Annual Report
October 9, 2016

National Pollutant Discharge Elimination System
Municipal Separate Storm Sewer System
Permit No. 11-DP-3313 MD0068276
Permit Term October 2015 to October 2020

SHA
State Highway Administration
Maryland Department of Transportation





Submitted to:
Water Management Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, MD 21230

Submitted by:
State Highway Administration
Office Of Environmental Design
707 North Calvert Street, C-303
Baltimore, MD 21202

Larry Hogan, *Governor*
Boyd K. Rutherford, *Lt. Governor*

State Highway Administration
Maryland Department of Transportation

Pete K. Rahn, *Secretary*
Gregory C. Johnson, P.E., *Administrator*

October 11, 2016

Mr. Raymond Bahr
Sediment, Stormwater, and Dam Safety Program
Water Management Administration
Maryland Department of the Environment
1800 Washington Boulevard, Suite 440
Baltimore MD 21230

Dear Mr. Bahr:

The State Highway Administration (SHA) is pleased to submit this first Annual Report addressing conditions under the SHA National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit (11-DP-3313 MD 0068276) which took effect on October 9, 2015. The report covers compliance efforts from October 1, 2015 through June 30, 2016, includes an overview of SHA's MS4 program, and describes how SHA has progressed in implementing water quality improvements.

This submission includes one hard copy and an electronic version of the annual report and appendices, along with accompanying digital geodatabase files. The geodatabase information provided is prepared in compliance with Attachment A included in the October 9, 2015 MS4 Permit. A copy of the SHA *Impervious Restoration and Coordinated TMDL Implementation Plan* that was delivered to MDE on October 7, 2016, is also attached.

If you have any questions or need additional information regarding this delivery, please contact Ms. Karen Coffman at 410-545-8407 (or via email at kcoffman@sha.state.md.us) or me at 410-545-8640 (or via email at sram@sha.state.md.us).

Sincerely,

FR

Sonal Ram, Director
Office of Environmental Design

Enclosures: SHA MS4 Annual Report, 10/9/2016
Impervious Restoration and Coordinated TMDL Plan, 10/07/2016

Cc: Mr. Robert Shreeve, Office of Environmental Design, SHA
Ms. Karen Coffman, Office of Environmental Design, SHA
Mr. Brian Cooper, Sediment, Stormwater, and Dam Safety Program, MDE

National Pollutant Discharge Elimination System
Municipal Separate Storm Sewer System
Permit No. 11-DP-3313 MD0068276
Permit Term October 9, 2015 to October 8, 2020

First Annual Report

October 9, 2016

Submitted to:
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CD Digital Copies of the Annual Report and Appendices, Geospatial Database, and Data Dictionary

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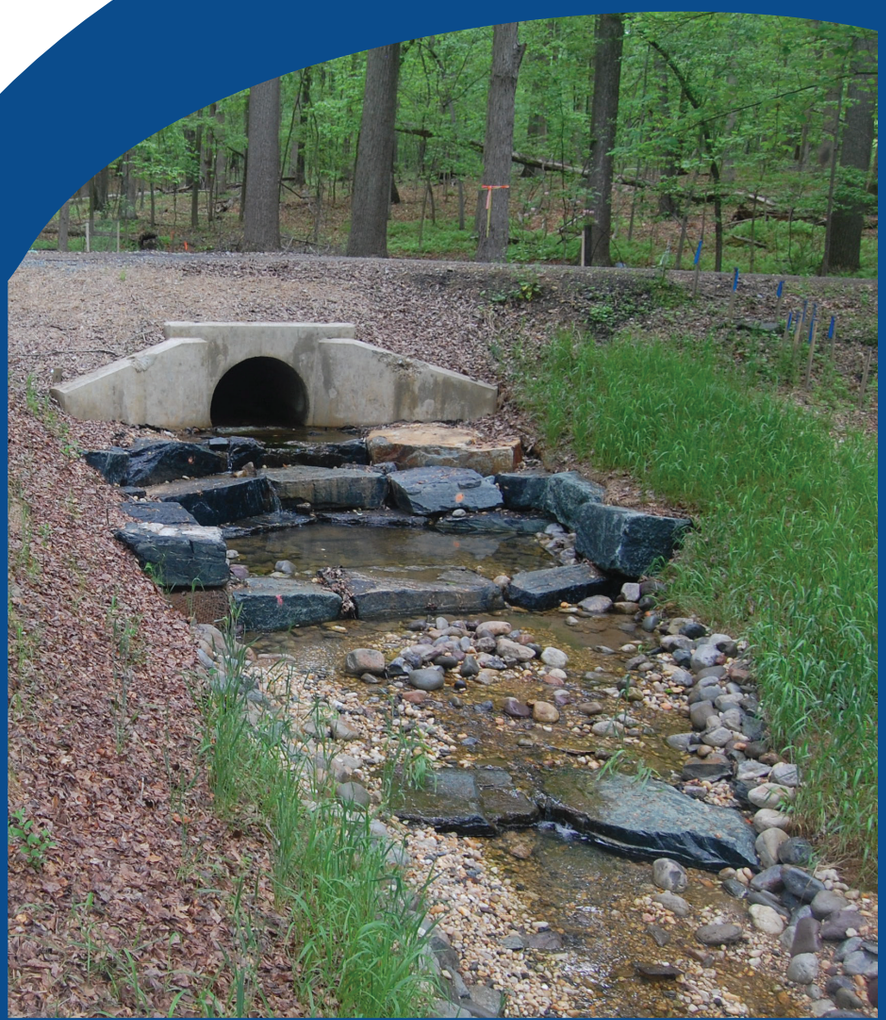
List of Acronyms

BMP	Best Management Practice
CFR	Code of Federal Regulations
COMAR	Code of Maryland Regulations
CWA	Clean Water Act
CCMS	Customer Care Management System
ECD	Environmental Compliance Division
ECU	Environmental Crimes Unit
EPA	Environmental Protection Agency
ESC	Erosion and Sediment Control
ESD	Environmental Site Design
FY	Fiscal Year
GIS	Geographic Information System
HEC-2	Hydrologic Engineering Centers – Water Surface Profiles
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HHD	Highway Hydraulics Division
HSPF	Hydrologic Simulation Program - Fortran
IDDE	Illicit Discharge Detection and Elimination
lbs	Pounds
MBSS	Maryland Biological Stream Survey
MD	Maryland
MDE	Maryland Department of the Environment
MES	Maryland Environmental Service
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
N	Nitrogen
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OAG	Office of the Attorney General
OED	Office of Environmental Design
OHD	Office of Highway Development
P	Phosphorus
PCB	Polychlorinated Biphenyls
PDF	Portable Document Format
PRD	Plan Review Division
RBP	Rapid Bioassessment Protocol
S	Sediment
SHA	State Highway Administration
SOIRP	Storm Drain and Outfall Inspection and Remediation Program
SWM	Stormwater Management
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorous
TPH	Petroleum Hydrocarbons
TSS	Total Suspended Solids
WLA	Waste Load Allocation
WMA	Water Management Administration
WPD	Water Programs Division
WQv	Water Quality Volume

Part One

Standard Permit Conditions and Responses





PART ONE

1. Standard Permit Conditions and Responses

Introduction

The State Highway Administration (SHA) is committed to continuing the National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Program efforts, and is pleased to partner with the Maryland Department of the Environment (MDE) Water Management Administration (WMA), the Environmental Protection Agency (EPA), and other NPDES jurisdictions in order to achieve the program goals.

The original SHA NPDES Phase I permit, MS-SH-99-011, was issued on January 8, 1999 and expired in 2004. This permit guided SHA through establishing an NPDES MS4 program.

The Phase II State and Federal Small MS4 General Permit (GP), 05-SF-5501, MDR 055501, was issued November 12, 2004 and expired November 12, 2009. SHA submitted an NOI for coverage under the Phase II MS4 GP and received authorization for coverage May 25, 2005. Under the authority of this Phase II permit, SHA extended the same MS4 program elements established under the Phase I permit to the SHA storm drain systems in Phase II areas.

The next Phase I permit (99-DP-3313, MD0068276, issued October 21, 2005 and expired on October 21, 2010) focused on improving water quality benefits, developing an impervious accounting database and developing a watershed-based outlook for stormwater management and MS4 program elements. SHA submitted a re-application for the Phase I permit on October 21, 2009 and a new permit was issued to SHA on October 9, 2015. This current permit covers SHA storm sewer systems in both the originally designated Phase I and Phase II jurisdictions. This report covers compliance with the permit that was issued in 2015.

This first annual report covers the period from October 1, 2015 through June 30, 2016. This timeframe is a shortened reporting period because SHA is adjusting the reporting timeframe from previously reported (October 1st through September 30th), which was based on the previous permit issuance date, to State Fiscal Year (FY) to comply with the current permit reporting requirement listed in Part V.A.1. The reporting period for future annual reports under this permit will cover a full FY.

Geographically, this report covers SHA compliance for storm drain systems owned or operated by SHA located within the NPDES counties of Anne Arundel, Baltimore, Carroll, Cecil, Charles, Frederick, Harford, Howard, Montgomery, Prince George's, and Washington and the cities of Cumberland, Salisbury, and Cambridge (See Figure 1-1 on the following page).

Part One lists permit conditions and explains SHA activities over the last year to comply with each one. Wherever possible, future activities and schedules for completion are provided. Part Two of this report discusses the SHA Stormwater and Drainage Asset Management Program in depth. Appendices are included at the end of the report that contains information on data, public outreach, research, responses to public comments regarding the SHA Impervious Restoration and Coordinated TMDL Implementation Plan, SHA's Restoration Modeling Protocol and the monitoring plan for watershed restoration.

A CD is included that contains portable document format (PDF) files of the report, database tables and GIS spatial data.

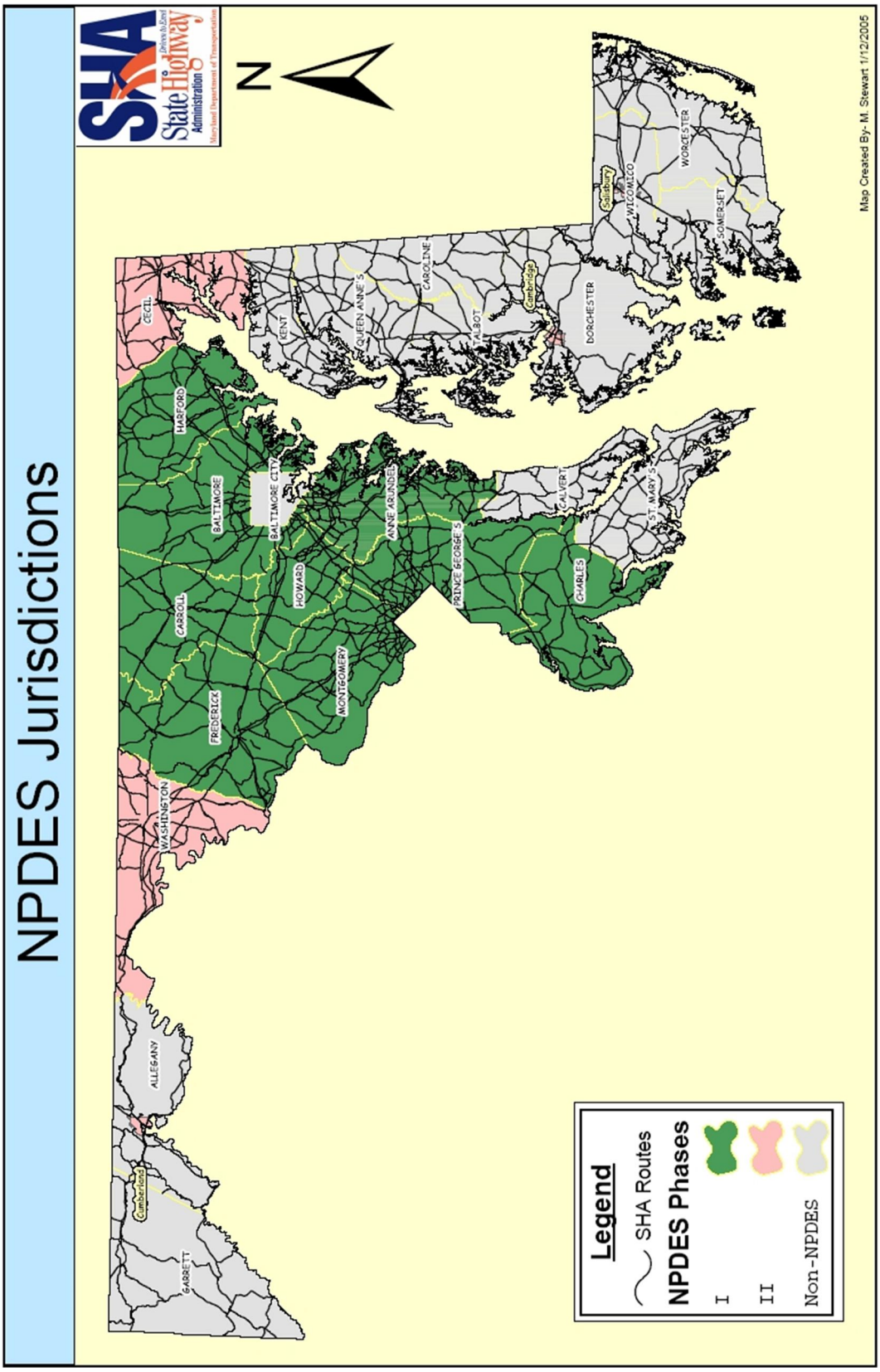


Figure 1-1: Municipal Separate Storm Sewer System (MS4) Jurisdictions

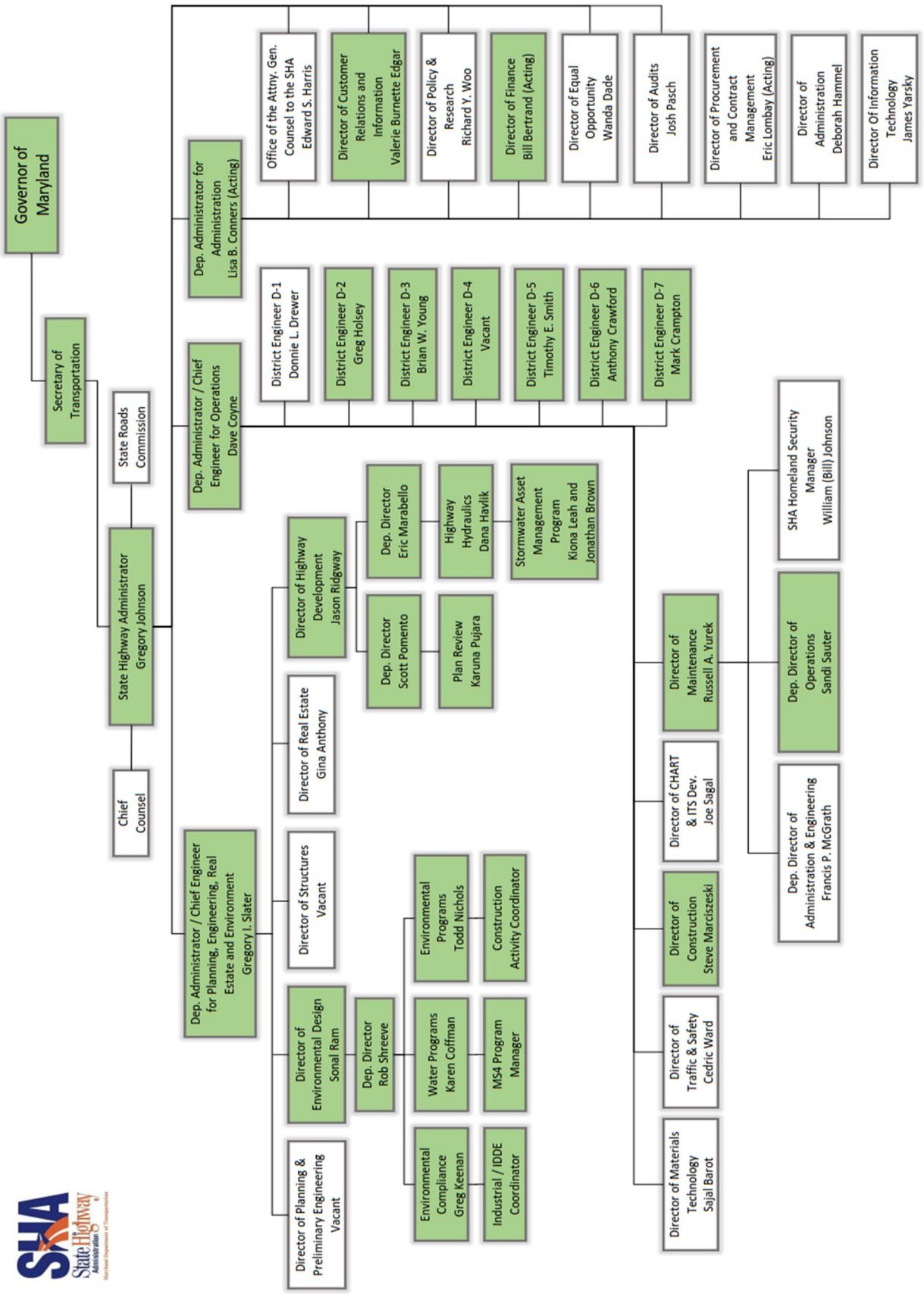


Figure 1-2: 2016 Organizational Chart for SHA NPDES MS4 Permit Administration

A. Permit Administration

Administration coordinator for the NPDES Program is listed below and an organizational chart detailing personnel responsible for major program components is included on page 1-3 as Figure 1-2.

Mr. Robert Shreeve
Deputy Director
Office of Environmental Design
(410) 545-8644
RShreeve@sha.state.md.us

The SHA Program Manager for the MS4 permit is:

Ms. Karen Coffman
Division Chief
Water Programs Division
Office of Environmental Design
(410) 545-8407
KCoffman@sha.state.md.us

B. Legal Authority

The following statement of legal authority was developed by the Assistant Attorney General and submitted with SHA's original permit application for the 1999 permit. It is under review by our current Attorney General Counsel for SHA and any necessary updates will be included in the report for next year. The requirements for legal authority contained in 40 CFR 122.26 are listed below with descriptions of how SHA meets them.

A demonstration that the applicant can operate pursuant to legal authority established by statute, ordinance or series of contracts, which authorizes or enables the applicant at a minimum to:

(A) Control through ordinance, permit, contract, order or similar means, the contribution of pollutants to the municipal storm sewer by storm water discharges associated with industrial activity and the quality of storm water discharged from sites of industrial activity:

The only legal manner in which a person may discharge or increase storm water runoff/volume into SHA's Municipal Storm Water Management System is by connection via access control permit issued in accordance with COMAR 11.04.05.06.C and D (commercial access) and 11.04.06.02.G (residential access). SHA assures that these permits limit volume and quality of stormwater input from adjacent properties. In addition, with respect to storm water runoff as a result of construction activity on state highways, SHA may, through contract, impose restrictions within the contract documents and, if violations with respect to storm water discharge is discovered, SHA may issue a stop work order which required the contractor and/or its subcontractors to cease and desist until the violations are corrected.

(B) Prohibit through ordinance, order or similar means; illicit discharges to the municipal separate storm sewer:

SHA does not enact ordinances per se, but may terminate or suspend a commercial or residential access permit as discussed above if a permit condition is violated or, as appropriate, may sue for injunctive relief to assure compliance in accordance with Maryland Transportation Code Annotated Section 8-625 (b). In the event the illicit discharge is caused by its contractor under a construction or maintenance project on a state highway, the procurement officer may issue a stop work order as discussed above which is an administrative order. The illicit discharges by persons other than permit holders or contractors (i.e., vehicles or pedestrians using the highway system) are prohibited by Md. Environ. Code Ann. §4- 410-413; and Md. Transp. Code Ann. §21- 1111(d) (dumping trash and oil into the storm sewer).

