July 31 , 2019

Prince George's County
DEPARTMENT OF THE
ENVIRONMENT

Restoration Plan for PCBs in the Patuxent River PAXTF, PAXOH, and PAXMH Segmentsheds

PRINCE GEORGE'S COUNTY
TREE ReLEAF
DEPARTMENT OF THE ENVIRONMENT Grant Program

Prepared for:
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Prince George's County
ALTERNATIVE COMPLIANCE PROGRAM

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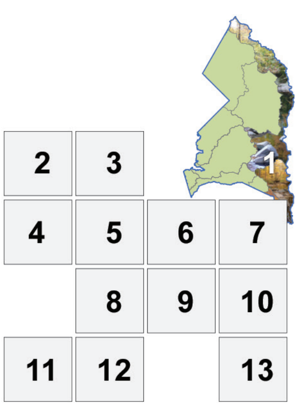

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Abbreviations and Acronyms

°F	degrees Fahrenheit
ac	acre(s)
B-IBI	Benthic Index of Biotic Integrity
BCF	bioconcentration factor
BMP	best management practice
CAST	Chesapeake Assessment Scenario Tool
CBP	Chesapeake Bay Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	Capital Improvement Program
COMAR	Code of Maryland Regulations
COPE	Community Outreach Promoting Empowerment
CSF	cancer slope factor
CWA	Clean Water Act
CWP	Clean Water Partnership
DO	dissolved oxygen
DoE	[Prince George's County] Department of the Environment
DPIE	Department of Permitting, Inspections, and Enforcement
DPW&T	Department of Public Works and Transportation
EOS	edge of stream
EPA	U.S. Environmental Protection Agency
ESD	environmental site design
GIS	geographic information system
HLI	Historic Landfill Initiatives
HOA	homeowners association
HSG	hydrologic soil group
IDDE	illicit discharge detection and elimination
LA	load allocation
LRP	Land Restoration Program
M-NCPPC	Maryland-National Capital Park and Planning Commission
MBSS	Maryland Biological Stream Survey
MD DNR	Maryland Department of Natural Resources
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
mi	mile(s)
MOS	margin of safety
MS4	municipal separate storm sewer system
ng/g	nanograms per gram
ng/L	nanograms per liter

NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	National Response Center
PADS	PCB Activity Database System
PAXMH	Patuxent River Mesohaline
PAXOH	Patuxent River Oligohaline
PAXTF	Patuxent River Tidal Fresh
PCB	polychlorinated biphenyl
ppb	parts per billion
R3	Round 3
R4	Round 4
ROW	right-of-way
SCA	stream corridor assessment
SIC	Standard Industrial Classification
sq mi	square mile(s)
SWM	Stormwater Management (Program)
TMDL	total maximum daily load
tPCB	total polychlorinated biphenyl
TRI	Toxic Release Inventory
TSS	total suspended solids
U.S. (adjective)	United States
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WIP	Watershed Implementation Plan
WLA	wasteload allocation
WWTP	wastewater treatment plant

1 INTRODUCTION

1.1 Background

On January 2, 2014, the Maryland Department of the Environment (MDE) issued Prince George's County (the County) a new municipal separate storm sewer system (MS4) permit. An MS4 is a series of stormwater sewers owned by a municipal entity (e.g., the County) that discharges the conveyed stormwater runoff into a water body (e.g., Patuxent River). The County's 2014 MS4 permit requires the County to develop local restoration plans to address each U.S. Environmental Protection Agency-(EPA) approved total maximum daily load (TMDL) with stormwater wasteload allocations (WLAs).

Since issuance of the MS4 permit in 2014, the County has been developing restoration plans for all water bodies subject to TMDL WLAs associated with the MS4 system. Those water bodies, moving from the headwaters to downstream, include the Patuxent River Tidal Fresh (PAXTF), Patuxent River Oligohaline (PAXOH), and Patuxent River Mesohaline (PAXMH) segmentsheds. "PAXTF," "PAXOH," and "PAXMH" are the watershed designations and boundaries used by the Chesapeake Bay Program (CBP) in the Chesapeake Bay Model. The term "segmentsheds" refers to those tidal segments and their associated watersheds and is used throughout this restoration plan.

This plan addresses the EPA-approved TMDL for "total polychlorinated biphenyls" (tPCBs) for the PAXTF, PAXOH, and PAXMH segmentsheds. It covers only the County's portions of the watersheds, so that any reference in this document to one of the watersheds refers only to those areas, unless otherwise noted. It was developed in a way similar to the way in which previous plans were developed, following guidance provided by MDE's *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated: Guidance for National Pollutant Discharge Elimination System Stormwater Permits* (MDE 2014a).

Local TMDL restoration plans were previously developed in 2014 for the County portions of the watersheds associated with the Anacostia River (nutrients, fecal coliform, sediment, polychlorinated biphenyls [PCBs], and trash); Mattawoman Creek (nutrients); Piscataway Creek (fecal coliform bacteria); the Upper Patuxent River and Rocky Gorge Reservoir (phosphorus, sediment, and fecal coliform bacteria); Western Branch (Chesapeake Bay TMDL); and PCB-impacted water bodies (Anacostia River, Mattawoman Creek, Piscataway Creek, and Potomac River). These plans and any future plans can be accessed on the Prince George's County website http://pgcdoe.net/pgcountyfactsheet/Factsheet/Default#watershed-restoration-plans.

1.1.1 What is a TMDL?

Section 303(d) of the Clean Water Act (CWA) and EPA's Water Quality Planning and Management Regulations (codified in Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to develop TMDLs for impaired water bodies. TMDLs provide the scientific basis on which a state can establish water quality-based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of the state's water resources (USEPA 1991).

A TMDL is a "pollution diet" that establishes the amount of a pollutant a water body can assimilate without exceeding its water quality standard for that pollutant and is represented as a mass per unit of time (e.g., grams per day [g/day]). The mass per unit time is called the "load." For instance, a TMDL could stipulate that a maximum load of 100 grams of PCBs per day could be discharged into an entire stream before the stream experiences any detrimental effects. A WLA is the portion of the overall pollution diet assigned to permitted dischargers such as the County's MS4). The TMDL for a given pollutant and water body is composed of the sum of individual WLAs for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. The following equation illustrates TMDL components:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

where:

TMDL = total maximum daily load
WLAs = wasteload allocations
LAs = load allocations
MOS = margin of safety

Figure 1-1 shows a generalized schematic of a TMDL. The TMDL identifies the maximum amount of pollutant load the water body can receive and still meet applicable water quality criteria. The bar on the left represents the current pollutant load (sometimes called the "baseline") that exists in a water body before a TMDL is developed. The elevated load causes the water body to exceed water quality criteria associated with the water body's officially designated uses. The bar on the right represents the amount by which the pollutant load will need to be reduced for the water body to meet water quality criteria. Another way to convey the required load reduction is by identifying the percent reduction needed. Given the baseline load levels determined for a long-term average annual condition and TMDLs established in 2017, the required overall load reduction for the County portion of the PAXTF segmentshed is 99.9 percent for tPCBs, while the PAXOH and PAXMH segmentsheds required no load reductions. The PAXTF segmentshed covers the Rocky Gorge Reservoir, and Upper and Middle Patuxent River watersheds, while the PAXOH and PAXMH segmentsheds cover the Lower Patuxent River watershed in the County.

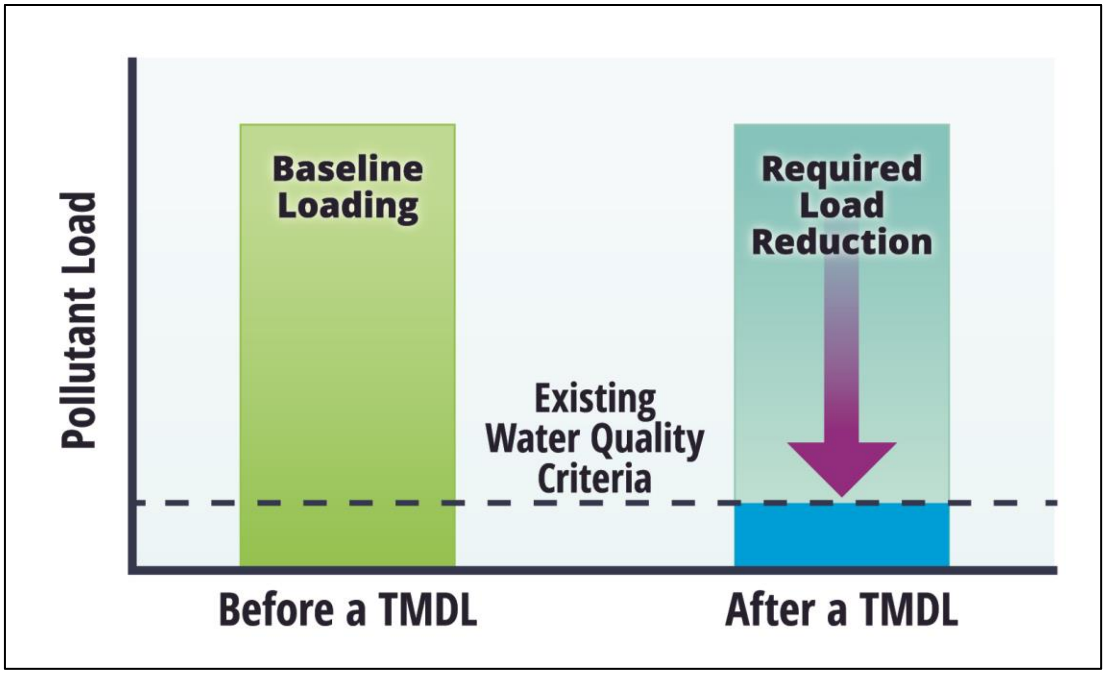


Figure 1-1. Conceptual schematic of a typical pollution diet, or TMDL.

1.1.2 What is a TMDL Restoration Plan?

A TMDL restoration plan is a strategy for managing the natural resources within a geographically defined watershed. For the County's Department of the Environment (DoE), this means managing urban stormwater (i.e., runoff originating from rain storms) to restore and protect the County's water bodies. Stormwater management is most effective when viewed in the watershed context—watersheds are land areas and their network of creeks that convey stormwater runoff to a common body of water. Successful stormwater management consists of both structural practices (e.g., vegetated roadway swale) and public outreach (e.g., pet waste campaigns and education) at both the public and private levels. The process of developing this restoration plan has addressed changes needed in the County's priorities to ensure they comply with water quality regulations, improve the health of the streams in the County, and create value for neighborhoods in the County's watersheds.

The overall goals of restoration planning are to:

- Protect, restore, and enhance habitat in the watershed;
- Restore watershed functions, including hydrology, water quality, and habitat, using a balanced approach that minimizes negative impacts;
- Support compliance with regional, state, and federal regulatory requirements; and
- Increase awareness and stewardship within the watershed, including encouraging policymakers to develop policies that support a healthy watershed.

This document represents the first stage in achieving those goals. It is not meant to be site-level planning, but rather focuses on watershed-based planning. For the Upper Patuxent River and Rocky Gorge Reservoir watersheds, accounting for portions of the PAXTF segmentshed, the restoration planning process began with the development of the *Upper Patuxent/Western*

Branch/Rocky Gorge Watershed Existing Conditions Report (PGC DER 2014). That report reviewed available data and began the process of identifying the causes and sources of pollution. The restoration planning process seeks to:

- Identify causes and sources of pollution,
- Estimate pollutant load reductions,
- Describe management options and identify critical areas,
- Estimate technical and financial assistance needs
- Develop an education component,
- Develop a project schedule,
- Describe interim, measurable milestones,
- Identify indicators to measure progress, and
- Develop a monitoring component.

In short, a restoration plan seeks to create the overall blueprint for restoration activities in a given watershed, allowing water bodies to achieve water quality standards.

1.2 Impaired Water Bodies and TMDLs

MDE has included the PAXMH, PAXOH, and PAXTF tidal segments as impaired for PCBs on its section 303(d) list. Those segments and their watersheds (segmentsheds) were developed as part of the Chesapeake Bay Model segmentation (USEPA 2010).

Using the Bay segmentation to define locations and extents of PCB impairment is somewhat unique since they typically are defined by state watershed. For PCBs, they include the Lower and Middle Patuxent River watersheds (012131101 and 012131102, respectively) and their tributaries. The Lower Patuxent River watershed is split between the PAXMH and PAXOH segmentsheds, while the Middle Patuxent River watershed is in the PAXTF segmentshed. PAXTF also includes the Upper Patuxent River and Rocky Gorge Reservoir watersheds, which are not listed as impaired for PCBs. Section 303(d)-listed waters fall under Category 5 of Maryland’s Integrated Report of Surface Water Quality (MDE 2019a). Impairments defined for the state watershed covered by the PCB-impaired Patuxent River segmentsheds include the following pollutants (listing year in parentheses):

Lower Patuxent River

- Nontidal sediment in first- through fourth-order streams (2014)
- PCBs in fish tissue (2008)
- Unknown causes (2006)

Middle Patuxent River

- PCBs in fish tissue (2016)
- Nontidal sediment in first- through fourth-order streams (2014)

- Sulfates (2014)
- Fecal coliform bacteria (2012)
- Unknown causes (2010)

Upper Patuxent River

- Chlorides (2014)
- Sulfates (2014)
- Escherichia coli bacteria (2008)
- Mercury in fish tissue (2004)
- Nutrients (total nitrogen and total phosphorus) (1996)
- Total suspended solids (TSS) (1996)

Rocky Gorge Reservoir

- TSS (2018)
- Mercury in fish tissue (2010)
- Total phosphorus (1998)

MDE developed TMDLs to address impairments caused by the violation of water quality standards for sediment and PCBs in the Lower and Middle Patuxent River watersheds. The TMDLs for PCBs were developed according to the Chesapeake Bay segmentation (PAXMH, PAXOH, and PAXTF), as discussed previously. MDE still needs to develop TMDLs for bacteria in the Lower Patuxent River watershed, chlorides and sulfates in the Upper Patuxent River watershed, and TSS in the Rocky Gorge Reservoir watershed. In addition, EPA published an overall TMDL for the Chesapeake Bay watershed for nitrogen, phosphorus, and sediment in 2010 (USEPA 2010). In 2011, the County developed a Watershed Implementation Plan (WIP) in response to the EPA Chesapeake Bay TMDL (PGC DER 2012).

This restoration plan addresses the PCB TMDLs for the PAXTF, PAXOH, and PAXMH segmentsheds of the Patuxent River as they pertain to Prince George's County. Those segmentsheds cover the PCB impairments listed for the state Lower and Middle Patuxent River watersheds. The PAXTF segmentshed also covers the state Upper Patuxent River and Rocky Gorge Reservoir watersheds, which are not impaired for PCBs and not addressed in this plan. Other existing and future TMDLs will be addressed by separate restoration plans.

1.2.1 Water Quality Standards

Water quality standards for the State of Maryland are defined by the designated uses assigned to state watersheds. The watersheds covered by the PAXTF, PAXOH, and PAXMH segmentsheds have the following designated uses (*Code of Maryland Regulations* [COMAR] 26.08.02.08O):

- Use Class I-P: Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply–Rocky Gorge Reservoir and Upper Patuxent River
- Use Class I: Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life–Rocky Gorge Reservoir and Upper, Middle, and Lower Patuxent River

- Use Class II: Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting–Middle and Lower Patuxent River (tidal reaches only)
- Use Class IV-P: Recreational Trout Waters and Public Water Supply–Rocky Gorge Reservoir

Maryland's General Water Quality Criteria state that:

> …the waters of this State may not be polluted by…any material, including floating debris, oil, grease, scum, sludge and other floating materials attributable to sewage, industrial waste, or other waste in amounts sufficient to be unsightly; produce taste or odor; change the existing color to produce objectionable color for aesthetic purposes; create a nuisance; or interfere directly or indirectly with designated uses (COMAR 26.08.02.03B(2)).

Specific water quality criteria also apply to tPCBs addressed in the TMDLs for the PAXTF, PAXOH, and PAXMH segmentsheds.

PCB Water Quality Criteria

The State of Maryland has adopted three separate water column tPCB criteria to account for different aspects of water quality (COMAR 2016d):

1. A human health criterion of 0.64 nanograms per liter (ng/L) or parts per trillion that addresses the consumption of PCB-contaminated fish;
2. A freshwater chronic criterion of 14 ng/L that is protective of aquatic life in nontidal systems; and
3. A saltwater chronic criterion of 30 ng/L that is protective of aquatic life in tidal systems.

The State of Maryland defines the "Patuxent River Area" (MD 6-Digit Code: 021311) as freshwater above a line connecting Chalk Point and God's Grace Point, which acts as the boundary between the PAXMH and PAXOH tidal segments. The PAXOH and PAXMH tidal segmentsheds encompass the Lower Patuxent River watershed, with the majority of the watershed located in PAXOH, which makes the saltwater aquatic life criterion is applicable to a small portion of the Lower Patuxent River. The freshwater aquatic life criterion applicable to the PAXOH and PAXTF segmentsheds is, thus, applicable to the Upper, Middle, and Lower Patuxent River and Rocky Gorge Reservoir watersheds that they cover.

For the remainder of this document, discussion of the tPCB TMDL and supporting analysis will be made in the context of the Chesapeake Bay Model segmentation for which it was developed.

Since the human health criterion is more stringent than the either the freshwater or the saltwater aquatic life criterion, meeting the human health criterion satisfies all applicable water quality criteria. The human health tPCB criterion is based on the following metrics:

- A cancer slope factor (CSF) of 2 milligrams per kilogram-day
- A bioconcentration factor (BCF) of 31,200 liters per kilogram
- A cancer risk level of 10^{-5}

- A lifetime risk level and exposure duration of 70 years
- Fish intake of 17.5 g/day

A CSF is a toxicity value used to evaluate the probability of an individual developing cancer from exposure (ingestion or inhalation) to a chemical substance over a lifetime. A BCF is the ratio of the concentration of a chemical (i.e. tPCBs) in an aquatic organism to the concentration of the chemical in the water column. The cancer risk level provides an estimate of the additional incidence of cancer that can be expected in an exposed population. A risk level of 10^{-5} indicates a probability of one additional case of cancer for every 100,000 people exposed.

PCB Fish Tissue Quality Criteria

CWA Section 101(a)(2) establishes the national goal of the attainment of "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water." This is commonly referred to as the CWA's "fishable/swimmable" goal. In addition, Section 303(c)(2)(A) requires water quality standards to protect the public health and welfare, enhance the quality of water, and serve the purposes of the Act. EPA, along with MDE, interprets those sections of the law to mean that water quality should support thriving and diverse fish and shellfish populations, which should be safe for humans to catch and consume.

Some contaminants, including PCBs, bioaccumulate in the tissues of gamefish (e.g., largemouth bass) and bottom-feeders (e.g., catfish). When a contaminant reaches levels in fish tissue associated with an increased risk of chronic health effects in humans that consume the fish, the State Department of Health issues a fish consumption advisory intended to protect the general public as well as sensitive populations (e.g., young children and women who are or may become pregnant). Recommendations are also issued to protect frequent fish consumers.

When a fish consumption advisory is issued for a water body, the designated use of that water body is accepted by the state as not being supported. This situation typically results in the water body being listed as impaired for the specific contaminant. State fish tissue contaminant thresholds have been developed to determine the necessity of consumption advisories and recommendations. The thresholds are compared to a sample weighted mean of the contaminant level in the edible portion of the common recreational fish species to determine impairment.

The State's tPCB fish tissue listing threshold is 39 nanograms per gram (ng/g). When tPCB fish tissue concentrations exceed that threshold, the water body is listed as impaired for PCBs in fish tissue in Maryland's Integrated Report and as not supporting the "fishing" designated use (MDE 2014b).

1.2.2 Problem Identification

This section provides a summary of the various problems identified in the PAXTF, PAXOH, and PAXMH segmentsheds and the data supporting the impairment decisions. All current PCB listings for the Patuxent River are a result of impairments for PCBs in fish tissue.

PCBs are a class of man-made organic chlorine compound widely used from the 1940s to the 1970s in manufacturing and industry for their fire-retardant and insulating properties. In 1979, the implementation of the Toxic Substances Control Act (Title 15 of the United States Code §

2601 *et seq.*) banned their use in the United States. The widespread use of PCBs resulted in the legacy contamination of soils that still release the compounds into waterways and the possibility that they might be found in materials produced before 1979. PCBs are released into the environment through sources such as poorly maintained hazardous waste sites that contain them, leaks or releases from electrical transformers containing them, and disposal of PCB-containing consumer products into municipal landfills not designed for hazardous waste.[1]

PCBs do not readily decompose once in the environment and have been demonstrated to cause cancer and negatively affect the immune, reproductive, nervous, and endocrine systems. They are hydrophobic and tend to become concentrated in sediment and in fatty tissues of animals. They bioaccumulate and do not break down over time. Small organisms that ingest PCB-contaminated sediment or food are then eaten by larger organisms, contributing to accumulation of PCBs in the tissues of the larger organisms.

Consumption of PCB-contaminated fish is a primary pathway of PCB exposure in humans. Although no longer manufactured, PCBs continue to exist in the environment and might still be released through legacy pollution such as fires or leaks from old PCB-containing equipment, accidental spills, burning of PCB-containing oils, and leaks from hazardous waste sites.

The listing of the PAXOH and PAXMH tidal segments in 2008 corresponded with a change in listing methodology for PCBs: the adoption of a more conservative threshold for fish tissue. The 2006 PCB threshold concentration used for fish tissue listing was reduced from 88 parts per billion (ppb) (i.e., ng/g – wet weight) to 39 ppb to be more protective of public health, with a focus on sensitive populations. The initial listing used fish tissue data collected in 2005 and identified contaminated sediments as the likely pollutant source (MDE 2008).

Maryland’s 2016 Integrated Report expanded the impairment listing to include the PAXTF because of PCB levels found in the tissue of channel catfish collected in 2009. The more recently collected fish tissue data from 2014 and 2015 also demonstrated that the PAXMH and PAXOH tidal segments are impaired by tPCBs for different species of fish—white perch in the PAXMH segment and channel catfish in the PAXOH segment. The PAXMH and PAXOH tidal segments are listed separately in the State’s 2016 Integrated Report (MDE 2016).

1.3 Previous Studies

The County’s Chesapeake Bay WIP developed in response to the 2010 Chesapeake Bay TMDL lays out a plan for implementing best management practices (BMPs) and other restoration activities through 2017 and 2025 (PGC DER 2012). In addition to urban stormwater runoff, the WIP covers agricultural practices and upgrades to wastewater systems (i.e., municipal wastewater treatment plants and on-site wastewater systems). Although the WIP addresses all the County’s land areas, many of its elements apply to the Lower and Middle Patuxent River watersheds and have been used to develop this restoration plan.

[1] Multiple potential sources of legacy PCBs exist in soils and sediment, including old electrical transformers (e.g., fires and illegal dumping), industrial activities, and oil spills. PCBs sprayed as a dust suppressant on County dirt roads is another potential source for all watersheds; however, no documentation of this practice exists, either of quantity sprayed or geographic locations.

In 2015, the County developed a restoration plan for the Upper Patuxent River covering a portion of the PAXTF segmentshed (Tetra Tech 2015a). The plan included an assessment of conventional pollutant impairments (fecal coliform bacteria, biological oxygen demand, dissolved oxygen (DO), nutrients, and TSS) and restoration strategies. In addition, Tetra Tech (2015b) developed a PCB restoration plan for other watersheds in the County, including the Anacostia River, Mattawoman Creek, Piscataway Creek, and the Potomac River. Those restoration plans address many of the pollutant source, transport, and fate considerations addressed in this plan.

Bioretention facilities (above) and permeable pavement (right) installed by the CWP as part of the Alternative Compliance Program.

2 WATERSHED CHARACTERIZATION

Seven Maryland counties share the Patuxent PAXTF, PAXOH, and PAXMH segmentsheds (Montgomery, Howard, Prince George's, Anne Arundel, Calvert, Charles, and St. Mary's counties), as shown in Figure 2-1. The Patuxent River discharges into the Chesapeake Bay near Solomons, MD, and the Patuxent River Naval Air Station. The PAXTF segmentshed has a drainage area of about 312,160 acres (ac), or 488 square miles (sq mi); the PAXOH segmentshed has a drainage area of about 74,360 ac, or 116 sq mi; and the PAXMH segmentshed has a drainage area of about 116,200 ac, or 182 sq mi, for a total area of 786 sq mi. This TMDL restoration plan will be specific only to the segmentshed portions in Prince George's County, the cities of Laurel and Bowie, and Eagle Harbor.

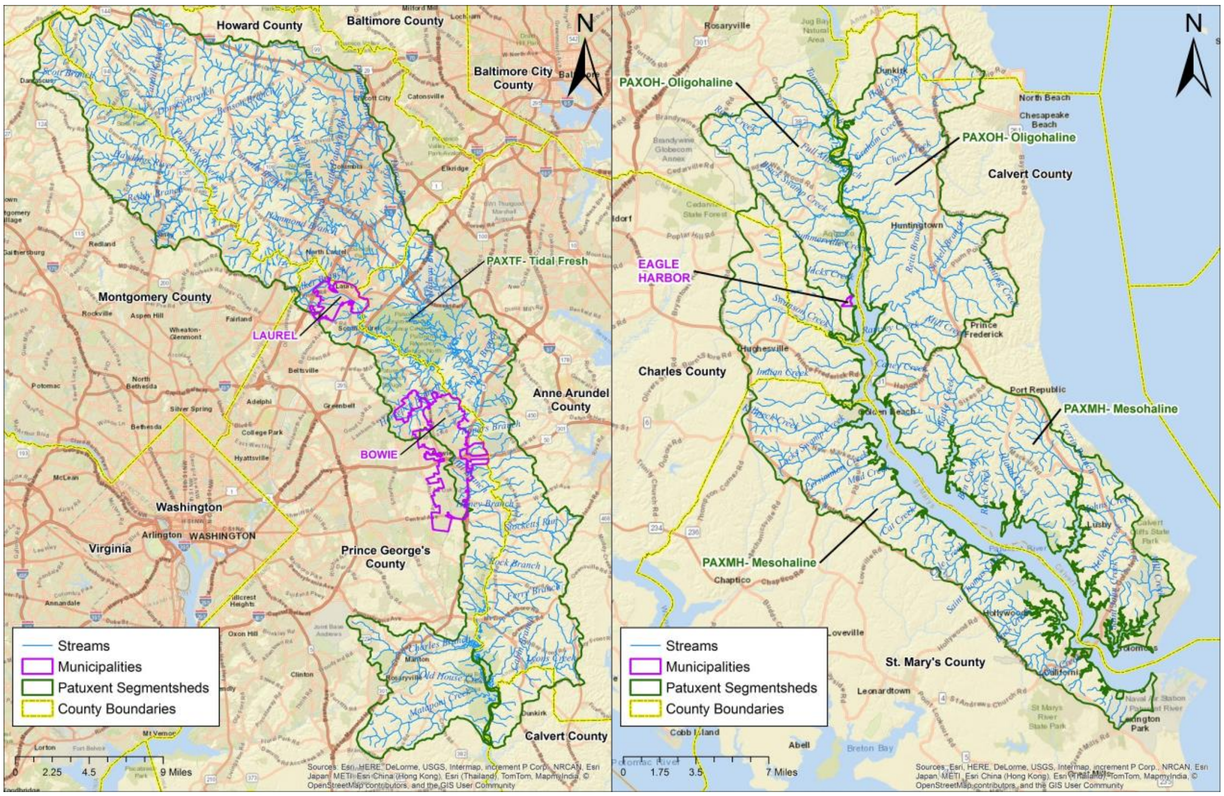


Figure 2-1. Location of the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

In the Patuxent River PAXTF, PAXOH, and PAXMH planning area (Prince George's County's portions of the watersheds), water flows through a dense network of streams, 1163, 208, and 369 miles (mi) for the PAXTF, PAXOH, and PAXMH, respectively. The Patuxent River main stem—115 mi in length—is tidal to the bridge on State Route 214 near Upper Marlboro, MD.

2.1 Physical and Natural Features

2.1.1 Hydrology

The main stem of the Patuxent River in the Lower and Middle watersheds forms the political boundary of Prince George's County. U.S. Geological Survey (USGS) stream gages along the main stem of the Patuxent River are limited, which makes characterizing stream depth and discharge in these areas difficult. Figure 2-2 shows the Patuxent River tidal segmentsheds, covering portions of multiple counties. In Prince George's County, the three segmentsheds are contained in the southeast corner of the County (Figure 2-1). This TMDL restoration plan is specific to the portions of the watersheds in the County.

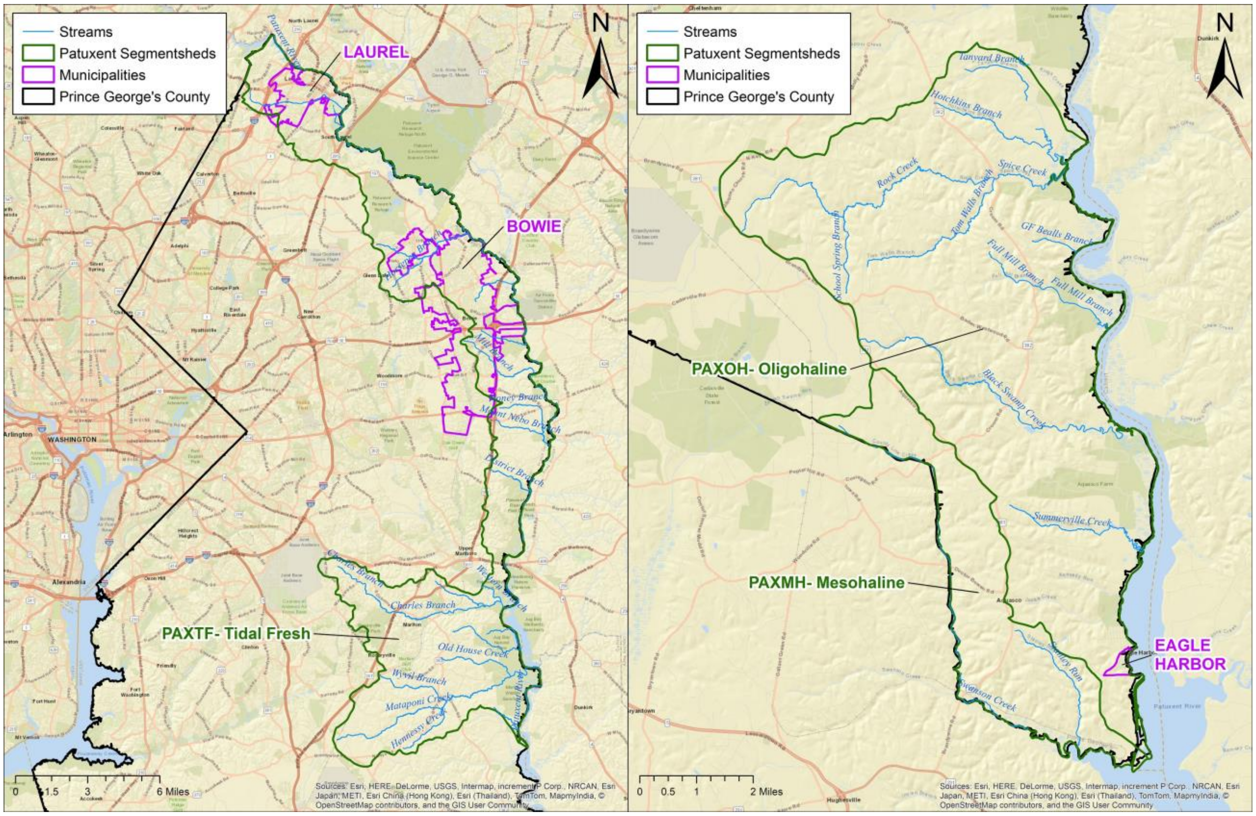
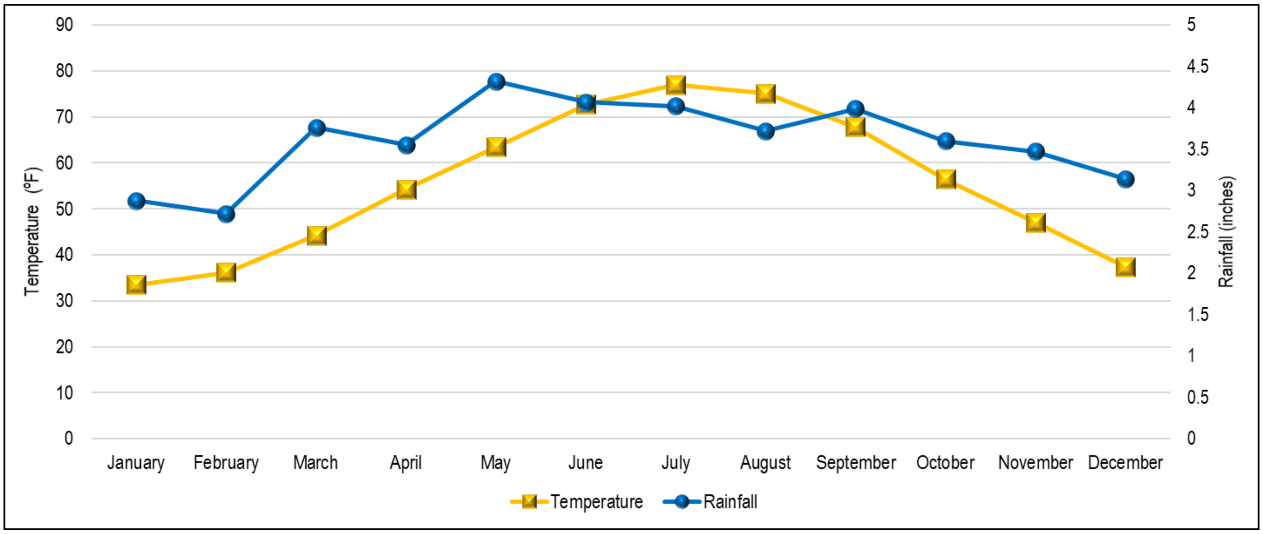


Figure 2-2. Location of the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*)within Prince George's County.

