



# NON TIDAL WEST RIVER WATERSHED

## SEDIMENT TMDL RESTORATION PLAN

APRIL 2020

DRAFT



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**APRIL 2020**

**FINAL**

### **PREPARED FOR**

Anne Arundel County

Department of Public Works

Watershed Protection and Restoration Program

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## List of Acronyms

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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
CAST	Chesapeake Assessment Scenario Tool
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

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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
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
WPRP	Watershed Protection and Restoration Program
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) Watershed Protection and Restoration Program (WPRP) 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 stormwater WLA (SW-WLA) approved by EPA prior to the effective date of the permit (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, once the modeling is conducted under Phase 2, will provide the loading target, recommended management measures, load reduction estimates, schedule, milestones, cost estimates and funding sources, and the tracking and monitoring approaches to meet the SW-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). Additionally, each segment is represented by separate land-river segments in the Chesapeake Assessment Scenario Tool (CAST), but the two separate land-river segments will be modeled as a single scenario under Phase 2 of this project. 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 or CAST 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.

Modeling will be conducted to determine the required reduction in sediment loads from the 2009 baseline levels to achieve the target SW-WLA under the Non-Tidal West River TDML for Anne Arundel County NPDES-regulated stormwater. A planning horizon of 2030 is used as the date to achieve these load reductions, with 2021, 2023, 2025, 2027, and 2029 proposed as interim milestones to assess progress.

CAST will be used to model baseline, progress, and planned loads. CAST, created by the Chesapeake Bay Program (CBP), is a web-based pollutant load estimating tool that calculates pollutant loads and reductions. CAST uses the same modeling approaches as the CBP Watershed Model Phase 6 (WMP6) (CBP, 2017). The 2009 baseline load is shown in Table 1-1 below.

**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 (%)
<b>Non-Tidal West River, Anne Arundel County Phase I MS4</b>	288	226	22

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, 2019 progress, 2025 interim milestone 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 CAST provides the loads in terms of lbs/yr.

- **2009 Baseline Loads:** 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 will be calculated by running the CAST model with the 2009 Progress BMPs. Baseline TSS loads, in conjunction with the percent load reduction prescribed by the TMDL, will be used to calculate the sediment SW-WLA and will be shown in Table 1-1.
- **2019 Progress Loads and Reductions:** These are the progress loads and load reductions achieved from stormwater best management practice (BMP) implementation through the end of 2019. The 2019 progress load reductions are calculated by modeling the restoration BMP implementation (post 2009 through end of 2019) in CAST. Additionally, reductions from inlet cleaning and street sweeping will be calculated outside of CAST and added to the BMP reductions from CAST to calculate the total progress load reductions. The 2019 progress load is then calculated by subtracting the 2019 progress load reductions from the 2009 baseline load.
- **2025 Interim Milestone Goal Planned Loads and Reductions:** These are the planned 2025 loads and reductions that will result from implementation of strategies through 2025. The 2025 planned load reductions are calculated by modeling all the strategies needed to meet the 2030 planned load reductions (based on the SW-WLA targets), and back-calculating the expected progress that will be achieved by 2025. All planned strategies are calculated using CAST. The 2025 planned loads are calculated by subtracting the 2025 planned 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 through 2030 and will meet the TMDL SW-WLAs. The 2030 planned load reductions are calculated using CAST. The 2030 planned loads are calculated by subtracting the 2030 planned load reductions from the 2009 baseline load.

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

	Non-Tidal West River Watershed Sediment (lbs/year)
2009 Baseline Load	TBD
2010-2019 Progress Load Reductions	TBD
2019 Progress Load	TBD
2020-2025 Planned Load Reductions	TBD
2025 Planned Load	TBD
2026-2030 Planned Load Reductions	TBD
2030 Planned Load	TBD
Required Reduction by 2030 (percent)	22
Planned Progress Reduction by 2030 (percent)	22

### 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, 2014c)

- *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*<sup>1</sup> (MDE, 2014a)

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 Program<sup>2</sup>) 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)
- f. A schedule for implementing the management measures identified in this plan that is reasonably expeditious. (Section 8 of this Restoration Plan)

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<sup>1</sup> MDE has since issued draft updated accounting guidance (*Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, MDE, December 2019), but this updated guidance was not used for this plan.

<sup>2</sup> <https://www.epa.gov/nps/319-grant-program-states-and-territories>

- g. A description of interim, measurable milestones 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

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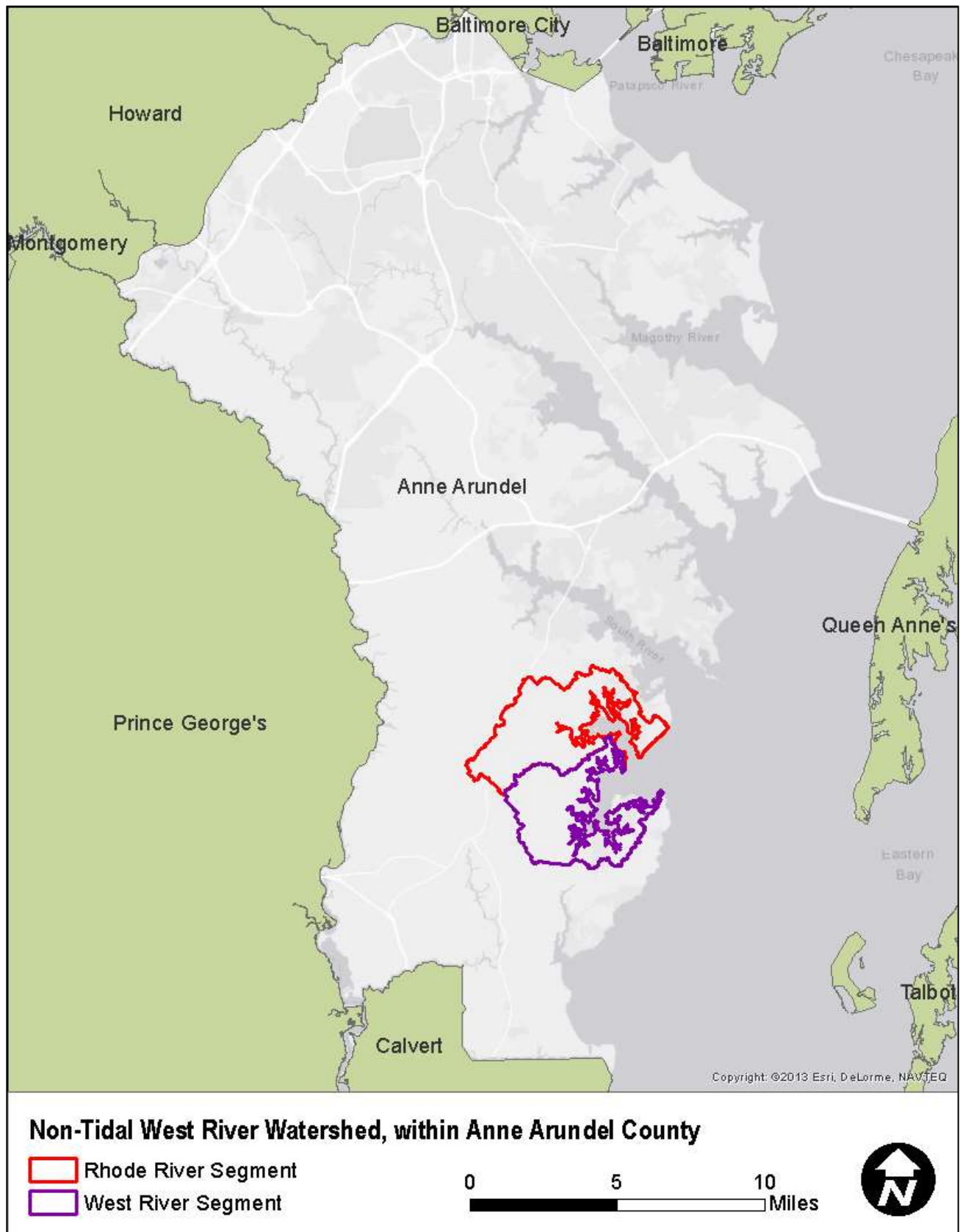
The following sections describe the watershed characteristics for the Non-Tidal West River watershed. Much of the information is presented as an aggregation of data from the West and Rhode Rivers, the two major segments of the Non-Tidal West River watershed.

### 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 mi<sup>2</sup>) 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.