(C) Control through ordinance, order or similar means the discharge to a municipal separate storm sewer of spills, dumping or disposal of materials other than storm water:

These concerns are covered in the previous paragraph.

(D) Control through interagency agreements among co-applicants the contribution of pollutants from one portion of the municipal system to another portion of the municipal system:

The State Highway Administration occasionally enters into memoranda of agreement with other agencies, counties and/or municipalities and would, by contract, provide for the coordination required by this subparagraph.

(E) Require compliance with conditions in ordinances, permits, contracts or orders:

As discussed above, SHA may require compliance with conditions in its permit and contracts by suspending privileges there under or issuing stop work or other appropriate orders in order to obtain compliance. Additionally, SHA may resort to legal action in the courts to enforce compliance.

(F) Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance and noncompliance with permit conditions including the prohibition on illicit discharges to the municipal separate storm sewer:

Compliance with permit conditions is determined routinely by inspections by SHA employees or consultants. Ordinarily, the permits issued are for construction of road access onto a state highway, which roads are subsequently dedicated to a public entity (i.e., a county dedication) or are part of a parking area open to the public. To our knowledge, there are no properties or developments for which permits are issued that are of such a nature as to prohibit subsequent inspection.

C. Source Identification

According to the permit language, source identification deals with identifying sources of pollutants in stormwater runoff and linking these sources to specific water quality impacts on a watershed basis.

Requirements under this condition include submitting information annually for all SHA stormwater infrastructures within the permit area:

1. *Storm drain systems: Delineate all infrastructure, major outfalls, inlets, and associated drainage areas;*
2. *Industrial and commercial sources: Identify industrial and commercial land uses and sites that have the potential to contribute significant pollutants to SHA storm drain systems;*
3. *Urban best management practices (BMPs): Collect stormwater management facility data including outfall locations and delineated drainage areas;*
4. *Impervious surfaces: Delineate SHA-owned and private land owned (if within SHA BMP drainage area) controlled and uncontrolled impervious areas based on, at a minimum, Maryland's hierarchical eight-digit sub-basins;*
5. *Monitoring locations: Locations established for chemical, biological, and physical monitoring of watershed restoration efforts and the 2000 Maryland Stormwater Design Manual; and*
6. *Water quality improvement projects: Projects proposed, under construction, and completed with associated drainage areas delineated, when applicable.*

C.1 Storm Drain System

SHA completed the inventory of drainage infrastructure, major outfalls, stormwater management facilities and associated drainage areas in 2008. A spatial GIS database was developed and since then SHA has been performing regular updates of the drainage infrastructure including new or altered storm drain systems and new or retrofitted SWM facilities. In the past year, significant effort and resources were allocated to complete updates of the SWM inventory and the associated drainage infrastructure to properly establish baseline impervious treatment.

Although the main focus has been to create a source identification and drainage/stormwater assets database for the MS4 jurisdictions, SHA has also added similar protocols for tracking drainage and stormwater infrastructure information in the remaining Maryland counties with the exception of Allegany and Garrett. The drainage assets inventory in those counties will be developed in 2017 and 2018.

The stormwater and drainage assets database allows for effective project planning and remediation effort prioritization. SHA has

expanded the drainage system inspection program by adding video inspections to allow for precise assessment of system functionality. In the past year, SHA purchased a total of nine video cameras to allow each SHA District Office to inspect drainage systems within their jurisdictions as needed. The future plan is to perform a systematic corridor assessment of drainage systems where the storm drain pipes and culverts are reaching the end of their service life, and incorporate pipe replacement or repair into roadway resurfacing projects. The video inspection information will be linked to the drainage assets database for future reference.

SHA is also in the process of updating the current data structure to integrate new data standards provided in the final version 1.1 of MDE's *NPDES MS4* Stormwater Program Geodatabase as described in the *MDE NPDES* Geodatabase *Design and User's Guide* published March 2015 (MDE 2015 Geodatabase Guidance) and the documentation requirements in the *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* guidance published by MDE in August 2014 (MDE 2014 Accounting Guidance). SHA provided the infrastructure, major outfalls, inlets and associated drainage areas in a supplemental geodatabase separate from the standard MDE NPDES MS4 Stormwater Program Geodatabase. GIS data submittals are described in additional detail in Appendix A of this report.

The schedule for future stormwater inspections, illicit discharge detection and elimination (IDDE) and infrastructure Source ID updates is detailed in Table 1-1.

Table 1-1: Inspection, IDDE and Source ID Schedule

Jurisdiction	Earliest Inspection of Recent Effort	Next Inspection, IDDE & Source ID Completed By
Prince George's County	March-14	April-17
City of Cambridge	April-14	April-17
City of Salisbury	April-14	April-17
Cecil County	June-14	June-17
Montgomery County	June-14	June-17
City of Cumberland	September-14	September-17
Anne Arundel County	August-15	September-18
Harford County	September-15	October-18
Baltimore County	March-16	April-19
Charles County	March-16	April-19
Frederick County	March-16	April-19
Howard County	March-16	April-19
Washington County	August-16	August-19
Carroll County	August-16	August-19

C.2 Industrial and Commercial Sources

SHA will prepare a GIS data layer by June 30, 2018 (FY18) to identify industrial and commercial land use and sites that have the potential to contribute significant pollutants to SHA storm drain systems. This layer will comply with the new permit requirements. SHA will gather the following datasets through our public outreach efforts which could include a Standard Industrial Classification (SIC) or North American Industry Classification System (NAICS) code used to identify commercial or industrial properties:

- Property polygons

- Property centroids
- Most current land-use layer
- County owned SIC code point layer

If data is unavailable from the MS4 counties, SHA will use other means to obtain the source data required to prepare the dataset. SHA will also use the following documentation to identify additional commercial and industrial permit holders:

- General Permit for Discharges from Stormwater Associated with Industrial Activities (12-SW)
- Maryland Phase WIP Appendix G – NPDES Dischargers
- Bureau of public records use code (BPRUC)

SHA will compile a statewide commercial and industrial dataset to track the annual visual inspections of these properties as required by the permit.

C.3 Urban Best Management Practices (BMPs)

The drainage and stormwater assets inventory data will be continuously updated as it is presented in Table 1-1 and eventually expanded statewide to allow data driven decision making for infrastructure system preservation projects and systematic remediation efforts. SHA has provided the urban BMP information in the MDE NPDES MS4 Stormwater Program Geodatabase format.

Part Two of this report focuses on components of the SHASWM and Drainage Asset Program. This includes inventory, inspections, drainage area delineation to determine the level of treatment, functional rating, assessment for remedial activities, project planning, design and implementation of remedial and retrofit projects. All SHA drainage outfalls within MS4 counties have been identified and captured in the spatial database. Efforts beyond the MS4 counties continue to identify outfalls within SHA ROW. The stormwater and drainage assets database is an excellent resource during drainage investigations, when addressing public flooding issues, or during assessment of outfall channel stability. It is an essential tool for initiating drainage improvement projects-, stormwater retrofits, major remediation and outfall stabilization planning, as well as rapidly addressing any emergency repairs.

C.4 Impervious Surfaces

SHA's baseline impervious accounting assessment has been completed based on the MDE 2014 Accounting Guidance. As discussed in Appendix A of this report, SHA provided the impervious surface areas in a supplemental geodatabase separate from MDE's NPDES MS4 Stormwater Program Geodatabase

Table 1-2 and Figure 1-3 (on the following pages) display the baseline controlled and uncontrolled impervious numbers as well as a graphic illustration of the controlled and uncontrolled impervious surfaces by county. SHA has provided the impervious accounting information in the MDE NPDES MS4 Stormwater Program Geodatabase format.

More information about the impervious accounting process, schedule, and resulting baseline is provided in Section E.2.a of this report as well as in the *SHA Impervious Restoration and Coordinated TMDL Implementation Plan* (SHA Implementation Plan), submitted to MDE on 10/7/2016 and available on the SHA MS4 website.

Table 1-2: SHA Baseline Impervious Accounting by County

County	Total SHA Owned Impervious Acreage	Baseline Treated Impervious (AC)	Untreated SHA Owned Impervious Acreage
Anne Arundel	3334.40	500.92	2833.48
Baltimore	3514.63	242.39	3272.25
Carroll	1273.02	71.70	1201.33
Cecil	1151.75	108.07	1043.68

Table 1-2: SHA Baseline Impervious Accounting by County

County	Total SHA Owned Impervious Acreage	Baseline Treated Impervious (AC)	Untreated SHA Owned Impervious Acreage
Charles	1271.29	128.96	1142.33
Frederick	2340.28	278.44	2061.85
Harford	1631.70	103.97	1527.73
Howard	2003.34	317.03	1686.31
Montgomery	3391.40	311.33	3080.07
Prince George's	4091.75	537.49	3554.27
Washington	1951.71	88.08	1863.64
Allegany (Cumberland)	96.86	0.00	96.86
Dorchester (Cambridge)	68.45	1.40	67.06
Wicomico (Salisbury)	180.82	16.04	164.78
Total	**26,301.45**	**2,705.80**	**23,595.65**

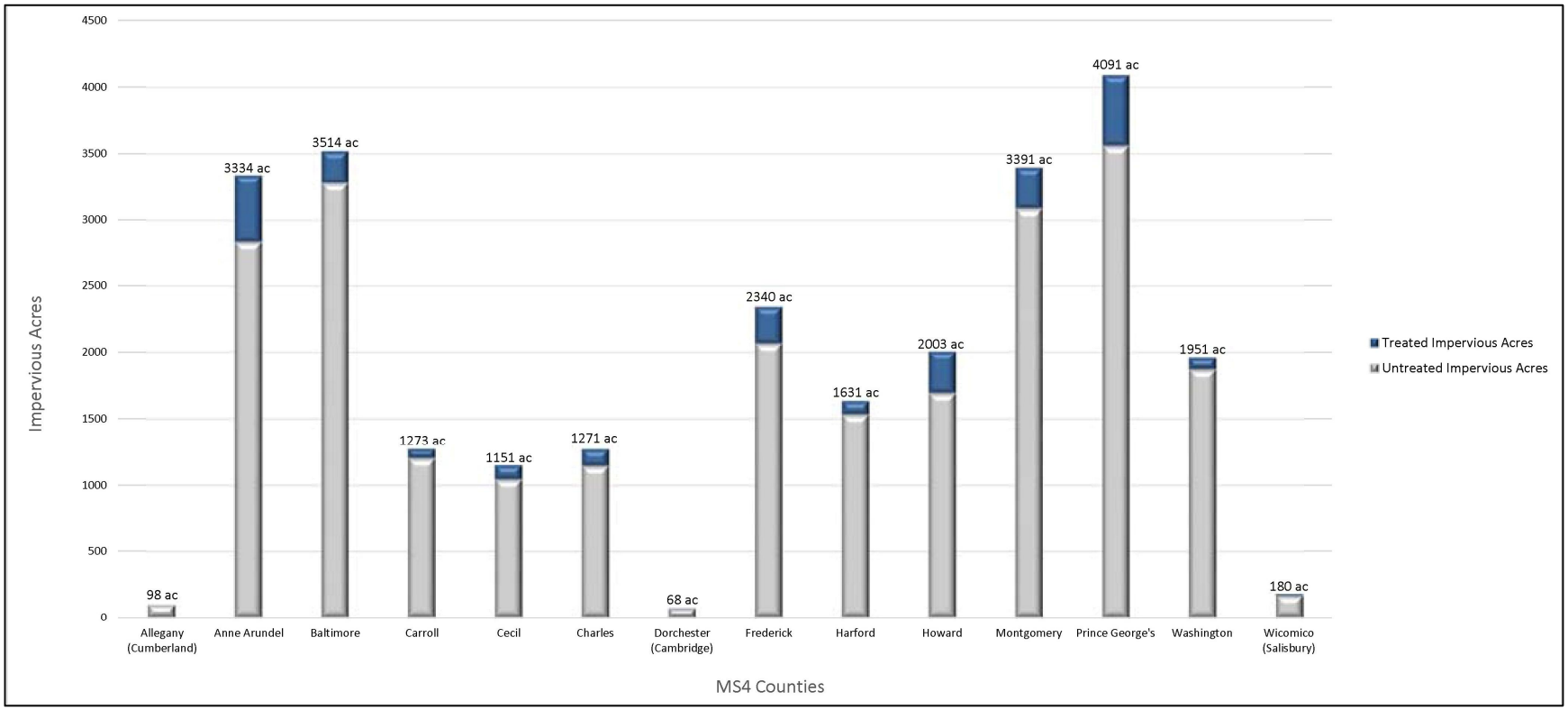


Figure 1-3: SHA Impervious Restoration Progress by County

(Note: Total SHA impervious acres for each county are noted above each bar.)

C.5 Monitoring Locations

Watershed Restoration Assessment

Chemical, physical, and biological monitoring will be performed to determine the effectiveness of restoration efforts at Little Catoctin Creek in Frederick County. . The restoration reach runs in a southeasterly direction from MD 180 and the total length of the stream channel proposed to be restored is approximately 3,100 linear feet of the Little Catoctin Creek main-stem.

For both pre and post restoration efforts, physical monitoring locations will be established in six locations within the project reach. For both pre and post restoration efforts, chemical monitoring locations will be sited at the top and bottom of the project reach. Biological monitoring locations will coincide with the physical monitoring reaches for both pre and post construction efforts. Sampling locations will be randomly taken through the project reach stream corridor. SHA has provided the monitoring locations in the MDE NPDES MS4 Stormwater Program Geodatabase format.

The Little Catoctin Creek monitoring plan is discussed in detail under Section F.1 of this report and the revised monitoring plan can be found in Appendix G.

2000 SWM Manual Implementation Assessment

SHA has coordinated with MDE on a project site location to fulfill permit condition IV.F.2. The site has not been agreed upon at this time, so no monitoring site data is included with this annual report. More discussion related to this is can be found in Section F.2.

C.6 Water Quality Improvement Projects

SHA has provided the water quality improvement project information for completed projects in the MDE NPDES MS4 Stormwater Program Geodatabase format. Data includes only completed projects at this time and does not include projects with a status of planning or under construction. Further discussion on progress meeting restoration goals is included in Section E.4.

For more information on SHA's proposed and under construction water quality improvement projects, please refer to Tables 2-2a – 2-2g in the SHA Implementation Plan, which provide a comprehensive list of annual operations practices and completed, planned, and under construction impervious restoration practices broken down by fiscal year. Additionally, proposed practices to meet various pollutant reductions for each impaired watershed with SHA assigned WLAs are shown in Section IV of the SHA Implementation Plan.

D. Management Programs

A management program is required to limit the discharge of stormwater pollutants to the maximum extent practicable (MEP). The idea is to eliminate pollutants before they enter the waterways. This program includes provisions for stormwater management, erosion and sediment control, IDDE, trash and litter reduction, property management and maintenance, and public education concerning stormwater and pollutant minimization.

D.1 Stormwater Management

The continuance of an effective stormwater management program is the emphasis of this permit condition. Requirements under this condition include:

a) Implement the stormwater management design principles, methods, and practices found in the 2000 Maryland Stormwater Design Manual;

b) Maintain programmatic and implementation information including but not limited to number of plans received, number of projects received, number of exemptions issued and number and type of waivers received and issued;

c) Maintain construction inspection information according to COMAR 26.17.02 for all ESD treatment practices and structural stormwater management facilities; and

d) Conduct preventative maintenance inspections according to COMAR 26.17.02 of all ESD treatment systems and structural stormwater management facilities at least on a triennial basis.

D.1.a Implement 2000 SWM Design Manual and Regulations

SHA continues to comply with Maryland State and federal laws and regulations regarding SWM as well as MDE permit requirements. SHA also continues to implement the practices established in the 2000 Maryland Stormwater Design Manual and the Maryland State Highway Administration Sediment and Stormwater Guidelines and Procedures (November 24, 2015) for all projects. SHA remains in compliance with the Stormwater Management Act of 2007, including the revised Chapter 5 of the 2000 Maryland Stormwater Design Manual, by implementing environmental site design (ESD) to the maximum extent practicable (MEP) for all new and redevelopment projects.

The SHA Plan Review Division (PRD) tracks SHA's progress towards satisfying the requirements of the Stormwater Management Act of 2007 (the Act) and identifies and reports problems and modifications needed to implement ESD to the MEP in its quarterly reports to MDE. During this reporting period PRD worked collaboratively with MDE to prepare draft Technical Procedures which were submitted to MDE for review in February 2016. PRD anticipates continuing this collaborative approach with MDE to finalize the Technical Procedures by February 2017.

As part of their reporting, PRD also makes required modifications to the plan review and approval processes to comply with the Act. During the reporting period, PRD made several minor changes or modifications to the Administrative Procedures such as consolidation of the Inspection, Compliance, Enforcement, and Plan Modification into its own section and updating the Water Quality Banking section.

D.1.b Maintain Programmatic and Implementation Information

SHA and MDE signed a Memorandum of Understanding (MOU), dated July 8, 2014, designating SHA as an approving authority for both erosion and sediment control and stormwater management for all SHA projects. This authority was given by a letter of authorization from MDE on February 24, 2015. SHA's approval authority lies with the PRD under the Office of Highway Development (OHD). PRD's sole responsibility is to review and approve SHA stormwater management and erosion and sediment control plans. The Plan Review Division is separate and distinct from the OHD design divisions. The Plan Review Division is supervised by the Deputy Director of Permits and Utilities who does not oversee design functions while the divisions responsible for engineering design are supervised by the Deputy Director of Programs. PRD maintains a database to track stormwater management submittals and design progress on all SHA projects.

During FY 2016, PRD received 610 submissions on 216 projects, provided 579 comment memoranda, approved 143 concept design stage submittals, approved 69 site development stage submittals, and issued 56 final approvals statewide.

ESD must be implemented to the MEP. However, there are situations that warrant relaxing stormwater management requirements due to site specific circumstances. For those situations, waivers or variances may be applicable. During the reporting period, PRD granted 54 SWM quantity and quality control waivers and granted 40 variance requests for SWM quantity control. To satisfy the requirements of SHA's delegated review and approval authority, PRD submitted its combined Second and Third Quarterly Report to MDE on November 24, 2015 covering the period May 2, 2015 through July 31, 2015 and August 1, 2015 through November 1, 2015. PRD submitted its Fourth Quarterly Report to MDE on February 22, 2016 covering the period November 2, 2015 through February 1, 2016. SHA has provided the stormwater management information in the MDE NPDES MS4 Stormwater Program Geodatabase

format. A summary by MS4 Jurisdiction is presented below in Table 1-3.

