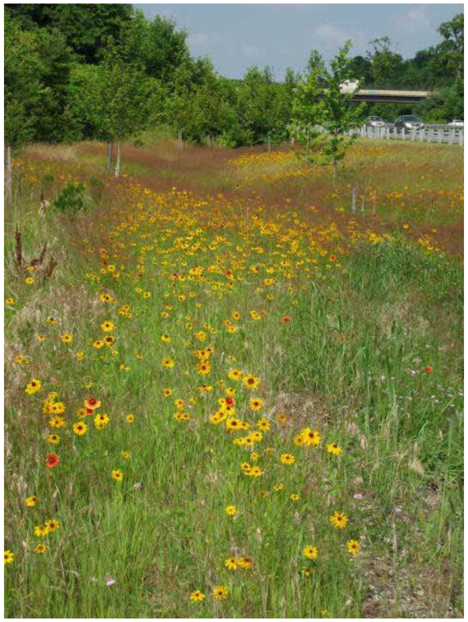
Part III

Coordinated TMDL Implementation Plan





III. COORDINATED TMDL IMPLEMENTATION PLAN

A. WATER QUALITY STANDARDS AND DESIGNATED USES

While the impervious restoration requirements discussed in **Part II** of this Plan focus on offsetting the impacts of urbanization to uncontrolled stormwater runoff, TMDLs focus on offsetting the impacts of pollutants to waterway designated uses. Both these perspectives address the quality of Maryland surface waters. The Federal Clean Water Act (CWA) established requirements for each State to develop programs to address water pollution including:

- Establishment of WQSs;
- Implementation of water quality monitoring programs;
- Identification and reporting of impaired waters; and
- Development of maximum allowable pollutant loads that when met and not exceeded will restore WQSs to impaired waters, called TMDL documents.

WQSs are based on the concept of designating and maintaining specifically defined uses for each waterbody. **Table 3-1** lists the designated uses for waterways in Maryland. TMDLs are based upon these uses.

One means for the EPA to enforce these standards is through the NPDES program, which regulates discharges from point sources. MDE is the delegated authority to issue NPDES discharge permits within Maryland and also to develop WQSs for Maryland including the water quality criteria that define the parameters to ensure designated uses are met.

Table 3-1: Designated Uses in Maryland

	Use Classes							
Designated Uses	**I**	**I-P**	**II**	**II-P**	**III**	**III-P**	**IV**	**IV-P**
Growth and Propagation of Fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use			✓	✓				
Seasonal Shallow-water Submerged Aquatic Vegetation Use			✓	✓				
Open-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Channel Refuge Use			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

Source: http://www.mde.state.md.us/programs/Water/TMDL/Water%20Quality%20Standards/Pages/programs/waterprograms/tmdl/wqstandards/wqs_designated_uses.aspx

MS4 Permit Requirements

The SHA MS4 Permit requires coordination with county MS4 jurisdictions concerning watershed assessments and development of a coordinated TMDL implementation plan for each watershed that SHA has a WLA. **Part IV, SHA Watershed TMDL Implementation Plans** contains implementation plans specific to each local TMDL watershed. It includes a brief description of each watershed including SHA facilities and land uses, SHA TMDLs within the watershed, SHA visual inventory of ROW, summary of county assessment review, and SHA pollutant reduction strategies.

Requirements from the SHA MS4 Permit specific to watershed assessments and coordinated TMDL implementation plans are copied below and include *Part III.E.1* and *2.b* of the Permit (See **Part I, Program Introduction** for complete wording from *Part III*.E of the SHA MS4 Permit).

Watershed Assessments (Permit Part III.E.1)

SHA shall coordinate watershed assessments with surrounding jurisdictions, which shall include, but not be limited to the evaluation of available State and county watershed assessments, SHA data, visual watershed inspections targeting SHA rights-of-way and facilities, and approved stormwater WLAs to:

- *Determine current water quality conditions;*
- *Include the results of visual inspections targeting SHA rights-of-way and facilities conducted in areas identified as priority for restoration;*
- *Identify and rank water quality problems for restoration associated with SHA rights-of-way and facilities;*
- *Using the watershed assessments established under section a. above to achieve water quality goals by identifying all structural and nonstructural water quality improvement projects to be implemented; and*
- *Specify pollutant load reduction benchmarks and deadlines that demonstrate progress toward meeting all applicable stormwater WLAs.*

Coordinated TMDL Implementation Plans (Permit Part III.2.b)

Within one year of permit issuance, a coordinated TMDL implementation plan shall be submitted to MDE for approval that addresses all EPA approved stormwater WLAs (prior to the effective date of the permit) and requirements of Part VI.A., Chesapeake Bay Restoration by 2025 for SHA's storm sewer system. Both specific WLAs and aggregate WLAs which SHA is a part of shall be addressed in the TMDL implementation plans. Any subsequent stormwater WLAs for SHA's storm sewer system shall be addressed by the coordinated TMDL implementation plan within one year of EPA approval. Upon approval by MDE, this implementation plan will be enforceable under this permit. As part of the coordinated TMDL implementation plan, SHA shall:

- *Include the final date for meeting applicable WLAs and a detailed schedule for implementing all structural and nonstructural water quality improvement projects, enhanced stormwater management programs, and alternative stormwater control initiatives necessary for meeting applicable WLAs;*
- *Provide detailed cost estimates for individual projects, programs, controls, and plan implementation;*
- *Evaluate and track the implementation of the coordinated implementation plan through monitoring or modeling to document the progress toward meeting established benchmarks, deadlines, and stormwater WLAs; and*

- *Develop an ongoing, iterative process that continuously implements structural and nonstructural restoration projects, program enhancements, new and additional programs, and alternative BMPs where EPA approved TMDL stormwater WLAs are not being met according to the benchmarks and deadlines established as part of the SHA's watershed* assessments.

B. WATERSHED ASSESSMENT COORDINATION

According to the USGS (2016):

> *A watershed is an area of land where all water that falls on it and drains off it flows to a common outlet. A watershed is an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel. The word watershed is sometimes used interchangeably with drainage basin or catchment. The watershed consists of surface water--lakes, streams, reservoirs, and wetlands--and all the underlying ground water. Larger watersheds contain many smaller watersheds. Watersheds are important because the streamflow and the water quality of a river are affected by things, human-induced or not, happening in the land area "above" the river-outflow point.*

The 8-digit scale is the most common management scale for watersheds across the state, and therefore is the scale at which most of Maryland's local TMDLs are developed. In some cases, a subwatershed has its own TMDL. See **Figure 3-1** for an illustration of an 8-digit watershed example in Maryland.

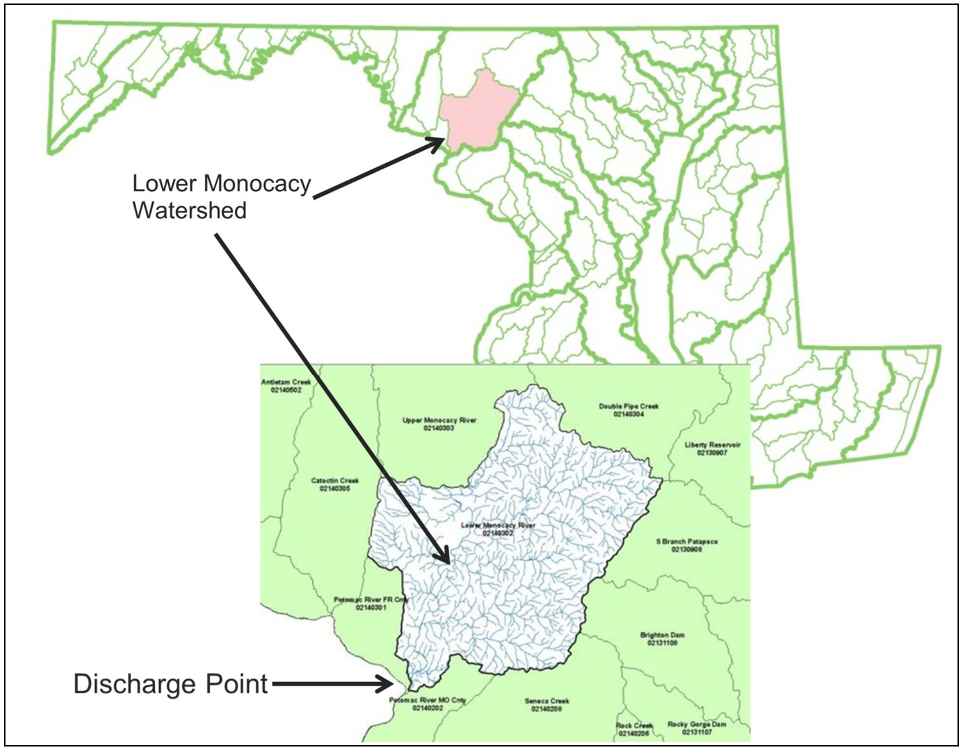


Figure 3-1: Maryland 8-digit Watershed Example

County Watershed Assessments

Each MS4 county is required to perform detailed assessments of local watersheds as a part of its MS4 permit requirements. These assessments determine current water quality conditions and include visual inspections; identify and rank water quality problems for restoration; prioritize and rank structural and non-structural improvement projects; and set pollutant reduction benchmarks and deadlines that demonstrate progress toward meeting applicable WQSs. SHA is not required to duplicate this effort, but is required to coordinate with the MS4 jurisdictions to obtain and review watershed assessments.

Relying on assessments performed by other jurisdictions avoids redundant analysis and places the responsibility for developing the assessments with the jurisdictions that have close connection to local communities and watershed groups. Currently, completed assessments are not available for all watersheds because deadlines for developing them vary. Also, methods for performing these assessments vary from one jurisdiction to another. The amount and level of detail for watershed assessment evaluations included in **Part IV, SHA Watershed Implementation Plans** also varies by watershed.

Watershed assessment evaluations conducted by SHA focus on issues that SHA can improve through practices targeting SHA ROW or infrastructure, and because SHA property is typically a fraction of land within each of these watersheds, pertinent information has been limited at times. This information is used by SHA to determine priority areas for BMP implementation and to identify potential project sites or partnership project opportunities. Summaries of these evaluations are included in **Part IV** of this Plan under each individual watershed section. SHA watershed assessment evaluations focus on the following:

- Impacts to SHA infrastructure such as failing outfalls and downstream channels;
- Older developed areas with little SWM and available opportunities to install retrofits;
- Degraded streams;
- Priority watershed issues such as improvements within a drinking water reservoir, special protection areas or Tier II catchments;
- Identification of areas most in need of restoration;
- Description of preferred structural and non-structural BMPs to use within the watershed;
- Potential project sites for BMPs; and,
- In watersheds with PCB TMDLs, identifying locations of any known PCB sources.

In addition to using information from the county watershed assessments, SHA also undertakes other activities to identify potential project sites and prioritize BMP implementation including:

- On-going coordination meetings with each of the MS4 counties to discuss potential partnerships with the mutual goal of improving water quality;
- Perform visual watershed inspections as described below;
- Model SHA load reductions within the watershed based on SHA land uses and ROW; and,
- Maximize existing impervious treatment within new roadway projects (practical design initiative).

C. VISUAL INSPECTIONS TARGETING SHA ROW

SHA has recently developed a process to methodically review each watershed for potential restoration projects within SHA ROW to meet the load reductions for current pollutant WLAs. Although these watersheds have previously been reviewed for all practice types, this new process adds a grid system to coordinate and track efforts of many teams systematically to ensure each watershed is thoroughly assessed. The method is currently being used for searches for new stormwater control structures and retrofits but will be expanded to include tree planting and stream restoration sites. The watershed review process includes two phases to visually inspect each watershed and identify all structural and non-structural water quality improvement projects to be implemented.

Desktop Evaluation

Phase one is a desktop evaluation of the watershed using available county watershed assessments and SHA data. SHA has created a grid system of 1.5 mile square cells to track the progress of the visual watershed inspections, allowing prioritized areas to be targeted first. With this grid system, many spatial data sets are reviewed to determine the most effective use of each potential restoration site. The sites are documented geographically and stored in GIS. Viable sites are prioritized and those located within watersheds with the most pollutant reduction needs move forward to the second phase, which is to perform field investigations. Data reviewed includes:

- Aerial imagery;
- Street view mapping;
- Environmental features delineations such as critical area boundary, wetlands buffers, floodplain limits;
- County data such as utilities, storm drain systems, contour and topographic mapping;
- SHA ROW boundaries;
- Current SHA stormwater control and restoration practice locations; and,
- Drainage area boundaries.

Figure 3-2 illustrates the 1.5 mile grid system for the Anacostia River watershed and **Figure 3-3** is grid cell 224 showing ranking of sites for structural stormwater controls.

Field Investigations

Phase two is a field investigation of each viable site resulting from the watershed desktop evaluation. SHA inspects and assesses each site in the field to capture existing site conditions and water quality problems and constraints. This information is used to determine potential restoration BMPs as well as estimated restoration credit quantities.

SHA will continue to prioritize visual inspections in the highest need watersheds. **Figure 3-4** is an example field investigation summary map that documents observations from the field analysis. A standardized field inspection form is used.

D. BENCHMARKS AND DETAILED COSTS

Benchmarks and deadlines demonstrating progress toward meeting all applicable stormwater WLAs are provided in each watershed discussion in **Part IV, SHA Watershed TMDL Implementation Plans**.

Generalized cost information is included for each WIP that includes an overall estimated cost for the proposed practices. This information is also included in **Part IV, SHA Watershed TMDL Implementation Plans**. Detailed costs for specific construction projects are available on SHA's website (www.roads.maryland.gov) under Contractors Information Center.