2.1.2 Climate and Precipitation

The climate of the Patuxent River tidal segmentsheds (PAXTF, PAXOH, and PAXMH) is characterized as temperate. The National Weather Service Forecast Office reports a 30-year average annual precipitation of 39.74 inches (NWS 2018a). On average, winter is the driest season with 8.48 inches of precipitation, and summer is the wettest season with 10.44 inches (NWS 2018a). Precipitation is highest in late spring to late summer. The average annual temperature is 58.2 degrees Fahrenheit (°F), with the January normal low at 28.6 °F and the July normal high at 88.4 °F (NWS 2018b). Average monthly temperatures range from approximately 33 °F in January to a peak of almost 80 °F in July. The normal monthly precipitation and temperature for Upper Marlboro, the seat of Prince George's County, are presented in Figure 2-3.

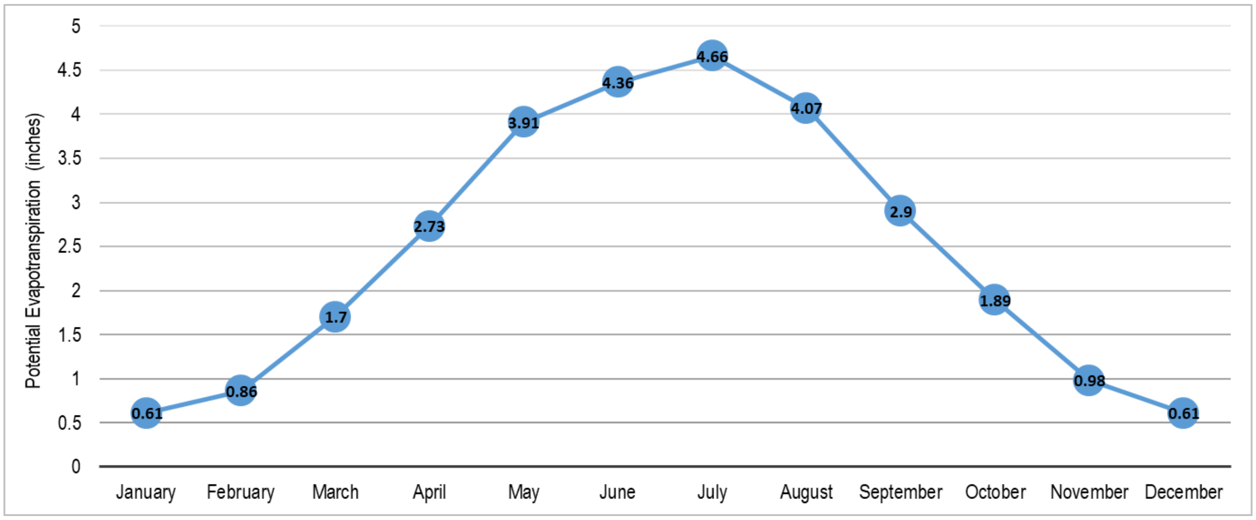


Source: NOAA 2018.

Figure 2-3. Average monthly temperature and precipitation.

Evapotranspiration accounts for water that evaporates from the land surface (including water bodies) and is lost through plant transpiration. The rate of evapotranspiration varies throughout the year based on climate but is highest in the summer. Figure 2-4 presents the "potential evapotranspiration," which is described by NOAA as ""the maximum amount of water that would be evapotranspired if enough water were available (from precipitation and soil moisture)" (NOAA n.d.). Solar radiation, air temperature, vapor pressure, and wind speed affect that amount. Expected rates of evaporation constitute a design consideration for certain BMPs, particularly those with permanent water (e.g., wet ponds) or that rely on moisture-rich soils (e.g., wetlands).

The County is reviewing the potential effects of climate change on resources in the County. Climate change is the result of rising temperatures caused by elevated levels of heat-trapping greenhouse gases such as carbon dioxide in the atmosphere. Rising temperatures are expected to increase and shift in energy distribution in the atmosphere, which could lead to a higher rate of evaporation, higher humidity, higher average rainfall, and more frequent occurrences of heavy rainstorms in some regions and droughts in others (USEPA 2016). Although average annual precipitation in Maryland has increased by approximately 5 percent in the past century, precipitation from extremely heavy events has increased in the eastern United States by more than 25 percent since 1958 (USEPA 2016). The amount and frequency of precipitation is projected to continue increasing, which could lead to more flooding such as past flooding in Upper Marlboro. Average precipitation is expected to increase during winter and spring, which will cause snow to melt earlier and intensify flooding during those seasons. The higher rates of evaporation will also likely result in drier soil during the summer and fall.

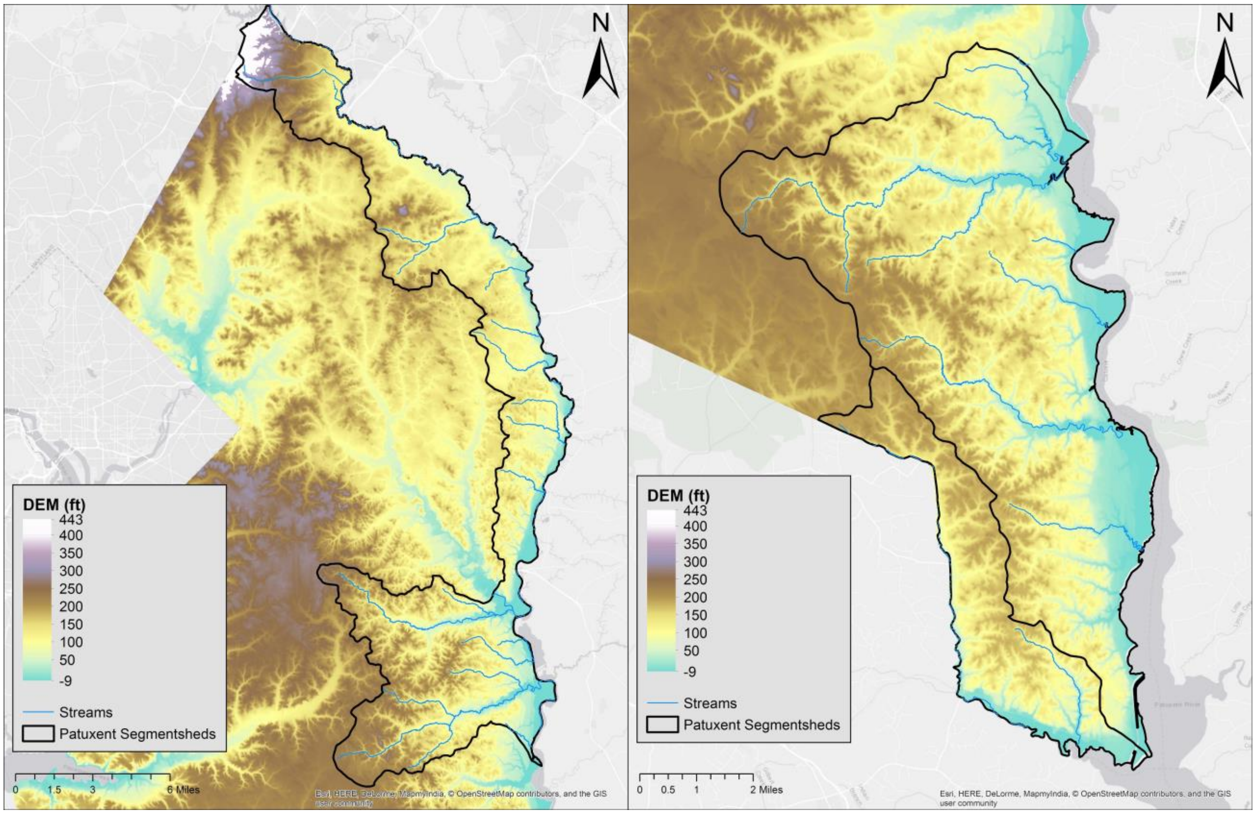


Source: NRCC 2014.

Figure 2-4. Average monthly potential evapotranspiration in inches (1981–2010).

2.1.3 Topography and Elevation

According to the Maryland Geological Survey, the Patuxent PAXTF, PAXOH, and PAXMH segmentsheds lie in the Coastal Plain geologic province, which is characterized by gentle slopes and drainage, and deep sedimentary soil complexes (MGS 2014). As illustrated in Figure 2-5, the watershed is relatively flat, especially along the Patuxent River main stem, with higher elevations in the range of 400-450 feet in the northern portions of this planning area. Since the landscape tends to have steeper slopes at the higher elevations, streams will flow faster in those areas.



Source: M-NCPPC 2014.

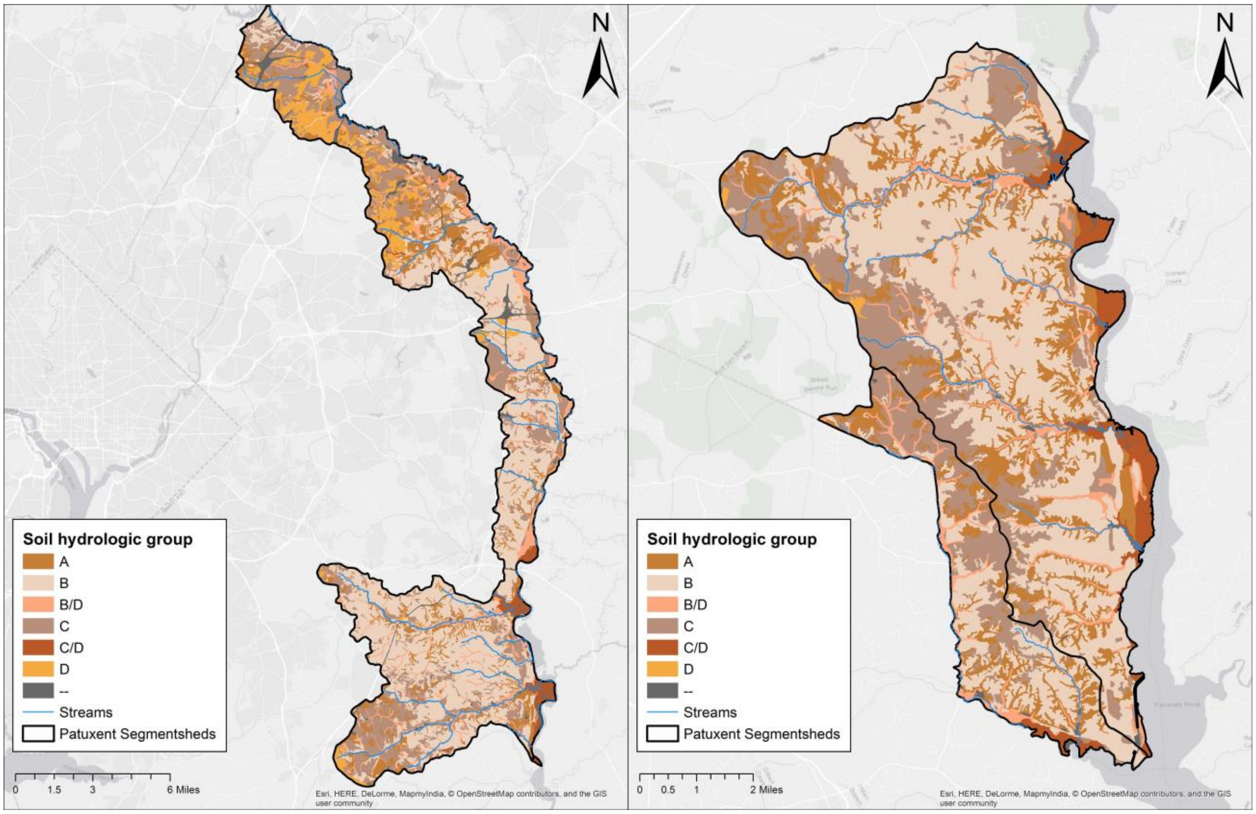
Figure 2-5. Elevation in the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

2.1.4 Soils

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service has defined four major hydrologic soil groups (HSGs) for categorizing soils by similar infiltration and runoff characteristics: A, B, C, and D (SCS 1974). Poorly drained clay soils (group D) have very low infiltration rates, resulting in the highest amount of runoff, while well-drained sandy soils (group A) have high infiltration rates with little runoff; group B and group C soils, in between groups A and D, have moderate and low levels of infiltration, respectively.

Figure 2-6 shows the locations of the different USDA HSGs across the PAXTF, PAXOH, and PAXMH segmentsheds (USDA 2003). The distribution of soil groups in the three segmentsheds is similar, with group B soils being predominant, followed by group C, then group A. Group D is the least common soil group across all three segmentsheds.

Soils in the urbanized portions of the segmentsheds are frequently also classified as urban land complex, or “udorthent,” soils. These soils have been significantly altered by disturbance from land development activities. Soils affected by urbanization can have a higher density because of compaction occurring during construction activities and might be more poorly drained.



Source: USDA 2003.

Figure 2-6. Hydrologic soil groups in the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

2.2 Land Use and Land Cover

Land use and land cover are key watershed characteristics that influence the type and amount of pollution entering the County's water bodies.

2.2.1 Land-Use Distribution

Land-use information for the PAXTF, PAXOH, and PAXMH segmentsheds is available from the Maryland Department of Planning (MDP) 2010 land use update (MDP 2010). Different land-use categories (e.g., agriculture, residential) have different types of land cover such as roads, roofs, turf, and tree canopy. Consequently, land use affects how readily stormwater drains from the land and how much pollution it carries. This information is useful in the later stages of restoration planning because land use influences the proposed types of water quality control strategies and BMPs implemented and where they can be installed.

Table 2-1 summarizes the land-use distribution by segmentshed. Figure 2-7 shows land use in the segmentsheds. Figure 2-11 shows the percent of tree canopy in each segmentshed.

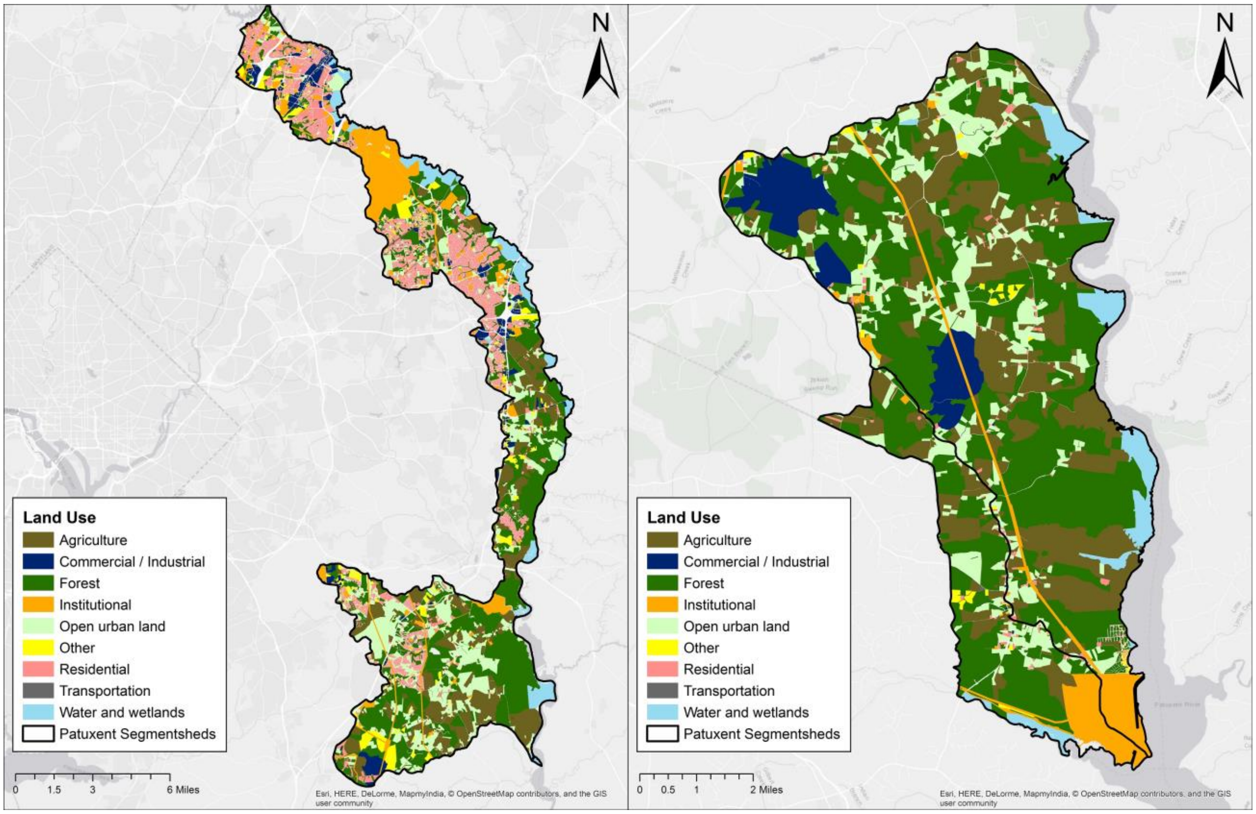
The dominant general land-use category in the three segmentsheds is urban, which accounts for 39 percent of the area. Most of the urban areas are in the northern portion of the PAXTF segmentshed. Forested land makes up another one-third (34 percent) of the area, while agricultural land covers 19 percent, mainly in the PAXOH and PAXMH segmentsheds and the southern portion of the PAXTF segmentshed. The occurrence of PCBs is typically associated with past industrial use and historical contamination, so urban areas are likely sources of current PCB loading to streams.

This information is useful in the later stages of restoration planning because land use influences the proposed types of water quality control strategies and BMPs implemented and where they can be installed.

Table 2-1. PAXTF, PAXOH, and PAXMH land use by segmentshed

Land Use	PAXTF (ac)	PAXOH (ac)	PAXMH (ac)	Total (ac)	% Total
Agriculture	9,503	6,927	1,213	17,643	18.61%
Forest	19,323	10,742	2,564	32,629	34.41%
Other	2,844	149	78	3,071	3.24%
Bare Exposed Rock	14	0	0	14	0.01%
Bare Ground	2,830	149	78	3,057	3.22%
Urban	28,909	6,437	1,606	36,951	38.97%
Commercial	1,371	16	3	1,390	1.47%
Extractive	412	1,793	0	2,205	2.33%
Industrial	526	0	0	526	0.56%
Institutional	6,533	963	748	8,245	8.70%
Mixed-Use Commercial	9	0	0	9	0.01%
Mixed-Use Residential	88	0	0	88	0.09%
Parks and Open Space	2,539	4	1	2,544	2.68%
Residential High	35	0	0	35	0.04%
Residential Low	7,350	247	70	7,667	8.09%
Residential Low Medium	649	0	9	658	0.69%
Residential Medium	1,644	0	0	1,644	1.73%
Residential Medium High	205	0	0	206	0.22%
Rural	7,147	3,401	765	11,313	11.93%
Transportation	400	13	9	422	0.45%
Water and Wetlands	3,241	1,095	180	4,516	4.76%
Water	55	20	0	75	0.08%
Wetlands	3,186	1,075	180	4,441	4.68%
Total	**63,820**	**25,349**	**5,641**	**94,810**	**100.00%**

Source: MDP 2010.



Source: MDP 2010.

Figure 2-7. Land use in the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

Differing land uses and land covers can contribute differing amounts of sediment to a stream based on certain characteristics. This is critical from a PCB loading standpoint as legacy contamination is typically associated with soils and sediment. Figure 2-8 illustrates where land-use and land-cover data suggest the sources of the highest loads of sediments are located. The highest per-acre sediment loading rates in the watershed are from agricultural and, in more urbanized areas, impervious land use/land cover, which is discussed in more detail in Section 2.2.3.

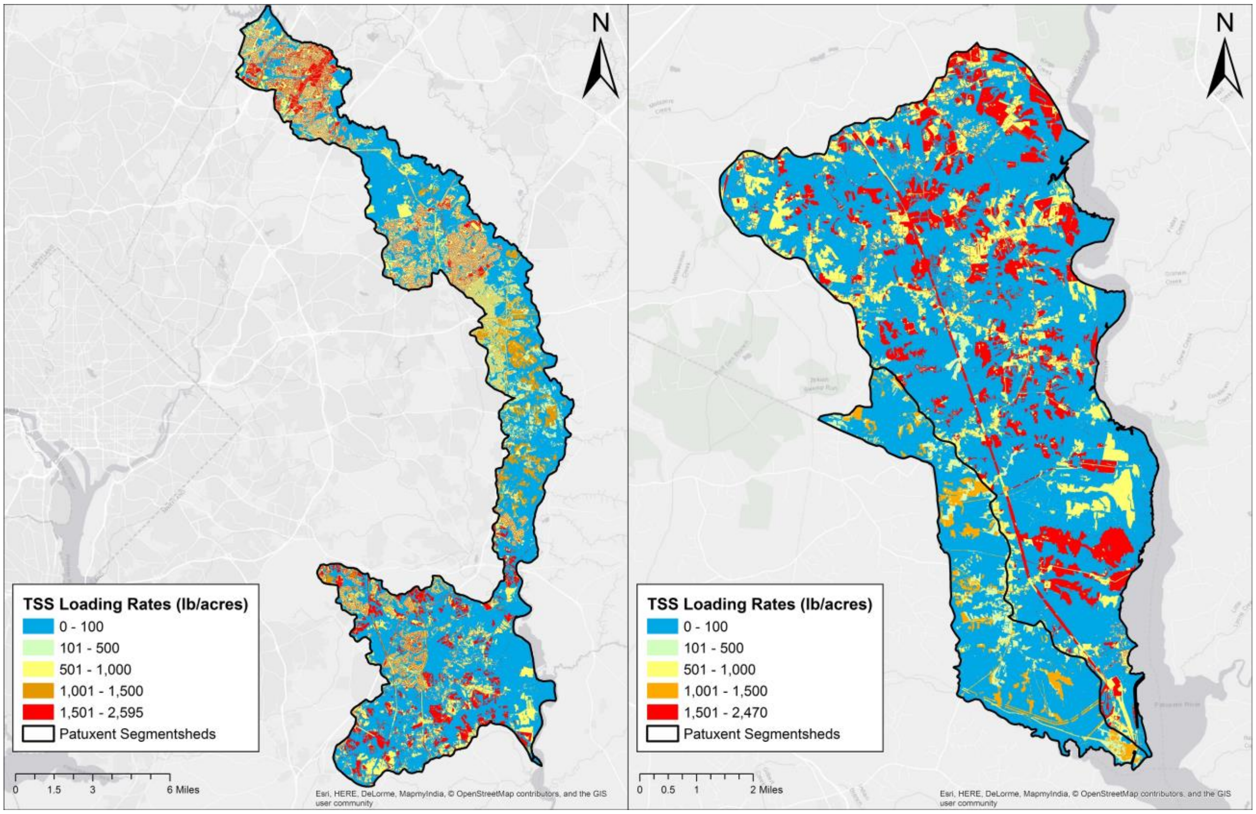


Figure 2-8. Geography of sediment loading rates within the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

2.2.2 Land Ownership

Overall, the watershed is primarily privately-owned residential land (Figure 2-9). A closer examination of land ownership might occur during more specific restoration planning, as it can sometimes be a simpler solution to implement certain pollutant reduction BMPs on County, or otherwise publicly owned, lands than on private property. While roadways are usually considered public rights-of-way (ROWs), Figure 2-9 was created using only parcel information, which does not include roadway information.

Figure 2-10 looks specifically at publicly owned lands in the planning area, and illustrates that most open public spaces (e.g., parks) are concentrated along or near the main stem of the Patuxent River.

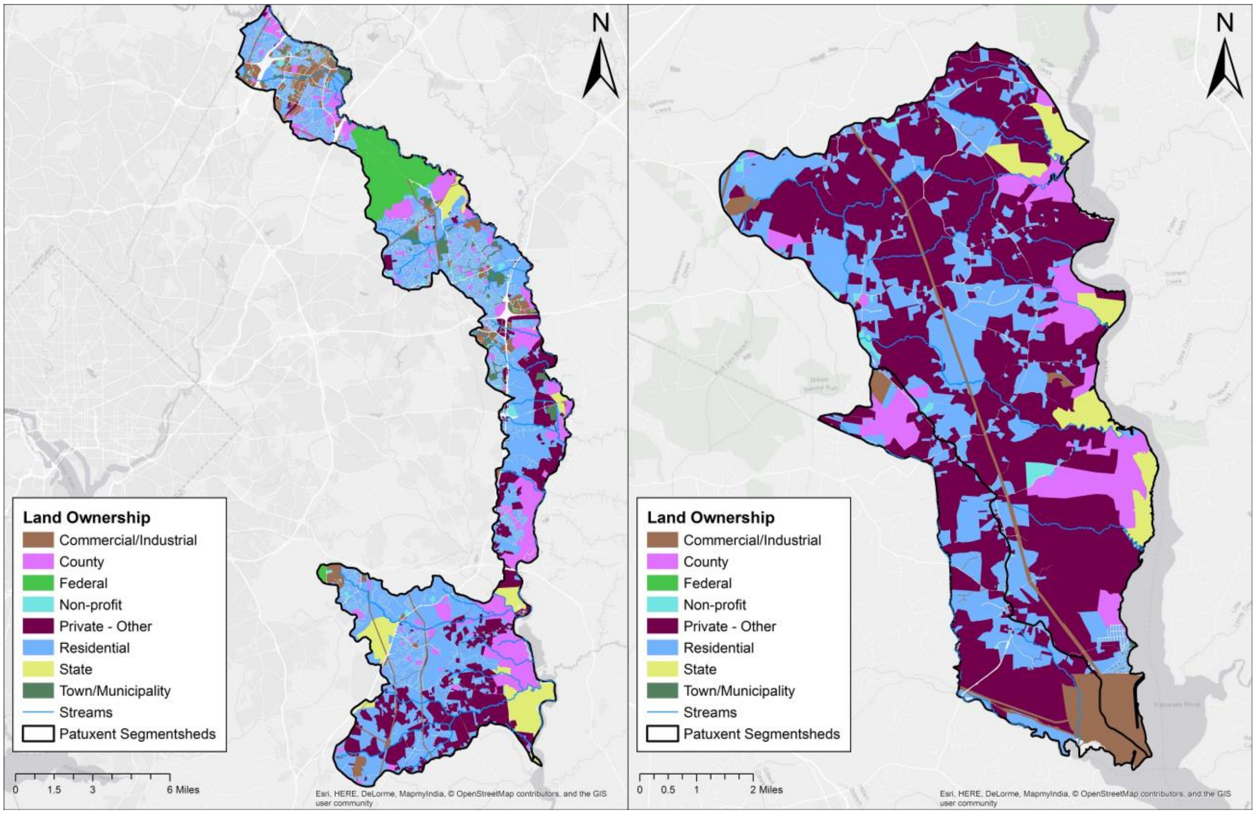


Figure 2-9. Land ownership in the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

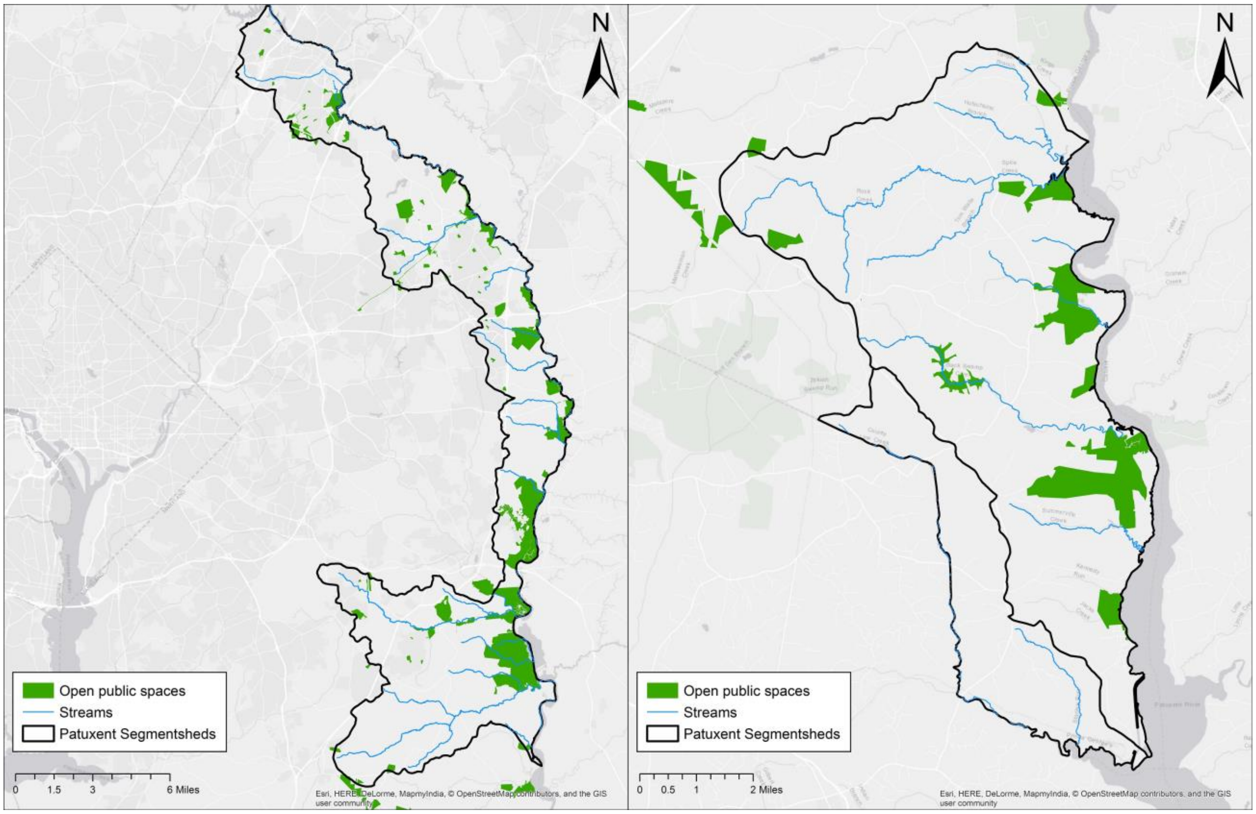


Figure 2-10. Open public spaces within the Patuxent PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

2.2.3 Imperviousness

Impervious area is land surface that is covered with solid material or compacted to the point at which water cannot infiltrate into underlying soils (e.g., parking lots, roads, houses, patios, swimming pools, and compacted gravel areas). Consequently, land development, which creates impervious areas, affect both the amount and the quality of runoff.

Compared to naturally vegetated areas, impervious areas generally decrease the amount of water infiltrating into groundwater and increase the amount of water flowing to the stream channels in the watershed. This increased surface flow not only carries larger amounts of nutrients and other pollutants, but also increases the velocity of the streams, which worsens erosion. Intensified erosion increases the amount of sediment carried by the water, which can be detrimental not only to the appearance of a stream, but also to its ecological health.

The quality of runoff is affected by the type of impervious area that generates it. For instance, driveways have a higher potential than roofs for nutrient loading to waterways because of the grass clippings and potentially fertilizer that can accidentally be spread on a driveway. Sidewalks have higher bacteria loadings than driveways because of the number of dogs that are walked along sidewalks.

