

NON TIDAL WEST RIVER WATERSHED

SEDIMENT TMDL RESTORATION PLAN

DECEMBER 2021

FINAL DRAFT



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PREPARED FOR

Anne Arundel County

Department of Public Works

Bureau of Watershed Protection and Restoration

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List of Acronyms

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

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

1 Introduction

1.1 Background and Purpose

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

Under the Federal Clean Water Act (CWA), the State of Maryland is required to assess and report on the quality of waters throughout the state. Where Maryland's water quality standards are not fully met, CWA Section 303(d) requires the state to list these water bodies as impaired waters. States are then required to develop a TMDL for pollutants of concern for the listed impaired waters. The Non-Tidal West River is listed in Maryland's Integrated Report of Surface Water Quality [303(d) list and 305(b) Report] for sediment pollution. On April 24, 2019 EPA approved a sediment (total suspended solids, or TSS) TMDL for the Non-Tidal West River watershed. This plan will address Anne Arundel County's responsibility for meeting the stormwater wasteload allocation (SW-WLA) required by the Non-Tidal West River sediment TMDL.

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

Anne Arundel County's current MS4 permit (11-DP-3316, MD0068306) issued in its final form by MDE in February of 2014, requires development of restoration plans for each SW-WLA approved by EPA prior to the effective date of the permit or within one year of EPA approval (permit section IV.E.2.b). This plan will satisfy this permit requirement for the Anne Arundel County SW-WLAs in the Non-Tidal West River Watershed TMDL and will provide the loading target, recommended management measures, load reduction estimates, schedule, programmed and proposed restoration, cost estimates and funding sources, and the tracking and monitoring approaches to meet the WLAs in the TMDL documents.

The Non-Tidal West River watershed is comprised of two major segments: the West River and the Rhode River. For allocation purposes, MDE has assigned one MS4 SW-WLA to the entire Non-Tidal West River watershed in the TMDL, and not to the segments individually. MDE has also assigned designated uses and impairment listings to the entire watershed. In contrast, the two segments are distinguished as separate watersheds in the County's GIS data. However, to be consistent with the TMDL, the County GIS data will be aggregated within this plan to present the information as a single watershed, unless there is a reason to

show the segments separately (e.g., for the purposes of providing additional, more detailed information). The designation as a single watershed is also consistent with the 8-digit watershed scale used in MDE's TMDL Implementation Progress and Planning (TIPP) tool. Subsequent tables and figures in this Restoration Plan group the two segments together when presenting information from MDE (i.e., data from the TMDL), but may show the two segments separately or aggregated together when presenting County GIS data, depending on which format provides the most information.

It is noted that TMDL restoration plans are an important first step towards achieving the SW-WLAs. The MS4 permit calls for an iterative and adaptive plan for implementation. If new methods of stormwater treatment are identified, or better approaches to source control are found, the restoration plans can be updated to take the changes into account. Similarly, if some elements of the plans are not as successful as expected, adaptations and improvements will be incorporated into future updates.

Anne Arundel County expects to meet its sediment SW-WLA for the Non-Tidal West River watershed by 2030. The strategies proposed in the plan will provide treatment to reduce current sediment loads from the urban stormwater sector.

1.2 TMDL Allocated and Planned Loads Summary

The Non-Tidal West River Watershed Restoration Plan (also called the Restoration Plan herein) only addresses loads allocated to Anne Arundel County's point source NPDES-regulated stormwater sediment as specified in the Final Technical Memorandum, Point Sources of Sediment in the Non-Tidal West River Watershed (MDE, 2019). Additional SW-WLAs for the Non-Tidal West River Watershed TMDL assigned to other regulated entities (i.e., Maryland State Highway Administration, others) are not the responsibility of Anne Arundel County and will not be addressed in this plan.

The Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) watershed model was used to calculate a 2009 baseline sediment load, and MDE refined the CBP P5.3.2 urban land-use data to determine the County's target SW-WLA under the Non-Tidal West River (MDE, 2019; Table 1-1). A planning horizon of 2030 is used as the date to achieve these load reductions, and to assess progress.

Table 1-1: Non-Tidal West River Sediment TMDL baseline loads, WLA, and required reductions for Anne Arundel County

NPDES Regulated Stormwater Sector	Baseline Load (ton/yr)	WLA (ton/yr)	Reduction (%)
Non-Tidal West River, Anne Arundel County Phase I MS4	288	226	22

The CBP P5.3.2 model used for the assignment of SW-WLAs for this TMDL has since been superseded by the CBP Watershed Model Phase 6 (WMP6) (CBP, 2017). In response to these model changes MDE developed the TIPP tool, a spreadsheet-based pollutant load estimating tool that calculates pollutant loads and reductions using the same modeling approaches as the WMP6 (CBP, 2017). The TIPP tool allows the original target reduction percentage (i.e., 22%) to be applied to the TIPP baseline loads, providing an updated SW-WLA and taking advantage of the model improvements and advances between CBP P5.3.2 and WMP6. MDE's TIPP tool was used to model baseline, progress, planned, and proposed loads.

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

This section of the plan provides a concise summary of the loads and reductions at important timeline intervals, including the 2009 baseline, 2021 progress, interim programmed restoration, and 2030 final planning intervals (Table 1-2). These terms and dates are used throughout the plan and are explained in more detail in the following sections. They are presented here to assist the reader in understanding the definitions of each and how they were derived and will be used to summarize the percent reduction required and percent reduction achieved through full implementation of this plan. Sediment loads and WLAs are presented as tons/year in the TMDL for the Non-Tidal West River watershed, but will be discussed as pounds/year (lbs/yr) in this Restoration Plan since TIPP provides the loads in terms of lbs/yr.

- **2009 Baseline Load:** These are the baseline level sediment loads from the 2009 conditions in the Non-Tidal West River watershed (i.e., 2009 land use loads minus any reductions from BMPs that were installed in 2009 or before). The baseline loads are calculated by running the TIPP model with the 2009 Progress BMPs. Baseline TSS loads, in conjunction with the percent load reduction prescribed by the TMDL (Table 1-1), are used to calculate the sediment SW-WLA.
- **2021 Progress Loads and Reductions:** These are the progress loads and load reductions achieved from stormwater best management practice (BMP) implementation through the end of 2021. The 2021 progress load reductions are calculated by modeling the restoration BMP implementation (post 2009 through end of 2021) in TIPP. The 2021 progress load is then calculated by subtracting the 2021 progress load reductions from the 2009 baseline load.
- **Interim Programmed Restoration Loads and Reductions:** These are the planned loads and reductions that will result from implementation of strategies and projects that are currently programmed (i.e., those projects for which design contracts have been issued). The programmed restoration loads are calculated by subtracting the programmed restoration load reductions from the 2009 baseline load.
- **2030 Planned Loads and Reductions:** These are the planned 2030 loads and reductions that will result from implementation of strategies, programmed restoration, and planned restoration (i.e., those projects for which a design contract has not been issued) through 2030 and will meet the TMDL SW-WLAs. 2030 planned loads are calculated by subtracting the 2030 planned load reductions from the 2009 baseline load.

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

	Non-Tidal West River Watershed Sediment (lbs/year)
2009 Baseline Load	99,166,940.6
2010-2021 Progress Load Reductions	58,254.7
2021 Progress Load	9,108,685.9
Interim Programmed Restoration Load Reductions	975,753.9
Interim Programmed Restoration Planned Load	8,132,932
2030 Planned Load Reductions	1,219,691.3
2030 Planned Load	6,913,240.7
Required Reduction by 2030 (percent)	22
Planned Progress Reduction by 2030 (percent)	24.59

1.3 Restoration Plan Elements and Structure

This plan is developed within the context of on-going watershed management planning, restoration, and resource protection being conducted by Anne Arundel County. The County initiated comprehensive watershed assessment and management plans in 2000 and has completed plans for all of the 12 major watersheds. A comprehensive watershed assessment for the watersheds of the West and Rhode River segments was completed in December of 2016. The County also prepared a Phase II Watershed Implementation Plan (WIP) for nitrogen, phosphorus, and sediment in 2012 in response to requirements set forth in the Chesapeake Bay TMDL. Information synthesized and incorporated into this Restoration Plan for the Non-Tidal West River watershed draws upon these sources, with updates and additions where necessary, to meet the specific goals of the TMDL. The TMDL analyses and reports developed by MDE were also used to develop this plan. These primary sources include:

- *West and Rhode Watersheds Assessment Comprehensive Summary Report* (Anne Arundel County, December 2016) (hereafter referred to as the “*West and Rhode River Watersheds Assessment Report*”)
- *Chesapeake Bay TMDL, Phase II Watershed Implementation Plan, Final* (Anne Arundel County, July 2012)
- *Total Maximum Daily Load of Sediment in the Non-Tidal West River Watershed, Anne Arundel, County, Maryland* (including supplemental technical memoranda and decision letters) (MDE, January 2019)

MDE has prepared several guidance documents to assist municipalities with preparation of TMDL restoration plans. This plan is developed following the guidance detailed in the following documents, with modifications as necessary:

- *General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan* (MDE, 2014b)

- *Guidance for Developing Stormwater Wasteload Allocation Implementation Plans for Nutrient and Sediment Total Maximum Daily Loads* (MDE, 2014b)
- *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE, 2020)
- *TMDL Implementation Progress and Planning Tool (TIPP)* (MDE, 2021)

The Non-Tidal West River Watershed Restoration Plan has been prepared in accordance with the EPA's nine essential elements for watershed planning. These elements, commonly called the "a through i criteria" are important for the creation of thorough, robust, and meaningful watershed plans and incorporation of these elements into the plan is of particular importance in receiving funding for implementation. EPA has clearly stated that to ensure that Section 319-(the EPA Nonpoint Source Management Program¹) funded projects make progress towards restoring waters impaired by nonpoint source pollution, watershed-based plans that are developed or implemented with Section 319 funds to address 303(d)-listed waters must include at least the nine elements. While the sediment Restoration Plan described herein is focused on Anne Arundel County MS4 point sources, EPA recommends including these nine elements in all watershed plans because they provide a quantitative framework for the planning process that leads to water quality improvements and restoration to attain water quality standards.

The Non-Tidal West River Watershed Restoration Plan is organized based on these nine elements. A modification to the order has been incorporated into this plan such that element c., a description of the management measures, is included in the plan as Section 4, before element b., the expected load reductions, which is included in the plan as Section 5. This modified approach makes the plan easier to follow. The planning elements (summarized below in the order presented by EPA) are:

- a. An identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the plan and to achieve any other watershed goals identified in the plan, as discussed in element (b) immediately below. (Section 3 of this Restoration Plan)
- b. An estimate of the load reductions expected for the management measures described under element (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time. (Section 5 of this Restoration Plan)
- c. A description of the management measures that will need to be implemented to achieve the load reductions estimated under element (b) above, as well as to achieve other watershed goals identified in the plan, and an identification of the critical areas in which those measures will be needed to implement this plan. (Section 4 of this Restoration Plan)
- d. An estimate of the amount of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. (Section 6 of this Restoration Plan)
- e. An information/education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the recommended management measures. (Section 7 of this Restoration Plan)

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

- f. A schedule for implementing the management measures identified in this plan that is reasonably expeditious. (Section 8 of this Restoration Plan)
- g. A description of interim programmed restoration for determining whether management measures or other control actions are being implemented. (Section 8 of this Restoration Plan)
- h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised. (Section 9 of this Restoration Plan)
- i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element (h) immediately above. (Section 10 of this Restoration Plan)

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

2 Watershed Characteristics

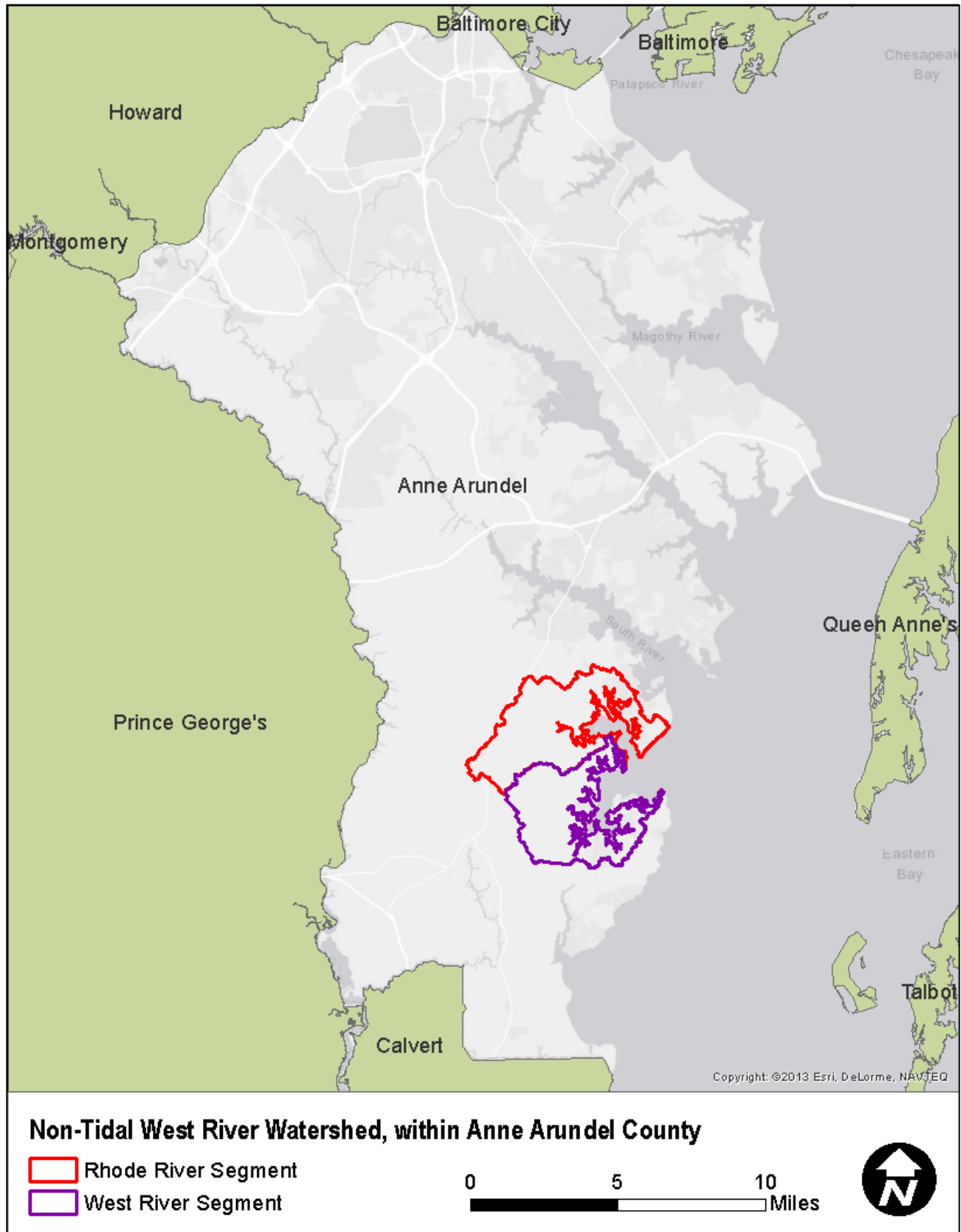
The following sections describe the watershed characteristics for the Non-Tidal West River watershed. Much of the information is presented as an aggregation of data from the West and Rhode Rivers, the two major segments of the Non-Tidal West River watershed.