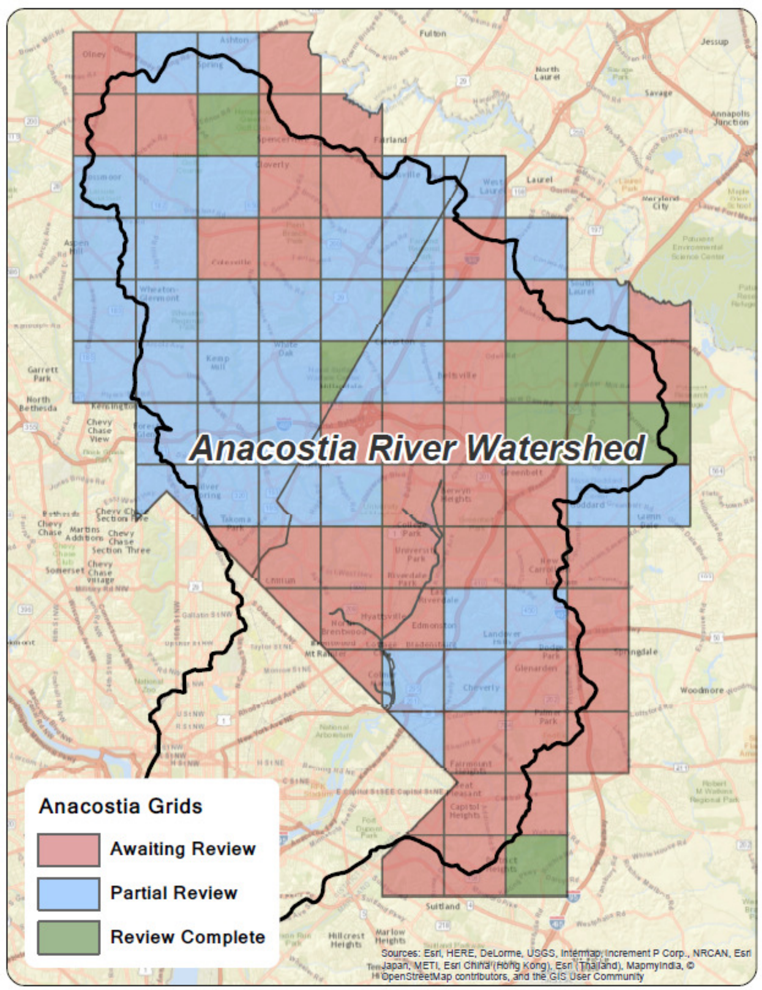


Figure 3-2: Example 1.5 Mile Grid System for Anacostia River Watershed

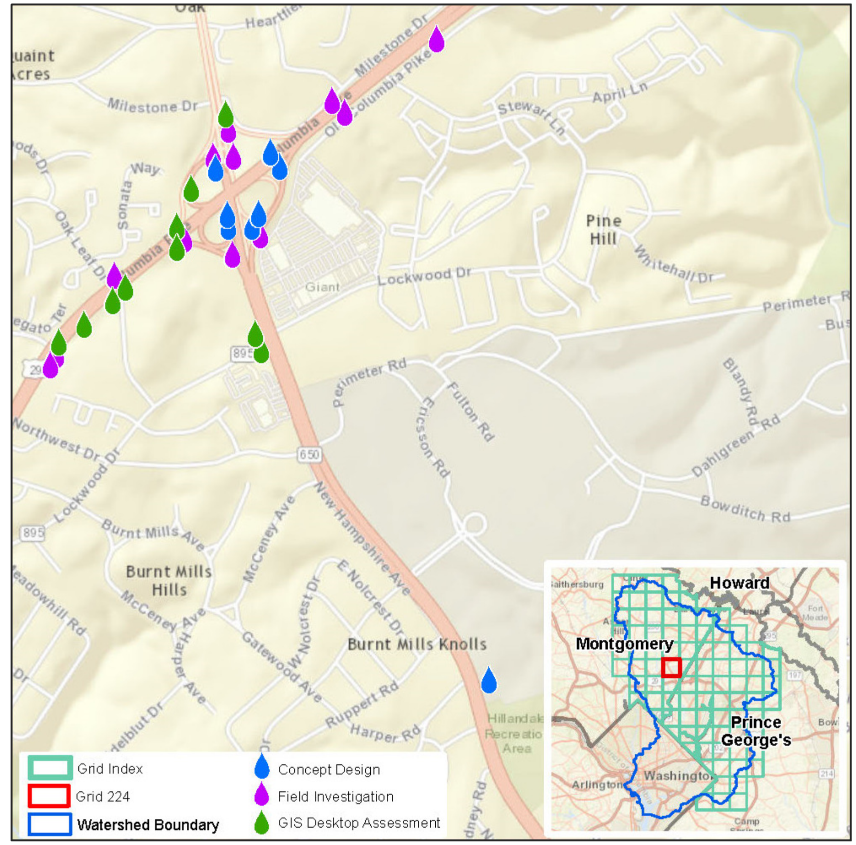


Figure 3-3: Anacostia River Grid #224 – New Stormwater Site Search

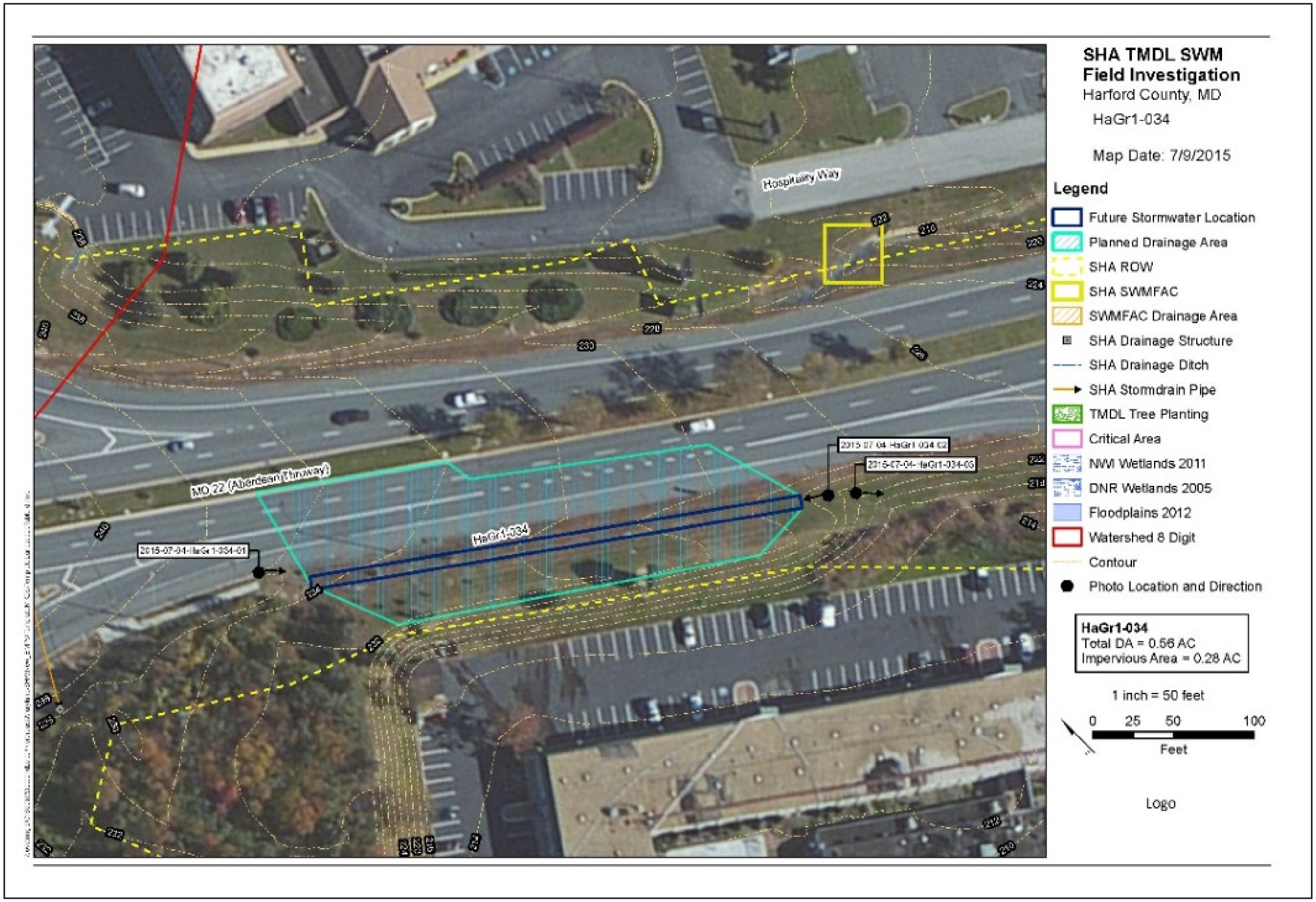


Figure 3-4: Example Field Investigation Summary Map

THIS PAGE INTENTIONALLY LEFT BLANK

E. POLLUTION REDUCTION STRATEGIES

E.1. SHA TMDL Responsibilities

TMDLs define the maximum pollutant loading that can be discharged to a waterbody and still meet water quality criteria for maintaining designated uses. **Figure 3-5** illustrates the concept of maximum loading. The green area on the bar depicts the maximum load that maintains a healthy water environment for the particular pollutant under consideration. When this load is exceeded, the waterway is considered impaired as illustrated by the red portion of the bar. The example waterway is in need of restoration through implementation of practices to reduce the pollutant loading to or below the WLA.

Generally the formula for a TMDL is:

$$TMDL = \sum WLA + \sum LA + MOS$$

Where:

TMDL = total maximum daily load
WLA = wasteload allocation for point sources;
LA = load allocation for non-point sources; and
MOS = margin of safety.

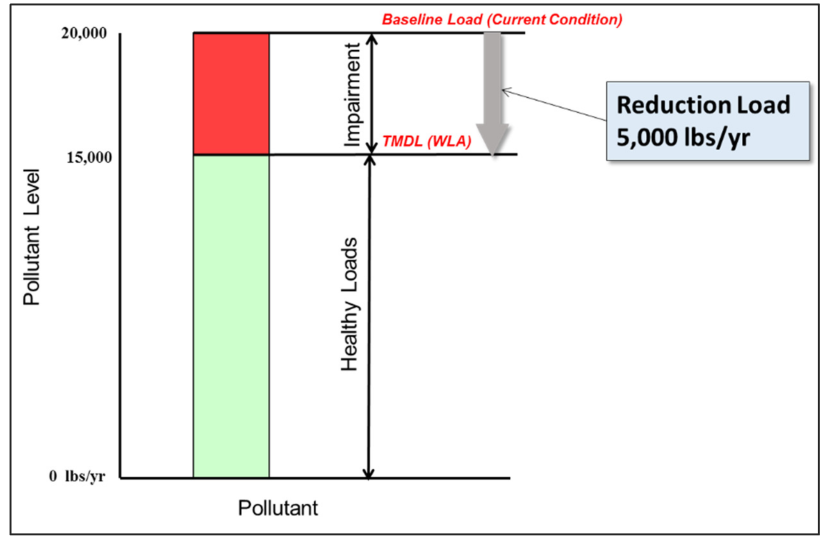


Figure 3-5: Example Wasteload Allocation and Reduction Requirement

Pollutants for SHA Focus

Upon issuance of the MS4 Permit, SHA was named in TMDLs for five different pollutants within the MS4 coverage area including

- Bacteria,
- PCBs,
- Phosphorus,
- Sediment, and
- Trash.

The SHA MS4 Permit covers eleven Maryland counties that cross 84 8-digit watersheds representing larger rivers or streams. There are 39 EPA approved TMDL documents that assign SHA to either an individual WLA or an aggregate WLA. Each watershed may be covered by one or more TMDL documents, so there is not a direct correlation between the number of TMDL documents and the number of watersheds affected. Lists of the TMDL documents addressed by this plan for each pollutant are included in **Sections E.2** through **E.5.**

Figure 3-6 shows a map of SHA TMDL responsibilities by watershed. **Tables 3-2** and **3-3** on the following pages summarize SHA's reduction requirements and projected progress in meeting pollution reduction wasteload targets within each of the local watersheds by the listed end dates. There are instances where the projected progress does not equal 100 percent by the end date listed. In these cases, discussion is added to the reduction strategy sections to analyze the conditions that preclude SHA from meeting the target reductions with currently available modeling methods, loading, reduction efficiencies, or practices.

Lists of proposed practices and costs to achieve the required reductions are included in **Part IV, SHA Watershed TMDL Implementation Plans.**

Modeling Parameters

MDE requires that pollutant modeling follow the guidance in MDE 2014a and if other methods are employed, they must be approved by MDE. SHA developed a restoration modeling protocol that describes the methods used for modeling pollutant load reductions for local TMDLs with SHA responsibility. This protocol will be submitted to MDE as an appendix with the SHA's MS4 annual report. Once approved, this protocol will be available on the SHA website.

Different modeling methods are used depending upon the pollutants and current reduction practices in use. Brief descriptions of modeling methods are included in the following sections, but the SHA restoration modeling protocol should be consulted for detailed descriptions.

Aggregated Loads

WLAs may be assigned to each MS4 jurisdiction separately or as an aggregated WLA that combines all urban stormwater permits into one required allocation and reduction target. In cases where SHA's requirement is part of an aggregated target, SHA has 'disaggregated' the SHA reduction target based on the percent of SHA ROW within the watershed area. This is in accordance with MDE (2014a).

Available Reduction Practices

SHA reserves the right to implement new BMPs, activities, and other practices that are not currently available to achieve local TMDL load reduction requirements. In the future, there may be new expert panels developed to study the effects of implementation of new or existing BMPs on various pollutants. SHA will modify reduction strategies as necessary based on new, approved treatment guidance and will include revised strategies in updates to this implementation plan.

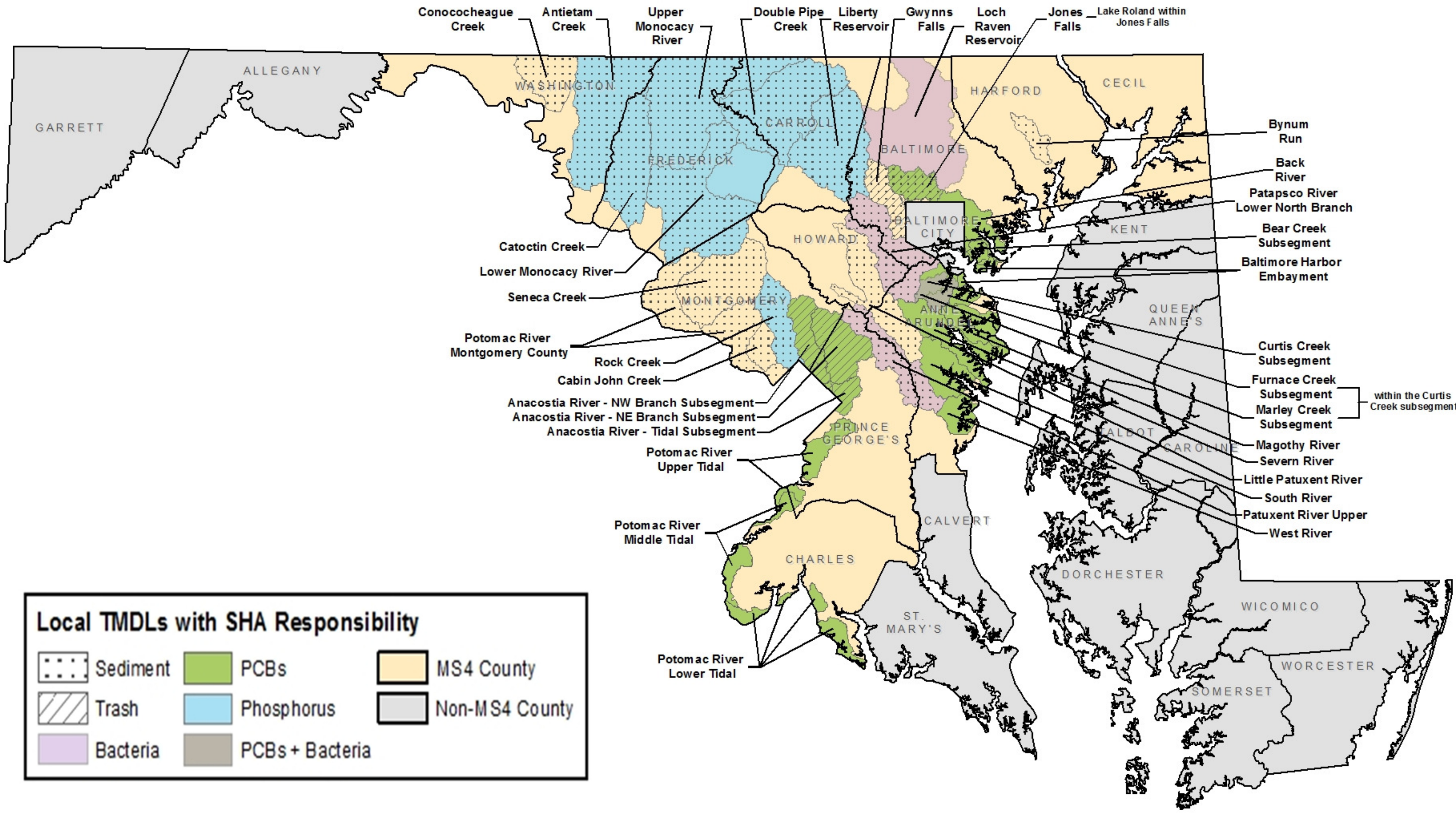


Figure 3-6: SHA TMDL Responsibilities in Local Watersheds

Table 3-2: MDOT SHA Nutrient, Sediment, PCB and Trash Modeling Results

Watershed Name	Watershed Number	County	Pollutant	EPA Approval Date	WLA Type	Baseline Year	Unit	MDOT SHA Baseline	MDOT SHA % Reduction Target	MDOT SHA Reduction Target	MDOT SHA WLA	Target Year
Nutrient and Sediment TMDLs												
Antietam Creek	02140502	WA	Phosphorus	09/25/2013	Individual	2009	EOS-lbs/yr	1,307	21.4%	280	1,027	2050
			Sediment	12/18/2008	Aggregate by County	2000	EOS-lbs/yr	1,758,141	58.1%	1,021,480	736,661	2050
Bynum Run	02130704	HA	Sediment	09/30/2011	Individual	2005	EOS-lbs/yr	135,225	19.3%	26,098	109,127	2032
Cabin John Creek	02140207	MO	Sediment	09/30/2011	Individual	2005	EOS-lbs/yr	1,052,663	22.9%	241,060	811,603	2041
Catoctin Creek	02140305	FR	Phosphorus	09/24/2013	Individual	2009	EOS-lbs/yr	1,730	9.0%	156	1,575	2025
			Sediment	07/31/2009	Aggregate by County	2000	EOS-lbs/yr	1,237,170	49.1%	607,450	629,719	2025
Conococheague Creek	02140504	WA	Sediment	11/24/2008	Aggregate by County	2000	EOS-lbs/yr	1,187,462	45.3%	537,920	649,542	2050
Double Pipe Creek	02140304	FR	Phosphorus	04/26/2013	Individual	2009	EOS-lbs/yr	1,593	66.0%	1,052	542	2045
		CL										
		FR	Sediment	02/20/2009	Aggregate by County	2000	EOS-lbs/yr	983,774	46.8%	460,406	523,368	2030
		CL										
Gwynns Falls	02130905	BA	Sediment	3/10/2010; WLA revised 8/31/2015	Individual	2005	EOS-lbs/yr	1,410,346	36.4%	513,366	896,980	2045
Jones Falls	02130904	BA	Sediment	09/29/2011	Individual	2005	EOS-lbs/yr	448,519	21.7%	97,329	351,190	2043
Liberty Reservoir	02130907	BA	Phosphorus	05/07/2014	Individual	2009	EOS-lbs/yr	1,311	45.0%	590	721	2036
		CL										
		BA	Sediment		Individual	2009	EOS-lbs/yr	1,190,032	45.0%	535,514	654,518	2040
		CL										
Little Patuxent River	02131105	AA	Sediment	09/30/2011	Individual	2005	EOS-lbs/yr	1,591,900	36.1%	574,676	1,017,224	2042
		HO										