Data from the Maryland-National Capital Park and Planning Commission (M-NCPPC) illustrate significant amounts of forest cover throughout the planning area, with the PAXTF, PAXOH, and

PAXMH segmentsheds having 42–59 percent, 52–63 percent, and 63 percent canopy cover, respectively (Figure 2-11). M-NCPPC data also show the Patuxent River tidal segmentsheds have varying degrees of imperviousness, with PAXTF at roughly 0–17 percent impervious, PAXOH at 0–2 percent impervious, and PAXMH at approximately 4 percent impervious (Figure 2-12). A representation of the actual impervious land cover is depicted in Figure 2-13, while the individual types of impervious land cover are shown in PAXTF (Figure 2-14), PAXOH (Figure 2-15), and PAXMH (Figure 2-16). Greater proportions of impervious land cover can be seen in more developed areas on smaller scales, especially in the form of roadways, parking facilities, and buildings.

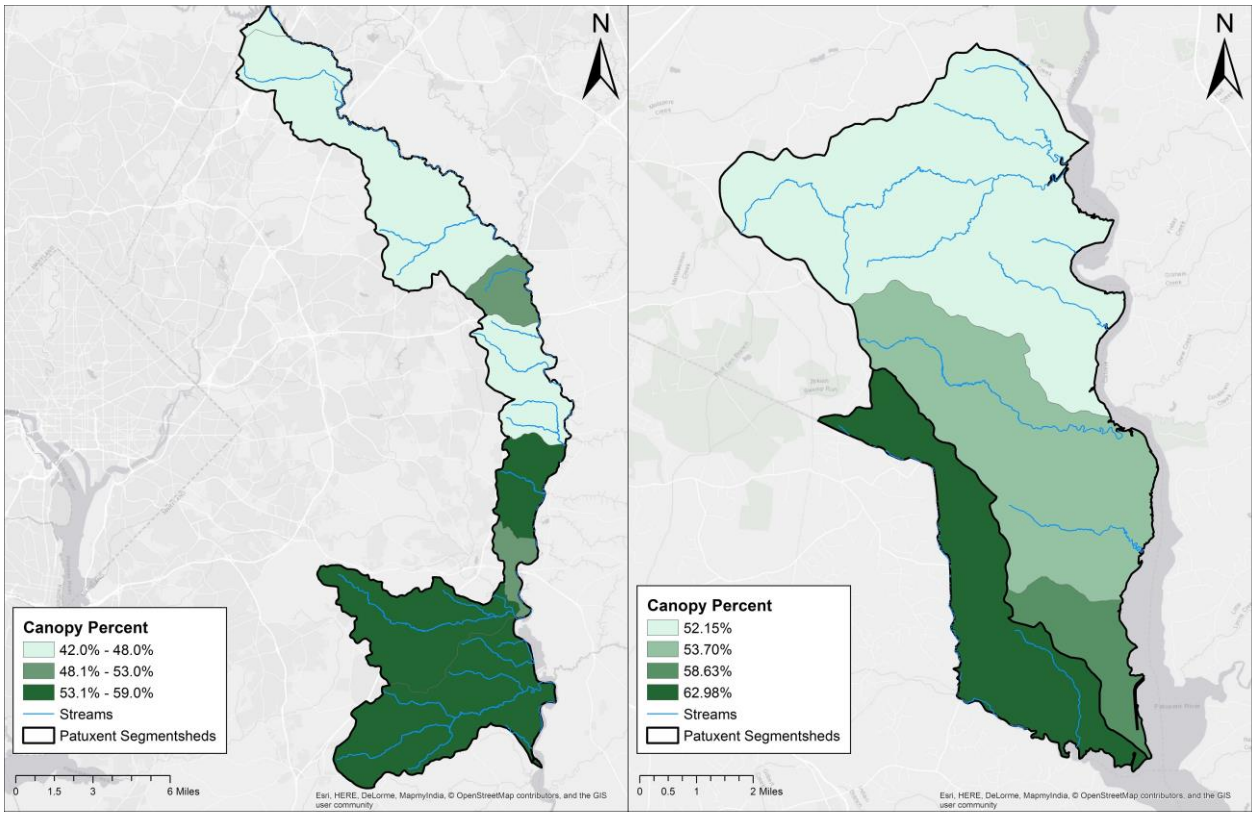


Figure 2-11. Tree canopy in the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH egmentsheds (*right*).

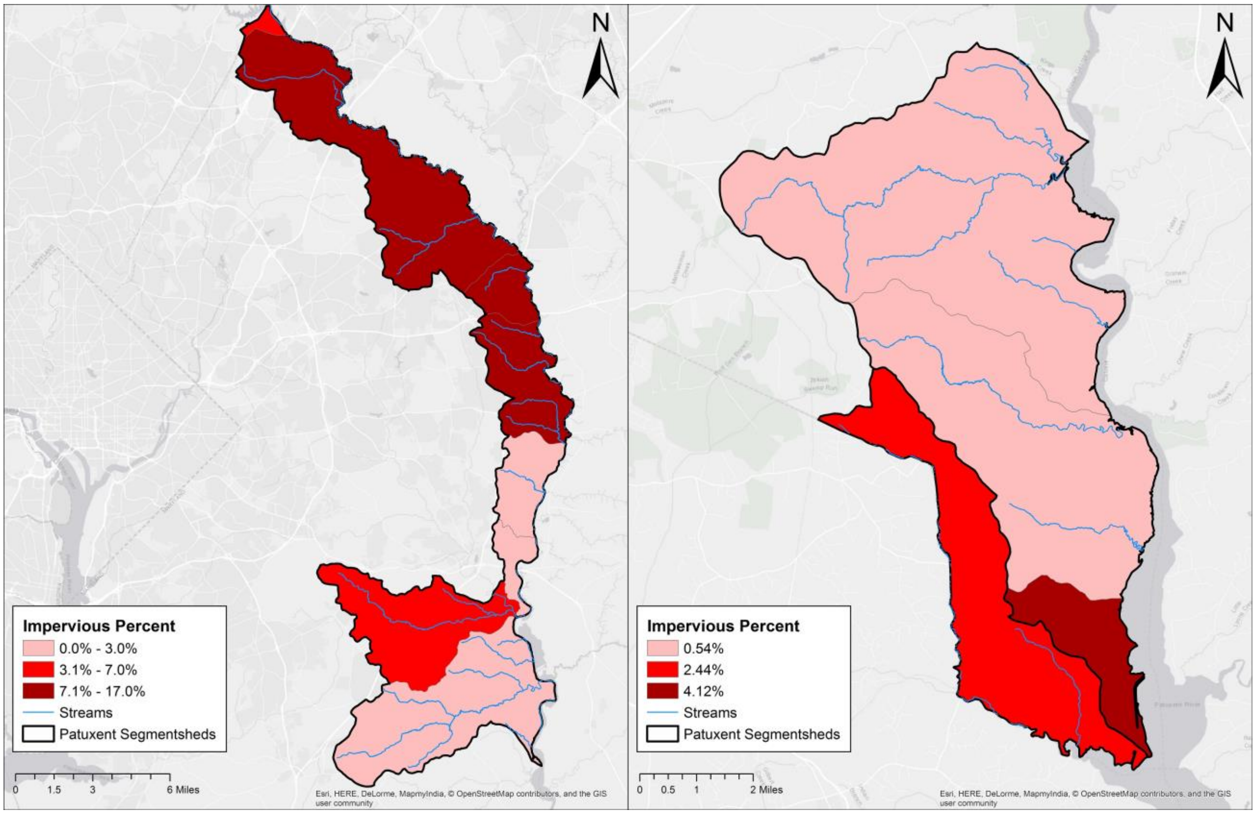


Figure 2-12. Percent impervious cover in the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

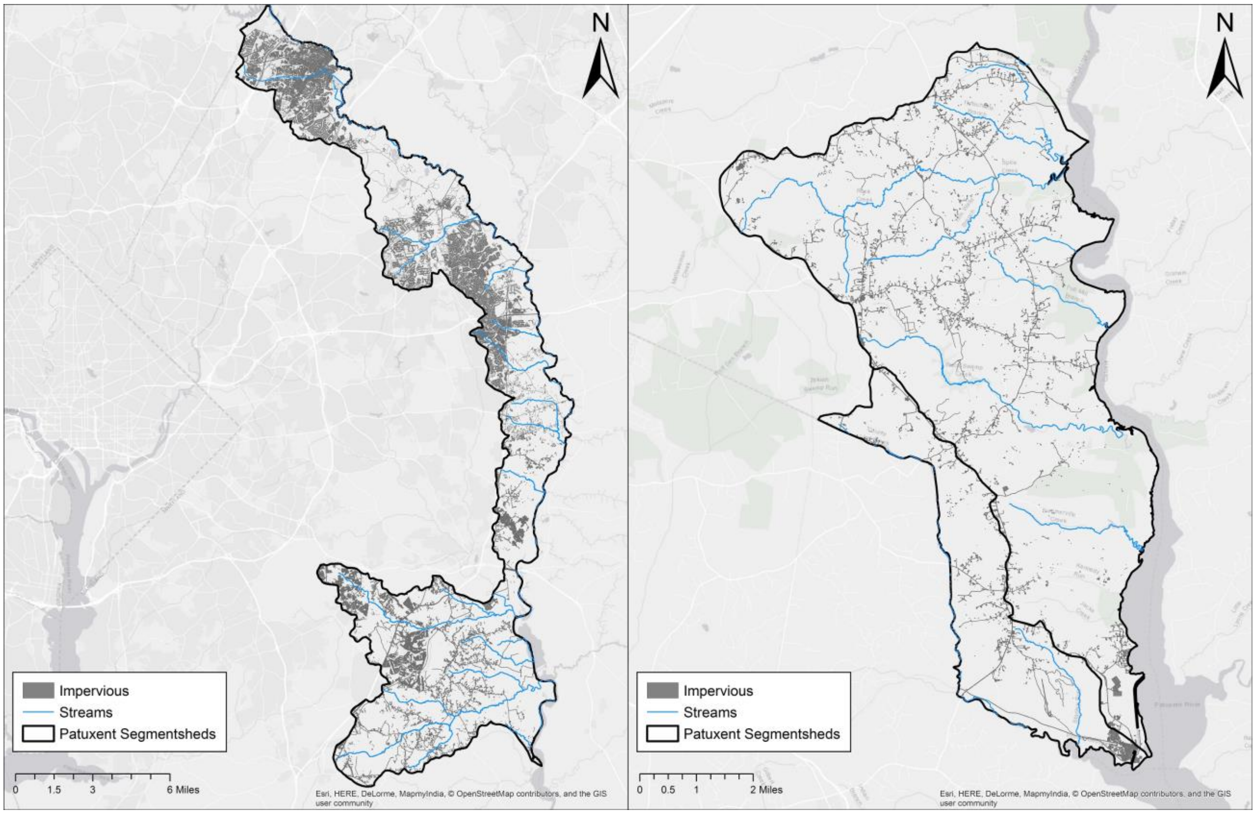


Figure 2-13. Location of impervious cover in the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

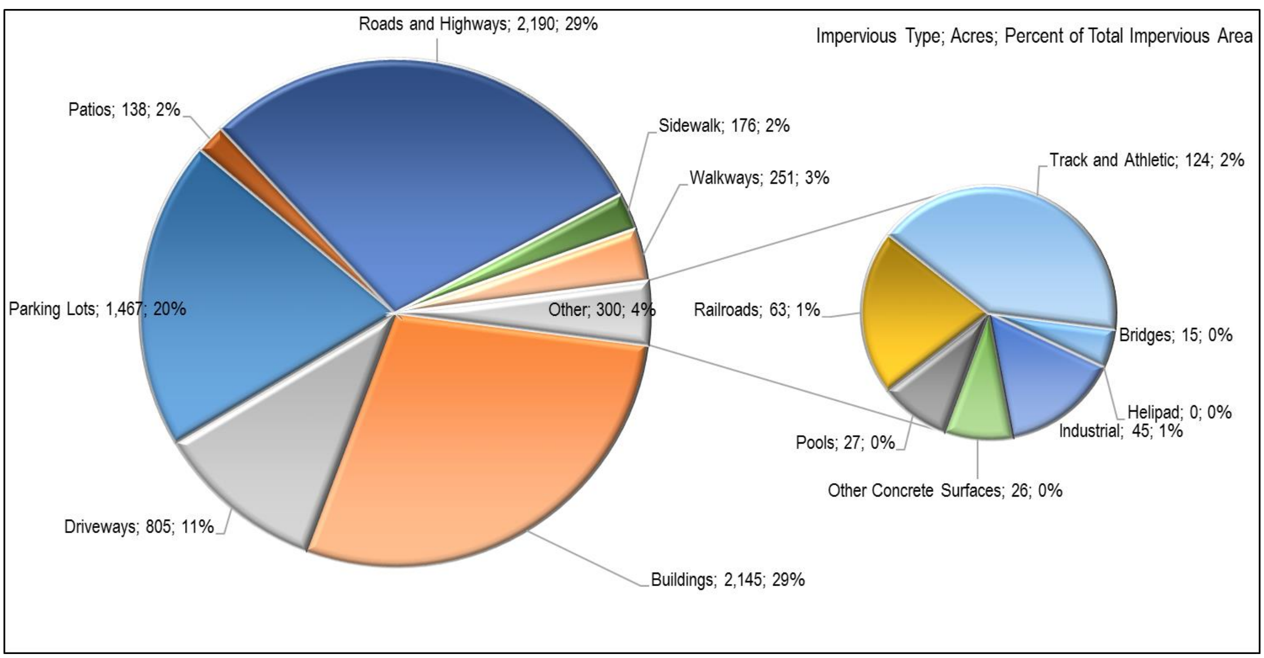


Figure 2-14. PAXTF segmentshed percent of impervious area by type.

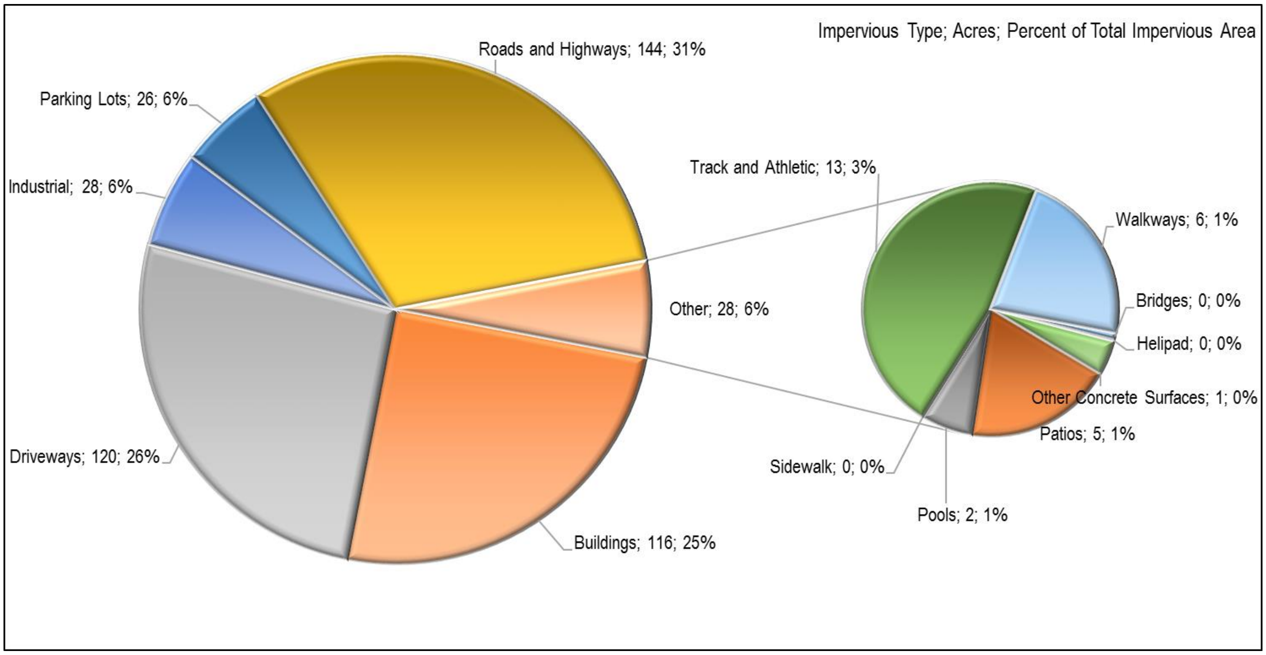


Figure 2-15. PAXOH segmentshed percent of impervious area by type.

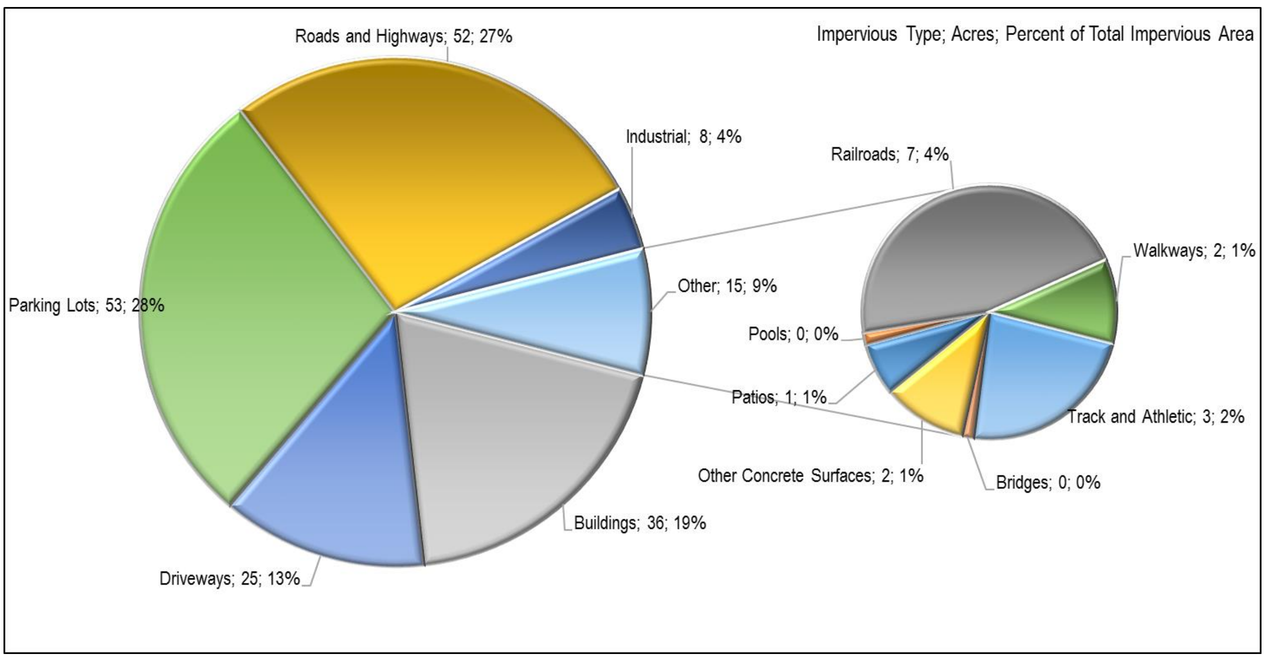


Figure 2-16. PAXMH segmentshed percent of impervious area by type.

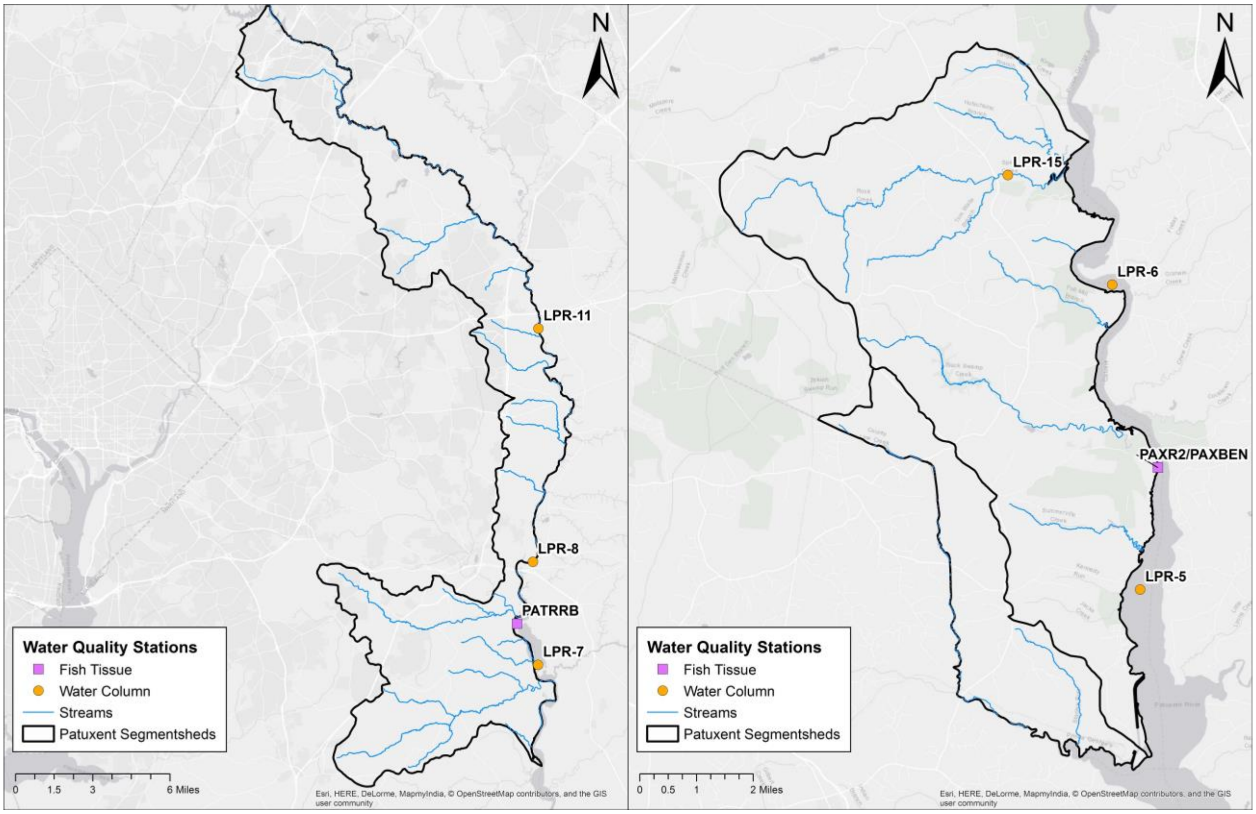
3 WATER QUALITY CONDITIONS

Water quality in a body of water is generally described by the chemical, physical, and biological conditions present in it. Understanding those conditions helps to determine whether a water body and its associated ecosystem are functioning in a way that is supportive of ecological needs (including human needs). Chemical characteristics of a stream can be examined to determine the amount of certain pollutants present in the water. Physical characteristics can identify certain conditions in the stream that water chemistry alone might not be able to distinguish, including the type and severity of stream channel erosion or the conditions of the land surface in proximity to the water body. Biological characteristics also are central to expressing aspects of water quality as the ability of a water body to support biological processes can provide strong indicators of water quality issues.

PCBs are a group of synthetic chemicals that consist of 209 individual compounds (known as "congeners"). Physically, they are either oily liquids or solids and are colorless to light yellow in color with no known smell or taste. Although it is now illegal to manufacture, distribute, or use PCBs, before 1979 they were used in numerous products. including capacitors, transformers, plasticizers, surface coatings, inks, adhesives, pesticide extenders, paints, and carbonless duplicating paper. Historically, PCBs had been introduced into the environment through discharges from point sources and through spills and releases. Although point source contributions are now controlled, facilities could be unknowingly discharging PCB loads from historical contamination. Sites with PCB-contaminated soils can also act as precipitation-driven nonpoint sources. Once in a water body, PCBs become associated with sediment particles. They are very resistant to breakdown and remain in river and lake sediments for many years.

3.1 Water and Fish Tissue Quality

The TMDLs developed for the PAXTF, PAXOH, and PAXMH tidal segments used both water column and fish tissue data to characterize the extent of PCB contamination in the study water bodies. Because of the hydrophobic nature of PCBs and their tendency to bioaccumulate in the food chain, fish tissue data are often used as a surrogate to determine surface water contamination levels. The TMDL report developed by MDE (2017) provided the water and fish tissue quality data used in developing the TMDLs. The reports were the sole source of PCB water quality data in the County and include the majority of fish tissue data used to determine impairments in the area. Figure 3-1 presents the locations of the monitoring stations in the PAXTF, PAXOH, and PAXMH segmentsheds.



Source: NWQMC 2018.

Figure 3-1. Locations of water and fish tissue quality monitoring stations in the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

3.1.1 Water Column

In 2013 and 2014, MDE conducted water quality monitoring surveys to measure water column tPCB concentrations in the PAXMH, PAXOH, and PAXTF tidal segments. Sediment sampling was also conducted at each tidal station within the Patuxent River to characterize tPCB sediment concentrations. Monitoring conducted included two tidal and one nontidal location in each of the PAXOH and PAXTF segmentsheds, for a total of six monitoring locations. The data were required to estimate loads from the watersheds.

Data summaries for each of the water column monitoring stations are presented in Table 3-1 and Figure 3-2. Water quality data analysis indicates the mean tPCB concentrations all exceed the applicable human health criterion of 0.64 ng/L, but not the freshwater or saltwater chronic aquatic life criteria (14 ng/L or 30 ng/L, respectively). Figure 3-2 also suggests an increasing trend in concentrations, but the relatively small number of samples and short sampling period make trend analysis difficult.

Table 3-1. Summary of water column tPBC data in Patuxent River segmentsheds

Segmentshed	Station Type	Station ID	Date Min.	Date Max.	Number of Records	Min. Value (ng/L)	Mean Value (ng/L)	Max. Value (ng/L)
PAXOH	Nontidal	LPR-15	8/20/2013	5/15/2014	4	0.02	2.29	8.62
	Tidal	LPR-5	8/20/2013	5/15/2014	4	0.28	2.98	8.21
		LPR-6	8/20/2013	5/15/2014	4	0.31	3.70	9.30
PAXTF	Nontidal	LPR-11	8/20/2013	5/15/2014	4	0.16	5.96	12.77
	Tidal	LPR-7	8/20/2013	5/15/2014	4	0.33	3.54	7.78
		LPR-8	8/20/2013	5/15/2014	4	0.51	5.35	12.43

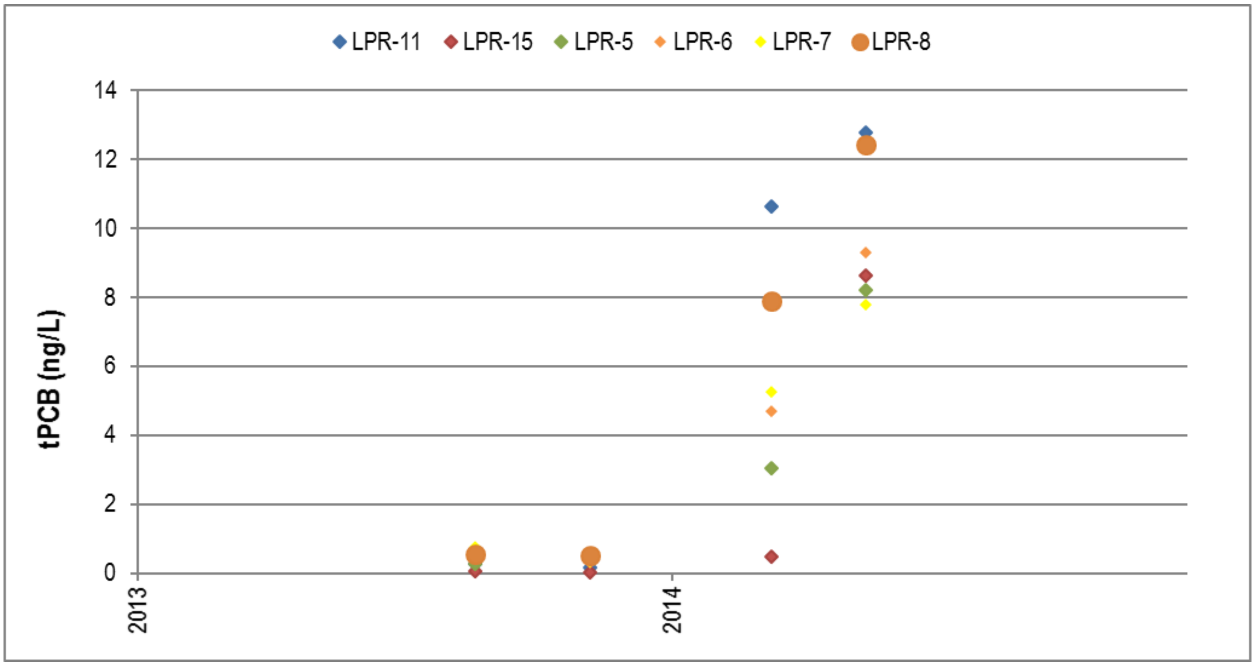


Figure 3-2. Plot of water column tPCB concentrations over time in the Patuxent River watershed.

3.1.2 Fish Tissue

Maryland regularly collects and analyzes fish tissue data to determine when to issue fish consumption advisories and recommendations and whether Maryland water bodies are meeting the "fishing" designated use. The State's tPCB fish tissue listing threshold of 39 ng/g is based on a fish consumption limit of four 8-ounce meals per month and is applied to the skinless fillet, which is the edible portion typically consumed by humans. When tPCB fish tissue concentrations exceed that threshold, MDE lists the water body as impaired for PCBs in fish tissue in Maryland's Integrated Report as it is not supportive of the "fishing" designated use (MDE 2014b).

MDE collected nine fish tissue composite samples (43 total fish) in the PAXOH tidal segment and four fish tissue composite samples (20 total fish) in the PAXTF tidal segment. Samples for tPCBs were collected in September 2009, May 2014, and September 2015. The fish tissue data are summarized in Table 3-2 and Figure 3-3. The mean tPCB concentrations of composites of channel catfish in the PAXOH tidal segment and white perch and channel catfish in the PAXTF tidal segment exceed the listing threshold, indicating that tPCB impairments exist in both segments.

Table 3-2. Summary of fish tissue tPBC data in Patuxent River segmentsheds

Segmentshed	Station ID	Fish Species	Date Min.	Date Max.	Number of Records	Min. Value (ng/g)	Mean Value (ng/g)	Max. Value (ng/g)
PAXOH	PAXBEN	Channel catfish	9/29/2009	9/29/2009	2	48.87	53.2	57.47
		White perch	9/29/2009	9/29/2009	1	18.42	18.4	18.42
	PaxR2	Channel catfish	5/14/2014	5/14/2014	3	138.6	195.0	268.9
		White perch	5/14/2014	5/14/2014	3	9.6	12.5	15.8
PAXTF	PATRRB	Channel catfish	9/22/2015	9/22/2015	2	115.1	120.3	125.5
		White perch	9/22/2015	9/22/2015	2	33.1	39.9	46.7

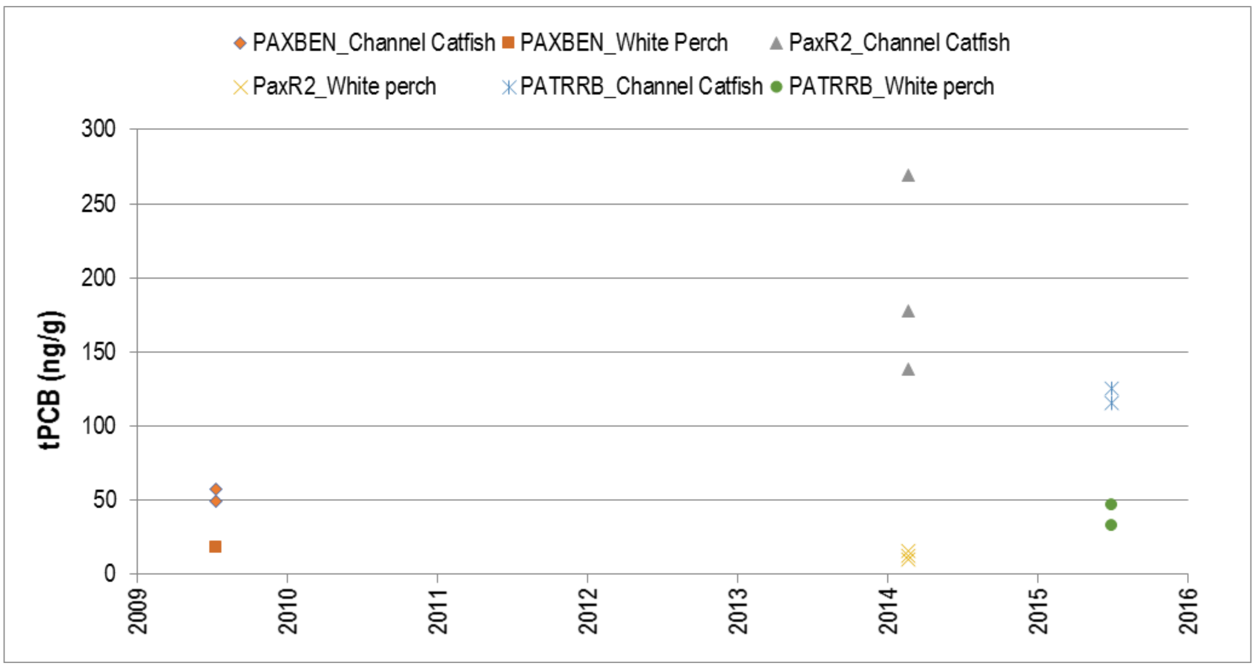


Figure 3-3. Plot of fish tissue tPCB concentrations over time in the Patuxent River watershed.