Table 1-3: Stormwater Management Review and Approval

Jurisdiction	Number of Projects	Review Submissions	Comment Memoranda	Concept Design Submittal Approvals	Site Development Stage Approvals	Final Approvals	Granted SWM Waivers	Granted SWM Variances
Anne Arundel	12	30	26	6	1	2	10	3
Baltimore	20	45	40	9	6	0	6	5
City of Cambridge	1	6	2	1	1	1	0	0
Carroll	7	19	19	3	2	0	0	1
Cecil	6	25	25	2	2	2	2	2
Charles	5	7	6	3	0	0	0	0
City of Cumberland	3	8	7	2	1	1	0	0
Frederick	15	45	43	10	2	2	3	4
Harford	4	13	12	2	0	1	0	0
Howard	7	20	20	4	4	5	1	2
Montgomery	29	84	80	22	9	7	16	4
Prince George's	24	69	64	18	8	6	2	4
City of Salisbury	3	6	14	3	1	1	1	3
Washington	11	35	35	6	6	5	2	1
MS4 Totals	**147**	**412**	**393**	**88**	**42**	**33**	**43**	**29**
Outside MS4	69	204	186	55	27	23	11	11
Statewide Total	**216**	**616**	**579**	**143**	**69**	**56**	**54**	**40**

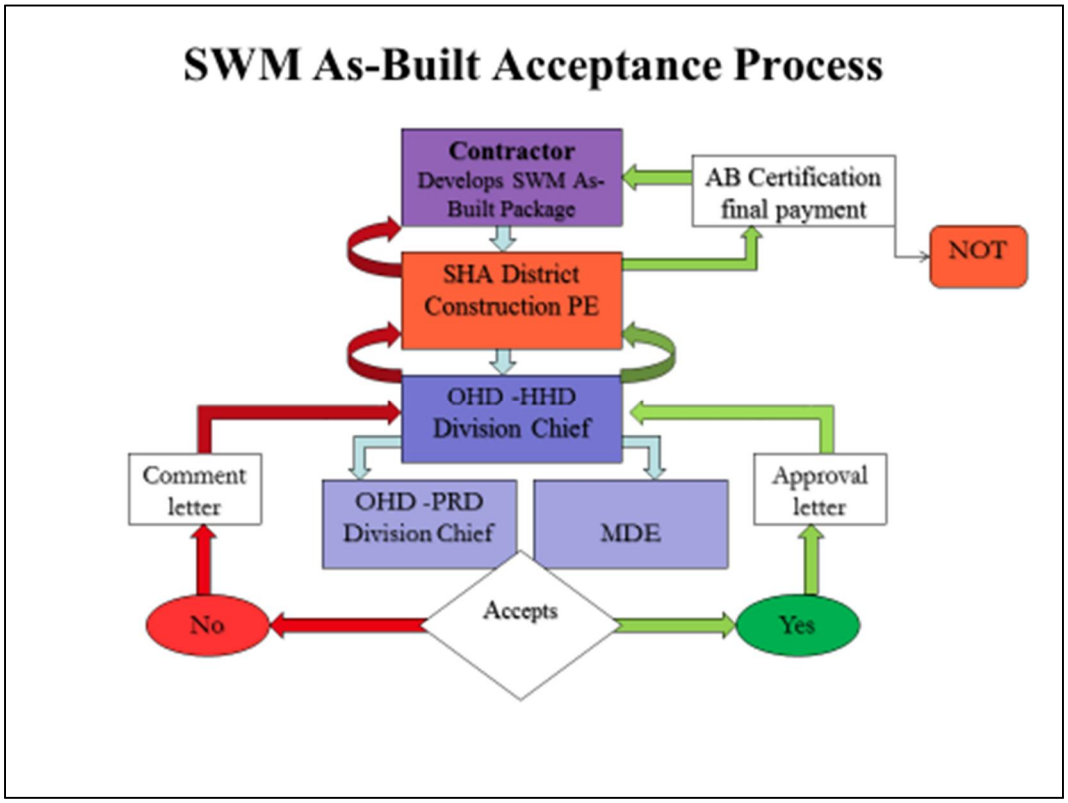


Figure 1-4: Internal Process for SWM As-Built Coordination

D.1.c Maintain Construction Inspection Information

SHA maintains and continues to improve the SWM facility as-built (AB) certification process in order to comply with the SWM approval and COMAR requirements. See Figure 1-4 for AB certification process flow chart. This process assures verification of proper construction of SWM facilities to meet the intent of the design. Throughout the SWM facility construction process, the Contractor's SWM as-built inspector coordinates with both the Office of Construction and the Contractor to perform required inspections during construction and to document information in the MDE as-built tabulations and construction checklists. The Contractor's as-built inspector certifies the SWM facility was constructed according to the approved design plans, within allowed tolerances, as stated in the SHA issued SWM Facility AB Certification Special Provision included in the Contract Documents.

The SWM AB certification is a separate pay/bid item in the contract documents for each project; this provides the contractor additional incentive to comply with regulatory requirements.

The HHD project engineer coordinates with MDE/PRD on the review and acceptance of the AB certified plan. The construction project cannot be closed out and accepted for maintenance until the SWM AB plans have been found acceptable by MDE/PRD. When SWM facilities do not meet the designed parameters or allowed tolerances as determined by either SHA or MDE, the Contractor must perform corrective construction or reconstruction, facilitate the re-inspection of the facility, and must then resubmit the SWM AB package to SHA. Copies of the final approved SWM AB plans and certifications, as well as photo documentation of the facility construction, are retained by SHA and integrated into the Drainage and Stormwater Assets GIS database. See Figure 1-5 and Figure 1-6 for examples of inspection documentation during construction of a bioswale facility.

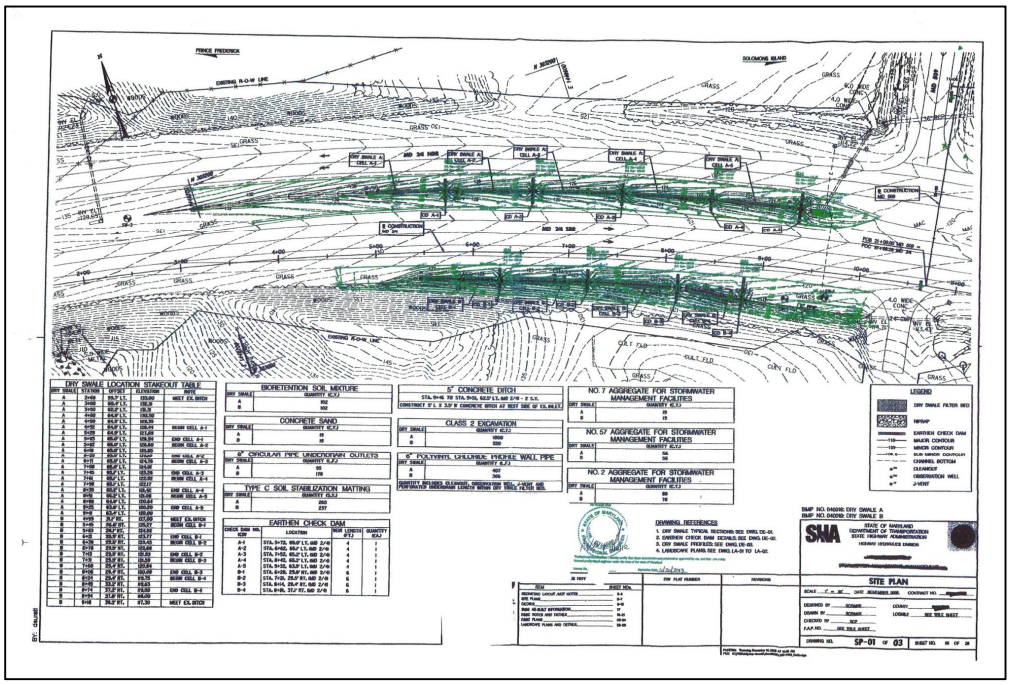


Figure 1-5: Example of SWM As-Built Plan



Figure 1-6: Photo Documentation of Bioswale Construction

D.1.d Preventative Maintenance

The State Highway Administration owns, operates, and maintains an extensive roadway network with significant drainage and stormwater management systems. The SHA Stormwater and Drainage Asset Management Program was established to operate and remediate permanent drainage and stormwater assets that convey and treat highway runoff. The program's goal is to provide preventive and remedial solutions for drainage and stormwater infrastructure within SHA right-of-way. As of June 30, 2016, SHA inspected and maintained nearly 6,000 permanent stormwater management facilities and ESD practices over 160,000 hydraulic structures, and 130,000 conveyance features (over 8 million linear feet) statewide. This includes over 5,000 permanent stormwater management facilities and ESD practices, nearly 123,000 hydraulic structures and over 99,000 conveyances (nearly 7 million linear feet) within the MS4 jurisdictions. The GIS inventory database is being continuously updated to include newly constructed SWM facilities. A rapid increase in the size of the SWM inventory is expected in upcoming years with the ongoing watershed restoration efforts and their associated SWM structures.

SHA continues to locate, inspect, evaluate, and remediate these assets to sustain their functionality, improve water quality and stability, protect sensitive water resources, and provide an aesthetic and safe transportation system. Inspections are conducted on a cyclical basis as part of the NPDES source identification and update effort (see Section C). Maintenance and remediation efforts are accomplished after the inspection data has been evaluated and ranked according to SHA rating criteria.

MDE requires all practices be inspected every three years and maintained as appropriate to ensure they function as designed. Before being included in the SHA impervious surface area assessment of facilities providing runoff treatment, data associated with these practices was evaluated to ensure they meet requirements for inspection, maintenance and functionality. SHA has a maintenance program focused on performing major maintenance within three years after a failed inspection.

SHA conducted preventative maintenance stormwater BMP inspections in accordance with our published Standard Operating Procedures manual during the last reporting period. SHA performed the BMP inspections in the MS4 areas to ensure facilities are in compliance with the triennial inspection requirement and to ensure all baseline facilities are eligible to claim credit with a current inspection in the impervious surface area assessment. The following counties were the focus of SHA's BMP inspection efforts during the reporting period:

- Anne Arundel County
- Baltimore County
- Carroll County
- Frederick County
- Harford County
- Howard County
- Washington County

During this reporting period, restoration BMP inspections were performed for 56 tree planting sites, and 199 SWM facilities. Inspections of stream, outfalls, and pavement removal sites did not occur until July and August of 2016, outside of the reporting period. SHA has provided stormwater BMP inspection information in MDE's NPDES MS4 Stormwater Program Geodatabase format.

In addition to the BMP inspections, SHA evaluated the MS4 BMP inventory to identify any facilities that require major maintenance (SHA maintenance rating of III) originating from inspections and engineer reviews greater than three years ago. As a subset of the overall maintenance program, SHA has prioritized completing the maintenance for the following 133 BMPs shown in Table 1-4 by the anticipated work order completion date. SHA has committed to re-establishing the intended design functionality for the BMPs and will claim credit for the facilities in the impervious surface area assessment. Any maintenance to a BMP that impacts protected

resources such as wetlands, will require a Joint Permit Application (JPA) to be submitted and approved and may require additional time beyond the anticipated completion date detailed below. SHA will report on our progress towards this commitment to perform major maintenance on the 133 stormwater facilities in the FY17 MS4 Annual Report.

Table 1-4: SHA BMPs In Maintenance Work Orders

SWM Facility Number	Facility Type	SHA Maintenance Rating	Anticipated Work Order Completion Date
30050	Infiltration basin	III	11/30/2016
30113	Infiltration trench	III	11/30/2016
30225	Infiltration trench	III	11/30/2016
30226	Infiltration trench	III	11/30/2016
30227	Infiltration trench	III	11/30/2016
30228	Infiltration trench	III	11/30/2016
30229	Infiltration trench	III	11/30/2016
30242	Infiltration trench	III	11/30/2016
30244	Infiltration trench	III	11/30/2016
130169	Wet pond	III	4/28/2017
130291	Micropool extended detention pond	III	6/20/2017
20485	Retention Pond	III	9/22/2017
30287	Dry pond	III	10/20/2017
30335	Dry swale	III	10/20/2017
30117	Dry Detention Pond	III	10/20/2017
30224	Infiltration trench	III	10/20/2017
20036	Infiltration trench	III	10/20/2017
20083	Infiltration trench	III	10/20/2017
20143	Infiltration trench	III	10/20/2017
20173	Infiltration trench	III	10/20/2017
20196	Infiltration trench	III	10/20/2017
20217	Infiltration trench	III	10/20/2017
20218	Infiltration trench	III	10/20/2017
20233	Infiltration trench	III	10/20/2017
20241	Infiltration trench	III	10/20/2017
20242	Infiltration trench	III	10/20/2017
20243	Infiltration trench	III	10/20/2017
20246	Infiltration trench	III	10/20/2017
20341	Infiltration trench	III	10/20/2017
20354	Infiltration trench	III	10/20/2017
20357	Infiltration trench	III	10/20/2017
20360	Infiltration trench	III	10/20/2017
20398	Infiltration trench	III	10/20/2017
20421	Infiltration trench	III	10/20/2017
20528	Infiltration trench	III	10/20/2017
20537	Infiltration trench	III	10/20/2017
20554	Infiltration trench	III	10/20/2017
20572	Infiltration trench	III	10/20/2017

Table 1-4: SHA BMPs In Maintenance Work Orders

SWM Facility Number	Facility Type	SHA Maintenance Rating	Anticipated Work Order Completion Date
20849	Infiltration trench	III	10/20/2017
20003	Infiltration basin	III	10/20/2017
20112	Bioretention	III	10/20/2017
20210	Infiltration trench	III	10/20/2017
80015	Infiltration trench	III	10/20/2017
80081	Infiltration basin	III	10/20/2017
80090	Infiltration basin	III	10/20/2017
80091	Dry Pond	III	10/20/2017
80093	Infiltration trench	III	10/20/2017
100126	Grass Swale	III	10/20/2017
100127	Dry Swale	III	10/20/2017
130136	Infiltration trench	III	10/20/2017
130204	Infiltration basin	III	10/20/2017
130225	Shallow marsh	III	10/20/2017
130238	Infiltration trench	III	10/20/2017
130315	Infiltration basin	III	10/20/2017
130323	Infiltration basin	III	10/20/2017
130358	Infiltration trench	III	10/20/2017
130365	Infiltration trench	III	10/20/2017
130369	Shallow marsh	III	10/20/2017
130388	Grass Swale	III	10/20/2017
130393	Grass Swale	III	10/20/2017
210014	Infiltration trench	III	10/20/2017
210233	Dry Pond	III	10/20/2017
20013	Wet pond	III	10/20/2017
20110	Wet pond	III	10/20/2017
20162	Wet pond	III	10/20/2017
20248	Wet pond	III	10/20/2017
20250	Wet pond	III	10/20/2017
20436	Wet pond	III	10/20/2017
20544	Wet pond	III	10/20/2017
100065	Micropool extended detention pond	III	10/20/2017
100068	Shallow marsh	III	10/20/2017
100094	Micropool extended detention pond	III	10/20/2017
130074	Micropool extended detention pond	III	10/20/2017
130228	Wet pond	III	10/20/2017
130230	Micropool extended detention pond	III	10/20/2017
130267	Micropool extended detention pond	III	10/20/2017
130268	Micropool extended detention pond	III	10/20/2017
130293	Micropool extended detention pond	III	10/20/2017
130294	Micropool extended detention pond	III	10/20/2017

Table 1-4: SHA BMPs In Maintenance Work Orders

SWM Facility Number	Facility Type	SHA Maintenance Rating	Anticipated Work Order Completion Date
130346	Micropool extended detention pond	III	10/20/2017
130349	Wet pond	III	10/20/2017
130198	Micropool extended detention pond	III	10/20/2017
210003	Dry Swale	III	10/20/2017
130417	Grass Swale	III	10/20/2017
130394	Grass Swale	III	10/20/2017
100048	Shallow marsh	III	10/20/2017
20240	Dry pond	III	10/20/2017
20807	Infiltration trench	III	10/20/2017
20809	Wet pond	III	10/20/2017
20812	Infiltration trench	III	10/20/2017
20850	Infiltration basin	III	10/20/2017
20893	Infiltration trench	III	10/20/2017
20115	Wet extended detention pond	III	10/20/2017
20124	Wet pond	III	10/20/2017
20165	Wet pond	III	10/20/2017
20256	Wet pond	III	10/20/2017
20272	Dry pond	III	10/20/2017
20307	Infiltration trench	III	10/20/2017
20479	Micropool extended detention pond	III	10/20/2017
20487	Wet pond	III	10/20/2017
80027	Wet swale	III	10/20/2017
20178	Infiltration trench	III	6/20/2018
80034	Infiltration trench	III	6/20/2018
100034	Wet pond	III	6/20/2018
100128	Dry swale	III	6/20/2018
130161	Infiltration trench	III	6/20/2018
130167	Dry pond	III	6/20/2018
130175	Infiltration Basin	III	6/20/2018
130178	Infiltration basin	III	6/20/2018
130208	Infiltration trench	III	6/20/2018
130292	Micropool extended detention pond	III	6/20/2018
130308	Infiltration trench	III	6/20/2018
130325	Shallow marsh	III	6/20/2018
130330	Infiltration trench	III	6/20/2018
130357	Infiltration trench	III	6/20/2018
130366	Infiltration trench	III	6/20/2018
130370	Infiltration trench	III	6/20/2018
130377	Infiltration basin	III	6/20/2018
130390	Grass Swale	III	6/20/2018
20490	Infiltration trench	III	9/22/2018

Table 1-4: SHA BMPs In Maintenance Work Orders

SWM Facility Number	Facility Type	SHA Maintenance Rating	Anticipated Work Order Completion Date
30189	Infiltration basin	III	6/20/2019
30214	Infiltration basin	III	6/20/2019
30256	Infiltration trench	III	6/20/2019
30258	Infiltration trench	III	6/20/2019
80057	Infiltration basin	III	6/20/2019
80089	Infiltration basin	III	6/20/2019
130181	ED or Wet pond	III	6/20/2019
130199	Wet pond	III	6/20/2019
130378	Infiltration basin	III	6/20/2019
210009	Infiltration basin	III	6/20/2019
100122	Underground detention	III	9/22/2019
130322	Infiltration basin	III	9/22/2019
130334	Underground detention	III	9/22/2019

In addition to the requirement to complete major maintenance for the MS4 stormwater BMPs listed above, SHA has identified 14 stormwater facilities in the MS4 area that require major remediation or enhancements originating from inspections and engineer reviews greater than three years ago. As a subset of the overall maintenance program, SHA has prioritized completing the major remediation or enhancement of the BMPs in Table 1-5 by the anticipated completion date. SHA has committed to re-establishing the intended design functionality or enhancing the original design, and will claim credit for these facilities in the impervious surface area assessment. SHA will report on progress towards this commitment to perform major remediation and enhancement on the 14 stormwater facilities in the FY17 MS4 Annual Report. SHA will be working to improve our tracking of maintenance procedures during the permit term to ensure BMP maintenance is performed in a timely manner.

SHA has provided the stormwater BMP maintenance information in MDE's NPDES MS4 Stormwater Program Geodatabase format. All baseline BMPs submitted for credit in the impervious surface area assessment, exclusive of the BMPs presented in Tables 1-4 and 1-5 had maintenance performed within the required timeframe and these maintenance dates are provided in the geodatabase. BMPs with recent inspections yielding required maintenance activities are being evaluated and will be contracted for completion prior to the next three-year inspection cycle. SHA will be working to improve our tracking of maintenance procedures during the permit term to ensure BMP maintenance is performed in a timely manner.

Details of SHA's Stormwater and Drainage Asset Management Program are included as Part Two of this report. Discussion of SWM inventory inspection results, maintenance, remediation, retrofit and enhancement efforts undertaken over the past year are included in that section.