Table 3-2: MDOT SHA Nutrient, Sediment, PCB and Trash Modeling Results

Watershed Name	Watershed Number	County	Pollutant	EPA Approval Date	WLA Type	Baseline Year	Unit	MDOT SHA Baseline	MDOT SHA % Reduction Target	MDOT SHA Reduction Target	MDOT SHA WLA	Target Year
Nutrient and Sediment TMDLs Continued												
Lower Monocacy River	02140302	CL	Phosphorus	05/22/2013	Individual	2009	EOS-lbs/yr	4,781	25.0%	1,195	3,586	2040
		FR										
		MO										
		FR	Sediment	03/17/2009	Aggregate by County	2000	EOS-lbs/yr	1,770,817	60.8%	1,076,657	694,160	2040
		MO										
Patapsco LN Branch	02130906	AA	Sediment	09/30/2011	Individual	2005	EOS-lbs/yr	2,731,330	18.0%	491,639	2,239,690	2041
		BA										
		HO										
Patuxent River Upper	02131104	AA	Sediment	09/30/2011	Individual	2005	EOS-lbs/yr	377,849	11.4%	43,075	334,774	2040
		HO										
		PG										
Potomac River MO County	02140202	MO	Sediment	06/19/2012	Individual	2005	EOS-lbs/yr	933,141	36.2%	337,797	595,344	2040
Rock Creek	02140206	MO	Sediment	09/29/2011	Individual	2005	EOS-lbs/yr	1,824,727	37.9%	691,572	1,133,156	2025
			Phosphorus	09/26/2013	Individual	2009	EOS-lbs/yr	1,114	32.0%	356	758	Met
Seneca Creek	02140208	MO	Sediment	09/30/2011	Individual	2005	EOS-lbs/yr	1,449,248	44.9%	650,712	798,536	2042
Swan Creek	02130706	HA	Sediment	09/30/2016	Individual	2010	EOS-lbs/yr	60,078	13.0%	7,810	52,268	2030
Upper Monocacy River	02140303	FR	Phosphorus	05/07/2013	Individual	2009	EOS-lbs/yr	1,914	3.0%	57	1,857	Met
		CL										
		FR	Sediment	12/9/2009	Aggregate by County	2000	EOS-lbs/yr	894,222	49.0%	438,169	456,053	2034
		CL										

Table 3-2: MDOT SHA Nutrient, Sediment, PCB and Trash Modeling Results

Watershed Name	Watershed Number	County	Pollutant	EPA Approval Date	WLA Type	Baseline Year	Unit	MDOT SHA Baseline	MDOT SHA % Reduction Target	MDOT SHA Reduction Target	MDOT SHA WLA	Target Year
PCB TMDLs												
Anacostia River Tidal	02140205	PG	PCBs	10/31/2007	Aggregate by County	2005	g/yr	16.9	99.9%	16.9	0.0	2050
Back River Oligohaline Tidal	MD-BACOH	BA	PCBs	10/01/2012	Aggregate by County	2001	g/yr	19.8	53.4%	10.6	9.2	2045
Baltimore Harbor Embayment	MD-PATMH-02130903	AA BA	PCBs	10/01/2012	Aggregate by County	2004	g/yr	6.3	91.1%	5.8	0.6	2038
Bear Creek	MD-PATMH-BEAR-CREEK	BA	PCBs	10/01/2012	Aggregate by County	2004	g/yr	6.5	91.5%	6.0	0.6	2038
Bird River	02130803	BA	PCBs	10/03/2016	Aggregate by County	2010	g/yr	1.3	70.0%	0.9	0.4	2050
Bush River Oligohaline	MD-BSHOH-02130701	HA	PCBs	08/02/2016	Aggregate by County	2010	g/yr	11.3	62.0%	7.0	4.3	2050
Curtis Creek/Bay	MD-PATMH-CURTIS_BAY_CREEK	AA	PCBs	10/01/2012	Aggregate by County	2004	g/yr	33.4	93.5%	31.2	2.2	2038
Gunpowder River Oligohaline	MD-GUNOH-02130801	BA HA	PCBs	10/03/2016	Aggregate by County	2010	g/yr	0.2	0.0%	-	-	N/A
Lake Roland	MD-02130904-Lake_Roland	BA	PCBs	6/30/2014	Aggregate by County	2010	g/yr	16.2	29.3%	4.8	11.5	2025
Magothy River Mesohaline	MD-MAGM-02131001	AA	PCBs	03/16/2015	Aggregate by County	2010	g/yr	1.4	0.0%	-	-	N/A
NE Branch Anacostia River	02140205	MO PG	PCBs	09/30/2011	Aggregate by County	2005	g/yr	8.1	98.6%	8.0	0.1	2045
NW Branch Anacostia River	02140205	MO PG	PCBs	09/30/2011	Aggregate by County	2005	g/yr	7.8	98.1%	7.7	0.1	2045
Potomac River Lower Tidal	02140101	CH	PCBs	10/31/2007	Aggregate by County	2005	g/yr	0.5	5.0%	-	-	N/A
Potomac River Middle Tidal	02140102	CH PG	PCBs	10/31/2007	Aggregate by County	2005	g/yr	0.3	5.0%	-	-	N/A

Table 3-2: MDOT SHA Nutrient, Sediment, PCB and Trash Modeling Results

Watershed Name	Watershed Number	County	Pollutant	EPA Approval Date	WLA Type	Baseline Year	Unit	MDOT SHA Baseline	MDOT SHA % Reduction Target	MDOT SHA Reduction Target	MDOT SHA WLA	Target Year
PCB TMDL Continued												
Potomac River Upper Tidal	02140201	CH	PCBs	10/31/2007	Aggregate by County	2005	g/yr	1.3	5.0%	0.1	1.3	2050
		PG										
Severn River Mesohaline	MD-SEVMH-02131002	AA	PCBs	07/19/2016	Aggregate by County	2010	g/yr	9	0.0%	-	-	N/A
South River Mesohaline	MD-SOUMH-02131003	AA	PCBs	04/27/2015	Aggregate by County	2010	g/yr	2.8	0.0%	-	-	N/A
West and Rhode Rivers Mesohaline	MD-WST-RHDMH-02131004	AA	PCBs	01/08/2016	Aggregate by County	2010	g/yr	0.2	0.0%	-	-	N/A
Note: MDOT SHA does not have a PCB WLA reduction responsibility for the following watersheds presented in this table: Gunpowder River, Magothy River Mesohaline, Potomac River Lower Tidal, Potomac River Middle Tidal, Potomac River Upper Tidal-Charles County portion, Potomac River Upper Tidal-Prince George's County portion, Severn River Mesohaline, South River Mesohaline and West and Rhode Rivers Mesohaline. Table 1-1 indicates that these watersheds list MDOT SHA for PCB responsibility and the reasons there are no reduction requirements for MDOT SHA are mentioned in Section E.4.												
Trash TMDLs												
Anacostia	2140205	MO	Trash	09/21/2010	Individual	2009	Lbs/ Yr	60,585	100.0%	6,044	6,044	2045
		PG						107,692	100.0%	14,134	14,134	2045
Patapsco -Gwynns Falls	MD-PATMH-0213095	BA	Trash & Debris	01/05/2015	Individual	2011	Lbs/ Yr	83,729	100.0%	2,415	2,415	2026
Patapsco - Jones Falls	MD-PATMH-02130904	BA	Trash & Debris	01/05/2015	Individual	2011	Lbs /Yrs	47,251	100.0%	1,490	1,490	2026
Note: For the Trash WLA MDOT SHA is require to remove the existing Trash baseline load plus an individual load set by MDE, thus the WLA here is equal to the reduction target.												

Table 3-3: MDOT SHA Bacteria Modeling Results

Watershed Name	Watershed Number	County	Pollutant	EPA Approval Date	WLA Type	Baseline Year	Unit	MS4 Baseline Load	MS4 % Reduction Target	MDOT SHA Reduction Target	MDOT SHA WLA	Target Year
Baltimore Harbor-Marley Creek	MD-PATMH-MARLEY_CREEK	AA	*Enterrococci*	03/10/2011	Aggregate by County	2006	billion MPN /yr	29,507	75.80%	22,366	7,141	2050
Baltimore Harbor - Furnace Creek	MD-PATMH FURNACE_CREEK	AA	*Enterrococci*	03/10/2011	Aggregate by County	2006	billion MPN /yr	40,454	77.80%	31,473	8,981	2050
Loch Raven Reservoir	02130805	BA CL HA	*E. coli*	12/03/2009	Aggregate by County	2004	billion MPN /yr	114,408	87.60%	100,221	14,187	2048
Patapsco River LN Branch	02130906	AA BA CL HO	*E. coli*	12/03/2009	Aggregate by County	2003	billion MPN /yr	234,029	14.80%	34,636	199,393	2046
Patuxent	02131104	AA PG	*E. coli*	08/09/2011	Aggregate by County	2009	billion MPN /yr	26,605	45.30%	12,052	14,553	2048

E.2 Nutrient and Sediment Implementation Plan

E.2.a Nutrient and Sediment TMDLs with SHA Responsibility

There are 23 EPA approved phosphorus or sediment TMDLs with SHA responsibility spanning 17 Maryland 8-digit watersheds (**Table 3-2**). The following TMDL documents for phosphorus and sediment are addressed in this plan:

- *Total Maximum Daily Load of Phosphorus in the Antietam Creek Watershed, Washington County, Maryland*, approved by EPA September 25, 2013;
- *Total Maximum Daily Load of Phosphorus in the Catoctin Creek Watershed, Frederick County, Maryland*, approved by EPA September 24, 2013;
- *Total Maximum Daily Load of Phosphorus in the Double Pipe Creek Watershed, Frederick and Carroll Counties, Maryland*, approved by EPA April 26, 2013;
- *Total Maximum Daily Loads of Phosphorus and Sediments for Liberty Reservoir, Baltimore and Carroll Counties, Maryland*, approved by EPA May 7, 2014;
- *Total Maximum Daily Load of Phosphorus in the Lower Monocacy River Watershed, Frederick, Carroll and Montgomery Counties, Maryland*, approved by EPA May 22, 2013;
- *Total Maximum Daily Load of Phosphorus in the Upper Monocacy River Watershed, Frederick and Carroll Counties, Maryland*, approved by EPA May 7, 2013;
- *Total Maximum Daily Load of Phosphorus in the Rock Creek Watershed, Montgomery County, Maryland,* approved by EPA September 26, 2013;
- *Total Maximum Daily Load of Sediment in the Antietam Creek Watershed, Washington County, Maryland*, approved by EPA December 18, 2008;
- *Total Maximum Daily Load of Sediment in the Bynum Run Watershed, Harford County, Maryland*, approved by EPA September 30, 2011;
- *Total Maximum Daily Load of Sediment in the Cabin John Creek Watershed, Montgomery County, Maryland*, approved September 30, 2011;
- *Total Maximum Daily Load of Sediment in the Catoctin Creek Watershed, Frederick County, Maryland*, approved by EPA July 31, 2009;
- *Total Maximum Daily Load of Sediment in the Conococheague Creek Watershed, Washington County, Maryland*, approved by EPA November 24, 2008;
- *Total Maximum Daily Load of Sediment in the Double Pipe Creek Watershed, Frederick and Carroll Counties, Maryland*, approved by EPA February 20, 2009;
- *Total Maximum Daily Load of Sediment in the Gwynns Falls Watershed, Baltimore City and Baltimore County, Maryland*, approved by EPA March 10, 2010 and revised August 31, 2015;
- *Total Maximum Daily Load of Sediment in the Jones Falls Watershed, Baltimore City and Baltimore County, Maryland*, approved September 29, 2011;
- *Total Maximum Daily Load of Sediment in the Little Patuxent River Watershed, Howard and Anne Arundel Counties, Maryland*, September 30, 2011;
- *Total Maximum Daily Load of Sediment in the Lower Monocacy River Watershed, Frederick, Carroll, and Montgomery Counties, Maryland*, approved by EPA March 17, 2009;

- *Total Maximum Daily Load of Sediment in the Patapsco River Lower North Branch Watershed, Baltimore City and Baltimore, Carroll, Howard, and Anne Arundel Counties, Maryland*, approved by EPA September 30, 2011;
- *Total Maximum Daily Load of Sediment in the Patuxent River Upper Watershed, Howard, Anne Arundel, and Prince George's Counties, Maryland*, approved by EPA September 30, 2011;
- *Total Maximum Daily Load of Sediment in the Potomac River Montgomery County Watershed, Montgomery and Frederick Counties, Maryland*, approved by EPA June 19, 2012;
- *Total Maximum Daily Load of Sediment in the Rock Creek Watershed, Montgomery County, Maryland*, approved by EPA September 29, 2011;
- *Total Maximum Daily Load of Sediment in the Seneca Creek Watershed, Montgomery County, Maryland*, approved by September 30, 2011; and
- *Total Maximum Daily Load of Sediment in the Upper Monocacy River Watershed, Frederick and Carroll Counties, Maryland*, approved December 3, 2009.

Table 3-2 shows a summary of the reduction requirements for the current SHA nutrient and sediment TMDLs. Two dates are shown including the EPA approval date and the baseline year set by MDE. The TMDLs were written at different times, based on monitoring data from different years. The baseline year published on the MDE Data Center will be used for SHA implementation planning. This usually correlates to the time period when monitoring data was collected for the MDE analysis.

E.2.b Nutrient and Sediment Sources

Discussions in the TMDLs concerning nutrient and sediment sources focus on types of land use with information derived from the Chesapeake Bay Watershed Model (CBWM). Cropland and regulated urban land tend to be the most significant sources, followed by other agricultural uses and wastewater sources. Specific sources of each pollutant that could be useful for targeting controls are not included in the TMDLs, but SHA researched a number of other references and determined sources beyond land uses that are summarized in **Table 3-4**. Sources of phosphorus are manure, fertilizers used for crops, residential lawn care, and wastewater discharges. Sources of sediment include surface erosion from construction sites and cropland as well as stream erosion from high flows during storm events.