2.1 Watershed Delineation

The Non-Tidal West River watershed is located in the southeastern part of Anne Arundel County, Maryland, and is one of the 12 major watersheds in the County. It is also part of the larger Chesapeake Bay watershed.

The Non-Tidal West River watershed consists of two major segments - the West River and the Rhode River - as shown in Figure 2.1. While Figure 2.1 shows these segments separately, the remainder of this section discusses the two segments in aggregate as the larger Non-Tidal West River watershed, unless the data is from existing County documents, in which case the two segments are shown separately (e.g., Figures 2-1 and 2-2).

Figure 2-1: Location of the Non-Tidal West River Watershed (With the West and Rhode River Segments) Within Anne Arundel County



2.2 Non-Tidal West River Subwatersheds

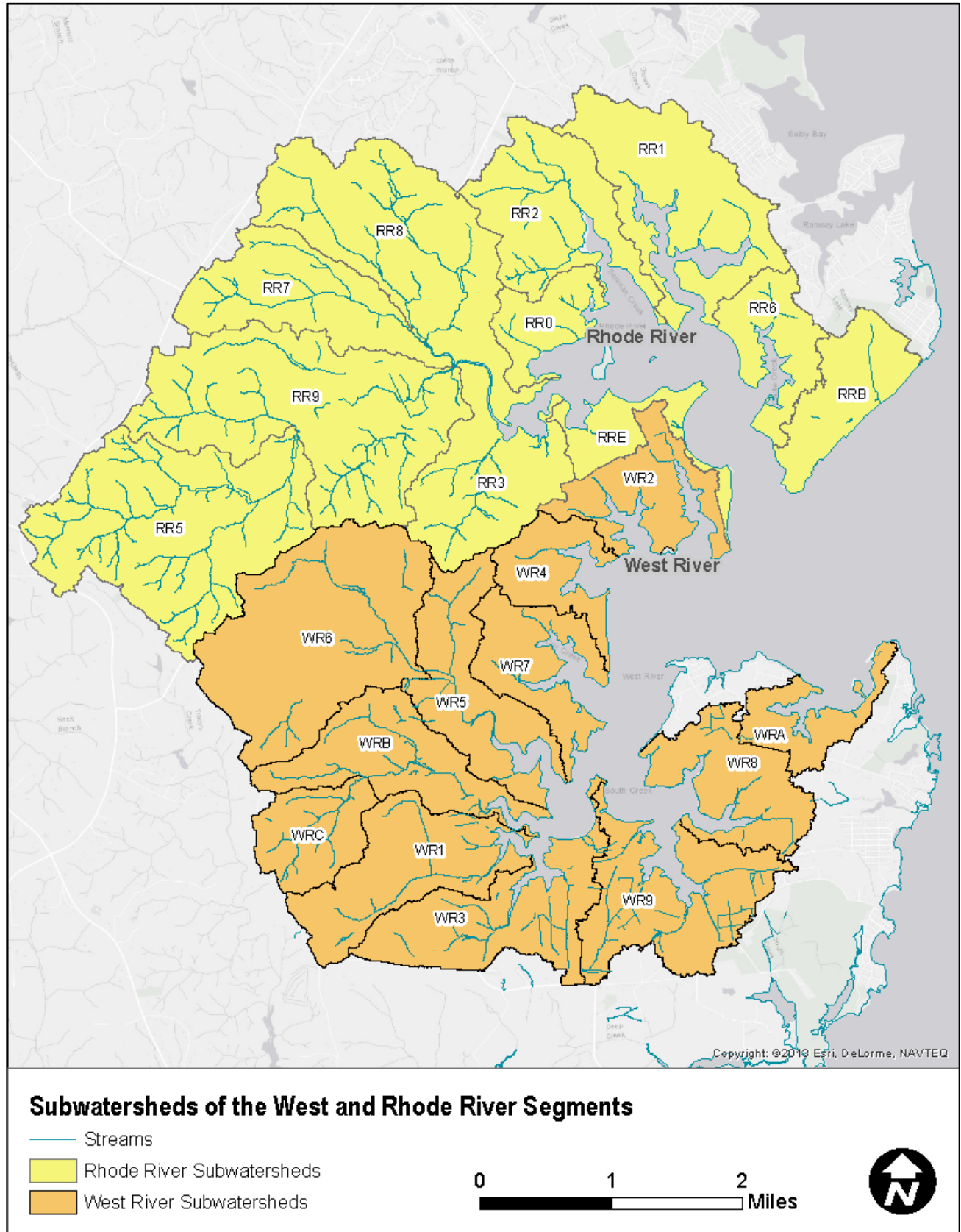
The following information was taken from the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016). The Non-Tidal West River watershed is approximately 15,623 acres (24.4 mi²) and contains approximately 62 miles of streams, 33 miles of which are perennial streams. The watershed is divided into 23 subwatersheds, which were used as the planning units. The West River segment encompasses 12 of these subwatersheds, and another 11 are located in the Rhode River segment. Table 2-1 shows the area and length of stream for each subwatershed.

Table 2-1: Non-Tidal West River Subwatershed Area and Stream Length

Subwatershed Code	Segment	Subwatershed Name	Drainage Area (acres)	Drainage Area (square miles)	Total Stream Length ¹ (miles)
WR1	West River	Johns Creek	683	1.07	1.9
WR2	West River	Cheston Creek	444	0.69	0.7
WR3	West River	Gales Creek	701	1.10	1.9
WR4	West River	Popham Creek	317	0.50	0.6
WR5	West River	Lerch Creek I	615	0.96	0.5
WR6	West River	Lerch Creek II	1,386	2.17	5.5
WR7	West River	Tenthouse Creek	434	0.68	0.6
WR8	West River	South Creek I	518	0.81	2.1
WR9	West River	South Creek II	749	1.17	5
WRA	West River	Parish Creek	266	0.42	0.4
WRB	West River	Smith Creek I	619	0.97	1.2
WRC	West River	Smith Creek II	372	0.58	3.4
RR0	Rhode River	Forrest Branch	275	0.43	1.1
RR1	Rhode River	Bear Neck Creek	879	1.37	3.2
RR2	Rhode River	Sellman Creek	701	1.10	3.5
RR3	Rhode River	Many Fork Branch	670	1.05	3.7
RR5	Rhode River	South Fork Muddy Creek II	1,488	2.33	9.6
RR6	Rhode River	Cadle Creek	355	0.55	0.6
RR7	Rhode River	Williamson Branch	660	1.03	4
RR8	Rhode River	North Fork Muddy Creek	1,259	1.97	7.6
RR9	Rhode River	South Fork Muddy Creek I	1,541	2.41	3.8
RRB	Rhode River	Beverley Beach	433	0.68	0.4
RRE	Rhode River	Boathouse Creek	258	0.40	0.4
Non-Tidal West River Total			15,623	24.44	61.7
¹ Stream miles includes ephemeral, intermittent channels as well as perennial stream reaches					

Figure 2-2 shows the subwatershed delineations for the watershed. Note that five subwatersheds that are included in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016) have not been included in the tables and figures included in this Restoration Plan because they drain directly to the tidal portions of their respective rivers and are not part of the TMDL watershed.

Figure 2-2: Subwatersheds of the West and Rhode Segments



2.3 Land Use/Land Cover

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

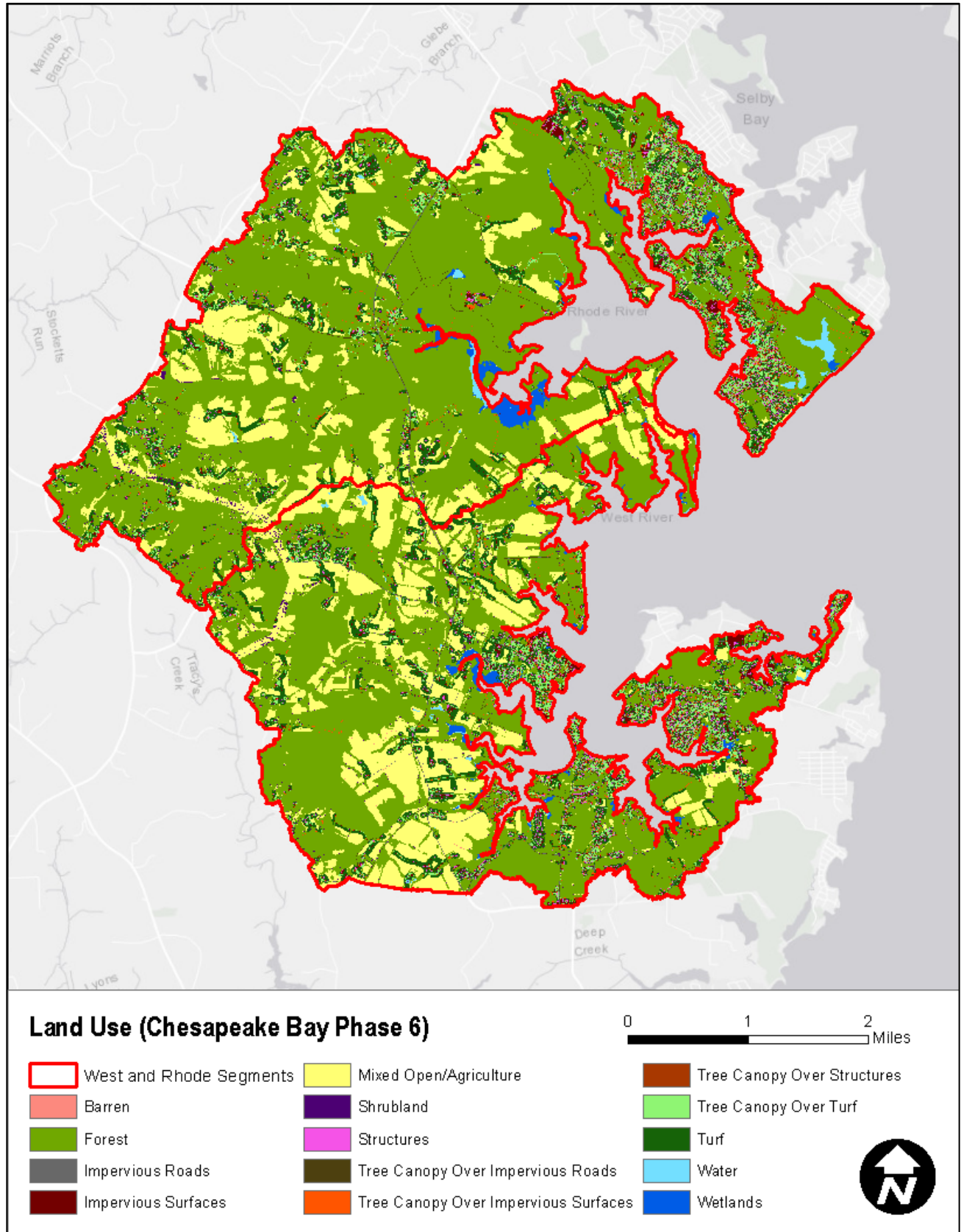
2.3.1 Existing Land Use/Land Cover

As shown in Table 2-2, the Non-Tidal West River watershed is largely undeveloped, containing mostly forest (57.9%) followed by mixed open/agriculture (18.5%) and turf (9.4%). Impervious surfaces account for approximately 6.3% (sum of all impervious LULC categories that include roads, surfaces, and structures, as well as tree canopy over roads, surfaces, and structures). Figure 2-3 shows the LULC of the watershed. These data were obtained from the CBP Phase 6 Land Use data set published by the United States Geological Survey (USGS, 2018).

Table 2-2: Non-Tidal West River Land Use/Land Cover

Land Use/Land Cover	West River Segment (Acres)	Rhode River Segment (Acres)	Non-Tidal West River Watershed (Acres)	Percent of Non-Tidal West River Watershed
Forest	5362	3681	9043	57.9%
Mixed Open/Agriculture	1236	1660	2896	18.5%
Turf	739	738	1477	9.4%
Tree Canopy Over Turf	410	352	761	4.9%
Shrubland	47	67	114	0.7%
Impervious Roads	91	75	166	1.0%
Impervious Surfaces	148	147	296	1.9%
Structures	92	93	185	1.2%
Tree Canopy Over Impervious Surfaces	94	79	174	1.1%
Tree Canopy Over Impervious Roads	56	46	102	0.7%
Tree Canopy Over Structures	33	27	60	0.4%
Barren	0	3	3	<0.1%
Wetlands	110	75	185	1.2%
Water	103	62	165	1.1%
TOTAL	8521	7105	15627	100%