3.2 Biological Assessment

Analysis of biological monitoring data provides insights into the status and trends of ecological conditions in a stream and watershed. Watershed planners can use the biological monitoring data to identify problems; document relationships among stressor sources, stressors, and response indicators; and evaluate environmental management activities, including restoration.

3.2.1 Assessment Methodology

DoE began implementing its countywide, watershed-scale biological monitoring and assessment program in 1996. To date, the department has assessed more than 79 stream locations in the Lower Patuxent River watershed, and 69 locations in the Middle Patuxent River watershed through three rounds of data gathering: Round 1 assessed 59 sites between 1996 and 2002, Round 2 assessed 44 sites from 2011 to 2013, and Round 3 (R3) assessed 48 sites between 2015 and 2017. The primary measure of stream health is the Benthic Index of Biotic Integrity (B-IBI) (Southerland et al. 2007). Because different stream conditions support different types of bottom-dwelling, or "benthic," organisms, analyzing those organisms collected along a stream reach can provide a good indication of the health of that reach.

Field sampling and data analysis protocols employed by the County for the program are comparable to the protocols used by the Maryland Department of Natural Resources (MD DNR) in the Maryland Biological Stream Survey (MBSS). Streams assessed are wadeable and generally first- through third-order according to the Strahler Stream Order system (Strahler 1957). Stream order designation is based on the National Hydrography Dataset map scale of 1:100,000. The number of streams sampled in each watershed is proportional to the size of the watershed and is allocated among first- to third-order streams, with a larger number of sites sampled on smaller first-order streams. Samples and data collected at each location include benthic macroinvertebrates, visual-based physical habitat quality, substrate particle size distribution, and field chemistry DO, conductivity, pH, and water temperature).

For the County's biological monitoring assessment, the team sampled a 100-meter reach at each selected site. Laboratory technicians identified them each to a target taxonomic level, usually genus. The number of different kinds of organisms found was used to calculate the B-IBI numeric value or score. Based on that score, biological integrity was rated as Good, Fair, Poor, or Very Poor. Stream reaches rated as Poor or Very Poor are considered degraded. Physical habitat quality scores were rated as Optimal, Suboptimal, Marginal, or Poor, based on cumulative scores along a 200-point scale; numeric values for dominant substrate particle sizes, and field chemistry measures are reported in the next section.

3.2.2 Biological Assessment Results

The biological data reveal that the Patuxent River PAXTF, PAXOH, and PAXMH segmentsheds consistently had low-to-moderate levels of degradation through the three assessment rounds, as illustrated in Figure 3-4. The monitoring results by segmentshed, presenting the biological assessment narrative ratings by monitoring location for rounds 1 through 3 are depicted in Figure 3-5.

A significant number of sites in the PAXOH and PAXMH segmentsheds were rated as Good or Fair, with only a few being rated as degraded (Poor or Very Poor). The data in the PAXTF segmentshed were more mixed with most sites being rated as Fair, with the next most being Poor. An equal number of Very Poor and Good sites exist in this segmentshed. These results could be somewhat reflective of the relative levels of impervious cover throughout the segmentsheds, where the PAXTF segmentshed had the highest impervious percentage (10 percent), and the PAXOH and PAXMH segmentsheds had impervious percentages of 2 percent and 3 percent, respectively (Figure 2-13). The narrative results of the biological assessments can be seen in Figure 3-6.

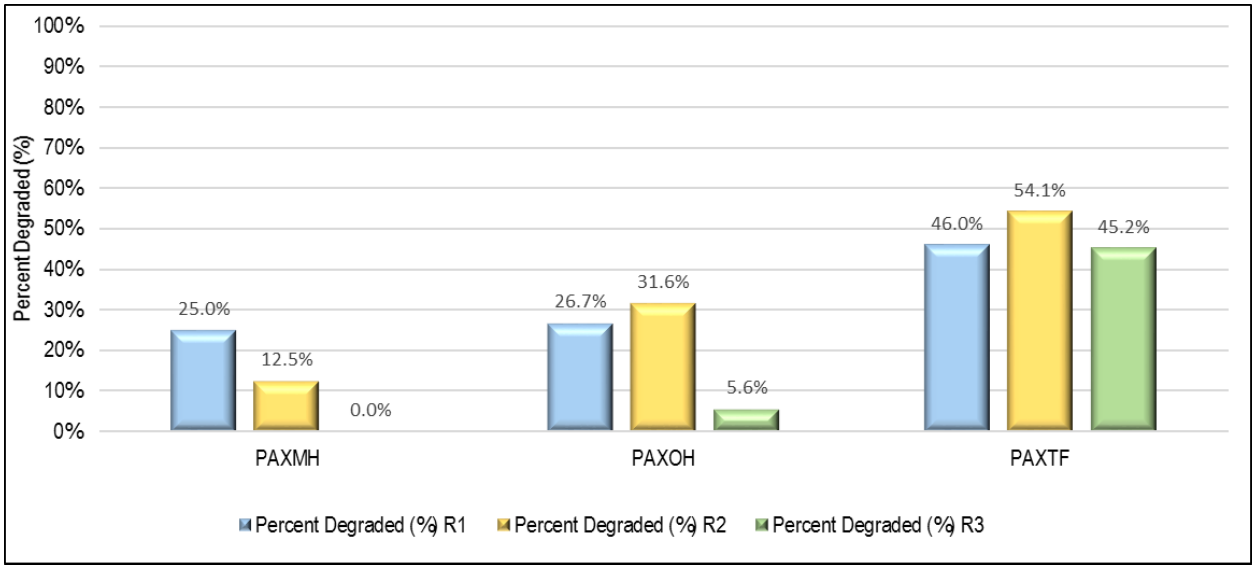


Figure 3-4. Patuxent River PAXMH, PAXOH, and PAXTF segmentsheds percent degraded by sampling round.

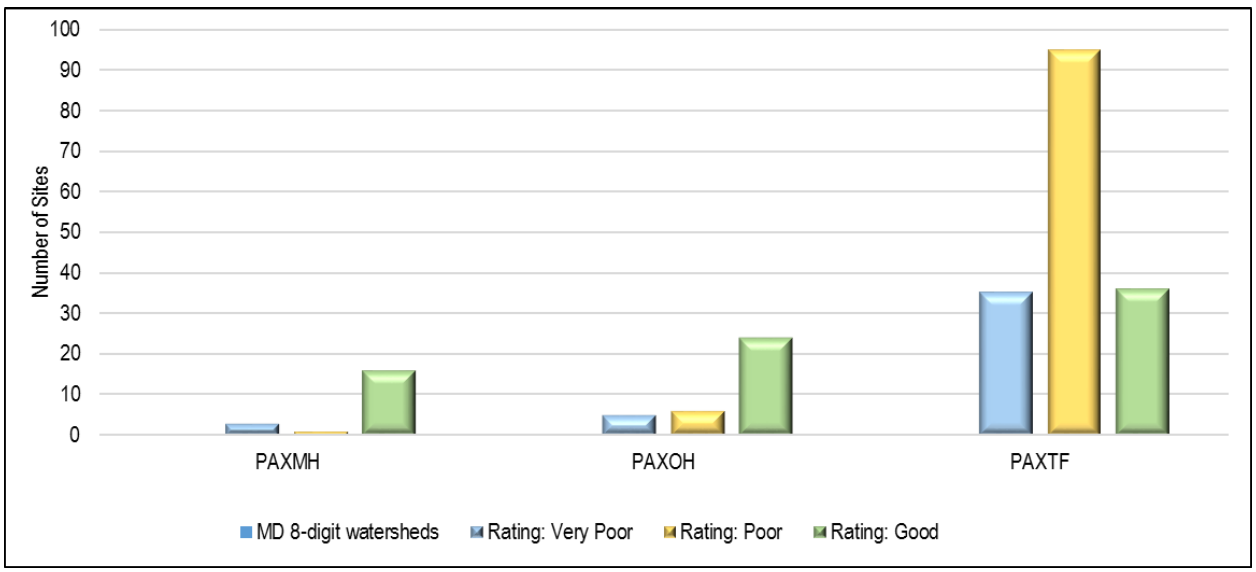


Figure 3-5. Patuxent River IBI narrative results by segmentshed.

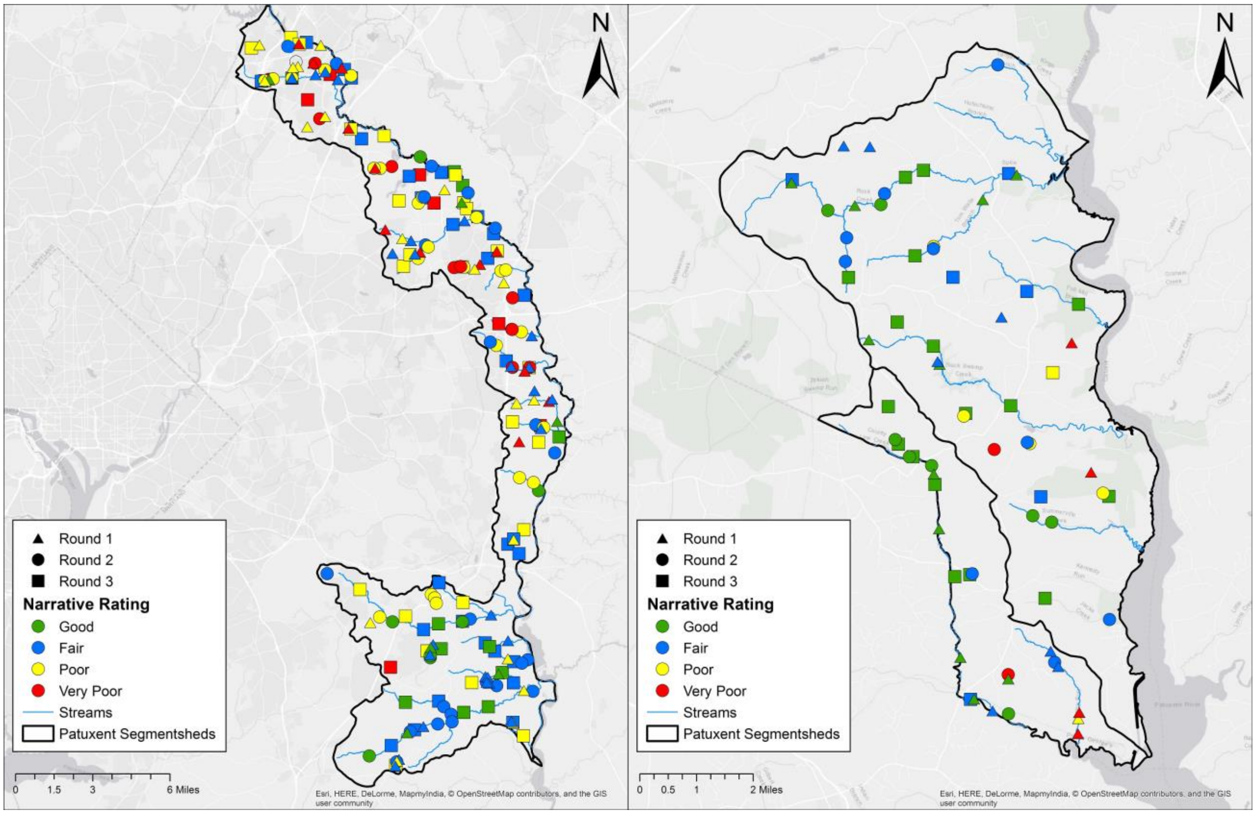


Figure 3-6. Biological assessment narrative ratings by monitoring location in the PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

4 WATERSHED CONDITIONS

This section focuses on the main permitted and nonpermitted pollutant sources in the watersheds and how pollution-generating land-uses are regulated. It also discusses the results of previously conducted stream corridor assessments (SCAs).

4.1 Pollutant Sources

This section provides an assessment of the potential point and nonpoint pollutant sources in the watersheds. Point sources discharge effluent through distinct points that are regulated through permits from the National Pollutant Discharge Elimination System (NPDES) program. Nonpoint sources are not covered by the permitting program because they are diffuse sources that typically cannot be identified as entering a water body through a discrete conveyance at one location. Nonpoint sources can originate from land activities that contribute pollutants to surface water from rainfall runoff. Identifying the sources of PCBs is valuable in developing appropriate strategies to reduce the amount of those pollutants getting into the environment.

4.1.1 NPDES-Permitted Point Sources

Under 40 CFR § 122.2, a "point source" is described as a discernible, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The NPDES program, established under CWA sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources, including MS4s.

MS4s

Stormwater discharges are generated by runoff from urban land and impervious areas such as paved streets, parking lots, and rooftops during precipitation events. Those discharges often contain high concentrations of pollutants that can eventually enter nearby water bodies.

Under the NPDES stormwater program, operators of large, medium, and regulated small MS4s must obtain authorization from MDE to discharge pollutants. The Stormwater Phase I Rule requires all operators of medium and large MS4s to obtain NPDES permits and develop stormwater management programs (55 FR 47990, November 16, 1990). Medium and large MS4s are defined by the size of the population in the MS4 service area, not including the population served by combined sewer systems. A medium MS4 serves a population of between 100,000 and 249,999. A large MS4 serves a population of 250,000 or more. The Stormwater Phase II Rule applies to operators of regulated small MS4s serving a population of less than 100,000 not already covered by Phase I; however, the Phase II Rule is more flexible and allows greater variability of regulated entities than the Phase I Rule (64 FR 68722, December 8, 1999).

Regulated small MS4s include those within the boundaries of urbanized areas as defined by the U.S. Census Bureau and those designated by the NPDES permitting authority. The NPDES permitting authority can designate a small MS4 as requiring regulation under any of the following circumstances: the MS4's discharges do or can negatively affect water quality; the population served exceeds 10,000; the population density is at least 1,000 people per square mile; or the contribution of pollutant loadings to a physically interconnected MS4 is evident.

The Phase II MS4s in the PAXTF, PAXOH, and PAXMH segmentsheds serve the mostly rural southeastern and residential northeastern portions of Prince George's County. The municipalities of Laurel and Eagle Harbor in the PAXTF and PAXOH segmentsheds, respectively, are separate jurisdictions but are both covered by the County's MS4 permit. The City of Bowie maintains its own Phase II MS4 permit and has its own MS4 program.

Table 4-1 lists the federal, state, and other entities in the PAXTF and PAXOH segmentshed planning area that possess an MS4 permit. There are no Phase II parcels in the PAXMH segmentshed.

Table 4-1. Phase II MS4 permitted federal, state, and other entities in the Patuxent River PAXTF and PAXOH segmentsheds

Segmentshed	Agency	Installation/Facility
PAXOH	U.S. Federal Government; Federal Aviation Administration; General Services Administration	Cluster of federal lands in vicinity of 13205 Croom Rd
PAXTF	U.S. Federal Government, U.S. Air Force, U.S. Fish and Wildlife Service, City of Bowie, MD	• Andrews Air Force Base • Small parcel adjacent to Mount Calvert Rd right-of-way 0.4 miles west of Duvall Rd • Parcel adjacent to Cherry Tree Crossing Rd • Parcel adjacent to Melford Dr in Bowie, MD • Parkland adjacent to Grason Ln, • Patuxent Research Refuge

4.1.2 Nonpoint and Other Sources

Nonpoint sources convey pollutants from rainfall runoff (in nonurban areas) and other landscape-dependent processes that contribute sediment, organic matter, and nutrient loads to surface waters. They vary greatly and include agriculture-related activities, atmospheric deposition, on-site treatment systems, stream bank erosion, wildlife, and unknown sources.

Nonpoint sources of pollution from agricultural activities include the runoff of fertilizers and exposed soils from crop fields as well as waste from animal operations. Agricultural activities are regulated by the Maryland Department of Agriculture and are outside the jurisdiction of DoE. Consequently, this Patuxent PAXTF, PAXOH, and PAXMH segmentshed restoration plan does not include restoration activities for agricultural practices.

Two types of atmospheric deposition can occur: wet deposition and dry deposition. Wet deposition occurs through rain, fog, and snow, and dry deposition occurs from gases and particles. After the particles and gases have been deposited, precipitation can wash them into streams from trees, roofs, and other surfaces. Winds can blow the particles and gases, contributing to atmospheric deposition over great distances, including across state and other political boundaries.

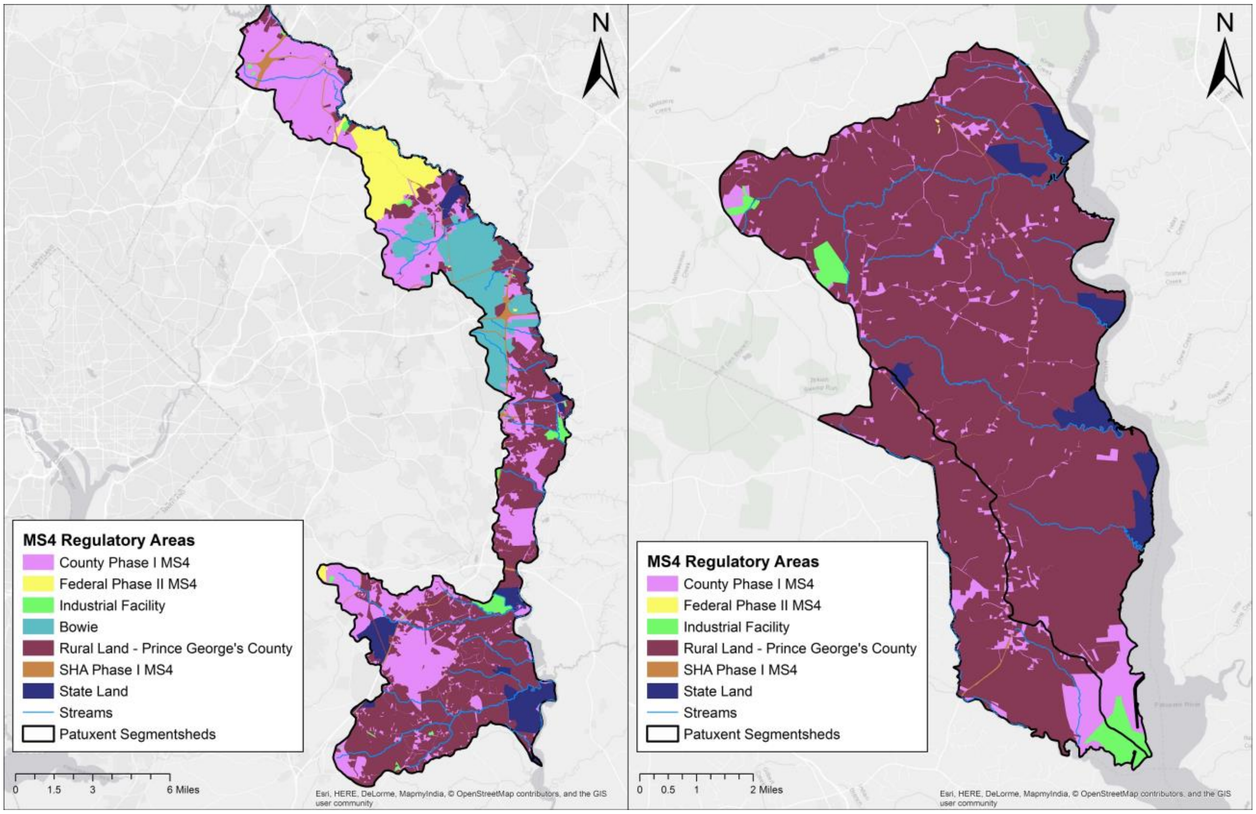


Figure 4-1. MS4 regulated areas in the Patuxent River PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

Development in the watershed has altered the landscape from presettlement conditions, which included grassland and forest, to post-settlement conditions, which include cropland, pasture, and urban/suburban areas. This conversion has led to increased runoff and flow into streams since presettlement conditions, potentially contaminated sites, streambank erosion, and straightening of meandering streams. The increased erosion not only increases sediment loading to water bodies but also has the potential to transport PCBs adsorbed to sediment particles.

4.2 Known Stream Erosion Issues

In the 2000s, MD DNR conducted SCAs of all County watersheds. The assessments included field site visits and stream walks to determine the conditions of the streams. Each site was given an identification number and photographed. Stream bank erosion and head cutting were among the items investigated during the analysis. Stream reaches were rated on severity of erosion, correctability, and access to the stream. Additionally, pipe outfalls were investigated and rated on severity of issue, correctability, and access. If a stream or outfall had erosion issues in the 2000s, it is likely to still have them today if no corrective actions have been taken.

The distribution of erosion sites in the PAXTF, PAXOH, and PAXMH segmentsheds are displayed in Figure 4-2. The most severely eroded stream reaches were identified in the PAXTF segmentshed, coinciding with the occurrence of regional urban centers and the associated impervious surfaces and disturbed land.

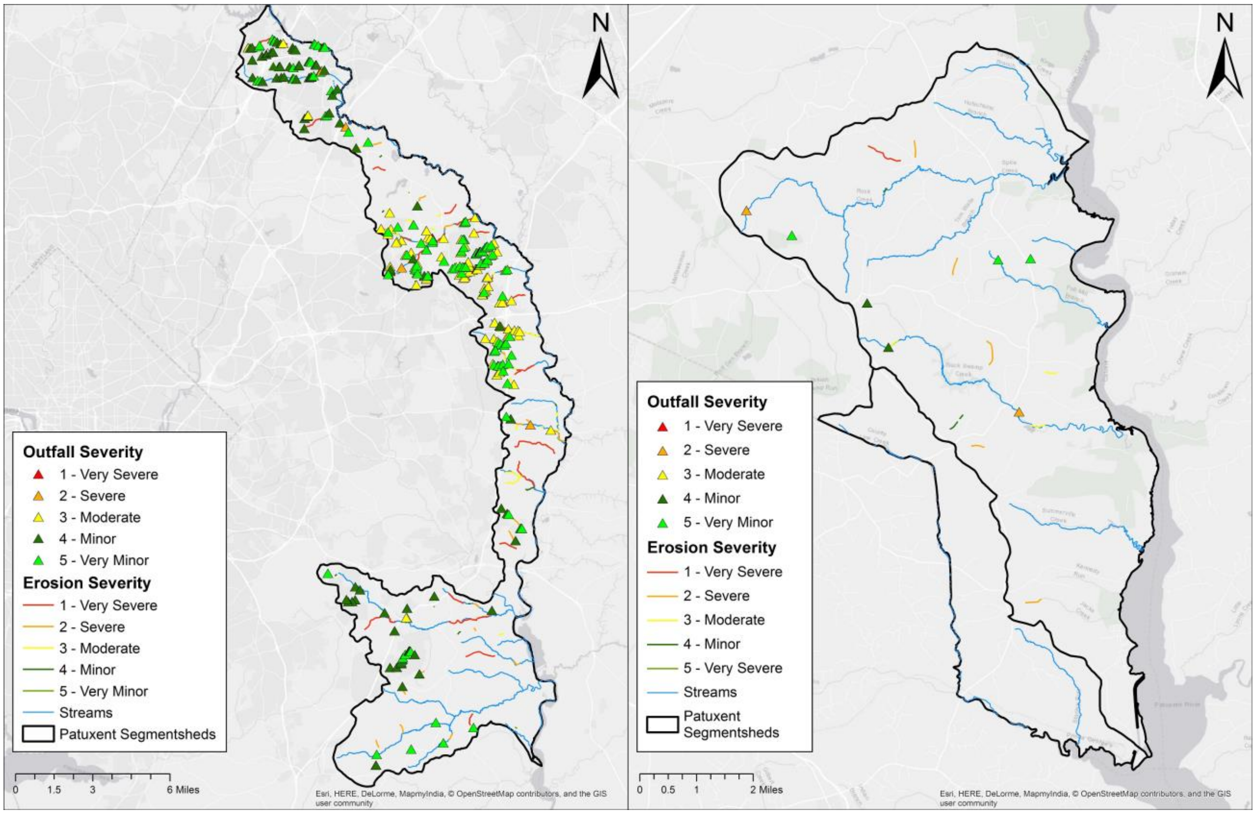


Figure 4-2. Locations of SCA-identified erosion (with severity) and outfall severity in the PAXTF segmentshed (*left*), and the PAXOH and PAXMH segmentsheds (*right*).

5 Current Management Activities

Management activities to specifically address tPCB loadings in the Patuxent River PAXTF, PAXOH, and PAXMH segmentsheds have not yet been developed. However, since tPCB concentrations in the water column are linked to TSS concentrations, a reduction in the sediment loads entering the river and its tributaries is expected to result in lower PCB concentrations. Therefore, in accordance with MDE guidance (MDE 2014c), current management activities that address sediment are also considered to be a means of tPCB removal.

When rain falls, the resulting runoff flows off roofs, lawns, driveways, and roads into a network of stormwater sewers that discharge directly to the streams. The sediments and other pollutants picked up from roofs and lawns, along with those from driveways and roadways, are transported into the waterways of the County in areas where there is no stormwater treatment. Many areas of the County (including much of the Patuxent River drainage) were developed before the adoption of stormwater regulations and practices in the 1970s and 1980s. In those older developments, no stormwater management facilities exist. The County enacted a stormwater management ordinance in 1971 and the State adopted a statewide stormwater law and regulations in 1983. Newer development in the County, including redevelopment built since 1971, is required to provide water quality treatment for this urban runoff using a wide range of stormwater practices. During the initial years of stormwater regulation, those practices were somewhat crude and simple—such as dry ponds—but have continuously improved. Today, *environmental site design* (ESD)—the approach to stormwater management required by MDE—is based on the use of landscape-based practices such as rain gardens and bioswales and is considered an ecologically sustainable approach to stormwater management. The County is currently installing those types of BMPs, which reduce sediment and will also reduce tPCBs. This section details the BMPs that are installed in the County as well as current programmatic activities.

5.1 Stormwater Management Programs

The County has implemented a wide range of programmatic stormwater management initiatives over the years to address existing water quality concerns. They are grouped into three categories: stormwater-specific programs, tree planting and landscape revitalization programs, and public education programs. This section describes each grouping (and its respective individual initiatives), including the contributions the programs make to water quality protection and improvement.

Many of the County's stormwater-related programmatic initiatives target more than one issue area. For example, in addition to promoting adoption of on-the-ground BMPs, the Alternative Compliance Program promotes stormwater education via environmentally focused sermons at places of worship. The following programs that either directly or indirectly support water quality improvement are administered by various departments within the County government or its partners that either directly or indirectly support water quality improvement related to tPCBs:

- Stormwater-Specific Programs
    - Stormwater Management Program
    - Clean Water Partnership (CWP)

  - Rain Check Rebate and Grant Program
  - Alternative Compliance Program
  - Rain Check Rebate and Grant Program
  - Stormwater Stewardship Grant Program
  - Countywide Green/Complete Streets Program
  - Erosion and Sediment Control
  - Street Sweeping
  - Storm Drain Maintenance: Inlet, Storm Drain, and Channel Cleaning
  - Storm Drain Stenciling
  - Illicit Connection and Enforcement Program
- Tree Planting and Landscape Revitalization Programs
  - Volunteer Tree Planting
  - Tree ReLeaf Grant Program
  - Neighborhood Design Center
  - Arbor Day Every Day
  - Tree Planting Demonstrations
- Public Education Programs
  - Interactive Displays and Speakers for Community Meetings
  - Stormwater Audit Program
  - Master Gardeners
  - Flood Awareness Month

5.1.1 Stormwater-Specific Programs

As required under NPDES regulations, the County must operate an overall stormwater program that addresses six minimum control measures—public education and outreach, public participation/involvement, illicit discharge detection and elimination (IDDE), construction site runoff control, post-construction runoff control, and pollution prevention/good housekeeping. To meet that requirement, the County administers various programs and initiatives, many of which have goals that will help achieve pollution reductions in response to TMDL requirements. Stormwater-specific program initiatives are designed to reduce flow volumes and pollutant loads reaching surface waters by facilitating the implementation of practices to retain and infiltrate runoff. Stormwater-specific programs include the following:

- *Stormwater Management Program (SWM) Program*. The SWM Program is responsible for performing detailed assessments of existing water quality. It also is responsible for preparing design plans for and overseeing the construction of regional stormwater management facilities and water quality control projects. Those activities contribute to annual load reductions through improved planning and assessment and implementation of BMPs that reduce pollutant loading.

- *Clean Water Partnership* (*CWP*). The County recently initiated this program, which is a community-based public-private partnership, to assist in addressing the restoration requirements of the Chesapeake Bay WIP program. The CWP program initially focused on ROW runoff management in older communities, which are primarily inside the Capital Beltway. The program is expected to be responsible for providing water quality treatment for impervious land.
- *Alternative Compliance Program.* The Alternative Compliance Program, administered by DoE, allows tax-exempt religious and nonprofit organizations to receive reductions in their CWA Fee if they adopt stormwater management practices. The organizations have three options and can use any combination to receive the credits. The options are to (1) provide easements so the County can install BMPs on their property; (2) agree to take part in outreach and education to encourage others to participate in the Rain Check Rebate and Grant Program and create an environmental team for trash pickups, tree planting, recycling, planting rain gardens, and so forth; and (3) agree to use good housekeeping techniques to keep their clean lots and to use lawn management companies certified in the proper use of fertilizers. The County has received more than 186 applications from eligible organizations. Thus far, 75 projects either have been completed or are under design and/or construction, treating 51.6 ac of impervious area (DoE 2018). In Fiscal Year (FY) 2018, 16 retrofit projects either were being designed, planned, or constructed or were complete.
- *Rain Check Rebate and Grant Program.* The Rain Check Rebate and Grant Program, administered by the DoE, allows property owners to receive rebates for installing County-approved stormwater management practices. It was established in 2012 through County Bill CB-40-2012 and implemented in 2013. The County will reimburse homeowners, businesses, and nonprofit entities (including housing cooperatives and places of worship) for some of the costs of installing practices covered by the program. Installing practices at the individual property level helps reduce the volume of stormwater runoff entering the storm drain system as well as the amount of pollutants in the runoff. In addition, property owners implementing these techniques through the program will reduce their CWA Fee if they maintain the practice for 3 years. Currently, rebates are capped at $4,000 for residential properties and $20,000 for commercial properties, multifamily dwellings, and nonprofit and not-for-profit groups. In FY 2018, 266 BMPs (pavement removal, permeable pavement, rain barrels, rain gardens, and tree canopy) were installed on private properties treating 2.3 ac (DoE 2018).

- *Stormwater Stewardship Grant Program.* Through the County's Stormwater Stewardship Grant Program, the Chesapeake Bay Trust (CBT) currently funds requests for construction of water quality improvement projects. The Trust also funds citizen engagement and behavior change projects implemented by a variety of nonprofit groups, including homeowners associations (HOAs). Nonprofit organizations, municipalities, watershed organizations, education institutions, community associations, faith-based organizations, and civic groups can be awarded $50,000 to $200,000 for water quality projects and $50,000 to $150,000 for tree planting projects. Projects must complete on-the-ground restoration that will result in improvements in water quality and watershed health (reduction in loads of nutrients or sediment) or significantly engage members of the public in stormwater issues by promoting awareness and behavioral change. In FY 2018, 15 grants were awarded to support green infrastructure implementation, trash removal, environmental education, and tree planting.
- *Countywide Green/Complete Streets Program.* The Department of Public Works and Transportation (DPW&T) initiated a countywide Green/Complete Streets Program in 2013 as a strategy for addressing mounting MS4 and TMDL treatment requirements. The program identifies opportunities to incorporate stormwater control measures, environmental enhancements, and community amenities into the DPW&T's capital improvement projects. The types of projects that can contribute to pollutant load reductions include ESD practices, tree shading, alternative pavements, and landscape covers.
- *Erosion and Sediment Control.* MDE has assigned the responsibility for conducting erosion and sediment control enforcement to the County. It involves conducting site inspections and providing Responsible Personnel Certification courses, which educate construction site operators to conscientiously manage disturbed land areas commonly found at construction sites. These control measures prevent excess sediment from entering County water bodies from active construction sites.
- *Street Sweeping.* The County conducts street sweeping operations on select arterial, collector, and industrial roadways. Residential subdivisions are swept on a request-only basis. Street sweeping can reduce the amount of debris, including sediment that reaches waterways.
- *Litter Control*. The County maintains an aggressive litter control and collection program along County-maintained roadways. The litter service schedule is based on historical collection data; therefore, the most highly littered roadways are serviced as often as 24 times per year.
- *Storm Drain Maintenance: Inlet, Storm Drain, and Channel Cleaning.* These are systematic water quality-based storm drain programs that provide routine inspections and cleanouts of targeted infrastructure with high sediment and trash accumulation rates. Municipal inspections of the storm drain system can be used to identify priority areas. DPW&T inspects and cleans major channels on a 3-year cycle. Additionally, the County performs storm drain vacuuming that removes sediments from the storm drain system. In FY 2018, the County removed 7,497.08 pounds of debris from storm drains in the PAXTF segmentshed and did not perform this service in the PAXOH or PAXMH segmentsheds.