Table 1-5: Priority SHA BMPs for Major Remediation or Retrofits

SWM Facility Number	Facility Type	SHA Maintenance Rating	Anticipated Work Order Completion Date
020015	Infiltration basin	IV	Spring 2017
020017	Infiltration basin	IV	Spring 2017
020037	Infiltration basin	IV	Spring 2017

Table 1-5: Priority SHA BMPs for Major Remediation or Retrofits

SWM Facility Number	Facility Type	SHA Maintenance Rating	Anticipated Work Order Completion Date
020039	Infiltration trench	IV	Spring 2017
020040	Infiltration trench	IV	Spring 2017
020260	Infiltration basin	IV	Fall 2018
020268	Infiltration basin	IV	Spring 2018
020388	Infiltration basin	IV	Fall 2020
020393	Infiltration basin	IV	Fall 2020
020394	Infiltration basin	IV	Fall 2020
130375	Infiltration basin	IV	Fall 2020
210008	Infiltration basin	IV	Fall 2020
130316	Infiltration basin	IV	Fall 2020
020061	Infiltration basin	IV	Fall 2020

D.2 Erosion and Sediment Control

Requirements under this condition include:

a) *Implement program improvements identified in any MDE evaluation of SHA's erosion and sediment control program;*

b) *Ensure construction site operators have received training regarding erosion and sediment control compliance and hold a valid Responsible Personnel Certification as required by MDE;*

c) *Record program activity on MDE's annual report database and submitted as required in Part V of this permit;*

d) *Ensure all applicable construction projects obtain a notice of intent (NOI) for stormwater associated with construction activity.*

D.2.a SHA's Erosion and Sediment Control Program

SHA continues to comply with Maryland State and federal laws and regulations for ESC as well as MDE requirements for permitting. SHA maintains compliance with the NPDES Stormwater Construction Activity permit for projects that disturb one acre or more of land. SHA continues to submit applications for coverage under this general permit for all qualifying roadway projects as described under Section D.2.d below.

As discussed in Section D.1.b above, SHA and MDE signed an MOU designating SHA as an approving authority for stormwater management and erosion and sediment control for all SHA projects. PRD maintains a database to track ESC submittals and design progress on all SHA projects. SHA continues to comply with the *Maryland Erosion & Sediment Control Guidelines for State and Federal Projects* published in January 1990 and revised in January 2004. In December 2011, MDE published the 2011 *Maryland Standards and Specifications for Soil Erosion and Sediment Control*. Projects are designed and constructed in compliance with these new specifications.

During FY 2016, PRD approved 56 final plans. However, due to the timing of the change of permit review from MDE to PRD, there were several projects that MDE granted approval for as they had initiated project review prior to the change in procedures. MDE approved 7 ESC projects during this time. An additional 11 projects received NPDES Construction General Permit approvals during FY16. In total, there were 49 grading permits issued for activity within the areas controlled by SHA's MS4 permit. These grading permits approved the disturbance of approximately 121.3 acres of land.

SHA ensures that permits and plan approval conditions are adhered to by performing unannounced inspections at project sites. During FY16, SHA performed 261 inspections at 54 project sites. These inspections resulted in 2 violations, and 2 stop-work orders. No fines were issued and no court enforcement actions were initiated. SHA utilizes liquidated damages against the contractors responsible for improper ESC activities and generally does not issue fines. Liquidated damages reduce the payment amount due contractors because of these types of violations. These damages are not considered fines.

SHA has provided the erosion and sediment control program information in the MDE NPDES MS4 Stormwater Program Geodatabase format. A summary by MS4 jurisdiction is presented in Table 1-6. It is important to note that plans reviewed and approved by PRD will not necessarily correlate directly to the number of permits issued during any reporting period. This reflects the fact that PRD's approval by itself does not constitute permit issuance as projects must meet additional regulatory criteria beyond MDE's standards.

Note that although fines are not explicitly issued, SHA reserves the right to utilize liquidated damages resulting from contractor's non-compliance with ESC and SWM approved plan elements. Historically, these damages have not been applied, but the potential amounts are communicated to the contractor in the Notice of Violation and subsequent reporting documents.

Table 1-6: Erosion and Sediment Control Permits and Disturbance Acreage

Jurisdiction	Number of Permits Issued	Acreage of Disturbance	Violations	Stop Work Orders	Fines Issued	Court Cases
Anne Arundel	2	3.9	0	0	0	0
Baltimore	8	33.56	1	1	0	0
City of Cambridge	1	5.14	0	0	0	0
Carroll	1	3.42	0	0	0	0
Cecil	5	3.63	0	0	0	0
Charles	0	0	0	0	0	0
City of Cumberland	0	0	0	0	0	0
Frederick	1	2.23	0	0	0	0
Harford	0	0	0	0	0	0
Howard	3	45.92	0	0	0	0
Montgomery	9	13.27	0	0	0	0
Prince George's	5	6.78	0	0	0	0
City of Salisbury	1	1.7	0	0	0	0
Washington	5	12.02	0	0	0	0
MS4 Total	**42**	**129.34**	**1**	**1**	**0**	**0**
Outside MS4	7	22.2	1	1	0	0
Statewide Total	**49**	**151.55**	**2**	**2**	**0**	**0**

* For purposes of summarizing the permitted grading activities in this table, SHA's grading contracts that span multiple counties (both MS4 and non-MS4) are included in the "Outside MS4" column as they do not lend themselves to geographic distribution.

** Although fines are not explicitly issues, SHA reserves the right to utilize Liquidated Damages resulting from contractor's non-compliance with ESC and SWM approved plan elements. Historically, these damages have not been applied, but the potential amounts are communicated to the contractor in the notice of violation and subsequent reporting documents.

D.2.b MDE Responsible Personnel Certification

MDE Responsible Personnel Certification is required for anyone overseeing the installation and maintenance of erosion and sediment control practices in Maryland. SHA specifications require that the Contractor assign an employee as the Erosion and Sediment Control Manager (ESCM) for each construction project. The ESCM and the superintendent must have successfully completed the MDE Responsible Personnel Certification course along with SHA's Erosion and Sediment Control Certification (Yellow Card). In addition, SHA also requires all Quality Assurance (QA) Inspectors, who inspect each project to ensure compliance with the approved erosion and sediment control plan, hold a valid MDE Responsible Personnel Certification. The entire SHA Plan Review Division, consisting of the Division Chief, the Assistant Division Chief, four Team Leaders, and the consultant review staff are all required to hold a valid MDE Responsible Personnel Certification. The MDE Responsible Personnel Certification is currently only available through an on-line training course through MDE's website, so numbers of SHA personnel certified through that website is not reported here.

SHA Erosion and Sediment Control Certification (Yellow Card)

The SHA, in cooperation with the Maryland Transportation Builders and Materials Association (MTBMA), continues to offer updated erosion and sediment control training, originally initiated in 2004. This erosion and sediment control on-line training is mandatory for SHA contractor superintendents and ESC managers and is highly recommended for contractor project managers, field personnel, and personnel responsible for erosion and sediment control. Each participant is required to hold a valid MDE Responsible Personnel Certification prior to taking this course. The class covers the basic science of erosion and sediment control, installing and maintaining E&S controls, using the ESC Quality Assurance checklist to monitor compliance, reviews key requirements of the NPDES construction activity permit, details ESC specifications, and reviews the process for addressing ESC modifications during construction. Certification is contingent upon successful completion of an exam. Successful completion requires a score of 80 percent or higher on the exam. This certification expires three years from the date of issuance. In FY16, SHA implemented on-line training for Yellow Card Certification. This is also a prerequisite for SHA's Erosion and Sediment Control Certification for Designers, described in the following sections. The number of SHA personnel certified during the reporting period is summarized in Table 1-7.



Figure 1-7: SHA Yellow Card Certification

SHA Erosion and Sediment Control Re-Certification (Yellow Card Re-Certification)

SHA Erosion and Sediment Control Re-Certification (Yellow Card Re-Certification) is only available for those that have previously taken and passed the SHA Yellow Card and MDE Responsible Personnel Certification courses and currently hold valid cards for both. Topics covered include changes to the specifications and environmental regulations along with updated information related to the SHA Quality Assurance program. Re-Certification is contingent upon successful completion of an exam and is valid for a period of three years. In FY16, SHA provided on-line re-certification training. The number of SHA personnel re-certified during the reporting period is summarized in Table 1-7.

Table 1-7: SHA ESC Training

Type of Training	Number Certified
SHA Erosion and Sediment Control Certification (Yellow Card)	368
SHA Erosion and Sediment Control Re-Certification (Yellow Card Re-Certification)	140

SHA Erosion and Sediment Control Certification for Designers

SHA is presently reevaluating the purpose and need for the ESC Certification for Designers as well as training format. SHA has not offered any designers classes during the reporting period.

Currently, MTBMA is holding a wait list of individuals interested in attending the next designer's course until the training course is finalized. In the event that class offerings resume, the course will be offered by the Highway Hydraulics Division (HHD) in the OHD. This training course would be intended for ESC design professionals to provide direction and guidance regarding the use of proper erosion and sediment control practices during the design phase of a project. Topics covered would include design considerations, standards, ESC plan preparation, specifications, and design strategies. Pre-requisites would continue to be the MDE's erosion and sediment control training course and the SHA Yellow Card Certification.

D.2.c Recording Program Activity

SHA has provided the erosion and sediment control program information in the MDE NPDES MS4 Stormwater Program Geodatabase format.

D.2.d NOI for Stormwater Associated with Construction Activity

The MDE issued the 2014 General Permit for Stormwater Associated with Construction Activity, which took effect on January 1, 2015. Projects that disturb one acre or more of earth must obtain a General or Individual Permit for Stormwater Associated with Construction Activity before beginning any earth disturbance.

SHA's HHD evaluates all SHA advertised construction projects and maintenance operations to determine if an NPDES permit associated with construction activity is required. Completed NPDES Notice of Intent (NOI) applications are submitted to MDE by HHD using the MDE e-Permits Portal, an online application system. HHD tracks the status of each NOI and ensures that any applicable NPDES permits are obtained and transferred to the SHA District office prior to the start of construction for each project. The NPDES permit is then posted at each construction site. During the reporting period, a total of 56 SHA construction projects receiving Notice to Proceed (NTP) required an NPDES permit associated with construction activity.

D.3 Illicit Discharge Detection and Elimination

Requirements under this condition include:

a) Field screen at least 150 outfalls annually;

b) Conduct annual visual surveys of commercial and industrial areas to discover, document and eliminate pollutant sources;

c) Maintain program to address and, if necessary, respond to illegal discharges, dumping and spills;

d) Use appropriate procedures to investigate and report illicit discharges, illegal dumping and spills to local or State authorities as applicable for control or clean-up. Report significant discharges to MDE for enforcement and/or permitting.

e) Coordinate with surrounding jurisdictions when illicit connections originate from beyond SHA's rights-of-way; and

f) Report illicit discharge detection and elimination activities as specified in Part V of this permit.

D.3.a Outfall Field Screening

SHA outfall inspections are conducted using the SHA Stormdrain and Outfall Inspection and Remediation Program (SOIRP) pipe and outfall

inspection protocol (Chapter 4 of SHA's MS4 standard procedures) to identify potential sources of pollution due illegal connections or outfall instability. Based on the inspection results, those with the poorest ratings are assessed for repair or remediation using the Outfall Channel Rapid Assessment Guidelines (Chapter 8 of the SHA's MS4 standard procedures).

Pipe and outfall inspections consist of visual evaluation of pipes and outfall structures (headwalls, end walls and end sections) to determine structural condition, functionality and integrity. Pipes are rated on a scale of 0 to 5 (5 being the worst rating) to identify the overall condition of the pipe and outfall. When illicit discharge is identified by the visual inspections, the protocol for disconnection described in Section D.3.c is followed.

The inspection results are based on issues that can be visually identified by the inspection crew. Photographs are taken for ratings of 3, 4, or 5 or as deemed necessary. When specific indicators are present that the pipe could be severely degraded and it is difficult to evaluate an entire pipe length visually, video inspection might be required to assess the structural integrity. SHA is in the process of developing a systematic approach for incorporating the inspection results into system preservation and resurfacing projects, so the deficiencies can be addressed electively and timely before catastrophic failures occur.

Rapid Assessment Guidelines are used evaluate outfall channels to determine urgency of restoration efforts. The purpose of the assessment is to protect the SHA drainage infrastructure from further degradation as well as address potential erosion issues of the outfall channel and prevent degradation, sediment transport, and pollution of downstream reaches. The inspection results are considered when outfall stabilization projects are initiated.

D.3.b Annual Visual Surveys of Commercial and Industrial Areas

As discussed in Section C.2, SHA will develop a GIS layer that identifies industrial and commercial land uses and sites that have the potential to contribute significant pollutants to SHA storm drain systems. SHA will use the commercial and industrial GIS layer as a foundation to establish a program to effectively perform and manage annual visual surveys for discovering, documenting, and eliminating pollutant sources. The program will inspect identified commercial and industrial areas on an annual basis. Using the Hot Spot Jr. Inspection form, the commercial and industrial locations identified will be surveyed at the outfalls of the identified commercial and industrial properties. SHA's visual commercial and industrial program will report results annually starting in 2018.

D.3.c Illegal Discharge, Dumping, and Spill Program

SHA's Environmental Compliance Division (ECD) manages the IDDE program and spill prevention and control program. ECD is continually reviewing the IDDE management program and process to determine areas that can be streamlined or updated. ECD is in the process of creating a GIS-based database to track all actions related to illicit discharges (ID). ECD continues to coordinate with MDE, surrounding jurisdictions and property owners to eliminate illicit discharges and spills.

As illicit discharges are identified through the field screening process, ECD utilizes an agreement with Maryland Environmental Service (MES) to follow-up and collect samples for laboratory analysis. If laboratory analysis indicates the discharge exceeds acceptable parameters, ECD coordinates elimination of the discharge with local NPDES coordinators, property owners and MDE. MES also performs on-call inspections of potential illicit discharges that are reported by SHA field staff or the public.

Discharges are deemed illicit based on two main criteria: flow and exceedance of discharge parameter(s). Some illicit discharges reported in past annual reports did not have flow and were therefore identified as closed in the 2015 annual report. Please note that any no-flow outfalls showing signs of potential pollution will be investigated further to ensure no stormwater pollution is occurring.

Due to this report's shortened reporting cycle, (which covers the final three quarters of FY16) data associated with ID screenings performed after June 30, 2016 will be reported with the FY17 annual report. Also, FY16 ID screenings that occurred during the first quarter of FY16 were reported in the 2015 annual report on Page 1-33.

After June 30, 2016, 180 outfalls were screened. As mentioned above, the data from these screenings will be delivered with next year's report. Of these outfalls, 57 had a discernible dry-weather flow and were sampled. Only one was identified as an ID requiring additional follow-up. Table 1-8 summarizes field screening efforts after June 30, 2016.

Table 1-8: Field Screening Summary

County	Number of Outfalls Field Screened	Discharges requiring follow-up
Anne Arundel	19	0
Montgomery	96	0
Prince Georges	65	1
Totals	**180**	**1**

D.3.d Investigation and Report of Illicit Discharge, Illegal Dumping and Spills

Currently, SHA notifies MDE and the appropriate county NPDES coordinator, or their IDDE designee, when illicit discharges to SHA storm drain system are discovered. In order to achieve better elimination results and increase public awareness of the issue, SHA has implemented a process to notify property owners when they are determined to be the origin of the illicit discharge. Educational materials on non-stormwater discharges and MS4 permits are included with the initial notification.

D.3.e Coordination with Surrounding Jurisdictions

Once an IC has been identified and confirmed through lab analysis SHA contacts the county MS4 for assistance in elimination of the discharge. If the county MS4 cannot assist with elimination then SHA contacts MDE for assistance. If attempts to eliminate the discharge fail after working with the local jurisdiction and MDE/WMA, MDE has the option of coordinating with the State's Office of Attorney General (OAG) Environmental Crimes Unit (ECU) to resolve the illicit discharge.

D.3.f Annually Report Illicit Discharge Detection and Elimination Activities

Outfalls were screened in three Phase I counties for illicit discharges including Montgomery, Prince Georges and Anne Arundel. As noted above, the geodatabase containing this data will be included in the next reporting year (FY17). During the reporting year, a total of one discharge was closed out. The discharge was eliminated by the property owners after SHA coordinated with MDE. The commercial property was releasing detergents into SHA's MS4 above acceptable limits through vehicle washing activities. SHA made several attempts to have the property owner discontinue their washing operations. The property owner did not respond to SHA's requests. SHA contacted MDE for assistance. MDE visited the site and notified the commercial entity to cease the vehicle washing discharge.

Table 1-9 below shows information for the one illicit discharge requiring follow-up. SHA is currently coordinating with Prince Georges County to address the open illicit discharge.

Table 1-9: Illicit Discharge Requiring Follow-up

Number	County	SHA Structure #	Date Identified	Potential Pollutant
1	Prince Georges	1600052.001	08/03/2016	Detergents

D.4 Trash and Litter

Requirements under this condition include:

a) *Document litter problems on properties, ways of eliminating litter, and opportunities for overall improvement;*

b) *Within one year of permit issuance, as part of the public education program, SHA shall develop and implement a public education and outreach program with specific performance goals to reduce littering. This shall include:*

   i) *Educating the transportation community on the importance of reducing, reusing, and recycling;*

   ii) *Disseminating information by using signs, articles and other media outlets; and*

   iii) *Promoting educational programs for SHA employees, consultants, contractors, travelling/trucking public, vacationers and commuters, etc.;*

c) *Evaluate annually the effectiveness of the education program; and*

d) *Submit an annual report that details progress toward implementing the public education and outreach program and trash reduction strategies.*

D.4.a Document Litter Problems and Ways to Eliminate Litter

The SHA has long maintained an anti-litter program, and continues to implement improvements to this program to help keep the roadways litter-free. Keeping our roadways free from litter and debris helps to increase safety, improve the health of our environment, and keep our state beautiful.

SHA's Office of Maintenance evaluates and documents litter control problems within SHA right-of-way throughout the entire State. Besides general roadside litter problems, typical problem areas identified include isolated dumping sites, highway interchange ramps, areas that are in close proximity to a landfill, and bus stops.

SHA has many programs in place to address and control litter within SHA right-of-way. A critical aspect of SHA's year round highway maintenance is the removal of litter from roadway shoulders and drainage systems. SHA uses a multi-pronged approach to control litter utilizing SHA employees, state workers, contractors, inmate clean-up crews, as well as labor donated through the Sponsor-A-Highway program and partnerships with Adopt-A-Highway volunteers. SHA also has taken several steps to "green" our litter removal efforts. For instance, instead of just picking up litter, SHA now provides our crews and volunteers with the means to separate recyclables from trash. All seven SHA Districts are currently recycling roadway litter in a formal manner. As the recycling efforts increase, the volume of waste taken to landfills continues to decrease.

SHA currently collects a substantial amount of litter and trash including pick-up along state roads, inlet cleaning and structural stormwater control structures. SHA's primary efforts to clean up and prevent litter and trash along our roadways are described in detail below.

Maintenance Crew Clean-Ups

SHA currently has 28 maintenance shops across the state, and 18 are responsible for areas within the 11 MS4 jurisdictions. Each maintenance shop 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 throughout the Spring and Summer mowing seasons. At times, additional trash pick-ups are scheduled upon public request. During the reporting period, SHA maintenance crews, inmate crews and contracted litter crews collected 3,576 truckloads of trash statewide, which is approximately 1.25 million pounds. Trash pick-up by each district shop is summarized below.

Contracted Clean-Ups

In addition to SHA maintenance crew clean-ups, SHA enters into contractual agreements for supplemental clean-ups along the right-of-way. This includes contracts with private companies as well as inmate clean-up crews contracted with various state penitentiaries. Contracts are

awarded for designated roadway segments and contractors are required to pick up on a regular schedule. SHA provides dump trucks, maintenance of traffic, crash attenuators, and other safety precautions for field crews working to pick up trash along the roadway. Contracted clean-up activities occur throughout the state, including MS4 jurisdictions.