Figure 2-3: Phase 6 Land use in the Non-Tidal West and Rhode River Segments



2.3.2 Impervious Surfaces

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

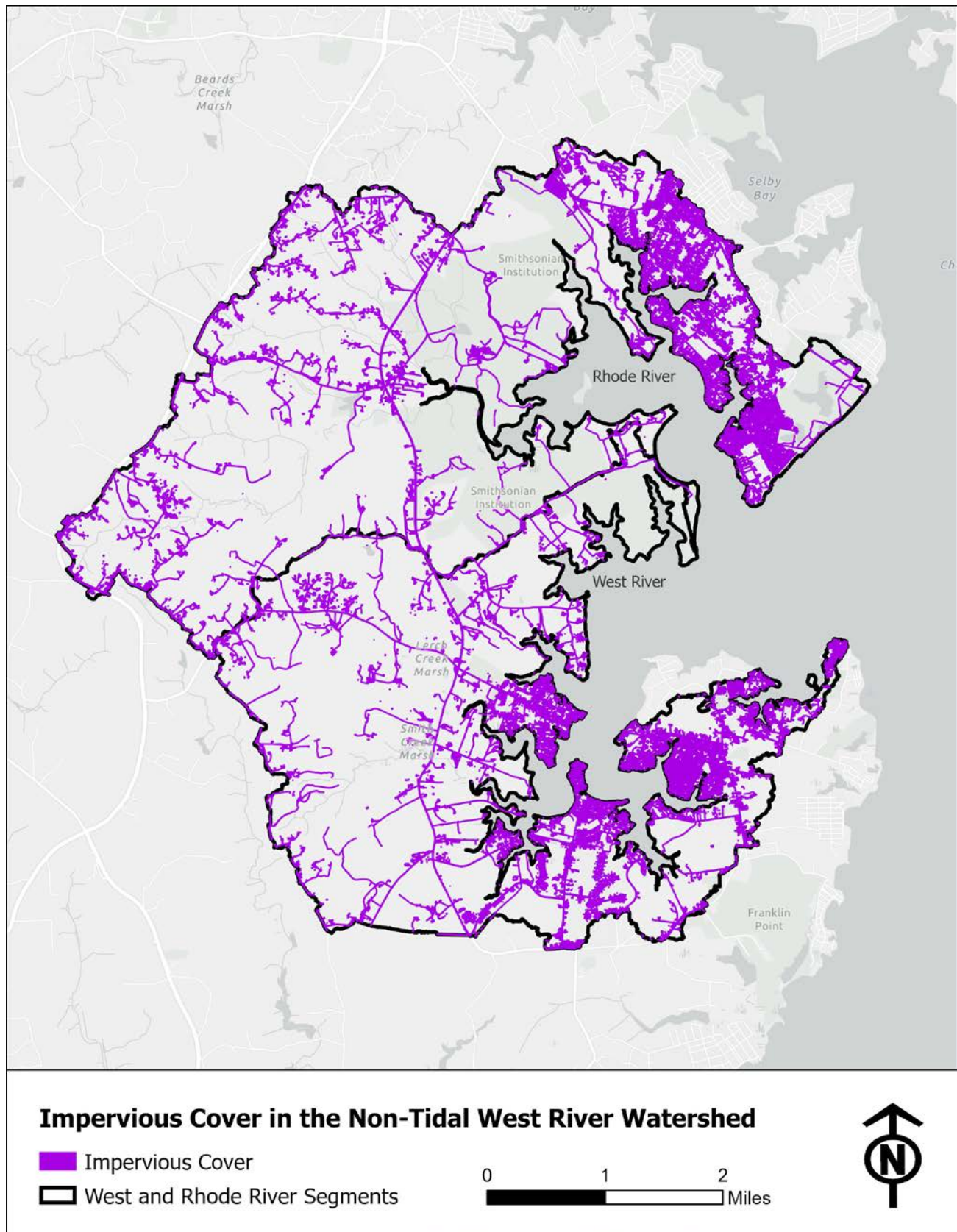
Impervious surfaces make up 6.3% of the Non-Tidal West River watershed, with the percent impervious in a given subwatershed ranging from 1.6% to as high as 23.0% impervious cover, as shown in Table 2-3. Figure 2-4 shows the impervious cover within the watershed.

Table 2-3: Non-Tidal West River Percent Impervious Area by Subwatershed²

Subwatershed Code	Segment	Subwatershed Name	Percent Impervious
WR1	West River	Johns Creek	3.9%
WR2	West River	Cheston Creek	2.0%
WR3	West River	Gales Creek	7.9%
WR4	West River	Popham Creek	2.8%
WR5	West River	Lerch Creek I	7.1%
WR6	West River	Lerch Creek II	3.3%
WR7	West River	Tenthouse Creek	11.8%
WR8	West River	South Creek I	19.2%
WR9	West River	South Creek II	9.1%
WRA	West River	Parish Creek	19.6%
WRB	West River	Smith Creek I	2.8%
WRC	West River	Smith Creek II	1.8%
RR0	Rhode River	Forrest Branch	3.8%
RR1	Rhode River	Bear Neck Creek	18.4%
RR2	Rhode River	Sellman Creek	2.8%
RR3	Rhode River	Many Fork Branch	2.3%
RR5	Rhode River	South Fork Muddy Creek II	3.7%
RR6	Rhode River	Cadle Creek	23.0%
RR7	Rhode River	Williamson Branch	4.6%
RR8	Rhode River	North Fork Muddy Creek	4.5%
RR9	Rhode River	South Fork Muddy Creek I	2.7%
RRB	Rhode River	Beverley Beach	10.3%
RRE	Rhode River	Boathouse Creek	1.6%
Non-Tidal West River Watershed			6.3%

² Anne Arundel County, Planimetric Impervious Surfaces, 2020.

Figure 2-4: Impervious Cover in the Non-Tidal West River Watershed



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

Table 2-4: Area of County-Owned Buildings and Parking Lots for Potential BMP Implementation in the Non-Tidal West River Watershed

Buildings	Total Area (sq.ft.)	Number of Buildings
2,000-4,000 sf	14,460	6
4,000-6,000 sf	5,028	1
>6,000 sf	89,936	7
TOTAL	109,424	14
Parking Lots	Total Area (sq.ft.)	Number of Parking Lots
1/16-1/8 acre	19,840	8
1/8-1/4 acre	8,297	1
1/4-1/2 acre	87,202	6
>1/2 acre	134,422	4
TOTAL	249,761	19

2.4 Water Quality

2.4.1 Use Designations

According to water quality standards established by MDE in the Code of Maryland Regulations (COMAR) 26.08.02.08³, the Non-Tidal West River is classified as a Class I water. Class I waters are generally designated to support “water contact recreation and protection of non-tidal warm water aquatic life.” The more detailed designated uses of Class I waters are shown below in Table 2-5.

Table 2-5: Designated Uses in the Non-Tidal West River and its Tributaries

Designated Use	Non-Tidal West River
Growth and propagation of fish (not trout), other aquatic life and wildlife	Yes
Water contact sports	Yes
Leisure activities involving direct contact with surface water	Yes
Fishing	Yes
Agricultural water supply	Yes
Industrial water supply	Yes
Public water supply	Yes

³ <http://www.dsd.state.md.us/comar/comarhtml/26/26.08.02.08.htm>

2.4.2 303(d) Impairments

According to Maryland’s final 2018 303(d) list of impaired waters, the Non-Tidal West River watershed is impaired by TSS and sulfates. The water quality impairment of the Non-Tidal West River watershed is caused, in part, by an elevated sediment load beyond a level that the watershed can sustain, thereby causing sediment-related impacts to aquatic life. The sediment impairment was listed in 2012. The impairment is Category 5, which indicates that the waterbody is impaired and a TMDL or water quality analysis (WQA) is needed. Impairments are summarized below in Table 2-6.

Table 2-6: 303(d) Impairments in the Non-Tidal West River watershed

Watershed	Basin Code	Non-tidal/ Tidal	Designated Use Class	Year Listed	Identified Pollutant	Listing Category
Non-Tidal West River	02131004	Non-tidal	Class I	2012	TSS	5
Non-Tidal West River	02131004	Non-tidal	Class I	2012	Sulfates	5

2.4.3 TMDLs

TMDLs are pollutant limits established for waterbodies on Maryland’s 303(d) list to help achieve the waterbody’s designated use. In order to establish the TMDL, the State estimates the maximum allowable pollutant load that the water body can receive and still meet water quality standards. TMDLs are required by the CWA for waters listed in Category 5. The Non-Tidal West River Sediment TMDL was approved on April 24, 2019. The TMDL targets for the Non-Tidal West River were obtained from the TMDL document titled “Final Technical Memorandum, Point Sources of Sediment in the Non-Tidal West River Watershed, January 2019” (MDE, 2019b). The watershed loads in the TMDL were modeled using the CBP Phase 5.3.2 (CBP P5.3.2) watershed model 2009 Progress Scenario edge-of-stream (EOS) sediment loads. The TMDL baseline loads, SW-WLAs, and required sediment load percent reduction are summarized in Table 2-7 below. Note that baseline year for the TMDL is 2009. For the Non-Tidal West River watershed, the County’s MS4 regulated area requires a 22% reduction in sediment load.

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

NPDES Regulated Stormwater Sector	Baseline Load (ton/yr)	SW-WLA (ton/yr)	Reduction (%)
Non-Tidal West River, Anne Arundel County Phase I MS4	288	226	22

Of the information presented in the TMDL, only the percent reduction will be used in this restoration plan. The baseline loads and SW-WLA target were recalculated using TIPP, as further explained in Section 4.1.

2.4.4 NPDES

Under section 402(p) of the CWA, the EPA’s NPDES permit program is required to include MS4 discharges. Since 2002, NPDES permits have included WLA requirements, including those for MS4 discharges. Anne Arundel County holds a Phase 1 Large Jurisdiction MS4 NPDES permit issued by MDE (11-DP-3316, MD0068306). The County’s first permit was issued in 1993. The current fourth permit was issued in 2014 and was administratively continued until the issuance of the fifth generation permit on November 5, 2021.

Section IV.E.2.b of the current permit requires the County to develop a restoration plan for any EPA approved local TMDLs with a stormwater wasteload (SW-WLA) allocation. The restoration plan must be completed within a year of the TMDL approval date. EPA approved the Sediment TMDL for the Non-Tidal West River Watershed on April 24, 2019, thus requiring the submittal of a restoration plan by April 24, 2020. An initial draft Restoration Plan was submitted to MDE on April 17, 2020.

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

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

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

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

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

2.4.5 Monitoring

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

3 Causes and Sources of Impairments

3.1 Impairments

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

3.2 Sources

Sediment can come from soil erosion or from the decomposition of plants and animals. Wind, water, and ice help carry these particles to rivers, lakes and streams. While natural erosion produces nearly 30 percent of the total sediment in the United States, accelerated erosion from human use of land accounts for the remaining 70 percent⁴. For Anne Arundel County's MS4 jurisdictional area, sediment sources are predominantly tied to the MS4 land use sources and stream erosion.

The loading rates used in the modeling for the Restoration Plan are from MDE's TIPP tool are shown in Table 3-1 below. The TIPP tool's loading rates are aggregated at the 8-digit watershed and Chesapeake Bay Segment scale by county. The loading rates include Stream Bed and Bank (STB) loads, which were determined by a variation of the method used to determine STB load in the 2020 MS4 Accounting Guidance document. The TIPP tool includes a range of land use types, but for the West River modeling, only the aggregate impervious and turf load sources were used, as shown in the Table 3-1.

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

Table 3-1: Percent Impervious and Turf Area in the MS4 Portion of the Non-Tidal West River and corresponding loading rate

Load Source	Amount (acres)	Percent of Total Area	Loading Rate
Aggregate Impervious	496	16%	7992.24
Tree Canopy over Aggregate Impervious	278	9%	7432.78
Turf	1526	49%	1415.90
Tree Canopy over Turf	787	25%	1333.78

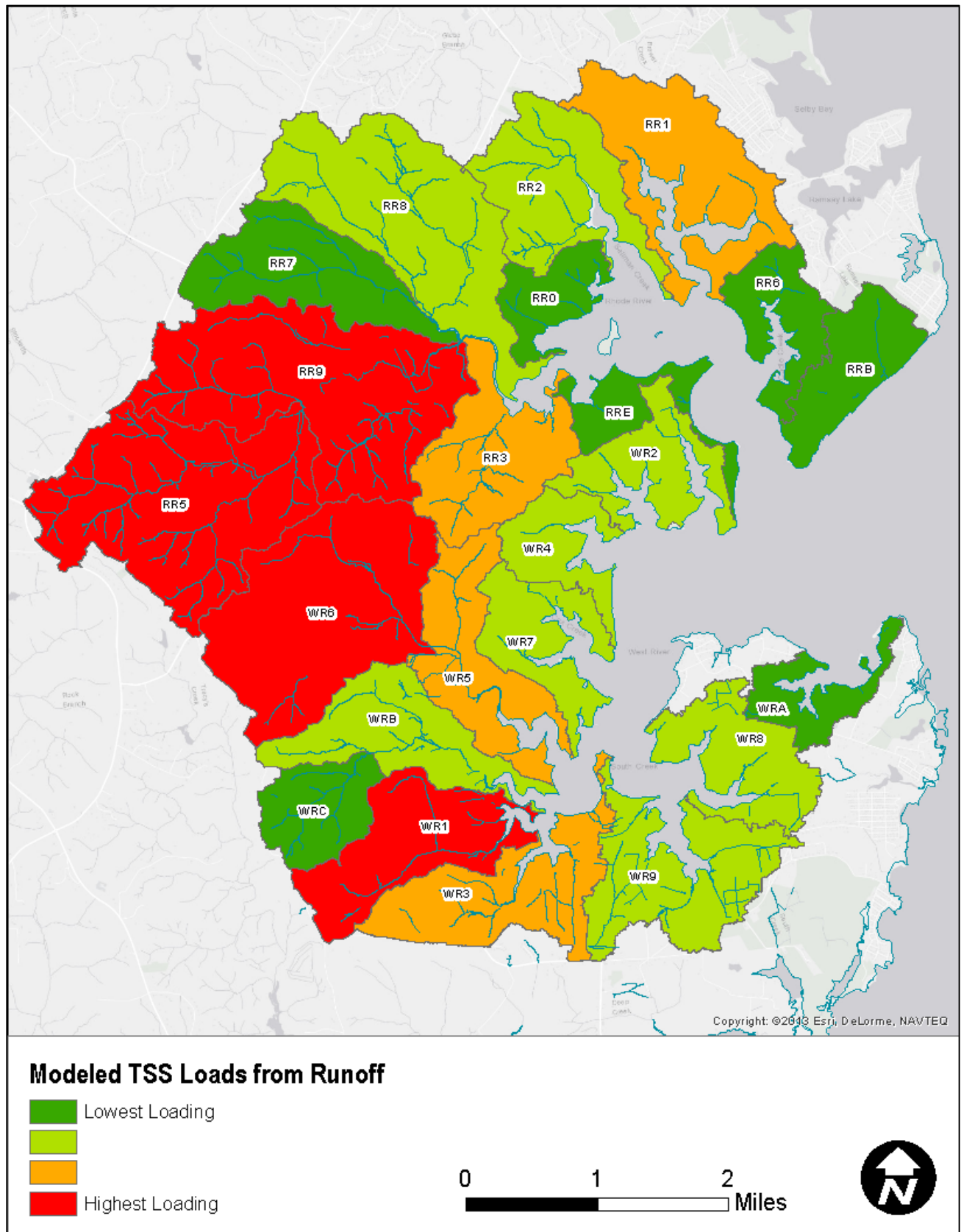
3.2.1 Urban Stormwater Runoff

The sediment load contribution of urban stormwater and urban nonpoint sources was analyzed in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016). Figure 3-1 presents the modeled annual total suspended solids runoff load as the relative quantity of sediment contributed from each subwatershed (i.e., lowest to highest). This modeling scenario represents current actual land use conditions and accounts for pollutant load reductions from existing public and privately owned BMPs, all restoration projects performed as part of the County's Capital Improvement Program (CIP), and disconnected impervious surfaces. The water quality model used for the assessment was based on EPA's Simple Method (Schueler, 1987) and PLOAD models (EPA, 2001) using event mean concentrations (EMCs) for each LULC type. The results presented here are the sediment associated with runoff, and do not reflect in-stream sources. Model results indicate that runoff from the following LULC categories contribute the most overall sediment: row crops, pasture and hay, transportation, and industrial areas. These LULC categories also have the highest sediment loading rates. While residential land has a lower sediment loading rate, it makes up a significant portion of the watershed (approximately 24%) and is therefore also a significant contributor to loads.