- *Storm Drain Stenciling.* The Storm Drain Stenciling Program continues to raise community awareness and alert community members to the connection between storm drains and the Chesapeake Bay. The County uses CBT funding to purchase the paint, tools, and stencils used by the volunteers to stencil the "Don't Dump—Chesapeake Bay Drainage" message. It is difficult to estimate the load reduction from storm drain stenciling; however, it is expected to help reduce pollutant loads to local water bodies.
- *Illicit Connection and Enforcement Program.* In partnership with the County's Comprehensive Community Cleanup Program, DoE conducts field screening and outfall sampling. Outfall sampling serves to detect and eliminate stormwater pollutants and support clean and healthy communities. DoE's *Investigation, Inspection and Enforcement Program* investigates incoming complaints on the County's Water Pollution Line (95-CLEAN). Enforcement actions associated with violations involving the improper storage of materials and/or dumping on private property are the responsibility of the Department of Permitting, Inspections, and Enforcement (DPIE) as authorized under the Zoning Ordinance, Housing and Property Codes. Illegal dumping on public property is the responsibility of DPW&T. Environmental enforcement; including for disturbed areas, grading, sediment and erosion control, and pollution, is authorized under Subtitle 32 with the enforcement authority assigned to the DPW&T. The control of hazardous chemicals or substances is governed by the Fire Safety Code. Where appropriate, the County also refers enforcement cases to MDE. It is difficult to estimate the load reduction from illicit discharge correction because their location and size are unknown until reported. Their correction is expected to help reduce loads to local water bodies.
- *Cross-Connections Elimination.* Another potential source of PCBs is the cross-connection, or a place where a facility's sewers are directly connected to the storm sewer instead of the sanitary sewer. These connections can be discovered by means of dye testing, smoke tracing, and chemical signatures. An aggressive program to discover and eliminate cross-connections could also reduce some PCB loads. The County has a program to detect these illicit discharges into the County's stormwater system, and thus into the County's water bodies. It is difficult to estimate the load reduction from eliminating cross-contamination because the location and size of the connections are unknown until reported. Their disconnection is expected to help reduce pollutant loads to local water bodies.

5.1.2 Tree Planting and Landscape Revitalization Programs

When localities convert urban land to forest, significant hydrologic and water quality benefits accrue. Tree planting typically occurs piecemeal across the urban landscape whereas reforestation usually occurs on a much larger scale. In either case, to claim these credits a survival rate of 100 trees or more per acre is necessary, with at least 50 percent of the trees being 2 inches or more in diameter at 4.5 feet above ground level (MD DNR 2009, MDE 2014a).

The pollutant load reduction credit for planting trees is based on the load difference when the land cover is converted from urban to forest. The hydrologic benefits of planting trees, including increased infiltration and decrease in surface runoff, is associated with decreased runoff and sediment loading to streams, which could also decrease tPCB loads. To qualify for the alternative credits for *Reforestation on Pervious Urban Land,* the County will need to demonstrate compliance with the credits criteria.

- *Volunteer Tree Planting.* DPW&T oversees volunteer tree planting in October of every year. Trees are planted by organizations (e.g., HOAs) on public spaces (e.g., parks and institutional areas). Approximately 2,000–2,500 trees are planted under the program every year.
- *Tree ReLeaf Grant Program.* DoE's Tree ReLeaf Grant Program is funded by fees-in-lieu; therefore, it only funds planting projects on public property. The program provides funding to neighborhood, civic, and community/homeowner organizations; schools; libraries; and municipalities for tree and shrub planting projects in public spaces or common areas. Goals of the program include increasing native tree canopy to improve air and water quality, conserve energy, and reduce stormwater runoff. Organizations can receive up to $5,000 under the program, and municipalities are eligible for grants up to $10,000.
- *Neighborhood Design Center.* The Neighborhood Design Center, a local nonprofit in Riverdale, is an important partner in many County initiatives. They furnish pro bono design and planning services to a wide variety of individuals, organizations, and low-to-moderate income communities. Their goal is to involve the entire community in developing and implementing initiatives and projects designed to revitalize neighborhoods. The Neighborhood Design Center develops plans for parks, gardens, and community plantings, including wetland and rain gardens, reforestation projects, and median and shade tree plantings. Collectively, these efforts have increased the County's green space, reduced stormwater runoff, and improved water quality through the creation of natural systems to cleanse stormwater runoff.
- *Arbor Day Every Day.* Arbor Day Every Day provides free trees to schools to plant and maintain on school grounds. This program educates students on the everyday importance of native trees, empowers them to enhance their community, and provides funds for planting projects.
- *Tree Planting Demonstrations.* The Sustainable Initiatives Division recently began a tree planting demonstration program to increase tree canopy and promote tree care.

5.1.3 Public Education Programs

DoE seeks every opportunity to promote environmental awareness, green initiatives, and community involvement to protect natural resources and promote clean and healthy communities. The County also integrates water quality outreach as a vital component of watershed restoration projects. At public outreach events, DoE staff provide handouts, answer questions, make presentations, promote programs, and display posters and real-world examples of stormwater pollution prevention materials (e.g., sample rain barrels and samples of permeable pavement). The County also has published a series of brochures to raise stormwater pollution awareness and educate the residential, business, and industrial sectors on their roles in preventing stormwater pollution. Topics include stormwater BMPs such as rain gardens, cisterns, and pavement removal.

Following are details about other County-administered outreach and education efforts that have the potential to reduce stormwater pollution through BMP implementation:

- *Interactive Displays and Speakers for Community Meetings.* County staff support multiple outreach events to provide presentations, displays and handouts, answer questions, and promote environmental stewardship. At these events, County staff provide information on the importance of trees and tree planting, stormwater pollution prevention, lawn care, Bayscaping (replacing turf with plants native to the Chesapeake Bay region), and trash prevention and cleanup.
- *Stormwater Audit Program*. DoE conducts stormwater audits on residential properties. During the audits, County staff walk a property with the homeowner and make suggestions on the most appropriate types and potential locations for stormwater BMPs.
- *Master Gardeners Program.* Master Gardeners are volunteer educators who provide horticultural education services to individuals, groups/institutions, and communities. The mission of the program is to educate Maryland residents about safe, effective, and sustainable horticultural practices that build healthy gardens, landscapes, and communities. The program has the potential to aid overall reduction of fertilizer and pesticide use as well as promote increases in stormwater practices such as installing rain gardens and using rain barrels.
- *Flood Management.* During June, DoE works to raise awareness of flood risks and what County residents can do to protect their homes, families, and personal belongings if flooding occurs. DoE incorporates messages that encourage residents to implement flood-prevention stormwater practices (e.g., BMPs) such as using permeable pavers and rain gardens to help prevent costly property damage caused by backyard flooding.

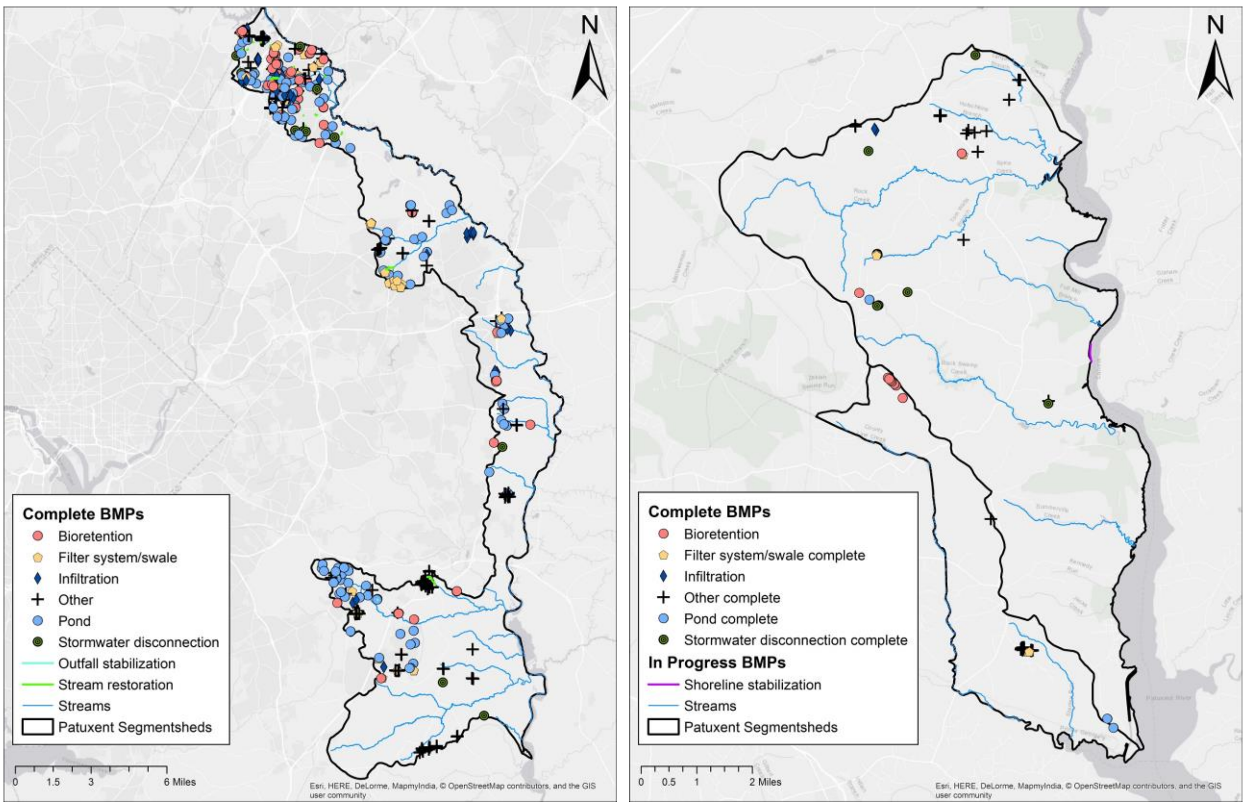
5.2 Existing BMPs

Table 5-1 lists documented existing County structural BMPs in the Patuxent River segmentsheds as of April 2019. The County actively updates their BMP geodatabase with new information as it becomes available. The BMPs were installed for either restoration activities or as offsets for development. Only BMPs specifically installed for restoration can be counted toward the TMDL-required load reductions. Figure 5-1 presents the locations of the restoration BMPs in the County by Patuxent River segmentshed. Permeable pavements are the most implemented BMP. Rainwater harvesting is the second-most-implemented practice, and bioretention systems and step pool storm conveyance have similar levels of implementation, as shown in Table 6-4.

Table 5-1. List of BMP types in the County's PCB-impacted segmentsheds

Segmentshed	BMP Type	Total Number	Total w/ Known DA	Total Known Acres Treated	Avg. Acres Treated
PAXMH	Micro-bioretention	1	1	0.44	0.44
PAXOH	Bioretention	1	1	1.00	1.00
	Rainwater Harvesting	2	2	0.04	0.02
PAXTF	Bioretention	1	1	1.1	1.1
	Grass Swale	1	1	0.9	0.9
	Micro-bioretention	5	5	2.78	0.56
	Permeable Pavements	3	3	1	0
	Rainwater Harvesting	7	7	0.12	0.02
Total		**29**	**21**	**21**	**7**

Source: DoE April 2019.
Note: DA=drainage area.



Source: DoE April 2019.

Figure 5-1. BMPs in the County's PAXTF (*left*), and PAXOH and PAXMH (*right*) PCB-impacted segmentsheds.

6 LOAD REDUCTION TARGETS AND EXISTING GAP

This section discusses the calculation of load reduction targets for each watershed, reductions that have resulted from current BMPs, and reductions remaining to be met through this restoration plan. The calculations rely on land-use information from section 2.2.1, TMDL information from section 1.2, and current BMP information from section 5.2.

6.1 Load Reduction Terminology

The amount of load still required to be reduced after accounting for load reductions from current practices is called the "load reduction gap." Figure 6-1 illustrates that concept.

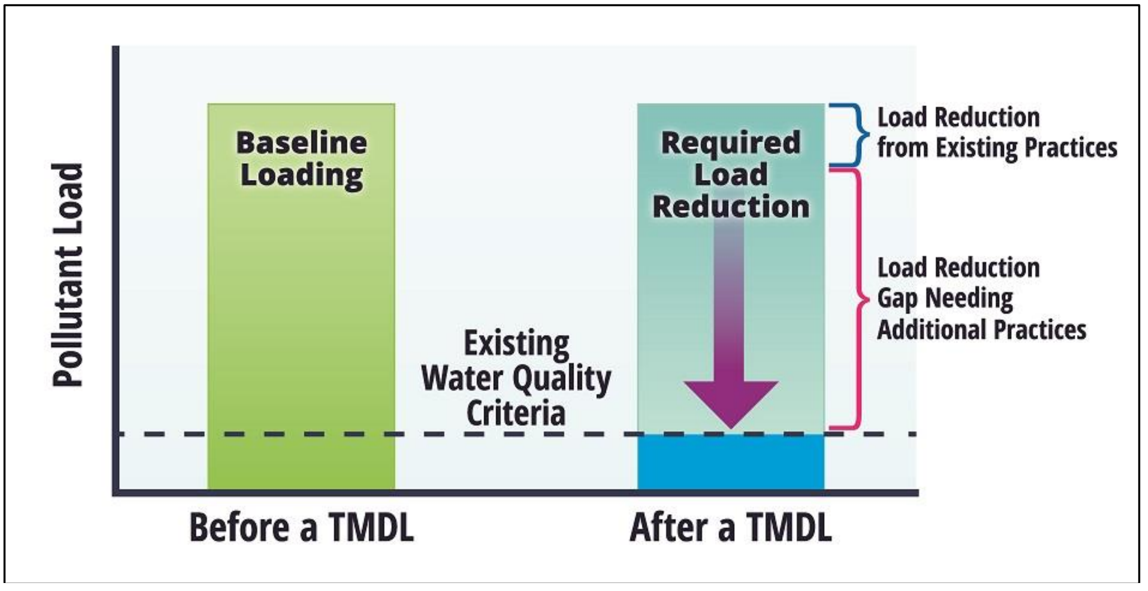


Figure 6-1. Schematic for typical pollution diet (TMDL) showing existing load reduction credits.

The following terms are used in text, tables, and plots throughout the remainder of this report:

- **Baseline load:** The pollutant load from the land surface at the time the TMDL was developed. It includes reductions from restoration BMPs installed prior to 2009.
- **Target load:** The load that will be met once load reductions specified in the Chesapeake Bay TMDL are met.
- **Required load reduction:** The load that will need to be reduced through BMPs. This load is the difference between the baseline load and the target load.
- **Current load (BMPs installed 2009–2018):** The County has already installed BMPs in the watersheds. This is the current load accounting for these BMPs and is the difference between baseline loads and the loads treated by current BMPs.
- **Load reduction to date:** The loads reduced by currently installed BMPs, or the difference between the baseline load and the current load.
- **% of target:** The percent of the required load reduction removed by installed BMPs.
- **Current load reduction gap:** The required load reduction remaining (i.e., gap) once the load reduction to date is subtracted from the required load reduction.

- **Load removed from BMPs in planning/design:** The load reduction from the BMPs not yet constructed but already being planned and designed.
- **Final load reduction gap:** The required load reduction that remains (i.e., gap) once the load reductions from current BMPs and BMPs in design and planning are subtracted. This is the load reduction this plan addresses.

6.2 Baseline Load Calculation

Baseline conditions, as defined by MDE, represent the impaired conditions the watersheds were under during TMDL development. The percent reduction of pollutants is based on loads needed to achieve the applicable water quality standards in specific water bodies. MDE's *TMDL Data Center* website (MDE 2014c) provides technical guidance for developing restoration plans for WLAs. Part of this guidance allows entities to calculate updated load estimates using specific land-use and other data for restoration planning. The guidance allows entities to use their own data to develop loads if they retain the percent reduction specified in the respective TMDL between baseline loads and the allocations for the applicable pollutants. This method also accounts for the loads from a more accurate and more recent urban footprint than the TMDL, so the baseline loads in this plan will not exactly match those in the TMDL documents.

DoE developed watershed- and land use-specific loading rates using information from the Chesapeake Assessment Scenario Tool (CAST) (CBP 2019). CAST uses the same information as the Chesapeake Bay Watershed Model. CAST results were used to determine land-use, edge-of-stream (EOS) loading rates for various land uses. CAST separates the loading rates to MS4-regulated areas and those to unregulated areas for urban land uses. DoE calculated the loading rates for an MS4 area, an unregulated area, and a combined area-weighted value.

Table 6-1 presents the TMDL baseline loads using recent land-use loading rate and area distribution data from the County's portions of the PAXTF, PAXOH, and PAXMH segmentsheds. Those baseline loads do not include loads attributed to federal or state land. The TMDL values in the table were obtained directly from the MDE TMDL report or point source technical memorandum (MDE 2017). The County-calculated figures are from County land-use data and EOS loading rates developed using CAST loading data.

The TMDL loadings and targets and the County-calculated loadings and targets do not exactly match. Potential reasons for the differences in the reported numbers include changes to the watershed since the 2009 baseline data was assessed by MDE, changes in accepted land-use loading rates used by the County, potential differences in the applicability of regulatory responsibility (e.g., changes from agricultural to urban land uses), and potential changes to the MS4 service area. In addition, the discrepancy could be the result of differences in the methodologies used to calculate loads: the TMDL loads were estimated based on unit-area flows and instream water quality monitoring data and the County loads were estimated using CAST EOS land-use sediment loading rates and a calculated PCB soil potency factor. The potency factor (3.3 ng/g) was calculated using two sediment samples collected in the PAXTF segmentshed as reported in the TMDL document (MDE 2017). Data collected in PAXTF were used because it is the only segment requiring TMDL reductions, as reported in the table.

Table 6-1 also presents the percent reduction from MDE's TMDL calculations, which was applied to the calculated baseline load to determine the implementation load reduction target. That target and the amount by which the loads need to be reduced are also presented in the table.

Table 6-1. MS4 baseline and implementation loads for the PAXTF, PAXOH, and PAXMH segmentshed local TMDLs in Prince George's County

Segment-shed	Parameter	Implementation Model Baseline (grams tPCB)	Percent Reduction from MDE (2017) TMDL	Implementation Model Target Load (grams tPCB)	Required Implementation Model Reduction (grams tPCB)
PAXTF	tPCB (g/yr)	MDE figure: 154.6 County figure (EOS): 21.09	99.9%	TMDL: 0.1 County figure (EOS): 0.01	MDE figure: 154.5 County figure (EOS): 21.08
PAXOH	tPCB (g/yr)	MDE figure: 1.4 County figure (EOS): 1.06	0%	MDE figure: 1.4 County figure (EOS): 1.06	MDE figure: 0 County figure (EOS): 0
PAXMH	tPCB (g/yr)	MDE figure: 0.6 County figure (EOS): 0.31	0%	MDE figure: 0.6 County figure (EOS): 0.31	MDE figure: 0 County figure (EOS): 0

Note: g/yr = grams per year.

6.3 BMP Pollutant Load Reduction

The main purpose of implementing BMPs is to remove sediment and other stormwater pollutants near their source and prevent pollutant loads from entering and degrading water bodies. Different types of BMPs remove pollutants with differing degrees of effectiveness, or "pollutant removal efficiency." Estimating pollutant reductions achieved through implementing BMPs is a three-step process: (1) determine the varying removal efficiencies of the BMPs being considered, (2) calculate the load reduction, and (3) calculate tPCB load reduction from TSS using a soil potency factor. The potency factor selected, 3.3 ng/g, was calculated from two sediment samples collected in the PAXTF segmentshed as reported in the TMDL document (MDE 2017). Data from the PAXTF segment were used because it is the only segment requiring TMDL reductions.

6.3.1 Removal Efficiencies

MDE's *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE 2014a) incorporates recent CBP recommendations for nutrient and sediment load reduction removal efficiencies associated with BMP implementation. By using those removal efficiencies in its reduction calculations, the County is consistent with regionwide efforts to meet the Chesapeake Bay TMDL. Because tPCB removal efficiencies are not available, the percent removal efficiencies for TSS provided in the MDE guidance was used to give a relative indication of tPCB removal efficiency, where the mass of tPCBs removed was defined using the selected potency factor (3.3 ng/g).

The general pollutant removal efficiencies of ESD practices in this restoration plan are provided in Table 6-2. Removal efficiency increases as more runoff volume is treated. The table also illustrates that runoff reduction practices consistently reduce pollutant loads at a higher efficiency than structural practices at all treatment volumes. In locations where runoff reduction or ESD practices are used, or other acceptable runoff reduction practices predominate, the ESD/

runoff reduction curves should be used. Otherwise, the stormwater treatment or structural practices curves should be used.

Table 6-2. Pollutant removal rates for ESD/runoff reduction and structural practices

Runoff Depth Treated (inches)	Total Nitrogen		Total Phosphorus		TSS	
	Runoff Reduction (%)	Structural Practices (%)	Runoff Reduction (%)	Structural Practices (%)	Runoff Reduction (%)	Structural Practices (%)
0.00	0%	0%	0%	0%	0%	0%
0.25	32%	19%	38%	29%	40%	37%
0.50	44%	26%	52%	41%	56%	52%
0.75	52%	30%	60%	47%	64%	60%
1.00[a]	57%	33%	66%	52%	70%	66%
1.25	60%	35%	70%	55%	76%	71%
1.50	64%	37%	74%	58%	80%	74%
1.75	66%	39%	77%	61%	83%	77%
2.00	69%	40%	80%	63%	86%	80%
2.25	71%	41%	82%	65%	88%	83%
2.50	72%	42%	85%	66%	90%	85%

Note:
[a] Typical scenario for redevelopment projects treating 50 percent of existing surface area.

Typical ESD/runoff reduction practices include the following:

- Bioretention
- Bioswale
- Disconnection of nonrooftop runoff
- Disconnection of rooftop runoff
- Dry swale
- Dry well
- Grass swale
- Green roof–extensive
- Green roof–intensive
- Infiltration basin
- Infiltration trench
- Landscape infiltration
- Micro-bioretention
- Perimeter (sand) filter
- Permeable pavements
- Rain gardens
- Rainwater harvesting
- Sheet flow to conservation areas
- Step pool storm conveyance
- Wet swale

Typical stormwater treatment/structural practices include the following:

- Extended detention–wetland
- Extended detention structure, wet
- Micropool extended detention pond
- Pocket pond
- Pocket wetland
- Retention pond (wet pond)
- Sand filter
- Shallow marsh
- Submerged gravel wetlands
- Underground filter

Table 6-3 presents the pollutant reduction efficiency of several alternative BMPs, including stream restoration (for which the load reduction efficiencies are only for planning purposes). Once the stream restoration projects are installed, the County will use the approved protocols—based on design and field measurements—to determine their actual load reductions.

Load reductions for outfall stabilization assume the same efficiencies as stream restoration and that 100 feet of stream will be restored for each failing outfall. MDE is currently evaluating an alternative method for calculating load reductions from outfall stabilization as proposed by the Maryland State Highway Administration (McCormick Taylor 2018). If MDE approves the methodology, the load reductions calculated using it are expected to be higher than those calculated using the current method. The higher load reductions will be accounted for in the County's annual MS4 reports.

Table 6-3. Pollutant removal efficiencies of selected alternative BMPs

BMP Type	ESD Practice?	Total Nitrogen (%)	Total Phosphorus (%)	TSS (%)
Planting Trees or Forestation on Pervious Urban Surface	No	66%	77%	57%
Planting Trees or Forestation on Impervious Urban Surface	No	71%	94%	93%
Stream Restoration[a]	No	0.075 lb/ft/yr	0.068 lb/ft/yr	15.1 lb/ft/yr
Street Sweeping–Regen/Vacuum	No	5%	6%	25%
Street Sweeping–Regen/Vacuum[b]	No	3.5	1.4	420
Catch Basin Cleaning / Storm Drain Vacuuming[c]	No	3.5	1.4	420

Source: MDE 2014.
Notes: lb/ft/yr = pound per foot per year.
a This restoration plan assumes that outfall stabilization has the same reduction efficiencies as stream restoration.
b These reductions are for high-density urban streets that are swept at least twice a month. These values are expected to change as the result of a recent Chesapeake Bay expert panel report.
c These reductions are for high-density urban areas, where storm drains are routinely maintained.

6.3.2 Load Reduction from Current Restoration BMPs

A systematic identification and locations of current BMPs as of April 2019 was conducted. Once identified, the BMPs' load reductions were quantified. The information available for most BMPs included drainage area (i.e., total land area flowing to a specific BMP [e.g., a bioretention system]). Load reductions for the existing BMPs were calculated using the documented pollutant removal rates in conjunction with BMP drainage area land cover and land-cover-specific pollutant loading rate. That calculation provided the loading attributed to the BMP drainage area, which was then multiplied by the BMP pollutant removal efficiency to determine the amount of load reduction attributed to a specific BMP.

The load reduction calculation included only BMPs implemented since the TMDL water quality data were collected (also known as the "baseline" year for the TMDL). For instance, the PCB TMDL was developed in 2017, while the water quality data for it were collected in 2014. Therefore, any BMP or other practice implemented or established before 2014 was not included in the PCB load reduction calculation.

Table 6-4 lists existing restoration BMPs in the segmentsheds that were implemented as part of the programs identified in section 5.1.

Table 6-4. List of BMP types in the PAXTF, PAXOH, and PAXMH segmentsheds

BMP Type	Number of Projects	Total Acres Treated	TSS Reduction (lb)			tPCB Reduction (mg)		
			PAXTF	PAXOH	PAXMH	PAXTF	PAXOH	PAXMH
Bioretention	2	2.09	1,095	779	0	1.64	1.17	0
Grass Swale	1	0.90	668	0	0	1.00	0	0
Micro-bioretention	6	3.22	2,249	0	330	3.37	0	0.49
Permeable Pavements	3	0.67	0	0	0	0	0	0
Rainwater Harvesting	9	0.16	101	39	0	0.15	0	0
Stream Restoration	9	9,170[b]	1,276,144	0	0	1,910.21	0	0
Outfall Stabilization	1	147[b]	0	0	0	0	0	0
Impervious Surface Elimination	7	0.16	134	0	0	0.20	0	0
Street Sweeping	44	0	341	0	0	0.51	0	0
Storm Drain Cleaning	15	0	7,509	0	0	11.24	0	0
Tree Planting	38	0	7,414	40	0.90	11.10	0.06	0.001
Total	**135**	**9,324**	**1,295,656**	**858**	**331**	**1,939.42**	**1.29**	**0.49**

Source: DoE 2019.
Notes: lb = pounds; mg = milligrams.
[a] Records split the watersheds, so total amount split.
[b] Linear feet.

6.4 Load Reduction Gap

The load reductions of the existing BMPs were calculated and used to determine the remaining load reduction gap. The load reductions from current BMPs and other practices and the load reduction gap are provided in Table 6-5. Figure 6-2 shows the graphical representation of the calculated baseline loads, implementation target load, required implementation load reduction, load reduction (from baseline loads) resulting from current BMPs, and the reduction gap. The implementation target load and required implementation reduction equal the baseline loading (with slight differences due to rounding), while the current BMP reductions and the reduction gap equal the required reduction. While the County implemented restoration BMPs prior to 2009, their load reductions are reflected in the baseline loadings, since they were in place when the TMDL was established. Besides restoration BMPs, there are BMPs installed by developers to offset the increased pollutant loads from new development and impervious areas. Because those BMPs are installed to offset new loadings and not to remove existing loadings, they are not counted towards watershed restoration.

As shown in Table 6-5, the load reductions from existing restoration activities are not sufficient to meet the targeted reductions. With the BMPs either previously implemented or planned, a reduction gap still exists in the PAXTF segmentshed, whereas the PAXOH and PAXMH did not require tPCB load reductions under the TMDL (MDE 2017). Additional practices will need to be planned in the PAXTF segmentshed to make up the gap in pollutant reduction requirements. When PCB sources are identified and it is determined that new ESD/runoff practices should be used, the County will focus on the practices that are most effective at reducing TSS and associated PCBs.

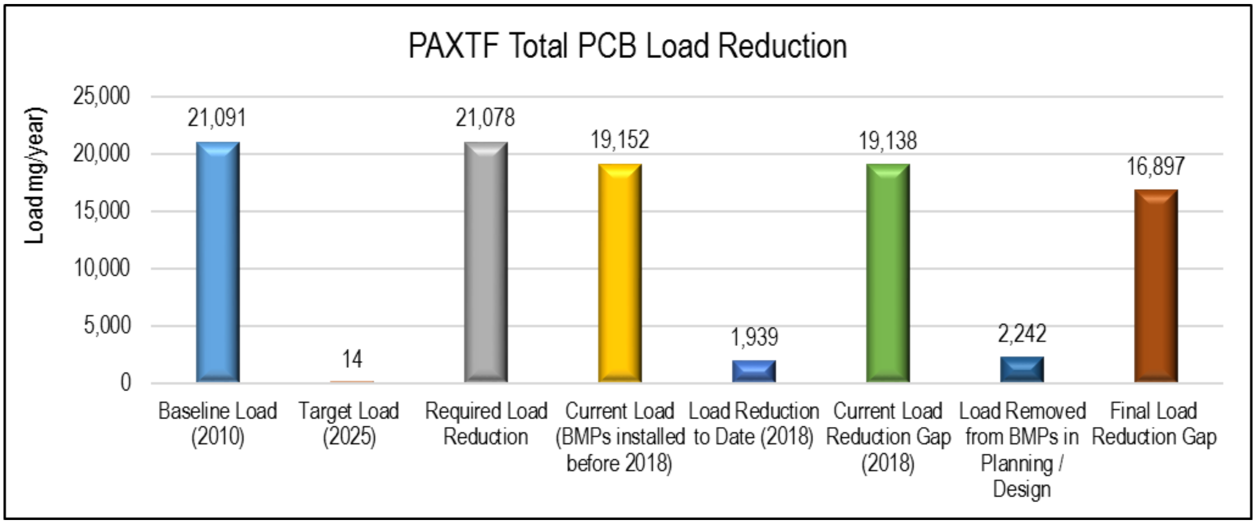


Figure 6-2. Pollutant load reduction targets and gaps for the PAXTF segmentshed.

Table 6-5. Pollutant load reduction targets for the PAXTF segmentshed

Measure	tPCB (mg/yr)
Baseline Load (2010)	21,091
Target Load (2025)	13.6
Required Load Reduction	21,078
Load Reduction to Date (2018)	1,939
Current Load (BMPs Installed 2010–2018)	19,152
% of Target to Date (2018)	9.20%
Current Load Reduction Gap (2018)	19,138
Load Removed from BMPs in Planning / Design	2,242
Final Load Reduction Gap	16,897
% of Target	19.84%

Notes: mg/yr = milligrams per year.

7 STRATEGY DEVELOPMENT

The watershed restoration activities in the PCB-impacted segmentsheds will require a significant level of effort, both challenging and costly, which requires a well-thought-out management approach. Consequently, the County has developed a strategy that includes five major components to achieve the goals of the restoration plan:

- Use land-use loading rates and accepted BMP pollutant load reduction efficiencies to evaluate the ability of existing practices and programmatic initiatives to meet the local TMDL WLAs. Identify and quantify future BMPs and programmatic initiatives necessary to meet the WLAs.
- Develop cost estimates associated with implementing the identified BMPs and initiatives.
- Develop timelines associated with the deployment of identified BMP practices and initiatives to determine if the timelines required by the TMDL program can be achieved.
- Identify opportunities for BMP practices and programmatic initiatives and develop cost estimates.
- Develop a PCB source tracking strategy to identify sources in the study area and prioritize potential BMP implementation.
- Identify the financial and technical resources required to implement the BMPs and initiatives and develop achievable timelines that can meet TMDL program requirements with the greatest efficiency.

