PATAPSCO LOWER NORTH BRANCH

2017 SEDIMENT TMDL ANNUAL ASSESSMENT REPORT

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Prepared For

Anne Arundel County
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List of Acronyms

BayFAST	Chesapeake Bay Facility Assessment Scenario Tool
BMP	Best Management Practices
BSID	Biological Stressor Identification
CBP	Chesapeake Bay Program
CIP	Capital Improvement Program
EOS	Edge of Stream
MDE	Maryland Department of the Environment
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
SPSC	Step Pool Storm Conveyance
SW to MEP	Stormwater to the Maximum Extent Practicable
SW-WLA	Stormwater Waste Load Allocation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
EPA	United States Environmental Protection Agency
WLA	Wasteload Allocation
WPRP	Watershed Protection and Restoration and Program

1 Introduction

1.1 Background

The Anne Arundel County Department of Public Works (DPW) Watershed Protection and Restoration Program (WPRP) 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, 2011). 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.

There are currently two final approved TMDLs within the Patapsco River Lower North Branch (Patapsco LNB); a bacteria TMDL approved in 2009, and a sediment TMDL approved in 2011. These TMDLs apply to several jurisdictions including Baltimore City and Baltimore, Carroll, Howard, and Anne Arundel Counties. Anne Arundel County WPRP developed a TMDL restoration plan, drafted in 2015 and finalized in November of 2016 (Anne Arundel County, 2016) after review and comment from MDE and the general public. The plan specifically addresses the Patapsco LNB sediment TMDL under the responsibility of Anne Arundel County. The bacteria TMDL is addressed by Anne Arundel County in a separate plan.

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

Anne Arundel County's current MS4 permit (11-DP-3316, MD0068306) issued in its final form by the MDE in February of 2014 required development of restoration plans for each stormwater 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 progress with implementation, pollutant load reductions, and program costs (permit section (IV.E.4). The *Patapsco River Lower North Branch Sediment TMDL Restoration Plan* (the plan) (Anne Arundel County, 2016) satisfied the permit planning requirement and this *2017 Patapsco River Lower North Branch Sediment TMDL Annual Assessment Report* satisfies the progress documentation requirement.

1.2 Watershed Description

The Patapsco LNB is one of 12 major watersheds in Anne Arundel County, Maryland, and is situated in the northwestern portion of the County (Figure 1**Figure 1**). The watershed shares political boundaries with Howard County along Deep Run and Baltimore County along the mainstem of the Patapsco River. The most downstream extent of the watershed borders Baltimore City. The Patapsco LNB watershed is a part of the Chesapeake Bay watershed with the Patapsco River mainstem discharging to the tidal portions of the Patapsco River in Baltimore City before entering the Chesapeake Bay.

The Patapsco LNB watershed is approximately 15,270 acres (23.9 square miles) in area and contains approximately 96 miles of streams. The watershed includes several named streams including Stoney Run, Piney Run, Deep Run, Holly Creek, and the mainstem of the Patapsco River.

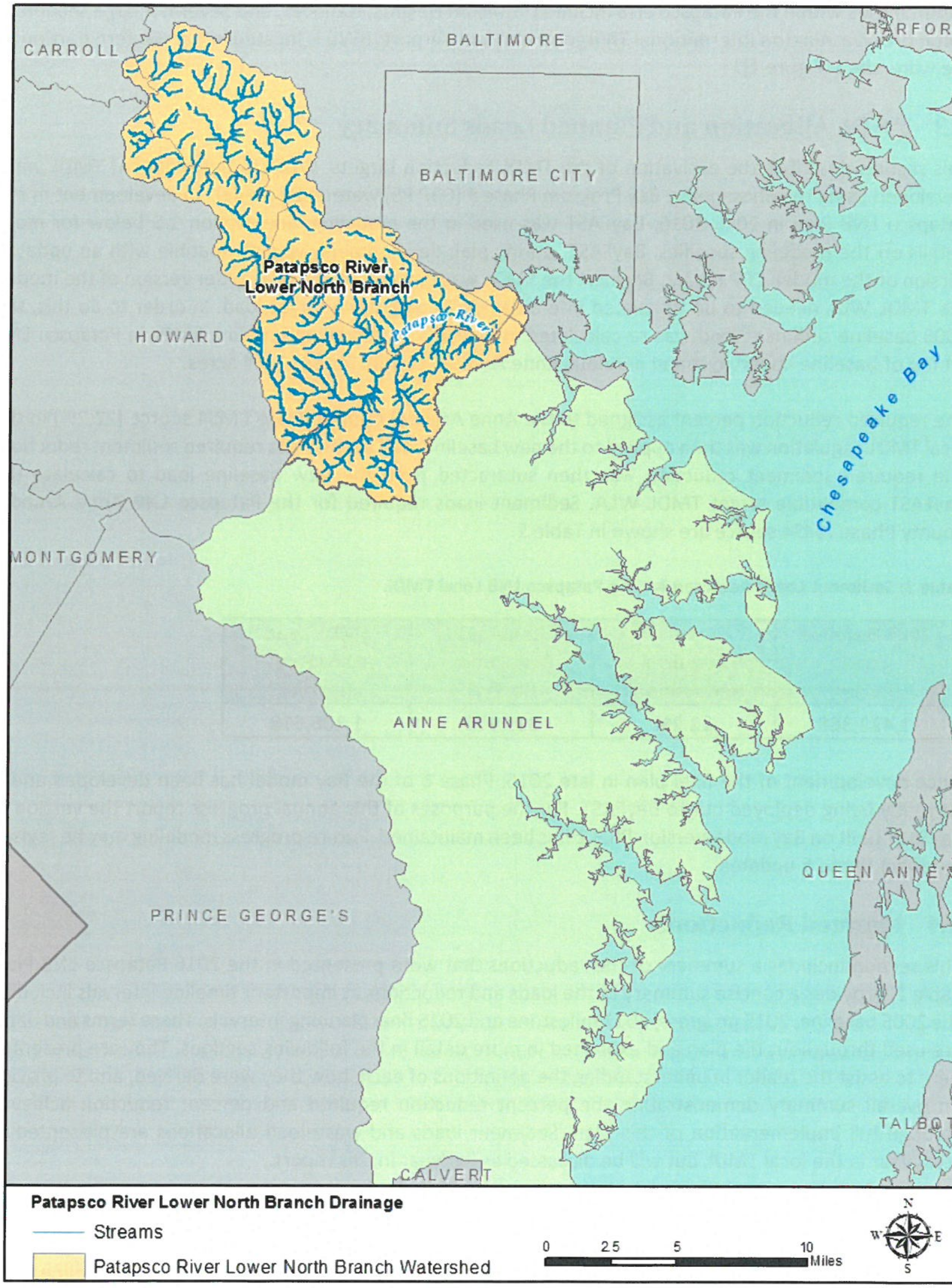

Figure 1: Watershed Location Map

Communities within the Patapsco LNB include Linthicum Heights, Hanover, and Severn. A large section of Baltimore-Washington International Thurgood Marshall Airport (BWI) is located in the western portion of the watershed (Figure 1).

