geodatabase

[1] Includes projects that convert dry ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds.

[2] Restoration completed in each specific period, i.e. CY2010-FY2019 and FY2020.

[3] Total cumulative restoration accounting for the full CY2010-FY2020 period.

[4] Cost of projects and programs for the FY2020 period only. Only costs using County funds are included.

[5] Number of inlets refers to the number of inlet cleaning records from the County's MS4 geodatabase.

[6] Value listed here is the lbs of material removed, not specifically the fine TSS sediment; FY2020 is the average of annual reported values for FY2016 through FY2020.

Table 6: Current BMP Implementation through FY2020 for the Middle Patuxent Watershed

BMP	Unit	CY2010 - FY2019 Restoration[2]	FY2020 Restoration[2]	FY2020 Progress[3]	FY2020 Restoration Cost[4]
Structural Permanent Practices					
Bioretention	acre	0	0	0	
Dry Ponds	acre	0	0	0	
Extended Detention Dry Ponds	acre	0	0	0	
Impervious Surface Reduction	acre	0.12	0	0.12	
Infiltration	acre	0	0	0	
Stormwater Retrofits[1]	acre	0	0	0	
Vegetated Open Channels	acre	0	0	0	
Wet Ponds or Wetlands	acre	0	0	0	
Urban Stream Restoration	linear ft	0	0	0	
Urban Tree Planting	acre	0.17	0	1.17	
Outfall Stabilization	linear ft	0	0	0	
Outfall Enhancement with SPSC	acre	0	0	0	
Annual Practices					
Inlet Cleaning[5]	Inlets/yr	NA	3	3	$6,243
Street Sweeping[6]	lbs /yr	NA	3,479	3,479	$1,823
				Total FY2020 Cost	$8,066

Source: BWPR urban BMP, WQIP and MDE MS4 FY20 geodatabase

[1] Includes projects that will convert dry ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds.

[2] Restoration completed in each specific period, i.e. CY2010-FY2019 and FY2020.

[3] Total cumulative restoration accounting for the full CY2010-FY2020 period.

[4] Cost of projects and programs for the FY2020 period only. Only costs using County funds are included.

[5] Number of inlets refers to the number of inlet cleaning records from the County's MS4 geodatabase.

[6] Value listed here is the lbs of material removed, not specifically the fine TSS sediment; FY2020 is the average of annual reported values for FY2016 through FY2020.

2.2 Load Reduction Results

The implementation summarized in Table 5 and Table 6 above resulted in the load reductions presented here in Table 7. Through FY2020, the County has achieved less than 0.1% reduction in TSS in both watersheds, with a goal of 61% reduction in Lower Patuxent River and 56% reduction in the Middle Patuxent River watershed.

Table 7: FY2020 Progress Reductions Achieved

Baseline Load and TMDL SW-WLA	Lower Patuxent River TSS-EOS lbs/yr	Middle Patuxent River TSS-EOS lbs/yr
2009 Baseline Scenario Load	1,708,554	12,426,617
Required Percent Reduction	61%	56%
Required Reduction	1,042,218	6,958,906
Local TMDL SW-WLA	666,336	5,467,712
2020 Results	**TSS-EOS lbs/yr**	**TSS-EOS lbs/yr**
Progress Scenario Load	1,708,529	12,422,636
Progress Reduction Achieved	25	3,982
Percent Reduction Achieved	>0.1%	>0.1%

3 Comparison of 2020 Progress and Planned Implementation

This section describes the current progress of both implementation and load reductions with comparison to the planned totals and progress that was expected by FY2020.

3.1 Implementation

Table 8 and Table 9 compares implementation of completed restoration BMPs through FY2020 (FY2020 Progress) with the total planned levels of implementation that were derived in the initial plan (Anne Arundel County, 2020) as well as with the planned restoration BMPs through FY2024 based on the County's MS4 geodatabase. It is noted that the Restoration Plan modeling methods differed slightly to methods used in this annual assessment, therefore the planned restoration BMPs identified to meet the TMDL goal may no longer be sufficient.

No restoration projects were completed during FY2020, however annual practices were continued. There are currently no planned projects in the County's MS4 geodatabase.

Estimates of inlet cleaning and street sweeping implementation in the development of the plan were based the pounds removed in the watershed in FY2018. Future levels of implementation are assumed to be similar. The plan then called for a level of treatment consistent with the progress rate of no inlets cleaned in Lower Patuxent and 2,833 pounds removed per year through inlet cleaning in the Middle Patuxent. Using the average rate of pounds removed per inlet in the watersheds, this translates to 2 inlets cleaned per year in the Middle Patuxent. The number cleaned in the current reporting period is 1 in the Lower Patuxent and 3 in the Middle Patuxent watershed. This level of inlet cleaning is removing more than the material estimated to be removed annually in the Restoration Plan.

According to the Restoration Plan, street sweeping is expected to remove 218 pounds of material per year in the Lower Patuxent and 21,445 pounds of material per year in the Middle Patuxent watershed. Using the average rate of pounds removed per mile swept, this translates to 0.06 miles swept in the Lower Patuxent and 5.8 miles swept in the Middle Patuxent watershed. The miles swept in the current reporting year is 17% of the prescribed rate in the Lower Patuxent and 16% in the Middle Patuxent watershed.

Table 8: Restoration BMP Implementation - Current FY2020 and Planned FY2024 Implementation Levels for the Lower Patuxent Watershed

BMP	Units	FY2020 Progress	Total Planned Restoration[1]	Total Planned – FY2024[2]	Percent Complete[3]
Bioretention	acre	0	0	0	NA
Dry Ponds	acre	0	0	0	NA
Extended Detention Dry Ponds	acre	0	0	0	NA
Impervious Surface Reduction	acre	0	0	0	NA
Infiltration	acre	0	0	0	NA
Stormwater Retrofits	acre	0	4.6	0	0%
Vegetated Open Channels	acre	0	0	0	NA
Wet Ponds or Wetlands	acre	0	0	0	NA
Urban Stream Restoration	linear feet	0	1,957	0	0%

BMP	Units	FY2020 Progress	Total Planned Restoration[1]	Total Planned – FY2024[2]	Percent Complete[3]
Outfall Enhancement with SPSC	acre	0	0	0	NA
Annual Practices					
Inlet Cleaning	inlets/yr	1	0	0	NA
Street Sweeping	curb-miles	0.01	0	0.06	17%

[1] Planned restoration totals used in 2020 Restoration Plan and CAST modeling.
[2] Planned restoration totals through FY2024 from County's current MS4 geodatabase and used in CAST modeling.
[3] Compares implementation progress through FY2020 to planned restoration totals through FY2024.