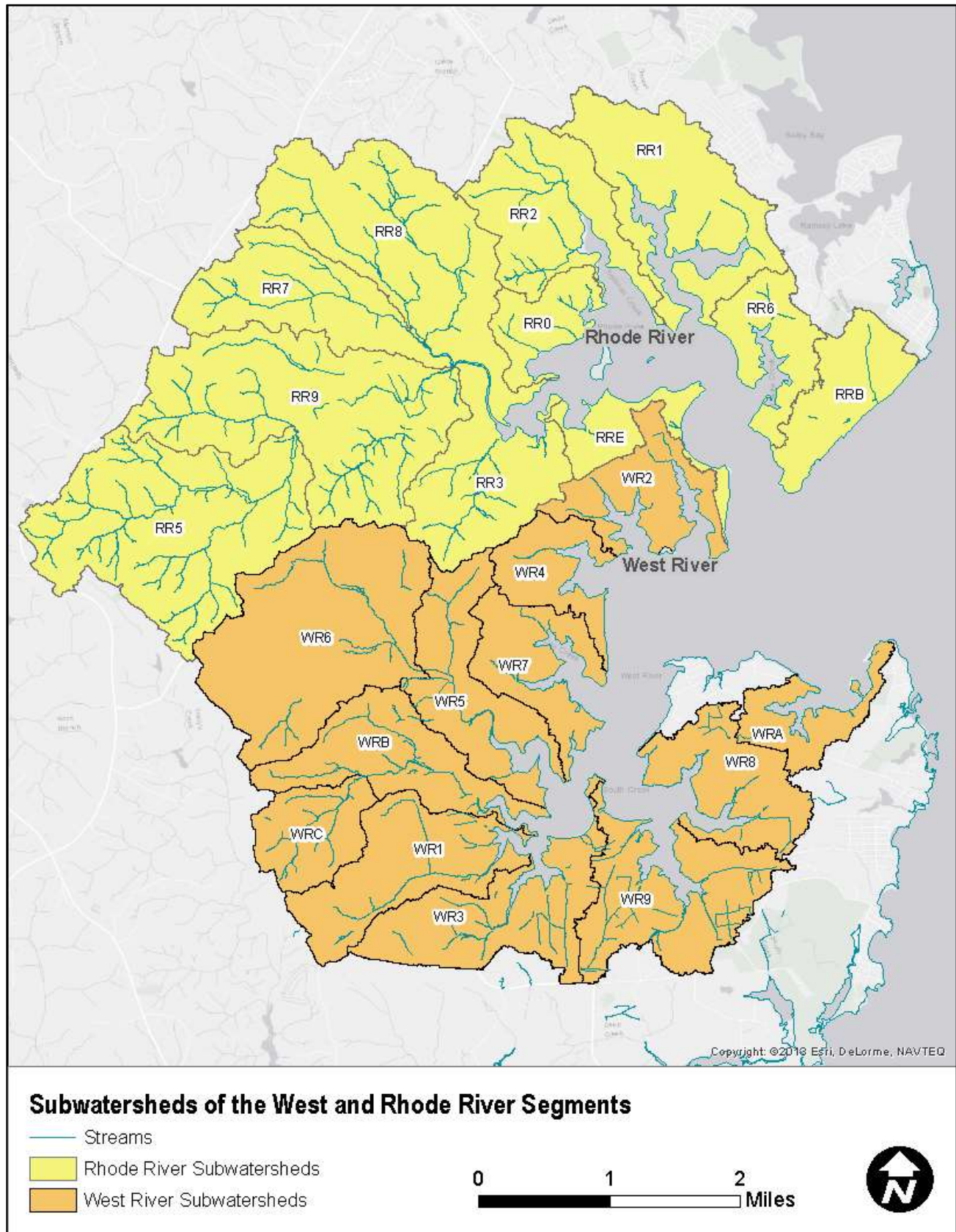
Figure 2-2 shows the subwatershed delineations for the watershed. Note that five subwatersheds that are included in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016) have not been included in the tables and figures included in this Restoration Plan because they drain directly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

**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 <sup>1</sup> (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
<b>Non-Tidal West River Total</b>			<b>15,623</b>	<b>24.44</b>	<b>61.7</b>

<sup>1</sup>Stream miles includes ephemeral, intermittent channels as well as perennial stream reaches

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.

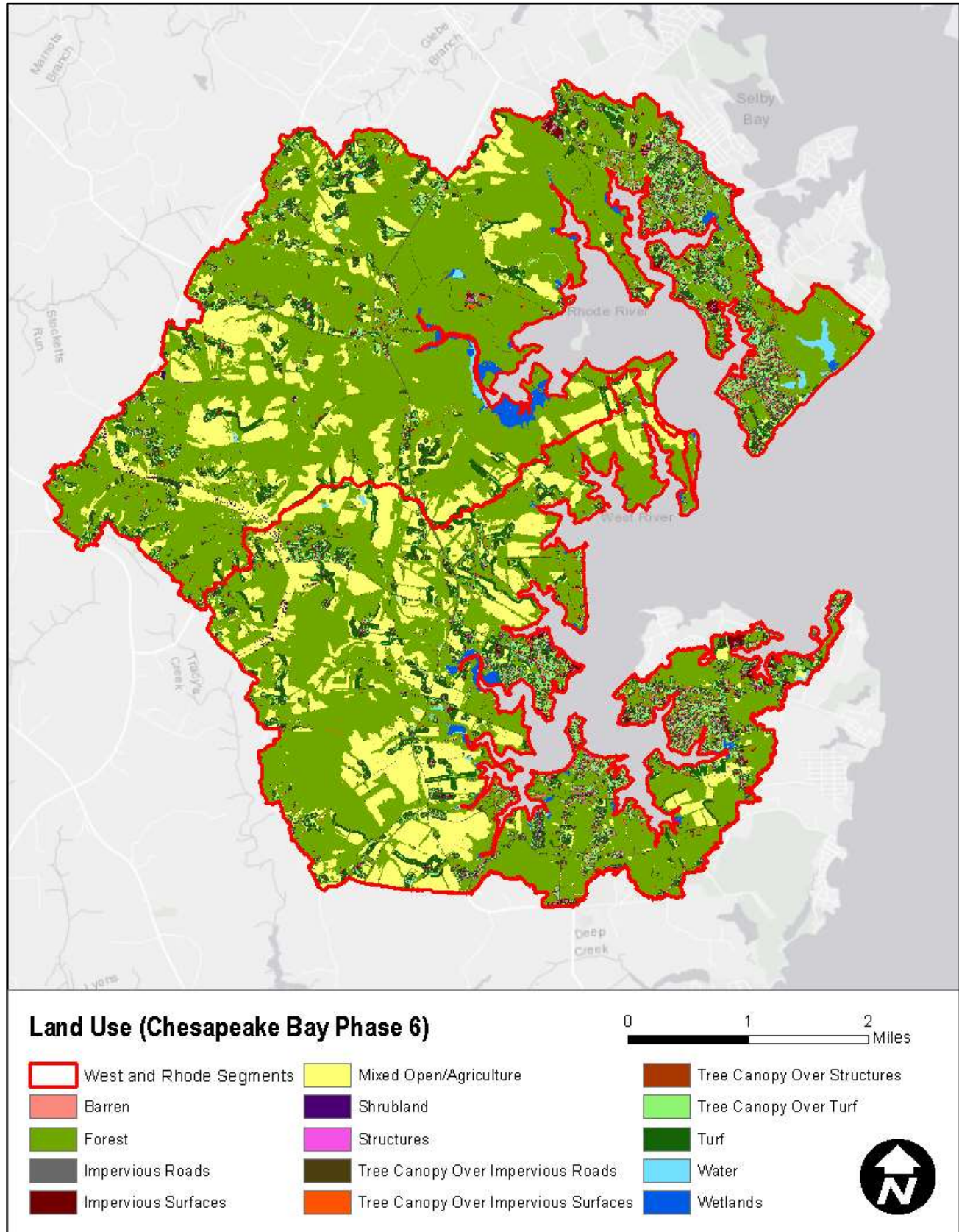
### 2.3.1 Existing Land Use/Land Cover

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%
<b>TOTAL</b>	<b>8521</b>	<b>7105</b>	<b>15627</b>	<b>100%</b>