1.3 TMDL Allocation and Planned Loads Summary

This section describes the derivation of the TMDL reduction targets. WLAs in the sediment TMDL were developed using the Chesapeake Bay Program Phase 5 (CBP P5) watershed model. In development of the Patapsco LNB Plan in 2015-2016, BayFAST was used in the modeling. See section 1.5 below for more details on the modeling specifics. BayFAST, during plan development, was compatible with an updated version of the model: CBP P5.3.2. Because the TMDL was developed under an older version of the model, the TMDL WLA needed to be translated into a BayFAST-compatible target load. In order to do this, the 2005 baseline sediment load was re-calculated in BayFAST by modeling baseline BMPs in Patapsco LNB on top of baseline impervious and pervious Anne Arundel County Phase I MS4 acres.

The required reduction percent assigned to the Anne Arundel County Phase I MS4 source (22.2%) in the local TMDL regulation was then applied to the new baseline load to calculate required sediment reduction. The required sediment reduction was then subtracted from the new baseline load to calculate the BayFAST-compatible target TMDL WLA. Sediment loads required for the Patapsco LNB Anne Arundel County Phase I MS4 source are shown in Table 1.

Table 1: Sediment Loads Required for the Patapsco LNB Local TMDL

2005 Baseline Load (lbs/yr)	Required Reduction %	Required Reductions (lbs/yr)	TMDL Load Allocation (lbs/yr)
1,422,388	22.2%	315,770	1,106,618

Since development of the final plan in late 2016, Phase 6 of the Bay model has been developed and is currently being deployed out to BayFAST. For the purposes of this annual progress report the version of BayFAST built on Bay model version P5.3.2 has been maintained. Future progress modeling may be revised to reflect Phase 6 updates.

1.4 Planned Reductions

This section includes a summary of the reductions that were presented in the 2016 Patapsco LNB Plan. Table 2, provides a concise summary of the loads and reductions at important timeline intervals including the 2005 baseline, 2015 progress, 2017 milestone and 2025 final planning intervals. These terms and dates are used throughout the plan and explained in more detail in the following sections. They are presented here to assist the reader in understanding the definitions of each, how they were derived, and to provide an overall summary demonstrating the percent reduction required and percent reduction achieved through full implementation of this plan. Sediment loads and wasteload allocations are presented as tons/year in the local TMDL but will be discussed as lbs/year in this report.

- **2005 Baseline Loads**: Baseline levels (i.e., land use loads with baseline BMPs) from 2005 conditions in the Lower Patuxent watershed using the Chesapeake Bay Facility Assessment Scenario Tool (BayFAST) Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) model. Baseline loads were used to calculate the stormwater allocated sediment loads, or SW-WLA.

- **2015 Progress Loads and Reductions**: Progress loads and load reductions achieved from stormwater best management practice (BMP) implementation through 2015. The 2015 Progress Loads are calculated from the 2005 Baseline Loads by the following calculations: 2005 Baseline – 2015 Progress Reduction.
- **2017 Interim Milestone Goal Planned Loads and Reductions**: Planned 2017 loads and reductions will result from implementation of strategies through 2017. The 2017 Planned Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 Baseline – 2017 Planned Reduction.
- **2025 Allocated Load**: Allocated loads are calculated from the 2005 baseline levels, calibrated to CBP P5.3.2 as noted above, using the following calculation: 2005 Baseline – (2005 Baseline x 0.205).
- **2025 Planned Loads and Planned Reductions**: Loads and reductions that will result from implementation of this plan. The 2025 Planned Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 – 2025 Planned Reduction.

Table 2: Patapsco LNB Local TMDL Allocated and Planned Loads

	Sediment (tons/year)	Sediment (lbs/year)
2005 Baseline Loads	711	1,422,388
2015 Progress Loads	631	1,263,460
2015 Progress Reductions	81	158,928
2017 Planned Loads*	457	916,013
2017 Planned Reductions	254	506,375
2025 TMDL Allocated Loads	553	1,106,618
2025 Planned Loads*	381	764,884
2025 Planned Reductions	330	657,504
Required Percent Reduction	22.2%	22.2%
Planned Percent Reduction Achieved	46.2%	46.2%

*2017 and 2025 planned loads are calculated by subtracting planned restoration sediment reductions from the 2005 Baseline Load. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and Accounting for Growth policies will address the remaining 10%.

1.5 Modeling Methods

1.5.1 Overview

Each BMP provides a reduction for nitrogen, phosphorus, and sediment, along with other pollutants. The pollutant load for the Patapsco LNB watershed was determined using BayFAST, which calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program Partnership Watershed Model. BayFAST, created by Devereux Environmental Consulting for MDE, is a web-based pollutant load estimating tool that streamlines environmental planning. BayFAST allows users to specify, delineate facility boundaries (e.g., watershed, parcel, drainage area), and alter land use information within the delineated boundary depending on the model year. Local TMDL baseline loads were calibrated in BayFAST by modeling BMPs installed prior to the TMDL baseline year on top of baseline land use background loads. This ensures that the same set of baseline BMPs are used throughout future progress and planned scenarios.

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

Pollutant load reductions achieved by annual based maintenance efforts (e.g., street sweeping and inlet cleaning) are calculated outside of BayFAST. Sediment reduction credit for vacuum-assisted street sweeping and inlet cleaning is calculated following methods described in MDE (2014b) based on the mass of material removed.

Both the Chesapeake Bay Program Partnership Watershed Model and BayFAST provide loads at two different scales: Edge-of-Stream (EOS) and Delivered (DEL). Delivered loads show reductions based on in-stream processes, such as nutrient uptake by algae or other aquatic life. This TMDL plan focuses on reducing load on the land, so EOS estimates are more appropriate and were used for all the modeling analysis.

1.5.2 Practice Level

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

1.5.2.1 Modeled in BayFAST

- **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. BayFAST modeling includes hydrodynamic structures in this category. These devices are designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.
- **Dry Extended Detention Ponds** - Depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. They are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, allowing additional wet sedimentation to improve treatment effectiveness.
- **Impervious Surface Reduction** - Reducing impervious surfaces to promote infiltration and percolation of runoff storm water. Disconnection of rooftop and non-rooftop runoff, rainwater

harvesting (e.g., rain barrels), and sheetflow to conservation areas are 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 BayFAST as bioswales.
- **Outfall Stabilization** – Restoration of outfalls using design approaches including rip-rap, riffle run sequences, step-pools and other grade and bank stabilization measures. These stabilization practices are modeled as stream restoration.
- **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, help improve habitat and water quality conditions in degraded streams.
- **Stormwater Retrofits** – Anne Arundel County plans to construct a variety of retrofits throughout the County. Stormwater retrofits may include converting dry ponds, dry extended detention ponds, or wet extended detention ponds into wet pond structures, wetlands, infiltration basins, or decommissioning the pond entirely to install SPSC (step pool storm conveyance).
- **Urban Filtering** - Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit.
- **Urban Tree Plantings** - Urban tree planting is planting trees on urban pervious areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting
- **Vegetated Open Channels** - Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff then releases it at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached pollutants. Until 2002 in Maryland, these practices were generally designed to meet water quantity, not water quality objectives. There is little or no vegetation within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.