Table 9: Restoration BMP Implementation - Current FY2020 and Planned FY2024 Implementation Levels for the Middle Patuxent Watershed

BMP	Units	2020 Progress	Total Planned Restoration[1]	Total Planned – FY2024[2]	Percent Complete[3]
Bioretention	acre	0	0	0	NA
Dry Ponds	acre	0	0	0	NA
Extended Detention Dry Ponds	acre	0	0	0	NA
Impervious Surface Reduction	acre	0.12	0	0	NA
Infiltration	acre	0	0	0	NA
Stormwater Retrofits	acre	0	156.6	0	0%
Vegetated Open Channels	acre	0	0	0	NA
Wet Ponds or Wetlands	acre	0	0	0	NA
Urban Stream Restoration	linear feet	0	11,395	0	0%
Urban Tree Planting	acre	1.17	0	0	NA
Outfall Enhancement with SPSC	acre	0	0	0	NA
Annual Practices					
Inlet Cleaning	inlets/yr	3	2	2	>100%
Street Sweeping	curb-miles	0.9	5.8	5.8	16%

[1] Planned restoration totals used in 2020 Restoration Plan and CAST modeling.
[2] Planned restoration totals through FY2024 from County's current MS4 geodatabase and used in CAST modeling.
[3] Compares implementation progress through FY2020 to planned restoration totals through FY2024.

To track progress, the 2030 implementation milestone first reported in the 2020 plan was compared against the 2020 progress reported here in this assessment. Table 10 presents the strategies that are planned for the 2021-2030 milestone period with a comparison to the practices that were completed for 2020.

Table 10: Implementation Milestones Comparison

BMP	Unit	Lower Patuxent River		Middle Patuxent River	
		2020 Progress	2021 – 2030 Planned Restoration	2020 Progress	2021 – 2030 Planned Restoration
Impervious Surface Reduction	acre	0	0	0.1	0
Outfall Enhancement with SPSC	acre	0	0	0	0
Stormwater Retrofits	acre	0	0	0	0
Urban Stream Restoration	linear foot	0	0	0	0
Urban Tree Planting	acre	0	0	1.2	0
Annual Practices					
Inlet Cleaning	inlets/yr	1	0	3	2
Street Sweeping	curb-miles	0.01	0.06	0.9	5.8

3.2 Load Reductions

This section compares the required and planned sediment load reductions against the progress made through FY2020. Values given in Table 11 and Table 12 include the load reductions for each period (generally the milestone years) and the resulting load. Actual reductions are shown for 2020 and planned results are provided for the 2030 period. The planned reductions in this case refer to projects that are in the County's database and are moving forward with implementation, and does not refer to the total planned projects and reductions that were presented in the initial TMDL Restoration Plan. All values shown (reductions, loads, percent reduction) are the cumulative values, not the year over year changes.

Overall, the results indicate that on a TMDL allocated goal of 61% in the Lower Patuxent and 56% in the Middle Patuxent, the County has achieved a reduction of less than 0.1% in both watersheds. This level of progress is expected, however, since the Restoration Plan was finalized in January 2020 and this annual assessment reports BMP implementation through the end of June 2020.

There are currently no planned projects in the County's MS4 geodatabase, with the exception of planned inlet cleaning and street sweeping practices. The County is evaluating the potential for achieving additional load reductions in this watershed through the implementation of land conversion BMPs including: forest planting, conservation landscaping, impervious surface reduction, tree canopy plantings and forest conservation. Implementation of these and other strategies will be necessary to achieve the TMDL goal.

MDE is currently working on a new local TMDL modeling tool that will be available in the future to report progress toward load reductions. It is anticipated that this new spreadsheet model will be used for FY2021 modeling, so additional changes are anticipated to the baseline, permit, and progress loads and load reductions in the FY2021 report.

Table 11: Planning and Target Sediment Load Comparison (lbs/year) for the Lower Patuxent Watershed

Milestone Year	Actual Load Reduction	Actual Load	Actual % Reduction from Baseline	Planned Load Reduction	Planned Load	Planned % Reduction From Baseline
2009 Baseline	-	1,708,554	-	-	-	-
2020 Progress	25	1,708,529	>0.1%	-	-	-
2030 Allocated	-	-	-	1,042,218	666,336	61.0%
2030 Planned	-	-	-	25	1,708,529	>0.1%

Table 12: Planning and Target Sediment Load Comparison (lbs/year) for the Middle Patuxent Watershed

Milestone Year	Actual Load Reduction	Actual Load	Actual % Reduction from Baseline	Planned Load Reduction	Planned Load	Planned % Reduction From Baseline
2009 Baseline	-	12,426,617	-	-	-	-
2020 Progress	3,982	12,422,636	>0.1%	-	-	-
2030 Allocated	-	-	-	6,958,906	5,467,712	56.0%
2030 Planned	-	-	-	3,982	12,422,636	>0.1%

4 Monitoring

Official monitoring for Integrated Report assessments and impairment status is the responsibility of the State; however, the County has many on-going monitoring programs that can support the State's efforts. In addition, MDE has stressed specifically for sediment impairments the connection between in-stream biological health and meeting the intent of the sediment TMDL goals.

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

MDE then utilized its Biological Stressor Identification (BSID) process to identify the probable or most likely causes of poor biological conditions. For sediment specifically, the BSID identified 'altered hydrology and increased urban runoff have resulted in degradation to streambed morphology, streambed scouring, and subsequent elevated suspended transport through the watershed.' Overall, the results indicated inorganic pollutants (i.e. chlorides, acute ammonia, sulfate), and flow/sediment related stressors as the primary stressors causing impacts to biological communities.

Based on the results of the BSID (MDE, 2011b), MDE replaced the biological impairment listing with a listing for total suspended solids (TSS). The 2014 and 2018 final Integrated Reports lists 'Fish and Benthic IBIs' as the indicator, and 'Source Unknown' as the source. It is noted that the *Decision Methodology for Solids for the April 2002 Water Quality Inventory (updated in February of 2012)*[1], makes a specific distinction between two different, although related 'sediment' impairment types in free-flowing streams:

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

Since two types of sediment impairments are identified in the integrated reports, monitoring of both water clarity and sedimentation should be incorporated into monitoring programs to track changes in the watershed condition over time.

[1] http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/AM_Solids_2012.pdf

Anne Arundel County's Watershed Bureau of Protection and Restoration (BWPR) has several on-going monitoring programs that target measures of water clarity and sedimentation. These programs are described here.

4.1 Countywide Biological Monitoring

4.1.1 Background and Goals

Biological monitoring and assessment provide a direct measure of the ecological health of a stream. Stream organisms are continuous monitors of both short- and long-term water quality and other environmental factors and provide direct indicators of the quality of a stream. Advantages of using benthic macroinvertebrates include their generally restricted mobility and often multi-year life cycles, allowing them to integrate the effects of both chemical and physical perturbations over time. When hydrologic regimes of streams are altered, the physical nature of the habitat changes due to accelerated erosion and deposition of channel soils and other materials. This changes the capacity of a stream to support a healthy biota. Changes in the quality of the water resource are reflected as changes in the structural and functional attributes of the macroinvertebrate assemblage. Biological monitoring and assessment results can be used to detect impairment of the biological community and to assess the severity of impacts from both point source (PS) and nonpoint source (NPS) pollution. When coupled with information on chemical and physical stressors, these types of exposure and effect data can be used to improve water quality assessments. Over the past several decades, biological monitoring and assessment of aquatic communities along with characterization of their chemical and physical habitats have increased with application of these data to watershed management policies and practices.

Historically, many municipalities have been hampered in their ability to recommend and implement pollution control and remediation efforts because the chemical, physical, and biological condition of most of their water resources have not been adequately characterized. To expand its monitoring program, Anne Arundel County developed a stream monitoring program consisting of chemical, physical, and biological assessment techniques to document and track changes in the condition of stream resources County-wide. Problems resulting from chemical contamination and physical habitat alteration are reflected by changes in the aquatic biota. Therefore, inclusion of a biological monitoring component is providing Anne Arundel County with the relevant indicators for assessing the condition of, and managing, its water resources.