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



### 2.3.2 Impervious Surfaces

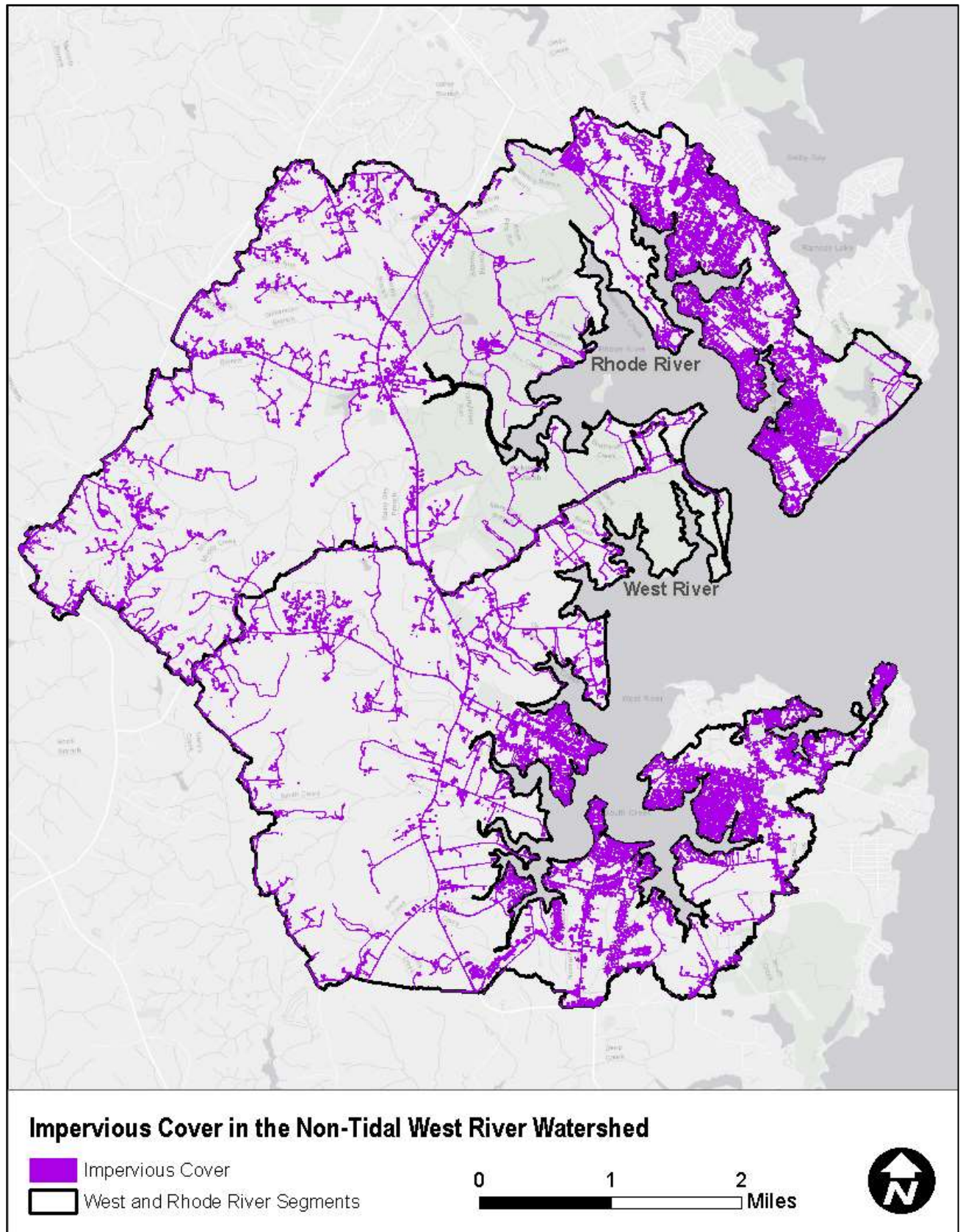
Impervious surfaces accelerate and concentrate stormwater runoff, causing significant potential for degradation when the runoff reaches the streams. Stormwater runoff also washes off pollutants accumulated on impervious surfaces, leading to degraded water quality in streams. Areas with lower levels of 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 1.2% to as high as 22.6% impervious cover, as shown in Table 2-3. Figure 2-4 show the impervious cover within the watershed.

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

Subwatershed Code	Segment	Subwatershed Name	Percent Impervious
WR1	West River	Johns Creek	3.7%
WR2	West River	Cheston Creek	2.0%
WR3	West River	Gales Creek	7.7%
WR4	West River	Popham Creek	2.7%
WR5	West River	Lerch Creek I	6.9%
WR6	West River	Lerch Creek II	3.2%
WR7	West River	Tenthouse Creek	11.7%
WR8	West River	South Creek I	18.8%
WR9	West River	South Creek II	9.1%
WRA	West River	Parish Creek	19.7%
WRB	West River	Smith Creek I	2.6%
WRC	West River	Smith Creek II	1.2%
RR0	Rhode River	Forrest Branch	3.8%
RR1	Rhode River	Bear Neck Creek	18.3%
RR2	Rhode River	Sellman Creek	2.9%
RR3	Rhode River	Many Fork Branch	2.3%
RR5	Rhode River	South Fork Muddy Creek II	3.6%
RR6	Rhode River	Cadle Creek	22.6%
RR7	Rhode River	Williamson Branch	4.5%
RR8	Rhode River	North Fork Muddy Creek	4.3%
RR9	Rhode River	South Fork Muddy Creek I	2.6%
RRB	Rhode River	Beverley Beach	10.3%
RRE	Rhode River	Boathouse Creek	1.7%
<b>Non-Tidal West River Watershed</b>			<b>6.3%</b>

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: Impervious Cover in the Non-Tidal West River Watershed

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 1/16<sup>th</sup> 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**

<b>Buildings</b>	<b>Total Area (sq.ft.)</b>	<b>Number of Buildings</b>
2,000-4,000 sf	11,323	4
4,000-6,000 sf	5,027	1
>6,000 sf	77,677	7
<b>TOTAL</b>	<b>94,027</b>	<b>12</b>
<b>Parking Lots</b>	<b>Total Area (sq.ft.)</b>	<b>Number of Parking Lots</b>
1/16-1/8 acre	57,847	17
1/8-1/4 acre	52,952	6
1/4-1/2 acre	104,484	7
>1/2 acre	96,241	3
<b>TOTAL</b>	<b>311,542</b>	<b>33</b>

## 2.4 Water Quality

### 2.4.1 Use Designations

According to water quality standards established by MDE in the Code of Maryland Regulations (COMAR) 26.08.02.08<sup>3</sup>, 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**

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

<sup>3</sup> <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 documentation entitled “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 will be recalculated using CAST, 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.

Section IV.E.2.b of the permit requires the County to develop a restoration plan for any local TMDLs. The restoration plan must be completed within a year of the TMDL approval date. The EPA approved the Sediment TMDL for the Non-Tidal West River Watershed on April 24, 2019, so the restoration plan must be submitted by April 24, 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; and
- 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 percent<sup>4</sup>. For Anne Arundel County's MS4 jurisdictional area, sediment sources are predominantly tied to the MS4 land use sources and stream erosion. The 2009 baseline loading rates for the MS4 portion of the Non-Tidal West River were obtained from CAST, and are shown in Table 3-1 below. More specific discussion of loading sources will be added following the completion of the modeling in Phase 2.

**Table 3-1: CAST Land Use Types with Corresponding Acreage and Loading Rates in the MS4 Portion of the Non-Tidal West River Watershed**

Load Source	Amount <sup>1</sup>	Loading Rate <sup>2</sup>
MS4 Buildings and Other	410 acres	TBD
MS4 Roads	105 acres	TBD
MS4 Tree Canopy over Impervious	376 acres	TBD
MS4 Tree Canopy over Turf Grass	553 acres	TBD
MS4 Turf Grass	1657 acres	TBD

<sup>4</sup> [https://cfpub.epa.gov/npstbx/files/ksmo\\_sediment.pdf](https://cfpub.epa.gov/npstbx/files/ksmo_sediment.pdf)

<b>Stream Bed and Bank<sup>2</sup></b>	22 miles	TBD
<sup>1</sup> Acreage and loading rates are rounded to the nearest integer for ease of presentation.		
<sup>2</sup> Stream bed and bank loads will be determined after MDE issues its sediment modeling guidance		

**Table 3-2: Sediment Loads Per Major MS4 Source in the Non-Tidal West River**

Load Source	Amount (lbs)	Percent of Total
<b>Impervious<sup>1</sup></b>	TBD	TBD
<b>Turf<sup>2</sup></b>	TBD	TBD
<b>Stream Bed and Bank</b>	TBD	TBD
<sup>1</sup> Includes “MS4 Buildings and Other”, “MS4 Roads, and “MS4 Tree Canopy over Impervious”		
<sup>2</sup> Includes “MS4 Tree Canopy over Turf Grass” and “MS4 Turf Grass”		

**Table 3-3: Percent Impervious and Turf Area in the MS4 Portion of the Non-Tidal West River**

Load Source	Amount (acres)	Percent of Total
<b>Impervious</b>	892	29%
<b>Turf</b>	2210	71%