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

Table 3: Typical Sediment Reduction from Stormwater BMPs

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%
Outfall Stabilization	44.9 lbs/linear ft
Stream Restoration	44.9 lbs/linear ft
Urban Filtering	80%
Urban Tree Plantings[1]	-
Vegetated Open Channels	70%
Wet Ponds or Wetlands	60%
Inlet Cleaning	420 lbs/ton removed
Inlet Cleaning	420 lbs/ton removed

Sources: Simpson and Weammert, 2009; and BayFAST documentation

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

[2] Outfall enhancement with SPSC modeled as bioswales in BayFAST

[3] Outfall stabilization and stream restoration listed with revised interim rate; specific stream restoration projects now use Bay Program Protocols however streams and outfalls for this assessment are modeled in BayFAST.

1.5.2.2 Modeled using MDE Guidance

Along with the structural BMPs listed above, treatment will also be provided through non-structural measures. These are treatments that rely on programs that continue throughout the year and are repeated annually. Both are calculated using MDE's accounting guidance (MDE, 2014b).

- **Inlet Cleaning** - Storm drain cleanout practice ranks among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with their NPDES stormwater permits. Sediment reduction credit is based on the mass of material collected, at the rate of 420 lb TSS per ton of wet material (MDE, 2014b). Data for the mass removed from each cleaned inlet was reported from the County's Bureau of Highways.
- **Street sweeping** — Starting Fiscal Year 2015, Anne Arundel County has enhanced their street sweeping program which now includes sweeping curb-miles and parking lots within the Patapsco LNB (Anne Arundel County DPW, 2015; Figure 2). This enhanced program targets impaired watersheds and curbed streets that contribute trash/litter, sediment, and other pollutants. Load reductions for this assessment are calculated using the material collected, at the rate of 420 lb TSS per ton of wet material (MDE, 2014b). The total mass of material collected by the street sweeping program each year is distributed proportionately across all of the roadway segments swept and then summed at the watershed scale. Note that currently the TSS reductions included in the County's MS4 NPDES geodatabase are calculated using the lane miles swept method and reduction rates from the Bay Program expert panel report (CBP, 2016).

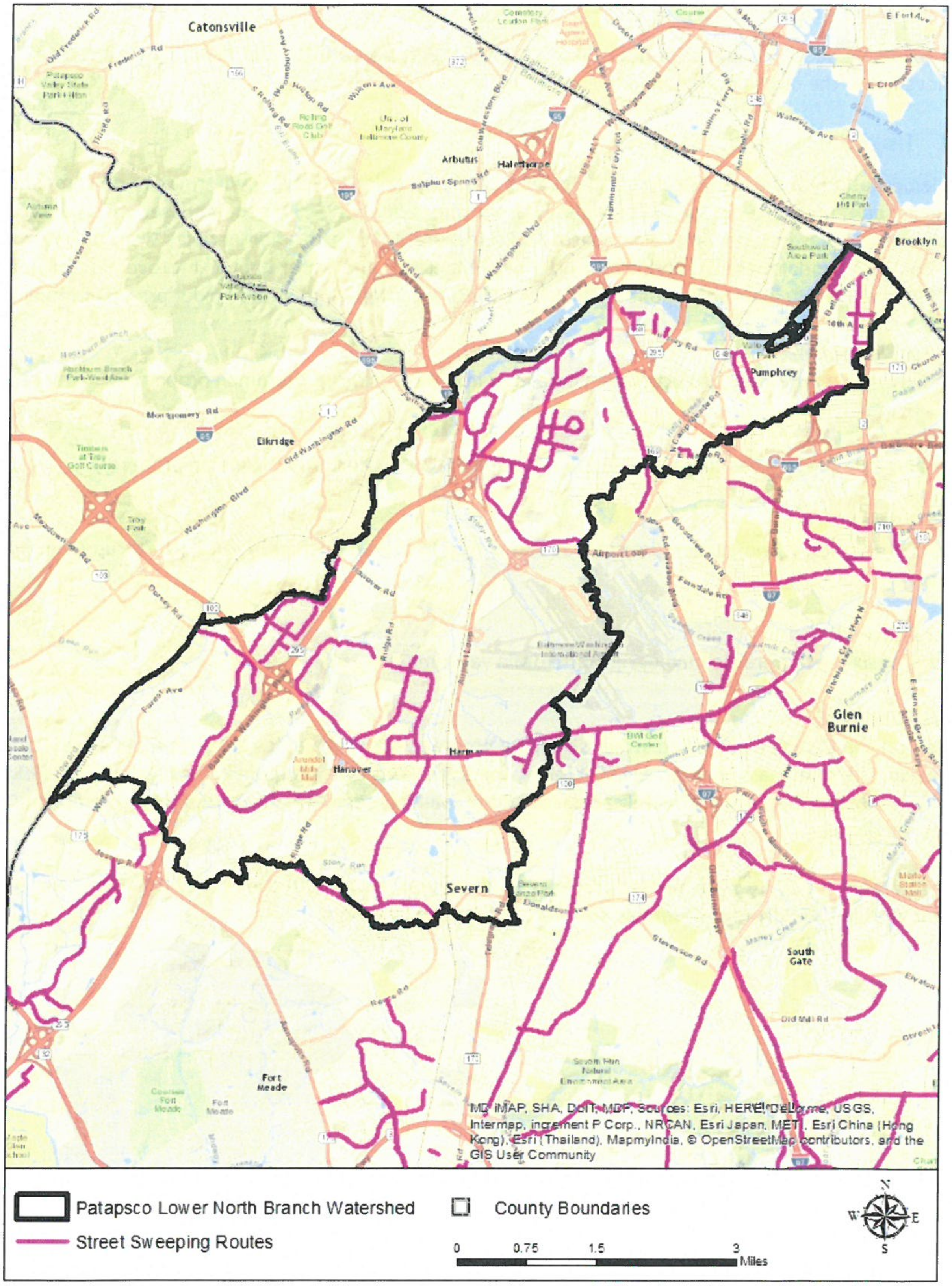

Figure 2: Street Sweeping Routes in Patapsco LNB Watershed, Anne Arundel County, Maryland

2 2017 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

Implementation up through the end of fiscal year 2017 is detailed in Table 4. Information on completed projects and programs is gleaned primarily from the County's MS4 geodatabase. All 2016-2017 implementation is included in the database. Additional pre-2016 restoration projects were pulled from the County's geodatabase of stormwater urban BMP facilities and water quality improvement projects (WQIP). The County is actively updating the MS4 NPDES geodatabase to include older pre-2014 projects.

Permeable Pavement
Five permeable pavement projects were completed in 2017 (Northrup Grumman property).

Bioswale
One bioswale project was completed in the watershed in 2017 (Northrup Grumman property).

Bioretention
One bioretention / rain garden project was completed in the watershed in 2017 (Northrup Grumman property).