This section describes the County's overall restoration strategy for the PCB-impacted segmentsheds, including funding sources. The recommended specific planned actions, cost estimates, proposed schedule, as well as financial and technical resources available to support implementation are discussed in section 8 of this document.

7.1 Existing Practices Evaluation Procedure

The County's strategy for developing a restoration plan includes evaluating the capacity of existing BMPs and restoration activities as well as identifying future activities necessary to meet the WLAs. The methodology emphasizes the use of adaptive management and a simplified project identification and implementation framework to achieve greater cost efficiency, while not sacrificing the resiliency of the restoration plan.

In a simplified framework, once the existing BMPs have been accounted for and the load reduction gap has been calculated, the County will attempt to identify potential future BMPs that could be implemented to close the remaining gap. Generally, the County's implementation of those BMPs would be prioritized by cost effectiveness in terms of meeting water quality goals. Seeking out cost-effective opportunities that deliver the greatest pollutant load reduction will ensure that the most beneficial practices that are easiest to accomplish are not overlooked during the implementation process.

The process shown in Figure 7-1 was developed to support a systematic evaluation of the number and general locations of BMPs and other restoration activities that will be necessary to achieve the targeted pollutant reduction for the PAXTF segmentshed. The flow chart does not represent the order in which the County will implement restoration practices but illustrates a possible procedural scenario that could be used to determine the number of restoration activities necessary to meet load reduction goals. Although the restoration strategy initially suggests installing BMPs on public ROWs, it does not restrict the County from installing similar BMPs to treat other land-use types (e.g., County facilities) to obtain similar load reduction goals.

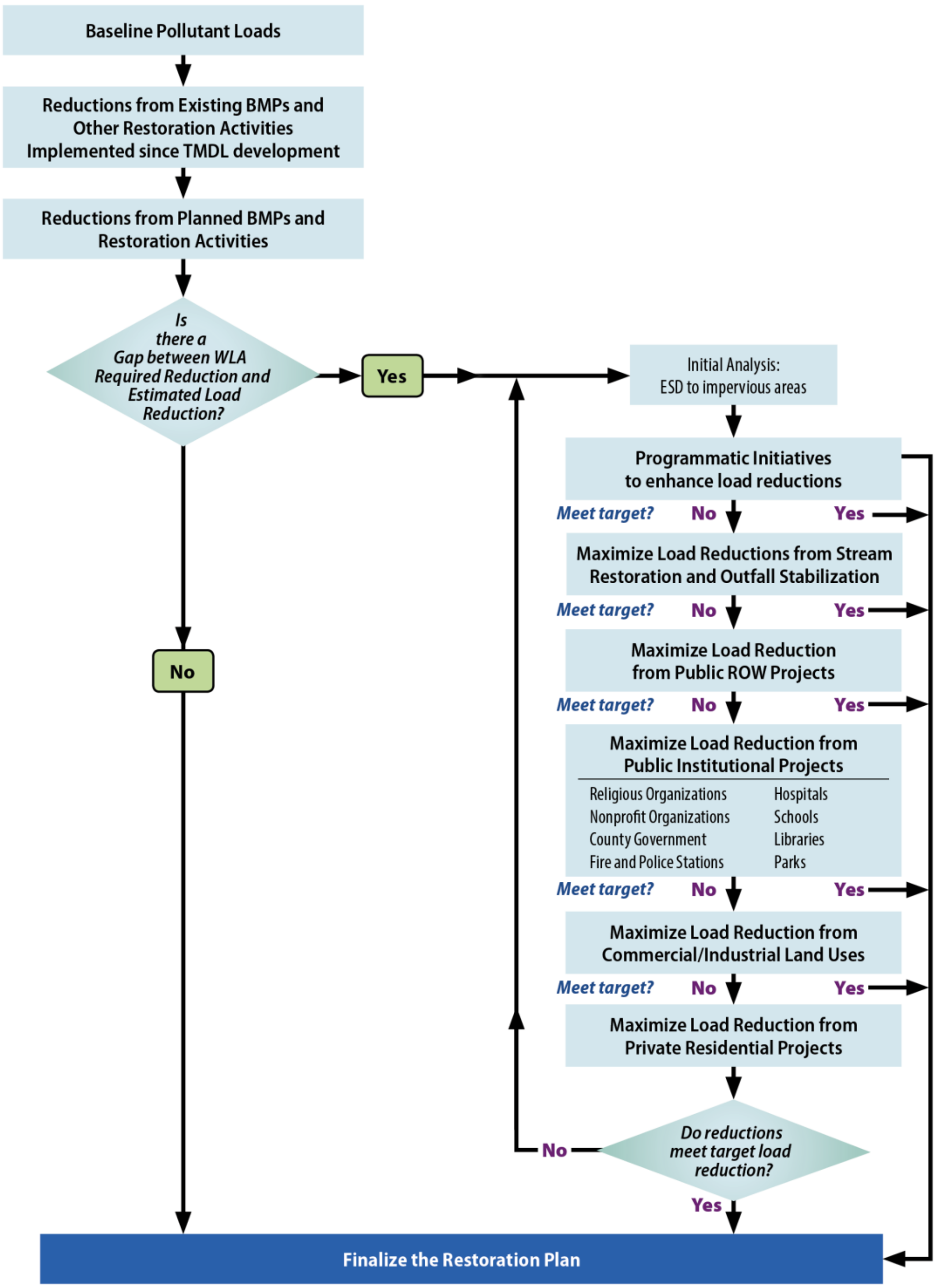


Figure 7-1. Restoration evaluation process.

7.2 Programmatic Initiatives

The County analyzed current stormwater programs discussed in section 5.1 to determine, where possible, their contribution to the necessary PCB load reductions. The existing programmatic activities are expected to continue and will be supplemented with additional practices as they are identified and/or developed to support the programmatic strategies for this restoration plan.

7.3 BMP Identification and Selection

The MDE 2000 *Stormwater Design Manual* provides guidance for designing several types of structural BMPs (wet ponds, wetlands, filtering practices, etc.) and ESD practices (infiltration trenches, bioretention, etc.) (MDE 2000). MDE also describes nonstructural BMPs that include programmatic, educational, and pollution prevention practices that work to reduce pollutant loadings. Examples of nonstructural BMPs include diverting stormwater from impervious to pervious areas, street sweeping, and homeowner and landowner education campaigns (MDE 2009a).

The County has implemented and will continue to implement runoff reduction ESD practices, structural and nonstructural stormwater treatment practices, and MDE-approved alternative BMP practices to meet its programmatic goals and responsibilities, including MS4 permit compliance, TMDL WLAs, and flood mitigation.

The process illustrated in Figure 7-1 was used to assess potential pollutant load reductions from multiple potential activities such as the following:

- Retrofits of existing BMP to enhance load reductions
- Public ROW projects
- Public institutional projects
- Commercial/industrial land uses
- Residential properties

For this restoration plan, the County prefers to use a more opportunistic approach to identifying potential pollutant load reductions than it has used in earlier plans. For example, rather than considering treatments limited to public ROWs, followed by considering opportunities limited to institutional lands, this plan is geared toward considering each opportunity as it is discovered, which allows for a more fluid approach to implementing and prioritizing opportunities. The final selection of BMPs will be prioritized according to factors such as cost efficiency for pollutant load reduction and ease of implementation. For example, a project in a ROW is generally less complex because it is on public property and typically constitutes about 15–20 percent of total impervious area within a subwatershed. Stormwater controls within a ROW can be retrofitted with moderate effort. For comparison, stream restorations tend to be very resource-intensive, incurring high costs and, at times, requiring a significant community buy-in because of the physical disturbance in which they result. On the other hand, stream restorations have a very high pollutant load reduction efficiency for sediments, making that option feasible in certain situations. These are some of the kinds of factors likely to be considered in determining implementation priority.

7.3.1 Urban Stream Restoration

Urban impacts on streams typically include bank and channel erosion, stream health degradation, and loss of natural habitat. Multiple techniques for restoring a stream can be used to mimic the natural state of the stream, provide stability to the channel bed and banks, and improve stream health and habitat in nontidal areas. Various kinds of in-stream structures can be used to restore the main channel by providing stable flow steering and energy dissipation as well as creating pools where natural habitats can develop. In addition to in-stream structures, the increase in riparian vegetation can help to stabilize stream banks, further reducing in-stream erosion in high-velocity areas. Examples of stream erosion that could benefit from stabilization are shown in Figure 7-2.

Using the SCA, the County identified 10.1 mi of streams with erosion issues in the PAXTF segmentshed.

Source: MD DNR n.d.

Figure 7-2. Examples of stream erosion.

7.3.2 Outfall Stabilization

Storm drainage systems in the County terminate at outfall structures that usually discharge to surface drainage features such as channels or streams. The outfall structures are often the initial source of stream erosion and degradation because they are the delivery point for the increased runoff from impervious areas. As the stream channel erodes and down cuts, it often undercuts the outfall structure, resulting in outlet failure (Figure 7-3). Outfall stabilization typically involves repairing localized areas of erosion below a storm drain pipe and addressing structural and functional problems associated with exposed infrastructure. DoE is currently identifying locations where outfalls are eroding and need to be stabilized. The County's storm drain outfall geospatial data are being used in that process. Outfall IDs will be related to areas of stream degradation and the drainage area to the outfall. The SCA field evaluations identified 110 failing stormwater outfalls in the PAXTF segmentshed. Because the failing outfalls actively contribute to stream erosion and sediment generation, they present many restoration opportunities.

Source: MD DNR n.d.

Figure 7-3. Examples of pipe outfall failure.

7.3.3 Structural Practices

The County will consider opportunities to implement BMPs on all types of land uses, wherever there is a need to provide treatment to currently untreated impervious surface. Some BMPs are better suited to certain land uses than others, and this section discusses examples of those land uses and their primary corresponding, but nonexclusive, BMPs.

BMPs can be grouped into two categories: runoff reduction or ESD practices and stormwater treatment practices. These practices can be installed to manage runoff generated by all urban land uses (e.g., street ROWs, residential, and institutional). ESD practices, which have a higher level of pollutant removal, reduce pollutants through infiltration interception by vegetation and adsorption by soil (e.g., bioretention systems and permeable pavement). Stormwater treatment practices reduce pollutants through filtration or settling (e.g., sand filters and wet ponds).

Rights-of-Way

The County owns and maintains ROWs, which are public space along streets and roadways. They represent a high-priority area for restoration and will be a major focus of the County watershed restoration efforts. If opportunities to implement BMPs in ROW areas present themselves, possible retrofits for different types of ROWs are available (see Table 7-1).

Table 7-1. Potential ROW BMP types per urban road grouping

Potential BMP	Urban Open Section with No Sidewalk	Urban Closed Section with Curb and Gutter but No Sidewalk	Urban Closed Section with Curb, Gutter, and Sidewalk	Suburban Open Section with No Curb, Gutter, or Sidewalk	Suburban Closed Section with Curb, Gutter, and Sidewalk
Permeable pavement or sidewalks	X	X	X	X	X
Permeable pavement shoulder instead of grass shoulder/buffer	X			X	
Curbside filter systems		X	X		X

Potential BMP	Urban Open Section with No Sidewalk	Urban Closed Section with Curb and Gutter but No Sidewalk	Urban Closed Section with Curb, Gutter, and Sidewalk	Suburban Open Section with No Curb, Gutter, or Sidewalk	Suburban Closed Section with Curb, Gutter, and Sidewalk
Curb extension with bioretention or bioswale		X	X		X
Curb cuts to direct runoff to an underground storage/infiltration or detention device		X	X		X
Grass swales and bioswales				X	
Bioretention or bioswales to convert an ROW to a green street				X	X
Infiltration trenches with underdrains				X	

Institutional Land Use

Existing institutional land uses also offer opportunities for BMP retrofits. The land uses include County and nonprofit organization properties such as schools, libraries, places of worship, parks, government buildings, fire and police stations, and hospitals. The County has implemented the Alternative Compliance Program, administered by DoE, which allows nonprofit organization property owners to reduce their CWA Fee by installing approved stormwater management practices. Most of the properties have substantial areas of impervious cover that include rooftops, driveways, and parking areas that offer opportunities for cost-effective retrofits. A BMP retrofit matrix can be applied to these sites based on impervious cover type (Table 7-2). The retrofit matrix will help in the selection process and identify practical and feasible practices that offer the highest pollutant removal at the lowest cost.

Table 7-2. Typical impervious area BMP retrofit matrix for institutional property

BMP Description	Impervious Cover Elements				
	Roofs	Driveways	Parking	Sidewalks	Other[a]
ESD from the *Manual*					
Permeable pavements		X	X	X	X
Disconnection of rooftop runoff	X				
Disconnection of nonrooftop runoff		X	X	X	X
Sheet flow to conservation areas		X	X		
Rainwater harvesting	X				
Submerged gravel wetlands			X		
Landscape infiltration	X	X	X		X
Dry wells	X				
Microbioretention / rain gardens		X	X		X
Grass, wet, or bioswale		X	X		X
Enhanced filters	X	X	X	X	X
Structural Practices					

BMP Description	Impervious Cover Elements				
	Roofs	Driveways	Parking	Sidewalks	Other[a]
Wet ponds/wetlands			X		X
Infiltration practices			X		X
Filtering practices		X	X	X	X
Tree Planting and Reforestation					
Impervious urban to pervious		X	X		X
Planting trees on impervious urban		X	X		X

Note:
[a] Includes miscellaneous other impervious surfaces (e.g., basketball courts, tennis courts, and patios).

Commercial/Industrial Land Use

Much like institutional properties, commercial and industrial properties are characterized by large areas of impervious cover, including roofs, driveways, parking lots, and other paved areas. From a technical standpoint, the opportunities for implementing a variety of BMPs in those areas are similar to the opportunities in institutional areas (Table 7-2). Most of the commercial and industrial facilities, however, are privately owned. Consequently, the County has limited influence on the use of BMPs in those areas except along the public roads that serve them. To encourage effective BMP development on private property, the Rain Check Program administered by DoE offers financial incentives for property owners to implement approved stormwater management practices. Property owners can benefit through rebates, grants, or a reduction in a portion of their CWA Fee.

Residential Land Use

Residential areas make up roughly 16 percent of the PAXTF segmentshed and have varying amounts of impervious cover such as roofs, driveways, walkways, and patios. Many of the practices in Table 7-2 can be used on residential land. The most common practices for individual homeowners are permeable pavement, rooftop disconnection, rainwater harvesting (e.g., rain barrels), landscape infiltration, rain gardens, and planting trees. For row houses, the most common practices probably are permeable pavement (on sidewalks leading to houses and alleyways), rooftop disconnection, rainwater harvesting (e.g., rain barrels), and rain gardens. Apartment and condominium communities could install any of the practices listed in Table 7-2.

It is difficult to implement BMPs on residential properties, however, because they are privately owned. As with commercial and industrial property owners, the Rain Check Program offers financial incentives for residential property owners to implement approved stormwater management practices. Additionally, the County could explore opportunities to provide further education and awareness outreach on residential BMPs to help property owners learn about their benefits.

7.4 Prioritizing BMP Locations

The location of a BMP or other restoration practice has a significant impact on how successful the restoration will be. For instance, a lawn care campaign will have little effect in areas with few homeowners to implement the strategy. In identifying the best locations for BMPs, the County will consider sites where the most significant water quality benefits will be realized for available funding and installing the BMPs in a desirable time frame with minimal disruption. Three main considerations for prioritizing BMP locations are land ownership and site access, location in the stream watershed, and locations of known issues and existing treatment.

7.4.1 Land Ownership and Site Access

DoE and CWP are actively installing BMPs throughout the County. The most suitable locations to install BMP practices are municipally owned land such as town halls, police stations, public schools, libraries, and the ROWs or easements along roads and stormwater outfalls. For example, the County has site access to stormwater outfalls (usually available as flood easements), which allows the County to proceed without delays that sometimes result from negotiating with private landowners, facilitating faster implementation and reducing the resources spent for interacting with landowners.

In some instances, the County is granted permission from a property owner to install a BMP on their property. For example, the County's Alternative Compliance Program provides incentives to faith-based and other nonprofit organizations to allow the County to install BMPs on their properties. The organizations are granted credit toward their CWA Fee. The aesthetics of a restoration project are often preferred to the condition of the site before the BMP was installed. Attractive examples of watershed restoration efforts can be used in an outreach effort to encourage property owners to grant access to their own properties. A public education campaign highlighting those examples can build public support for implementing BMPs on private properties.

7.4.2 Location in the Watershed

Another factor to consider in BMP placement is how close the location is to the stream headwaters. Improvements to water quality and stream stability in stream headwaters will provide benefits along the entire length of the stream. Restoring downstream reaches first, on the other hand, will later expose the restored reaches to sediment from upstream, increasing the risk that the restored channel will fail because of the fresh sediment deposits. Water quality improvement projects that address excess sediment from stream erosion are most appropriately placed in smaller headwater (i.e. first- and second-order) subwatersheds. Adding BMPs to headwaters above stream restoration projects will help protect the stream reaches that have been restored. Restoring conditions in the headwaters makes it easier to detect and attribute the water quality improvements to each restoration project because the complexity of factors that could be affecting water quality tends to decrease with drainage area.

7.4.3 Locations of Known Issues and Existing Treatment

A third key consideration in determining where to place BMPs is identifying where known erosion issues and areas of poor biological health exist and where treatment practices exist but have not yet been adequately implemented. Figure 7-4 shows how those locations can be mapped to identify priority areas for targeted BMP development. The locations were identified by reviewing existing and planned locations and types of BMPs, regulatory agency (only County MS4 land is identified), bioassessment results, and areas of concentrated impervious surfaces.

Note: The impervious and regulatory areas are not included on the map to make it clearer and easier to read.

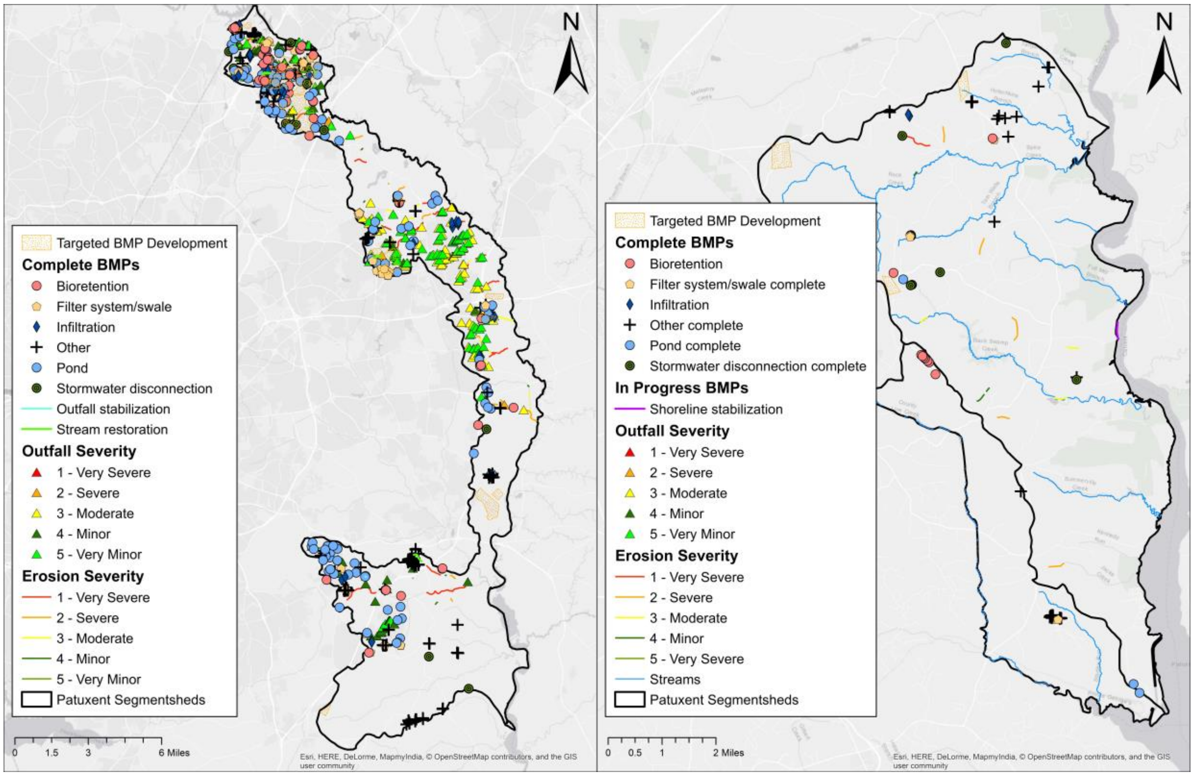


Figure 7-4. Example map for areas for BMP prioritization in the PAXTF segmentshed (*left*), and PAXOH and PAXMH segmentsheds (*right*).

7.5 PCB Source Tracking

The primary strategy for additional and targeted PCB reduction is the development of a source tracking and elimination program that traces the contamination back to its source and removes it from the system. The source tracking program identifies areas where PCB sources have been documented or are likely to exist. Those areas can be assessed to target sediment-trapping BMPs (e.g., stormwater ponds) and waterways where PCBs are most likely to have been carried by stormwater. Sediments and surface water in those BMPs and waterways can then be sampled and analyzed with a targeted monitoring program to determine PCB presence and concentrations. If PCB-impacted sediments are present above the action level, they will be removed from the system and the County will take credit for the PCB load reduction. This section provides details of a source tracking program. Ideally, the source of PCBs can be immediately identified and corrected during the source removal/remediation phase.

7.5.1 Source Targeting

PCB sources in the County are most likely diffuse and difficult to pinpoint. In the absence of a significant, known source such as a Superfund site, the primary pathway by which PCBs enter the County’s waterways is through washoff of contaminated sediment from urban and industrial areas. The contaminant migrates as the suspended sediment is transported downstream; a process that is heightened during increased stream flow.

“Source targeting” is locating and identifying watershed sources of PCBs. For areas with known or suspected PCB contamination, existing information is reviewed as part of the assessment to help identify present or historical sources of contamination, their levels, and their spatial distribution. The difference between historical and current sources of PCBs can have a major impact on defining the extent of contamination problems and setting restoration goals. Source targeting requires gathering, compiling, and assessing existing PCB data within the watershed, including:

- Documented soil contamination
- Known PCB spills
- Storage, handling, and disposal of PCB-containing equipment
- Manufacturing of PCB-containing materials
- Local, state, or independent monitoring data
- Stormwater ponds (or other sediment-trapping BMPs)
- Ancillary data (e.g., current and historical industrial, commercial, or residential land use; NPDES permits; and associated Standard Industrial Classification [SIC] codes with PCB potential)

Two major areas of investigation—records analysis and geographic information system (GIS) analysis—were completed to support the source targeting categories.

Records Analysis

"Records analysis" is the review of federal, state, and county data sources to provide source targeting information on facilities handling PCBs as well as on spills that might have occurred. The County reviewed the records associated with those sources to identify facilities from which PCB contamination might be originating that were not previously identified. The data will also help prioritize the sites identified. For example, if spill reports are associated with a particular facility identified in the NPDES GIS analysis, that facility will be prioritized for sampling in the next phase of the program. The County's source tracking effort will focus on the following available datasets:

- EPA PCB Transformer Registration Database
- PCB Activity Database System (PADS)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Sites Database (Superfund sites)
- Toxic Release Inventory Database (TRI)
- MDE Land Restoration Program (LRP)
- National Response Center (NRC) Database
- MDE Historic Landfill Initiatives (HLI) Report

In addition to aiding in prioritizing identified sites, the records found in these databases can also aid in tracing the ultimate source of PCBs. Once contaminated stream sediments or BMPs are identified, the County will use those datasets to identify facilities where likely active or legacy sources are located.

EPA PCB Transformer Registration Database

EPA maintains an inventory of all in-use PCB transformers in the country in its Transformer Registration database, which is available online to the public. The database contained 26 records in Maryland; however, no transformers are located in the study segmentsheds.

PCB Activities Database

EPA maintains the PCB Activity Database (PADS), which identifies generators, transporters, commercial stores, and/or brokers and disposers of PCBs. Companies or individuals engaged in those activities or conducting PCB research and development must notify EPA, which issues them an identification number. This database is also available online to the public.

A review of PADS identified a single site, Andrews Air Force Base (AFB), in the study area (PAXTF segmentshed). Andrews AFB is identified as a PCB generator, but not a storage, transport, or disposal site. The County can use that information in conjunction with the industrial/commercial land use and NPDES GIS analyses to identify facilities with a high potential for PCB contamination.

Comprehensive Environmental Response, Compensation, and Liability Act Sites Database

CERCLA, commonly referred to as Superfund, is legislation enacted in 1980 that created a tax on the chemical and petroleum industries. The law provides for federal authority to respond to existing or threatened hazardous substance releases. Revenues generated by the tax provide funding for cleaning up abandoned or uncontrolled hazardous waste sites. The act established EPA's National Priorities List (NPL), which is an inventory of sites for which remedial response has been authorized.

A CERCLA database search identified one Superfund site (Brandywine-Launch) in the PAXTF segmentshed, where hazardous waste is known to be present. Two others—Andrews Air Force Base and Brandywine Defense Reutilization and Marketing Office (DRMO)—straddle or are located on the drainage boundary and might impact the Patuxent River watershed. Assessments at some of those sites have determined that PCBs are present. Table 7-3 lists the identified Superfund sites and those where PCBs are a known or suspected contaminant, as well as NPL designation.

Table 7-3. Superfund sites in Prince George's County

EPA ID	Site Name	City	NPL	PCBs
MD0570024000	Andrews Air Force Base	Andrews AFB	Y	Y
MD9570024803	Brandywine Defense Reutilization and Marketing Office (DRMO)	Brandywine	Y	Y
MDD981108202	Brandywine-Launch	Upper Marlboro	N	

Toxic Release Inventory Database

The TRI is a publicly available EPA database that contains information on toxic chemical releases and other waste management activities, including those related to PCBs. A review of the TRI found no facilities within the study segmentsheds.

MDE Land Restoration Program

The LRP is a Maryland effort to clean up uncontrolled hazardous waste sites found throughout the state. It focuses on protecting public health by limiting the risk to human health and the environment posed by contaminated soil, groundwater, and surface water.

A search of the LRP database returned 30 sites located in the study segmentsheds, 27 of which are located in the PAXTF segmentshed (Table 7-4). Only one site, the Patuxent Wildlife Research Center, has records identifying PCBs contamination, which was also highlighted in the Patuxent River PCB TMDL (MDE 2017). The baseline load of tPCBs attributed to the site was calculated to be 0.012 g/year, which was considered insignificant and, thus, required no load reduction as part of the TMDL.

Table 7-4. LRP sites in the Patuxent River segmentsheds

Segment-shed	BMI Number	EPA ID	Site Name	City	Acres	Brown-field
PAXMH	MD0443	MDD985408491	Eagle Harbor Tire Fire	Eagle Harbor	4	No
PAXOH	MD0355	MDD985381433	Nelson Perrie Dump	Brandywine	3.44	No
	MD1434		FERST, Inc.	Brandywine	28	No
PAXTF	MD0040	MDD980705156	Koppers Co. Dumpsite - Laurel	Laurel	2	No
	MD0090	MDD980538565	Bowie-Belair Landfill	Bowie	120	No
	MD0134		Koppers Co Laurel	Laurel	0	No
	MD0183	MDD981038557	Laurel City Landfill	Laurel	22	No
	MD0228		Croom/Brandywine - Launch	Upper Marlboro	21	No
	MD0229	MDD981108269	Brandywine - Control	Upper Marlboro	15.16	No
	MD0230	MDD981108327	Croom - Launch	Upper Marlboro	13.27	No
	MD0231	MDD981108442	Croom - Control	Upper Marlboro	13	No
	MD0267	MD6470090014	Patuxent Wildlife Research Center	Laurel	12,800	No
	MD0393	MDD985382829	Windsor Manor Road Site	Upper Marlboro	4.09	Yes
	MD0468	MDD985403831	Croom Military Housing	Upper Marlboro	3.5	No
	MD0489		Zeal Scrap Tire Site	Upper Marlboro	0	No
	MD0750		Free State Shopping Center	Bowie	28.42	No
	MD0852		Osborne Shopping Center Parcel E	Upper Marlboro	3.03	No
	MD0853		Osborne Shopping Center Parcel G	Upper Marlboro	17.6	No
	MD0994		Bowie Market Place	Bowie	20.23	No
	MD1037		Laurel Building Supply	Laurel	2.35	No
	MD1105		Osborne Shopping Center	Upper Marlboro	1.76	No
	MD1241		Bowie Plaza Shopping Center	Bowie	10.8	No
	MD1296		Office Depot Shopping Center	Laurel	3.733	No
	MD1367		Laurel Shopping Center	Laurel	26.48	No
	MD1407		Industrial Towel Supply, Inc.	Laurel	2.45	Yes
	MD1500		Diplomat Cleaners	Bowie	19.97	No

Segment-shed	BMI Number	EPA ID	Site Name	City	Acres	Brown-field
	MD1502		14415 Greenview Drive Property	Laurel	191.75	No
	MD1567		Laurel Town Center	Laurel	9.3	No
	MD1613		Laurel Commerce Center	Laurel	0	No
	MD1814		Bevard Landfill	Bowie	0	No

National Response Center Database

The NRC is a 24-hour-a-day emergency call center operated by the U.S. Coast Guard. It is tasked with recording and reporting instances of oil and chemical releases into the environment. Reports generated by the NRC are forwarded to appropriate federal or state agencies for response and are available by year at http://www.nrc.uscg.mil/ beginning in 1990. All available data were searched for events involving PCBs or miscellaneous oil discharges, which revealed 63 incidents in the study segmentsheds, as shown in Table 7-5.

Table 7-5. NRC reported PCB and miscellaneous oil spills in the study segmentsheds

Report Year	Hydraulic Oil	Oil, Misc: Lubricating	Oil, Misc: Mineral	Oil, Misc: Transformer	PCBs	Unknown Oil	Waste Oil	Total
1990					1			1
1991		1	1		3	1		6
1992			1	2	1	1		5
1993				1	2	1	1	5
1994						2		2
1995				1	1	1	1	4
1996				1		1		2
1998					1			1
1999	1			1		1		3
2000		1				4		5
2001						1		1
2002		1		1		2		4
2003			2		2	1		5
2005				2	1			3
2008						1		1
2009				1				1
2010				1				1
2012	3					1	1	5
2013	1			1		1		3
2015						2		2
2016		1						1
2017	1		1					2
Total	6	4	5	12	12	21	3	63

MDE Historic Landfill Initiatives Report

Dumps and landfills in the State of Maryland were generally unregulated prior to the 1950s. To better understand the extent and severity of potential environmental and human health hazards, MDE (2009b) was tasked to document historic landfill sites throughout the state. The HLI has identified 456 sites—defined either as municipal, industrial, rubble, land clearing, clean fill, or unknown—235 of which have locational data. A review of those sites found three facilities in the study segmentsheds and two other facilities potentially within the drainage. All five sites (listed in Table 7-6) have unknown waste types, except the Cherry Hill Sand and Gravel Rubblefill, and two sites, J. Nelson Perrie Dump and Laurel Town Dump, are registered CERCLA sites. No site has been identified as a PCB disposal location, however.

Table 7-6. HLI sites in the Patuxent River segmentsheds

Site Name	Waste Status	Waste Burned?	Primary Waste Type	Nearest Town	In Segmentshed?	CERCLA Site?
Cherry Hill Sand & Gravel Rubblefill	Buried	Not Burned	Rubble	Upper Marlboro	Possible	No
Belair Bowie Landfill	Unknown	Unknown	Unknown	Bowie	Yes	No
Bevard Landfill	Unknown	Unknown	Unknown	Bowie	Yes	No
J. Nelson Perrie Dump	Unknown	Unknown	Unknown	Brandywine	Possible	Yes
Laurel Town Dump	Unknown	Unknown	Unknown	Laurel	Yes	Yes

GIS Analysis

A GIS application can be employed to facilitate data storage as well as to perform geospatial analyses of existing data. A desktop GIS analysis can quickly and cost-effectively identify areas where PCB sources most likely exist. All potential sources of PCBs identified during the records analyses would be mapped, along with BMP locations, into GIS. The County's BMP coverage geographically displays BMPs where sediment is collected and identifies the BMP type. Targeting BMPs in areas where PCBs are likely to be found narrows the amount of fieldwork and sampling costs associated with source tracking. This can be done using several existing GIS sources, including:

- Public ROW coverage
- Commercial and industrial land-use coverage
- NPDES permits coverage
  - Significant wastewater treatment plants (WWTPs)
  - Industrial facilities with PCB-related SIC codes
- Electrical substation locations
- Military facilities
- Sewer tracking
- Locations of existing stormwater BMPs and their associated drainage areas

Public ROW Coverage

ROWs, which are public spaces owned and maintained by the County along roads, have a high density of substations and transformers that might contain PCBs, particularly in industrial, commercial, and high-density urban areas. BMPs receiving runoff from those ROW areas will be a priority focus area if there are no access restrictions involved. Using GIS, these ROW areas can be identified and the resulting set of sites will be targeted for a first round of sampling and source investigation.