Subwatersheds contributing the highest amount of existing sediment loads include WR1, WR6, RR5, RR9, and to a lesser extent, subwatersheds WR3, WR5, RR3, RR1.

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

Figure 3-1: Modeled Existing Watershed Sediment Loads for the Non-Tidal West River by Subwatershed from the 2016 Watershed Characterization Report



3.2.2 In-stream Sources

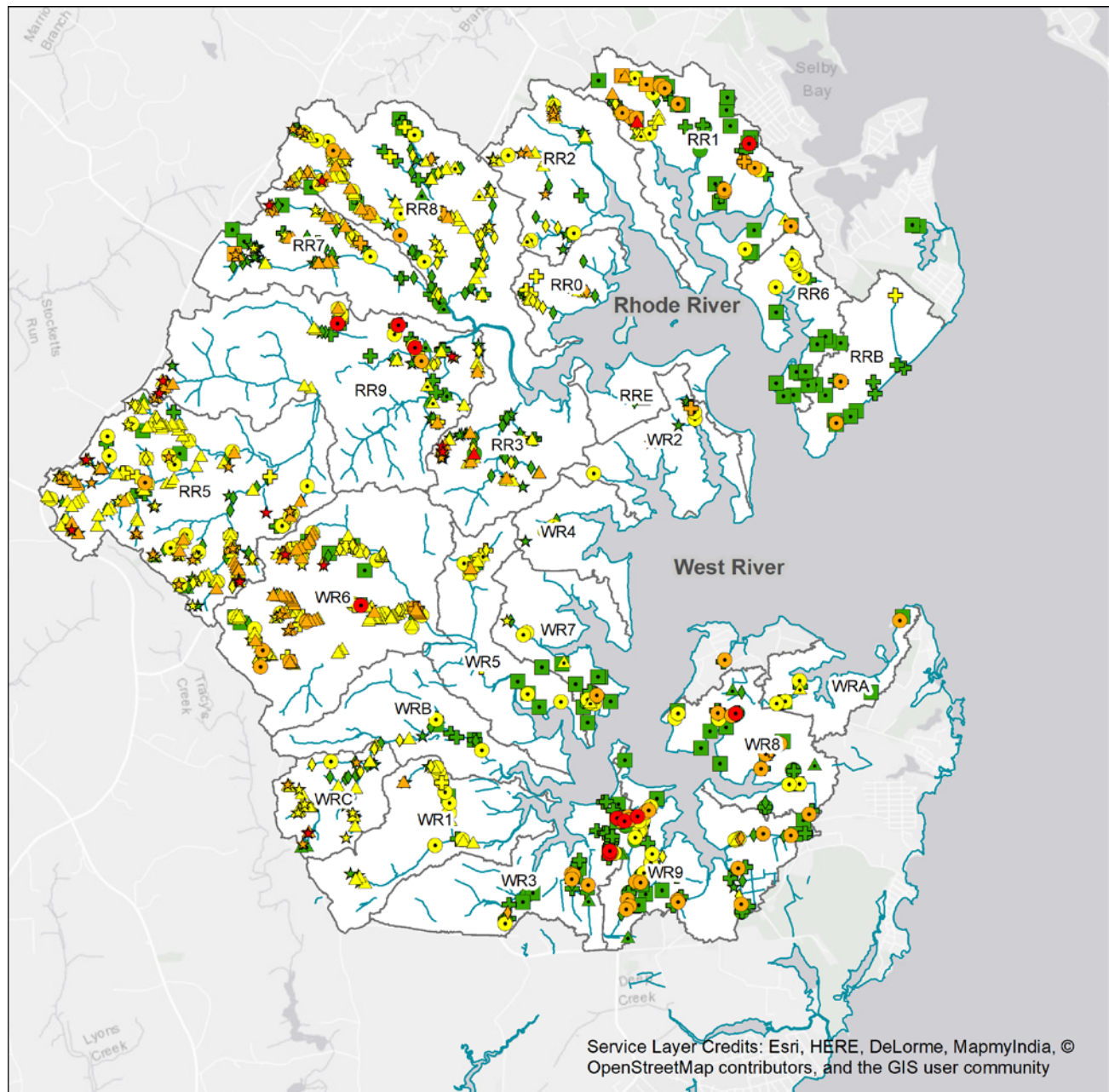
Although channel bed and bank erosion occurs naturally as streams work to maintain a state of dynamic equilibrium, excessive erosion can occur due to increased stream discharge and velocity. Increased stream discharge is often associated with development and agricultural activities that increase runoff and encroach on riparian buffers within the watershed. Channel erosion can deliver excessive pollutants such as sediment and phosphorus downstream, where water quality can be impacted and important habitat for fish spawning and benthic invertebrates can be degraded. Excessive erosion can also threaten the stability of nearby built infrastructure. The Biological Stressor Identification Analysis (BSID) included in the *West and Rhode Watersheds Assessment Report* determined that biological communities in this watershed are likely degraded due to sediment and in-stream habitat related stressors, as well as water quality (Anne Arundel County, 2016). These stressors often result from altered hydrology and increased runoff from impervious area, specifically from channel erosion and subsequent elevated suspended sediment transport through the watershed. Thus, suspended sediment was identified as a probable cause and confirmed the Category 5 listing for TSS as an impairing substance in this watershed.

Approximately 62 miles of streams were assessed and characterized for the Non-Tidal West River watershed, as described in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016). Data collected included stream classifications, physical habitat condition assessment, inventory of infrastructure and environmental features, habitat scores, channel geomorphology, road crossing flood potential, bioassessments, and aquatic resource indicators. Within each perennial reach, channel erosion was assessed and scored based on severity. A score of five was considered Moderate impact, a score of seven was considered Severe, and a score of 10 was considered an Extreme condition. A total of 360 erosion locations in the Non-Tidal West River watershed were cataloged with erosion severity rated as moderate, severe, or extreme (Figure 3-2). Erosion impacts were attributed mostly to development in the watersheds. In addition to stream erosion, a total of 206 headcuts were inventoried (Table 2.4 in *West and Rhode Watersheds Assessment Report*, Anne Arundel County, 2016). The information on location of erosion and height of headcut, along with other collected data such as length of erosion, are used to assess potential stream restoration projects.

An assessment of channel geomorphology utilizing Rosgen Level I geomorphic classifications (Rosgen, 1996) was also developed for each single-threaded, perennial reach throughout the watershed as part of the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016). An assessment of channel geomorphology is useful to better understand the stability of a stream and its associated behaviors, including channel entrenchment. The Rosgen classification system has four levels. The Level I classification is a geomorphic characterization that groups streams as Types A through G based on aspects of channel geometry, including water surface slope, entrenchment, width/depth ratio, and sinuosity.

The majority of the assessed perennial stream miles in the Non-Tidal West River watershed were Type B (29.5 percent) or Type C (28.4 percent) channels. Type B channels are typically characterized as predominantly stable, moderate gradient channel, with low sinuosity and low erosion rate. Type C channels exhibit a well-developed floodplain, higher sinuosity, and susceptibility to de-stabilization when flow regimes are altered. Type G channels, which make up 18.8 percent of the assessed stream miles, are unstable, incised “gully” channels with high erosion rates. Type F channels made up 15.5 percent of assessed stream miles, and are generally entrenched, meandering streams, often with high width/depth

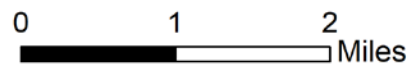
Figure 3-2: Watershed Infrastructure and Environmental Features Including Stream Erosion Inventory (Anne Arundel County, 2016)



Infrastructure and Environmental Features in Non-Tidal West River Watershed

- Ditches
- ▣ Pipes
- ⊙ Buffers
- ⊕ Crossings
- △ Dumpsites
- △ Erosion
- ☆ Head cuts
- ◇ Obstructions

- Minor Impact
- Moderate Impact
- Severe Impact
- Extreme Impact



ratios, and very high bank erosion and lateral extension rates. The remaining 7.8 percent of stream miles were of other types. Because they represent such a small percentage of stream miles, these streams are not discussed further here, but they are discussed in more detail in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016).

3.3 Anticipated Growth

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

3.3.1 Estimates of Future Growth

As stated in the MDE guidance document *General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan*, Section 1.h. (MDE, 2014b):

New urban areas that have been developed since TMDL allocations were set imply loads beyond the original SW-WLA (i.e., additional urban footprint within a watershed). This can confound the process of accounting for load reductions to meet the allocations. MDE is working to develop methods to deal with this issue. However, MDE is also recommending that within the SW-WLA implementation plans, local jurisdictions estimate this potential new urban load as the next step in a longer-term process to address the issue.

Anne Arundel County’s planning and policies for addressing future growth are included in the County’s General Development Plans. The most recent General Development Plan, *Plan 2040: Anne Arundel County General Development Plan*, was adopted on May 3, 2021 (Bill No. 11-21) and became effective on June 27, 2021. Plan2040 establishes a vision, goals, policies, and strategies to guide development of Anne Arundel County over the next twenty years. It lays out a policy framework that informs many of the County’s future decisions on land use, environmental protection, transportation, open space, agriculture, community facilities, historic preservation, housing, economic development, and quality of life. Plan2040 incorporates five themes (Resilient, Environmentally-Sound, and Sustainable Communities; New and Improved Infrastructure Strategic Economic Growth and Redevelopment; Community Character; and Inclusive, Equitable, and Responsive Government) that are integrated into a comprehensive set of goals and policies. Plan2040 will be implemented through Region Plans, functional plans, design manuals, regulations, the capital budget, and the work programs of County departments.

Plan 2040 is divided in to two volumes adopted by the County Council. Volume I includes a description of the County’s vision for the future; a discussion of challenges and opportunities and limitations; a discussion of equity within the Plan; a discussion of how to use of the Plan; a summary of the existing Growth Management Program and its six elements; and a description of how the Plan aligns with the State of

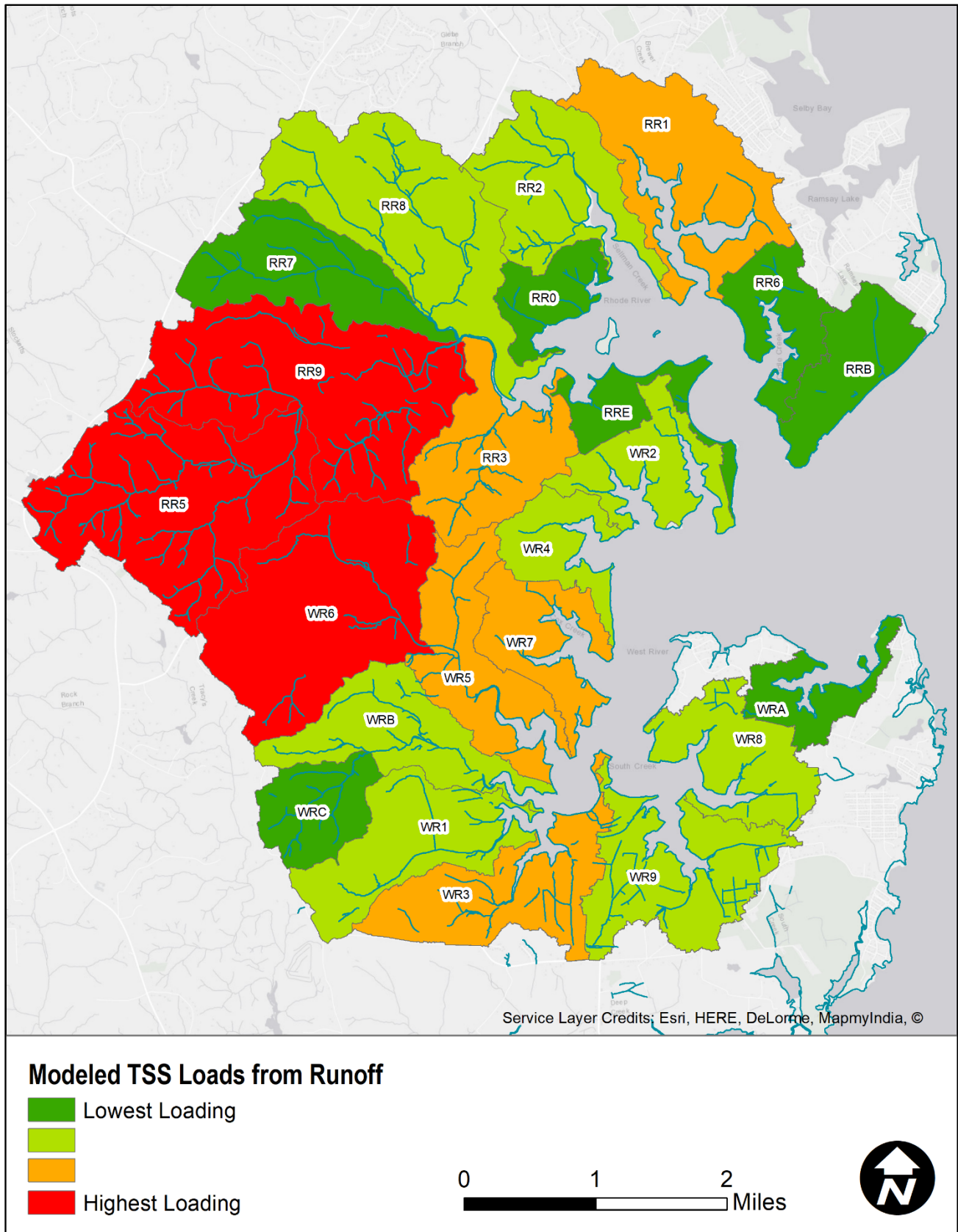
Maryland's "12 Visions." In addition, Volume I includes goals and policies; and strategies to implement the Vision. Volume II provides the background underlying the Plan.

As defined within Plan 2040, the Nontidal West River watershed includes Rural and Agricultural, Peninsula, and Neighborhood Preservation Policy Areas, as well as Village Center areas. Plan2040 capitalizes on the County's assets and aims to conserve its critical resources. As documented in the Plan in the "Planning for the Natural Environment" chapter, the Nontidal West River watershed contains multiple parklands and preserved open space, as well as categorized wetlands. There are also Priority Preservation Areas for agricultural and woodland preservation.