Inlet Cleaning
A total of six inlets were cleaned using storm drain vacuuming in 2017.

Street Sweeping
Based on the County's enhanced street sweeping program, 46.5 curb miles are swept in the watershed annually. The total mass of material collected by the street sweeping program in fiscal year 2017 (599.92 tons) was distributed proportionately across all of the roadway segments swept and then summed at the watershed scale.

The total cost of County implemented practices and programs implemented in FY2017 is $ 75,462. Projects completed at the Northrup Grumman site were completed by others.

Table 4: Current BMP Implementation through FY2017

BMP	Unit	2005 Baseline	2006 - 2015 Restoration[2]	2016 Restoration[2]	2017 Restoration[2]	2017 Progress[3]	2017 Restoration Cost[4]
Structural Permanent Practices							
Bioretention	acre	2.3	0	0	0.03	0.03	NA
Bioswale	acre	4.5	0	0	0.55	0.55	NA
Dry Ponds	acre	314.2	0	0	0	0	NA
Extended Detention Dry Ponds	acre	532.1	16.5	0	0	16.5	NA
Impervious Surface Reduction	acre	13.0	0	0	0	0	NA
Infiltration	acre	599.4	3.7	0	0	3.7	NA
Permeable Pavement	acre	0	0	0	5.8	5.8	NA
Stormwater Retrofits[1]	acre	0	76.7	15.8	0	92.5	NA
Vegetated Open Channels	acre	0	0	0	0	0	NA
Wet Ponds or Wetlands	acre	705.3	161.0	18.4	0	179.4	NA
Urban Stream Restoration	linear feet	0	1,150	0	0	1,150	NA
Outfall Stabilization	linear feet	0	0	0	0	0	NA
Outfall Enhancement with SPSC	acre	0	46.9	0	0	46.9	NA
Annual Practices							
Inlet Cleaning	inlets/yr	0	213	NA	6	6	$ 4,239
Street Sweeping[5]	lbs /yr	0	NA	NA	195,433	195,433	$ 71,223
Total Cost							$75,462

Source: WPRP urban BMP, WQIP and MDE MS4 FY17 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. 2006-2015, 2016 and 2017.

[3] Total cumulative restoration accounting for the full 2005-2017 period.

[4] Cost of projects and programs for the 2017 period only. Only costs using County funds are included.

[5] Value listed here is the lbs of material removed, not specifically the fine TSS sediment

2.2 Load Reduction Results

The implementation summarized in Table 4 above resulted in the load reductions presented here in Table 5. Reductions in 2017 were higher than those reported in the previous 2016 period.

Of the 196,611 lbs of progress reduction achieved through FY2017, 41,041 lbs (20.9% of the total reduction) are being removed by street sweeping, and 697 lbs (0.4%) is accounted for by inlet cleaning. The remainder is being reduced by the suite of restoration projects.

Table 5: 2017 Progress Reductions Achieved

Baseline Load and TMDL WLA	TSS-EOS lbs/yr
2005 Baseline Scenario Load	1,422,388
Required Percent Reduction	22.2%
Required Reduction	315,770
Local TMDL WLA	1,106,618
2015 Results	**TSS-EOS lbs/yr**
2005-2015 Load Reduction	158,928
2005-2015 Load Reduction Percent	11.2%
Progress Scenario Load	1,263,460
Progress Reduction Achieved	158,928
Percent Reduction Achieved	11.2%
2016 Results	**TSS-EOS lbs/yr**
2016 Load Reduction	6,397
2016 Load Reduction Percent	0.45%
Progress Scenario Load	1,257,063
Progress Reduction Achieved	165,325
Percent Reduction Achieved	11.6%
2017 Results	**TSS-EOS lbs/yr**
2017 Load Reduction	31,286
2017 Load Reduction Percent	2.2%
Progress Scenario Load	1,225,777
Progress Reduction Achieved	196,611
Percent Reduction Achieved	13.8%

3 2017 Progress Comparison

This section describes the current progress of both implementation and load reductions with comparison to the planned totals and the progress that was expected by 2017.

3.1 Implementation

Table 6 compares implementation of existing restoration BMPs up through fiscal year 2017 (2017 Progress) with the total planned levels of implementation that were derived in the initial plan (Anne Arundel County, 2016). Several of the strategies were completed fully in the initial 2006-2015 period (e.g. stormwater retrofits) and street sweeping is continuing at the prescribed rate. Implementation of wet ponds/wetlands and smaller micro-scale practices were the primary types completed recently.

Estimates of inlet cleaning in the development of the plan were based on the total number of inlets cleaned Countywide with estimates based on the numbers of inlets in each watershed and assumptions of the average sediment yield from each inlet cleaned. The plan then called for a level of treatment consistent with the progress rate of 213 inlets per year. The actual number cleaned in the current reporting period is 6, however the mass of sediment extracted from those inlets exceeded the initial average estimates therefore a significant drop in loads reduced by that practice did not occur.

Table 6: Restoration BMP Implementation - Current 2017 and Planned 2025 Implementation Levels

BMP	Units	Total Planned Restoration	2017 Progress	Percent Complete
Bioretention	acre	12.9	0.03	0.2%
Bioswale	acre	0	0.55	NA
Extended Detention Dry Ponds	acre	16.5	16.5	100%
Impervious Surface Reduction	acre	0	0	NA
Infiltration	acre	24.6	3.7	15.0%
Permeable Pavement	acre	0	5.8	NA
Stormwater Retrofits	acre	76.7	92.5	120.6%
Wet Ponds or Wetlands	acre	759.7	179.4	23.6%
Urban Stream Restoration	linear feet	15,150	1,150	7.6%
Outfall Enhancement with SPSC	acre	166.4	46.9	28.2%
Inlet Cleaning	inlets/yr	213	6	2.8%
Street Sweeping	curb-miles	46.5	46.5	100%

To track progress, the 2017 implementation milestone first reported in the 2016 plan was compared against the 2017 progress reported here in this assessment. Table 7 presents the strategies that were planned for the 2017 milestone period, which includes 2016 and 2017 with a comparison to the practices that were completed for that period.

Two wet pond / wetland projects were completed in the period along with two stormwater retrofits, permeable pavement, a bioswale, and a bioretention. Many of the practices being implemented were not originally planned for and are not therefore included in the following table. Street sweeping continues at the prescribed rate and with better supporting information on measured quantities of material removed is now yielding very good results.

Table 7: Implementation Milestones Comparison

BMP	Unit	2016-2017 Planned	2016-2017 Actual	Percent Complete
Bioretention	acre	12.9	0	0%
Infiltration	acre	20.9	0	0%
Wet Ponds or Wetlands	acre	598.6	18.4	3%
Urban Stream Restoration	linear feet	4,000	0	0%
Outfall Enhancement with SPSC	acre	211.6	0	0%
Inlet Cleaning	inlets/yr	213	6	3%
Street Sweeping	curb-miles	46.5	46.5	100%

3.2 Load Reductions

This section compares the required and planned sediment load reductions against the progress made through fiscal year 2017. Values given in Table 8 include the load reductions for each period (generally the milestone years) and the resulting load. Both the planned results and the actual results are shown for the 2015, 2016, and 2017 periods. 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 22.2%, the County has achieved a 13.8% reduction, which translates to 95% progress towards the reduction goal. The 2016 plan (Anne Arundel County, 2016) anticipated 18.1% reduction by 2017, indicating that progress on track. It is noted that the 35.2% reduction planned is based on the assumption that all of the recommended strategies would be completed, which is not often the case due to feasibility, site constraints etc.