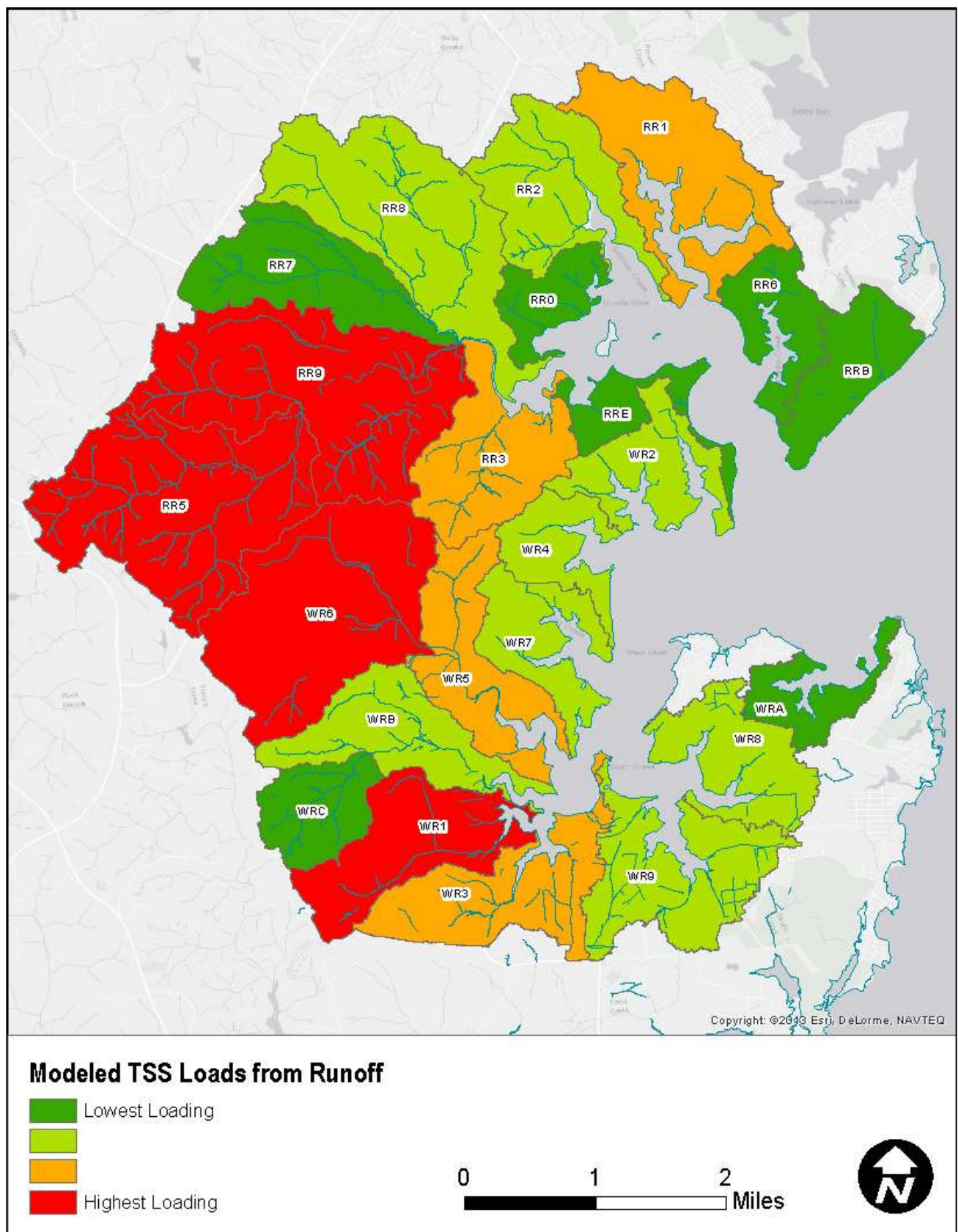
### 3.2.1 Urban Stormwater Runoff

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, will be used to assess potential stream restoration projects.

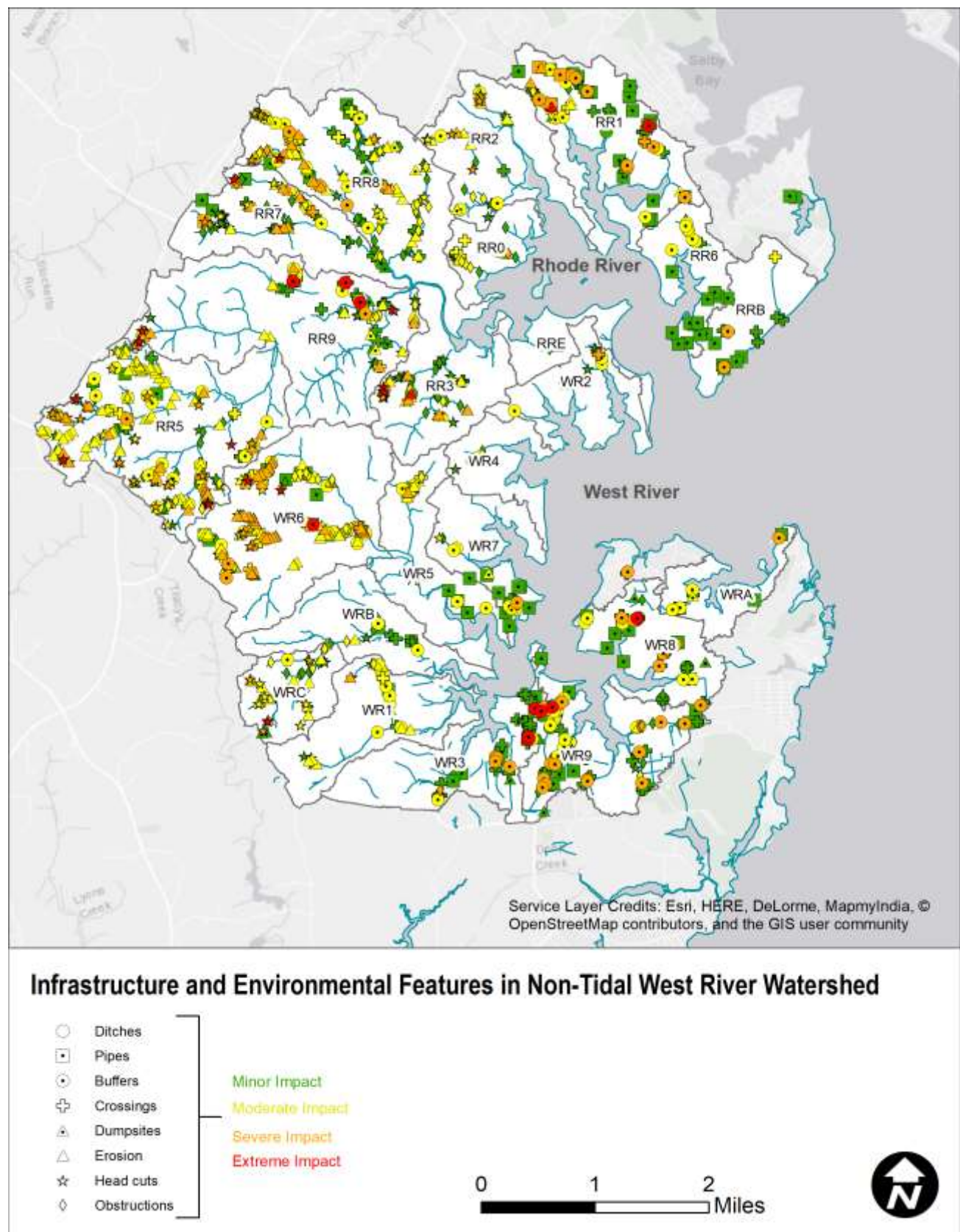
An assessment of channel geomorphology utilizing Rosgen Level I geomorphic classifications (Rosgen, 1996) was also developed for each single-threaded, perennial reach throughout the watershed as part of the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016). An assessment of channel 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

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).



**Figure 3-2: Watershed Infrastructure and Environmental Features Including Stream Erosion Inventory (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 will be 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.*

The *Anne Arundel County General Development Plan* (Anne Arundel County, 2009) was finalized April 2009 and was adopted in October 2009 (Bill No. 64-09). The next update of the plan, *Plan2040*, is scheduled for completion in 2020. *Plan2040* will capitalize on the County’s assets and conserve its critical resources. *Plan 2040* will be divided in to two volumes. Volume I will be the General Development Plan adopted by the County Council and will include the Countywide Vision, an Action Plan of goals, policies and recommendations for each of the Plan elements, a process for new Region Plans, a Concurrency and Implementation Plan and a plan for measuring the success of *Plan 2040*. Volume II will provide more detail of the regulatory framework for the General Development Plan, background reports and the public engagement process. During the early stages of the *Plan2040* planning process, protection of the natural environment and rural areas, as well as revitalization and redevelopment of older communities and maintaining quality of life, were identified as the highest priorities. *Plan2040* will identify opportunities to expand protection of the natural environment and conserve land and resources. Anne Arundel County is considered one of the fastest growing counties in the region with 14.6 percent population growth (427,239 to 489,656 persons) over 1990-2000 compared to 6.9 percent growth in the Baltimore region and 10.8 percent growth throughout the State of Maryland (Anne Arundel County, 2009). The population in Anne Arundel County is projected to increase to 564,925 persons by 2025, which is an increase of 15.4 percent from 2000 data, and to 579,137 persons by 2035, an increase of 18.3 percent from 2000 data.