In 2004, a Countywide Biological Monitoring and Assessment Program for Anne Arundel County, Maryland was developed to assess the biological condition of the County's streams at multiple scales (i.e., site-specific, primary sampling unit (PSU), and countywide). Under the Countywide Biological Monitoring and Assessment program, biology (i.e., benthic macroinvertebrates) and stream habitat, as well as geomorphological and water quality parameters, are assessed at approximately 240 sites throughout the entire County over a 5-year period using a probabilistic, rotating-basin design.

Round 1 of the County's Biological Monitoring and Assessment Program occurred between 2004 and 2008, and Round 2 followed between 2009 and 2013. During 2017, Round 3 monitoring was initiated and fish sampling and additional water quality parameters were added. Field data collection in the Lower Patuxent and Middle Patuxent watersheds took place during 2020, with completion of the Round 3 scheduled for 2021. Annual reports and Round summary reports are available for review at: http://www.aacounty.org/departments/public-works/wprp/ecological-assessment-and-evaluation/biological-monitoring/biological-monitoring-reports/index.html

The primary goals of the program are to assess the current status of biological stream resources, establish a baseline for comparison with current and future assessments, and to relate them to specific programmatic activities. The County currently uses a combination of chemical sampling, geomorphic assessment, storm water sampling, and biological sampling to assist in its environmental management decision-making process. This combination of monitoring greatly assists the County in assessing progress toward achieving Stormwater Wasteload allocations set forth in TMDLs. The biological monitoring program's stated goals are applicable at three scales; Countywide, Watershed-wide, and Stream-specific, and include the following components.

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

4.1.2 Methods

Both field sampling and data analysis methods were developed for the program to be directly comparable to Department of Natural Resources' Maryland Biological Stream Survey (MBSS), and complementary to those in place in Prince George's, Montgomery, and Howard Counties in Maryland (Hill and Stribling, 2004). Primary data collected include site location (latitude and longitude), pH, dissolved oxygen, water temperature and conductivity, benthic macroinvertebrate index of biotic integrity (BIBI), and physical habitat index (PHI) following MBSS methodologies (Kazyak, 2001; DNR, 2007) and EPA's Rapid Bioassessment Protocol (EPA RBP). Biological data were analyzed using the revised (2005) version of the MBSS Coastal Plain BIBI (Southerland et al., 2005).

A more detailed description of the sampling and analysis methods can be found in the annual Biological Monitoring and Assessment Program Annual Reports (Crunkleton, et al., 2013; Crunkleton, et al., 2012; Crunkleton, et al., 2011; Crunkleton, et al., 2010; Victoria, et al., 2011). Specific information regarding the sampling and analysis methods, including the standard operating procedures (SOPs), can be found in the Documentation of Method Performance Characteristics for the Anne Arundel County Biological Monitoring Program (Hill et al., 2010) and the Quality Assurance Project Plan for Anne Arundel County Biological Monitoring and Assessment Program (Hill et al., 2011).

- The Lower Patuxent watershed is made up of one (1) PSU: Hall Creek. The Middle Patuxent watershed is made up of four (4) PSUs: Rock Branch, Ferry Branch, Cabin Branch, and Lyons Creek. Ten sampling sites were sampled in each of these PSUs during each round of sampling.

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

- Water Quality Measures and Observations
  - Turbidity (measured), observations of general water clarity and color
- Biological Measures
  - Benthic macroinvertebrates (BIBI)
- Habitat Measures
  - General: bar formation and substrate, presence/absence of substrate type
  - PHI: epibenthic substrate, instream habitat

  - RBP: epifaunal substrate / available cover, pool substrate characterization, sediment deposition, channel alteration
- Geomorphic Measures
  - Particle size analysis using modified Wolman pebble counts at 10 transects proportioned by channel bed features

4.1.3 Results

The Lower Patuxent watershed wholly overlaps with the Hall Creek PSU that was sampled in 2006 & 2012 and is scheduled to be monitored again in the County's rotating framework in 2021. The Middle Patuxent watershed contains four (4) individual PSUs that were sampled on a randomly-assigned rotating basis in Rounds 1 & 2. Only one (1) PSU, Rock Branch, has been sampled thus far in Round 3 in 2020. The remaining PSUs are scheduled to be monitored again in 2021. Results from Rounds 1, 2, and 3 are summarized at the PSU scale with mean BIBI and habitat ratings (PHI and RBP) and presented in Table 13.

Table 13: Countywide Biological Monitoring Results

Watershed	PSU Name	Round	PSU Code	Year Sampled	Drainage Area (acres)	BIBI Rating	PHI Rating	RBP Rating
Lower Patuxent	Hall Creek	1	24	2006	3,168	P	D	PS
Lower Patuxent	Hall Creek	2	24	2012	3,168	P	PD	PS
Middle Patuxent	Rock Branch	1	20	2008	6,131	P	PD	PS
Middle Patuxent	Rock Branch	2	20	2009	6,131	F	PD	PS
Middle Patuxent	Rock Branch	3	20	2020	6,131	P	PD	PS
Middle Patuxent	Ferry Branch	1	21	2004	8,038	F	MD	C
Middle Patuxent	Ferry Branch	2	21	2010	8,038	P	PD	PS
Middle Patuxent	Cabin Branch	1	23	2008	6,443	P	PD	PS
Middle Patuxent	Cabin Branch	2	23	2013	6,443	F	PD	PS
Middle Patuxent	Lyons Creek	1	22	2005	6,152	P	D	PS
Middle Patuxent	Lyons Creek	2	22	2013	6,152	F	PD	S

BIBI Ratings: G = Good, F = Fair, P = Poor, VP = Very Poor
PHI Ratings: MD = Minimally Degraded, PD = Partially Degraded, D = Degraded, SD = Severely Degraded
RBP Ratings: C = Comparable, S = Supporting, PS = Partially Supporting, NS = Non-Supporting

4.1.3.1 Biological

During Round 1, biological sampling was completed in 2004 (Ferry Branch), 2005 (Lyons Creek), 2006 (Hall Creek) and 2008 (Rock Branch and Cabin Branch). Results of the Round 1 sampling effort are presented in Table 14. BIBI narrative condition ratings for all three rounds of sampling are presented in Figure 3. Overall, 38% of the sites in the watershed were rated as "Poor," 34% rated "Fair," 20% rated "Very Poor," and 8% rated "Good." Ferry Branch received the highest average BIBI score of the five PSUs during Round 1, with a mean BIBI score of 3.20 ± 0.26 and a corresponding biological condition rating of "Fair." Cabin Branch received the lowest mean BIBI score if 2.31 ± 0.16 and a corresponding biological condition rating of "Poor."

During Round 2, biological sampling was completed in 2009 (Rock Branch), 2010 (Ferry Branch), 2012 (Hall Creek), and 2013 (Lyons Creek and Cabin Branch). Results of the Round 2 sampling effort are presented in Table 15. Overall, 44% of the sites in the watershed were rated as "Fair," 32% rated "Poor," 16% rated

"Very Poor", and 8% rated "Good." Cabin Branch received the highest average BIBI score during Round 2, with a mean BIBI score of 3.34 ± 0.25 and a corresponding biological condition rating of "Fair." The Hall Creek PSU received the lowest mean BIBI score of 2.20 ± 0.26.