As reported in a Land Use Market Analysis conducted by RKG Associates in 2018 for Plan2040, the County experienced a 2% annual average population growth and captured the highest share of growth in the region between 1970 to 2010. However, the County's growth rate since 2010 has been slowing. With an estimated 2018 population of 576,031, population growth averaged roughly 0.7% annually between 2010 and 2018. That is slower than the 1% annual growth rate achieved during the 2000-2010 period. According to Plan2040, the population of the County is expected to increase by 0.4 - 1 % per year from 2020 to 2040. The Baltimore Metropolitan Council projects the County's population to grow by approximately 50,000 people (29,000 households) by 2040. Countywide employment is projected to grow by more than 68,000 jobs by 2040.

There are no major cities or towns located in the Non-Tidal West River watershed. The primary developed areas located in watershed are residential properties located in Mayo, Shady Side and Galesville or along the major road arteries. The majority of the watershed is forested, followed by agriculture and turf. Additional residential properties may develop as growth occurs throughout the County. Anne Arundel County continues to utilize strategies such as promoting low impact development and implementing stormwater BMPs for water quality treatment. However, increased urban stormwater related loads will inevitably occur as growth continues. Figure 3-3 depicts sediment loading by subwatershed based on a future conditions modeling scenario with the implementation of projects funded in the County's CIP as recommended in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016) and discussed further in Section 4. This modeling scenario relies on a realistic estimate of future development (informed by legal/physical constraints on development, capacity studies conducted by the County's Office of Planning and Zoning, and expected changes in land use), under the assumption that any future development complies with Environmental Site Design (ESD) to the MEP. In general, future sediment loading is projected to be highest in Lerch Creek II (WR6), South Fork Muddy Creek I (RR9), South Fork Muddy Creek II (RR5), Gales Creek (WR3), Many Fork Branch (RR3), Lerch Creek I (WR5), and Bear Neck Creek (RR1) subwatersheds.

Figure 3-3: Modeled Future Watershed Sediment Loads for the Non-Tidal West River by Subwatershed from the 2016 Watershed Characterization Report



3.3.2 Offsetting Sediment Loads from Future Growth

Anne Arundel County's new General Development Plan, *Plan2040*, establishes the following vision for the County's natural environment into the future: *Resilient, Environmentally-Sound, and Sustainable Communities – Planning and land use decisions affecting development and redevelopment will enhance neighborhoods while protecting the natural environment and increasing community resilience to climate change. We will support the diverse communities in the County from rural lands, to waterfront communities, to suburban neighborhoods, to town centers. Collective efforts to reduce stormwater runoff, and restore forests, rivers, and shorelines will contribute to a healthier environment. The County will strive to reduce greenhouse gas emissions through conservation and renewable energy production.*

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

In Volume 2 of *Plan2040*, in the section describing "Planning for the Built Environment," the County describes trends and lays out its policies for land use and development. *Plan2040* addresses land use needs Countywide and specifically where future growth and development should be concentrated, where land should be preserved and how established neighborhoods can be preserved. The Plan revises the County's adopted 2009 Development Policy Areas and

- Creates an intentional and strategic approach to direct the County's future development in areas where redevelopment and revitalization opportunities exist;
- Creates vibrant, mixed-use, transit oriented, walkable communities;
- Capitalizes on existing and planned infrastructure investments;
- Preserves natural, rural and agricultural resources; and
- Protects existing neighborhoods and the peninsula areas from additional impacts of development is to create development policy areas.

A Land Use Market Analysis completed in 2019 revealed that over 90% of the County's land area is classified as developed, in large part due to large-lot residential development in the southern and central parts of the County. Approximately 13,736 acres of developable land (land zoned for development without environmental constraints) remains in the County. About one-fourth of this land is in the southern part of the County, where growth potential is limited by low-density zoning and development policies.

According to the latest adopted forecasts by the Baltimore Metropolitan Council, the population of the County is projected to grow by approximately 50,000 people (29,000 households) by 2040. Countywide employment is projected to grow by more than 68,000 jobs by 2040. Based on the development capacity analysis, there is sufficient buildable land under current zoning to support that growth. *Plan2040* establishes a framework for where and how growth occurs. Low-density, suburban growth patterns will strain availability of undeveloped land and costs for development and maintenance of public infrastructure and services. Given the commitment to environmental, rural and agricultural preservation, redevelopment and revitalization of existing developed areas will be the key to the County's sustainability. The requirements of environmental regulation, adequate public facilities ordinance, limitations on upzoning based on consistency with the adopted land use plan, along with real estate economics and development incentives are likely to direct much of that future growth to redevelopment within Targeted Growth Areas with less

subdivision of forest and farmland than has occurred in recent decades. Based on these considerations, the County developed an updated Planned Land Use Map for inclusion in Plan2040. Changes from the 2009 land use map included changes in land use categories; minor consistency changes; planned land use change application requests, and “comprehensive land use changes” that are either to reflect better alignment with the parcel boundary that is not considered a minor change or to change an existing nonconforming use expected to continue within the planning horizon to the appropriate planned land use designation.

Overall, growth and development is expected to occur throughout Anne Arundel County, and depending on when and where this growth occurs, pollutant loading from urban stormwater sources may also increase. *Plan2040* will direct and, in association with programmatic and regulatory measures, will manage future growth in a way that will minimize increases in sediment loading from new development in the [Non-Tidal] West River watershed. In addition, Maryland's baseline programs, including the 1991 Forest Conservation Act, the 1997 Priority Funding Areas Act, the 2007 Stormwater Management Act, the 2009 Smart, Green & Growing Planning Legislation, the 2010 Sustainable Communities Act, the 2011 Best Available Technology Regulation, and the 2012 Sustainable Growth & Agricultural Preservation Act, effectively mitigate the majority of the impacts from new development. Any additional loads will be offset through Maryland's alignment for growth policies and procedures as articulated through Chesapeake Bay milestone achievement. The overriding goal of no net growth in loads is reflected in these policies, programs, and implementation as part of the net WLA accounting as stipulated in Part IV.E.4.b.ii of the NPDES-MS4 permit.

It is anticipated that new development will make use of ESD stormwater treatment according to MDE's Stormwater Regulations. Further, Maryland's 2007 Stormwater Management Act went into effect in October of 2007, with resulting changes to COMAR and the 2000 Maryland Stormwater Design Manual in May of 2009. The most significant changes relative to watershed planning are in regard to implementation of ESD. The 2007 Act defines ESD as “using small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources.” As such, Anne Arundel County has updated Articles 16 and 17 of the County Code to incorporate the requirements for ESD. Anne Arundel County finalized the *Anne Arundel County Stormwater Management Practices and Procedures Manual* (Anne Arundel County, 2010) to incorporate criteria specific to the County that are not addressed within the Maryland Design Manual. Additionally, a comprehensive review and update to the County's Manual was completed in 2017 and approved by MDE. The update included a new “Temporary Stormwater Management” policy that requires management of the 1-year storm for all construction projects that require grading permits.

Anticipated AFG policies will address the residual load (TN: 50 percent, TP: 40 percent, TSS: 10 percent, and bacteria: 30 percent) that is potentially uncontrolled by development-based stormwater controls. As required by the State's Phase III Watershed Implementation Plan (Bay Restoration Plan) Maryland is developing an AFG policy that will address the expected increase in the State's pollution load from increases in population growth and new development. While not currently a fully formed policy, the State's plan, as of the *Final Report of the Workgroup on Accounting for Growth in Maryland* (August 2013), focuses on two elements: 1) the strategic allotment of nutrients loads to large wastewater treatment plants, upgraded to the best available technology; and 2) the requirement that all other new loads must be offset by securing pollution credits.

4 Management Measures

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

4.1 Modeling Approach

BMPs provide reductions for nitrogen, phosphorus, sediments, and other pollutants. The sediment pollutant loads for the Non-Tidal West River watershed were determined using the TIPP Tool [Version 8/16/21] developed by MDE. The TIPP tool functions as a calculator to estimate pollutant loads and evaluate current progress and implementation scenarios, ensuring sufficient restoration and management practices are planned to meet the load reduction target.

The loads provided in the TIPP Tool are available at two different scales: Edge-of-Stream (EOS) and Edge-of-Tide (EOT). EOS refers to loads that reach the edge of a small stream, while EOT refers to loads that reach the edge of the tidal portion of the Bay. EOS loads are more appropriate for watershed restoration plans and were used for all modeling analyses. The TIPP tool calculates EOS loads using the methods and BMP efficiencies recommended by the expert panels approved by CBP.

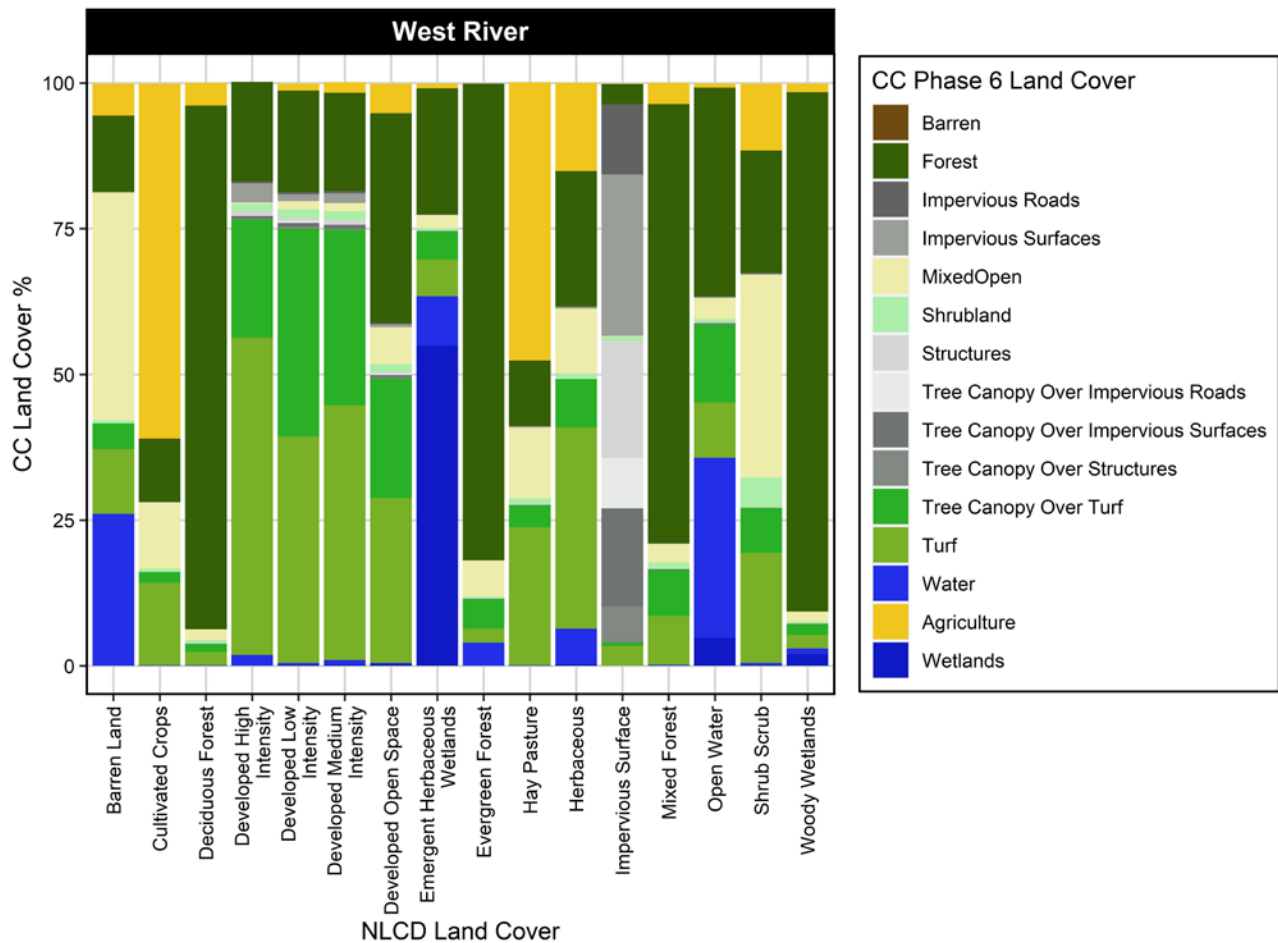
Land cover data from the National Land Cover Database (NLCD) was used to quantify land cover acreage for the baseline year. Because NLCD land cover classifications are inconsistent with the Phase 6 Chesapeake Bay Watershed Model land cover classes, the backcasting method developed by Baltimore County was applied to NLCD data used within the TMDL progress modeling.

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

As NLCD land cover data does not have an 'Impervious' land cover category, but rather is classified as different intensities of 'Developed', all NLCD land cover data were reclassified as 'Impervious' if it intersected with the County's impervious land cover dataset. The 2007 County impervious data were used for backcasting, as it was the earliest impervious dataset closest to the 2009 baseline year. Finally, NLCD data were clipped to the extent of the County MS4-regulated area, removing State, Federal, and any other land that does not fall under the County's jurisdiction.

Backcasting was conducted for the West River TMDL watershed separately, rather than county-wide. Using both the 2013/2014 NLCD and CC land cover data, for each NLCD land cover category, the percentage of different CC land cover classes within each NLCD land cover class were summarized. The NLCD land cover acreages were then multiplied by the percentages of CC land covers presented in Figure 4-1, transforming the NLCD land cover to CC land cover classes compatible with the TIPP spreadsheet tool.

Figure 4-1: Unique NLCD-CC translations for the West River TMDL watershed.



To run the TIPP tool, basic project information such as watershed, baseline year, and required reduction were first entered. The tool allows users to provide their own specific land use information or use aggregate impervious data. The County used the aggregate impervious data approach, which is an option within TIPP that allows the tool to pull from MDE’s reclassified land cover dataset. For each watershed, backcasted Aggregate Impervious and Turf acres were entered into the TIPP Tool to determine the baseline load. Land cover including Tree Canopy over Turf and Tree Canopy over Aggregate Impervious were added as land cover conversions from Turf. In these cases, Tree Canopy over Turf and Tree Canopy over Aggregate Impervious acres were added to the baseline Turf acres. Baseline conditions were established by entering BMPs in place by fiscal year 2009. Current Progress was evaluated separately by specifying BMP information for practices implemented through the current fiscal year (2021).

When exploring future implementation, two scenarios were established. The first one was a milestone scenario for Interim Programmed Restoration, which includes BMPs currently under a design contract that have reached the 30% design stage. The second scenario was for Planned Restoration, which includes projects that are proposed but not currently under a design contract.