Table 1-10: Maintenance/Contracted/Inmate Right-of-Way Trash/Litter Removal

Jurisdiction	Truckloads	Conversion to Pounds
Anne Arundel	556	194,600
Baltimore	988	345,800
Carroll	39	13,650
Cecil	117	40,950
Charles	141	49,350
Frederick	129	45,150
Harford	142	49,700
Howard	237	82,950
Montgomery	228	79,800
Prince George's	895	313,250
Washington	104	36,400
Totals	**3,576**	**1,251,600**

Adopt-A-Highway Program

This program encourages volunteer groups (families, non-profit organizations, schools and civic organizations) to pick up litter along one to two mile stretches of non-interstate roadways four times a year for a two year period as a community service. SHA provides each group with training, safety vests, trash bags, and tips on how to pick up trash and recyclables. The trash collected is placed in bags that are picked by SHA maintenance crews. SHA will also place signs recognizing the organization or group at both ends of the adopted roadside (See Figure 1-8).



Figure 1-8: SHA Adopt-A-Highway Sign

Since the Adopt-A-Highway program started in 1989, SHA has partnered with more than 120,000 Marylanders who have cleaned and enhanced over 15,000 miles of roadway. Table 1-11 identifies the participation for the Adopt-A-Highway program throughout the current reporting period.

Table 1-11: Adopt-A-Highway Program Right-of-Way Trash/Litter Removal

Jurisdiction	Number of Groups	Number of Bags	Miles Adopted
Anne Arundel	1	18	.9
Baltimore	14	87	15.6
Carroll	14	115	16.8
Cecil	7	69	8.4
Charles	0	0	0
Frederick	9	55	12.7
Harford	4	23	5.4
Howard	0	0	0
Montgomery	2	22	2
Prince George's	1	5	1.1
Washington	8	59	10.6
Cumberland, Cambridge, Salisbury	0	0	0
Totals	**60**	**453**	**81.6**
Data extracted from the Adopt-A-Highway database for the period 10/01/2015 to 06/30/2016.			

Sponsor-A-Highway Program

Maryland has joined numerous other states in this national effort to reduce litter along our roads. Each year, SHA spends millions of dollars to remove litter and debris from our roadways, which can create safety and environmental hazards for motorists, cyclists, and pedestrians. Litter removal also forces SHA maintenance staff

to commit time, money, and manpower to this effort when they should be concentrating on other highway safety activities.

SHA's corporate sponsorship program allows corporations to sponsor sections of Maryland roadways by funding contracted clean-ups for one-mile sections of Maryland roadways. The sponsor enter into an agreement with a maintenance provider to remove litter from the sponsored highway segment, typically an interstate roadway. The maintenance providers are responsible for removal of trash from sponsored segments of roadways.

As part of the highway sponsorship, the sponsoring group will receive an acknowledgement sign with their corporate logo along their segment of roadway (See Figure 1-9 below).



Figure 1-9: SHA Sponsor-A-Highway Sign

Table 1-12 below shows the miles currently being sponsored through the Sponsor-A-Highway program. As of this reporting period, SHA has 352 sponsored segments of roadway statewide.

Table 1-12: Sponsor-A-Highway Program

Jurisdiction	Available Miles	Miles Sponsored
Anne Arundel	51.5	77.7
Baltimore	103.3	92.4
Carroll	0.0	0.0
Cecil	0.0	0.0
Charles	13.2	4.5
Frederick	15.9	9.3
Harford	8.0	1.3
Howard	18.6	39.6
Montgomery	3.2	48.2
Prince George's	14.5	71.4
Washington	11.5	5.9
Cumberland, Cambridge, Salisbury	2.0	2.0
Totals	**241.6**	**352.2**

Data extracted from the Sponsor-A-Highway database for the period 10/01/2015 to 06/30/2016.

Stormwater Management Facilities

Stormwater Management (SWM) facilities are designed to capture stormwater runoff, allowing the velocity to reduce and the pollutants to settle out before being released to an outfall structure or infiltrate directly into the ground. Many SWM facilities are constructed with a forebay and a riser structure with a trash rack. The main purpose of the forebay is to reduce water velocities and collect sediment as stormwater enters the facility. An additional benefit is that it helps to collect and concentrate trash, debris, and floatable material within the stormwater management basin. Trash racks prevent large debris, trash, and floatable materials from entering the outfall conveyance structure. Maintenance crews can then collect the trash and debris contained within the SWM facilities during routine maintenance.

D.4.b Litter Education and Outreach Program

As part of the public education program described in Section D.6 of this report, SHA is developing a public education and outreach program with specific performance goals to reduce littering. Key to this effort is defining the problem and determining target audiences in order to identify the best tactics. Rather than implement a set of tactics up front, SHA is following the established process to develop a public relations plan. SHA's Office of Customer Relations and Information (OCRI) has contracted with a public relations research firm to develop a public relations plan based on the industry recognized four-step process including:

1. Research – Define the opportunity or potential threat, it's impact to the organization and identify target audiences;
2. Planning – Analyze the research, segment target audiences, set goals and identify strategies or tactics;
3. Action and Communication – Strategies are implemented and tactics developed and executed; and
4. Evaluation and Adjustment – Methods to evaluate the effectiveness of the public relations campaign are identified and implemented. Adjustments are made as necessary.

SHA is working through the first two steps of this process currently. The initial Litter Reduction Education Initiative plan is located in Appendix B. This plan will be modified as steps one and two are completed and steps three and four are initiated. SHA anticipates that steps one and two will be complete within the next six months and step three, Action and Communication, implemented by the next annual report in October 2017. Step four, Evaluation and Adjustment, will take place each remaining year of the permit term until 2020.

This current phase will narrow the focus areas for the anti-litter initiative through statistically valid qualitative and quantitative research during 2016-2017. This research will establish baseline awareness, perceptions, specific litter problem areas, and behavioral motivations for littering.

The research plan includes four key components:

Focus Groups: 12 on-line bulletin board focus groups will be conducted to test messaging and knowledge, as well as attitudes, behaviors, and beliefs about litter in each of the MS4 counties. The research will refine target audiences and perceptions about littering laws and the problems associated with trash and debris discarded on roadways. These focus groups will provide important information regarding public perception and behavior modification. Additionally, SHA will use focus groups to identify barriers and develop potential messaging that might resonate with target audiences

Target Audience: The focus groups will help refine the target audience, which will generally include MS4 Counties, mixed genders and a diversity of demographics.

Online Survey: Based on the results of the qualitative portion of this research phase, an online survey surrounding the topic of litter will be developed and conducted of 1,000 MD residents.

Analysis: Survey results will be compared and contrasted within sub-groups established by certain quotas. This will culminate in outreach recommendations and a final topline report.

The research phase of this effort has been initiated, and the final topline report is expected by March 2017. These findings will be used to build a litter reduction initiative with realistic goals, sound strategies, measurable objectives and proven tactics.

At the completion of the research phase, a subsequent planning phase will begin. During this time, SHA will develop strategies, and specific campaign goals that attempt to change behavior, and decrease litter in specified target areas.

These strategies will be implemented in the subsequent action phase. This phase will involve implementing the strategic plans developed in the planning phase.

Once the litter reduction educational initiative is developed and implemented, it will be followed by an evaluation phase, which will assess the program's effectiveness in meeting the criteria that were set. These results will be used to plan for future actions.

Existing Litter Awareness Programs

SHA currently has an anti-litter public outreach campaign. The program focus is to promote the Adopt-A-Highway and Sponsor-A-Highway programs and educate citizens about environmental stewardship. SHA's OCRI and Office of Maintenance (OOM) collaborate on this campaign. The campaign includes litter awareness events at schools and civic events, and

offers materials such as coloring books, brochures, and speakers. Furthermore, SHA's website http://www.roads.maryland.gov offers some information about recycling and litter prevention.



Figure 1-10: Keep Maryland Beautiful Sign

Environmental Education Grants

The Maryland Environmental Trust (MET) awards grants to nonprofits, community groups, and schools to carry out environmental projects across the state. These grants are given through the KMB program in partnership with SHA. In 2016, recipients were awarded $9,600 in grants.

The Margaret Rosch Jones Awards are presented to volunteer or non-profit groups active in educating their community in matters related to litter prevention, community beautification, and eliminating or reducing the causes of a local environmental problem. In 2016, seven of these grants were awarded.

The Bill James Environmental Grants are presented to non-profit youth groups for proposed environmental education projects. The objectives of these grants are to encourage a sense of stewardship and personal responsibility for the environment, stimulate a better understanding of environmental issues, aid in the elimination or reduction of a local environmental problem, and encourage education about growth management and the protection of rural areas and sensitive resources. In 2016, six of these grants were awarded to the following recipients.

D.4.c Evaluation of Litter Education and Outreach Program Program

The effectiveness of the litter education and outreach program will be evaluated annually beginning in 2018 once the research and planning phases have been completed and the communication plan has been implemented. Information relating to the program evaluation will be provided in SHA's NPDES Annual Report.

Historic information on the litter level of service (LOS) obtained from SHA's Maryland Condition Assessment Reporting System (MCARS) indicates that the litter LOS has increased over the past 10 years, which indicates a more positive public perception of the cleanliness of SHA's roadways. This demonstrates the improved results of SHA's efforts to clean up trash and litter in recent years. Use of the MCARS will continue in order to assess public perception as SHA's trash reduction strategy is implemented.

As part of SHA OCRI's strategic communication plan included in Appendix B and discussed in section D.4.b, various new performance metrics will be established and tracked in order to evaluate the effectiveness of the public education and outreach program. These metrics may include volunteer participation numbers, public opinion polling, media hits, as well as money spent.

D.4.d Progress Implementing Litter Education and Outreach Program

As discussed in Section D.4.b, SHA has initiated a research plan to assist in the development and implementation of a litter education and outreach program with the specific performance goal to reduce littering through raising awareness of the negative environmental impact of littering along Maryland's roadways. This task has been budgeted $500,000 and approximately $100,000 will be used for the research and planning phases. SHA will report annually on the progress and effectiveness of the program components and the

funding level will also be evaluated and adjusted as necessary.

During this reporting period, SHA's OCRI developed a strategic communication plan (included as Appendix B) and research was initiated to set the foundation for this public relations and awareness program.

D.5 Property Management and Maintenance

Requirements under this condition include:

a) *Ensure that an NOI has been submitted to MDE and a pollution prevention plan developed for each SHA-owned facility requiring NPDES stormwater general permit coverage. The status of the pollution prevention plan development and implementation for each SHA-owned municipal facility shall be reviewed, documented and submitted to MDE annually;*

b) *Continue to implement a program to reduce pollutants associated with maintenance activities at SHA-owned facilities including garages, roadways parking lots, rest areas and park and rides. The maintenance program shall include, but not be limited to, these activities:*

   i) *Street sweeping;*

   ii) *Inlet inspection and cleaning;*

   iii) *Minimizing the use of pesticides, herbicides, fertilizers and other pollutants associated with vegetation management through increased use of integrated pest management;*

   iv) *Minimize to the MEP the use of winter weather deicing materials through research, continual testing and improvement of materials, equipment calibration, employee training and effective decision-making; and*

   v) *Ensure that all SHA staff receives adequate training in pollution prevention and good housekeeping practices.*

   SHA shall report annually on the changes in any maintenance practices and the overall pollutant reductions resulting from the maintenance program. Within one year of permit issuance, an alternative maintenance program may be submitted for MDE approval indicating the activities to be undertaken and associated pollutant reductions.

D.5.a NOI Submission and Pollution Prevention Plan Development

As discussed in previous Annual Reports, SHA has implemented an Environmental Management System (EMS) to ensure multi-media compliance at maintenance facilities statewide. The EMS covers procedures for management of environmental compliance issues, including those related to Industrial NPDES at maintenance facilities, such as spill response, material storage and vehicle washing. It includes the implementation of Standard Operating Procedures (SOPs), routine compliance inspections and environmental training covering a variety of media areas including stormwater management and spill prevention and response.

The EMS includes routine multimedia compliance inspections of 162 SHA facilities. These inspections include recommendations for stormwater improvements and pollution prevention. As shown in Table 1-13, certain facilities are currently covered under the General Discharge Permit (12-SW). Actions taken to meet 12-SW requirements include:

- Updated Storm Water Pollution Prevention Plans (SWPPP) and maps
- Roll-out and training of standard operation procedures for Quarterly Visual Monitoring
- Updated internal self-assessment compliance checklists for routine and annual inspections
- Trained shop personnel on pollution prevention requirements and incorporated updates in annual environmental awareness training provided to all SHA maintenance staff
- Established a specific training program for pollution prevention team members performing stormwater inspections and quarterly visual monitoring assessments
- Evaluated all permitted facilities for the presence of non-stormwater sources

- Completed annual comprehensive site compliance evaluations

SHA maintenance facility staff are continuing to perform monthly inspections and the SHA Environmental Compliance Division (ECD) is continuing to perform quarterly inspections at all SHA facilities through its District Environmental Coordinators (DEC). ECD, through the DECs, is performing annual comprehensive site compliance evaluations for all 12-SW permitted facilities. Quarterly and annual inspections are performed to ensure stormwater pollution prevention BMPs are implemented and the 12-SW permitting requirements are being met. The DEC and facility staff are responsible for ensuring compliance with all applicable permits, plans, and regulations at facilities in their region.

SHA has provided the municipal facilities program information in the MDE NPDES MS4 Stormwater Program Geodatabase format.

12-SW Bay Restoration

As a MS4 permit holder, SHA has assessed the Bay Restoration requirement for facilities covered under the 12-SW permit and included them in the SHA MS4 20 percent impervious baseline and restoration implementation. See Section E.2.a for further discussion of the impervious baseline and 20 percent restoration requirement. SHA performed an impervious accounting assessment of all industrial facilities covered under the 12-SW permit. The assessment of the controlled and uncontrolled impervious surfaces on the property of SHA industrial facilities was included in the overall impervious accounting assessment for the entire SHA MS4 area.

Table 1-13: Industrial NPDES Permit Status

District	Maintenance Facility	Permit Type
1	Berlin	General
	Cambridge	General
	Princess Anne	General
	Salisbury	General
	Snow Hill	General
2	Centreville	Individual – SW
	Chestertown	General
	Denton	General
	Easton	General
	Elkton	General
3	Fairland	General
	Gaithersburg	General
	Laurel	General
	Marlboro	General
4	Churchville	Individual – SW
	Golden Ring	General
	Hereford	General
	Owings Mills	General
5	Annapolis	General
	Glen Burnie	General
	La Plata	General
	Leonardtown	General
	Prince Frederick	General
	Hanover Auto Shop	General
6	Hagerstown	General
	Keyser's Ridge	Individual – GW
	La Vale	General
	Oakland	General
7	Dayton	General
	Frederick	General
	Thurmont	General
	Westminster	General
Notes: SW = Surface Water, GW = Groundwater		

The 12-SW permit is applicable to the discharge of stormwater associated with industrial activities to waters of the state. SHA considers any site that is partly industrial as if it is entirely industrial and this was the methodology applied to the entire property boundary of the maintenance shop. As presented in Table 1-14 below, each SHA maintenance facility covered under the 12-SW in MS4 areas of responsibility has a controlled and uncontrolled impervious area and an associated 20 percent restoration requirement.

Table 1-14: 12-SW Impervious Accounting Included in MS4 Baseline

Maintenance Facility	Total Impervious Area (AC)	Controlled Area (AC)	Uncontrolled Area (AC)	20% Impervious Restoration Requirement (AC)
Annapolis	6.60	3.97	2.63	0.53
Cambridge	3.68	1.80	1.88	0.38
Churchville	6.07	3.45	2.61	0.52
Dayton	7.96	5.69	2.27	0.45
Elkton	9.69	1.96	7.74	1.55
Fairland	5.52	5.52	0.00	0.00
Frederick	8.75	8.57	0.19	0.04
Gaithersburg	10.14	1.79	8.35	1.67
Glen Burnie	7.68	3.55	4.13	0.83
Golden Ring	6.15	2.24	3.91	0.78
Hagerstown	6.15	0.00	6.15	1.23
Hanover	22.74	22.30	0.45	0.09
Hereford	5.57	1.19	4.37	0.87
LaPlata	6.18	4.74	1.45	0.29
Laurel	5.86	3.79	2.07	0.41
Marlboro	10.88	9.00	1.89	0.38
Owings Mills	7.67	7.60	0.07	0.01
Salisbury	8.96	2.13	6.83	1.37
Thurmont	3.25	0.39	2.86	0.57
Westminster	7.81	7.81	0.00	0.00
Totals	**157.32**	**97.48**	**59.84**	**11.97**

Note: This accounting is presented to illustrate SHA 12-SW permitted areas that are covered under the MS4 impervious baseline and 20 percent treatment requirement of 4,719 acres. See Section E.2.a for more discussion on the SHA impervious accounting and 20 percent impervious restoration.

As described above, SHA continues to maintain an effective Industrial Stormwater NPDES Program through ECD to ensure pollution prevention and permit requirements are being met at SHA maintenance facilities. Annually, and as change dictates, SHA updates it's combined Storm Water Pollution Prevention Plans (SWPPP) and Spill Prevention, Control, and Countermeasure (SPCC) Plans. As a continuing best management practice, SHA has developed SWPPPs for facilities that are typically not required to have one (e.g. salt storage facilities).

Throughout the reporting year, SHA continued to address potential stormwater pollution issues by implementing Best Management Practices (BMPs) and designing/constructing capital improvements. BMPs were identified during pollution prevention plan updates and routine facility inspections. The status of BMP implementation for maintenance facilities is tracked by each DEC during routine inspections. Potential capital improvements are prioritized based on risk to human health and the environment, and funding availability. The following list details the major pollution prevention efforts and maintenance facility improvements since the last annual report.

Completed Projects:

- 12-SW quarterly visual monitoring and annual comprehensive site compliance evaluations
- Update of all associated SWPPPs

- Standard Operating Procedure creation and updates to ensure compliance with 12-SW permit
- Updating existing and creation of a new training program to ensure compliance with 12-SW permit
- Petroleum storage tank system upgrades at various SHA maintenance facilities
- OWS Upgrades at Princess Anne and Thurmont facilities

Ongoing Projects / Efforts:

- Statewide stockpile management assessment, planning, and design for new structural controls, including covered/roofed storage structures for erodible material
- Statewide brine secondary containment assessment
- Design and construction of new wash bays to ensure indoor vehicle washing
- Salt barn repair plan and development of on-call repair contracts
- Initial assessment reports and preliminary design completed for erosion issues noted at various facilities statewide
- Statewide discharge sampling and reporting program for facilities with Individual Discharge Permits
- Routine compliance inspections at all SHA facilities
- Annual multimedia compliance training provided to maintenance shop personnel

Table 1-15 shows the SHA capital expenditures towards industrial pollution prevention BMPs from the current and past 11 fiscal years. Projected expenditures for Fiscal Year 16 are also included.

Table 1-15: Capital Expenditures for Pollution Prevention BMPs

Fiscal Year	Expenditure
2005	$ 613,210 - actual
2006	$ 592,873 - actual
2007	$ 450,608 - actual
2008	$ 590,704 - actual
2009	$ 478,889 – actual
2010	$ 613,766 - actual
2011	$ 595,984 - actual
2012	$ 664,577 - actual
2013	$ 917,902 - actual
2014	$641,512 - actual
2015	$2,339,971 - actual
2016	$1,858,544 - actual
2017	$3,093,750 - projected

D.5.b Maintenance Activity Pollution Reduction Program

SHA continues to implement programs and activities aimed at reducing pollutants associated with maintenance activities at SHA owned facilities. Such activities include street sweeping and inlet cleaning, and are discussed in the following sections. In addition, SHA is conducting efforts to minimize the use of pesticides, herbicides, and fertilizers associated with vegetation management and minimizing the use of winter weather deicing materials.

i. Street Sweeping

The current SHA street sweeping program is predicated upon operational and safety needs for maintaining drainage from roadways, keeping roadsides free from lose debris that can be thrown by turning wheels, and keeping roadsides visually attractive. As SHA has developed the Impervious Restoration and Coordinated TMDL Implementation Plan discussed in Section E.2.b, other water quality modeling, reduction calculations, data tracking and reporting, and practice implementation standards have entered into the decision making processes. Street sweeping programs to address water quality issues and various guidance from MDE and the

Chesapeake Bay program are under development. This section of the report addresses operational and safety needs for street sweeping. Section E.4 of future MS4 annual reports will discuss SHA's progress in implementing street sweeping routes, equipment, frequencies, and disposal methods in compliance with water quality standards.