In Round 3, biological sampling was completed in 2020 in Rock Branch at a total of 8 sites due to modifications in the study design for Round 3. Results of the Round 3 sampling effort are presented in Table 16. Sixty-three percent of the sites were rated as "Fair," 25% rated as "Very Poor," and 13% were rated as "Very Poor."

Table 14: BIBI Data for Round 1.

Site ID	Year	Number of Taxa	Number of EPT Taxa	Percent Ephemeroptera	No. of Ephemeroptera Taxa	Percent Intolerant Urban	Number Scraper Taxa	Percent Climbers	BIBI	Rating
21-01	2004	17	3	0.0	0	12.0	0	31.0	2.43	Poor
21-02	2004	22	5	0.0	0	13.5	2	25.8	3.57	Fair
21-03	2004	25	10	6.1	2	10.1	4	32.3	4.43	Good
21-04	2004	14	4	0.0	0	7.0	0	20.0	2.14	Poor
21-05	2004	19	4	0.0	0	20.0	2	25.0	3.00	Fair
21-06	2004	25	4	4.2	1	18.9	0	26.3	3.29	Fair
21-07	2004	24	6	15.3	1	17.1	0	35.1	3.86	Fair
21-08	2004	20	7	9.1	2	10.1	2	39.4	4.14	Good
21-09	2004	19	5	6.6	1	7.7	0	39.6	3.00	Fair
21-10	2004	17	2	0.0	0	4.5	1	3.6	2.14	Poor
22-01	2005	22	6	6.1	2	9.1	5	26.3	4.14	Good
22-02	2005	19	3	0.0	0	1.0	1	41.3	2.43	Poor
22-03	2005	12	0	0.0	0	1.0	0	24.0	1.57	Very Poor
22-04	2005	19	4	0.9	1	23.1	0	13.0	3.00	Fair
22-05	2005	17	4	0.0	0	8.2	1	16.3	2.43	Poor
22-06	2005	13	2	0.0	0	56.7	0	0.0	1.86	Very Poor
22-09	2005	19	3	0.0	0	30.5	1	9.5	3.00	Fair
22-11A	2005	23	3	2.9	1	1.9	3	16.5	3.57	Fair
22-16A	2005	17	2	0.0	0	9.0	1	8.0	2.43	Poor
22-17A	2005	18	4	3.8	1	7.7	3	26.0	3.29	Fair
24-02	2006	15	4	0.0	0	30.9	0	0.0	2.14	Poor
24-04	2006	20	3	0.0	0	14.9	0	0.9	1.86	Very Poor
24-05	2006	22	3	4.6	1	28.4	0	45.0	3.57	Fair
24-06	2006	28	6	0.0	0	9.3	0	3.7	2.43	Poor
24-07	2006	26	6	5.2	2	25.0	0	55.2	3.86	Fair
24-08	2006	26	2	0.0	0	13.0	0	2.6	2.43	Poor

Site ID	Year	Number of Taxa	Number of EPT Taxa	Percent Ephemeroptera	No. of Ephemeroptera Taxa	Percent Intolerant Urban	Number Scraper Taxa	Percent Climbers	BIBI	Rating
24-09	2006	34	5	0.9	1	10.9	0	34.5	3.57	Fair
24-10	2006	33	5	1.9	1	6.8	0	42.7	3.29	Fair
24-11A	2006	31	1	1.7	1	5.1	0	17.9	2.71	Poor
24-13A	2006	15	1	0.0	0	0.9	0	9.8	1.86	Very Poor
20-01	2008	12	3	0.0	0	71.6	0	0.0	1.86	Very Poor
20-02	2008	31	8	3.8	1	47.6	2	21.0	4.43	Good
20-03	2008	18	1	0.0	0	2.5	0	0.8	1.29	Very Poor
20-04	2008	15	1	0.0	0	43.6	0	0.0	1.86	Very Poor
20-05	2008	15	4	0.0	0	51.0	0	0.0	2.14	Poor
20-06	2008	41	6	2.0	2	22.0	0	3.0	3.57	Fair
20-07	2008	24	4	0.0	0	9.2	0	1.7	2.14	Poor
20-08	2008	17	3	0.0	0	10.9	0	13.9	2.43	Poor
20-10	2008	26	4	2.5	1	7.6	0	43.7	3.00	Fair
20-11A	2008	12	3	0.0	0	16.0	0	0.0	1.57	Very Poor
23-01	2008	22	6	0.0	0	12.4	0	10.5	3.00	Fair
23-02	2008	31	4	0.0	0	4.0	0	5.0	2.14	Poor
23-03	2008	14	1	0.0	0	4.9	0	4.9	1.57	Very Poor
23-04	2008	20	2	0.0	0	16.5	0	1.9	2.14	Poor
23-05	2008	19	5	0.0	0	9.9	0	2.0	2.14	Poor
23-06	2008	23	3	0.0	0	18.6	0	2.9	2.43	Poor
23-07	2008	20	2	0.0	0	4.0	0	1.0	1.86	Very Poor
23-09	2008	20	1	0.8	1	1.7	1	1.7	2.43	Poor
23-10	2008	26	0	0.0	0	9.3	0	9.3	2.14	Poor
23-13A	2008	38	3	1.0	1	8.7	1	20.4	3.29	Fair

Table 15: BIBI Data for Round 2.

Site ID	Year	Number of Taxa	Number of EPT Taxa	Percent Ephemeroptera	No. of Ephemeroptera Taxa	Percent Intolerant Urban	Number Scraper Taxa	Percent Climbers	BIBI	Rating
20-01	2009	24	1	0.0	0	17.2	0	41.9	2.43	Poor
20-03	2009	20	7	0.0	0	71.8	0	3.9	2.71	Poor
20-04	2009	31	8	6.3	1	24.1	1	14.3	3.86	Fair
20-07	2009	28	2	0.9	1	17.6	1	26.9	3.57	Fair
20-08	2009	24	6	0.0	0	7.8	0	12.1	2.71	Poor
20-11A	2009	37	12	9.6	3	22.1	0	15.4	3.86	Fair
20-12A	2009	22	2	0.0	0	5.9	0	33.9	2.43	Poor
20-13A	2009	24	4	0.0	0	6.8	0	23.7	2.43	Poor
20-14A	2009	31	10	4.6	3	15.7	1	25.0	4.14	Good
20-17A	2009	20	3	0.0	0	0.9	0	33.9	2.14	Poor
21-01	2010	33	3	0.0	0	21.8	4	16.4	3.29	Fair
21-03	2010	21	5	0.0	0	66.7	3	2.6	3.29	Fair
21-04	2010	20	3	0.0	0	38.5	3	3.8	3.00	Fair
21-05	2010	27	4	1.0	1	37.9	1	7.8	3.57	Fair
21-06	2010	21	1	0.9	1	41.7	2	0.9	3.00	Fair
21-07	2010	25	2	0.0	0	3.8	2	24.5	3.00	Fair
21-10	2010	13	1	0.9	1	40.4	4	0.0	2.71	Poor
21-13A	2010	24	3	0.0	0	4.7	2	44.9	3.00	Fair
21-14A	2010	11	3	0.0	0	10.0	1	4.2	2.14	Poor
21-15A	2010	21	1	0.0	0	2.7	1	22.7	2.14	Poor
24-03	2012	24	2	0	0	6.3	1	10.7	2.71	Poor
24-04	2012	12	2	0	0	25.3	1	0	1.86	Very Poor
24-05	2012	22	1	0	0	20	2	2.9	2.43	Poor
24-06	2012	13	1	0	0	6.3	0	34.2	1.57	Very Poor
24-08	2012	15	4	0.9	1	4.7	1	40.2	3	Fair
24-09	2012	19	4	1.9	2	1.9	4	15.5	3.57	Fair
24-10	2012	19	2	0.9	1	25.9	0	2.8	2.71	Poor
24-11A	2012	7	0	0	0	0.9	0	0.9	1	Very Poor
24-12A	2012	21	1	0	0	11	0	0	1.57	Very Poor
24-13A	2012	11	2	0	0	6.4	0	5.5	1.57	Very Poor
22-01	2013	15	3	41.5	1	15.3	1	0.0	3.00	Fair
22-02	2013	15	1	0.0	0	4.0	1	0.0	1.57	Very Poor
22-03	2013	9	0	0.0	0	46.6	0	3.4	1.86	Very Poor