Table 3-4: Nutrient and Sediment Sources from Various References

Land Use	Nutrient Sources	Sediment Sources
Agriculture	Chemical Fertilizer Manure	Soil Erosion
Urban	Pet Waste Lawn Fertilizer Parking Lot, Roof, and Street Runoff	Construction Erosion Parking Lot, Roof, and Street Runoff
Wastewater	Municipal Industrial Failed Septic Systems CSO/ SSO Leaking Sewers	
Natural	Atmospheric Deposition	Stream Erosion Shoreline Erosion

References used to develop the table are MDE, 2014b; EPA, 2010b; Hoos et al., 2000; and Schueler, 2011.

SHA Loading Sources

SHA-owned land is a small portion of each of the TMDL watersheds and it consists of relatively uniform land uses including roadways and roadside vegetation. In urbanized areas, the SHA ROW may extend to include sidewalks and portions of driveways. There are also parking areas associated with SHA land such as park and ride facilities, office complexes, and maintenance facilities.

Of the land uses in **Table 3-4**, SHA is a contributor of nutrients and sediments mostly through urban and natural sources. SHA has no responsibility for agriculture and wastewater sources, other than a few septic systems at outlying facilities. Street and parking lot runoff concentrates pollutants from adjacent land and from atmospheric deposition attributed to both the airshed and vehicles. Deteriorating streets themselves can be a source of sediment. Construction erosion, even with well-maintained erosion and sediment control (ESC), is a source of sediment in urban areas. Stream erosion downstream of SHA facilities, particularly older areas without SWM, is a potential source of sediment and attached phosphorus.

E.2.c SHA Nutrient and Sediment Model Methods

Nutrient and sediment TMDLs were developed using the CBWM with edge of stream (EOS) loading rates. Throughout the years, different versions of the Bay model have been used (as indicated in **Table 3-5**) depending upon which version was active at the time the TMDL was written. The Bay model combines a suite of individual models, including a watershed model that calculates pollutant loads from point sources and runoff, an air deposition model, and an estuary model that estimates pollutant concentrations based on loading, hydrodynamics of the estuary, and pollutant transformations in the Bay.

Table 3-5: Nutrient and Sediment TMDL Watersheds and Bay Model Versions

TMDL Watershed	Pollutant	TMDL Model
Antietam Creek	Phosphorus	CBP P5.3.2
	Sediment	CBP P5
Bynum Run	Sediment	CBP P5.2
Cabin John Creek	Sediment	CBP P5.2
Catoctin Creek	Phosphorus	CBP P5.3.2
	Sediment	CBP P5
Conococheague Creek	Sediment	CBP P5
Double Pipe Creek	Phosphorus	CBP Phase 5.3.2
Gwynns Falls	Sediment	CBP P5
Jones Falls	Sediment	CBP P5
Liberty Reservoir	Phosphorus	Refined version of the CBP P5.3.2 watershed model, with CE-QUAL-W2 model of the reservoir
	Sediment	
Little Patuxent River	Sediment	CBP P5
Lower Monocacy River	Phosphorus	CBP P5.3
Patapsco LN Branch	Sediment	CBP P5
Patuxent River Upper	Sediment	CBP P5.2
Potomac River MO County	Sediment	CBP P5.2
Rock Creek	Phosphorus	CBP P5.2
	Sediment	
Seneca Creek	Sediment	CBP P5.2
Upper Monocacy River	Phosphorus	CBP P5.3.2

Baseline Loading for Nutrients and Sediment

Baseline loads represent the current level of pollutant loading being discharged by a given entity. If the loads exceed the WLA, the waterway is considered impaired and the baseline loads must be reduced to or below the WLA in order to restore the designated uses for the waterway (see **Figure 3-5**). As illustrated by **Table 3-5**, depending upon the year the TMDL was develop, different modeling methods and base data such as land use and per acre pollutant loading rates may have been used. Replicating these various baseline load calculations poses a challenge for SHA because accurate SHA data for ROW area and land use prior to 2011 is not available. Rather than try to replicate the SHA baseline loads for each individual TMDL year and then model progress baselines with new practices relative to the WLA level, SHA has chosen to focus on the required reduction load and determine the menu of new practices that bring the reduction load to zero.

Pollutant Reduction Load Calculations for Nutrients and Sediment

The first step in our modeling procedure is to determine the reduction loads for each watershed and pollutant. In order to do this, the WLA specific to SHA and the percent reduction required are needed. There are two types of WLAs for local TMDLs including individual (SHA-specific) WLAs and aggregate WLAs. Individual WLAs are specifically assigned to SHA and are published in the point source technical memorandum for each TMDL. Aggregate WLA values are published in the main report or point source technical memorandum for each TMDL and are often aggregated as urban stormwater sector including all MS4 permittees (county, municipalities, industrial, and federal and state agencies, including SHA).

SHA's required TMDL reductions for nutrients and sediment are calculated using the following formula. The required percent reduction and WLA are published in the TMDL document.

$$Reqd\ Reduction_{SHA} = \frac{WLA}{(1 - Reqd\ Reduction\ \%)} - WLA$$

Where

Reqd Reduction $_{SHA}$ = Reduction pounds required for SHA

WLA = Published WLA or SHA disaggregated WLA_{SHA} defined below

Reqd Reduction % = Published percent reduction

Aggregate WLAs are disaggregated by applying the percent of SHA land (both impervious and pervious) within SHA ROW within the local TMDL watershed to the published aggregate WLA according to the equation below.

$$WLA_{SHA} = WLA\left(\frac{A_{SHA}}{A_{TMDL}}\right)$$

Where

WLA_{SHA} = Disaggregated WLA for SHA

A_{SHA} = Area of SHA-owned land

A_{TMDL} = Area of aggregate TMDL

WLA = the maximum load of pollutants each discharger of waste is allowed to release into a particular waterway.

Nutrient and Sediment Reduction Modeling

Once the required reduction targets are derived using the above formulas, determining the menu of practices needed to reduce the targets to zero is an iterative process where the target is compared to modeled reductions from sets of restoration practices. Calculations for nutrient and sediment TMDLs will be performed with a model developed by SHA called the Automated Modeling Tool (AMT) that uses planned, under-design and constructed restoration practice data from several production databases and follows approved modeling parameters defined in *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE, 2014a). Documentation on SHA restoration modeling methods is under development and will be submitted to MDE for review and approval along with this implementation plan. The modeling documentation will provide detail on the AMT parameters.

The AMT will be used to plan reduction scenarios and to track progress. Although this is a custom model, it draws on BMP efficiencies, loading rates and delivery factors from MDE (2014a), Maryland Assessment Scenario Tool (MAST), and published CBP BMP protocols. It is also based on CBP loading rates by land-river segment for EOS loads and can calculate reductions from different practices using the removal rates from Table 6 of MDE, 2014a.

Within each county-watershed segment, structural stormwater controls and alternative practice reductions are calculated by multiplying the removal efficiency for each specific practice type, the quantity of each practice applied to the area and a unit loading rate for land uses taken from a no-BMP scenario extracted from MAST.

For structural stormwater controls:

- The load removed in lb/unit for each BMP within the specific county or-watershed is calculated by multiplying the loading rate from the lookup table by the BMP removal rate.
- The pollutant load reduction is calculated by multiplying the unit removal above by the land use (pervious and impervious) in the BMP drainage area.

For alternative practices based on removal by linear foot of restoration (outfalls, streams), the load removed in lb/unit is given in the pollutant removal table. Only one step is required:

- The pollutant load reduction is calculated by multiplying the unit removal per LF by the length of the restoration project.

For alternative practices based on amount of load removed (inlet cleaning), the load is measured directly.

- The pollutant load reduction is calculated by multiplying the amount of material collected by the conversion factor for each pollutant.

SHA manages restoration practice data associated with planning, design, construction, inspection, maintenance and credit verification through spatial geodatabases and an MS Access database. Depending upon where the BMP is in the project development process, information may be found in different databases with different levels of data and tracking required. These sources are queried to develop input files for the AMT.

E.2.d SHA Nutrient and Sediment Reduction Strategies

To date, SHA has used a variety of structural, non-structural, and alternative BMPs in an effort to reduce nutrient and sediment in the watersheds that have a corresponding TMDL. However, we have not limited our load reduction activities to just BMP implementation. The use of nutrient credit trading will also be explored as a tool in reaching load reduction targets. When SHA partners on projects with other MS4 jurisdictions, load splitting can be used as a means to achieve WLA reductions.

BMP Implementation

As a requirement under the MS4 permit, SHA must complete the implementation of restoration efforts for 20 percent of its impervious surface area. SHA has an extensive program to plan, design, and construct BMPs that offset untreated impervious surfaces in SHA ROW as discussed in **Part II, Impervious Restoration and Chesapeake Bay TMDL Compliance**.

SHA intends to build these BMPs used for impervious restoration in watersheds that have a TMDL where possible. The AMT is then used to model the load reduction from implementation of currently constructed BMPs and BMPs planned in the future. The AMT also assesses the impact that these BMPs will have on meeting TMDL load reductions as a percent achieved. The results of this analysis are presented in **Table 3-2** and a chart of the overall practices used to achieve the results are shown in **Figures 3-7** and **3-8** on the following pages. Proposed practices to be implemented for each watershed are shown in **Part IV, SHA Watershed TMDL Implementation Plan** under the specific watersheds with phosphorus and sediment WLAs.

One of the major challenges with using a strategy of building BMPs to meet WLAs is that there can be a lack of feasible ROW for BMP placement opportunities. There are instances where SHA roadway encompasses a majority of the area in the ROW leaving very little land to construct BMPs. The visual watershed inspection process has indicated areas where BMP placement is possible and where it is not feasible do to utility relocation, land purchases, site access problems, and a host of other issues. Therefore, SHA is continually seeking new opportunities and partnerships to install BMPs.

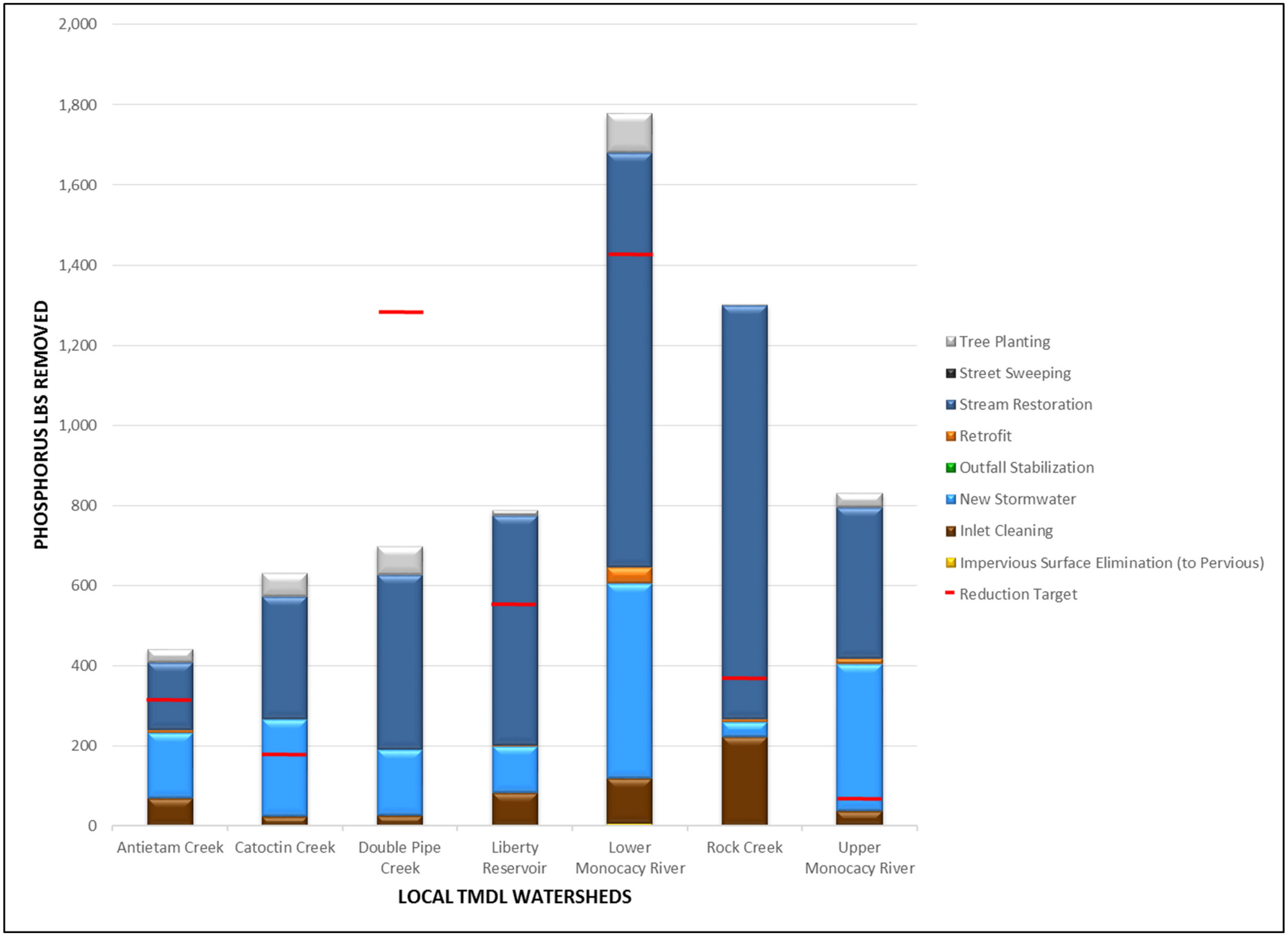


Figure 3-7: Phosphorus WLA Reductions by Watershed with Practice Menu

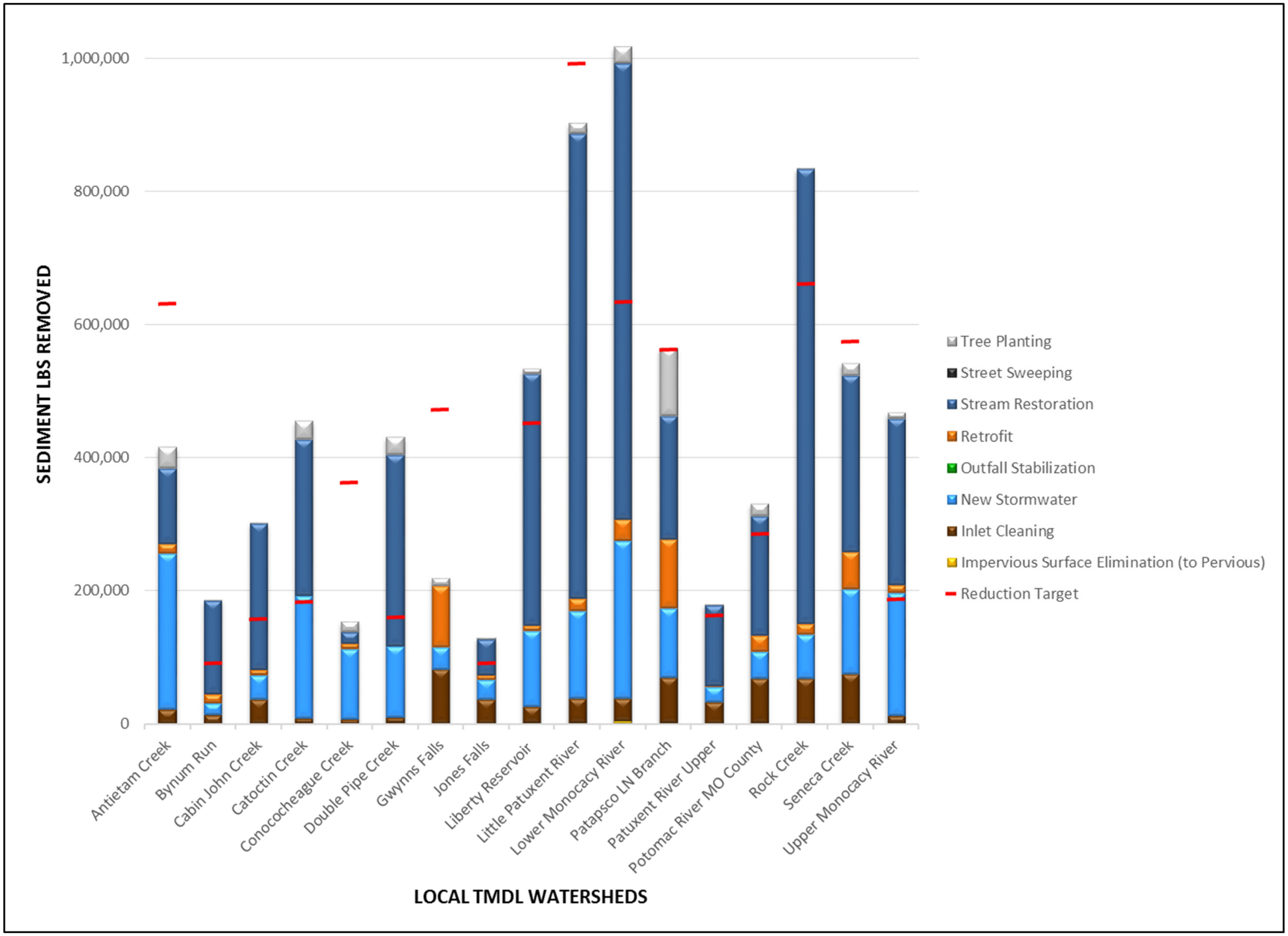


Figure 3-8: Sediment WLA Reductions by Watershed with Practice Menu

Nutrient Credit Trading

In an effort to meet the SHA WLA in watersheds with a high difficulty of BMP placement, SHA is exploring the possibility of nutrient credit trading. It is expected that MS4 jurisdictions will have the ability to purchase pounds of phosphorus, nitrogen, and sediment in a quantity that will allow them to reach their intended WLA. Once the trading program, regulations and guidance are finalized and approved by EPA, SHA intends to utilize this program as another practice to meet TMDL requirements.