If the current two-year rate of progress (5.9% from 2016-2017) is maintained, it is expected that the TMDL allocation load and load reduction would be met by 2020. The County's initial estimate and plan were based on a 2025 end date for meeting the TMDL; therefore the program is currently on track to meet the end date ahead of schedule.

Table 8: Planning and Target Sediment Load Comparison (lbs/year)

Milestone Year	Planned Load Reduction	Planned Load	Planned % Reduction From Baseline	Actual Load Reduction	Actual Load	Actual % Reduction from Baseline
2005 Baseline	-	-	-	-	1,422,388	-
2015 Progress	-	-	-	158,928	1,263,460	11.2%
2016 Progress	-	-	-	165,325	1,257,063	11.6%
2017 Planned and Progress	506,375	916,013	35.6%	196,611	1,224,777	13.8%
2025 Allocated	315,770	1,106,618	22.2%	-	-	-
2025 Planned	657,504	764,884	46.2%	-	-	-

The County currently has 10 projects in the planning and design stages that are set to be completed in 2018-2019. They include SPSCs, wet pond / wetlands, infiltration trenches, and stormwater retrofits. The estimates sediment load reductions for these projects totals 70,161 lbs or 4.9% of the required sediment reduction. Completion of these projects would bring the total reduction to 18.8% by 2019.

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 Patapsco LNB was originally listed for sediments in 1996 as a suspended sediment listing. This was refined in 2008 to a listing for total suspended solids. 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 Patapsco LNB 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, 2012c), MDE replaced the biological impairment listing with a listing for total suspended solids (TSS). The 2012 and 2014 integrated reports (MDE, 2012a and MDE, 2014a) lists 'Habitat Evaluation' as the indicator, and urban runoff/storm sewers as the source. It is noted that the *Decision Methodology for Solids for the April 2002 Water Quality Inventory (MDE, 2012b) (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).

With these two sediment impairments in mind the Patapsco LNB, which is listed as impaired for TSS, would seem to be a water clarity issue; however the methodology used for listing (biological and habitat

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

measures related sediment deposition) seems to point to an in-stream sediment deposition problem. In all likelihood both types of impairment, water clarity and sedimentation, are factors and both should be incorporated into monitoring programs to track changes in the watershed condition over time.

Anne Arundel County's Watershed Protection and Restoration Program (WPRP) 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 One of the County's Biological Monitoring and Assessment Program occurred between 2004 and 2008, and Round Two took place between 2009 and 2013. During 2017, Round 3 monitoring was initiated and fish sampling and additional water quality parameters were added. Field data collection was completed and analysis is currently underway. 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 Sediment 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 Patapsco LNB watershed is made up of three PSUs, Piney Run, Stony Run and Lower Patapsco. Ten sampling sites were sampled in each of these PSUs in each round of sampling. Methodologies follow those used by MBSS for the biological sampling (benthic macroinvertebrates only) and habitat evaluations have included both MBSS's Physical Habitat Index (PHI) and the EPA's Rapid Bioassessment Protocol (RBP) metrics. In-situ water quality measures are also collected at each site along with a geomorphic evaluation utilizing cross-sections, particle substrate analysis using pebble counts, and measures of channel slope.

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

- Water Quality Measures and Observations
    - Turbidity (measured), observations of general water clarity and color
- Biological Measures

  - Benthic macroinvertebrates (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 Patapsco LNB watershed is made up of three PSUs: Piney Run, Stony Run and Lower Patapsco. Results summarized at the PSU scale with mean BIBI and habitat ratings (PHI and RBP) are presented in Table 9.

Table 9: Countywide Biological Monitoring Results

PSU Name	Round	PSU Code	Year Sampled	Drainage Area (acres)	BIBI Rating	PHI Rating	RBP Rating
Piney Run	1	1	2007	4,868	P	D	PS
Stony Run	1	2	2007	6,203	P	D	PS
Lower Patapsco	1	3	2004	4,040	P	PD	PS
Piney Run	2	1	2012	4,868	P	D	PS
Stony Run	2	2	2010	6,203	P	PD	S
Lower Patapsco	2	3	2012	4,040	P	PD	NS

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 (Lower Patapsco) and 2007 (Piney Run and Stony Run). Results of the Round 1 and Round 2 sampling efforts are presented in Table 10 and Table 11, respectively. BIBI narrative condition ratings are presented in Figure 3. Overall, 40% of the sites in the watershed were rated as "Fair," 40% rated "Poor," and 10% were rated "Very Poor." There were no sites rated as 13% rated "Good." Lower Patapsco received the highest average BIBI score of the three PSUs during Round 1, with a mean BIBI score of 2.69 ± 0.61 and a corresponding biological condition rating of "Poor," while Piney Run received a nearly identical mean BIBI score of 2.69 ± 0.80 and a "Poor" rating. Stony Run received the lowest mean BIBI score if 2.37 ± 0.70 and a corresponding biological condition rating of "Poor."

During Round 2, biological sampling was completed in 2010 (Stony Run) and 2012 (Piney Run, Lower Patapsco). Overall, 43% of the sites in the watershed were rated as "Poor," 30% rated "Fair," and 23% rated "Very Poor", and 3% rated "Good." All three PSUs in the watershed received a corresponding biological condition rating of "Poor." Piney Run and Stony Run received nearly identical mean BIBI scores of 2.69 ±0.90 and 2.69 ±0.98, respectively. The Lower Patapsco PSUs received the lowest mean BIBI score of 2.43 ±0.74.

Table 10: BIBI Data for Round 1 (2004-2008)