Site ID	Year	Number of Taxa	Number of EPT Taxa	Percent Ephemeroptera	No. of Ephemeroptera Taxa	Percent Intolerant Urban	Number Scraper Taxa	Percent Climbers	BIBI	Rating
22-08	2013	20	5	12.1	3	8.4	2	1.9	3.86	Fair
22-09	2013	26	5	2.6	2	2.6	5	4.3	3.86	Fair
22-10	2013	20	2	29.1	2	19.4	3	5.8	3.86	Fair
22-12A	2013	14	2	0.0	0	23.8	1	0.0	2.14	Poor
22-19A	2013	26	6	1.0	1	24.5	1	3.9	3.57	Fair
22-21A	2013	19	6	35.5	3	10.0	3	5.5	4.14	Good
22-27A	2013	14	0	0.0	0	14.7	1	4.2	2.14	Poor
23-01	2013	29	7	9.9	2	53.5	3	6.9	4.43	Good
23-03	2013	24	4	6.5	2	14.1	2	10.9	4.14	Good
23-04	2013	21	4	0.0	0	39.4	1	1.0	2.71	Poor
23-05	2013	28	2	7.3	2	8.5	2	19.5	3.86	Fair
23-06	2013	25	4	0.0	0	30.7	4	5.9	3.29	Fair
23-07	2013	16	2	0.0	0	12.1	2	0.0	2.43	Poor
23-08	2013	19	4	22.8	1	30.4	3	6.5	3.86	Fair
23-09	2013	13	1	0.0	0	37.0	1	0.9	1.86	Very Poor
23-10	2013	26	7	0.0	0	19.2	2	3.3	3.29	Fair
23-12A	2013	25	1	3.1	1	12.5	3	13.5	3.57	Fair

Table 16: BIBI Data for Round 3.

Site ID	Year	Number of Taxa	Number of EPT Taxa	Percent Ephemeroptera	No. of Ephemeroptera Taxa	Percent Intolerant Urban	Number Scraper Taxa	Percent Climbers	BIBI	Rating
20-L1M-04	2020	23	3	5.4	2	7.1	4	12.5	3.86	Fair
20-L1M-08	2020	26	2	1.0	1	2.0	2	21.8	3.57	Fair
20-L2M-01	2020	15	2	0.0	0	0.0	1	47.7	2.43	Poor
20-L2M-03	2020	27	2	0.0	0	1.9	2	20.4	3.00	Fair
20-R3M-03	2020	19	1	0.0	0	0.9	1	19.8	2.14	Poor
20-R3M-06	2020	24	2	0.0	0	29.6	1	4.6	3.00	Fair
20-R3M-09	2020	24	2	0.0	0	20.0	2	8.2	3.29	Fair
20-R3M-10	2020	15	0	0.0	0	25.9	0	4.5	1.86	Very Poor

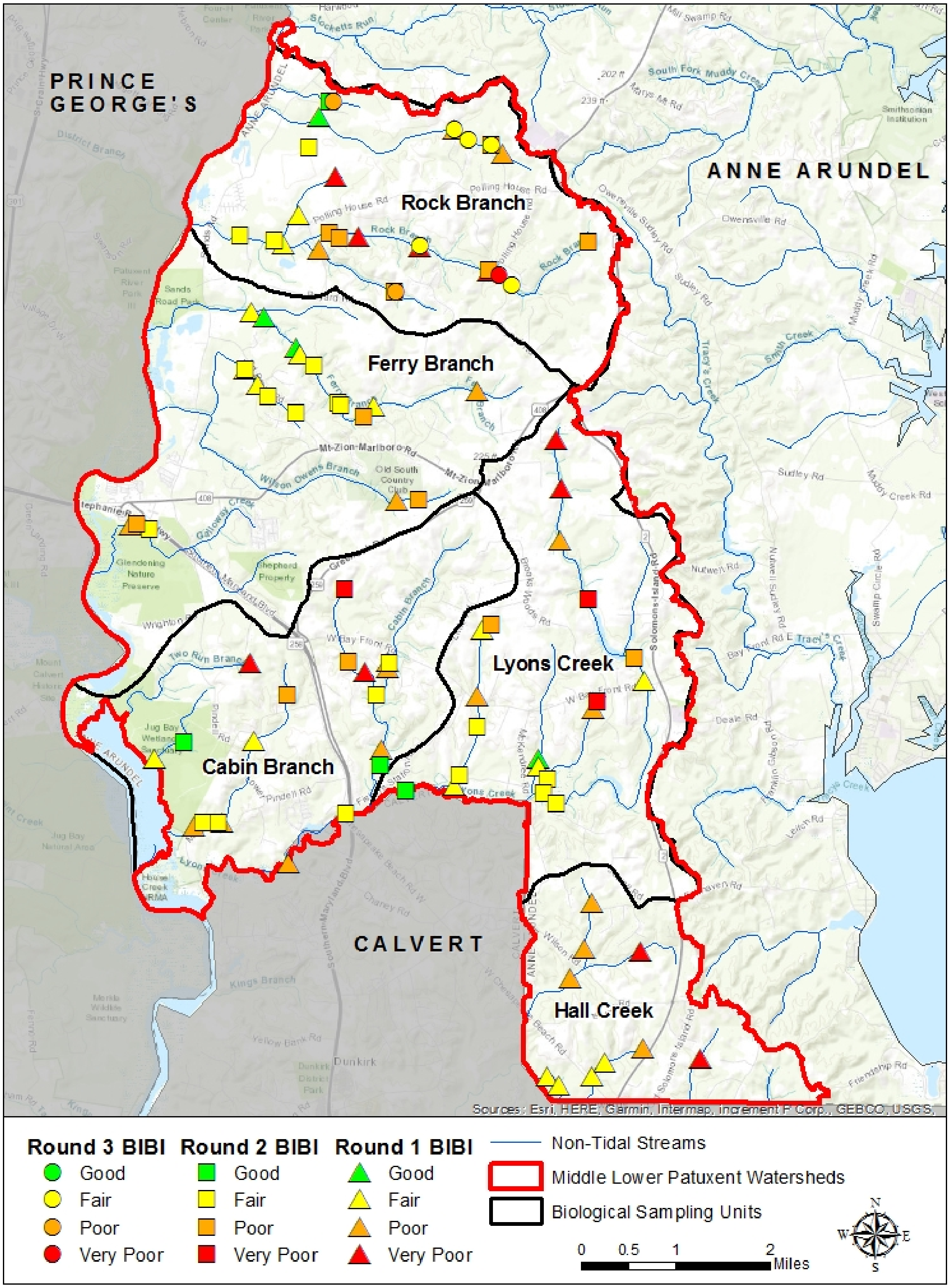

Figure 3: Biological Sampling Results from 2004 – 2020.