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.

### 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 – Land use decisions affecting future growth and development will recognize the value of, and strive to balance good neighborhood planning, while retaining open space, preserving and restoring forest cover, investing in the health of our rivers and waterways, and increasing the ability of communities to withstand climate change impacts. Agricultural areas will remain important to the character of the County, and efforts to curb stormwater runoff, create living shorelines, and restore oyster populations will contribute to a cleaner and more sustainable environment.*

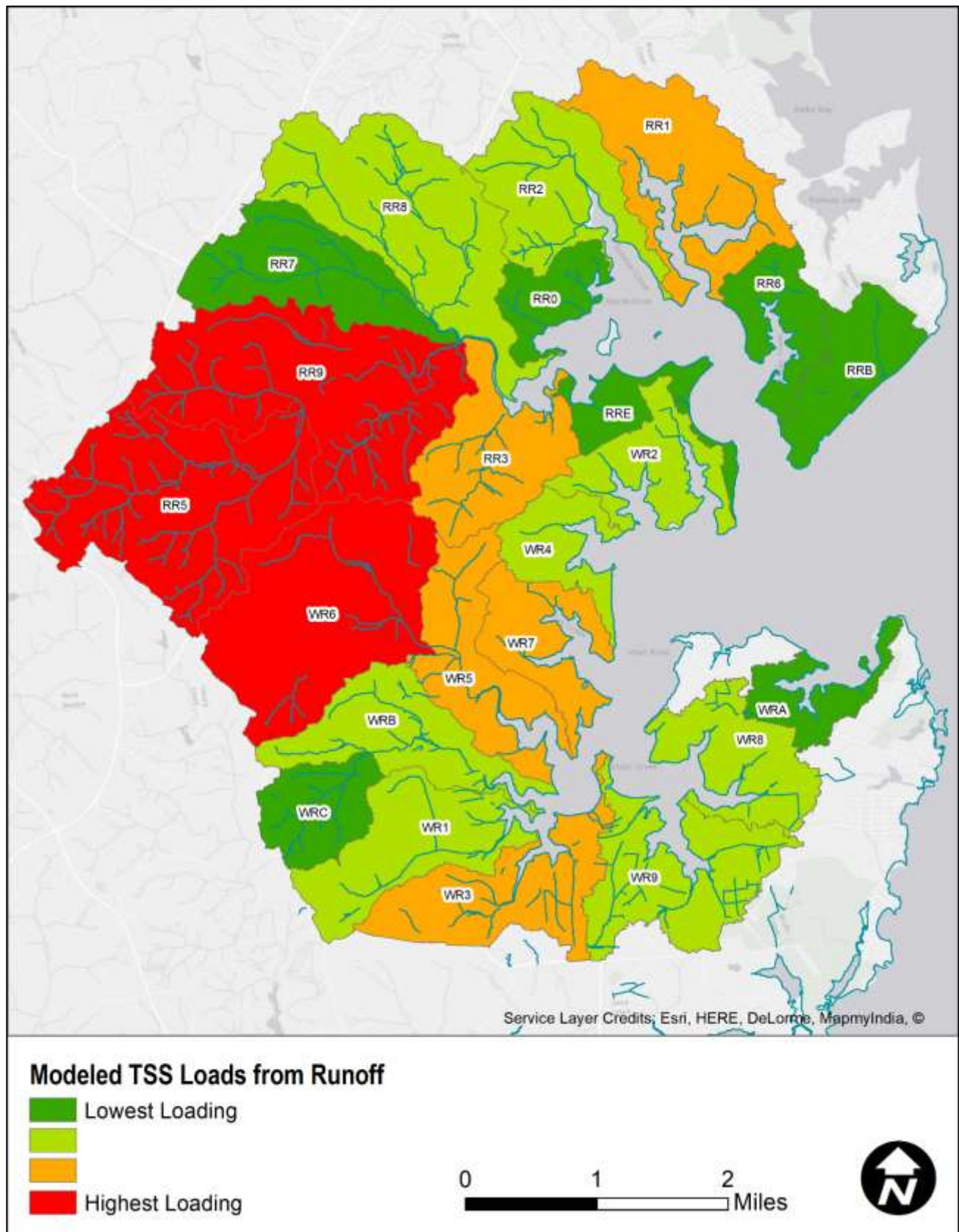
The land and water conservation framework within Anne Arundel County consists of multiple programs, plans and regulatory measures in place at the Federal, State, and County levels for protection of natural resources. Collectively they accomplish much in terms of natural resource preservation, land conservation, and water quality improvements. 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 shall be no net growth in loads and Anne Arundel County shall reflect these policies, programs, and implementation as part of its net WLA accounting as stipulated in Part IV.E.4.b.ii of this 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 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.

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



## 4 Management Measures

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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. While the actual load modeling for this Restoration Plan will be conducted when the sediment modeling methodology currently under development by MDE is made available for use for this project (Phase 2), a modeling approach and template discussion for results are presented as placeholders in this section. The modeling approach and results template are presented in the past tense to facilitate an easier update process following the completion of the modeling in Phase 2. It should also be noted that MDE is currently updating sediment modeling guidance, which is anticipated to be released in 2020. Sections of the modeling approach may be revised in Phase 2 based on the anticipated updated guidance.

### 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 CAST, a web-based estimator tool that calculates pollutant loads and reductions calibrated to the CBP's Watershed Model (CBP, 2017). CAST allows users to specify inputs such as geographic areas, the baseline year, and types of BMPs to create scenarios. CAST can then run these scenarios to determine land use acres and loads applicable to the conditions defined in the scenario. A scenario for implementing restoration projects was created for the Non-Tidal West River watershed. The baseline year for the TMDL is 2009, so the BMPs from the CAST scenario called "2009 Progress" were incorporated into the baseline scenario.

The loads provided in the CBP's Watershed Model are presented 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.

As further discussed in sections 5.1 and 5.2, all baseline loads and most current and planned source reductions were calculated in CAST. Pollutant load reductions from non-structural maintenance efforts (i.e., street sweeping and inlet cleaning) were calculated outside of CAST, based on the mass of material removed as calculated using the MDE guidance document *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE, 2014a). The modeling results were compiled and summarized in a spreadsheet. Current loads (2019 and earlier) were compared to the 2009 baseline loads to determine the percent of sediment reduction already achieved by the existing management measures. To fill the gap between the current sediment reductions and the reduction required by the TMDL, additional source reductions were planned.

The planned source reductions will be determined in Phase 2. The total planned load reduction needed to meet the TMDL SW-WLA was then apportioned to various progress checkpoints through 2030.