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
01-01	2007	14	1	0.0	0	0.0	0	3	1.57	Very Poor
01-02	2007	33	5	2.9	1	27.5	1	9	3.86	Fair
01-04	2007	27	6	1.0	1	3.8	0	5	3.00	Fair
01-05	2007	24	6	0.0	0	43.6	1	5	3.29	Fair
01-07	2007	27	2	0.9	1	1.8	0	5	2.71	Poor
01-08	2007	23	0	0.0	0	0.9	0	13	2.14	Poor
01-09	2007	31	4	1.0	1	1.9	1	10	3.29	Fair
01-10	2007	30	5	0.0	0	3.0	1	2	2.71	Poor
01-12A	2007	30	3	1.0	1	7.7	1	3	3.00	Fair
01-13A	2007	11	1	0.0	0	0.0	0	2	1.29	Very Poor
02-01	2007	31	1	0.0	0	26.9	0	2	2.14	Poor
02-03	2007	25	4	0.0	0	19.6	0	0	2.14	Poor
02-04	2007	18	3	0.0	0	76.2	2	1	3.00	Fair
02-05	2007	31	3	0.9	1	13.9	0	7	3.00	Fair
02-06	2007	12	0	0.0	0	0.0	1	0	1.29	Very Poor
02-07	2007	20	1	0.0	0	1.9	0	6	1.57	Very Poor
02-11A	2007	25	3	0.9	1	33.3	0	12	3.57	Fair
02-18A	2007	26	6	0.0	0	6.7	1	5	2.71	Poor
02-19A	2007	19	2	0.0	0	5.7	1	1	2.14	Poor
02-20A	2007	25	3	0.0	0	2.8	0	4	2.14	Poor
03-01	2004	13	1	0.0	0	2.0	2	4	1.86	Very Poor
03-02	2004	21	3	0.0	0	22.6	0	9	2.43	Poor
03-04	2004	23	0	0.0	0	0.9	4	13	2.71	Poor
03-05	2004	30	7	0.0	0	20.2	4	15	3.57	Fair
03-07	2004	26	4	0.0	0	19.5	1	11	3.00	Fair
03-09	2004	15	4	1.0	1	4.0	1	2	2.71	Poor
03-12A	2004	14	3	2.2	1	2.2	2	8	3.00	Fair
03-13A	2004	22	2	1.0	1	4.1	1	14	3.29	Fair
03-16A	2004	12	0	0.0	0	1.6	1	7	1.57	Very Poor
03-17A	2004	19	1	2.0	1	2.0	1	12	2.71	Poor

Table 11: BIBI Data for Round 2 (2009-2013)

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
01-01	2012	8	0	0.0	0	0.0	1	6.0	1.57	Very Poor
01-02	2012	20	1	0.0	0	3.6	4	18.9	2.43	Poor
01-03	2012	20	1	0.0	0	2.0	4	10.8	2.43	Poor
01-04	2012	19	1	0.0	0	24.8	1	1.8	2.14	Poor
01-05	2012	11	1	0.0	0	5.5	1	18.3	1.86	Very Poor
01-06	2012	19	1	0.0	0	9.2	5	14.7	2.43	Poor
01-07	2012	25	7	0.0	0	9.3	4	10.2	3.29	Fair
01-08	2012	25	3	1.9	1	10.2	6	21.3	3.86	Fair
01-09	2012	18	0	0.0	0	3.6	2	15.5	2.43	Poor
01-10	2012	29	6	4.4	2	10.6	4	14.2	4.43	Good
02-01	2010	30	2	0.0	0	5.5	6	16.4	3.00	Fair
02-02	2010	16	1	0.0	0	0.0	4	14.9	2.43	Poor
02-06	2010	31	8	0.0	0	45.8	9	3.7	3.57	Fair
02-08	2010	28	7	0.0	0	15.6	3	8.3	3.57	Fair
02-09	2010	28	5	0.0	0	3.5	6	8.8	3.29	Fair
02-10	2010	23	3	0.0	0	2.6	7	4.4	2.71	Poor
02-15A	2010	24	0	0.0	0	0.0	2	10.8	2.71	Poor
02-16A	2010	31	6	0.0	0	19.2	5	9.6	3.57	Fair
02-18A	2010	12	1	0.0	0	0.0	0	0.0	1.00	Very Poor
02-20A	2010	11	0	0.0	0	0.0	0	0.0	1.00	Very Poor
03-02	2012	21	3	0.0	0	1.9	2	1.9	2.43	Poor
03-03	2012	22	4	0.9	1	15.4	3	9.4	3.57	Fair
03-04	2012	8	0	0.0	0	1.0	2	2.9	1.86	Very Poor
03-05	2012	8	0	0.0	0	0.9	1	6.9	1.57	Very Poor
03-06	2012	14	4	0.0	0	8.6	1	1.9	2.14	Poor
03-07	2012	17	4	0.0	0	4.6	1	2.8	2.14	Poor
03-08	2012	18	5	1.9	2	15.4	3	4.8	3.86	Fair
03-10	2012	18	2	0.0	0	9.9	1	22.5	2.43	Poor
03-11A	2012	22	4	2.0	2	8.9	4	5.9	3.57	Fair
03-15A	2012	11	3	0.0	0	12.1	1	1.0	2.14	Poor