Commercial and Industrial Land-Use Coverage

Commercial and industrial areas also have a high potential for PCB contamination above background levels. The County's 2010 land-use coverage is the most recent dataset that identifies industrial areas and high-density urban areas. That coverage can be used to filter the BMPs that receive runoff from commercial and industrial areas, providing a second set of BMPs to be targeted for sampling and source investigation. In addition, historic land-use data might identify areas that were historically industrial but have been since developed into parks or residential developments.

NPDES Permit Coverage

The State of Maryland has developed a shapefile coverage of NPDES-permitted discharger locations (MDE 2013). The data show 12 dischargers located in the Patuxent River segmentsheds. However, not all dischargers likely handle PCBs. Those with the potential to do so include large WWTPs and facilities with SIC codes that could be associated with PCBs. **Error! Reference source not found.**Table 7-7 lists the NPDES-permitted facilities in the study area as well as the average tPCB load for those assigned WLAs in the 2017 TMDL (MDE 2017).

Table 7-7. NPDES permitted facilities in the Patuxent River segmentsheds

Segment	NPDES ID	Facility Name	Owner Type	Facility Type	Avg Flow (MGD)	tPCB Load (g/yr)
PAXMH	MD0002658	GenOn - Chalk Point Generating Station	Private	Power Plant	506.6	1,448.8
PAXOH	MDG493000	Rockhill Sand and Gravel Corp / Gudelsky Materials	Private	Mineral Mine	--	--
PAXOH	MDG498049	Aquasco Materials LLC		Mineral Mine	--	--
PAXTF	MD0021628	City of Bowie WWTP	Municipal	WWTP	1.862	2.33
PAXTF	MD0022781	Marlboro Meadows WWTP	County	WWTP	--	--
PAXTF	MD0052680	Henson Valley Montessori School WWTP	Private	WWTP	0.005	0.01
PAXTF	MD0065111	Prince George's County Yard Waste Composting Facility	State		--	--
PAXTF	MD0065358	National Wildlife Visitor Center		WWTP	0.007	0.01
PAXTF	MDG766165	Bowie Sport Fit	Private		--	--
PAXTF	MDG766402	Willow Lake Apartments	Private	Swimming Pool	--	--
PAXTF	MDR000118	Parkway WWTP	County	WWTP	--	--
PAXTF	MDR000121	Western Branch WWTP	County	WWTP	--	--

Note: g/yr = grams per year; MGD = million gallons per day.

Electrical Substation Locations

Review of the EPA PCB Transformer Registry Database found no registered electrical transformers containing PCBs in the study area. It is possible, however, that electrical substations currently have electrical components that contain PCBs. Historical spills and leaks in those areas also pose a threat of PCB contamination in the soil or nearby water bodies. Available parcel layer and aerial imagery data can be used to identify electrical substations within the study segmentsheds, which can be flagged and used to inform targeted monitoring activities.

Military Facilities

Military facilities often have operational equipment, including electrical transformers, circuit breakers, and other electrical systems, that could contain PCBs. A review of the available regulatory databases and GIS datasets identified two federal military facilities in the study segmentsheds: Andrews Air Force Base and Brandywine DRMO. Both of those facilities have already been identified as sites of interest based on the CERCLA Sites Database review.

Sewer Tracking

The County could use sewer tracking to identify hot spots, guided by the approach demonstrated by the Camden County Municipal Utility Authority in Camden, NJ, as part of a PCB TMDL (Belton et al. 2008). The goal of that study was to develop appropriate sampling and analytical techniques for tracking down hot spots of contamination in the collection system and to identify potential sources.

Stormwater BMPs

Stormwater BMPs, specifically stormwater ponds, have the potential to accumulate PCBs over time and can have significant amounts of soil contamination. Contaminated stormwater ponds might be a source of PCBs to downstream water bodies during large storm events if sediments are washed out. An analysis of the stormwater BMPs located within the study segmentsheds can be conducted to identify the facilities with the greatest potential for PCB contamination, including those that treat public ROW, industrial, and commercial parcels.

Monitoring

Tetra Tech (2016) prepared draft documentation for the CBP Water Quality, Toxic Contaminants Workgroup that identifies four steps for the development of PCB trackdown studies to support TMDL implementation (Figure 7-5). That guidance was developed using an extensive literature review, expert interviews, and previous successful PCB trackdown efforts.

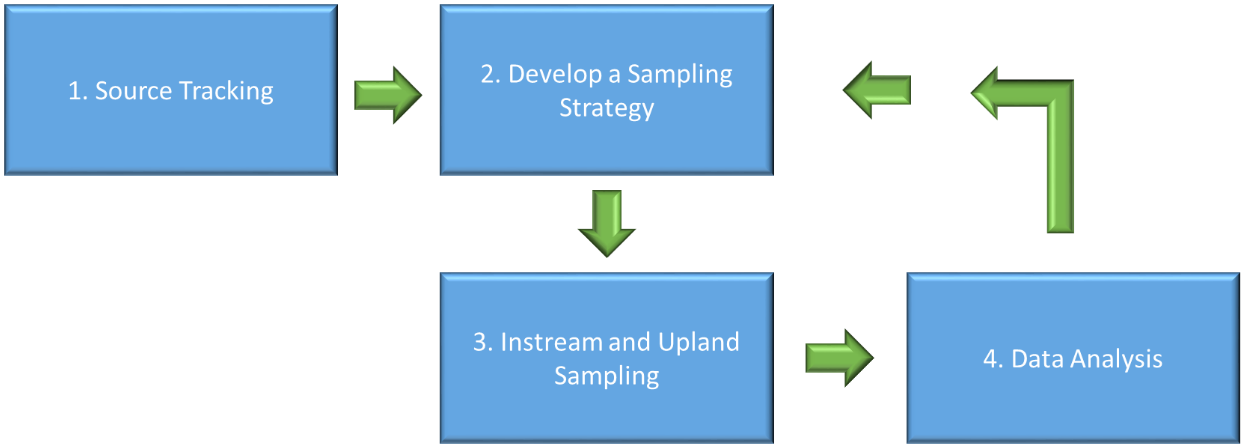


Figure 7-5. Four steps for the development of a PCB trackdown study.

Developing a monitoring plan creates a framework to systematically identify and characterize source areas and active sources of PCBs in the Patuxent River watershed in Prince George's County. MDE (2017) identified the Patuxent Wildlife Research Center as a PCB-contaminated site as part of the TMDL development. Soil concentration data were obtained from MDE Land Management Administration's contaminated site survey and investigation records (MDE 2017).

The source targeting detailed above also identified multiple locations with potential for PCB contamination. Each potential source could be classified based on its relative potential for PCB contamination with sampling prioritization determined by that ranking. For example, locations with known PCB contamination could be classified as Level 1 priority, which would include U.S. Army Fort George G. Meade and the National Security Agency, both federal facilities. Locations with unknown levels of contamination could be set at lower priority levels.

For sites that have been identified and prioritized for sampling, the County can apply best professional judgment to decide whether to monitor a site or rely on MDE for data on PCBs. Once priority BMPs or stream sediments have been identified using the records search and GIS analysis, a sampling and analysis plan will be developed. The plan will specify the sample locations, sample numbers, analytical methods, and quality control requirements. To optimize the monitoring plan, a pilot sampling strategy will be completed.

This section describes general categories of monitoring types. In addition to supporting the identification of PCB hot spots, sampling data generated during the monitoring efforts could also be used to establish regression relationships between soils/sediment PCB contamination levels and various source/site categories.

Water Column, Clam, and Fish Tissue Monitoring

MDE conducts water column, clam, and fish tissue monitoring, which can be used to identify PCB hot spots in the Patuxent River segmentsheds. The monitoring plan should prioritize PCB-impacted drainages where existing data identifies areas with PCB concentrations above background levels. This will serve to identify sites such as BMPs or streambeds where sediment removal will result in PCB load reduction that can be credited toward the TMDL. It will also serve to aid in the tracking of upstream sources.

Site Sampling

If monitoring data and other supporting analysis have identified a PCB hot spot, site sampling should be conducted. If a hot spot is identified, the County will take extra precautions not to disturb the sediment or will contain the potentially PCB-contaminated sediment on-site to prevent it from entering County water bodies. DoE will inform the DPIE of the hot spot locations. DPIE will then identify any construction permits that require sediment movement in those areas. These proactive measures will ensure that DPIE issues grading permits so that PCB-containing sediment is not disturbed during construction, thus potentially releasing PCB-laden sediment into the County's water bodies.

The following steps will be followed to identify and backtrack from hot spots to potential upland sources of PCBs.

1. If a BMP or stream contains contaminated sediments above the site-specific mitigation level, the County will investigate the drainage area to attempt to track the source of PCBs back to an active or legacy source.
2. If, through the tracking of sources upstream from a contaminated BMP or stream site, a source (legacy or active) is identified, the County will sample the source to determine its significance.

3. If the level of contamination is above the mitigation levels, the County will work with MDE, EPA, and the property owner to abate the source and remediate any contaminated material in accordance with federal, state, and local regulations.

Site-specific PCB mitigation levels will be developed for each identified area. If PCBs are found above the site mitigation level, the County will document and justify its decision on whether PCB load reduction remediation will be undertaken, as described in section 8.2.2.

Because considerable effort and funding would be required to investigate potential sites, source tracking will be targeted by prioritizing critical areas and sites within those areas.

Sampling Methods

A review of the available literature by Tetra Tech (2016) found that PCB sampling is most effectively applied in sediment and surface water media when developing a trackdown plan. A variety of PCB sampling methods is available and are listed in Table 7-8 for comparison purposes.

Table 7-8. PCB sampling methods

Method	Pros	Cons
ISCO Samplers	• Collects total PCBs (dissolved and particulate) • Most quantitative method • Used for wet or dry sampling	• High initial cost
Grab Samples	• Collects total PCBs (dissolved and particulate) • Quicker and less expensive than ISCO samplers	• More challenging to get representative samples or composites • Labor intensive
Mounted Stormwater Samplers	• Passive approach saves money compared to auto or grab sampling • Collects total PCBs (dissolved and particulate)	• Deployment can be difficult
PISCES (Passive in situ Continuous Extraction Samplers)	• Integrates results over an extended sampling period (7+ days) • Passive approach can save money compared to other methods • May provide for a more representative sample result	• Deployment can be difficult • Captures only dissolved PCBs • Less reproducible than grab samples • Sampling medium can be toxic and may require careful disposal
SPMD (Semipermeable Membrane Devices)	• Integrates results over an extended sampling • period (7+ days) • Passive approach can save money compared to other methods • Sampling medium is nontoxic • Can provide a link between sediment and pore water concentrations	• Deployment can be difficult • Captures only dissolved PCBs
ELISA (Enzyme-Linked Immunosorbent Assays)	• Rapid and inexpensive method to sample sediment • Can be applied in the field	• Higher detection limits than EPA methods • Reports only total PCBs

If the initial phase of source tracking indicates the presence of an upland source, follow-up samples will be analyzed using EPA Method 1668 per MDE guidance, which measures total PCBs on a congener (chemical constituent) basis and has the detection level necessary to identify the low concentrations associated with a diffuse source. The ability to identify a specific congener can aid in identifying an upland source because congeners can be specific to a specific use or industry.

7.6 Implementation Budgeting and Funding

7.6.1 Estimated Budgets

This section provides projected estimated budgets for the probable expenditures and staff resources that might be anticipated over the period of implementation. The costs are estimated in January 2018 values and do not account for inflation over the lifetime of this plan. Given the iterative and adaptive nature of the restoration plan and the potential for proposed activities being modified, the estimated budget should be considered preliminary for the year estimated and, in later years, should be revisited as the implementation period moves forward and new data become available.

Costs of Programmatic Initiatives

Generally, the costs of programmatic initiatives for nonstructural BMPs (e.g., public education, tree planting, and downspout disconnection) are more difficult to determine than costs for structural BMPs (e.g., ponds, stream restoration, and ESD practices). Some of the programmatic initiatives are current County practices. For instance, the ReLeaf Grant Program is one of the County's active tree planting programs with an existing budget. Costs for programs that result in structural BMP implementation such as the CWP are included in the BMP analysis; the only additional cost to the County is staff time for administering and coordinating the program as part of regular duties. Nonstructural BMPs are funded through DoE's operating budget whereas structural BMPs are funded through the Capital Improvement Program (CIP) budget.

Costs of BMP Implementation

Table 7-9 presents data on BMP unit cost per impervious acre treated and estimated cost per pound of TSS removed, including costs for continued operation and maintenance. These unit costs were previously developed in *Costs of Stormwater Management Practices in Maryland Counties* (King and Hagan 2011).[2] The costs were converted to January 2018 dollars using the RSMeans historical cost indexes (Gordian 2018).

The table lists restoration practices in increasing average annual costs over 20 years. The load reduction for each practice was estimated for treating 1 impervious acre. It was then used to calculate the cost per pound of TSS removed. Of the three types of practices listed—alternative, runoff reduction, and stormwater—runoff reduction/ESD practices are the most efficient, removing 70 percent of sediment versus 66 percent for stormwater treatment practices.

[2] The cost-estimating framework used in the report develops full life-cycle cost estimates using the sum of initial project costs (preconstruction, construction, and land costs) funded by a 20-year county bond issued at 3 percent, plus total annual and intermittent maintenance costs over 20 years. Annualized life-cycle costs are estimated as the annual bond payment required to finance the initial cost of the BMP (20-year bond at 3 percent) plus average annual routine and intermittent maintenance costs.

Table 7-9. BMP costs by application

Stormwater Restoration Practices	Type of Practice	Avg. Annual Cost/Imp. Acre over 20 years[a]	Cost / Pound TSS Removed from Treating 1 Imp. Acre[b]
Street sweeping	Alternative	$832	$0.25
Vegetated open channels	Runoff reduction	$2,107	$1.73
Wet ponds & wetlands (new)	Stormwater	$2,281	$1.99
Urban forest buffers (no land acquisition acquired)	Alternative	$3,155	$3.63
Bioswale	Runoff reduction	$3,454	$2.84
Bioretention new	Runoff reduction	$4,440	$3.65
Infiltration practices without sand	Runoff reduction	$4,456	$3.66
Wet ponds & wetlands (retrofit)	Stormwater	$4,482	$3.91
Urban stream restoration	Alternative	$4,540	$3.03
Filtering (sand above ground)	Stormwater	$4,557	$3.97
Infiltration practices with sand	Runoff reduction	$4,654	$3.83
Filtering (sand below ground)	Stormwater	$4,888	$4.26
Dry ext. detention ponds retrofit	Stormwater	$5,357	$4.67
Impervious surface reduction	Alternative	$9,043	$6.19
Urban tree planting (with land acquisition)	Alternative	$11,428	$19.88[c]
Bioretention retrofit	Runoff reduction	$11,990	$9.86
Permeable pavement without sand	Runoff reduction	$15,628	$12.85
Permeable pavement with sand	Runoff reduction	$21,875	$17.98

Source: King and Hagen 2011.
Notes:
[a] Costs inflated to January 2018 dollars.
[b] Practices assumed to treat 1 inch of runoff.
[c] Considers 1 acre of pervious land.

Outfall stabilization is not included in the King and Hagen report (2011). Consequently, because this restoration plan assumes that the outfall stabilization will be a mini-stream restoration project, the unit costs for stream restoration are used for outfall stabilization, so design and construction costs for the two types of BMP projects are similar.

7.6.2 Budget Funding

Funding refers to sources of revenue to pay for annual operating expenditures, including maintenance and administrative costs; pay for management activities directly out of current revenues; and repay debt issued to finance capital improvements projects.

Sources of Funding

The County has largely relied on stormwater bonds, general obligation bonds, federal and state grants, and the State Revolving Fund to pay for the stormwater CIP that includes watershed restoration projects. The County's Stormwater Enterprise Fund pays for debt service on the bond sales and agency operating costs.

In 2013, the County enacted a CWA Fee that provides a dedicated revenue source for addressing stormwater runoff and improving water quality for regulatory mandates such as the Chesapeake Bay WIP, TMDL restoration plans, and the NPDES MS4 permit (independent of the ad valorem tax and General Fund). The fee is based on a property's assessed impervious surface coverage and provides a mechanism to equitably allocate the fee based on a property's stormwater contribution. Thus, each property contributes a fair and equitable share toward the overall cost of improving water quality and mitigating the impact of stormwater runoff. The fee is expected to collect roughly $14 million of dedicated funding annually. Depending on the rate of restoration activities completed by the CWP and County CIP efforts, the County might reevaluate funding options in the future.

Besides funds from the CWA Fee, stormwater ad valorem tax, and CIP budget, federal, state, or other grants are expected to provide a minor, but essential, contribution to funding. The County has successfully obtained various grants in the past and expects that trend to continue. The County will continue to pursue grant opportunities available for restoration projects. In addition to grants, federal and state loans (e.g., State Revolving Fund) might be an option for helping to fund part of the TMDL restoration process. In addition, the County encourages government entities (e.g., municipalities) and private organizations (e.g., watershed groups and nonprofits) to identify and apply for grant opportunities.

The County expects current Stormwater Enterprise Fund sources and funding levels to remain consistent with the County's by annual Financial Assurance Plan (FAP), expected to reoccur over the life of this restoration plan. The countywide dollars for restoration average no more than $70 million per year for all stormwater restoration. The available funding will need to compete across multiple local restoration plans, including the Chesapeake Bay WIP; however, many of the activities in the WIP can be counted toward local restoration plans. As part of its NDPES permit requirements, the County updates and submits its 2-year Financial Assurance Plan (FAP) to MDE for review. The FAP includes planned restoration projects of 5-year periods and the funding commitment for the next 2 fiscal years. The most recent plan approved by County Resolution is for FY 2019 and FY 2020.

Budget for Restoration Activities

The stormwater CIP contains project construction budget projections for the next 6 years. For countywide watershed or water quality restoration projects, the County primarily relies on two CIP projects: the CWP Project and NPDES MS4 Permit Compliance & Restoration. Other stormwater CIP projects include funding appropriation for restoration activities.

The County's stormwater CIP budget has in the past appropriated up to $100 million per year for countywide watershed or water quality restoration activities. For current funding capacities, the County typically prioritizes programs and shifts funding between watersheds. By doing so, the County can prioritize and shift year-to-year load reduction goals between watersheds; however, the County aims to achieve the targeted completion dates.

Table 7-10 provides a list of countywide stormwater CIP projects that include aspects of watershed restoration. The projects generally fund new watershed restoration activities or rehabilitation of existing assets to improve water quality. Specific watershed restoration projects or locations are not listed. However, the County maintains a project list that is used to determine the proposed funding. Once this restoration plan is completed, the County will start incorporating proposed restoration scenarios, subject to funding availability.

The County's stormwater CIP budget has in the past appropriated up to $100 million per year for countywide watershed or water quality restoration activities. For current funding capacities, the County typically prioritizes programs and shifts funding between watersheds. By doing so, the County can prioritize and shift year-to-year load reduction goals between watersheds; however, the County aims to achieve the targeted completion dates.

Table 7-10. Proposed 2020–2025 CIP budget for stormwater management

CIP ID	Project Name	Project Class
DV 542015	Bear Branch Subwatershed	Rehabilitation
DV 546001	Clean Water Partnership NPDES	Rehabilitation
DV 541685	COE County Restoration (Anacostia River Watershed)	New construction
DV 542105	MS4/NDPES Compliance & Restoration	Rehabilitation
DV 540465	Participation Program	New construction
DV 664285	Stormwater Management Restoration	Rehabilitation

Aerial and ground-level view of bioretention facility collecting runoff from parking lot at County office building in Largo.

8 Restoration Activities

The County has constructed BMPs throughout the County, including in the PAXTF, PAXOH, and PAXMH segmentsheds, although only the PAXTF segmentshed requires PCB load reductions. Existing and planned BMPs will meet only 19.8 percent of the PCB target goal in the PAXTF segmentshed.

This section describes the County's proposed changes intended to strengthen the implementation process it uses to improve water quality and meet the goals and objectives of this restoration plan. It includes specific planned actions, cost estimates, and a proposed schedule and describes the financial and technical resources available to support and implement the plan. This section also describes how the County will involve the public throughout the plan's implementation, including keeping residents informed and encouraging them to participate directly in the implementation actions. The restoration plan creates the overall blueprint for restoration activities in the PAXTF segmentshed.

8.1 Proposed Management Approach

BMP types and locations are not explicitly specified, giving the County flexibility to identify specific locations for and to work with partners on implementing BMPs (e.g., to install BMPs on institutional land). The County also will have the flexibility to select suitable ESD practices based on costs, land availability, feasibility, pollutant removal efficiencies, and other factors. Figure 8-1 presents conceptual art of an urban area with a variety of practices. It includes some practices not specifically mentioned in the plan, but that could be incorporated into the County's overall strategy.

Credit: EPA OWOW.

Figure 8-1. Conceptual urban area with ESD practices.

8.2 Estimated Restoration Load Reductions

This section presents the resultant final load reductions (from proposed programmatic initiatives and BMP implementation). Load reductions from existing BMPs are presented in section 5. Calculations to determine the load reductions from BMPs and programmatic initiatives were added to the assessment used to determine the implementation load reduction goals (see section 6). This load reduction analysis was performed using the steps presented in section 7.1. After each step, the estimated load reductions were compared to implementation load reduction goals to determine the remaining load reduction gap. These steps were followed and repeated until the implementation load reduction goal was met by the estimated load reductions:

1. Account for load reductions from current BMPs and their impervious drainage area and subtract them from the necessary load reduction and available impervious area, respectively.
2. Subtract the load reductions from existing programmatic initiatives from the necessary load reductions.
3. Subtract the load reductions from recommended programmatic initiatives from the necessary load reductions.
4. Subtract the load reduction from planned BMPs from the necessary load reductions.
5. Subtract proposed BMPs and their associated load reductions and impervious area treated from the necessary load reductions.

8.2.1 Programmatic Initiatives

The County's existing programmatic practices (section 5.1) are expected to remain in place and will be supplemented with additional practices discussed in this section to make up the programmatic strategies for this restoration plan.

Estimating potential load reductions resulting from programmatic initiatives is challenging since some of the initiatives require public participation and changes in long-standing behaviors. Therefore, several assumptions must be made. The County has accounted for the need to reevaluate the estimated load reductions in the future in its adaptive management approach (section 11.3).

Some of the existing and new programmatic initiatives will result in BMPs being installed. The acreage that will be treated through those programs has not yet been estimated. BMPs installed as those programs are implemented will be credited towards the identified load reduction targets and load reduction gap discussed in section 6. These BMP-related programs include the following:

- SWM Program
- CWP Program
- Rain Check Rebate and Grant Program
- Alternative Compliance Program
- Countywide Green/Complete Streets Program
- Street Sweeping
- Storm Drain Maintenance

- Tree ReLeaf Grant Program
- Volunteer Tree Planting
- Master Gardeners Program
- Flood Management

Estimating the load reduction capabilities of some programmatic activities is impossible (e.g., storm drain stenciling or litter control). Although the cumulative effects of those activities will help reduce loads entering local water bodies in different ways, thus improving their health, their impacts cannot be calculated and are not included as part of this restoration plan. Those activities do, however, form an important part of this plan. Most of them serve to educate the public on how they can help improve water quality. The improvements in water quality resulting from the activities will be reflected through adaptive management, through which the County will assess cumulative improvements in the water quality and health of water bodies under the restoration plan.

8.2.2 Structural BMPs

This section assesses different treatment options, including stream restoration and outfall stabilization. It also explores tree planting, new wet ponds, and ESD practices (e.g., grass swales and bioretention systems) that treat stormwater runoff from both pervious and impervious land. The combination of pervious and impervious land is used in calculating the load reduction potential of new wet ponds and ESD practices. ESD practices are typically smaller and treat smaller areas than wet ponds. Wet ponds are typically regional facilities that remove sediments and other pollutants by treating runoff from large drainage areas. For costing, only the impervious area is assessed because the available cost data are provided per impervious acre.

The County could use many different combinations of BMPs to meet the load reductions for the PCB TMDL. Cost and lack of available space for implementation, however, would make many of them unfeasible. The results of a cost analysis of various combinations would assist the County in selecting BMPs that could work together most effectively to meet the load reduction targets at the lowest cost.

The Microsoft Excel Solver Add-in was used to determine the most cost-effective scenarios to meet the load reductions for this restoration plan. Solver processes a set of conditions to meet the County's objective: the lowest cost. The main condition was meeting the load reduction in every scenario. Other conditions set a range of implementation for ESD practices, outfall stabilization, stream restoration, tree planting, and new wet ponds. For example, one scenario limited ESD practices to treat runoff from 1 to 150 ac of land. Solver then determined the best value in that range for that scenario.

The overall costs for 16 scenarios ranged from $743 million to $824 million, with a median of $782 million. The median scenario (shown in Table 8-1) was selected for the restoration plan to provide the County with several options. The scenario that has been selected for presentation with this plan serves as a starting point for the County to make future decisions. The actual combination of BMPs implemented to meet the TMDL can change over time as adaptive management principles are applied to this plan. Table 8-2 presents a comparison of the eight most cost-effective scenarios.

Table 8-1. Results of cost optimization—median scenario (scenario 8)

Variable	PAXTF	Constraints
Stream restoration (linear feet)	53,340	50%–100% of SCA known issues (section 4.2)
Outfall stabilization (outfalls)	55	50%–100% of SCA known issues (section 4.2)
Tree planting (acres planted)	10	5–10 ac
New wet ponds (acres treated)	5,114 total; 1,892 imp.	1–6,000 ac
ESD practices (acres treated)	6,000 total; 3,420 imp.	1–6,000 ac
Cost ($M)	$782	Lowest cost

Table 8-2. Comparison of top eight most cost-effective scenarios for PAXTF

Practice	Top 8 Low-Cost Scenarios							
	8	7	6	5	4	3	2	1
Total cost ($M)	$782.0	$780.4	$780.4	$775.6	$775.6	$759.6	$756.2	$743.4
Stream restoration (linear feet)	53,340	53,340	53,340	53,340	53,340	53,340	53,340	53,340
Outfall stabilization (outfalls)	55	44	44	11	11	55	11	33
Tree planting (acres planted)	10	10	10	10	10	10	10	10
New wet ponds (acres treated)	5,114	5,137	5,137	5,207	5,207	5,616	5,642	5,955
ESD practices (acres treated)	6,000	6,000	6,000	6,000	6,000	5,684	5,726	5,500

8.3 Technical Assistance

Overall success of the restoration plan will depend on the concerted effort of the County and many regional agencies, municipalities, community leaders, and local landowners. Each watershed partner (e.g., federal, state, or local government; nonprofit; business owner; or private landowner) has an important role to play in the restoration process. The proposed management actions will require significant time and resources from all those entities. Technical assistance and other in-kind support from the watershed partners and the public will be important in implementing the plan. That support will be especially important in addressing impediments to implementing the plan that include permitting challenges, technological limitations, and lack of available BMP and ESD sites. In addition, new BMP technologies are being researched that will help lower costs, decrease BMP footprint, and increase removal efficiencies. MDE and the CBP will need to approve the technologies and assign them removal efficiencies in a timely manner. In addition to having new BMP technologies approved, the County looks to MDE to continue issuing grants for stormwater restoration activities and to help in performing water quality monitoring in high-priority watersheds in the County.

Many sites that are suitable for BMP implementation are not owned by the County. The County will seek partnerships with other organizations (e.g., nonprofit organizations and businesses) to gain access to private lands and be able to conduct restoration activities on them. For example, a shopping center owner could partner with the County to gain assistance with installing BMPs ranging from technical assistance to partnering to install a BMP that treats the shopping center parking area and the County ROW. Without forming partnerships and being granted access to private land, the County will be able to install BMPs only on property to which it has direct access such as ROWs or County government-owned land.

Recently completed stream restoration project. Rocks were used to stabilize the banks and fresh vegetation was planted along both banks.

9 Proposed Restoration Plan Estimates

9.1 Load Reductions

Table 9-1 restates the load calculations from earlier in the document along with new reductions for the different restoration activities relevant to this plan (BMPs and programmatic initiatives). The most significant reductions will be obtained through ESD practices in the PAXTF segmentshed.

Table 9-1. tPCB load reductions in the PAXTF segmentshed in Prince George's County

Measure or Practice	tPCB (mg/yr)	tPCB (g/yr)	% of Target
Baseline load (2010)	21,091	21.1	100.1%
Target load (2025)	14	0.0	0.1%
Required load reduction	***21,078***	***21.1***	***100.0%***
Load reduction to date (2010-2018)	1,939	1.9	9.2%
Current load (BMPs installed 2010-2018)	19,152	19.2	90.9%
Current load reduction gap (2018)	19,138	19.1	90.8%
Load removed from BMPs in planning / design	2,242	2.2	10.6%
Initial load reduction gap	***16,897***	***16.9***	***80.2%***
Restoration Plan			
Stream restoration / outfall stabilization	1,329.9	1.3	6.3%
Tree planting	20.2	0.0	0.1%
New wet ponds	5,429	5.4	25.8%
ESD practices	10,117	10.1	48.0%
Total restoration plan	***16,897***	***16.9***	*80.2%*
Total Restoration Activities			
Current BMPs, planned BMPs, and restoration plan BMPs	***21,078***	***21.1***	***100.0%***

Notes: mg/yr = milligrams per year; g/yr = grams per year.

9.2 Restoration Budget

The planning level costs per restoration activity are shown in Table 9-2, along with the estimated load reductions and cost per pound of sediment reduced. The overall cost for this plan is $782 million. The BMP unit costs from Table 7-9 were used to determine the budget. Because this plan does not specify exact ESD types, the average of the ESD practices was used to determine the budget for the ESD practices in Table 9-2. The most cost-effective strategy is creating new wet ponds, while tree planting is the least effective, partially due to the land costs associated with planting. If trees are planted on existing properties without land having to be acquired, the cost-effectiveness of this practice will increase and the overall restoration cost will go down.

Table 9-2. Total BMP implementation and programmatic initiatives cost and load reductions in PAXTF segmentshed by restoration strategy (in 2018 dollars)

Practice	tPCB (mg/yr)	Budget	$/mg
Stream restoration / outfall stabilization	1,330	$106,864,491	$80,353
Tree planting	20	$2,285,679	$113,261
New wet ponds	5,429	$86,325,059	$15,899
ESD practices	10,117	$586,559,501	$57,977
Total restoration plan	16,897	$782,034,729	$46,284

Note: $/mg = dollars per milligram; mg/yr = milligrams per year.

9.3 Implementation Schedule

This section provides the planning level implementation schedule for the BMP and programmatic strategy necessary to meet TMDL compliance milestones. There is no mandated end date to the local TMDL restoration plans; however, the County understands the public prefers an expedited restoration process and shares that sense of urgency. However, new BMPs with better efficiencies could be lacking and adequate site opportunities could be limited for restoration activities. Nonetheless, the County and its watershed partners are committed to finding site opportunities and expediting the planning, design, and construction phases for management activity to the maximum extent practicable.

Implementing the restoration activities in the proposed schedule will depend largely on future available funding and program capacity. The County has additional local TMDL restoration plans in the Anacostia River, Piscataway Creek, Mattawoman Creek, Rocky Gorge Reservoir, Patuxent River (Upper, Middle, and Lower), and other PCB-impacted watersheds and will need to allocate available funding and resources across those priority watersheds.

DoE estimates that it can retrofit an average of 2 percent of its untreated impervious area a year (as per next NPDES permit conditions). This estimate is backed up by MDE in its draft Phase III Chesapeake Bay WIP (MDE 2019b). Using that implementation average as a guide, we can determine the length of time needed to fully implement this restoration plan. There are 6,935 ac of untreated impervious area in the PAXTF segmentshed. Based on the impervious area to be treated in Table 8-1, full restoration in the PAXTF segmentshed will take 38 years.

Factoring in the implementation of the competing priority restoration plans, source identification, available BMP technologies, and ease of implementation, this restoration plan will probably be fully implemented by FY 2059, including treating the identified impervious acres with BMPs and all programmatic activities. Because the County already has a FY 2020 budget and project list, work toward this restoration plan could start as early as FY 2021 or 2022 once funds are allocated and implementation site selection has begun.

Table 9-3 presents the estimated average annual number of impervious acres to be treated in PAXTF and the estimated load reductions by year from BMP implementation in the segmentshed. There will be slight fluctuations in the annual load reductions due to the types of BMPs used and the land uses they treat, but the County will aim to meet or exceed the annual goals. Table 9-4 presents the overall target milestone timeline for this restoration effort. This schedule will be continuously monitored by the County to assess ways to increase the rate of implementation and to ensure practices are implemented as planned.