Mechanical sweeping of the roadway is essential in the collection and disposal of loose material, debris, and litter. This material, such as dirt, sand, small rocks, trash, and other debris collects along curbs and gutters, bridge parapets, inlets, and outfall pipes. Street sweeping prevents buildup along sections of roadway and allows for the free flow of water from the highway to enter into the storm drain system. SHA sweeps a selected number of roadways regularly during the Spring, Summer, and Fall months from April through November. The collected material is then properly disposed of in an approved landfill. See Figure 1-11 for an example of SHA's street sweeping activity.



Figure 1-11: SHA Nighttime Street Sweeping Operation

The SHA desired operational condition is 95 percent of the traveled roadway clear of loose material or debris. In addition, 95 percent of closed section roadways (curb and gutter) should have less than 1 inch depth of loose material, debris, or excessive vegetation that can capture debris in the curb and gutter.

ii. Inlet Cleaning

As stated above under Section D.5.b.i for street sweeping, inlet cleaning is another operations practice that has been identified as useful in meeting water quality standards. The current SHA inlet cleaning program is predicated upon operational and safety needs for maintaining drainage from roadways, deterring flooding, minimizing ice development during winter storms, keeping roadsides free from lose debris that can be thrown by turning wheels, preventing damage to underground inlets and pipes, and keeping roadsides visually attractive. SHA is currently developing inlet cleaning programs to address water quality standards, MDE and Chesapeake Bay Program guidance, data tracking and reporting, and modeling and reduction calculations. This report addresses operations and safety components of the current SHA inlet cleaning program and future reports will discuss progress in implementing inlet cleaning efforts to meet water quality standards under Section E.4.

Inlets are structures that allow water to flow from the roadway surface and enter closed storm drain systems. These storm drain systems convey runoff to a discharge point at a ditch, channel, or waterway. Some inlets have been designed with catch basins, chambers where sediment, trash, and debris are captured before it can enter the waterway. These catch basins, along with "self-cleaning" inlets that have been clogged with debris, are cleaned periodically by SHA maintenance crews using vacuum trucks to remove the sediment and debris and to allow free flow through the inlet and prevent the storm drain system from becoming clogged. SHA maintenance personnel perform routine inlet inspection and cleaning. This helps to ensure proper water flow, protects drainage structures, and lessens the likelihood of flooding. In many cases, measures are employed to prevent erosion and sedimentation, as well as protect aquatic life in adjacent streams and rivers.

SHA owns and operates four vacuum pump trucks used to routinely clean storm drain inlets along roadways. Sediment and trash make up the majority of the material that is removed. The vacuum trucks operate in central Maryland,

spanning the following counties: Anne Arundel, Baltimore, Calvert, Carroll, Charles, Frederick, Harford, Howard, Montgomery, Prince George's, and St. Mary's. See Figure 1-12 and Figure 1-13 for examples of inlet cleaning equipment and before and after results.



Figure 1-12: SHA Vacuum Truck Used to Clean Inlets



Figure 1-13: Inlet Before and After Cleaning

iii. Minimize Use of Pesticides, Herbicides, Fertilizers and Other Pollutants

One of SHA's standards for maintaining the highway system is the *SHA Integrated Vegetation Management Manual for Maryland Highways, October 2003* (IVMM). This manual provides guideline for performing activities involved in the management of roadside vegetation including application of herbicides, mowing, and the management of woody vegetation. In order to maximize the efficiency of funds and to protect the roadside environment, an integration of these activities is employed. SHA has provided the chemical application program information, where available, in the MDE NPDES MS4 Stormwater Program Geodatabase format.

The Office of Environmental Design offers Pesticide Applicator Training (ENV100, ENV 200 and ENV210) classes throughout the year. ENV100 allows participants to become a Registered Pesticide Applicator with the Maryland Department of Agriculture (MDA) and receive a Pesticide Service I.D. card. Training covers pesticide safety, emergency protocols, plant ID, drift reduction, water quality, and Integrated Pest Management. ENV 200 provides recertification credits for SHA employees and consultants: Certified Pesticide Applicators are required by MDA to annually obtain continuing education credits in order to renew certifications. Training topics are developed by SHA and approved by MDA. ENV 210 is a Pesticide Core and Right-of-Way Certification preparation class. Table 1-16 below lists classes and participation rates during this reporting period.

Table 1-16: Pesticide Applicator Training

Date	Training Session		
	ENV100	ENV200	ENV210
10/20/2015			3
11/10/2015	9		
12/22/2015	32		
1/11/2016	22		
3/3/2016		13	
3/10/2016		15	
3/15/2016		9	
3/16/2016		14	

Table 1-16: Pesticide Applicator Training

Date	Training Session		
	ENV100	ENV200	ENV210
3/30/2016		7	
4/5/2016	25		
4/7/2016		19	
4/14/2016		9	
4/20/2016	15		
Sum Total	103	86	3
Total	**192**		

Herbicide Application

The majority of SHA's vegetation management is accomplished mechanically through the use of mowers and brush axes. However, in areas where mechanical control is not practical or feasible, SHA manages vegetation through the use of targeted applications of herbicide. Vegetation controlled by SHA includes noxious weeds, invasive weeds and plant material that is a safety hazard.

SHA promotes the safe and responsible use of herbicide for the control of vegetation. All SHA employees and contractors who apply herbicide on SHA rights-of-way must be registered with the MDA and operate under the supervision of a MDA-certified pesticide applicator.

Environmental stewardship is a primary focus of SHA's business plan, and SHA uses selective herbicides when available and targeted application, rather than broad application of non-selective herbicides. SHA uses the lowest pressure and largest droplet size for each application. Along with the addition of anti-drift agents these measures reduce the potential for drift, runoff and non-point source contamination. The selection of herbicide is based on the plant species that is being targeted. This ensures the effects on other plants are minimized and soil residual activity is limited. Application rates are based on the label minimum amount required to control the targeted plant species, which further reduces the potential for runoff and non-point source contamination.

Based on the reporting of individual SHA Shops, SHA applies approximately 4,661 gallons of liquid herbicides across their facilities. Additionally, 86 pounds of granulated herbicides are applied to these maintained areas.

Herbicide application equipment is routinely inspected and calibrated to ensure that applications are accurately applied in accordance to the IVMM, Maryland State law, and the herbicide label.

Nutrient Management Plans

The Maryland Lawn Fertilizer Law limits the total amount and timing of fertilizer applications associated with turfgrass establishment and maintenance. SHA uses slow-release nitrogen and low or no phosphorus fertilizers when establishing turf, meadows, and other vegetation. Topsoil, both existing and supplied, is sampled and tested for major and minor plant nutrients, pH, organic matter, and soluble salts. The test results are used to develop a nutrient management plan (NMP) for each soil to ensure optimal nutrient levels and growing conditions, and to avoid the application of excess fertilizer.

The Maryland Fertilizer Law requires that fertilizers are applied by a MDA Professional Fertilizer Applicator. While SHA personnel do not directly apply fertilizer they do have two Professional Fertilizer applicators on staff. The contractors are also required to provide application information to MDA on an annual basis. Detailed information regarding the application of fertilizer is currently maintained by MDA. As no SHA employees are applying fertilizers, there is no data to present since SHA does not receive detailed information regarding contractor applied fertilizer.

Mowing Reduction & Native Vegetation Establishment

A major initiative at the SHA is to reduce the extent of frequently mowed areas within our right-of-way. . There are also instances where SHA must maintain shorter vegetation for safety reasons. Shorter vegetation provides greater site distance at intersections and curves, and allows

for greater visibility of signs. Within clear zones, vegetation must be less than four inches in diameter to provide an area for errant vehicles that leave the road to safely stop. SHA's Turfgrass Management Policy has been revised to provide consistent guidance to decrease the size of mowed areas and the number of mowing cycles per year while still meeting the safety goals.

Several projects have been completed throughout the state to install and maintain reforestation and native meadow areas. Reforestation and native meadow areas require infrequent mowing, enhance and preserve native vegetation, and provide stormwater benefits such as increased nutrient uptake.

iv. Minimize Use of Winter Weather Deicing Materials

SHA continues to test and evaluate new winter materials, equipment and strategies in an on-going effort to improve the level of service provided to motorists during winter storms while at the same time minimizing the impact of its operations on the environment.

One method employed to decrease the overall application of deicing materials is to increase application of deicing materials prior to and in the early stages of a winter storm (anti-icing). This prevents snow and ice from bonding to the surface of roads and bridges and ultimately leads to lower material usage at the conclusion of storm events, thus lessening the overall usage of deicers.

SHA will have Liquid Only Snow Routes in each of its seven engineering districts. This operation is a designated snow route that only uses a critically measured salt brine solution to prevent the snow and ice from bonding to the pavement. Unlike anti-icing, which takes place prior to the event, this operation continues for the duration of the winter storm event and has proven to be quite effective. Data has shown that an average application rate of 120 lbs / lane mile / inch exceeded SHA's level of service metric by 17 percent, and also helped reduce a pilot facility's usage rate by 61 percent in the past season.

In addition, SHA is continuing its 'sensible salting' training of State and hired equipment operators in an on-going effort to decrease the use of deicing materials without jeopardizing the safety and mobility of motorists during and after winter storms. Table 1-17 lists the types of materials used by SHA in winter deicing operations.

Table 1-17: SHA Deicing Materials

Material	Characteristics
Sodium Chloride (Rock and Solar Salt)	The principle winter material used by SHA. Effective down to 20° F and is relatively inexpensive.
Abrasives	These include sand and crushed stone and are used to increase traction for motorists during storms. Abrasives have no snow melting capability.
Calcium Chloride	A solid (flake) winter material used during extremely cold winter storms. SHA uses limited amounts of calcium chloride.
Salt Brine	Liquid sodium chloride or liquefied salt is a solution that can be used as an anti-icer on highways prior to the onset of storms, or as a deicer on highways during a storm. Used extensively by SHA. Freeze point of -6° F.
Magnesium Chloride (Mag)	A liquid winter material used by SHA for deicing operations in its northern and western counties. It has a freeze point of -26° F and has proven cost effective in colder regions.

New Road Salt Management

On May 20, 2010 the Governor approved Senate Bill 775, requiring SHA, in consultation with the MDE, to develop a best practices road salt management guidance document by October 2011. This document is necessary to reduce the adverse environmental impacts of road salt storage, application, and disposal on Maryland's water and land resources. The objective and goal of this Statewide Salt Management Plan (SMP) is to provide a framework for highway agencies to deliver safe, efficient roadway systems during winter storms in a cost effective manner, while recognizing their obligation to do so in the most environmentally sensitive manner applicable.

SHA posted the SMP on its website in October 2011. The SMP was subsequently updated in October 2012 and October 2015 and has recently been revised and approved for publication in 2016. The October 2015 SMP can be accessed via the SHA website: http://roads.maryland.gov/oom/statewide_salt_management_plan.pdf.

The SMP provides guidance on snow and ice control operations with an emphasis on lessening the impact of salt on the environment. The SMP covers all aspects of winter operations including:

- Safety and mobility of motorists during and after winter storms;
- Defining levels of service provided during winter storms;
- Establishing long-term goals to lessen the usage of salt, and reduce its impact on the environment;
- Salt and other winter materials;
- Material storage and handling;
- Winter storm fighting equipment;
- Training initiatives;
- Winter storm management from pre-storm preparations through post-storm operations;
- Post-storm material and equipment cleanup;
- Post-storm and post-season data analysis;
- Public education and outreach, and
- Testing and evaluation of new materials, equipment, and strategies for continual improvement.

Roadside Deicer Application

SHA has been tracking road salt usage for approximately 15 years. Table 1-18 shows recent data since the inception of the SMP. It shows the yearly average number of storms fought by SHA and the average amount of snow accumulated in inches. The salt usage in tons is a statewide seasonal total.

Table 1-18: Recent Salt Usage)

Winter	Storms	Inches	Salt Used (tons)
2011 to 2012	5.2	11.8	85,536
2012 to 2013	10.3	25.0	205,212
2013 to 2014	17.3	66.5	551,443
2014 to 2015	16.0	47.4	340,083
2015 to 2016	7.6	40.0	137,358

Focusing on the future, a trend seems to be developing that shows movement toward reduced road salt usage, represented by the graph in Figure 1-14. In reading the graph, it is important to understand how SHA makes comparisons of road salt usage. SHA uses a metric of pounds of road salt per total lane miles per inch of snow. This allows an equal comparison across the state in the measurement of road salt usage.

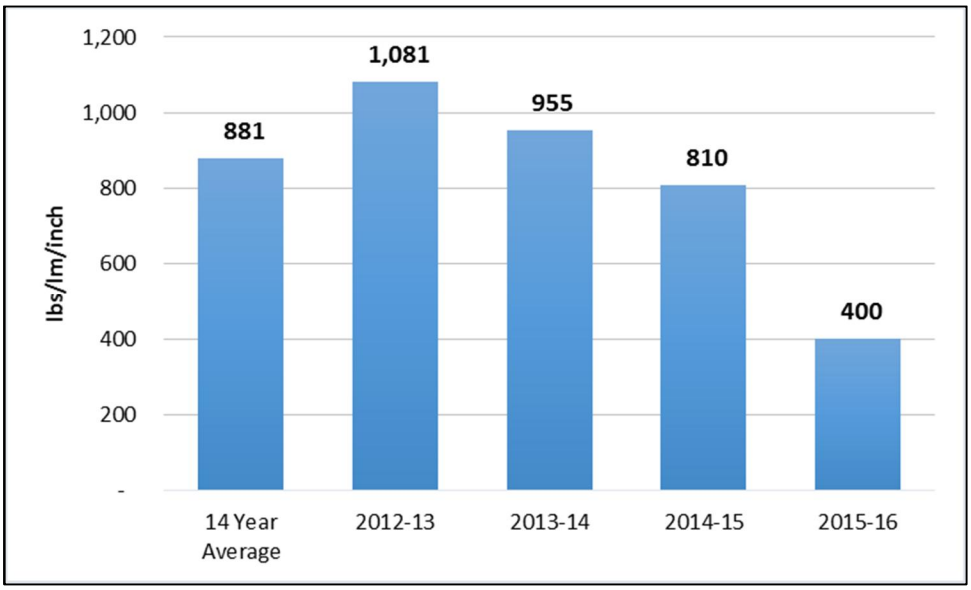


Figure 1-14: Comparison of Salt Usage Normalized by Snow Depth (lb/lane-mile/inch)

Prior to the 2014-2015 winter season, a challenge was issued by SHA management to reduce road salt usage by five percent. This challenge resulted in a statewide reduction in pounds per lane mile per inch of 14 percent.

By encouraging the expanded use of salt brine for anti-icing and re-application (liquid-only routes), reduced granular road salt application, and improved weather forecasting, further reduction is achievable without impacting the level of service to the traveling public.

SHA Annual Snow College

This training is offered annually at each of the seven SHA districts for new maintenance shop hires as well as 20 percent of veteran shop forces. The goal is to train all maintenance personnel over a five year period and repeat the process. This ensures that all maintenance personnel are exposed to current trends and technologies. The training presentations are included in the Statewide Salt Management Plan, Appendices II and III. Snow College includes the following subjects: safety, pre-season and pre-storm preparations, use of chemicals, environmental impacts of winter operations, weather information and data collection, equipment maintenance, plowing tips and techniques, and post-storm operations. During the reporting period, seven Snow College sessions were held and more than 100 employees were trained. See Table 1-19 for number of participants trained during this reporting period.

Table 1-19: SHA Snow College Training

SHA District Shops	Dates	Attendees
1 DO, WI, WO, SO	11/30/15 – 12/1/15	17
2 CE, KE, QA, CO, TA	10/28/15 – 10/29/15	7
3 MG, MF, PL, PM	10/26/15 – 10/27/15	25
4 BG, BH, BO, HA	11/23/15 – 11/24/15	18
5 AA, AG, CV, CA, CH, SM	11/9/15 – 11/10/15	20
6 GA, AL, WA	12/15/15 – 12/16/15	10
7 FR, CL, HO	11/2/15 – 11/3/15	17
Total		**114**

Annual Maintenance Shop Winter Meetings

In 2015, SHA developed training on Best Practices for Salt Management and Environmental

Stewardship during Winter Operations. Training is based on the practices outlined in the Salt Management Plan and is targeted specifically at the facility maintenance employees who manage or perform winter emergency operations. During the reporting period, 28 sessions were held and approximately 1,000 employees were trained.

Hired Equipment Operator Training

Prior to the start of each winter season, SHA provides this training to hired equipment contractors and operators. The training presentations are included in the Statewide Salt Management Plan, and topics covered include effective plowing, sensible salting and adhering to all pertinent SHA policies and procedures. This training has also been made available in a bilingual format aiding in information decimation. During the reporting period, more than 28 sessions were held and approximately 2,100 hired equipment operators were trained.

v. Pollution Prevention and Good Housekeeping Training

SHA continues to provide annual training to its maintenance personnel as described in the previous section. Environmental compliance training covers a variety of media areas including stormwater management, spill prevention and response, pollution prevention requirements, and training for pollution prevention team members performing stormwater inspections and quarterly visual monitoring assessments.

Each facility has a designated Pollution Prevention Team that is responsible for developing, implementing, maintaining control measures, utilizing corrective actions when required, and revising the SWPPP.

The Pollution Prevention Team is responsible for making sure that all operations staff understands the components of the SWPPP, how it will be implemented, and their role in contributing to the effectiveness of stormwater control measures. The Resident Maintenance Engineer is responsible for coordinating discharge prevention activities at the facility. Appropriate training and instruction is given to all employees regarding the SWPPP. Initial training occurs within six months of hiring. At a minimum, personnel training will be conducted annually to provide consistent understanding of pollution prevention and to notify employees of SWPPP changes.

Training documentation is maintained on SHA's Online Learning Center. Table 1-20 includes information related to SWPPP training during this reporting period.

Table 1-20: SWPPP Training By Shop

District	Maintenance Facility	Training Date	Total Trained
1	Salisbury	12/10/2015	23
2	Elkton	12/1/2015	32
3	Fairland	12/7/2015	29
3	Gaithersburg	12/9/2015	26
3	Laurel	12/9/2015	25
3	Marlboro	12/7/2015	22
5	Annapolis	6/14/2016	2
5	Glen Burnie	6/14/2016	5
5	La Plata	6/14/2016	4
7	Westminster	11/19/2015	40
Total			**208**

D.5.c Changes in Maintenance Practices and Overall Pollutant Reductions

SHA has reviewed its current maintenance program and determined that, along with the programs in place to plan and construct structural stormwater treatment, the program is adequately meeting the requirements. No alternative maintenance program was submitted to MDE in FY16.

Concerning overall pollutant reductions resulting from the SHA maintenance program, we are assuming that data relative to this condition is for deicing, fertilizer, and herbicide. Table ChemicalApplication (CAP) from the MDE NPDES Stormwater Program Geodatabase has been provided along with this report. The data includes only chemical applications supplied by SHA personnel and does not include applications on SHA right-of-way by contracted personnel.