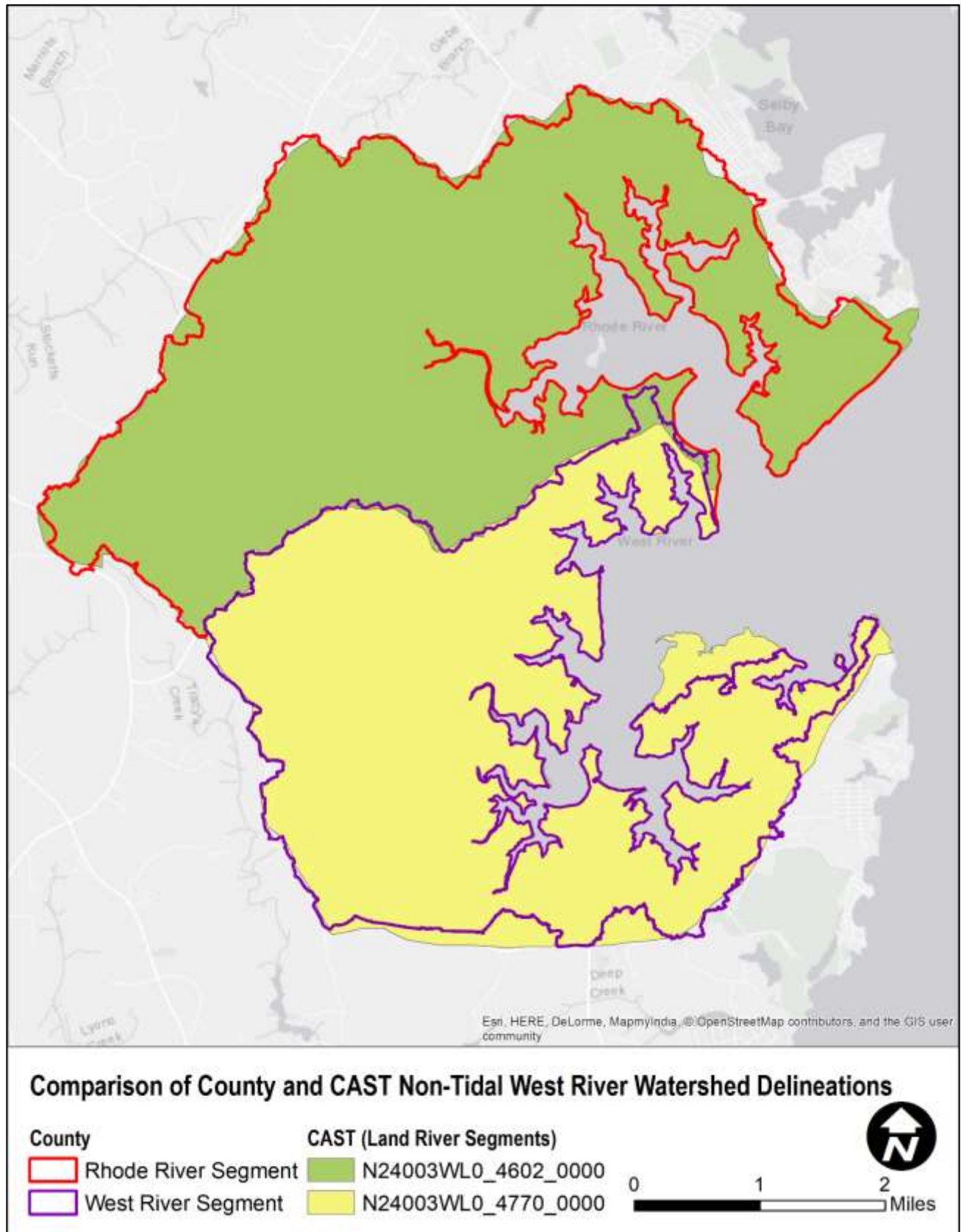
## 4.2 Use of CAST Data for Modeling

The watershed data presented in Section 2 (Watershed Characteristics) was compiled from *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016), and was presented to provide background information on the watershed. However, for the purposes of modeling, the data in CAST was utilized and superseded data from alternative data sources. This may result in slight discrepancies between CAST and other data sources. For example, the land river segments for the watershed that are included in CAST have small differences from the County watershed delineations. The differences in area (absolute and percent of the total) are shown below in Table 4-1. Given that the differences are small, they are considered to fall within the uncertainty of modeled results and should not have an impact on meeting the WLA. Similarly, the County's GIS resources list 33 miles of perennial streams, compared to the 22 miles in CAST; however, this discrepancy is not expected to impact the load reduction strategies or the ability to achieve the SW-WLA.

**Table 4-1: Differences Between County and CAST Watershed Delineations**

	West River	Rhode River
<b>County Delineation</b>	7106 acres	8521 acres
<b>CAST Delineation</b>	7588 acres	8721 acres
<b>Absolute Difference</b>	482 acres	200 acres
<b>% Difference</b>	6.6%	2.3%

**Figure 4-1: County vs. CAST Watershed Delineations for the Non-Tidal West River Watershed**





### 4.3 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, 2014a).

- **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

As described in Section 4, the modeling will be conducted in Phase 2 of this project. This Section presents a template for discussion of modeling results, and may be revised following the completion of the modeling. The discussion is presented using past tense to facilitate an easier update process when modeling is completed.

### 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. Currently, CAST is using a computational framework that is compatible with an updated version of the model: CBP WM P6. Because the TMDL was developed under an older version of the model, the TMDL WLA needed to be translated into a CAST-compatible target load. In order to do this, the 2009 baseline sediment load was re-calculated in CAST by modeling MDE 2009 Progress BMPs in the Non-Tidal West River watershed. To derive the stream loads allocated to the County's urban stormwater sector, the stream bed and bank loads calculated by CAST were pro-rated according to the ratio of Anne Arundel County MS4 area to total area in the watershed, and then these calculated stream bed and bank loads were assigned to the County's urban stormwater sector. 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 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)
TBD	22%	TBD	TBD

### 5.2 2019 Progress Load (Current Implementation)

Implemented BMPs are reported to EPA through the National Environmental Information Exchange Network (NEIEN) before being transferred into the CAST dataset. The BMPs in CAST through the year 2009 were used to calculate the baseline conditions. From there, additional source reduction practices implemented after 2009 were incorporated into the calculations to determine the current (2019) loads (i.e., the 2019 Progress Load). For the West River segment, no source reduction practices were completed during this time period. For the Rhode River segment, inlet cleaning, street sweeping, and stream restoration were completed during this time period. 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 2019 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 2019 for Non-Tidal West River**

	Load Source	EOS Sediment Load (lbs)
<b>CAST Baseline Loads</b>	MS4 Buildings and Other	TBD
	MS4 Roads	TBD
	MS4 Tree Canopy over Impervious	TBD
	MS4 Tree Canopy over Turf Grass	TBD
	MS4 Turf Grass	TBD
	Stream Bed and Bank	TBD
<b>2009 Baseline Load</b>		<b>TBD</b>
<b>Current Source Reductions</b>	Inlet Cleaning	418
	Street Sweeping	122
	Stream Restoration	21,000
<b>2019 Progress Load</b>		<b>TBD</b>

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

**Table 5-3: 2019 Progress Reductions Achieved in the Non-Tidal West River**

Results and TMDL WLA	Loads and Percent Reduction
<b>2009 Baseline Load (lbs)</b>	TBD
<b>2019 Progress Load (lbs)</b>	TBD
<b>Percent Reduction</b>	TBD
<b>Target TMDL WLA Reduction</b>	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. Less than 6.3% of the watershed consist 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. Inlet cleaning and street sweeping practices are recommended to continue at the current rates. Additional restoration practice recommendations may be included following the completion of the modeling in Phase 2 of the project.

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

Load Source				Amount	Unit	EOS Sediment Load (lbs)
<b>Baseline (2009) Load Total</b>						<b>TBD</b>
<b>Current (2019) Load Total</b>						TBD
<b>Planned Source Reductions</b>	TBD		TBD	TBD	TBD	TBD
<b>2030 Planned Load (=2019 Progress Load – sum of planned source reductions)</b>						<b>TBD</b>
<b>Total Sediment Reduction</b>	Percent Reduction Achieved		TBD			
	Target TMDL WLA Reduction		22%			
	Remaining Reduction Required		TBD			

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 and milestones, 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

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### 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, 2014b).

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.

Technical assistance for public participation and education and for monitoring will also be 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 \$TBD. 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 <sup>1</sup>	Unit	Cost/Unit	Total Cost <sup>1</sup>
<b>Shoreline Management/Stabilization</b>	760	linear feet	TBD	TBD
<b>Other Projects</b>	TBD	TBD	TBD	TBD
<b>Inlet Cleaning<sup>2</sup></b>	418	lbs removed	\$0.42	\$175.56
<b>Street sweeping<sup>2</sup></b>	112	lbs removed	\$0.95	\$39.71
			<b>Total</b>	<b>TBD</b>
1. Numbers shown in this table have been rounded.				
2. Inlet cleaning and street sweeping are annual activities. The numbers shown here represent the amount and total cost for the period of 2019.				

**Table 6-2: Planned Projects Cost Estimate Through 2030**

Watershed	2021	2023	2025	2027	2029	2030	Total
<b>West River</b>	TBD	TBD	TBD	TBD	TBD	TBD	TBD

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.

Non-structural BMP costs for inlet cleaning and street sweeping are based on implementation cost records in the County's geodatabase. Operating costs do not include the purchase and maintenance of street sweeping equipment. Costs for street sweeping and inlet cleaning are included because these activities must continue into the future as part of the planned management measures. The annual costs for these were aggregated over the 12-year (2019-2030) planning period.

### 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 forthcoming 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 2019.

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

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### 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. There are currently more than 220 certified Master Watershed Stewards representing over 100 communities throughout Anne Arundel County. In 2019 AAWSA installed 964,538 square feet of new-in-the ground projects, provided outreach to 31,688 County residents, and planted 7,463 native plants and trees.

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](http://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

These programs and others like them could be more focused 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 service clubs:
  - Maryland Home Builders Assoc.
  - Audubon Naturalist Society of the Central Atlantic States
  - Audubon Society of Central Maryland
  - Blue Water Baltimore
  - 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
- Magothy River Association
- Patuxent Riverkeeper
- West/Rhode Riverkeeper
- 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 WPRP 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 WPRP 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 WPRP webpage.