Table 9-3. Proposed average annual number of impervious area (acres) in PAXTF and load reductions goals/milestones

Fiscal Year	Impervious Acres Treated	tPCB (mg/year)	Estimated Budget
2021	138.7	1,408	$20,419,564
2022	277.4	2,816	$40,839,128
2023	416.1	4,224	$61,258,692
2024	554.8	5,632	$81,678,256
2025	693.5	7,040	$102,097,819
2026	832.2	8,448	$122,517,383
2027	970.9	9,856	$142,936,947
2028	1,109.6	11,264	$163,356,511
2029	1,248.3	12,672	$183,776,075
2030	1,387.0	14,080	$204,195,639
2031	1,525.7	15,489	$224,615,203
2032	1,664.4	16,897	$245,034,767
2033	1,803.1	18,305	$265,454,331
2034	1,941.8	19,713	$285,873,895
2035	2,080.5	21,121	$306,293,458
2036	2,219.2	22,529	$326,713,022
2037	2,357.9	23,937	$347,132,586
2038	2,496.6	25,345	$367,552,150
2039	2,635.3	26,753	$387,971,714
2040	2,774.0	28,161	$408,391,278
2041	2,912.7	29,569	$428,810,842
2042	3,051.4	30,977	$449,230,406
2043	3,190.1	32,385	$469,649,970
2044	3,328.8	33,793	$490,069,533
2045	3,467.5	35,201	$510,489,097
2046	3,606.2	36,609	$530,908,661
2047	3,744.9	38,017	$551,328,225
2048	3,883.6	39,425	$571,747,789
2049	4,022.3	40,833	$592,167,353
2050	4,161.1	42,241	$612,586,917
2051	4,299.8	43,650	$633,006,481
2052	4,438.5	45,058	$653,426,045
2053	4,577.2	46,466	$673,845,609

Fiscal Year	Impervious Acres Treated	tPCB (mg/year)	Estimated Budget
2054	4,715.9	47,874	$694,265,172
2055	4,854.6	49,282	$714,684,736
2056	4,993.3	50,690	$735,104,300
2057	5,132.0	52,098	$755,523,864
2058	5,270.7	53,506	$775,943,428
2059	5,312.0	53,926	$782,034,729

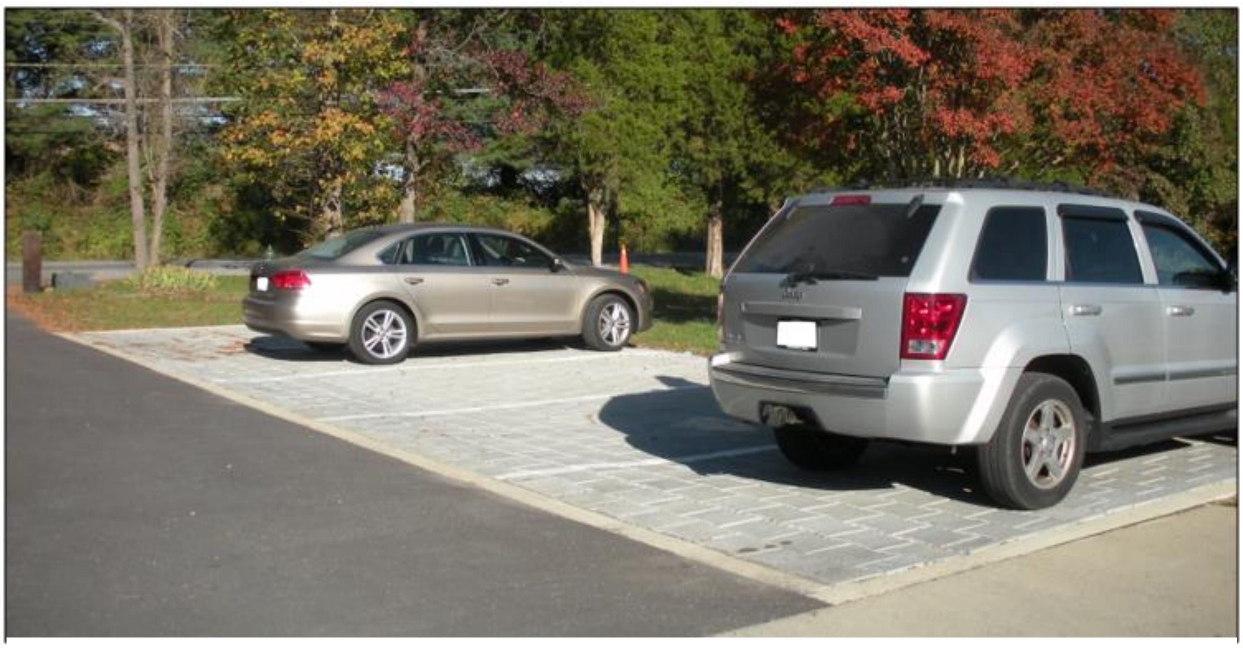
Table 9-4. Countywide target timeline for local TMDL restoration plans

Target	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031	…	FY2058	FY2059
Public Outreach														
Public outreach	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Measure progress/reevaluate public outreach campaigns		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BMP Implementation														
BMP planning and design	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BMP implementation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NPDES MS4 Permit														
5th generation	✓	✓	✓	✓										
Future Permits	□	□	□	□	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Monitoring														
Countywide biological monitoring.	✓	✓		✓	✓	✓		✓	✓	✓		✓[a]	✓	✓
Representative watershed monitoring (could be in another watershed)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tracking and Reporting														
Update MS4 geodatabase with BMP, programmatic, and monitoring info.	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
MS4 Annual Report	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Adaptive Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note:
[a] Countywide biological monitoring occurs in a 3-year cycle, with one-year break in-between each cycle.

Restoration activities on the scale of this plan are difficult to estimate to the exact acres treated per year. Restoration plans are planning guides for the estimated level of effort that could be needed to meet reduction goals. The number of impervious acres to be treated every year will vary depending on funding, program capacity, and availability of sites. It is always the County's goal to exceed those estimates to speed up the restoration process. The County realizes that some efforts might be more successful than others and reserves the right to prioritize specific watersheds with higher load reduction requirements. For that reason, this restoration plan offers an adaptive management component to ensure issues are identified and addressed early. The County expects to reevaluate this plan every 5 years based on program capacity, funding, priority watersheds, staffing, and industry resources.

The FY 2059 projected end date was developed using estimates of the number of acres of impervious area that could be treated each year. During that period, the County will be implementing several other watershed restoration plans, creating competing priorities that could limit the pace at which restoration is accomplished in the PAXTF segmentshed. Faster implementation would require additional funding, staffing, and industry resources (e.g., bioretention soils, plants) sooner. The County is working through its watershed protection restoration program to increase TMDL reduction rates. The County continues to research and evaluate innovative practices to help increase BMP efficiencies while lowering costs. Additional staff at the local level and close coordination with the State would be needed to review and approve BMP plans and permits in a timely manner so as not to slow implementation. Between now and FY 2059, implementation uncertainties could emerge requiring that adjustments be made to the plan.



Permeable pavement is one way to treat runoff from impervious parking lots.

10 Public Outreach and Involvement

The County recognizes the importance to the success of its stormwater management efforts of involving the public in planning and implementing the restoration process. It welcomes any ideas citizens have to improve the process, recognizing that the people who live and work in the watersheds are most familiar with them. They can act as the eyes and ears of the County on a day-to-day basis to identify water quality issues, pollutant spills, or potential BMP opportunities. Residents can stay informed on the County's progress through the annual MS4 report to MDE, which is posted on the County's website and contains information on BMP implementation, public outreach events, and other County programs that can help meet TMDL goals. In addition, the County welcomes public input on restoration activities and potential BMP types or locations.

Besides staying informed, homeowners, nonprofit organizations, and business associations can play a more active role in the restoration process. Residents can take a pledge to clean up after their pets and practice environmentally friendly lawn care. In addition, the public can participate in the Rain Check Rebate and Grant Program and nonprofits can participate in the Alternative Compliance Program. Private landowners and nonprofit organizations can aid in restoring the watersheds by installing BMPs (e.g., rain barrels, rain gardens, and permeable pavement) on their properties to help minimize their impact on the overall pollution loading to the County's water bodies. Installing BMPs on private property reduces the owner's CWA Fee. Although those practices might seem insignificant, the overall load reductions can be significant if enough private landowners get involved. Organizations such as HOAs, neighborhood associations, and business organizations can also help by promoting the programmatic initiatives outlined in this restoration plan.

DoE has initiated a wide range of initiatives to inform County residents about the impacts their daily activities have on the health of their watershed and local water bodies. During FY 2018, the County hosted more than 500 events to promote environmental awareness, green initiatives, and community involvement in reducing the amount of pollution entering the County's waterways. More than 28,000 members of the public participated. DoE's outreach and educational programs also encourage volunteerism and environmental stewardship among community organizations, businesses, and citizens. Under DoE's Sustainability Division, the Community Outreach Promoting Empowerment (COPE) Section is the lead office managing and administering most of the education and outreach initiatives described in this section.

Current outreach programs are discussed in section 5.1. Beyond those targeted efforts, the County will work with watershed partners to ensure the public is informed of implementation progress and that active public involvement is pursued throughout the process.

10.1 Outreach to Support Implementation Activities

The County's outreach efforts continue to specifically target TMDL pollutants and pollutant-generating behaviors. Over the past several years, COPE has sponsored the following activities and projects to target TMDL pollutants and encourage the adoption of pollutant-reducing behaviors:

- ***Inventory of Environmental Outreach Programs in and around Prince George's County***. COPE inventoried existing local programs (e.g., nonprofits and educational) working toward shared goals of environmental stewardship or stormwater pollution reduction and that already have ongoing or planned outreach efforts in and around the County. This was done to identify potential outside partners and overlapping programs/efforts. COPE researched which types of programs and materials have been successful and are available to share and cross-market to target audiences.
- ***Audience Research Analysis: A Review of Target Audience Characteristics in Prince George's County for a Stormwater Outreach Strategy***. The County is made up of a diverse population in terms of age, race, culture, language, education, and income. As a result, COPE analyzed U.S. Census data and secondary research to gain an understanding of the potential target audiences and their specific characteristics as well as possible barriers to environmental messages (e.g., lack of homeownership, native language, age, and household economics). This analysis helped determine the best way to reach diverse groups and identify different messaging and methods that would resonate with target audiences.
- ***Priority Watersheds Analysis***. The County has nine major watersheds, each with different water quality concerns. COPE identified location-specific outreach needs based on water quality priorities and areas where the County should target its outreach efforts. Coupled with the Audience Research Analysis, this analysis recommended target locations and audiences for developing topic-specific outreach campaigns (e.g., pet waste and lawn care).
- ***Prince George's County Stormwater Outreach and Engagement Strategies***. COPE developed seven individual campaign strategies: pet waste disposal, increasing the tree canopy, stormwater management and implementation, antilittering, lawn stewardship, household hazardous waste, and residential car care. Each campaign included goals, target audiences, priority locations, key messages, delivery techniques (e.g., events, materials, trainings, social media, and developing and promoting programs), metrics, potential partnerships, and priority neighborhoods. The campaigns also included slogans and messages on what citizens should be doing (e.g., using fertilizer only if soil tests dictate a need) and not be doing (e.g., spilling fertilizer on driveways). COPE is using these outreach and engagement strategies to plan and implement programs, events, and other efforts to encourage residents to adopt pollutant-reducing behaviors.
- ***Enhancing and Growing Partnerships***. The County's numerous partnerships with groups such as Master Gardeners, CBT, and the University of Maryland Environmental Finance Center (EFC) continue to be fostered and supported so that outreach efforts piggybacking on the efforts undertaken by those groups can continue to grow. In addition, new partnerships with groups such as landscapers, nursery suppliers, HOAs, and local boy scout or girl scout groups help broaden stormwater outreach and reach citizens who have not been reached in the past.

Although results of outreach and involvement efforts are difficult to quantify in terms of pollutant reductions, these activities make a difference by slowly changing the mindsets and behaviors of County residents over time.

10.2 Public Involvement to Support Implementation Activities

Community organizations and citizens groups can participate in restoration activities by getting involved in local nonprofit groups with which the County is currently partnering. This section lists ways County residents and organizations can stay informed and help promote pollutant-reducing behaviors. These activities will also reduce the demand on the County's resources and staff's limited time.

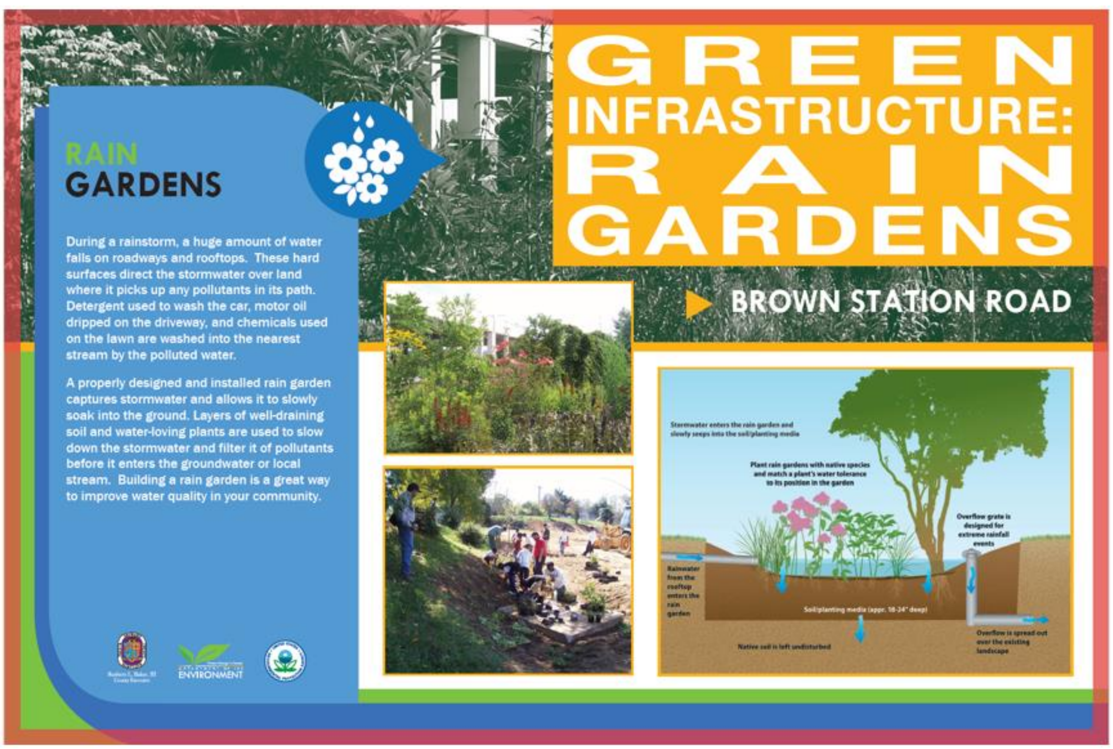
- **Learn about County programs that promote tree plantings, cleanup events, and community awareness**. COPE manages numerous programs in which citizens can get involved and promote pollutant-reducing behaviors. Residents can either organize or participate in volunteer efforts by working with their civic associations or schools, or one-on-one with property owners. The public can visit the Community Outreach web page at https://www.princegeorgescountymd.gov/351/Community-Outreach for more information on COPE programs and how to contact the County. See section 5.1.2 for details about the County's tree planting and landscape revitalization programs. Other volunteer programs included the following:
  - **Volunteer Neighborhood Cleanup Program**, which provides interested communities with technical assistance and materials such as trash bags, gloves, and roll-off containers (depending on availability). The public can visit the website at https://www.princegeorgescountymd.gov/464/Volunteer-Neighborhood-Cleanup-Program.
  - **Volunteer Storm Drain Stenciling Program**, which helps spread the word to prevent water pollution by stenciling/inlet marking the storm drains in neighborhoods with "Don't Dump - Chesapeake Bay Drainage." Stenciling serves as a visual reminder to neighbors that anything dumped in the storm drain contaminates the Chesapeake Bay. COPE provides the supplies and helps design a storm drain stenciling/inlet marking project that can be accomplished with any size team or age group at https://www.princegeorgescountymd.gov/465/Volunteer-Storm-Drain-Stenciling-Program.
- **Apply for grants to implement projects through the Chesapeake Bay Trust (CBT)**, which manages the Rain Check Rebate and Stormwater Stewardship programs as well as the Litter Reduction and Citizen Engagement Mini Grant. See section 5.1.1 for details on the Rain Check Rebate and Stormwater Stewardship programs. The public can find more information about the CBT grants at https://cbtrust.org/grants/.
  - **Litter Reduction and Citizen Engagement Mini Grants** support efforts that engage and educate residents, students, and businesses on ways to make their communities cleaner and greener. Up to $2,500 can be awarded to HOAs and nonprofits to develop and implement projects such as community cleanups, "Adopt-a-Stream" projects to remove litter from a local stream, and storm drain stenciling.
- **Stay informed**. The County provides numerous ways for residents to stay informed about community events, trainings, emergencies, and County news:
  - **Monitor the County's social media accounts** to become aware of trainings and community events that promote environmental education and include opportunities to provide feedback to the County. See the County's accounts at Facebook (PGC

Department of the Environment), Twitter (PGC Environment @PGCsprout), and Instagram (pgcsprout).

  - **Monitor the County's website** to view information about upcoming events, meetings, recent news, and details about the County's programs at https://www.princegeorgescountymd.gov/.
  - **Sign up to receive "Alert Prince George's"** to receive emergency alerts, notifications, and updates to registered devices. Example notifications include traffic conditions, government closures, public safety incidents, and severe weather. More information is available at http://www.princegeorgescountymd.gov/794/Alert-Prince-Georges.
  - **View the Clean Water Map,** an interactive tool to help the community stay informed about the health of County waters and know where restoration efforts are taking place. Residents can view BMPs, BMP drainage areas, and locations of activities such as Rain Check Rebates and Stormwater Stewardship Grants at https://princegeorges.maps.arcgis.com/apps/webappviewer/index.html?id=dc168a43d3554905b4e4d6e61799025f.

- **Provide feedback**. The County heard through numerous outreach and engagement events that several citizens and watershed groups want to provide information and feedback about on-the-ground support for BMP implementation projects, programmatic initiatives, and other outreach efforts to support implementation. Ways to provide this feedback include the following:
  - **Attend a public involvement meeting.** The County holds public outreach and involvement meetings as part of restoration planning efforts and other programs. At these meetings, residents can suggest specific locations for biological or water quality monitoring activities to be carried out based on surrounding land uses/ changes, historic water quality problems, or public desires. The County also welcomes suggestions on potential BMP types or locations so that the County can help communities identify and install the best BMPs for specific areas.
  - **Use County Click 3-1-1**, a call center (available weekdays 7 a.m. to 7 p.m.) and a website application (download CountyClick311Mobile) that allows County residents to request services or report problems. This tool could be used to report on visual inspections of installed BMPs and is available at www.countyclick311.com.
- **Help foster partnerships.** Residents and civic and environmental groups can work directly with an organization or commercial business that has a significant amount of untreated impervious surface such as large parking lots or a large building footprint. The groups can help obtain a commitment from the business to participate in the Rain Check Rebate Program or Alternative Compliance Program, or install stormwater BMPs on the property. Group members can offer technical assistance and volunteer labor hours to support installation and/or maintenance. The participating civic or environmental group should discuss the selected location and BMP type with the County prior to working with the property owner. Groups can also work with established organizations such as the Alice Ferguson Foundation to participate in cleanup events or provide volunteer hours.

- **Become educated through partner trainings and events**. Numerous organizations in Prince George's County are always in need of volunteers. They also provide meaningful education programs in which participants learn about the issues through hands-on educational experiences. Those organizations include the following:
  - **Watershed Stewards Academy** equips and supports community leaders to recognize and address local pollution problems in their nearby streams and rivers. They provide community leaders with the tools and resources they need to bring solutions to those problems, restoring their local waterways and the communities they affect. More information is available at http://extension.umd.edu/watershed/watershed-stewards-academy.
  - **Alice Ferguson Foundation** has training and outreach events to unite students, educators, park rangers, communities, regional organizations, and government agencies throughout the Washington, DC, metropolitan area to promote the environmental sustainability of the Potomac River watershed. More information is available at https://fergusonfoundation.org/.
  - **Anacostia Watershed Society** has numerous educational programs, river restoration programs, and community events. More information is available at https://www.anacostiaws.org/.



11 TRACKING AND ADAPTIVE MANAGEMENT

The County is required by its MS4 permit to:

> …[e]valuate and track the implementation of restoration plans through monitoring or modeling to document the progress toward meeting established benchmarks, deadlines, and stormwater WLAs.

The County will fulfill this requirement by producing its annual MS4 report and undertaking additional environmental monitoring. The County intends not only to track its implementation of this restoration plan but also to evaluate how well its efforts improve conditions in the County's surface waters and adjust its restoration activities accordingly. The County will use the data from tracking and monitoring efforts to inform its adaptive management of this restoration plan.

11.1 Implementation Tracking

To assess reasonable compliance with its permit, the County has an effective process in place to track and report pollutant load reductions. The County's annual MS4 report is the main mechanism for tracking permit activities and reporting them to MDE. While DoE is responsible for its submittal, it is a collaborative effort between DPW&T and DPIE. The completed annual report and appendices are posted on DoE's stormwater management website.[3]

As specified in the County's permit, the annual report includes information about the County's BMP implementation, IDDE, trash and litter control measures, public outreach and education initiatives, watershed assessments, and funding. It is the chief vehicle for tracking and reporting BMP implementation and programmatic initiatives. The annual report provides the following information:

- Estimated pollutant load reductions resulting from all completed structural and nonstructural water quality improvement projects and enhanced stormwater management programs.
- Comparison of achieved load reductions to required load reductions to determine the degree to which the County is meeting its restoration goals or needs to adjust its programs to be more effective.

The annual report is accompanied by supplemental data about BMPs (including alternative practices such as stream restoration, septic system upgrades, and tree planning), funding, and water quality. Data about all the County's stormwater BMPs are provided in a georeferenced database. For each BMP, the database provides descriptive details, including BMP type, project location, drainage area delineation, and equivalent acres of impervious surface treated. County staff update the database as new projects are completed and approved.

11.2 Biological and Water Quality Monitoring

The purpose of monitoring conditions in the watershed is to determine the degree to which implementation of the restoration plan is resulting in the intended improvements. DoE recognizes that effective environmental monitoring requires a long-term commitment to routine

[3] https://www.princegeorgescountymd.gov/293/NPDES-MS4-Permit. Accessed April 2019.

and consistent sampling, measurement, analysis, and reporting. Although some of the monitoring requirements for assessing progress toward meeting TMDLs originate with MDE, others reflect the County's own interest in providing additional meaningful information to policymakers and the public.

Biological indicators will continue to be used to document and report ecological conditions in the PAXTF, PAXOH, and PAXMH segmentsheds. Other types of monitoring will contribute to understanding whether restoration activities are leading to the elimination, reduction, or otherwise more effective management of pollutants within the County. To ensure that the compiled datasets are of known and acceptable quality, monitoring is performed in accordance with a quality plan with standard operating procedures and performance standards for sample collection.

11.2.1 Biological Monitoring

The biological condition of the County's streams is rated using MD DNR's B-IBI, which is calculated based on the number of different kinds of organisms (benthic macroinvertebrates) found in samples taken along a stream section, or reach. Because the types of organisms found reflect the cumulative influence of a variety of environmental factors, a low B-IBI value alone is unlikely to point definitively to a singular pollutant or other stressor that should be reduced to improve the condition of the stream. Rather, the usefulness of the B-IBI in the context of a stream restoration effort is that a sufficiently long record of B-IBI values can be expected to reveal the overall effect of a broad restoration program aimed at eliminating, reducing, or otherwise managing known and potentially unknown stressors and their sources.

Since 1999, the County has been continuously implementing biological monitoring and assessment. Sampling at each stream location focuses on the benthic macroinvertebrate populations, physical habitat quality, and *in situ* water quality (pH, conductivity, temperature, and DO). Site locations were selected for each round using a stratified random process, where all wadeable, nontidal streams were stratified by subwatershed and stream order. Stream order designations (generally, first through fourth order) were based on the Strahler system of 1:100,000 map scale (Strahler 1957). Distribution of sample locations was more heavily weighted to smaller first- and second-order streams. The County is currently implementing the first year of Round 4 (R4), which will span from 2019 to 2021. For each subwatershed, the County will obtain a value for percent biological degradation from R3, noting the intensity of impairment and any known or most probable sources of pollution or other stressors. It will then compare the percent degradation with the values found in R4 to determine the direction and magnitude of changes.

The County will focus its efforts on areas of BMP implementation by the CWP. Additional and more detailed analyses of conditions and data in individual subwatersheds can help associate stream biological health with implementation of BMPs (and programmatic initiatives) so the County can adjust its restoration strategy, if needed, as part of its vision for overall adaptive management.

The approach presented in this plan assumes continuation of routine, countywide monitoring of biological conditions for wadeable streams in R4 and beyond, with potentially additional effort being applied to data analyses related to physical habitat characteristics, altered hydrology, and water chemistry. This not only provides insight into those stressors most likely causing biological degradation, but also aids in identifying sources of stressors where additional restoration efforts would be beneficial.

The stepwise progression presented in this section can be applied to any watershed in the County. The evaluation of changes in biological health is focused on the County's framework of subwatersheds, although for assessments it is possible to group on the larger scales of the major watersheds (Patuxent River [Lower, Middle, and Upper], Anacostia River, Mattawoman Creek, Piscataway Creek, and Potomac/non-Anacostia River, and Western Branch) as well as countywide.

- *Step 1*. Record percent biological degradation of subwatershed A from the most recent biological assessment report (R3), noting intensity of impairment and known or most probable sources of pollution or other stressors.
- *Step 2*. Compare percent biological degradation of subwatershed A from subsequent monitoring (R4) and determine whether positive change or an improvement (A:R3 > A:R4), negative change or further degradation (A:R3 < A:R4), or no change (A:R3 = A:R4) has occurred. Use 90-percent confidence intervals as provided in biological assessment reports to document relative significance of changes. This procedure constitutes trend analysis for assessing changes in biological condition.

Countywide biological monitoring is a routine part of the County's current monitoring strategy and occurs in 3-year cycles, for which funding is in place for 2019–2021. In addition, MD DNR conducts the MBSS (a qualitative fish survey) and, in the spring, the Metropolitan Washington Council of Governments conducts fish surveys to provide additional biological health measurements for Anacostia River tributaries.

11.2.2 Water Quality Monitoring

The County will continue dry- and wet-weather monitoring to determine the concentrations of various pollutants, including PCBs, using MDE-approved methods and laboratories. Water quality monitoring is conducted to assess a set of upstream restoration practices. The County will request that MDE allow the County to relocate its two NPDES monitoring stations in Bear Branch watershed to another watershed. The new monitoring locations will be downstream of multiple planned restoration activities (e.g., ESD practices, stream restoration, and public outreach). The County also requested that MDE continue its Integrated Report assessment monitoring in the watersheds.

Currently, the County does not have the resources to conduct water quality monitoring at multiple locations throughout the County. If monitoring were to be conducted in each watershed in the County, then funding availability for implementing restoration activities would be substantially reduced. Although it is desirable to monitor the farthest downstream location in a subwatershed, several other siting factors must also be considered, including location of potential restoration activities, site accessibility, presence of stream flow gages, and proximity to prior water quality monitoring stations (which can be advantageous in helping establish long-term trends).

Monitoring will not be conducted at any individual BMP sites to assess their effectiveness in reducing pollutant loads. Pollutant removal efficiencies have already been established for the proposed BMP types, so only new and innovative BMPs will need to be individually monitored to assess their load reduction capabilities.

The County will use the monitoring data to assess the overall load reductions from upstream activities in a watershed with a large amount of planned activity. The data will also be reviewed to assess trends, including whether improvement was gradual or loadings significantly decreased in 1 year, and which practices were installed in the previous year and how they related to load reductions in the stream. There is natural variability in stream water quality. Looking into smaller watersheds with fewer implementation activities occurring could make it difficult to separate improvements from natural variability. By looking at a watershed with larger scale implementation, the improvements as a direct result of that effort should be more easily identified. The County can look at the observed load reductions in the stream, compare them to the projected load reductions, and adjust accordingly. Those adjustments would not only be applied to the monitored watershed but also countywide in other restoration plans. Adjustments could take the form of implementing more BMPs, using different types of BMPs, or expanding education and outreach efforts.

11.3 Adaptive Management Approach

The County will continue watershed restoration using the best information available at the time the plan was developed. As implementation progresses, an adaptive management approach will facilitate adjustments to restoration activities as new information becomes available and opportunities emerge to increase effectiveness and reduce costs. It will be important for the County, MDE, and watershed partners to work together on this management approach to ensure successful ongoing implementation.

For this restoration plan, adaptive management will involve stream monitoring, evaluating applied strategies, analyzing and interpreting biological assessments at multiple spatial scales, assessing progress, and incorporating any useful new knowledge into expanding restoration efforts. As part of its NPDES permit, the County evaluates its countywide watershed restoration progress at the end of each permit cycle (anticipated to start in late 2019 / early 2020) following this adaptive management approach. The evaluation will take advantage of an updated BMP inventory, new BMP technologies, experience with the new programmatic initiatives, and more current water quality data.

In the case of the PCB-impacted watersheds, adaptive management is used to assess whether the actions identified as necessary are the correct ones and whether they are working to solve the identified obstacles to the plan implementation. Although the restoration plan was developed using the best available data, unanticipated circumstances might arise. As examples, the installed BMPs might remove significantly more or less pollution than expected; a natural disaster could affect the plan’s implementation; or, if BMPs are being implemented at a slower rate than is called for in the restoration plan, the adaptive management process will need to include a look at the causes of the lag in implementation and either address those causes or otherwise propose changes to the plan to accommodate the lag. Implementation lags can be caused by a lack of available land, delays in obtaining the necessary permits for constructing BMPs, being denied permission to build a BMP on private land, and lapses in funding. In addition, implementing this restoration plan depends on public and private entities effectively modifying some of their behaviors regarding trash and lawn care.

Several aspects of this restoration plan support the use of adaptive management:

- Determining the most appropriate restoration practices at the best locations. The County will look across land uses to determine where restoration projects will be most cost-effective in achieving pollutant load reductions. The County reserves the right to use alternative restoration activities if the opportunity arises and the alternative practices will produce greater load reductions than ESD practices or a similar load reduction at a lower cost.
- Helping to reduce long-term costs while increasing load reduction. The County recognizes that future BMP-related research could result in new, more efficient pollution reduction technologies becoming available. Those advances could reduce cost, reduce BMP footprints, or increase load reduction efficiencies. Some of the advances could come from proprietary technologies, which the County will evaluate based on their cost and performance.
- Using biological monitoring results. DoE can adjust implementation priorities and target areas of poor stream health within the watershed. The biological assessment results will be interpreted at multiple spatial scales as Degraded/Not Degraded (for specific stream sites) and percent degradation. The County will use those results as the principal indicator of stressor reduction effectiveness. A lack of positive response will be taken as evidence that additional or more intensive stormwater management is necessary to achieve ecologically meaningful pollutant reductions.

In the future, climate change will play a role in watershed restoration and BMP implementation. The County is becoming more aware of the potential effects of climate change and their impact on BMPs. EPA conducted a modeling study investigating the resilience of BMPs in withstanding more extreme precipitation events caused by climate change (USEPA 2018). The results of the study found that BMPs designed for current conditions will most likely fail to sufficiently treat and reduce runoff from the projected larger and more intense storm events. That failure could cause stormwater to overflow or damage BMPs; the BMPs would not treat all the runoff and would not reduce runoff volume reaching the County’s water bodies. That situation, in turn, could result in downstream channel erosion and flooding. BMPs developed with current design standards will require a larger temporary storage volume or reconfigured outlet structures to reduce the hazard of flooding and channel erosion likely to be experienced from more frequent and intense precipitation events in the future.

The County proposes to evaluate progress from the local TMDL restoration plans in the third year of each MS4 permit cycle and update this plan if necessary. The new permit is expected in late 2019, so the updates would be in 2021/2022. They will use more comprehensive information on the actual rate of implementation and take advantage of recent technological advances and increases in BMP load reduction efficiencies to more accurately estimate the end date by which the load reduction targets will be met. In addition, R4 of the countywide biological assessments will be completed in 2021 and used in the revision process. The results of each of the revisions will be included in a plan addendum with updates to provisional milestones and costs.

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