Load Splitting

SHA is partnering with other willing NPDES permittees to complete programs or projects that will reduce nutrients and sediments. The goal is to produce projects that will have a WLA reduction and move each permittee closer to meeting its load reduction requirement. An agreement on how the credit pounds of phosphorus and sediment is split will be project specific.

TMDL End Dates

Currently, SHA models BMP implementation using the AMT and notes the progress towards reduction goals in **Table 3-2**. In this model, SHA considers the possible restoration practices that can be placed in the watershed based on the visual watershed inspection process. For some watersheds, 100 percent of the WLA reduction goal has been met and a year for meeting the WLA is given. For other watersheds, a year is listed next to a percentage that is less than 100 percent. This indicates that SHA will be able to reach a certain percentage of the WLA reduction goal by the estimated year.

For example, in Double Pipe Creek, SHA believes that it will be able to reach 55 percent of the WLA for phosphorus by 2045 by exhausting SHA ROW with BMPs outlined in MDE (2014a) guidance. Thus, SHA will have to explore the possibility of nutrient credit trading, internal credit trading, or load splitting efforts, which cannot be modeled at this time. SHA will review any future changes to current BMP removal rates or efficiencies presented in MDE, 2014a and determine what effect a change will have on TMDL end dates.

Internal Credit Trading

The preliminary draft guidance of the nutrient credit trading program developed by MDA and MDE established trading boundaries in which nutrients can be traded in three geographic zones. These are called Maryland Trading Regions, and trading can occur between cross-sector agencies such as regulated MS4 permittees. SHA proposes to trade within the three geographical regions between itself.

For example, in the Potomac trading region, if SHA is able to exceed its WLA for sediment reduction in Catoctin Creek by 270,744 lb/yr, SHA would like to apply the over treatment to the Seneca Creek watershed. The WLA will then be met for Seneca Creek by applying over treatment from one watershed to another watershed within the same trading region. In **Table 3-6** the watersheds are grouped into the three Maryland Trading Regions: Potomac, Western Shore/Eastern Shore Susquehanna, and Patuxent. It then sums up the pollutant load reduction achieved for watershed against its reduction target. Next, the table sums up over treatment or under treatment for all the watersheds within the trading region. At this point, the table illustrates trading regions that will exceed its reduction requirement or under treat its reduction requirement collectively as a region.

Table 3-6: Example Internal Credit Trading Analysis

Watershed Name	Watershed Number	Trading Zone	County	Pollutant	Unit	SHA Reduction Target (Lbs/Yr)	Modeled Reduction Achieved (Lbs/Yr)	% Progress	Reduction Loads Remaining (Lbs/Yr)	Extra Reduction (Lbs/Yr)
Antietam Creek	02140502	Potomac	WA	Sediment	EOS-lbs/yr	630,688	414,938	66%	215,750	0
Conococheague Creek	02140504	Potomac	WA	Sediment	EOS-lbs/yr	360,747	153,873	43%	206,874	0
Seneca Creek	02140208	Potomac	MO	Sediment	EOS-lbs/yr	573,400	540,989	94%	32,411	0
Potomac Trading Region - Sediment Treatment Remaining Total									**455,035**	
Cabin John Creek	02140207	Potomac	MO	Sediment	EOS-lbs/yr	156,000	301,881	194%	0	145,881
Catoctin Creek	02140305	Potomac	FR	Sediment	EOS-lbs/yr	183,338	454,082	248%	0	270,744
Double Pipe Creek	02140304	Potomac	FR CL	Sediment	EOS-lbs/yr	160,971	430,368	267%	0	269,397
Lower Monocacy River	02140302	Potomac	FR MO	Sediment	EOS-lbs/yr	633,145	1,016,125	160%	0	382,980
Potomac River MO County	02140202	Potomac	MO	Sediment	EOS-lbs/yr	286,000	330,812	116%	0	44,812
Rock Creek	02140206	Potomac	MO	Sediment	EOS-lbs/yr	658,800	834,171	127%	0	175,371
Upper Monocacy River	02140303	Potomac	FR CL	Sediment	EOS-lbs/yr	186,344	467,084	251%	0	280,740
Potomac Trading Region - Sediment Extra Treatment Total										**1,569,925**
Double Pipe Creek	02140304	Potomac	FR CL	Phosphorus	EOS-lbs/yr	1,282	699	55%	583	0
Potomac Trading Region - Phosphorus Treatment Remaining Total									**737**	
Antietam Creek	02140502	Potomac	WA	Phosphorus	EOS-lbs/yr	315	443	141%	0	128
Catoctin Creek	02140305	Potomac	FR	Phosphorus	EOS-lbs/yr	176	632	359%	0	456
Lower Monocacy River	02140302	Potomac	CL FR MO	Phosphorus	EOS-lbs/yr	1,428	1,777	124%	0	349

Table 3-6: Example Internal Credit Trading Analysis

Watershed Name	Watershed Number	Trading Zone	County	Pollutant	Unit	SHA Reduction Target (Lbs/Yr)	Modeled Reduction Achieved (Lbs/Yr)	% Progress	Reduction Loads Remaining (Lbs/Yr)	Extra Reduction (Lbs/Yr)
Rock Creek	02140206	Potomac	MO	Phosphorus	EOS-lbs/yr	369	1,300	352%	0	931
Upper Monocacy River	02140303	Potomac	FR CL	Phosphorus	EOS-lbs/yr	65	832	1280%	0	767
Potomac Trading Region - Phosphorus Extra Treatment Total										**2,631**
Gwynns Falls	02130905	WS/ES Susquehanna	BA	Sediment	EOS-lbs/yr	472,800	218,445	46%	254,355	0
WS/ES Susquehanna Trading Region - Sediment Treatment Remaining Total									**254,355**	
Bynum Run	02130704	WS/ES Susquehanna	HA	Sediment	EOS-lbs/yr	89,600	181,444	207%	0	95,844
Jones Falls	02130904	WS/ES Susquehanna	BA	Sediment	EOS-lbs/yr	90,800	129,164	142%	0	38,364
Liberty Reservoir	02130907	WS/ES Susquehanna	BA CL	Sediment	EOS-lbs/yr	450,000	532,711	118%	0	82,711
Patapsco LN Branch	02130906	WS/ES Susquehanna	AA	Sediment	EOS-lbs/yr	561,400	563,543	100%	0	2,143
WS/ES Susquehanna Trading Region - Sediment Extra Treatment Total										**219,062**
Liberty Reservoir	02130907	WS/ES Susquehanna	BA CL	Phosphorus	EOS-lbs/yr	554	798	142%	0	235
WS/ES Susquehanna Trading Region - Phosphorus Extra Treatment Total										**235**
Little Patuxent River	02131105	Patuxent	AA HO	Sediment	EOS-lbs/yr	991,000	900,852	91%	90,148	0
Patuxent Trading Region - Sediment Treatment Remaining Total									**90,148**	

Table 3-6: Example Internal Credit Trading Analysis

Watershed Name	Watershed Number	Trading Zone	County	Pollutant	Unit	SHA Reduction Target (Lbs/Yr)	Modeled Reduction Achieved (Lbs/Yr)	% Progress	Reduction Loads Remaining (Lbs/Yr)	Extra Reduction (Lbs/Yr)
Patuxent River Upper	02131104	Patuxent	AA HO PG	Sediment	EOS-lbs/yr	163,000	178,868	110%	0	15,868
Patuxent Trading Region - Sediment Extra Treatment Total										**15,868**

E.3 BACTERIA IMPLEMENTATION PLAN

E.3.a Bacteria TMDLs Affecting SHA

There are four EPA approved bacteria TMDLs with SHA responsibility spanning five Maryland 8-Digit watersheds (**Table 3-3).** The following TMDL documents for bacteria are addressed with this Plan:

- *Total Maximum Daily Loads of Bacteria for Impaired Recreational Areas in Marley Creek and Furnace Creek of Baltimore Harbor Basin in Anne Arundel County, Maryland*, approved by EPA March 10, 2011;
- *Total Maximum Daily Loads of Fecal Bacteria for Loch Raven Reservoir Watershed in Baltimore, Carroll and Harford Counties, Maryland*, approved by EPA December 3, 2009;
- *Total Maximum Daily Loads of Fecal Bacteria for Lower North Branch Patapsco River Watershed in Baltimore, Carroll, Anne Arundel, Howard Counties and Baltimore City, Maryland*, approved by EPA December 3, 2009; and
- *Total Maximum Daily Loads of Fecal Bacteria for the Patuxent River Upper Basin in Anne Arundel and Prince George's Counties, Maryland*, approved by EPA August 9, 2011.

For two of the TMDLs, the impairment and TMDL are for subwatersheds within the 8-digit watershed. In Baltimore Harbor, two of the tributary creeks are involved, and for Upper Patuxent River, the TMDL is for the lower half of the watershed.

- Baltimore Harbor (Marley and Furnace Creeks);
- Patapsco River, Lower North Branch;
- Upper Patuxent River; and
- Loch Raven Reservoir.

Table 3-3 shows a summary of the reduction requirements for the current SHA bacteria TMDLs. Two dates are shown including the EPA approval date and the baseline year set by MDE. The TMDLs were written at different times, based on monitoring data from different years. The baseline year published on the MDE Data Center will be used for SHA implementation planning. This usually correlates to the time period when monitoring data was collected for the MDE analysis.

E.3.b Bacteria Sources

Fecal indicator bacteria (FIB) are used to identify the presence of fecal matter, which indicates potential presence of pathogens associated with fecal matter. FIBs are not pathogens. A pathogen is a bacterium, virus, or other microorganism that can cause disease. MDE identified the FIB for which SHA is responsible, including:

- *E. coli*, and
- *Enterococcus.*

For most of the bacteria TMDLs, MDE has included some type of Bacterial Source Tracking (BST), which is a method of estimating the source of the bacteria by matching DNA or RNA with a library of samples from known species. BST has been used to categorize the fraction of bacteria coming from four general sources: humans, domestic pets, wildlife, or livestock. It is important to note that BST is performed on samples from the impaired water body, and thus the estimate of the fraction from each source is for the watershed as a whole, not from particular locations, jurisdictions, or permittees. The sources of bacteria in the four categories can be identified in further detail, as shown in **Table 3-7**. These have been derived from MDE's stormwater WLA bacteria guidance (MDE, 2014c) and Watershed Protection Techniques Article 17 (Schueler, 2000), which describes the sources to be addressed for load reduction in an implementation plan.

Table: 3-7 Bacteria Sources

Sector	MS4 Point Source	Non-Point Source
Human	Sanitary sewer illicit discharge	Septic systems
	Sanitary sewer exfiltration	Sanitary sewer overflow
	Homeless populations	Combined sewer overflow (CSO)
		Recreational boating
Domestic Pets	Pets, urban areas	Pets, rural areas
Wildlife	Urban wildlife	Non-urban wildlife
Livestock		Agriculture, hobby farms
		CAFOs

The bacteria sources listed as MS4 sources are all diffuse sources that enter the storm drain system either through runoff or cross-connections. SHA, as a MS4 permittee, by definition only has point source discharges. These sources can be treated by stormwater practices or load reduction strategies. Loads from the non-point source list are either discrete sources, which can only be addressed through a load reduction approach, or diffuse rural sources that do not flow through storm drains.

The sources are significant in relation to permit conditions. The TMDL SW-WLA is the only load that must be addressed to meet the permit requirements, so that reduction of loads from livestock, sewer overflows, or septic systems would not be applicable to meet the permit requirement. Bacteria from these sources generally enter the receiving waters directly.

Bacteria concentrations in stormwater runoff are typically elevated above the primary contact recreation standards, regardless of the type of land use in the watershed (Clary et al., 2008). This type of pollution is significant because, unlike the water that goes down a sink or toilet in your home and is fed to a WWTP or septic system, stormwater runoff that is not intercepted by a BMP, is untreated and drains directly to lakes, rivers, and ultimately the Bay.

SHA Bacteria Loading Sources

SHA-owned land is a small portion of each of the TMDL watersheds. Very few of the bacteria sources listed in **Table 3-7** exist within SHA's land. However, there is some very limited potential for bacteria to originate from SHA ROW.

SHA owns only two septic systems in these watersheds; one at the Hereford shop in Loch Raven Reservoir watershed and one at a salt storage facility in Patapsco Lower North Branch watershed. SHA's Facility Maintenance Division (FMD) has standard operating procedures that includes regular inspections and maintenance for facilities with onsite septic systems. This helps to prevent sanitary overflows that may cause bacteria pollution.

SHA does not own or maintain sanitary sewers, although some of these utilities may be present with the ROW. However, there is potential for a sewage leak from one of these utilities. SHA has program that conducts regular inspections and testing for any suspected illicit discharge within the drainage system. If an illicit discharge is confirmed, the SHA works with local jurisdictions to disconnect the discharge from the drainage system.

Potential for human or animal waste contamination is minimal. There are no residents or livestock pasture lands in the ROW, so the only source of animal waste bacteria would be feral animals, adjacent residents walking pets along SHA roads, drainage washing from pasture lands, or homeless individuals. Wildlife sources are typically generated as a non-point source throughout the watershed, and are typically deterred from SHA ROW for safety reasons.

E.3.c SHA Bacteria Model Methods

Baseline Loading for Bacteria

Unlike TMDLs for nutrients and sediment, MDE's bacteria TMDLs were not prepared using a watershed model. Loads discussed in the bacteria TMDLs are based on monitoring in the impaired water body. Fate and transport from the watershed are not accounted for, including the quantity of bacteria from various sources in the watershed, die-off (or growth) in transit to the water body, potential sequestering and re-suspension from bottom sediments, or other factors.