WPRP 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](http://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 WPRP website at [www.aarivers.org](http://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 and Milestones

This section presents the interim milestones, target loads, and activities required to achieve load reduction targets based on a planning horizon of 2030 for achieving the target load reductions. Two-year milestones for 2021, 2023, 2025, 2027, and 2029 are proposed as interim milestones to assess progress towards this target.

### 8.1 Loading Allocations and Milestone Targets

Progress loads for 2019 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)
<b>2009 Baseline Load</b>	TBD
<b>2019 Progress Load</b>	TBD
<b>2030 TMDL Allocated Load</b>	TBD
<b>Percent Reduction between 2009 Baseline and 2030 Loads</b>	TBD

### 8.2 Implementation Milestones

To meet the final SW-WLAs and the interim milestones, implementation of programs and BMPs must keep pace and meet planned implementation targets. Table 8-22 outlines the progress necessary to stay on track with the sediment reduction goals in the Non-Tidal West River watershed. Beginning in 2021, the County will have milestones every two years until the Restoration Plan is complete in 2030.

**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
2021	TBD	TBD	TBD
2023	TBD	TBD	TBD
2025	TBD	TBD	TBD
2027	TBD	TBD	TBD
2029	TBD	TBD	TBD
2030	TBD	TBD	TBD

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

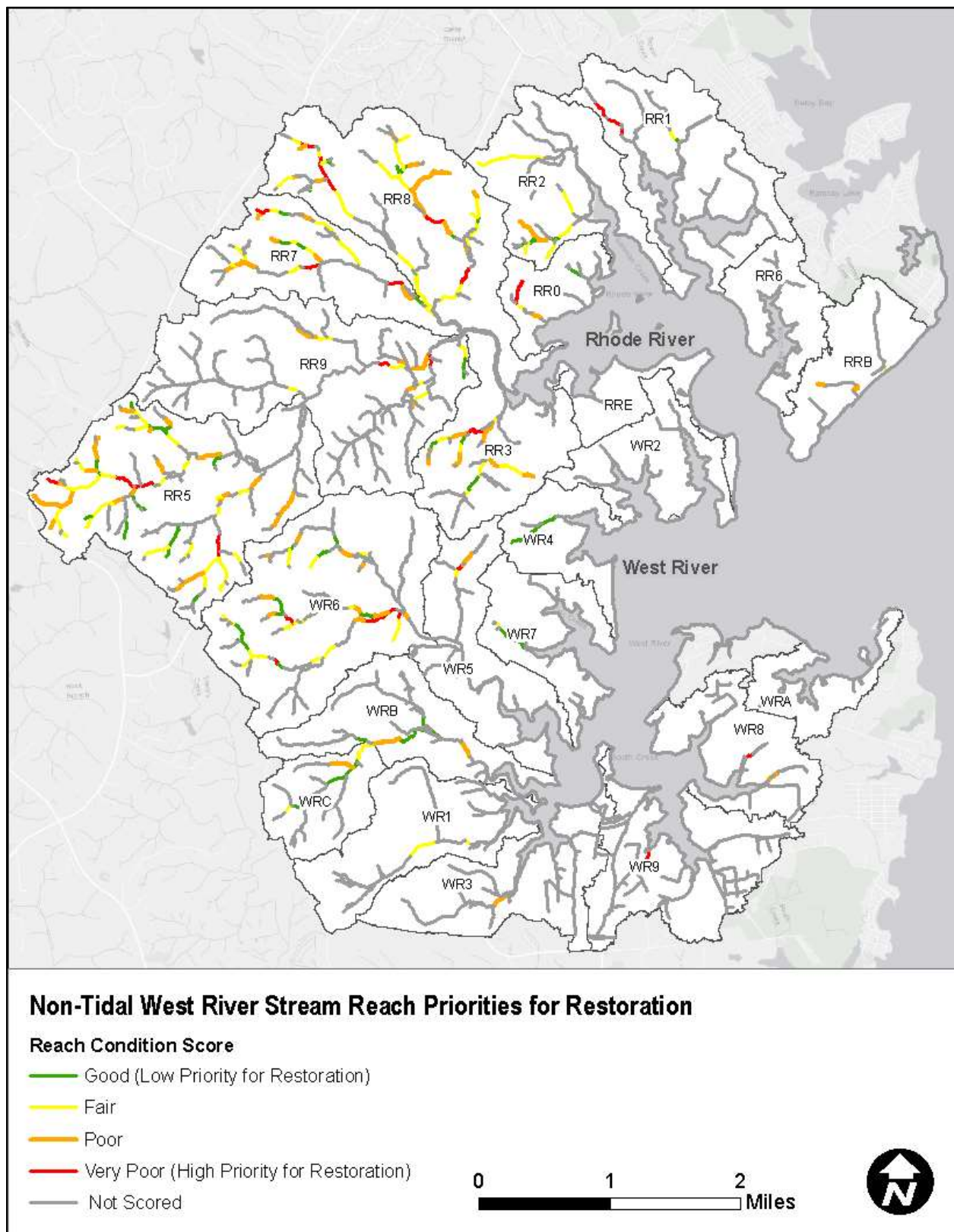
The stream restoration prioritization uses a suite of indicators that are weighted and then combined into a final relative rating for each perennial reach as identified in the Physical Habitat Condition Assessment in the *West and Rhode Watersheds Assessment Report* (Anne Arundel County, 2016). The suite 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 a Figure 8-1 below.





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 below as Figure 8-2. Tables 8-3 and 8-4 below show the prioritization of subwatersheds in a tabular format.

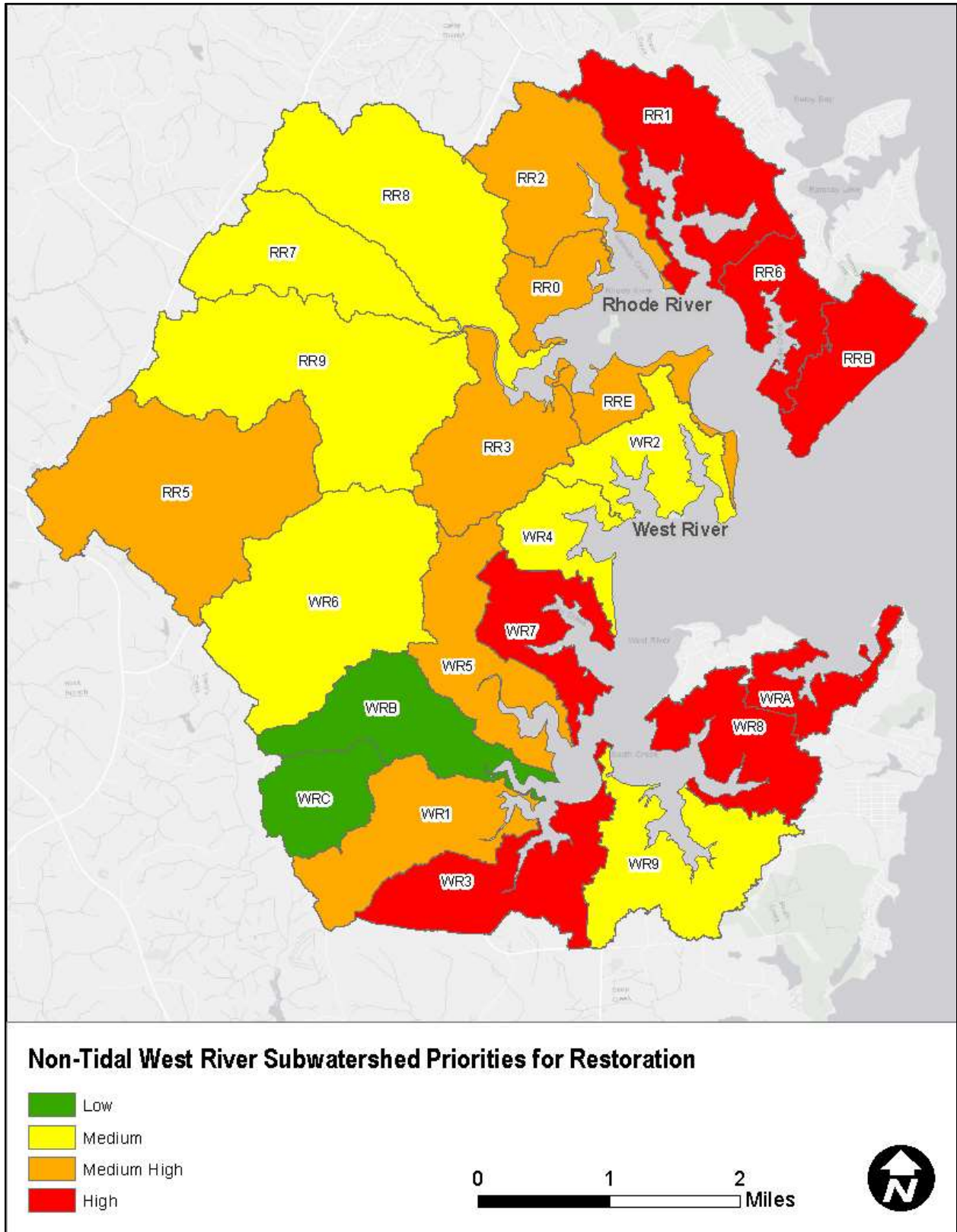
**Table 8-3: Non-Tidal West River Subwatershed Priority for Restoration**

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
<b>High</b>	4	3	7	33.3%	27.3%	30.4%
<b>Medium High</b>	2	5	7	16.7%	45.5%	30.4%
<b>Medium</b>	4	3	7	33.3%	27.3%	30.4%
<b>Low</b>	2	0	2	16.7%	0.0%	8.7%
<b>Total</b>	<b>12</b>	<b>11</b>	<b>23</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

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.