4.1.3.2 Physical Habitat

Physical habitat assessments during Round 1 were performed concurrently with the biological assessments during the spring index period. Results of the Round 1 sampling are presented in Table 17 and Figure 4. The PHI rated 42% of sites "Partially Degraded," 32% as "Degraded," 18% as "Minimally Degraded, 4% as "Severely Degraded," and 4% as unrated. Ferry Branch received the highest average PHI score of the five PSUs during Round 1, with a mean score of 86.72 ± 1.77 and a corresponding narrative rating of "Minimally Degraded." Lyons Creek received the lowest mean PHI score of 62.31 ± 3.81 and a corresponding rating of "Degraded."

In Round 2, the majority of sites were rated as either "Partially Degraded" (60%) or "Degraded" (30%), with the remaining sites rated "Minimally Degraded (6%) and "Severely Degraded (4%)." Site specific results of the Round 2 sampling are presented in Table 18. Cabin Branch received the highest average PHI score of the five PSUs during Round 1, with a mean score of 72.41 ± 3.20 and a corresponding narrative rating of "Partially Degraded." Hall Creek received the lowest mean PHI score of 68.17 ± 3.20 and a corresponding rating of "Partially Degraded."

In Round 3, physical habitat assessments were completed in 2020 in Rock Branch. Results of the Round 3 sampling effort are presented in Table 19. Fifty percent of the sites were rated as "Partially Degraded," 25% rated as "Degraded," and 13% were rated as "Minimally Degraded."

Table 17: Physical Habitat Index Data from Round 1.

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	#Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
21-01	2004	37.70	91.34	90.48	97.14	71.95	67.08	75.95	Partially Degraded
21-02	2004	80.78	99.94	100.00	100.00	81.51	80.63	90.47	Minimally Degraded
21-03	2004	100.00	99.94	100.00	85.57	64.63	83.67	88.97	Minimally Degraded
21-04	2004	100.00	91.34	93.75	98.70	58.66	67.08	84.92	Minimally Degraded
21-05	2004	59.24	99.94	100.00	100.00	82.48	97.47	89.85	Minimally Degraded
21-06	2004	91.55	91.34	89.46	88.38	52.95	74.16	81.31	Minimally Degraded
21-07	2004	100.00	100.00	87.68	96.68	88.31	83.67	92.72	Minimally Degraded
21-08	2004	100.00	78.67	100.00	100.00	69.90	92.20	90.13	Minimally Degraded
21-09	2004	96.93	84.56	100.00	100.00	77.19	92.20	91.81	Minimally Degraded
21-10	2004	26.93	100.00	80.15	92.01	92.46	94.87	81.07	Minimally Degraded
22-01	2005	66.96	58.94	62.01	72.27	83.56	79.58	70.55	Partially Degraded
22-02	2005	100.00	68.32	28.71	48.95	55.47	70.71	62.03	Degraded
22-03	2005	100.00	91.34	20.49	26.54	49.54	82.16	61.68	Degraded
22-04	2005	79.24	68.32	67.30	56.42	88.06	91.29	75.10	Partially Degraded
22-05	2005	39.70	91.34	49.08	34.94	82.50	74.16	61.96	Degraded
22-06	2005	10.15	73.32	43.49	77.71	92.99	100.00	66.28	Partially Degraded
22-09	2005	39.70	0.00	5.29	6.25	56.90	79.58	31.29	Severely Degraded

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	#Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
22-11A	2005	63.17	49.95	38.57	71.95	77.29	83.67	64.10	Degraded
22-16A	2005	67.57	99.94	48.29	65.04	82.36	65.19	71.40	Partially Degraded
22-17A	2005	70.53	91.34	35.83	45.46	54.79	54.32	58.71	Degraded
24-02	2006	75.39	99.94	57.99	50.92	73.11	31.62	64.83	Degraded
24-04	2006	64.62	36.34	77.09	77.71	74.78	77.46	68.00	Partially Degraded
24-05	2006	80.78	100.00	81.50	64.41	60.51	70.71	76.32	Partially Degraded
24-06	2006	59.24	99.94	57.14	57.10	70.40	70.71	69.09	Partially Degraded
24-07	2006	43.08	99.94	81.10	69.34	56.87	63.25	68.93	Partially Degraded
24-08	2006	53.85	58.94	39.25	30.60	50.63	70.71	50.66	Severely Degraded
24-09	2006	91.55	68.32	48.91	57.24	51.93	63.25	63.53	Degraded
24-10	2006	86.16	91.34	89.82	79.82	70.10	54.77	78.67	Partially Degraded
24-11A	2006	75.39	99.94	68.71	64.18	90.51	63.25	76.99	Partially Degraded
24-13A	2006	53.85	84.56	48.94	40.27	61.55	44.72	55.65	Degraded
20-01	2008	75.39	100.00	76.41	75.03	77.08	67.08	78.50	Partially Degraded
20-02	2008	43.08	99.94	44.87	74.69	59.17	63.25	64.17	Degraded
20-03	2008	43.08	100.00	49.15	67.99	100.00	77.46	72.95	Partially Degraded
20-04	2008	59.24	99.94	42.61	81.88	100.00	59.16	73.80	Partially Degraded
20-05	2008	32.31	84.56	38.20	76.93	70.74	50.00	58.79	Degraded
20-06	2008	43.08	100.00	42.57	72.69	87.20	59.16	67.45	Partially Degraded
20-07	2008	26.93	91.34	53.11	80.13	89.51	70.71	68.62	Partially Degraded
20-08	2008	10.77	100.00	46.03	57.91	77.21	63.25	59.20	Degraded
20-10	2008	53.85	100.00	73.65	81.79	51.57	77.46	73.05	Partially Degraded
20-11A	2008	10.77	100.00	55.65	73.01	85.04	44.72	61.53	Degraded
23-01	2008	48.47	91.34	66.40	86.68	--	67.08	--	N/A
23-02	2008	32.31	100.00	28.97	65.99	67.75	70.71	60.95	Degraded
23-03	2008	43.08	68.32	51.41	79.42	--	74.16	--	N/A
23-04	2008	26.93	84.56	44.22	68.12	81.71	74.16	63.28	Degraded
23-05	2008	43.08	84.56	44.22	73.68	61.01	67.08	62.27	Degraded
23-06	2008	43.08	100.00	64.61	89.42	92.78	74.16	77.34	Partially Degraded
23-07	2008	43.08	100.00	49.33	70.25	100.00	67.08	71.63	Partially Degraded
23-09	2008	53.85	84.56	58.05	79.12	63.64	70.71	68.32	Partially Degraded
23-10	2008	75.39	21.22	30.56	74.41	55.02	94.87	58.58	Degraded
23-13A	2008	75.39	99.94	34.06	57.35	61.80	94.87	70.57	Partially Degraded

Table 18: Physical Habitat Index Data from Round 2.