Given the circumstances that the TMDL documents do not provide watershed loads nor loads by land use, SHA does not consider it feasible to meet the numerical TMDL goals expressed as counts/day or counts/yr. The lack of a watershed model with usable loading rates, transformations, and reduction parameters that provide a calculation of the baseline, TMDL, and WLA loads means that implementation progress cannot be measured with this approach.

Instead, SHA plans to follow the general SW-WLA implementation guidance (MDE, 2014d) to determine whether TMDL requirements have been met:

> *… it is recommended that local jurisdictions demonstrate their progress towards achieving SW-WLAs by comparing reduction percentages rather than absolute loads.*

This approach will allow SHA to use land use and treatment data to develop baseline loads consistent with the baseline TMDL dates. Demonstrating progress by percent reduced will allow SHA to plan for the TMDL based on the best and most accurate data available on land use, sources, loading rates, and removal efficiencies.

Bacteria Reduction Requirements

Required reduction calculations described in **Section E.2** are used for the determining bacteria reductions also. Maximum Practicable Reduction (MPR) is based on reductions for each of the four source categories. Human sources potentially have the highest risk of causing disease, so the maximum reduction was set at 95 percent. The domestic pet reduction was based on an estimated success of education and outreach programs, set at 75 percent. The livestock target, also 75 percent, was based on the level of sediment reductions from agricultural BMPs. Wildlife reductions were assumed to be 0 percent.

The target reduction is based on MDE's requirement to determine a TMDL which will meet WQSs. This analysis removed the practicality constraints, with a maximum allowable reduction of 98 percent for all sources. The resulting reduction requirements were higher than the MPR for Loch Raven Reservoir overall and in one subwatershed for Patapsco Lower North Branch.

Table 3-8: Comparison of Bacteria MPR with Target Load Reductions by Source

	Domestic	Human	Livestock	Wildlife	Target
MPR	75.0%	95.0%	75.0%	0.0%	
Loch Raven	94.8%	91.9%	94.6%	60.6%	76.6%
Patapsco LNB	14.0%	56.6%	11.7%	0.0%	16.0%

In the TMDL documents, MDE has recognized that:

> *…the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices. … In cases where such high reductions are required to meet standards, it is*

expected that the first stage of implementation will be to carry out the MPR scenario." (MDE, 2009b; MDE, 2009c)

SHA Bacteria Reduction Modeling

MDE recommended the Watershed Treatment Model (WTM) (Caraco, 2013) as one of the models that could be used for implementation modeling for nutrients, sediment, and bacteria. It is a spreadsheet-based model that is capable of modeling loads from runoff and also other secondary sources that are associated with dry weather flows. For bacteria, it allows for input for all human sources except homeless populations, domestic pets, and livestock. Loads from wildlife are not modeled except as a contributor to runoff. It provides methods to estimate load reductions from both stormwater BMPs and source controls.

The model was selected because it was recommended by MDE, it could model almost all of the sources and controls that SHA would require, and as a spreadsheet, it is relatively easy to use. Documentation on SHA restoration modeling methods is under development and will be submitted to MDE for review and approval along with this Plan. The modeling documentation will provide detail on how the WMT was used to model bacteria loading and reductions.

The WTM models a single watershed. Loads from runoff and other sources are calculated individually, and then added to find the total untreated load for the watershed. Load reductions from source controls and stormwater BMPs are calculated individually, and then summed to find the total reduction. For stormwater BMPs, load reductions are calculated based on percent removal by BMP against the total load in the watershed. Loads to each BMP are not based on the type of land use in the treated drainage area. They are based on total drainage area and percent impervious.

Three scenarios can be modeled by the WTM:

- *Existing Loads* include current land use and treatment;
- *Loads with Future Practices* consist of current land use and proposed (future) treatment; and
- *Loads with New Development* include forecast changes in land use and the treatment associated with it. Models prepared for this analysis have not included any new development; only the first two WTM scenarios have been used.

The model consists of a number of interconnected worksheets and not all of them have been used for this analysis.

SHA manages restoration practice data associated with planning, design, construction, inspection, maintenance and credit verification through spatial geodatabases and an Microsoft Access database. Depending upon where the BMP is in the project development process, information may be found in different databases with different levels of data and tracking required. These sources are queried to develop input files for the WTM.

In addition, to implementation practice data, land use, land use loading rates, and reductions by implementation practice type are needed to utilize the WTM.

Land Use and Impervious Area Data

Land use within and adjacent to the ROW was described using the land use classifications, (i.e. residential, commercial, industrial, forest, agriculture) mapped by the MDP. SHA mapped its impervious cover using remote sensing methods. The source data for analysis was statewide orthophotography as of 2011. This impervious cover layer was overlaid on the land use, clipped to SHA ROW, resulting in a summary table of pervious and impervious area for each land use.

Bacteria Loading Rates by Land Use

The WTM uses a variation of the Simple Method (Schueler, 1987) to calculate loads from urban areas and export coefficients to calculate rural loads. The Simple Method requires area and percent impervious for each land use to calculate annual runoff, and an Event Mean Concentration (EMC) to calculate loads. The program's default data were used for rural loads, but urban loads were calculated using EMCs reported in the National Stormwater Quality Database (NSQD) (Pitt et al., 2004). The database included stormwater runoff data from NPDES permit applications and annual monitoring reports nationwide, organized by land use. Numerous constituents were analyzed, including two pathogens, fecal coliforms and fecal strep.

EMCs used in the model are shown in **Table 3-9**, which also cross-references land use categories from MDP and the NSQD.

Table 3-9: Bacteria EMCs Used for Modeling

MDP Land Use	MDP LU Codes	NSQD Land Use	EMC
Residential	11,12,13,191,192	Residential	8,345
Open Urban	18	Open Space	7,200
Commercial / Institutional	14,16	Commercial[1]	4,300
Roadway	80	Freeways	1,700
Industrial	15	Industrial	2,500

1. NSQD has a category for institutional, but no bacteria samples were reported.

Bacteria Removal Rates by BMP Type

A literature review was conducted for reports that summarized the results of BMP performance sampling for bacteria removal. The International Stormwater BMP Database (ISWBMPDB) (Leisenring, et al., 2014) was used to develop the BMP reductions.

The ISWBMPDB consolidates a large number of studies and appears to be a good source for the data. It should be noted that monitoring data have not been collected or reported for all of the BMPs that SHA could potentially use for TMDL implementation.

Three of the four TMDLs were based on sampling for *E. coli,* therefore, the data used to develop BMP efficiencies for this assessment used *E. coli* if available and fecal coliform otherwise. Finally, for BMPs which are not represented in the ISWBMPDB, alternate sources were used and noted.

Removal efficiencies were calculated as follows:

$$Removal\ Rate = \frac{EMC_{in} - EMC_{out}}{EMC_{in}}$$

Table 3-10 shows the BMP efficiencies to be used in the WTM for bacteria in implementation planning.

Table 3-10: SWM BMP Removal Rates for Bacteria

BMP	MDE Codes	SW BMP Database Type	Bacteria Type	Bacteria Reduction	Note
Bioretention (all soils)	FBIO, MMBR	Bioretention	*E. coli*	65%	1
Bioswales	ODSW, MSWB		*E. coli*	4%	1
Dry Detention Ponds	XDPD	Detention Basin	FC	60%	1
Dry Extended Detention Ponds	XDED	Detention Basin		60%	7
Impervious Surface Reduction*	NDNR, NDRR, NSCA, IMPF, IMPP			0%	3
Infiltration (all types).	IBAS, ITRN, MIBR, MIDW, MILS			90%	4
Outfall Enhancement with SPSC	SPSC			N/A	5
Permeable Pavement (all types).	APRP	Porous Pavement		58%	2
Stream Restoration	STRE			0%	3
Street Sweeping	MSS, VSS			N/A	5
Urban Filtering	FSND, FUND, FORG, FPER	Media Filter	FC	58%	1
Urban Tree Plantings	FPU			0%	3
Vegetated Open Channels	MSWG	Biofilter - Grass Swale		0%	6
Wet Ponds	PWET, PPKT, PWED, PMED, PMPS	Retention Pond	*E. coli*	95%	1
Grass Strip	--	Biofilter - Grass Strip		N/A	5
Green Roof	AGRE, AGRI			0%	3
Wetland	WSHW, WEDW, WPKT, WPWS	Wetland Basin	*E. coli*	53%	1

Notes:
1. Source is the 2014 ISWBMPDP; Median, 95% confidence inflow/outflow in MPN/100mL, *E. coli* or FC, FC preferred.
2. Permeable pavement with sand functions as a media filter.
3. Not a bacteria source
4. Source is the WTM v.3.0 Manual, 2001, based on Schueler estimate in 1987 that it's equivalent to septic systems.
5. No data available.
6. Studies not cited here indicate grass channels increase bacteria levels rather than removing them.
7. Dry ED ponds assumed to be as effective as dry ponds.

E.3.d Bacteria Reduction Strategies

SHA's bacteria reduction strategy will be an iterative process to address bacteria sources with the greatest impact on water quality, while considering difficulty of implementation and cost. SHA first started with using the WTM. Next, SHA will develop local monitoring data of stormwater outfalls in the SHA drainage system. Then, the data from the outfall monitoring effort is analyzed to identify any BMP in which water flowing from or in the BMP are not meeting bacteriological WQSs set by MDE. Source elimination will follow the analysis of the local monitoring data. In the source elimination stage SHA will seek to remove the source of the bacteria.

Watershed Treatment Modeling

The WTM was used to better understand what bacteria load reduction SHA can capture using the portfolio of BMPs that will be used to meet the required 20 percent impervious restoration goal. This model is summarized in **Section E.3**. The idea is to determine what impact the impervious surface restoration has on reducing the bacteria in the local watersheds. The expectation is where fecal bacteria are transported through our MS4 conveyance system, stormwater BMPs implemented to control urban runoff should help in reducing fecal bacteria loads in the watershed. The results of the WTM are shown earlier in **Table 3-3**.

Local Monitoring Effort

SHA will develop a protocol for monitoring stormwater outfalls and/or other BMPs that may have possible contaminated flow. This protocol is expected to be developed and approved by MDE by 2018. After the monitoring protocol is in place, SHA will start with sampling outfalls and BMPs in the watershed with a bacteria TMDL on a cost efficient schedule.

It is expected that during the local monitoring effort, SHA will be able to determine if there are any waters flowing from the MS4 drainage system where water quality is not meeting bacteriological WQSs. Once locations are identified, an effort to further investigate the source of the bacteria will be undertaken. SHA will review MDE's BST data for the identified area, and make a determination on what the potential source(s) of contaminate are. MDE's BST data tests microbial isolates collected from water samples and compares the isolates with a library from known sources to identify the host organism the bacteria came from. Once the BST data is examined a source can be identified and source elimination efforts can be focused.

Source Elimination

The effort to eliminate bacteria sources will focus on achieving load reductions for domestic pets, wildlife loads, and human waste only in Marley and Furnace Creek of the Baltimore Harbor Basin. These physical actions may include but not be limited to:

- Eliminating illicit sewer discharge connections discharging into stormwater collection systems;
- Addressing areas frequented by homeless populations; and
- Installing pet waste disposal bins on areas in SHA Row that have a high pet usage.

E.4 Polychlorinated Biphenyls (PCBs) Implementation Plan

E.4.a PCB TMDLs Affecting SHA

There are 10 EPA approved PCB TMDLs with SHA responsibility spanning 15 Maryland 8-digit watersheds (**Table 3-2).** The following TMDL documents for PCBs are addressed with this plan:

- *Total Maximum Daily Loads of Polychlorinated Biphenyls (PCBs) for Tidal Portions of the Potomac and Anacostia Rivers in the District of Columbia, Maryland , and Virginia*, approved by EPA October 31, 2007;
- *Total Maximum Daily Loads of Polychlorinated Biphenyls in the Northeast and Northwest Branches of the Nontidal Anacostia River, Montgomery and Prince George's County, Maryland*, approved by EPA September 30, 2011;
- *Total Maximum Daily Load of Polychlorinated Biphenyls in the Back River Oligohaline Tidal Chesapeake Bay Segment, Maryland*, approved by EPA October 1, 2012;
- *Total Maximum Daily Loads of Polychlorinated Biphenyls in the Baltimore Harbor, Curtis Creek/Bay, and Bear Creek Portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Maryland*, approved by EPA October 1, 2012;
- *Total Maximum Daily Load of Polychlorinated Biphenyls in the Bush River Oligohaline Segment, Harford County, Maryland, approved by EPA August 2, 2016*
- *Total Maximum Daily Load of Polychlorinated Biphenyls in Lake Roland of Jones Falls Watershed in Baltimore County and Baltimore City, Maryland*, approved by EPA June 30, 2014;
- *Total Maximum Daily Load of Polychlorinated Biphenyls in the Magothy River Mesohaline Chesapeake Bay Tidal Segment, Anne Arundel County, Maryland*, approved by EPA March 16, 2015.;
- *Total Maximum Daily Load of Polychlorinated Biphenyls in the Severn River, Mesohaline Chesapeake Bay Tidal Segment, Anne Arundel County, Maryland, approved by EPA July 19, 2016;*
- *Total Maximum Daily Load of Polychlorinated Biphenyls in the South River Mesohaline Chesapeake Bay Segment, Anne Arundel County, Maryland, approved by EPA April 27, 2015; and*
- *Total Maximum Daily Load of Polychlorinated Biphenyls in the West River and Rhode River, Mesohaline Segments, Anne Arundel County, Maryland, approved by EPA January 8, 2016.*

Table 3-2 shows a summary of the reduction requirements for the current SHA PCB TMDLs. Two dates are shown, the EPA approval date and the baseline year set by MDE. These TMDLs were written at different times, based on monitoring data from different years. The baseline year published on the MDE Data Center will be used for SHA's implementation planning. This usually correlates to the time period when monitoring data was collected for MDE's TMDL analysis.

SHA Proposed PCB No-Action Watersheds

SHA is proposing no action for some of the watersheds within the TMDL documents as discussed below.

For the Anacostia, Tidal Portion and Potomac River Upper Tidal-Prince Georges County's portion, SHA has not been able to determine a load reduction requirement based on the information given in the TMDL document. Instead of publishing a percentage, the MDE Data Center says "see report." Because of the way the reductions are listed in the tables in the TMDL report, with totals added together either by tributary or by segment or jurisdiction, it is not possible to determine a load reduction for these waterbodies so that SHA's requirement could be calculated.

In the Magothy River TMDL, modeling shows that tidal flows from the Chesapeake Bay mainstem tidal influence to the river were the source of 98.7 percent of PCBs and regulated stormwater was less than 0.2 percent. Because loads from resuspension and diffusion from bottom sediments, see **Table 3-11**, are not considered to be directly controllable loads and are considered as internal within the modeling framework of the TMDL; they are not included in the tPCB baseline load and TMDL allocation. MDE stated in the Final Magothy River TMDL (MDE, 2015b) that attenuation in the Bay will meet the TMDL in 43.4 years. MDE determined that reducing watershed loads by 100 percent would not appreciably change this date, and assigned a load reduction of 0.0 percent to regulated stormwater sources.

TMDL modeling has showed that tidal flows from the Chesapeake Bay to the South River were the source of 97.8% of PCBs and regulated stormwater was less than 0.2 percent. Attenuation in the Bay will meet the TMDL in 12.3 years. Much like the Magothy River TMDL, MDE determined that reducing watershed loads by 100 percent in the South River would not appreciably change this date, and assigned a load reduction of 0.0 percent to regulated stormwater sources for PCB TMDL of the South River.

As stated in the TMDL, the Potomac River Lower Tidal, Middle Tidal, and the Charles County portion of Potomac River Upper Tidal watersheds have a reduction requirement of 5 percent, which is entirely due to the Margin of Safety (MOS). Without the MOS, no additional reduction is required. The reduction attributed to the MOS is expected to be treated through the proposed 93% reduction in atmospheric deposition of PCBs.