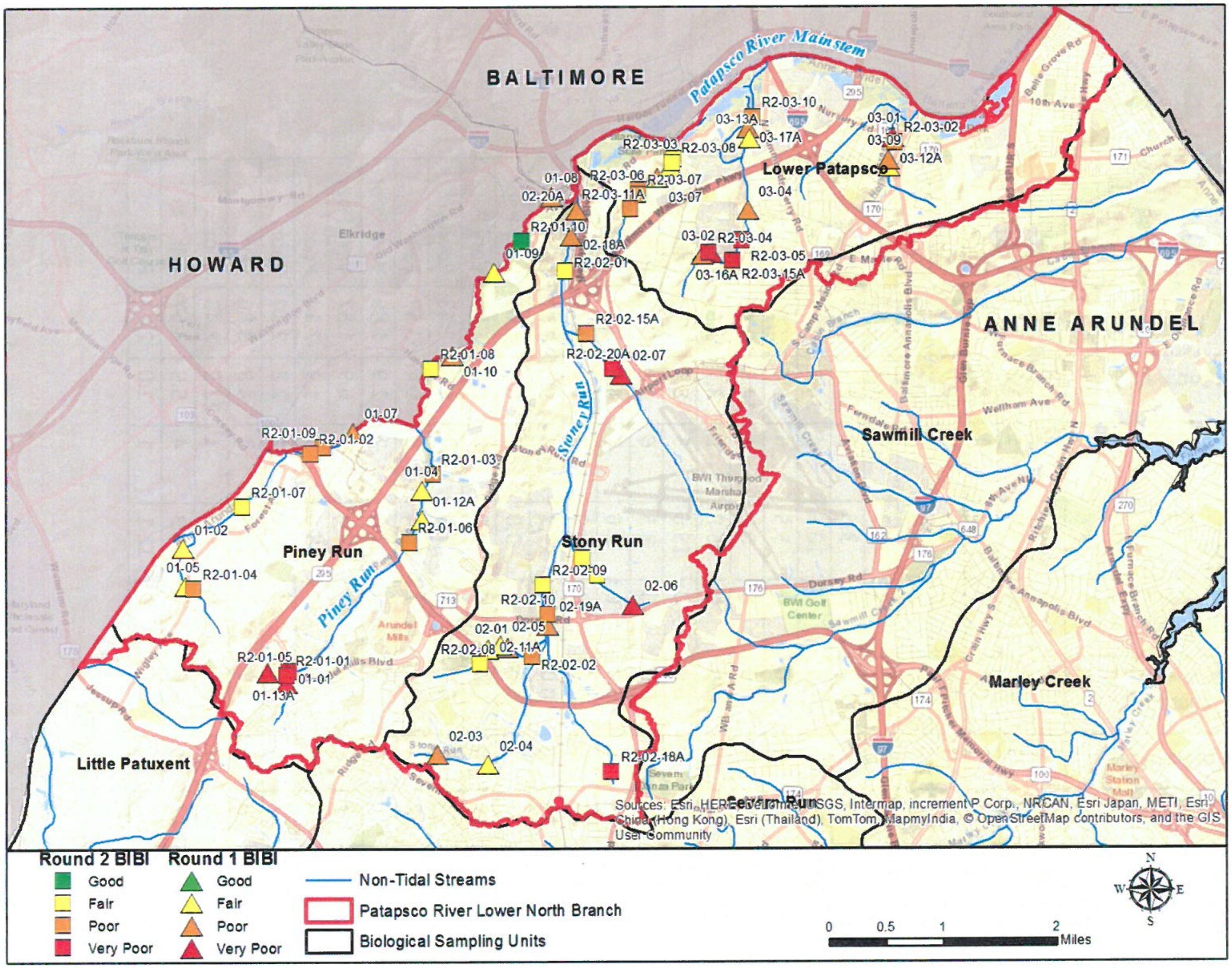

Figure 3: Biological Sampling Results from Round 1 and Round 2

4.1.3.2 Physical Habitat

Physical habitat assessments during Round 1 were performed concurrently with the biological assessments. Results of the Round 1 habitat assessments are presented in Table 12. MPHI narrative condition ratings are presented in Figure 4. The MPHI rated 50% of sites "Degraded," 30% as "Partially Degraded," 17% "Severely Degraded" and 3% "Minimally Degraded." Lower Patapsco received the highest average MPHI score of the three PSUs during Round 1, with a score of 67.14 ± 11.79 and a corresponding narrative rating of "Partially Degraded." Both Piney Run and Stony Run received narrative ratings of "Degraded," with average MPHI scores of 58.76 ± 14.01 and 58.66 ± 7.92, respectively.

Table 12: Physical Habitat Index Data from Round 1 (2004-2008)

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	# Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
01-01	2007	48.47	91.34	83.31	83.91	66.63	54.77	71.41	Partially Degraded
01-02	2007	43.08	63.55	55.64	65.84	58.92	54.77	56.97	Degraded
01-04	2007	43.08	99.94	87.61	90.65	74.09	59.16	75.75	Partially Degraded
01-05	2007	21.54	58.94	84.06	85.08	70.89	70.71	65.20	Degraded
01-07	2007	37.70	84.56	64.11	59.29	42.14	59.16	57.83	Degraded
01-08	2007	16.16	99.94	35.28	44.96	26.50	67.08	48.32	Severely Degraded
01-09	2007	43.08	40.96	12.21	39.67	26.79	54.77	36.25	Severely Degraded
01-10	2007	26.93	15.33	53.26	45.82	24.50	63.25	38.18	Severely Degraded
01-12A	2007	43.08	73.32	76.11	80.10	49.93	63.25	64.30	Degraded
01-13A	2007	43.08	100.00	59.77	98.11	82.12	54.77	72.97	Partially Degraded
02-01	2007	37.70	54.42	55.91	64.29	69.48	63.25	57.51	Degraded
02-03	2007	21.54	40.96	58.67	99.96	87.35	70.71	63.20	Degraded
02-04	2007	48.47	54.42	88.68	88.76	77.69	83.67	73.61	Partially Degraded
02-05	2007	16.16	58.94	44.81	59.56	64.47	83.67	54.60	Degraded
02-06	2007	43.08	68.32	47.29	48.79	64.61	63.25	55.89	Degraded
02-07	2007	37.70	58.94	75.23	71.21	64.42	54.77	60.38	Degraded
02-11A	2007	43.08	99.94	58.16	73.38	73.40	54.77	67.12	Partially Degraded
02-18A	2007	43.08	45.47	51.79	69.28	32.04	77.46	53.19	Degraded
02-19A	2007	5.39	8.55	70.71	75.21	47.69	63.25	45.13	Severely Degraded
02-20A	2007	37.70	84.56	57.53	58.08	34.88	63.25	56.00	Degraded
03-01	2004	59.24	78.67	84.49	82.18	61.54	83.67	74.97	Partially Degraded
03-02	2004	16.16	84.56	40.96	68.20	70.84	89.45	61.69	Degraded
03-04	2004	37.70	78.67	84.77	77.06	56.10	92.20	71.08	Partially Degraded
03-05	2004	91.55	78.67	100.00	67.46	66.85	74.16	79.78	Partially Degraded
03-07	2004	96.93	84.56	100.00	69.68	69.31	70.71	81.87	Minimally Degraded
03-09	2004	26.93	68.32	85.18	77.71	62.73	67.08	64.66	Degraded

03-12A	2004	10.77	58.94	50.85	39.70	57.73	94.87	52.14	Degraded
03-13A	2004	43.08	73.32	81.59	60.97	53.54	44.72	59.54	Degraded
03-16A	2004	21.54	45.47	57.99	50.92	67.19	44.72	47.97	Severely Degraded
03-17A	2004	59.24	91.34	100.00	99.70	71.16	44.72	77.69	Partially Degraded

Results of the Round 2 habitat assessments are presented in Table 13. The MPHI rated 37% of sites as "Partially Degraded," 30% as "Degraded," 17% as "Severely Degraded," and 17% as "Minimally Degraded." Both Stony Run and Lower Patapsco PSUs received "Partially Degraded" narrative ratings, with mean MPHI scores of 68.7 ± 15.1 and 66.3± 14.9, respectively. Piney Run received the lowest MPHI score of 64.5 ± 13.1 and a corresponding narrative rating of "Degraded."

Table 13: Physical Habitat Index Data from Round 2 (2009-2013)

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	# Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
01-01	2012	59.24	91.34	83.75	84.59	91.05	63.25	78.87	Partially Degraded
01-02	2012	37.7	49.95	82.42	71.77	79.17	83.67	67.45	Partially Degraded
01-03	2012	26.93	45.47	87.4	74.05	49.37	83.67	61.15	Degraded
01-04	2012	5.39	73.32	41.73	41.66	72.18	92.2	54.41	Degraded
01-05	2012	32.31	63.55	73.29	66.19	65.22	80.63	63.53	Degraded
01-06	2012	64.62	63.55	88.18	80.81	80.29	86.61	77.34	Partially Degraded
01-07	2012	32.31	99.94	100	90.06	100	92.2	85.75	Minimally Degraded
01-08	2012	5.39	21.22	59.04	45.78	51.08	94.87	46.23	Severely Degraded
01-09	2012	5.39	84.56	70.78	66.19	64.35	80.63	61.98	Degraded
01-10	2012	53.85	31.57	58.57	50.58	29.54	67.08	48.53	Severely Degraded
02-01	2010	48.47	78.67	80.75	74.69	73.30	83.67	73.26	Partially Degraded
02-02	2010	16.16	58.94	54.72	45.78	70.37	94.87	56.80	Degraded
02-06	2010	80.78	91.34	97.13	83.77	75.14	70.71	83.14	Minimally Degraded
02-08	2010	32.31	99.94	83.59	82.37	68.33	67.08	72.27	Partially Degraded
02-09	2010	43.08	73.32	81.54	79.51	84.78	80.63	73.81	Partially Degraded
02-10	2010	16.16	54.42	76.15	69.07	55.92	59.16	55.15	Degraded
02-15A	2010	75.39	99.94	90.91	85.11	73.21	94.87	86.57	Minimally Degraded
02-16A	2010	53.85	99.94	96.73	83.16	71.50	100.00	84.20	Minimally Degraded
02-18A	2010	32.31	78.67	47.90	53.32	69.85	89.45	61.92	Degraded
02-20A	2010	32.31	0.00	52.82	55.86	51.06	44.72	39.46	Severely Degraded
03-02	2012	53.85	84.56	85.1	77.58	71.47	80.63	75.53	Partially Degraded
03-03	2012	64.62	78.67	90.29	91.29	95.28	92.2	85.39	Minimally Degraded
03-04	2012	26.93	31.57	34.29	33.54	63.42	63.25	42.17	Severely Degraded
03-05	2012	26.93	91.34	34.36	24.53	100	63.25	56.73	Degraded
03-06	2012	5.39	73.32	88.62	75.6	78.82	77.46	66.54	Partially Degraded