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	#Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
20-01	2009	43.08	100.00	57.38	88.81	89.80	80.63	76.62	Partially Degraded
20-03	2009	26.93	100.00	42.60	76.31	85.52	31.62	60.50	Degraded
20-04	2009	100.00	84.56	84.09	79.94	43.61	80.63	78.80	Partially Degraded
20-07	2009	37.70	78.67	57.71	83.77	81.49	67.08	67.74	Partially Degraded
20-08	2009	16.16	15.33	40.10	61.65	59.76	83.67	46.11	Severely Degraded
20-11A	2009	70.01	100.00	61.41	75.27	56.42	74.16	72.88	Partially Degraded
20-12A	2009	70.01	100.00	45.43	58.56	87.48	31.62	65.52	Degraded
20-13A	2009	70.01	100.00	66.61	79.14	100.00	74.16	81.65	Minimally Degraded
20-14A	2009	26.93	100.00	57.96	100.00	81.93	74.16	73.50	Partially Degraded
20-17A	2009	86.16	100.00	39.22	65.46	82.61	54.77	71.37	Partially Degraded
21-01	2010	86.16	99.94	76.27	69.26	62.05	67.08	76.79	Partially Degraded
21-03	2010	32.31	91.34	76.80	78.86	91.51	80.63	75.24	Partially Degraded
21-04	2010	37.70	99.94	69.15	66.84	69.34	50.00	65.49	Degraded
21-05	2010	53.85	99.94	67.62	64.44	87.39	70.71	73.99	Partially Degraded
21-06	2010	26.93	0.00	52.32	49.53	70.90	70.71	45.06	Severely Degraded
21-07	2010	86.16	99.94	65.27	64.69	60.17	67.08	73.88	Partially Degraded
21-10	2010	26.93	91.34	63.87	60.52	64.87	59.16	61.11	Degraded
21-13A	2010	91.55	99.94	65.29	64.72	86.83	67.08	79.23	Partially Degraded
21-14A	2010	37.70	99.94	58.50	57.27	73.99	63.25	65.11	Degraded
21-15A	2010	75.39	91.34	66.20	60.60	61.78	67.08	70.40	Partially Degraded
24-03	2012	64.62	78.67	58.91	54.34	82.36	80.63	69.92	Partially Degraded
24-04	2012	80.78	91.34	56.28	57.36	100	70.71	76.08	Partially Degraded
24-05	2012	59.24	99.94	69.29	72.61	81.42	74.16	76.11	Partially Degraded
24-06	2012	86.16	100	52.87	53.97	96.75	80.63	78.4	Partially Degraded
24-08	2012	86.16	99.94	64.67	59.8	82.26	74.16	77.83	Partially Degraded
24-09	2012	5.39	99.94	55.1	55.86	68.59	67.08	58.66	Degraded
24-10	2012	96.93	8.55	74.19	69.58	68.53	0	52.96	Degraded
24-11A	2012	53.85	91.34	61.94	64.65	61	0	55.46	Degraded
24-12A	2012	59.24	99.94	63.36	66.87	75.3	89.45	75.69	Partially Degraded
24-13A	2012	59.24	100	53.87	49.99	68.9	31.62	60.6	Degraded
22-01	2013	64.62	73.32	78.32	68.90	88.05	70.71	73.99	Partially Degraded
22-02	2013	53.85	91.34	73.42	79.10	94.52	67.08	76.55	Partially Degraded
22-03	2013	59.24	91.34	72.48	72.44	80.35	100.00	79.31	Partially Degraded
22-08	2013	86.16	84.56	78.45	70.72	90.72	44.72	75.89	Partially Degraded

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	#Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
22-09	2013	53.85	68.32	61.96	55.55	71.65	44.72	59.34	Degraded
22-10	2013	64.62	68.32	72.46	63.27	70.21	67.08	67.66	Partially Degraded
22-12A	2013	70.01	73.32	66.66	72.05	81.03	77.46	73.42	Partially Degraded
22-19A	2013	86.16	73.32	76.23	76.36	79.21	63.25	75.76	Partially Degraded
22-21A	2013	75.39	91.34	80.20	68.29	66.44	44.72	71.07	Partially Degraded
22-27A	2013	70.01	26.57	75.59	68.20	57.91	94.87	65.52	Degraded
23-01	2013	100.00	100.00	96.46	86.30	89.99	83.67	92.74	Minimally Degraded
23-03	2013	75.39	91.34	81.32	68.07	75.52	63.25	75.82	Partially Degraded
23-04	2013	53.85	99.94	55.25	55.74	81.40	44.72	65.15	Degraded
23-05	2013	59.24	91.34	64.45	61.43	80.67	89.45	74.43	Partially Degraded
23-06	2013	53.85	84.56	79.29	74.01	85.05	44.72	70.25	Partially Degraded
23-07	2013	48.47	99.94	52.04	52.67	53.89	31.62	56.44	Degraded
23-08	2013	70.01	91.34	93.68	83.90	72.10	77.46	81.41	Minimally Degraded
23-09	2013	59.24	99.94	65.99	57.94	81.10	31.62	65.97	Degraded
23-10	2013	75.39	78.67	82.71	75.81	80.90	63.25	76.12	Partially Degraded
23-12A	2013	26.93	91.34	60.40	59.00	62.31	94.87	65.81	Degraded

Table 19: Physical Habitat Index Data from Round 3.

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	#Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
20-L1M-04	2020	82.45	84.56	70.65	75.11	100.00	76.81	81.60	Minimally Degraded
20-L1M-08	2020	44.33	99.94	58.56	59.33	100.00	53.85	69.34	Partially Degraded
20-L2M-01	2020	50.84	91.34	51.23	54.97	86.24	41.63	62.71	Degraded
20-L2M-03	2020	45.09	99.94	85.87	93.46	100.00	83.37	84.62	Minimally Degraded
20-R3M-03	2020	3.31	84.56	70.46	85.54	86.41	69.28	66.59	Partially Degraded
20-R3M-06	2020	49.00	78.67	86.58	87.43	90.57	71.88	77.36	Partially Degraded
20-R3M-09	2020	54.78	91.34	71.05	66.25	100.00	52.44	72.64	Partially Degraded
20-R3M-10	2020	23.05	91.34	51.64	48.46	66.77	54.77	56.01	Degraded