4.2 Best Management Practices

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

- **Infiltration** — A depression or trench to form a shallow basin where sediment is trapped and stormwater infiltrates into the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil; they are not constructed on poor soils, such as C and D soil types. Yearly inspections to determine if the basin or trench is still infiltrating runoff are planned.
- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the stormwater runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants.
- **Dry Detention Ponds** – Depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow. These devices are designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff and then releases it at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached pollutants. There is little or no vegetation within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.
- **Filtering Practices** - Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter.
- **Swales** – Channels that provide conveyance, water quality treatment, and flow attenuation of stormwater runoff. Swales provide pollutant removal through vegetative filtering, sedimentation, biological uptake, and infiltration into the underlying soil media. Types of swale practices include dry swales, grass swales, wet swales, and bio-swales. Implementation of each is dependent upon site soils, topography, and drainage characteristics.
- **Dry Well** – Excavated pit or structural chamber filled with gravel or stone that provides temporary storage of stormwater runoff from rooftops. The storage area may be constructed as a shallow trench or a deep well. Rooftop runoff is directed to these storage areas and infiltrates into the surrounding

soils prior to the next storm event. The pollutant removal capability of dry wells is directly proportional to the amount of runoff that is stored and allowed to infiltrate.

- **Rain Garden** – Shallow, excavated landscape feature or a saucer-shaped depression that temporarily holds runoff for a short period of time. Rain gardens typically consist of an absorbent-planted soil bed, a mulch layer, and planting materials such as shrubs, grasses, and flowers. An overflow conveyance system is included for bypass of larger storms. These types of practices typically capture runoff from downspouts, roof drains, pipes, swales, or curb openings. The captured runoff temporarily ponds and slowly filters into the soil over 24 to 48 hours.
- **Infiltration Berms** – A mound of earth composed of soil and stone that is placed along the contour of a relatively gentle slope. This practice may be constructed by excavating upslope material to create a depression and storage area above a berm or earth dike. Stormwater runoff flowing downslope to the depressed area filters through the berm in order to maintain sheetflow. Infiltration berms should be used in conjunction with practices that require sheetflow (e.g., sheetflow to buffers) or in a series on steeper slopes to prevent flow concentration.
- **Disconnection of Rooftop Runoff** – Involves directing flow from downspouts onto vegetated areas where it can soak into or filter over the ground. This disconnects the rooftop from the storm drain system and reduces both runoff volume and pollutants delivered to receiving waters. To function well, rooftop disconnection is dependent on several site conditions (e.g., flow path length, soils, slopes).
- **Disconnection of Non-Rooftop Runoff** – Involves directing flow from impervious surfaces onto vegetated areas where it can soak into or filter over the ground. This disconnects these surfaces from the storm drain system, reducing both runoff volume and pollutants delivered to receiving waters. Non-rooftop disconnection is commonly applied to smaller or narrower impervious areas like driveways, open section roads, and small parking lots and is dependent on several site conditions (e.g., permeable flow path length, soils, slopes, compaction) to function well.
- **Sheetflow to Conservation Areas** – Stormwater runoff is effectively treated when flow from developed land is directed to adjacent natural areas where it can soak into or filter over the ground. To function well, this practice is dependent on several site conditions (e.g., buffer size, contributing flow path length, slopes, compaction).
- **Stream Restoration** - Stream restoration is a set of techniques and methods that restores the natural hydrology and landscape of a stream by engineering the stream to reduce stream bank erosion, reconnecting the stream bed to the floodplain, minimizing down-cutting of stream bed, and restoring the aquatic ecosystems.

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

- **Inlet Cleaning** - Storm drain cleanout practice ranks among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with their NPDES stormwater permits. Sediment reduction credit is based on the mass of material collected (MDE, 2020).

- **Street sweeping** - This practice uses mechanical or vacuum-assisted sweeper trucks to remove the buildup of pollutants that have been deposited along streets or curbs. The amount of nutrient and sediment reduction associated with this program is dependent on the stream sweeping technology and the frequency of sweeping.

5 Expected Load Reductions

5.1 2009 Baseline Load

SW-WLAs in the sediment TMDL were developed using the CBP Watershed Model Phase 5.3.2 (CBP WM P5.3.2) watershed model. The TIPP tool used for TMDL planning in this Restoration Plan uses the Chesapeake Bay Phase 6 CAST-2017d Watershed Model No Action (No BMP) scenario loading rates to generate loads based on user inputs of land use and existing BMPs. The required reduction percent assigned to the Anne Arundel County Phase I MS4 source from the TMDL document was then applied to the new baseline load calculated in TIPP to calculate the required sediment reduction expressed as a load. The required sediment reduction load was then subtracted from the new baseline load to calculate the target TMDL SW-WLA. The sediment load requirements for the Non-Tidal West River watershed is shown in Table 5-1.

Table 5-1: Anne Arundel County Sediment SW-WLA Reduction Required for the Non-Tidal West River Watershed

2009 Baseline Load (lbs/yr)	Required Reduction (%)	Required Reductions (lbs/yr)	TMDL SW-WLA (lbs/yr)
9,166,940.6	22%	2,016,726.9	7,150,213.7

5.2 2021 Progress Load (Current Implementation)

BMP data used in the TIPP modeling was taken from the County's BMP inventory, which is also submitted to MDE as part of the County's MS4 annual report. Source reduction practices implemented after 2009 were incorporated into the calculations to determine the current (2021) loads (i.e., the 2021 Progress Load). No source reduction practices were completed in the West River segment during 2021. Inlet cleaning, street sweeping, and stream restoration were completed in the Rhode River segment during 2021. The total load reduction in pounds for these source reduction practices are shown in Table 5-2. Urban BMPs constructed as part of development or re-development after 2009 were not included in the 2021 Progress scenario because they were required to be implemented to offset the increase in impervious area caused by development or re-development, and therefore should not be counted for additional sediment load reduction credit for the TMDL.

Table 5-2: Current BMP Implementation through 2021 for Non-Tidal West River

Load Source		EOS Sediment Load (lbs)
TIPP Baseline Loads	MS4 Aggregate Impervious	3,970,090.5
	MS4 Tree Canopy over Aggregate Impervious	2,062,867.9
	MS4 Tree Canopy over Turf	1,049,557.6
	MS4 Turf	2,160,324.3
	Baseline BMPs Load Reduction	(75,899.6)
2009 Baseline Load		9,166,940.6
TIPP Current Load Reductions	Inlet Cleaning	682.4
	Street Sweeping	87.2
	Land Use Conversions	532.7
	Stormwater Management BMPs	8,583.3
	Stream Restoration	46,363.9
2021 Progress Load		9,110,691.1

As shown in Table 5-3, Non-Tidal West River has currently achieved a sediment reduction of 0.61 percent compared to its 22 percent target reduction.

Table 5-3: 2021 Progress Reductions Achieved in the Non-Tidal West River

Results and TMDL WLA	Loads and Percent Reduction
2009 Baseline Load (lbs)	9,166,940.6
2021 Progress Load (lbs)	9,110,691.1
Percent Reduction	0.61%
Target TMDL WLA Reduction	22%

5.3 Planned Implementation

As shown in the previous section, Anne Arundel County must achieve further load reductions to meet its TMDL requirements in these watersheds. The Non-Tidal West River watershed is located within a more rural portion of Anne Arundel County. A vast majority of the land cover is forested (57.9%) with significant portions of mixed open/agriculture (18.5%) and turf (14.3%, including turf and tree canopy over turf) land, as previously described in Section 2.3.1. Approximately 6.3% of the watershed consists of impervious surfaces (including roads, surfaces, and structure as well as tree canopy over roads, surfaces, and structures), which leaves little opportunity to achieve additional sediment load reductions from managing stormwater runoff from impervious surfaces.

Planned BMP implementation for the Non-Tidal West River watershed is shown in Table 5-4. Planned implementation projects include stormwater management BMPs and stream restoration.

Table 5-4: Planned BMP Implementation through 2030 for Non-Tidal West River Watershed

Load Source		Amount	Unit	EOS Sediment Load (lbs)
Baseline (2009) Load Total				9,166,940.6
Current (2021) Load Total				9,110,691.1
Planned Source Reductions	Stormwater Management BMPs	22.55	acres	62,645.2
	Stream Restoration	8,600	ft	2,132,800
2030 Planned Load (=2021 Progress Load – sum of planned source reductions)				2,195,445.2
Total Sediment Reduction	Percent Reduction Achieved		24.6%	
	Target TMDL WLA Reduction		22%	
	Remaining Reduction Required		(234,968)	

Feasibility studies of the planned strategies may reveal that some existing structures identified for retrofitting or enhancement may not be feasible candidates for future projects and may be eliminated from consideration. The County will take an adaptive management approach and will reevaluate treatment needs as feasibility studies progress. The County will continue to track the overall effectiveness of the various BMP strategies and will adapt the suite of solutions based on the results. In addition, new technologies are continuously evaluated to determine if the new technologies allow more efficient or effective pollution control.

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

6 Technical and Financial Assistance Needs

6.1 Technical Needs

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

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

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

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

6.2 Financial Needs

The total projected cost to implement the County's CIP projects described in this Restoration Plan for the Non-Tidal West River watershed is approximately \$12.9M. Table 6-1 includes a summary of funding needs per BMP type. Project costs are inclusive of all project elements and include design, obtaining land right of way (ROW), construction, and County overhead and administrative costs. The costs are presented based on restoration planning periods out to FY2030. The total cost of the suite of BMPs necessary to meet the TMDL was calculated and then divided proportionally across the milestone periods (Table 6-2).

Table 6-1: Non-Tidal West River Watershed Planned Projects Cost Estimate

Load Source	Amount ¹	Unit	Cost/Unit	Total Cost ¹
Stormwater Management BMPs (new)	3.32	acres	\$165,500	\$537,000
Stormwater Management BMPs (retrofit)	19.23	acres	\$106,000	\$2,039,000
Stream Restoration	8,600	linear feet	\$1,200	\$10,320,000
			Total	\$12,895,000

1. Numbers shown in this table have been rounded.

Table 6-2: Planned Projects Cost Estimate Through 2030

Watershed	2025	2030	Total
West River	\$537,000	\$12,358,000	\$12,895,000

Several sources were used to calculate the cost estimates for each BMP type. Implementation cost of completed projects in the County's geodatabase were used to calculate average costs for inlet cleaning, street sweeping, and other types of projects the County will do to address its load reduction requirements. King and Hagan (2011) was also consulted for reference.

6.3 Funding Sources

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

In 2015, the Maryland Legislature passed Senate Bill 863 (Watershed Protection and Restoration Programs – Revisions) which repealed House Bill 987. Senate Bill 863 removed the *requirement* that jurisdictions adopt the Stormwater Remediation Fee but did still allow for the jurisdictions to adopt and collect the fee. As a replacement of the stormwater remediation fee requirement, jurisdictions are now to develop financial assurance plans (FAP), due initially on July 1, 2016, and subsequently every two years, that describe how stormwater runoff will be treated and paid for over the next five years to meet TMDL and impervious surface treatment requirements. Anne Arundel County's initial FAP was adopted by County Council on July 5, 2016. The most recent update to the County's FAP was submitted with the annual NPDES report in February 2021.

The County's Stormwater Remediation Fee, which is termed the 'Watershed Protection and Restoration Fee' (WPRF) is assessed to Anne Arundel County property owners based on the type of property and the amount of impervious surface on their property and is included as a separate line item on the owner's real property tax bill. The fee is structured to provide sufficient funding for projects to meet the

pollutant load reduction required by the Chesapeake Bay TMDL and EPA-approved individual TMDLs with a SW-WLA, and to meet the impervious surface management requirements, as well as other stormwater obligations set forth in the County's NPDES MS4 Permit. More information on the rate structure can be found at <https://www.aacounty.org/departments/public-works/wprp/wprf-rate-information/index.html> along with information on the WPRF Credit Program and Appeal Program.

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

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

7 Public Participation / Education

7.1 County Outreach Efforts

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

In order to implement an effective strategy to meet water quality standards and achieve pollutant load reduction, an effort to engage a very broad audience of landowners was a necessity. AAWSA, a non-profit 501(c)(3) environmental organization, was formed through Anne Arundel County Department of Public Works and the County Board of Education's Arlington Echo Outdoor Education Center (Anne Arundel County, 2012). AAWSA's mission is to identify, train, and support citizens to become Master Watershed Stewards who take action with their neighbors to restore local waterways in Anne Arundel County. This program is a unique way to integrate education as a vital element in the AAWSA's role in preservation, conservation, and advocacy. Since 2009, 307 Watershed Stewards have been trained in Anne Arundel County – of whom about 220 remain active today. These 220 Watershed Stewards represent over 100 residential communities and over 30 houses of worship. Stewards also serve institutional communities such as schools, parks and libraries. In FY2021 AAWSA managed 330 restoration projects, provided outreach to 9,775 County residents, planted 21,832 native plants and trees, removed 50,005+ square feet of invasive plants and removed 280 pounds of trash.

The AAWSA has extensive resources through the Consortium of Support Professionals, which is composed of over 80 governmental, non-profit, and business professionals who provide technical assistance to Master Watershed Stewards. Consortium members are experts in their field of conservation, ecology, government laws, landscape architecture, low impact design, water quality monitoring, and watershed assessment, and provide consulting on design and development of watershed restoration projects. The AAWSA is also supported by staff that provides day-to-day guidance to Master Watershed Stewards, connecting Stewards to Anne Arundel County resources, coordinating Stewards certification, post certification professional development, and networking opportunities for Stewards and Consortium of Support Professionals.

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

- Reduce Your Pollution
 - Practice Bay-Friendly Lawn Care

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

Moving forward, the County will focus these programs and others like them on the Non-Tidal West River watershed.

In addition to the AAWSA, the following organizations have been identified for possible partnerships and education and outreach for the Non-Tidal West River watershed:

- Master Gardeners
- Audubon Society
- Students for the Environment
- Maryland civic associations and NGOs:
 - Maryland Home Builders Assoc.
 - Audubon Naturalist Society of the Central Atlantic States
 - Audubon Society of Central Maryland
 - Arundel Rivers Federation
 - Chesapeake Audubon Society
 - Chesapeake Bay Program
 - Chesapeake Bay Foundation
 - Chesapeake Bay Trust
 - Chesapeake Ecology Center
 - Center for Watershed Protection

- Alliance for the Chesapeake Bay
- Alliance for Sustainable Communities
- Baywise Master Gardeners
- Sierra Club – Maryland Chapter
- Nature Conservancy
- Smithsonian Environmental Research Center
- Anne Arundel Community College
- University of Maryland
- University of Maryland Extension
- Volunteer Center for Anne Arundel County

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

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

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

7.2 Public Comment Period

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

8 Implementation Schedule

This section presents the target loads, load reductions expected to be achieved through interim programmed restoration, and activities required to achieve load reduction targets based on a planning horizon of 2030 for achieving the target load reductions.