03-07	2012	32.31	99.94	86.45	86.86	91.05	83.67	80.05	Partially Degraded
03-08	2012	70.01	58.94	84.55	80.31	89.49	92.2	79.25	Partially Degraded
03-10	2012	32.31	63.55	57.73	54.46	67.26	63.25	56.43	Degraded
03-11A	2012	75.39	100	59.58	62.54	80.04	63.25	73.47	Partially Degraded
03-15A	2012	37.7	58.94	29.34	25.77	60.74	70.71	47.2	Severely Degraded

4.1.1 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). None of the individual PSUs saw a significant change in mean BIBI scores between Round 1 and Round 2. These results suggest there has not been a measurable increase in the average BIBI condition across the broader Patapsco Lower North Branch Watershed between Round 1 and Round 2. However, future sampling efforts in Round 3 of the CBMP 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 Restoration 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 11 sites in the program, 10 of which are past stream restoration reaches that the County tracks to see how the stream insect community changes 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. The latest summary report can be found here: http://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.

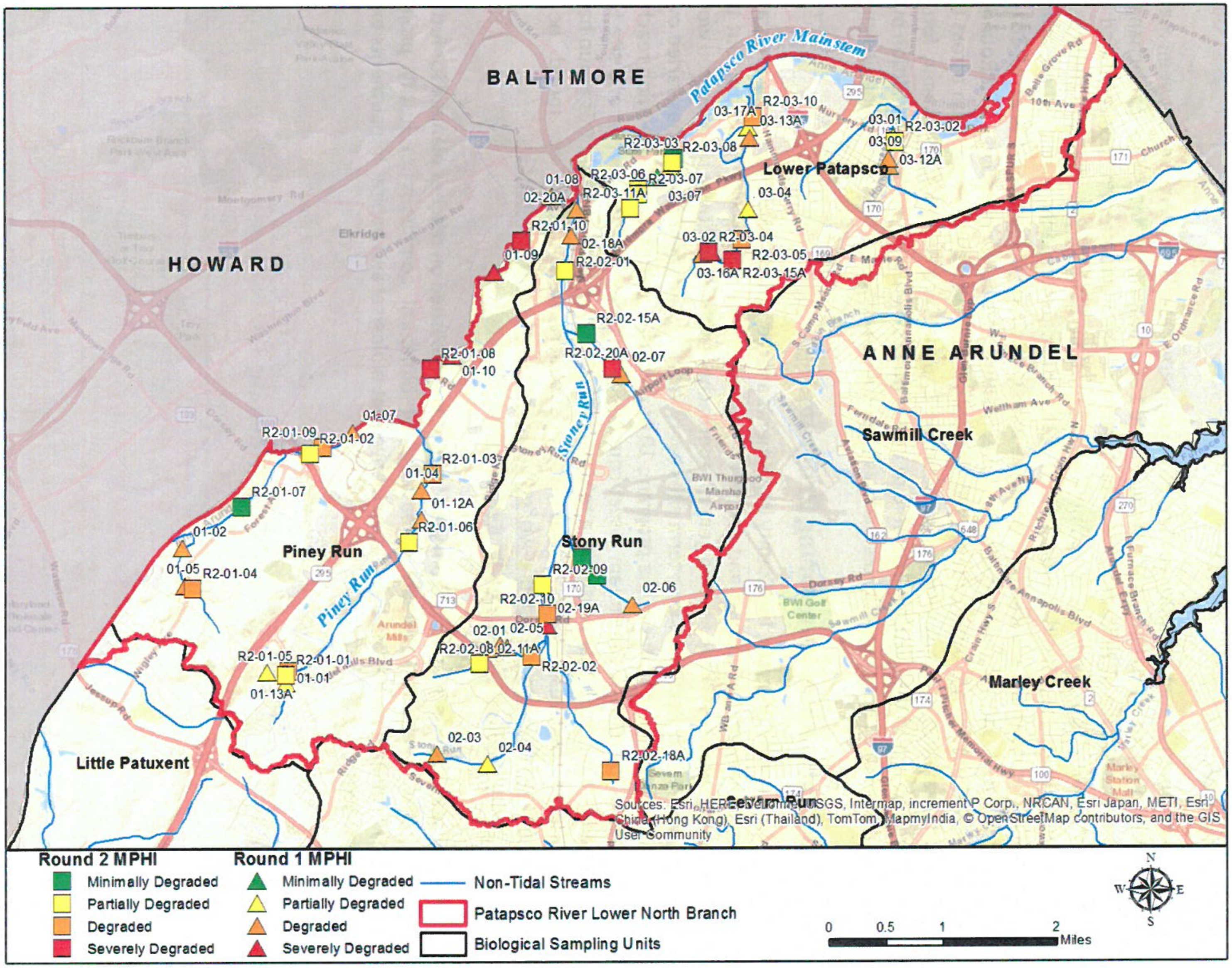

Figure 4: Physical Habitat Assessment Results from Round 1 (2007) and Round 2 (2009).

5 Conclusion

This Patapsco LNB TMDL Annual Assessment report documents the progress achieved through the end of fiscal year 2017. The assessment includes a report on the project and program implementation completed in the current report year and cumulatively through FY2017. 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 TMDL WLA, and the planned milestone targets as outline in the 2016 plan (Anne Arundel County, 2016).

Anne Arundel County spent $75,462 in FY2017 in operational costs in the Patapsco LNB Watershed. With those funds the County is implementing programmatic practices including inlet cleaning and street sweeping. Load reductions are at 13.8% on a total goal of 22.2%. Based on the current rate of progress and the projects that the County has in design phases to be complete in 2018-2019, the County is on track to meet the WLA and load reduction by the 2025 date set in the County's plan.

Biological stream monitoring data thus far with two rounds completed between 2004 and 2012 indicates a watershed that is in poor biological health. The Patapsco LNB watershed (PSUs 1, 2, 3) are scheduled to be monitored again in the County's rotating framework in 2018 and 2020 which will provide a check on overall biological conditions.

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