Because this data is also reported to the MDA, SHA does not track it for contracted personnel. Data for previous years is zero at this reporting milestone, since this is the first year SHA has been required to report the data.

Once the programs have been established, reductions associated with street sweeping and inlet cleaning will be reported as part of Section E.4, TMDL Compliance, rather than the CAP table.

D.6 Public Education

Requirements under this condition include:

a) Maintain a compliance hotline or similar mechanism for public reporting of water quality complaints, including suspected illicit discharges, illegal dumping and spills;

b) Provide information to the transportation community about the benefits of:

- *i) Stormwater management implementation and facility maintenance;*
- *ii) Proper erosion and sediment control practices;*
- *iii) Increasing proper disposal of vehicle fluids such as brake fluid or motor oil (not in inlets or catch basins);*
- *iv) Refraining from and reporting roadside dumping;*
- *v) Proper litter and trash disposal;*
- *vi) Decreasing vehicle idling;*
- *vii) Utilizing alternative modes of transportation (bus, train, walking, biking, carpooling);*
- *viii) Car care and washing; and*
- *ix) Proper pet waste management at rest areas and welcome centers.*

c) Provide information regarding the following water quality issues to the regulated community when requested:

- *i) NPDES permitting requirements;*
- *ii) Pollution prevention plan development;*
- *iii) Proper housekeeping; and*
- *iv) Spill prevention and response.*

D.6.a Mechanism for Public Reporting

The SHA Customer Care Management System, better known as CCMS, was implemented in July 2007 as a central customer service reporting and tracking system for SHA. CCMS is updated regularly based on input from its primary users and the CCMS Administrator. Every SHA administrative office, district office, and maintenance shop participates in CCMS.

Customers can submit their concerns or requests directly into CCMS from the SHA webpage at:

http://marylandsha.force.com/customercare/request_for_service

This feature reduces emails to generic and project specific group email accounts. Once the customer clicks the submit request button, the ticket is in the system and on its way to the correct work unit. Inputs to CCMS are monitored and tracked on a daily basis. Each request is dealt with individually and closed out of the tracking system once SHA completes the service or addresses an inquiry. The system can be used to report a variety of service requests including water quality complaints such as suspected illicit discharges, illegal dumping, spills, and trash and litter problems along SHA roadways and facilities.

During the reporting period of October 1, 2015 through June 30, 2016, SHA's CCMS system received 19,860 service requests. There were 427 service requests regarding littering and illegal dumping related issues of which 416 are closed. Tickets reporting debris, litter, and graffiti account for 6 percent of all CCMS tickets. Such tickets peak in March following the winter season.

An email reporting mechanism has also been implemented via wpd@sha.state.md.us.

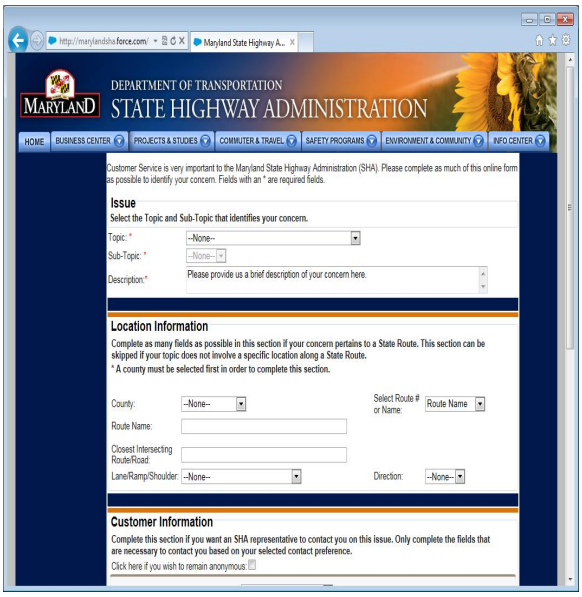


Figure 1-15: Screen Capture of CCMS



Figure 1-16: SHA Bay Restoration Informational Brochure

D.6.b Provide Information to the Transportation Community

SHA is dedicated to providing resources to members of the transportation community interested in learning about ways to reduce stormwater pollution in local waterways and the Chesapeake Bay. A new SHA Public Education webpage has been developed for this purpose and can be accessed at: https://www.roads.maryland.gov/Index.aspx?pageid=48.

The webpage includes information related to all the following topics. Please click on the link to review the content. Additional information related to the topics that is not provided on the website is discussed below.

i. Stormwater Management Implementation and Facility Maintenance

To educate the transportation community regarding stormwater management implementation as it relates to our Bay restoration strategies, SHA created a brochure titled SHA *Chesapeake Bay and Local Waterway Restoration Projects*, see Figure 1-16. This brochure provides information on environmental concerns resulting from increased stormwater runoff from urbanization along with descriptions of the various stormwater management restoration strategies SHA utilizes, such as structural stormwater controls, non-structural stormwater and natural resource controls, land use change, and pollutant source controls. This brochure is included with project notification letters that are sent to adjacent property owners when a restoration project is planned in their area.

In addition, SHA's Plan Review Division conducted one training session on March 23, 2016 targeted towards consultant design staff. The class provided technical guidance for the preparation of Stormwater Management plans, computations, and reports for SHA projects. A total of 103 people attended the training.

ii. Proper Erosion and Sediment Control Practices

SHA has a well-established erosion and sediment control training program which serves to educate and bring awareness to SHA designers, construction employees, design consultants, and contractors. See Section D.2 for information on training provided over the last reporting period.

Since 2004, SHA's Erosion and Sediment Control Certification (Yellow Card) has served to provide up to date awareness and education, a requirement to conduct construction business with SHA. This training can now serve a greater number of participants since it went on-line. In addition to these training courses SHA has created a variety of other media to provide education and awareness of the regulatory requirements on SHA projects. For instance, SHA has published an "Environmental Guidelines for Construction" along with an erosion and sediment control Field Guide to support the 2011 MDE specifications and illustrate increased requirements, and created a reference library (on-line/CD) for project personnel use.

Through in-field education and working partnerships throughout SHA, the ESC program has taken the lead to help end users understand and meet the environmental requirements. In 2012, SHA successfully launched an on-line training and certification for the SHA Yellow Card re-certification which is still utilized to date.

To increase public awareness regarding proper erosion and sediment control practices, the SHA public education webpage includes links to the MDE erosion and sediment control page for community members interested in learning about the program. Other educational links are provided as well.

iii. Increasing Proper Disposal of Vehicle Fluids (Not in Inlets or Catch Basins)

Vehicle Fluid Recycling

SHA's public education webpage includes valuable information about the importance of proper vehicle fluid disposal, along with links to MDE's Maryland Used Motor Oil Recycling Program webpage

Storm Drain Stenciling

As discussed in the 2015 MS4 Annual report, SHA supported the Howard County Watershed Stewards Academy (WSA) who initiated a storm drain stenciling program in collaboration with local Boy Scouts of America. The goal of the project was to educate middle school-aged students about sources of stormwater pollution, provide them with information to help solve stormwater pollution problems, and reduce polluted runoff into the Chesapeake Bay. The first storm drain stenciling occurred on October 10, 2015 at the Scaggsville Park and Ride off of MD 216 in Howard County. The lot is extremely busy, so the message will reach many Maryland commuters. See Figure 1-17 for a photo of one of the winning stencil designs.

Storm drain stenciling raises awareness about water quality issues within our communities, the

adverse impacts of urban pollutions to the water resources, and potential stewardship measured. Included on SHA's public education webpage are links to get started spreading awareness of stormwater pollution through storm drain stenciling.



Figure 1-17: Fox 5 News Tweet of Storm Drain Stenciling Project



Figure 1-18: SHA Illegal Dumping and Illicit Discharge E-Flyer

iv. Refraining from and Reporting Roadside Dumping

As part of SHA's public education initiative to discourage and report problems associated with illegal roadside dumping, SHA created an e-brochure titled "Keep Our State Waterways Clean" (see Figure 1-18). This e-flyer provides information as to the definition of illegal dumping, why it's a problem, common items associated with illegal dumping, and how to properly report it if you encounter illegally dumped items along SHA roadways. The e-flyer can be found via SHA's public education webpage along with links to the SHA CCMS to report roadside dumping. Additionally, SHA has strategically placed "No Dumping" signs throughout the state.

v. Proper Litter and Trash Disposal

SHA continues many initiatives that encourage proper litter and trash disposal. See Section D.4 for more information on litter education.

The SHA public education webpage includes information and links about proper litter and trash disposal and how members of the transportation community can help reduce the volume of trash entering local waterways.

vi. Decreasing Vehicle Idling

SHA is saving money and reducing emissions through a vehicle equipment idling policy. The newest idling policy for SHA's vehicle and equipment fleet took effect on September 22, 2009. The policy restricts operation of a motor vehicle engine for more than five (5) consecutive minutes when the vehicle is not in motion. The two exceptions to this policy are when a unit is deployed along a state route in preparation for winter operations, or when a unit functioning under an emergency situation or maintaining traffic through the use of emergency lighting. The policy applies to all operators of SHA vehicles and equipment, as well as drivers of consultant support vehicles. SHA has saved more than 170,000 gallons of light duty gasoline because of this idling policy.

To increase public awareness regarding the benefits of reducing vehicle idling, educational information has been provided on the SHA public education webpage.

vii. Utilizing Alternative Transportation

SHA offers several incentives to reduce the number of drivers and/or number of commuter days/miles per week by Administration employees. Fewer commuter days and miles mean less vehicle pollutants entering the watershed.

Alternate Work Schedules for Employees

Alternate work schedules include flexible work hours allowing employees to work compressed workweeks reducing the total number of commuting days and miles.

Teleworking for Employees

Teleworking allows employees to work from a remote location (presumably at or close to home) and also reduces the number of commuting days and miles per week. Each office has or is developing a teleworking policy.

Carpooling

Carpooling has been encouraged at SHA for both its employees and the traveling public for many years and reduces the number of commuters on the road. SHA carpooling incentives for employees include prioritizing parking space allocation to those in a designated car pool and Administration assistance in locating a carpool within the employee's residential area for those that wish to carpool to work.

SHA promotes carpooling for the traveling public by constructing and maintaining park and ride facilities throughout the entire state. All SHA park and ride facilities are free and can accommodate carpools and van pools. Overnight parking is also permitted. SHA currently has more than 100 park and ride locations throughout Maryland that provide more than 12,000 free parking spaces for commuters. There is an interactive map on SHA's web page to

help the traveling public locate and get directions to all SHA's park and ride facilities, see Figure 1-19.

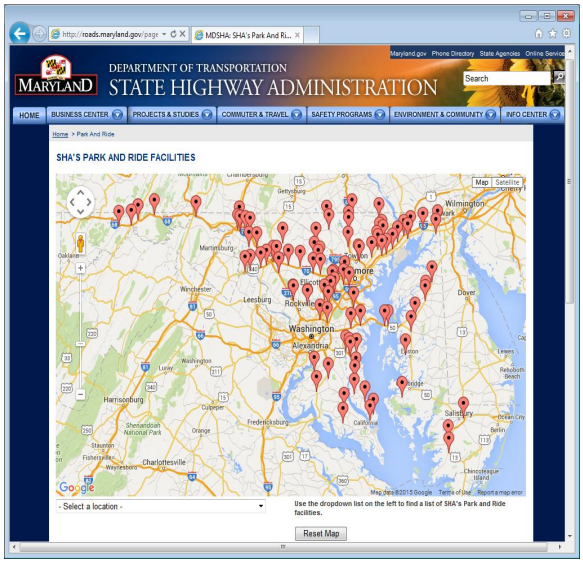


Figure 1-19: Screen Capture of SHA's Park and Ride Facility Locator Interactive Map

HOV Lanes

In addition to park and ride facilities, SHA has also constructed High Occupancy Vehicle (HOV) lanes on some of its interstates to promote carpooling. HOV lanes are reserved for carpools, vanpools, buses, and motorcycles during designated time periods. HOV lanes are intended to save commute time for carpool users and bus riders by enabling them to bypass areas of heavy traffic congestion. By giving carpool users and bus riders a quicker and more reliable ride during peak traffic periods, HOV lanes serve as a strong incentive for ridesharing, which in turn helps to manage congestion and contributes to improved air quality. HOV lanes are generally designated via white diamonds on signage and pavements markings. SHA currently has two HOV facilities, along I-270 in Montgomery County and along US 50 in Prince George's County.

National Bike to Work Day

Bicycle commuting is also encouraged with SHA's support to promote bicycle safety laws, implementing new bike facilities throughout the state. SHA also participated in a number of bicycle safety events and campaigns across the state year round. See Figure 1-29 for an image from Bike to Work Day.

National Bike to School Day

National Bike to School Day provides an opportunity for schools across the country to join together to celebrate and to build off of the energy on National Bike Month. National Bike to School Day was held on May 4, 2016. SHA promoted this event through public outreach using its social media feeds such as Facebook, Twitter, and Instagram.

International Walk to School Day

To promote walking, SHA promoted International Walk to School Day in October through its social media feeds on Instagram. This is a global event that involves communities from more than 40 countries walking to school on the same day. Over time, this event has become part of a movement for year-round routes to school and a celebration. This event was held on October 5, 2016.

Safe Routes to School

SHA's Safe Routes to School program focuses on improving the safety of children who walk or bicycle to school through the use of sidewalks, crosswalks, signage, pedestrian signals, and bike racks. This enables and encourages children in grades K-8 to walk and bicycle to school and makes walking and bicycling to school a safer and more appealing transportation alternative. The end result is improved safety, reduced traffic, fuel consumption, and air pollution in the vicinity of elementary and middle schools.

Mass Transit

Employee ID badges allow state employees free access to MTA mass transit including the Baltimore area subway, light rail, and buses. This encourages the use of mass transit by SHA employees who live or work within the Baltimore area.

The SHA public education webpage includes information regarding the benefits of using alternative transportation as well as links to learn more about the above mentioned programs.

viii. Proper Car Care and Washing

Improper car care and car washing can readily contribute pollutants into the adjacent storm drain system. Simply following a few simple steps when maintaining or washing your vehicle can help to conserve water and protect the quality of nearby water bodies.

To increase public awareness regarding proper car care and washing, educational information has been provided on the SHA public education webpage.

ix. Proper Pet Waste Management

SHA currently owns and maintains seven Welcome Centers and Rest Areas within the MS4 jurisdictions of Charles, Frederick, Howard, and Washington Counties. SHA Welcome Centers and Rest Areas are provided as a service to the traveling public.

The risk of water pollution increases when pet waste is left on rest area sidewalks, parking lots, and any undesignated grassy areas, as stormwater runoff can carry pet waste left on the ground into storm drains and nearby waterways. SHA has already begun to address proper pet waste management at some of its rest areas and welcome centers.

For instance, at SHA's newer welcome centers, such as the I-70 Eastbound and Westbound Rest Area and Welcome Center situated on South Mountain between Fredrick and Hagerstown in Frederick County, SHA has incorporated designated pet walking areas. These areas contain pet waste disposal stations which feature pet waste bag dispensers, educational signs, and trash bins specifically for the collection and proper disposal of pet waste. The disposal stations aim to educate the public on the importance of proper pet waste management and to encourage pet owners to pick up and properly dispose of their pet's waste, thereby keeping pet waste out of our waterways.



Figure 1-20: Pet Waste Disposal Station at the I-70 Eastbound Rest Area

x. Other SHA Water Quality Awareness Training

Chesapeake Bay Field Trips

This class is offered through SHA's On-line Learning Center sign up, College of Engineering, Environmental design training. It is a class that requires no pre-requisite training and is offered to all employees seeking to improve their environmental awareness. Therefore, this class has a mixture of employees from all over the state with varied levels of experience and educational background. This field trip demonstrates the link between highway runoff and its impacts on streams, rivers, and on the health of the Chesapeake Bay. It is a great opportunity to learn about one another's careers and our habits and actions in our daily work and home environment that may affect the health of the Chesapeake Bay.

The training includes visits to important environmental sites including wetlands, streams, forests, and a boat trip on the Bay. Four trips were taken during this reporting period on October 20, 2015, November 3, 2015, May 3, 2016 and May 18, 2016 with 81 participants attending in all. See Figure 1-26 for an image from the November, 2015 training.



Figure 1-21: November 2015 SHA Chesapeake Bay Field Trip

Washington County Public School's 8th Grade Day on the Job

On February 2, 2016 OED participated in Washington County Public Schools 8th Grade "Day on the Job" program. This day offers 8th grade students a unique opportunity to explore and learn about careers. Through this program, each eighth grade student in the Washington County Public School System must shadow an individual in a career of their interest. This program is meant to increase information for career planning, promotes a more clear understanding of the work ethic, provides insight into the real world of work, and improves student relationships outside of school. OED's Water Programs Division hosted an 8th grade student from Boonsboro Middle School located in Boonsboro, Maryland in Washington County. The student spent one full work day learning about the Water Program Division's role in restoring the Chesapeake Bay along with other topics such as various requirements of SHA's MS4 permit, the importance of stormwater management and erosion and sediment control, litter and trash problems along state roadways, and the importance of proper pet waste management. The student also visited an active stream restoration construction site along Broad Creek in Anne Arundel County to assess construction operations and gain first-hand knowledge on stream restoration as a nonstructural bay restoration strategy.



Figure 1-22: Washington County Public School's 8th Grade Day on the Job

OHD University

The Office of Highway Development (OHD) University is an in-house training program initially established to provide new OHD employees with the technical and project management skills that have been identified as essential for success in OHD. The program currently includes eighteen first year classes and eight second year classes that cover a variety of topics. When first developed, the OHDU program's course content was specifically developed for new OHD entry-level engineers. Since that time, this program has grown to include all new OHD employees and other newly hired professionals within OHD.

"Environmental Permits and Regulations" is a 2nd year OHDU class that provides information on the types of environmental permits that are typically required for projects, including storm water management (SWM), erosion and sediment (E&S)

control, Joint Permit Application (JPA), Wetlands and Waterways, Dam Safety, NEPA, Roadside Tree, and Reforestation -- just to name a few. The class includes discussion of what is needed for each permit submittal and the regulations with which SHA must comply as it relates to the project development process. This class was held on 6/1/16 and included 26 participants.

Another OHDU course, "SWM & Erosion and Sediment Control" took place on 10/6/16 and included 27 participants. Information about this class will be included in next year's annual report.

D.6.c Information for the Regulated Community

i. NPDES Permitting Requirements

Information relating to NPDES Construction Activity Permits is available on the MDE website, and SHA directs requests for information to that site.

ii. Pollution Prevention Plan Development

Stormwater Pollution Prevention Plans (SWPPP) are required by NPDES General Permit No. 12—SW for each of SHA's industrial facilities. The SWPPPs are available for review upon request.

iii. Proper Housekeeping

Proper housekeeping measures are identified in SHA's Stormwater Pollution Prevention Plans for industrial facilities. These documents are available upon request.

Proper housekeeping measures include sweeping areas in front of salt and material storage structures, pick-up and proper disposal of garbage and floatable debris, routine inspections of drums, tanks, and other containers, and conducting vehicle and equipment repairs indoors or under cover.

iv. Spill Prevention and Response

SHA maintains Standard Operating Procedures related to spill prevention and response that are available upon request. These documents are updated on a routine basis per SHA's Environmental Management System and are available upon request.

E. Restoration Plans and Total Maximum Daily Loads (TMDLs)

In compliance with §402(p)(3)(B)(iii) of the CWA, MS4 permits require stormwater controls to reduce the discharge of pollutants to the MEP. By regulation at 40 CFR §122.44, BMPs and programs implemented pursuant to this permit must be consistent with applicable wasteload applications (WLAs) developed under EPA approved TMDLs.