8.1 Loading Allocations and Targets

Progress loads for 2021 and final load requirements for 2030 in the Non-Tidal West River watershed are shown in Table 8-1. As discussed in Section 5, some progress has already been made towards reaching the target TMDL WLA. However, large load differences remain between current progress and the 2030 allocated load. Significant load reduction efforts are still needed to achieve the final goal.

Table 8-1: Non-Tidal West River Watershed Planning and Target Loads

Load	Non-Tidal West River Watershed Sediment Load (lbs/yr)
2009 Baseline Load	9,166,940.6
2021 Progress Load	9,110,691.1
2030 TMDL Allocated Load	6,915,246
Percent Reduction between 2009 Baseline and 2030 Loads	24.6%

8.2 Planned Progress

To meet the final SW-WLAs, implementation of programs and BMPs must keep pace and meet planned implementation targets. Table 8-2 outlines the expected progress that will allow the County to stay on track with the sediment reduction goals in the Non-Tidal West River watershed, based on interim programmed restoration scheduled to be completed by 2025.

Table 8-2: Planned Progress from 2021 to 2030 for the Non-Tidal West River Watershed

Progress Year	Period Load Reduction (lbs)	Period End Load (lbs)	Total Percent Reduction from 2009 Baseline Load
2025	7,103.11	9,103,588	0.7%
2030	2,188,342.1	6,915,246	24.6%

Feasibility studies of the planned strategies may reveal that some existing structures identified for retrofitting or enhancement may not be feasible candidates for future projects and may be eliminated from consideration. The County will take an adaptive management approach and will reevaluate treatment needs as feasibility studies progress. The County will continue to track the overall effectiveness of the various BMP strategies and will adapt a suite of solutions based on those results. In addition, new technologies are continuously evaluated to determine if they allow more efficient or effective pollution control.

8.3 Implementation Priorities

To meet the load reduction milestones outlined in the previous sections, implementation will be planned based on prioritization analyses presented in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016). Subwatersheds in the West and Rhode segments were prioritized for restoration/retrofit project selection potential using three separate prioritization models. The models integrated historical environmental data, current stream assessment monitoring data, drainage area characteristics, and watershed modeling results into indicators of watershed condition and need. The indicators are combined into the three models:

- Stream Reach Restoration
- Subwatershed Restoration
- Subwatershed Preservation

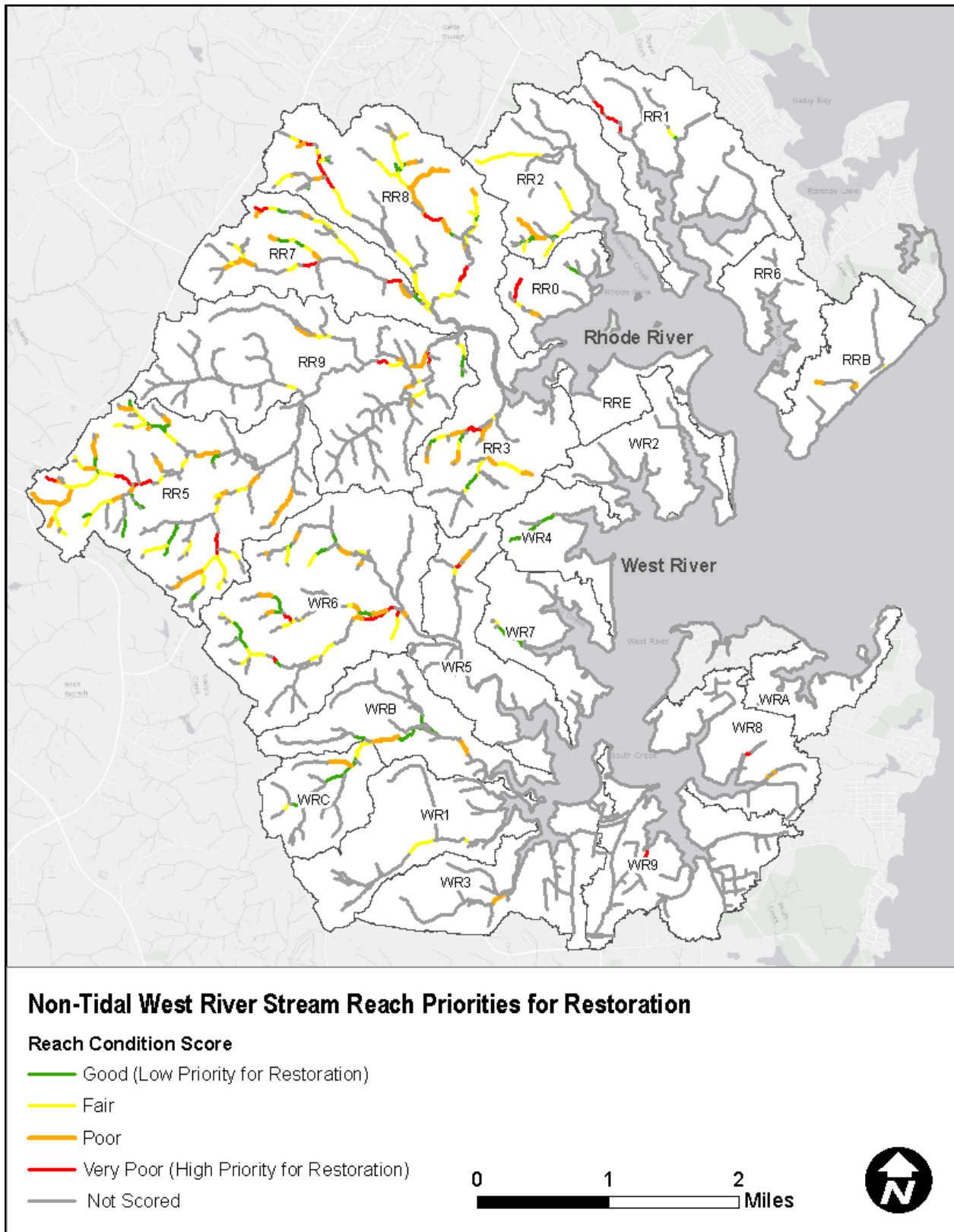
The models were designed to operate at three management scales: the individual stream reach scale; the parcel scale; and the subwatershed scale. Additionally, the models differentiated between identification of restoration opportunities for the degraded portions of the watershed (reach and subwatershed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

8.3.1 Stream Reach Restoration

The stream restoration prioritization uses a suite of indicators that are weighted and then combined into a final relative rating for each perennial reach as identified in the Physical Habitat Condition Assessment in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016). The suite of stream restoration indicators were grouped into five categories, including indicators to rate stream habitat, stream morphology, land cover, infrastructure, and hydrology and hydraulics.

In the Non-Tidal West River watershed, 266 perennial reaches were assessed using these indicators. Of these, a total of 30 reaches were rated as “High” priority for restoration, 75 reaches were rated as “Medium High,” 105 reaches were rated as “Medium,” and 56 were rated as “Low.” A map of the stream reach prioritization was generated using data from the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016), and was included in Figure 8-1.

Figure 8-1: Non-Tidal West River Stream Reach Priorities for Restoration (Anne Arundel County, 2016)



8.3.2 Subwatershed Restoration

Similar to the stream restoration assessment, the subwatershed assessment in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016) used a collection of restoration indicators that were weighted and combined to assign a single rating to each subwatershed. Restoration indicators fell into one of seven categories: stream ecology; TMDL impairments; On-site Disposal Systems (OSDS); BMPs; Hydrologic and Hydraulic (H&H) Modeling; Water Quality; and Landscape.

In the Non-Tidal West River watershed, seven of the 23 subwatersheds were rated as a “High” priority for restoration. Seven subwatersheds were assessed to be “Medium High” on the prioritization scale for restoration needs, and seven subwatersheds were assessed to be “Medium” priority. Finally, two subwatersheds were assessed to be “Low” priorities. A map of the subwatershed restoration prioritization was included in the *Middle and Lower Patuxent Watershed Assessment Report*, and is included as Figure 8-2. Tables 8-3 and 8-4 below show the prioritization of subwatersheds in a tabular format.

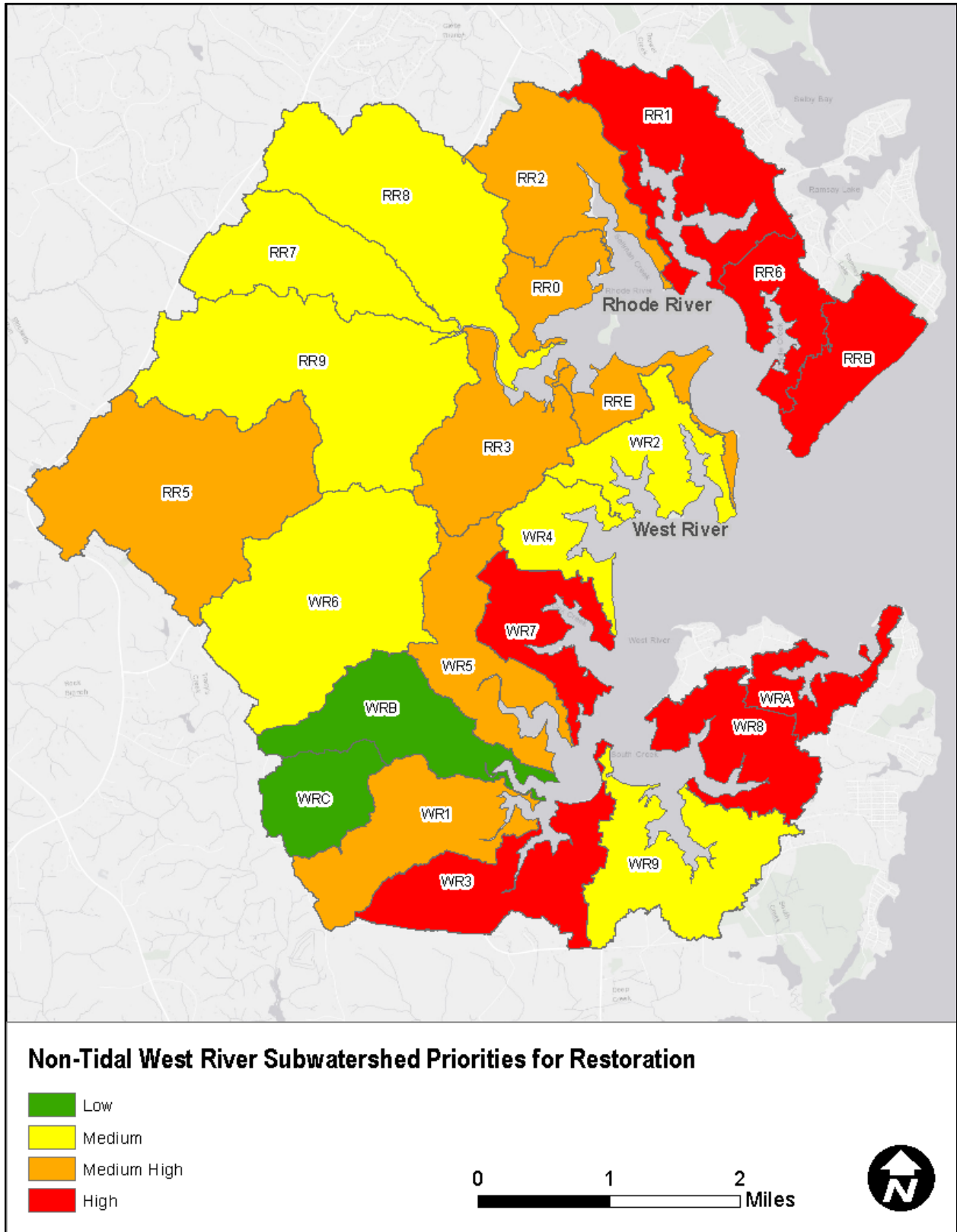
Table 8-3: Non-Tidal West River Subwatershed Priority for Restoration

Subwatershed Code	Segment	Subwatershed Name	Priority for Restoration
WR3	West River	Gales Creek	High
WR7	West River	Tenthouse Creek	High
WR8	West River	South Creek I	High
WRA	West River	Parish Creek	High
RR1	Rhode River	Bear Neck Creek	High
RR6	Rhode River	Cadle Creek	High
RRB	Rhode River	Beverley Beach	High
WR1	West River	Johns Creek	Medium High
WR5	West River	Lerch Creek I	Medium High
RR0	Rhode River	Forrest Branch	Medium High
RR2	Rhode River	Sellman Creek	Medium High
RR3	Rhode River	Many Fork Branch	Medium High
RR5	Rhode River	South Fork Muddy Creek II	Medium High
RRE	Rhode River	Boathouse Creek	Medium High
WR2	West River	Cheston Creek	Medium
WR4	West River	Popham Creek	Medium
WR6	West River	Lerch Creek II	Medium
WR9	West River	South Creek II	Medium
RR7	Rhode River	Williamson Branch	Medium
RR8	Rhode River	North Fork Muddy Creek	Medium
RR9	Rhode River	South Fork Muddy Creek I	Medium
WRB	West River	Smith Creek I	Low
WRC	West River	Smith Creek II	Low

Table 8-4: Subwatershed Restoration Assessment Results

Rating	Number of Subwatersheds			Percent of Subwatersheds		
	West River Segment	Rhode River Segment	Non-Tidal West River	West River Segment	Rhode River Segment	Non-Tidal West River
High	4	3	7	33.3%	27.3%	30.4%
Medium High	2	5	7	16.7%	45.5%	30.4%
Medium	4	3	7	33.3%	27.3%	30.4%
Low	2	0	2	16.7%	0.0%	8.7%
Total	12	11	23	100.0%	100.0%	100.0%

Figure 8-2: Non-Tidal West River Subwatershed Priorities for Restoration (Anne Arundel County, 2016)



8.3.3 Subwatershed Preservation

The subwatershed preservation assessment in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016) used a collection of preservation indicators that were weighted and combined into a single rating for each subwatershed for consideration for preservation activities. Restoration indicators fell into one of five categories: stream ecology; future departure of water quality conditions; soils; landscape; and aquatic living resources.

In the Non-Tidal West River watershed, eight subwatersheds were rated to be “High” priority for preservation, eight subwatersheds were rated “Medium High,” three subwatersheds were rated “Medium,” and four were rated “Low” priority for preservation.

A map of the subwatershed preservation prioritization was included in the *West and Rhode Watersheds Assessment Report* and is as Figure 8-3. Tables 8-5 and 8-6 below show the prioritization of subwatersheds for preservation in a tabular format.