TMDL modeling has showed that tidal flows from the Chesapeake Bay to the Severn River Mesohaline were the source of 98.2 percent of PCBs and regulated stormwater was less than 0.4%. Attenuation in the Bay will meet the TMDL in 46.2 years. MDE determined that reducing watershed loads by 100 percent would not appreciably change this date, and assigned a load reduction of 0.0% to regulated stormwater sources.

As stated in the TMDL, modeling showed that tidal flows from the Chesapeake Bay to the West and Rhodes Rivers Mesohaline were the source of 96.8 percent of PCBs and regulated stormwater was less than 0.2%. Attenuation in the Bay will meet the TMDL in 16.8 years. MDE determined that reducing watershed loads by 100 percent would not appreciably change this date, and assigned a load reduction of 0.0 percent to regulated stormwater sources.

E.4.b PCB Sources

The objective to establish a TMDL for PCBs is to ensure that the designated use is protected in each of the impaired waterbodies. Monitoring to identify the impairment may have been performed in the water column, in sediments, or in fish tissue depending on whether the impairment was for water contact recreation or fish consumption.

PCBs do not occur naturally in the environment. Therefore, unless existing or historical anthropogenic sources are present, their natural background levels are expected to be zero. Although PCBs are no longer manufactured in the United States, they are still being released to the environment via accidental fires, leaks, or spills from PCB-containing equipment; potential leaks from hazardous waste sites that contain PCBs; illegal or improper dumping; and disposal of PCB-containing products into landfills not designed to handle hazardous waste. Once in the environment, PCBs do not readily break down and tend to cycle between various environmental media such as air, water, and soil.

Sources are not identified in detail, either by land use or other breakdowns. Two non-point sources are related to the waterbody itself: resuspension and diffusion from bottom sediments and tidal exchange with the Bay. Bottom sediments were not considered a source in any of the TMDLs, since the PCBs stayed within the waterbody. The Bay tidal influence can be either a source or sink. For the Magothy, Severn, South and West and Rhodes River TMDLs, the Bay tidal influence is the single major source of PCBs. Back River, on the other hand, exports more PCBs to the Bay than it receives.

There are three diffuse watershed sources including atmospheric deposition, non-regulated watershed runoff, and NPDES regulated stormwater. Also there are four discrete sources: contaminated sites, WWTP facilities, industrial process water and Dredged Material Containment Facilities (DMCF), which are described by name in the TMDL. **Table 3-11** shows which sources are described in the seven TMDLs.

For PCBs, studies have shown the largest sources impacting stormwater are building demolition, building remodeling, and old industrial areas. The main pathways are runoff, wheel and foot tracking, and dust dispersion from industrial areas (San Francisco Estuary Institute [SFEI], 2010).

Table 3-11: PCB Sources in Each TMDL

Source	Contaminant	TMDL Watershed								
		Baltimore Harbor	Back River	Tidal Potomac/ Anacostia River	Non-Tidal Anacostia River	Lake Roland	Magothy River	Severn River	South River	West & Rhodes River
Non-Point Sources	Bottom Sediments									
	Chesapeake Bay Mainstem Tidal Influence						o	o	o	o
	Atmospheric Deposition	o	o	o		o	o	o	o	o
	Non-regulated Watershed Runoff	o	o	o	o	o	o	o	o	o
	Contaminated Sites	o	o	o	o	o	o			
Point Sources	Municipal WWTP and CSO	o	o	o	o	o		o	o	o
	Industrial Process Water	o								
	DMCF	o								
	NPDES Regulated Stormwater	o	o	o	o	o	o	o	o	o

Significance for SHA

SHA roadways pass through or in close proximity to areas that contain facilities or industries that may contribute PCBs to the environment. Two of the controllable sources in **Table 3-11** appear to fall under SHA's responsibility: contaminated sites and NPDES-regulated stormwater. SHA has conducted research on our industrial sites and to date has not discovered any legacy contaminated sites. Thus SHA is left with stormwater as the only source to be addressed now. SHA has not completed a comprehensive investigation of all of SHA's ROW and will do so in the future as part of SHAs PCB research study.

E.4.c SHA PCB Modeling Methods

Unlike TMDLs for nutrients and sediment, MDE's PCB TMDLs were not prepared using a watershed model. SHA's modeling will focus on runoff loads and reductions from stormwater BMPs. The approach to modeling PCB reductions is based on the results of a literature review of PCB sources and treatment.

Two documents from the CBP discuss PCB sources, pathways, and treatment. (Schueler and Youngk, 2015) summarized research nationwide. They reported that PCB sampling in San Francisco Bay showed urban stormwater was the dominant pathway for PCBs to enter the Bay. The Chesapeake Bay *Toxic Contaminants Policy and Prevention Outcome* (CBP, 2015) also concluded that stormwater was a significant pathway for both particulate and dissolved PCBs. Additionally, land use is also a factor.

Baseline Loading for PCBs

Loads discussed in the PCB TMDLs are based on monitoring the impaired waterbody. Watershed loads were estimated by deriving concentrations from the monitoring data and multiplying these by estimated flow rates to the impaired waterbody. As a result, the loads reported in the TMDL do not account for fate and transport from the watershed.

While PCBs can exist in stormwater in both dissolved and particulate forms, they are generally insoluble in water. Lighter compounds may dissolve and subsequently volatize to the air and heavier compounds bind to sediment. Schueler and Youngk (2015) discussed research indicating that a large portion of the PCB load was attached to sediment, including a sampling study in the Susquehanna River basin that showed 75 percent of PCB loads were associated with particulates. CBP (2015) concluded that contaminated soils were a predominant source of PCBs in stormwater. Both these reports and others (Gilbreath et al., 2012) found that runoff from older industrial areas tended to have a higher concentration of PCBs in runoff and in sediments.

Given the understanding that removal of contaminated sediment from stormwater can be an effective method of reducing the PCB loads, the modeling approach will be to focus on stormwater BMPs that treat sediment. The basis of the modeling will be Total Suspended Solids (TSS) loading and reduction calculations based on approved rates from MAST (2016) and MDE (2014a). This approach has also been documented by Interstate Commission on the Potomac River Basin (ICPRB) in the Tidal Potomac PCB TMDL.

Six of the seven TMDLs provide sufficient information on sediment concentrations to estimate an average value by watershed. No sediment data was reported in the TMDL for the Anacostia River Northeast and Northwest Branch. In lieu of this, data from the Tidal Potomac TMDL for Anacostia will be used.

SHA is responsible for PCB TMDLs located in multiple watersheds and counties with varying baseline years. This poses a challenge for SHA because accurate data for ROW area, land use, and impervious area prior to 2011 is unavailable. Also, with local TMDL baseline years ranging from 2000 to 2010, baseline loads are not reliable. Without a baseline, SHA is unable to track progress towards achieving SW-WLAs by comparing reduction percentages. For that reason; the same modeling approach implemented for nutrient and sediment TMDLs has been used.

PCB Reduction Requirements

The model uses a reduction target for SHA either published in the TMDL document or disaggregated. The target is compared to modeled reductions from restoration BMPs. This method is based on the assumption that like sediment, PCB is a conservative pollutant, and that loads exported from the watershed will approximate the loads in the waterbody, without significant loss or degradation in transport.

Reduction Modeling

The model is based on an Excel spreadsheet, using data derived from MAST and SHA's stormwater geodatabases. Documentation on SHA restoration modeling methods is under development and will be submitted to MDE for review and approval along with this implementation plan. The modeling documentation will provide detail on how PCB reductions were computed using this spreadsheet method. A brief description summary of process developed follows.
The model determines sediment reductions achieved by each type of practice and then multiplies the sediment reductions by a PCB concentration to determine the PCD reductions. Sediment reduction computations vary depending upon the type of restoration practice planned: stormwater control structures or inlet cleaning. Steps for determining sediment reductions for stormwater controls include:

- Sediment loading within the drainage area is determined by identifying the MAST land-river segment containing the BMP and recording the loading rate for SHA pervious and impervious land use. (MAST, 2016);
- TSS removal rates from the database are stored with each BMP, based on its type;
- Load removal (lb/ac/yr) is calculated for pervious and impervious area by multiplying land use loading rate by TSS removal rate; and
- TSS removed (lb/yr) is calculated by multiplying load removal by pervious and impervious area within the BMP drainage area.

Steps for determining sediment reductions for inlet cleaning include:

- GIS analysis of the area of SHA ROW within each shop boundary within each TMDL watershed;
- Fraction of ROW area in the TMDL watershed within each shop boundary;
- Lookup of dry weight of material collected from each shop;
- Calculation of material collected within the TMDL watershed by multiplying fraction of TMDL ROW by the total material collected; and
- Calculate TSS pounds removed using parameter from MDE Guidance (MDE, 2014a).

Computing PCB loads removed based on the sediment removal calculated in the previous steps includes:

- Add stormwater BMP and inlet cleaning pounds removed to find total sediment removed in each TMDL watershed and convert to grams;
- Multiply by PCB concentration factor of 80 ng/g (Schueler and Youngk, 2015) to find PCB load removed; and
- Multiply by 50% to account for inconsistency in BMP removal (results are in g/yr).

PCB Pollutant Loading Rates by Land Use

Loading rates for TSS were created using 2011 pollutant loading and land use acres from MAST v.5.3.2. This is the "2011 original" initial conditions background data with no BMPs. This date corresponds with the baseline date of October 21, 2010 used in developing the SHA baseline impervious accounting and restoration requirements. Loading rates have been calculated by averaging the loads for all land-river segments within a subwatershed by County for SHA MS4 Phase I/II Impervious, and SHA MS4 Phase I/II Pervious land uses. With the no-BMP scenario, loading rates for each SHA land use will stay constant for different baseline years, so these values will be valid for both the Bay TMDL and local TMDL analyses.

PCB Pollutant Removal Rates by BMP Type

The modeling approach has been to focus on stormwater BMPs that treat sediment. BMP removal rates for structural and ESD stormwater controls (ESD/Runoff Reduction (RR) and Stormwater Treatment (ST) practices), and alternative BMPs (catch basin cleaning have been created following MDE (2014a). For determining BMP efficiencies using MDE (2014a), the first version of the model assumes 1-inch of treatment for ESD/RR and ST practices. At a later time, when data on the amount of treatment and Pe for each BMP is confirmed and entered into the database, the model will be refined to use Pe to calculate reductions from greater than or less than 1-inch treatment. See **Table 3-12** for assumed PCB removal efficiencies.

Table 3-12: PCB BMP Pollutant Removal Efficiencies

MAST Description	Unit	BMP Type	TSS Removal
Structural / ESD BMPs			
Bioretention/Rain Garden	AC	RR/ESD	70%
Bioswale	AC	RR/ESD	70%
Dry Detention	AC	N/A	0%
Dry Extended Detention Pond	AC	N/A	0%
Retrofits	AC	-	65%
Urban Filtering	AC	ST	66%
Urban Infiltration	AC	RR	70%
Vegetated Open Channels	AC	RR	70%
Wet Pond	AC	ST	66%
Wetland	AC	ST	66%
Alternative BMPs			
Mechanical Street Sweeping	AC	Alt	10%
Regenerative/Vacuum Sweeping	AC	Alt	25%
Pavement Removal	AC	Alt	84%
Regenerative Stormwater Conveyance	AC	Alt	70%
Trees - Urban	AC	Alt	57%
Alternative BMPs			
Outfall Stabilization	LF	Alt	15/45
Stream Restoration - Urban, Coastal Plain	LF	Alt	15
Stream Restoration - Urban, Non-Coastal Plain	LF	Alt	45
Alternative BMPs			
Catch Basin Cleaning	TON	Alt	420

E.4.d PCB Reduction Strategies

SHA will implement an evolving management process that relies on four main PCB reducing efforts. The first strategy will be source tracking and elimination. The second effort will be to track PCBs reduction achieved from ongoing impervious restoration efforts for SHA's MS4 permit. SHA will develop a monitoring and evaluation plan to study the effects of natural attenuation in our PCB TMDL watersheds. Lastly, partnering efforts to reduce PCB concentrations in the local watersheds will be explored with other jurisdictions where it is perceived to be mutually beneficial for both parties.

WLA BMP Reduction Modeling

As a byproduct of meeting the impervious surface restoration required under the existing MS4 permit, many of the BMPs used to reduced nutrients and sediment TMDLs will provide a secondary benefit in removing PCBs associated with sediments. To model the removal of sediments that have PCBS attached to them from the watershed, SHA uses a PCB Stormwater Modeling Approach. The purpose is to determine what impact the impervious surface restoration has on reducing the PCB loads in the local watersheds. The expectation is that PCB binds to sediment in stormwater runoff and can then be transported through our MS4 conveyance system, thus stormwater BMPs implemented to control urban runoff should help in reducing PCB loads in the watershed. The results of the Stormwater Modeling Approach are shown earlier in **Table 3-3.**

Based on the low reduction achieved through the approach of building BMPs in the watersheds, SHA has concluded that a more effective way of achieving PCB load reduction is source tracking and elimination. Furthermore, MDE has specifically stated, "Reduction of PCB concentrations within stormwater runoff through BMP implementation is not deemed by MDE to be an effective strategy for removal of PCBs in the environment" (MDE, 2014e, p. 11).

Source Targeting and Elimination

According to MDE's main reports for PCB TMDLs, its noted that an effective way to meet the WLA is to implement a PCB source targeting and elimination effort. This will allow the administration to identify and eliminate PCBs at the source rather than an end of pipe situation in contaminated watersheds.

SHA will develop a protocol describing the process to implement steps that target a PCB source in the ROW. This protocol will also explain how SHA will evaluate feasibility of source elimination. SHA expects to have this protocol approved by MDE in 2018.

Monitoring and Evaluation Plan

SHA will continue to monitor the declining PCB concentrations in the local watersheds due to natural attenuation. This process will involve obtaining PCB concentration data directly from MDE and or other approved sources. SHA will to keep a record of the decline of PCB concentration decline in the water column and fish tissue.

Partnering Efforts

SHA will implement a partnering effort with other local jurisdiction to insure that PCB WLAs are met. However, at this time it has not been determined what this effort will entail. There may be a possibility to work with another agency on a public education campaign or contribute effort or money to a PCB cleanup effort in a watershed in which there is an SHA responsibility. It is anticipated that an overall reduction of PCBs released in the watershed will have a positive load reduction on SHA's WLA reduction goals.

E.5. Trash Implementation Plan

E.5.a. Trash TMDLs Affecting SHA

There are two EPA approved TMDLs for trash with WLAs assigned to SHA, and these are covering three watersheds. WLAs assigned to SHA in these separate TMDLs are listed in **Table 3-13 and 3-14** by watershed. The trash TMDLs with SHA responsibility include:

- *Total Maximum Daily Loads of Trash for the Anacostia River Watershed, Montgomery and Prince George's Counties, Maryland and the District of Columbia*, approved by EPA September 21, 2010; and

- *Total Maximum Daily Loads of Trash and Debris for the Middle Branch and Northwest Branch Portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Baltimore City and County, Maryland*, approved by EPA January 5, 2015 (includes separate WLAs for the Gwynns Falls and Jones Falls watersheds).

These allocations are written differently than the TMDLs discussed above. Rather than meeting the WLA by reducing loading down to the WLA level, this WLA represents an amount that must be collected and removed at 100 percent annually. This does not to mean that zero trash is left in the watershed, but that the assigned loads are to be removed in their entirety each year.

Trash to be removed for WLA (attributed to point sources) is defined as any items of a size to fit within a storm drain regardless of where it is found within the watershed. According to the Anacostia TMDL (MDE, 2010a):

> *The WLAs address trash items that can typically travel through sewer systems, while the LA is assigned to larger trash and debris that are attributed to activities such as dumping.*

SHA has currently been assigned only WLAs for trash in these watersheds and not load allocations (LA). SHA trash collection typically occurs within areas that drain to the MS4 including upstream of and within storm sewer systems, grass swales and ditches, stormwater control structures, outfalls, roadway side slopes, and streams.