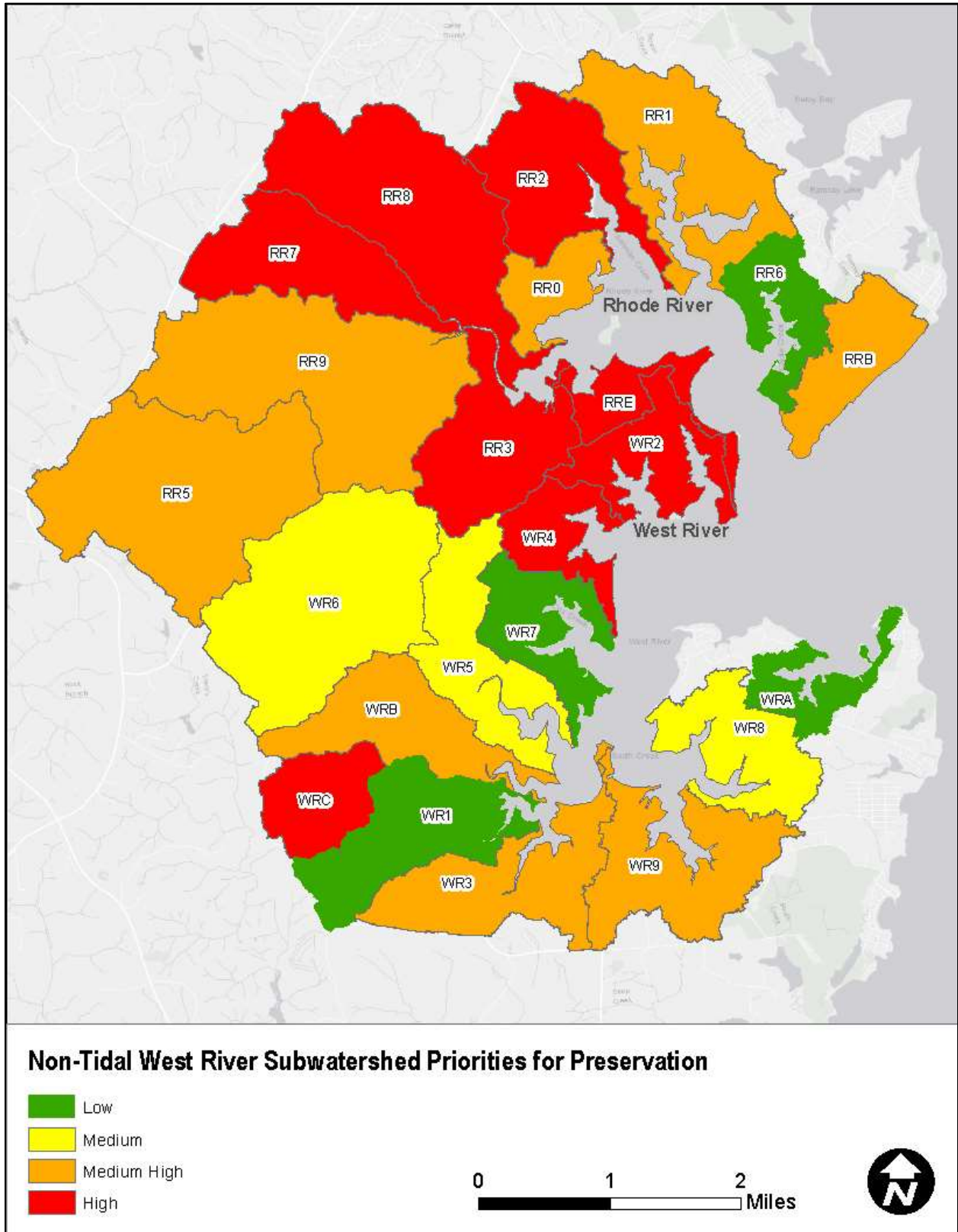
**Table 8-5: Non-Tidal West River Subwatershed Priority for Preservation**

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
<b>High</b>	<b>3</b>	<b>5</b>	<b>8</b>	25.0%	45.5%	34.8%
<b>Medium High</b>	<b>3</b>	<b>5</b>	<b>8</b>	25.0%	45.5%	34.8%
<b>Medium</b>	<b>3</b>	<b>0</b>	<b>3</b>	25.0%	0.0%	13.0%
<b>Low</b>	<b>3</b>	<b>1</b>	<b>4</b>	25.0%	9.1%	17.4%
<b>Total</b>	<b>12</b>	<b>11</b>	<b>23</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

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



## 8.4 Implementation Strategy

Following the adoption of its Stormwater Remediation Fee in 2013, Anne Arundel County developed a six-year CIP in FY14 that created a WPRP class of projects to implement those 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 \$74M annually. Projects in the WPRP class are identified and prioritized through a planning level assessment.

The MS4 permit calls for an iterative and adaptive plan for implementation. As WPRP 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

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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 established implementation and load reduction targets at specific intervals between current progress and the 2030 end date to provide interim planning targets and to serve as a vehicle for assessing progress toward the load reduction targets. The interim milestone dates are 2021, 2023, 2025, 2027, and 2029.

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. WPRP 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 WPRP. The County is also capturing and tracking projects implemented by the AAWSA through the WPRP-Chesapeake Bay Trust Restoration Grant Program.

#### 9.1.1 Two-Year Milestone Reporting

As a part of the federal Chesapeake Bay Accountability Framework, the County is required to report to MDE on two-year milestones, which represent near-term commitments and progress towards achieving load reduction goals for the Bay TMDL. These efforts will also support local TMDL planning and tracking at the County level.

Milestones were previously reported in two forms: Programmatic, and BMP Implementation. Programmatic milestones identify the anticipated establishment or enhancement of the institutional means that support and enable implementation. Examples of Programmatic milestones include projected funding, enhancement of existing programs and resources, and the establishment of new programs and studies. The milestone period for Programmatic Milestones covers two calendar years – for example, the period for 2020 -2021 is from January 1, 2020 through December 31, 2021. Following the development of MDE's NPDES MS4 geodatabase as a reporting vehicle for BMP Implementation, 2-Year BMP Implementation milestone reports are no longer required to be submitted.

### 9.1.2 Annual NPDES Reporting

As a requirement of the NPDES permit described in Section 2.4.4, on or before the anniversary date of the current 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.)

**9.1.3 Annual Assessment Report**

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 in February of each year.

**9.1.4 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 an updated version was submitted in February of 2019.

**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 CAST 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 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 WPRP inspection staff.

#### **9.4.2 Phase 1 Inspection and Enforcement**

Phase 1 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 1 Correction Notice issued in the field or mailed to the property owner. The Phase 1 Correction Notices are prepared using the I&P standard computerized inspection report software. They include a detailed description of the maintenance required and the compliance date by which the required maintenance is to be completed. If necessary, Phase 1 Correction Notices can be completed by hand using the standard Environmental Programs Inspection Report Form. Phase 1 Correction Notices contain the proper contact information. 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 facilities inspected or as new correction notices issued. Depending on the degree of maintenance required, a Compliance

Schedule may be appropriate. All proposed Compliance Schedules must be authorized by the WPRP Supervisor.

#### **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 in the form of a certified letter to the property owner or responsible party. The Phase 2 Violation Notice is prepared by the WPRP Inspector using the appropriate form letter, reviewed by the WPRP Supervisor/Environmental Code Administrator as appropriate, and signed by the WPRP Supervisor. The Phase 2 Notice establishes final compliance dates for the completion of the required maintenance. The final compliance dates may reflect agreed-upon Compliance Schedules as authorized by the WPRP 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 is prepared by the Environmental Code Administrator using the records associated with the violation.

## 10 Monitoring

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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 WPRP 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 will be 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 WPRP. 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 this monitoring program is noted 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.



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## Appendix A: Public Comments

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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.