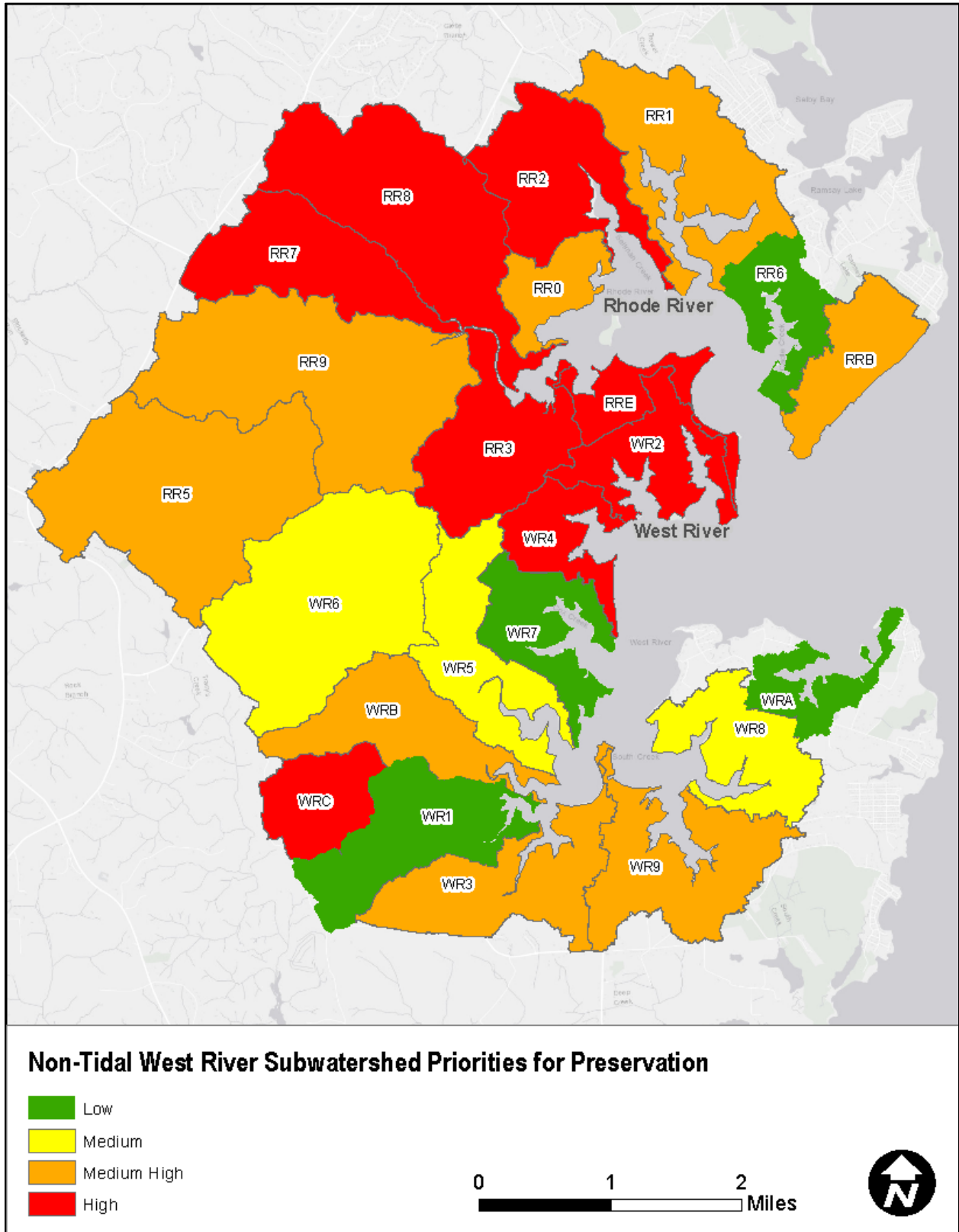
Table 8-5: Non-Tidal West River Subwatershed Priority for Preservation

Subwatershed Code	Segment	Subwatershed Name	Priority for Preservation
WR4	West	Popham Creek	High
WR2	West	Cheston Creek	High
WRC	West	Smith Creek II	High
RRE	Rhode	Boathouse Creek	High
RR3	Rhode	Many Fork Branch	High
RR2	Rhode	Sellman Creek	High
RR7	Rhode	Williamson Branch	High
RR8	Rhode	North Fork Muddy Creek	High
WRB	West	Smith Creek I	Medium High
WR3	West	Gales Creek	Medium High
WR9	West	South Creek II	Medium High
RR9	Rhode	South Fork Muddy Creek	Medium High
RR0	Rhode	Forrest Branch	Medium High
RRB	Rhode	Beverley Beach	Medium High
RR5	Rhode	South Fork Muddy Creek II	Medium High
RR1	Rhode	Bear Neck Creek	Medium High
WR5	West	Lerch Creek I	Medium
WR6	West	Lerch Creek II	Medium
WR8	West	South Creek I	Medium
WR1	West	Johns Creek	Low
WR7	West	Tenthouse Creek	Low
WRA	West	Parish Creek	Low
RR6	Rhode	Cadle Creek	Low

Table 8-6: Non-Tidal West River Subwatershed Preservation Assessment Results

Rating	Number of Subwatersheds			Percent of Subwatersheds		
	West River Segment	Rhode River Segment	Non-Tidal West River	West River Segment	Rhode River Segment	Non-Tidal West River
High	3	5	8	25.0%	45.5%	34.8%
Medium High	3	5	8	25.0%	45.5%	34.8%
Medium	3	0	3	25.0%	0.0%	13.0%
Low	3	1	4	25.0%	9.1%	17.4%
Total	12	11	23	100.0%	100.0%	100.0%

Figure 8-3: Non-Tidal West River Subwatershed Priorities for Preservation (Anne Arundel County, 2016)



8.4 Implementation Strategy

Anne Arundel County's FY22 six-year CIP budget includes BWPR class projects to continue implementing restoration projects identified in the County's Phase II WIP and applicable individual TMDLs for achieving SW-WLAs. Funding for this class of projects averages approximately \$27M annually. Projects in the BWPR class are identified and prioritized through a planning level assessment.

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

9 Load Reduction Evaluation Criteria

Adaptive management is a critical component of achieving the SW-WLAs required by the Non-Tidal West River TMDL. As presented in Section 8 of this plan, the County has developed an expected implementation and load reduction goal for 2025 based on interim programmed restoration. Evaluation of progress achieved by 2025 can serve as a vehicle for assessing incremental progress toward the load reduction targets.

Progress will be measured through three approaches: tracking implementation of management measures; estimating load reductions through modeling; and tracking overall program success through long term monitoring. Planning targets will be re-evaluated against progress and revised to ensure that Anne Arundel County is on track to meet established goals. Progress assessments are completed annually and reported to MDE with the County's MS4 Annual Report.

9.1 Tracking Implementation of Management Measures

Implementation will be measured by determining whether the targets for implementation shown in Table 8-21 are maintained according to the milestone schedule. Anne Arundel County manages a comprehensive system for adding and tracking projects and accounting for new programs. New BMPs constructed through new development and redevelopment projects are entered into the County's BMP database and NPDES MS4 geodatabase as they come on-line. BWPR is responsible for implementing and tracking Water Quality Improvement Projects (WQIP; i.e., restoration and retrofit projects and programs). Additional internal County groups including Bureau of Highway Road Operation Division, which is responsible for maintenance efforts (i.e., street sweeping and inlet cleaning), report back to BWPR. The County is also capturing and tracking projects implemented by the AAWSA through the BWPR-Chesapeake Bay Trust Restoration Grant Program.

9.1.1 Annual NPDES MS4 Reporting

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

- a. The status of implementing the components of the stormwater management program that are established as permit conditions including:
 - i. Source Identification
 - ii. Stormwater Management**
 - iii. Erosion and Sediment Control
 - iv. Illicit Discharge Detection and Elimination

- v. Litter and Floatables
- vi. Property Management and Maintenance
- vii. Public Education
- viii. Watershed Assessment

ix. Restoration Plans

x. TMDL Compliance

- xi. Assessment of Controls; and,
- xii. Program Funding

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

- c. Expenditures for the reporting period and the proposed budget for the upcoming year
- d. A summary describing the number and nature of enforcement actions, inspections, and public education programs

e. The identification of water quality improvements and documentation of attainment and/or progress toward attainment of benchmarks and applicable WLAs developed under EPA approved TMDLs; and,

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

g. The County is required to complete a database containing the following information:

- i. Storm drain system mapping
- ii. Urban BMP locations**
- iii. Impervious surfaces
- iv. Water quality improvement project locations**
- v. Monitoring site locations**
- vi. Chemical monitoring results**
- vii. Pollutant load reductions**
- viii. Biological and habitat monitoring**
- ix. Illicit discharge detection and elimination activities
- x. Erosion and sediment control, and **stormwater program information**
- xi. Grading permit information
- xii. Fiscal analyses – cost of NPDES related implementation

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

- AltBMPLine - stream restoration, shoreline restoration, outfalls
- AltBMPPoint – septic system practices (pump-out, upgrades, connections)

- AltBMPPoly – tree planting, street sweeping, inlet cleaning, impervious removal
- RestBMP – stormwater BMPs (SPSC, bioretention, wet ponds etc.)

9.1.2 TMDL Annual Assessment Reports

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

9.1.3 Financial Assurance Plan Reporting

The County's FAP outlines the County's financial ability to meet its local and Chesapeake Bay TMDL obligations and is another mechanism of reporting to MDE. The FAP demonstrates the County's ability to fund projects that will reduce pollutants of concern and make measureable progress towards improving water quality. Anne Arundel County's first FAP was submitted to MDE in July of 2016 and submitted an updated version in February 2021 with its NPDES MS4 Annual Report. A copy of the 2021 Financial Assurance Plan can be found at: <https://www.aacounty.org/departments/public-works/wprp/financial-assurance-plan/index.html>.

9.2 Estimating Load Reductions

The County performs modeling annually to evaluate load reductions and progress towards meeting SW-WLA goals. The load reductions are reported in the County's "Annual Assessment Reports" as described above and in the County's MS4 Annual Report. Modeled baseline and current loads are reported in the NPDES geodatabase in the "LocalStormwaterWatershedAssessment" table. The progress assessments contribute to ongoing re-evaluation of management plans, and adapting responses accordingly as technologies and efficiencies change, programs mature, credit trading is enacted, and regulations are put in place. The County will model load reductions for the Non-Tidal West River watershed using TIPP to maintain consistency with the model framework used to develop the Restoration Plan and initial progress loads.

9.3 Tracking Overall Program Success through Monitoring

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

9.4 Best Management Practices Inspection and Maintenance

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

9.4.1 Background

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

9.4.2 Phase 1 Inspection and Enforcement

Phase I Inspection and Enforcement reflects the first time a stormwater management practice receives a three-year maintenance inspection and maintenance is required. Using the proper Maintenance Inspection Checklists, the Inspector performs the required three-year maintenance inspection, indicating on the Checklist boxes if maintenance is required, not required, or the item is non-applicable. The information on the completed Checklist will serve to comply with the inspection requirements of COMAR 26.17.02.11 and is used to complete a Phase I Correction Notice that is mailed to the current listed property owner on record with SDAT. The Phase 1 Correction Notices are prepared using the I&P standard computerized inspection report. They include a detailed description of the maintenance required and the compliance date by which the required maintenance is to be completed. Phase 1 Correction Notices contain the proper contact information for the Inspector that performed the inspection. The Urban BMP geodatabase is updated to document when a three-year Maintenance Inspection is performed. For monthly reporting purposes, all re-inspections are recorded as inspections and not as new facilities inspected or as new correction notices issued. Depending on the degree of maintenance required, a Compliance Schedule (or extended maintenance timeline) may be appropriate. All proposed Compliance Schedules must be authorized by the BWPR Supervisor. Phase 1 enforcement allows for (2) sequential 30-day correction periods to complete required work if compliance has not been achieved by the initial inspection specified due date.

9.4.3 Phase 2 Inspection and Enforcement

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

9.4.4 Phase 3 Inspection and Enforcement

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

10 Monitoring

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

To determine the specific parameters to be monitored for tracking progress, one must understand the approach used for the initial listing. 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 percent 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 Non-Tidal West River watershed was listed for biological community impairment in 2002.

MDE then utilized its BSID process to identify the probable or most likely causes of poor biological conditions. For sediment specifically, the BSID identified that 'natural sediment conditions of the Coastal Plain physiographic region that have been exacerbated by anthropogenic sources, have resulted in altered habitat heterogeneity and subsequent elevated suspended sediment in the watershed, which are in turn the probable causes of impacts to biological communities.' Overall, the results indicated sulfates, sediment and in-stream habitat related stressors as the primary stressors causing impacts to biological communities.

Based on the results of the BSID, MDE replaced the biological impairment listing with a listing for total suspended solids (TSS) and sulfates in 2012. The 2014, 2016 and 2018 final Integrated Reports list '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, 2012) makes a specific distinction between two different - although related - 'sediment' impairment types in free-flowing streams:

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

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

10.1 Countywide Biological Monitoring

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

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

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

The West and Rhode River segments are each a single PSU in the program. Ten sampling sites were sampled in each PSU in Round 1 and Round 2 sampling, while eight sites were sampled in Round 3. All Rounds follow procedures and protocols developed for the MBSS for the biological sampling. Habitat evaluations have included both MBSS's Physical Habitat Index (MPHI) and the EPA's Rapid Bioassessment Protocol (RBP) metrics. In-situ water quality measures are also collected at each site, along with a geomorphic evaluation utilizing cross-sections, particle substrate analysis using pebble counts, and measures of channel slope. As stated previously, fish sample and a water chemistry grab sample were added to the assessment activities for Round 3.

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
 - Water chemistry sample (Round 3 only)

- Biological Measures
 - Benthic macroinvertebrates (benthic index of biotic integrity - BIBI)
 - Fish (fish index of biotic integrity – FIBI—Round 3 only)

10.2 Restoration Monitoring

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

10.3 Watershed Assessments Monitoring

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

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

Biological monitoring in support of the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016) was completed in 2013 and 2014. A full description of the results of this monitoring is too lengthy to describe in this report, but can be found at <https://www.aacounty.org/departments/public-works/wprp/watershed-assessment-and-planning/watershed-studies/West%20and%20Rhode%20Watershed%20Assessment%20Study%20Report.pdf>. This monitoring program is noted herein because the associated BIBI and PHI data can be used as additional baseline data points to track changes over time. The County continues to reevaluate its monitoring programs as the state of the science progresses, as the understanding of water quality and ecological interactions are improved, and as regulatory programs are added or modified.

11 References

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Appendix A: Public Comments

The *Non-Tidal West River Watershed Sediment TMDL Draft Restoration Plan, Anne Arundel County, Maryland* was posted on the County's web page and advertised for public comment in the *Maryland Gazette* and *The Capital* newspapers from TBD to TBD.

Comments were received from TBD. Comments received, and Anne Arundel County's response to those comments, are included in this appendix. Also included are the Notice of Public Comment and *The Capital* newspaper posting.