Table 3-13: Anacostia River Watershed SHA Trash Allocations

WLA Lbs/Day	WLA Lbs/Year	5% MOS Lbs/Yr	Total Annual Responsibility (WLA + MOS) Lbs/Yr
Anacostia River MO County			
16.6	5,756	287.8	6,044
Anacostia River PG County			
38.7	13,461	673.05	14,134
Totals for Anacostia			
55.3	**19,217**	**961**	**20,178**

Table 3-14: Patapsco River Mesohaline Tidal Bay Segment SHA Trash/Debris Allocations

WLA Lbs/Day	WLA Lbs/Year	5% MOS Lbs/Yr	Total Annual Responsibility (WLA + MOS) Lbs/Yr
Gwynns Falls, BA County			
6.3	2,300	115	2,415
Jones Falls, BA County			
3.9	1,418.7	70.9	1,490
Totals for Patapsco Mesohaline TBS			
10.2	**3,718.7**	**185.9**	**3,905**

E.5.b. SHA Trash Baseline Calculations

SHA does not own any roadways within Baltimore City and therefore only maintains a presence in Baltimore County for the Patapsco watershed, which includes both the Jones Falls and Gwynns Falls watersheds. This area is mostly encompassed within the SHA Hereford and Owings Mills maintenance shops. In the Anacostia watershed, SHA owns roadways in both Montgomery and Prince George's counties and these areas are mostly encompassed by the SHA Fairland shop in Montgomery County and the Laurel and Marlboro shops in Prince George's County.

The baseline loads for these TMDLs are the amount of litter and trash removed during the year of monitoring for the TMDL (See **Table 3-15**). SHA currently collects a substantial amount of litter and trash with pick-up along roads and in structural stormwater control structures, street sweeping, and inlet cleaning. SHA does not currently characterize trash picked up along roadsides as qualifying as either WLA or LA, but the other types of trash collection are considered to qualify as WLA collection. The SHA Office of Maintenance (OOM) tracks trash removal by maintenance shop area rather than roadway or watershed.

Trash Baseline Roadside Trash Pick-up

SHA currently performs the following activities to pick up litter and trash along roadsides:

- Maintenance Crew Clean-ups – SHA's maintenance crew is responsible to perform a number of routine activities including trash clean-up as well as mowing, plowing, and other activities to ensure safety and environmental stewardship along the ROW. Trash clean-ups are performed regularly before mowing and supplemental clean-ups occur as needed or upon public request when possible.
- Contracted Crew Clean-ups – In addition to SHA maintenance crew clean-ups, OOM also issues trash removal contracts for supplemental clean-ups along the ROW. Contractors include private companies and inmate cleaning crews. Contracts are awarded for designated roadway segments and contractors are required to pick up on a regular schedule.
- Adopt-A-Highway (AAH) – SHA's AAH program utilizes volunteer groups that pick up litter along one to three mile stretches of non-interstate roadways. The groups are encouraged to perform this community service a minimum of four times per year for a two year period. (Not used in baseline calculations.)
- Sponsor-A-Highway (SAH) – The SAH program allows corporate sponsors to fund contracted clean-ups for one-mile sections of Maryland roadways. The sponsor has an agreement with a maintenance provider to remove litter from the sponsored highway segment. Segments are typically interstate roadways.

Table 3-15: Trash TMDL Baseline Years and WLA Percentages

Watershed	County	Baseline Year	TMDL[1] (Lbs/Yr)	WLA[2] (Lbs/Yr)	% of TMDL[2]
Anacostia	Montgomery	2009	309,200	243,256	79%
	Prince George's	2009	662,013	314,055	47%
Patapsco -Jones Falls	Baltimore	2011	149,067	130,153	87%
Patapsco - Gwynns Falls	Baltimore	2011	194,348	173,067	89%
Totals			**1,314,628**	**860,531**	

1. Trash load assigned to all point and non-point sources, excluded MOS.
2. MDE assigned this wasteload allocation for all point sources

Current SHA roadside trash pick-up data does not characterize the size of material picked up, and therefore SHA cannot differentiate between WLA and LA. A significant portion of trash currently collected may qualify as LA, and should not be counted towards the trash TMDL baseline WLA. As part of this Plan, a study will be conducted to characterize trash collected by SHA within these watersheds to determine what percentage qualifies as WLA. In the interim, an assumption based on the percent of WLA to overall TMDL for the specific watersheds is used as defined in **Table 3-15**. Current SHA baseline loads for roadside trash pick-up have been reduced to equal these percentages and are included in **Table 3-17**. Increases in roadside trash pick-up needed to meet the WLA will be divided by these percentages to determine the overall pick-up needed to ensure the WLA is provided.

SHA has determined that the loads collected through roadside trash pick-up within the shop boundaries during the year of monitoring are as listed in **Table 3-17** in the column titled 'Reported Trash Pick-up per Shop'. At the time the TMDL monitoring was conducted, trash collection was (and still is) reported by truckloads.

Baseline trash loads by watershed were computed based on the assumption that trash collected within the shop area is spread evenly over the SHA ROW. This number can be computed using percent of SHA shop ROW that lies within the watershed multiplied by the number of truckloads of trash picked up for the shop area, see **Table 3-16**. This number is then translated to pounds from truckloads based on a conservative estimate of 300 lbs/truckload, and is listed per shop in **Table 3-17** in the column labeled 'Calculated Trash Pick-up per Watershed (Lbs)'.

Table 3-16: SHA Shop ROW within Watersheds

Watershed[2]	County	SHA Maintenance Shop[3]	SHA ROW Within Shop (acres)	SHA ROW within Watershed (acres)	SHA ROW within Watershed (%)
Anacostia	Montgomery	Fairland	2,740	1,210	44%
	Prince George's	Laurel	3,925	2,344	60%
		Marlboro	5,646	509	9%
Patapsco - Jones Falls	Baltimore	Hereford	2,524	856	34%
Patapsco - Gwynns Falls	Baltimore	Owings Mills	3,252	1,662	51%
Totals			**18,087**	**6,581**	

Table 3-17: SHA Baseline Roadside Trash Pick-up							
Watershed[2]	**County**	**SHA Maintenance Shop[3]**	**Reported Trash Pick-up per Shop[4] (Truckloads)**	**Calculated Trash Pick-up per Watershed (Truckloads)**	**Calculated Trash Pick-up per Watershed (Lbs)[1]**	**WLA Percent of TMDL (%)**	**SHA WLA Baseline Pick-up[5] (Lbs)**
Anacostia	Montgomery	Fairland	505	223	78,054	79%	61,663
	Prince George's	Laurel	786	469	164,289	47%	77,216
		Marlboro	1,300	117	41,019		19,279
Patapsco - Jones Falls	Baltimore	Hereford	423	143	50,210	87%	43,683
Patapsco - Gwynns Falls	Baltimore	Owings Mills	527	269	94,267	89%	83,898
Totals			**3,541**	**1,222**	**427,839**		**285,739**

1. SHA tracks trash removal by truckload. SHA estimates 50 bags per truckload at 7 Lbs per bag, totaling 350 Lbs per truckload. Truckloads are multiplied by 350 to derive total Lbs.
2. Small portions of other shop boundaries fall within the watershed boundaries, but the area is so insignificant that the bulk of the TMDL responsibility lies with the shop identified above.
3. For locations of shop boundaries relative to the watershed, refer to the individual watershed discussions in Part IV for maps and descriptions.
4. Trash collection that should be continued annually to ensure baseline trash collection component of the TMDLs are met.
5. Amount of roadside pick-up that is considered to meet WLA removal is based upon the WLA % of total TMDL as listed in Table 3-15.

Trash Baseline Inlet Cleaning

SHA owns and operates vacuum pump trucks and routinely cleans storm drain inlets to remove sediment, gross solids, litter, and debris that accumulate inside drainage inlets and catch basins. Truckloads of debris removed are tracked and reported by SHA maintenance shop personnel. SHA estimates that on average, 300 pounds is removed from inlets (210 lbs dry weight) of which 8.9% is assumed to be trash (CWP, 2008a). See **Table 3-18** for baseline inlet cleaning trash removal reductions.

Trash Baseline Structural Stormwater Controls

MDE guidance from the TMDL Data Center, *Guidance for Developing Stormwater Wasteload Allocation Implementation Plans for Trash/Debris Total Maximum Daily Loads,* lists structural stormwater controls as an allowable trash load reduction practice (MDE, 2014f). The Patapsco Mesohaline TMDL cites 2.06 lbs/acre for transportation land use in Baltimore County while the Anacostia TMDL cites 2.22 lbs/ac. This trash land use loading is used in the TMDL models to estimate the WLAs and LAs.

There appears to be inconsistency between this loading rate and the WLA Anacostia watershed TMDL. When this rate is applied to SHA ROW within the watershed, the required WLA is much higher than the actual load being produced. In other words, SHA would be required to pick up more trash than is actually being deposited. Therefore, this rate does not seem to be well correlated to SHA land use and loading in the watershed, and cannot be used to model loads and reductions for stormwater control structures. See **Table 3-19** for these computations. Also, reduction efficiencies for structural stormwater controls have not been located that can be used along with land use loading to determine reductions achieved.

Table 3-18: SHA Baseline Inlet Cleaning for Trash Removal

Watershed	County	SHA Maintenance Shop	Reported Inlets Cleaned[1]	Calculated Baseline Inlets Cleaned[2]	Calculated Baseline Trash Removal[3] (Lbs./Yr)
Anacostia	Montgomery	Fairland	960	422	11,394
	Prince George's	Laurel	2,427	1,456	39,312
		Marlboro	1,389	125	3,375
Patapsco - Jones Falls	Baltimore	Hereford	731	249	6,723
Patapsco - Gwynns Falls	Baltimore	Owings Mills	1,777	906	24,462
Totals			**7,284**	**3,158**	**85,266**

1. Derived from 2014 inlet cleaning report. This level of inlet cleaning should be maintained to meet the TMDL baseline loads.
2. Derived by multiplying percentage of Shop ROW in watershed, as listed in Table 3-16, and multiplying by total inlets cleaned.
3. This assumes 300 pounds debris removed per inlet, of which 8.9% is trash, resulting in 27 lbs. per inlet.

Table 3-19: Comparison of TMDL Trash Loading Rates and WLA for Transportation

Watershed	County	SHA Shop[3]	SHA ROW (acres)	TMDL Roadway Loading Rates (lbs/ac)	Annual Load (lbs/yr)	WLA (lbs/yr)
Anacostia	MO	Fairland	1,210	2.22	2,686	6,044
	PG	Laurel Marlboro	2,853	2.22	6,334	14,134
Patapsco - Jones Falls	BA	Hereford	856	2.06	1,763	1,490
Patapsco - Gwynns Falls	BA	Owings Mills	1,662	2.06	3,424	2,415

The absence of reduction efficiencies for stormwater controls makes it difficult to model reductions accurately. Therefore, SHA is assuming the same 27 lbs/yr per structure reduction as was used for inlet cleaning. This assumption will be adjusted as more definitive reductions are located through literature search or monitoring.

SHA has in place many structural stormwater controls and also plans to build more in conjunction with future 20 percent reduction requirements anticipated to be included in the next MS4 permit. See **Table 3-20** for estimated baseline structural stormwater control trash reductions using 27 lbs/yr assumption.

Table 3-20: SHA Baseline Structural SW Control for Trash Removal

Watershed	County	SHA Maintenance Shop	No. Structural SW Controls	Calculated Baseline Trash Removal[1] (Lbs/Yr)
Anacostia	Montgomery	Fairland	49	1,323
	Prince George's	Laurel	47	1,269
		Marlboro	4	108
Patapsco - Jones Falls	Baltimore	Hereford	25	675
Patapsco - Gwynns Falls	Baltimore	Owings Mills	17	459
Totals			**142**	**3,834**

1. Using the same trash removal as inlets (27 lbs. per SW control) until a more definitive reduction can be located through literature research.

E.5.c. SHA Trash Reduction Strategies

The trash WLAs are the amount of trash to be removed and therefore no additional computations are necessary to determine SHA reduction requirements. Meeting the WLAs will entail both maintaining current baseline levels of trash collection and increasing efforts to meet the additional WLA. SHA must continue to measure and report annually levels of trash collection by the shops to ensure new levels are being met that include both baseline and increased activities. Activities will be increased gradually until the full baseline plus WLA is being met.

SHA proposes increasing current practices beyond baselines and adding a few new ones to capture the WLA loads including the following show in **Table 3-21**:

- Increase roadside litter and trash pick-up by contracted crews and sponsor-a-highway;
- Increase inlet cleaning;
- Construct new structural stormwater controls;
- Implement litter public education program; and
- Target drainage systems and waterways.

SHA proposes to both increase existing activities and add two new activities in order to meet the trash WLAs in each watershed. The increased activity descriptions are above under Section E.5.b, SHA Trash Baseline Calculations. Descriptions of the new activities are below.

Table 3-21:– Summary of Activities to Meet SHA Trash WLAs

Watershed	County	SHA Maintenance Shop	WLA	Increased Inlet Cleaning		New Public Education Program		Drainage Systems and Waterways		New Structural SW Controls		Increased Roadside Pick-up		Total Proposed Reduction Activities (WLA)	
			(Lbs/Yr)	(Lbs/Yr)	(%)	(Lbs/Yr)	(%)	(Lbs/Yr)	(%)	(Lbs/Yr)	(%)	(Lbs/Yr)	(%)	(Lbs/Yr)	(%)
Anacostia	Montgomery	Fairland	6,044	2,670	44%	725	12%	0	0%	108	2%	2,765	46%	6,268	104%
	Prince George's	Laurel	14,134	7,343	63%	1,696	12%	525	4%	189	1%	3,784	27%	14,205	100%
		Marlboro		668	26%										
Jones Falls	Baltimore	Hereford	1,490	0	0%	179	12%	350	23%	54	4%	914	61%	1,497	100%
Gwynns Falls	Baltimore	Owings Mills	2,415	0	0%	290	12%	0	0%	0	0%	2,181	90%	2,471	102%
Totals				**10,681**		**2,890**		**875**		**351**		**9,644**		**24,441**	

Litter Education and Outreach Program

SHA currently conducts many litter awareness initiatives. In order to improve the results of the anti-littering message, SHA has initiated a research study to determine target audiences, baseline levels of awareness of the negative impacts of littering, costs associated with littering, motivations for littering, and motivations to stop littering. Based on the results of this research, SHA will develop or improve existing messages and tactics for each segment of the target audience and develop methods to measure the success of the campaign. This serves as a source control measure to meet the trash removal requirement. New or improved activities may include:

- Updated SHA webpage for anti-littering message;
- Public outreach efforts such as storm drain stenciling, presentations to community and school groups, activity books stressing the Chesapeake Bay and local waterways, and event booths at pertinent events;
- Partnering with counties and watershed groups;
- Messaging including:
  - Radio;
  - Interpretive signage at SHA rest stops;
  - Social media feeds;
  - Bumper stickers;
  - Press releases and articles; and
- Other activities as determined to augment littering awareness.

Using a model similar to the Montgomery County Implementation Plan for the Anacostia River Watershed Trash TMDL (MC-DEP, 2012), SHA assumes that the anti-littering campaign will be effective at reducing litter by 12 percent of the WLA. To achieve this reduction, SHA estimates that the message will reach at least half of the traveling public in one way or another. The message will be at least 60 percent effective in promoting awareness and at least 40 percent of the aware audience will modify their behavior.

$$50\% \text{ X } 60\% \text{ X } 40\% = 12\%$$

Target Drainage Systems and Waterways

SHA is proposing to target drainage systems and waterways in each of the watersheds to augment roadside trash pick-up on an annual basis.

Trash TMDL End Dates

Both efforts of maintaining the current baseline and steadily increasing best practices to meet the trash loading reductions will be tracked and reported in the MS4 annual reports. Proposed end dates for meeting the reduction targets are indicated in **Table 3-2**. SHA will review new strategies and technology as they become available in order to further reduce trash loads. SHA will continue research to determine a trash load reduction for stormwater controls.