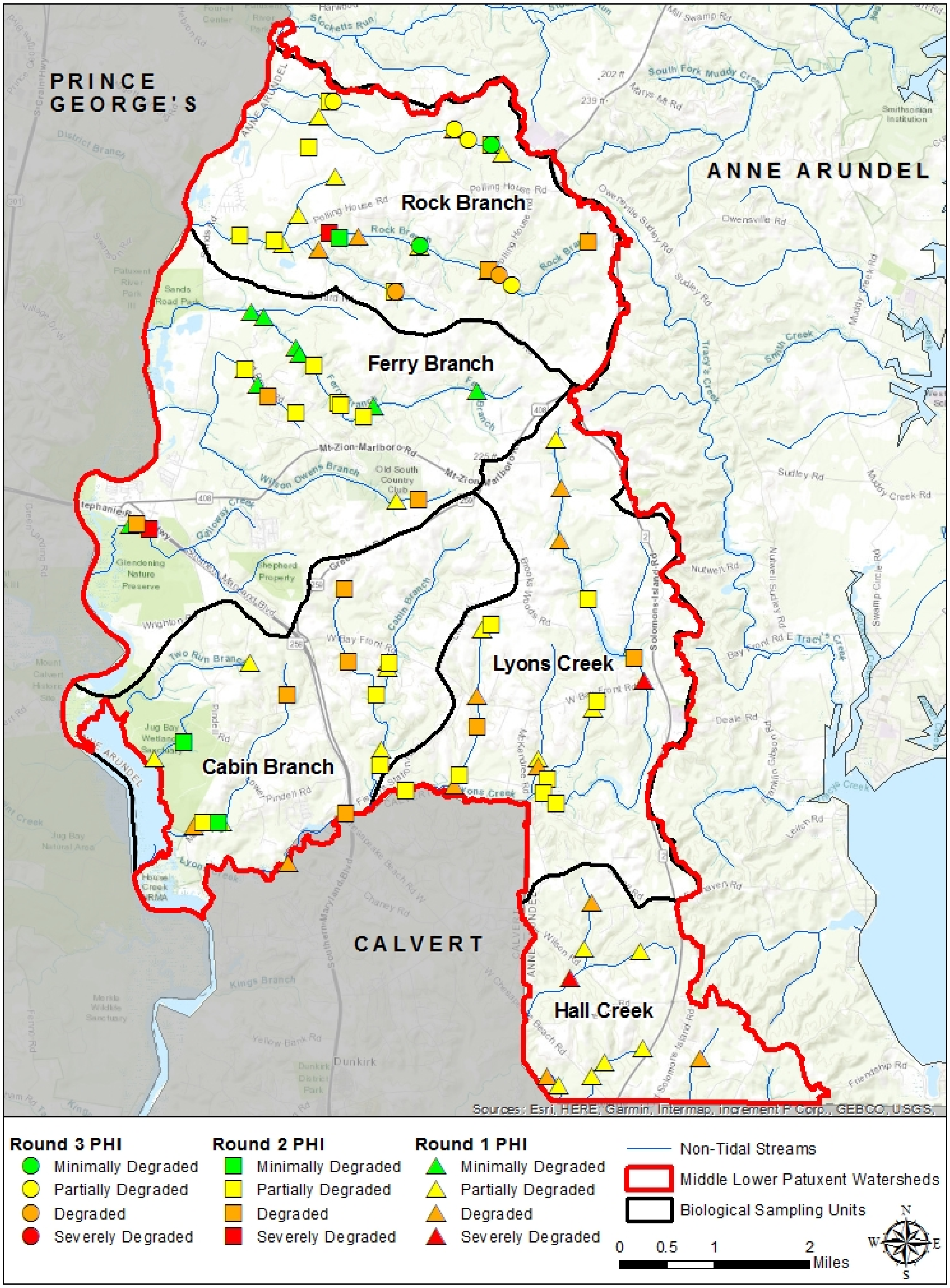

Figure 4: Physical Habitat Assessment Results from 2004 – 2020.

4.1.4 Conclusions

At the completion of Round 2, analyses were performed to compare statistical differences between mean index values (i.e., BIBI, PHI) from two time periods (e.g., Round 1 and Round 2) to determine if any changes in PSU scores were statistically significant. The report authors used the method recommended by Schenker and Gentleman (2001), which is the same method used by the MBSS to evaluate changes in condition over time, and is considered a more robust test than the commonly used method, which examines the overlap between the associated confidence intervals around two means (Hill et. al, 2014). Only one PSU, Cabin Branch, displayed a statistically significant increase in mean BIBI scores between Rounds 1 and 2, using a 95% confidence interval. These results suggest there has not been a measurable increase in the average BIBI condition across the Lower and Middle Patuxent watersheds from Round 1 to Round 2. However, future sampling efforts in Round 3 of the program will be able to better detect trends in biological condition over time due to a number of fixed (i.e., repeat) sites that have been incorporated into the sampling design.

4.2 Targeted Biological Monitoring Program

In addition to the Countywide Program, the County implements a targeted biological monitoring program. This program utilizes the same techniques and procedures as use in the Countywide Program, but the sites are not randomly selected. There are two general approaches to site selection in the targeted work. First, the County samples a collection of long term sites every year, the number of which has varied over the years. Currently, there are 34 sites in the program, 18 of which are past or proposed stream restoration sites that the County tracks to see how the stream insect community has changed, or will change, over time while one site is a minimally disturbed stream reach that is used as a reference reach. Most of the sites in this group have only been monitored post-restoration. Another 15 sites are allocated to the Sawmill Creek Project (SCP) with the purpose of tracking changes in the aquatic biological integrity, as well as several abiotic factors, in Sawmill Creek and its tributaries over a period of five years (2017-2021). The goal of this project is to ascertain which factor, or combination of factors, are contributing to the watershed's unexpected biological integrity.

A more detailed description of the Targeted Biomonitoring Program, including the latest published summary report can be found here:
https://www.aacounty.org/departments/public-works/wprp/targeted%20biomonitoring/index.html
and here:
https://www.aacounty.org/departments/public-works/wprp/ecological-assessment-and-evaluation/2016%20Targeted%20Site%20Summary%20Report_Final.pdf

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.

5 Conclusion

This Lower and Middle Patuxent River TMDL Annual Assessment report documents the progress achieved through the end of FY2020. The assessment includes a report on the project and program implementation completed in the current report year and cumulatively through FY2020. The report summarizes the modeled and calculated pollutant load reductions and loads achieved through the implemented programs. Further, the report compares the implementation levels and load reductions against the overall goals, specifically the SW-WLA, and the planned milestone targets as outline in the 2020 plan (Anne Arundel County, 2020).

Anne Arundel County spent $8,127 in FY2020 in capital and operational costs in the Lower and Middle Patuxent watersheds. With those funds, the County is implementing programmatic practices including inlet cleaning and street sweeping. While load reductions are less than 0.1% in both watersheds, on a total goal of 61% in the Lower Patuxent and 56% in the Middle Patuxent, the Restoration Plan was only just completed in January 2020 and this assessment report documents implementation through the end of June 2020. The County will need to implement additional projects to meet the goal of the TMDL before the 2030 end date. Biological stream monitoring data thus far with two rounds completed and a third under way indicates a watershed that is in fair to poor biological health. Four of the five PSUs that comprise the Lower and Middle Patuxent watersheds are scheduled to be monitored again in the County's rotating framework in 2021, which will provide a check on overall biological condition trends at the completion of Round 3.

MDE is currently working on a new local TMDL modeling tool that will be available in the future to report progress toward load reductions. It is anticipated that this new spreadsheet model will be used for FY2021 modeling, so additional changes are anticipated to the baseline, permit, and progress loads and load reductions in the FY2021 report.

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