In pursuit of these goals, SHA shall coordinate watershed assessments with surrounding jurisdictions and annually report on restoration plans, opportunities for public participation, and TMDL compliance status to MDE. As required below, watershed assessments and restoration plans shall include a thorough discussion of water quality analysis findings based on coordination with surrounding jurisdictions, TMDL documents and other resources when available, identification of water quality improvement opportunities, and a schedule for BMP and programmatic implementation to meet stormwater WLAs included in EPA approved TMDLs. SHA shall address both specific WLAs and target loads when SHA is part of larger aggregate loads. A list of EPA approved TMDLs for SHA in the permit area is included in Attachment B of the permit.

Research Activity

By employing improvements to practices, SHA can ensure the most effective use of ROW, funding and other resources. On-going research activities performed during the permit term are discussed below.

Assessment of Stream Restoration Projects

As discussed in the SHA 2015 Annual Report Update, Dr. R. P. Morgan and his students at UMCES continue to assess and monitor completed and proposed SHA stream restoration projects. This assessment provides a framework and historical database of recommendations for

future SHA stream restoration projects, and for the assessment and potential revitalization of existing SHA restoration projects throughout the state of Maryland. The full 2015-2016 monitoring report is included in Appendix C.

The following sites were monitored in 2016:

- Montgomery County – Long Draught Branch
- Harford County – Plumtree Run
- Howard County – Upper Little Patuxent River
- Montgomery County – Watkins Mills Road
- Baltimore County – White Marsh Run

Polychlorinated Biphenyls in Stormwater Runoff

To assist in the establishment of benchmarks and timeframes for TMDL program implementation, SHA has initiated a research study on biphenyls (PCBs) in SHA watersheds and stormwater. The study is focused on PCB concentrations, the relationship to sediment concentrations and sediment grain sizes, and the relationship between PCB removal and sediment removal. This research will determine the effectiveness of stormwater control practices in removing PCBs. The research is being performed by Dr. Davis, Dr. Kjellerup, and their students from the University of Maryland. A progress report of their work is included in Appendix C starting on page C-118.

Inlet Cleaning Pollutant Characterization Study for TMDL Compliance

A prime challenge of meeting TMDL requirements is the mandate to quantify the pollutants captured and removed from inlets and road surfaces. Defining the composition of those captured solids is of major interest for SHA for compliance planning, implementation, and reporting. In March 2016, MD SHA contracted with Morgan State University (MSU) in partnership with the Center for Watershed Protection, Inc. (CWP) to evaluate its inlet cleaning operations and recommend how SHA can optimize their inlet cleaning operations to maximize nutrient, sediment, and trash load reduction credits for TMDL compliance. The purpose of the study is to determine appropriate crediting of this practice for TMDL compliance and to collect information that could support enhancements to the existing credit allowed by MDE.

The scope of work includes a monitoring effort to characterize and quantify the amount of material and debris, to include nutrients, sediment and trash, collected in inlets maintained by SHA. The information generated from the monitoring study will be evaluated along with programmatic information to develop recommendations to optimize SHA's inlet cleaning program for TMDL compliance.

The results will be used for future adaptive management adjustments for impervious restoration and for implementation plans for trash, nutrient, and sediment TMDLs.

To date, the project team (MSU and CWP) has completed on-site visits with SHA Maintenance crews to review current practices for cleanout and disposal, and reviewed the SHA geodatabases relevant to the study. A progress report of this study is included in Appendix C starting on page C-124.

Assessment of Bioswale Performance

Although bioswale and bioretention facilities (and other stormwater management techniques) are now becoming common practices to treat roadway runoff, there is a critical need to understand their overall efficiency (both in the short-term and in the long-term) as well as their lifetime expectancy, especially under real-life field conditions. As discussed in the 2015 Annual Report Update, Dr. R. P. Morgan and his students at the Appalachian Laboratory of the University of Maryland Center for Environmental Science (UMCES) continue to evaluate the effectiveness of bioswales and their pollutant removal efficiency in Phase II of their Assessment of Bioswale Performance.

There are four distinct project objectives for this project:

The first objective is to determine if there are reductions in base pollutant levels (primarily focusing on TSS, TN and TP) as roadway stormwater runoff passes through SHA bioswale design facilities (both lined and unlined), with a corollary objective to examine selected heavy metal concentrations, or other important roadway pollutants associated with roads, in both runoff and bioswale soil samples.

The second objective is to continue to develop field procedures employed in this study to monitor the ability of the designed bioswale facilities to infiltrate storm water flowing into the facilities over an extended period of time, as well as to characterize the bioswale filter soil to determine its long-term efficiency and usefulness. This element is of great importance to SHA since the bioswale material will eventually need to be replaced.

The third objective is to understand the dynamics of water movement through the bioswales in order to determine whether these systems have been optimally designed.

The fourth objective is to examine the potential recharge capacity of unlined bioswales at the interface of the bioswale and the underlying soil.

Bioswales were selected for detailed assessment, with special emphasis on two bioswales constructed in the median of Dual Highway in Hagerstown, MD. The study also includes a control site (lacking bioswale structures) adjacent to the two bioswales.

During this reporting period, the research team sampled the bioswales and the control site for soil chemistry, and subsequently processed the samples for metals and nutrients as well as physical soil properties. The team also assessed vegetation structure, measured soil infiltration rates, and examined the recharge capacity of the bioswales to the underlying soil. Quarterly progress reports from October and December 2015 are included in Appendix C starting on page C-128.

TMDL Salt Management Planning

SHA is currently conducting a research study geared toward reducing long term salt use. The purpose of the study is to review and update SHA's current Salt Management Plan, identify other effective methods of snow removal, and develop an implementation plan that could address a future TMDL requirement to reduce chlorides. Finally, the study will provide a method for SHA to demonstrate that road salt use is appropriate given weather conditions, and that it is achieving the lowest salt usage while maintaining public safety to the maximum extent practicable.

The study includes the following tasks:

- Research and recommend procedures for comparing winter severity. SHA currently uses inches of snow, which may underestimate the severity and need for salt application for other events such as freezing rain. A measure of severity that takes into account other forms of precipitation, pavement temperature, and other metrics would improve SHA’s management of salt usage from season to season.

- Research and assist in testing equipment to collect salt usage data during storm events. Current data collection involves operators tracking the amount of salt loaded onto each truck. During the winter of 2016-2017 SHA will pilot the use of automated loader data capture systems, which would reduce errors and allow for real-time tracking and management of salt usage during the event.

- Determine the feasibility of expanding the use of brine for de-icing; assess the feasibility and constraints of 100% brine usage; determine the capacity and logistics of brine production; and research the expansion of existing usage in a Pilot Program on designated routes.

A progress report from this study will be included in next year’s annual report update.

E.1 Watershed Assessments

Requirements under this condition include:

a) 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:

i) Determine current water quality conditions;

ii) Include the results of visual inspections targeting SHA rights-of-way and facilities conducted in areas identified as priority for restoration;

iii) Identify and rank water quality problems for restoration associated with SHA rights-of-way and facilities;

iv) 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

v) Specify pollutant load reduction benchmarks and deadlines that demonstrate progress toward meeting all applicable stormwater WLAs.

E.1.a Watershed Assessment

SHA has coordinated with county MS4 jurisdictions concerning watershed assessments and the development of a TMDL implementation plan for each watershed for which SHA has a wasteload allocation. Summaries of county assessments and SHA activities within the individual TMDL watersheds are included in Part IV of the SHA *Impervious Restoration and Coordinated TMDL Implementation Plan* (SHA Implementation Plan) that was submitted to MDE on October 7, 2016. This plan has also been posted to the SHA website at the following link:

http://roads.maryland.gov/index.aspx?PageId=336

The SHA Implementation Plan is comprised of four parts:

- Part I: Program Introduction;
- Part II: Impervious Restoration & Chesapeake Bay TMDL Compliance;
- Part III: Coordinated TMDL Implementation Plan; and
- Part IV: SHA Watershed TMDL Implementation Plans.

SHA has established an outreach team tasked with coordinating the pollution reduction strategies in each of the MS4 jurisdictional counties. The purpose is to establish a cooperative relationship and identify partnering opportunities. This coordination is important to ensure that locals are informed and able to provide input on SHA's planned activities, and that efforts are complimentary and not duplicative. These meetings result in more efficient efforts to address TMDL load reductions in targeted areas and help establish relationships to coordinate other MS4 program initiatives, such as the litter education and outreach initiative.

Additionally, SHA is utilizing information from each county's watershed assessments to help identify specific watershed issues and restoration project opportunities. This methodology and individual assessment summaries are presented in the SHA Implementation Plan, discussed in the following sections.

i. Current Water Quality Conditions

Water quality criteria are discussed in Part III, Section A of the SHA Implementation Plan. Table 3-1 of the plan, lists the designated uses for waterways in Maryland. It is these uses upon which TMDLs are based.

County watershed assessments are described in Part III, Section B of the plan. These assessments determine current water quality conditions.

Summaries of these evaluations are included in Part IV of the plan under each individual watershed section.

ii. Visual Inspections Targeting SHA ROW

SHA's visual inspections targeting SHA right-of-way are described in Part III, Section C of the SHA Implementation Plan.

Summaries of these evaluations are included in Part IV, under each individual watershed section.

iii. Water Quality Problems for Restoration

County watershed assessments are described in Part III, Section B of the SHA Implementation Plan. These assessments identify and rank water quality problems for restoration.

Summaries of these evaluations are included in Part IV of the plan, under each individual watershed section.

iv. Water Quality Improvement Projects

County watershed assessments are described in Part III, Section B of the SHA Implementation Plan. These assessments prioritize and rank all structural and non-structural improvement projects to be implemented.

Summaries of these evaluations are included in Part IV of the plan, under each individual watershed section.

v. Pollutant Load Reduction Benchmarks and Deadlines

County watershed assessments are described in Part III, Section B of the SHA Implementation Plan. These assessments set pollutant reduction benchmarks and deadlines that demonstrate progress toward meeting all applicable water quality standards.

Benchmarks and deadlines demonstrating progress toward meeting all applicable stormwater WLAs are provided in each watershed discussion in Part IV of the plan.

E.2 Watershed Restoration Plans

Requirements under this condition include:

a) Within one year of permit issuance, SHA shall submit an impervious surface area assessment consistent with the methods described in the MDE document "Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollutant Discharge Elimination System Stormwater Permits" (MDE, August 2014 or subsequent versions). Upon approval by MDE, this impervious surface area assessment shall serve as the baseline for the restoration efforts required in this permit.

By the end of this permit term, SHA shall commence and complete the implementation of restoration efforts for twenty percent of SHA's impervious surface area consistent with the methodology described in the MDE document cited in PART IV.E.2.a. that has not already been restored to the MEP. Equivalent acres restored of impervious surfaces, through new retrofits or the retrofit of pre-2002 structural BMPs, shall be based upon the treatment of the WQv criteria and associated list of practices defined in the 2000 Maryland Stormwater Design Manual. For alternate BMPs, the basis for calculation of equivalent impervious acres restored is based upon the pollutant loads from forested cover.

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:

i) 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;

ii) Provide detailed cost estimates for individual projects, programs, controls, and plan implementation;

iii) 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

iv) 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.

E.2.a Impervious Surface Area Assessment

SHA performed an impervious surface area assessment using the best available data to support this process in accordance with MDE's *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollutant Discharge Elimination System Stormwater Permits* (MS4 Accounting Guidance) document published in August 2014. The development of the impervious surface area assessment was completed to establish a baseline for SHA's 2015 – 2020 permit term defining the controlled and uncontrolled surfaces and the associated 20 percent impervious restoration requirement. This assessment is included in Part II, Section B of the SHA Implementation Plan and is outlined below.

SHA performed the following activities to prepare the impervious surface area assessment:

- Compile SHA owned impervious surfaces within the 11 MS4 counties and three jurisdictions in 2011;
- Research and quantify the treatment provided by stormwater BMPs in 2011;
- Delineate drainage areas for Stormwater BMPs;
- Research and quantify the treatment provided by alternative practices in 2011 in terms of impervious equivalent acreage;
- Perform all required inspections for SWM structure and alternative practice BMPs providing baseline treatment;
- Review maintenance records to ensure proper maintenance is performed on baseline BMPs and establish work orders for any outdated maintenance;
- Identify and quantify the treatment provided by inventoried grass swale BMPs by using the MDE-approved Grass Swale Protocol; and
- Research and quantify redevelopment baseline impervious credit.

Impervious Surface Compilation

An inventory of impervious surfaces (in acres) currently owned by SHA within the MS4 areas and an assessment to quantify those impervious surfaces that receive runoff treatment was performed. This inventory and assessment was used to compute the untreated acreage baseline and 20 percent treatment requirement. MDE and SHA agreed on the date of October 21, 2010 to define baseline treatment requirements. In other words, impervious surfaces, stormwater control structures and alternative restoration practices built prior to this date are used in this baseline inventory and assessment for calculating the amount of impervious surfaces that SHA is responsible for treating. The baseline development process and data have been compiled into a separate *SHA Restoration Modeling Protocol*, included as Appendix E to this annual report.

Impervious Surface Inventory

An inventory of SHA-owned impervious surfaces was conducted by producing a planning-level

ROW GIS layer demarcating SHA-owned property and an impervious surface layer. The ROW layer was produced by extracting data from the MDP Property View GIS product and refining it with property boundary data from other sources such as recorded plats and ROW GIS data from other agencies. The ROW layer was then edited to contain only those surfaces within the MS4 areas.

The impervious surface layer was produced using high-resolution aerial imagery consistent with the baseline date of October 21, 2010. The layer was generated using the Feature Analyst toolset within GIS, along with desktop review and calibration, to produce polygons from the aerial imagery. This layer was then intersected with the ROW layer to create a GIS layer representing SHA's impervious surfaces within MS4 areas. Based on the best available data, SHA owned a total of 26,301 acres of impervious surface within our right-of-way in 2011.

Baseline Runoff Treatment Assessment

Baseline runoff treatment is provided by restoration facilities built as a condition to the last MS4 permit (October 2005 to October 2010) and structural stormwater controls built under stormwater regulations for roadway development. To be consistent with the impervious inventory, only SHA-owned facilities built prior to October 21, 2010 were used.

A database of existing SHA-owned stormwater control structures, conveyances and drainage areas was developed by SHA under the previous MS4 permit database development, tracking and reporting requirement. There are 2,081 stormwater control structures that were constructed prior to the baseline date and used in this assessment. Runoff treatment for impervious surfaces located within the SHA ROW that is treated by stormwater control structures which are owned and operated by SHA are included. SHA delineated drainage areas to define the treatment areas for the BMP facilities. Also, restoration projects built under the previous permit term including stream stabilization, stormwater control structure retrofits and outfall stabilization are included.

MDE requires all practices be inspected every three years and maintained as appropriate to ensure they function as designed. Before being included in the SHA impervious surface area assessment of facilities providing runoff treatment, data associated with these practices was evaluated to ensure they meet requirements for inspection, maintenance and functionality. SHA performed 1,492 inspections of baseline stormwater facilities and 30 inspections of baseline tree planting sites during the reporting period.

SHA has a maintenance program focused on performing major maintenance within three years after a failed inspection. SHA did not include practices that have required major maintenance for longer than three years, unless the facility is included in a retrofit design and construction project programmed for completion within the permit term. SHA also did not include facilities that were not inspected within the three-year timeframe.

Tables 1-4 and 1-5 (in section D.1.d of this report) include BMPs where maintenance or remediation efforts are under way but not yet completed under the three year timeframe. SHA has committed to complete these efforts within established timeframes and therefore has kept them in the baseline accounting.

MDE also requires documentation including plans, design specifications and complete maintenance records in order to claim baseline or restoration credit. For baseline facilities, SHA has evaluated records for existing stormwater control structures to determine if adequate documentation exists to demonstrate water quality treatment levels provided. In cases where records were not located, an analysis was performed using field surveys and accepted engineering computational standards to determine water quality treatment levels used in the baseline assessment. Each facility has a researched water quality volume that is used to calculate the inches of rainfall treated (Pe). The associated impervious area credit is then determined based on the calculated Pe value, drainage area and impervious surfaces draining to the facility. Documentation was produced to accompany these analyses and support runoff

treatment assigned to these facilities. All documentation supporting treatment assessment are filed and associated with database records. The 2,081 stormwater facilities provide 1,890 acres of baseline impervious treatment.

MDE allows removing impervious surfaces from the treatment requirement for areas that are considered to be "disconnected" from storm drain systems because they drain to open areas or channels. One method to employ this concept is the use of open section roads with swales that meet the grass swale criteria provided by the MDE MS4 Accounting Guidance. An open section road is one where stormwater is not conveyed by closed storm drain systems but instead drains to open channels. SHA developed the *Existing Water Quality Grass Swale Identification Protocol* (Grassed Swale Protocol) to document criteria used to evaluate existing open channels or ditches that meet these criteria. This protocol was initially approved by MDE on April 16, 2013 and was recently revised and approved by MDE on May 18, 2016. It is available on the SHA MS4 website.

An extensive inventory was undertaken within the MS4 areas along SHA ROW and open section roadways to identify, document, field verify, and place open channels that qualify for this treatment credit into the SHA database. These open channels are considered to be structural stormwater controls and will be inspected according to the three-year requirement for other practices. SHA inventoried and documented treatment for 2,573 grass swale BMPs providing 604 acres of baseline impervious treatment throughout the SHA MS4 area.

SHA has claimed baseline impervious area credit for alternative practices implemented prior to the baseline year including 232 tree planting sites providing an impervious equivalence of 125.68 acres and 10 stream restoration projects providing the equivalent of 38.78 acres of impervious treatment. In addition, SHA has claimed baseline credit for three stream restoration projects reported under the last permit providing a total of 23.18 acres of impervious treatment.

Lastly, MDE allows SHA to claim redevelopment credit and pavement removal associated with new roadway development against SHA's impervious surface area assessment. Redevelopment is a requirement of past and present stormwater regulations that currently requires 50 percent of existing impervious surfaces within a site development area to be included in the water quality volume calculations used in sizing the stormwater control structure. This existing impervious area that received runoff treatment for new roadway projects and impervious surfaces removed are subtracted from the baseline treatment requirement. SHA documented 275 projects that provided a total of 23.34 acres of baseline impervious treatment.

The results of the impervious surface area assessment are:

- SHA owns 26,301 acres of impervious surfaces within the MS4 areas.
- Treated impervious surfaces total 2,705 acres.
- Untreated impervious surfaces total 23,596 acres (26,301 minus 2,705). This is the untreated surface baseline.
- 4,719 acres of impervious surfaces (23,596 multiplied by 0.2) must be treated or offset within the 5 year permit term by October 9, 2020. This is the baseline treatment requirement.

SHA is committed to continuous improvement of our impervious accounting efforts, and has developed plans to continue to investigate, research and evaluate baseline treatment that is provided throughout the MS4 area for the purposes of updating the baseline during the permit term. Below are the future initiatives that SHA may pursue to revise the baseline impervious accounting:

- Additional BMP treatment determination;
- Additional BMP ownership verifications;
- County restoration research to remove from SHA baseline;
- Offsite treatment research;
- Inventory impervious disconnections; and

- Research impervious ownership transfers.

SHA has provided the impervious surface area assessment results and baseline BMP treatment information, in the MDE NPDES MS4 Stormwater Program Geodatabase format.

E.2.b TMDL Implementation Plan

As discussed in earlier sections, the SHA Implementation Plan was submitted to MDE on October 7, 2016.

i. Schedule

In order to meet the 20 percent impervious restoration requirement by October 9, 2020, a specific number of acres have been planned for treatment each year. Part II, Section D of the plan projects the cumulative percentages of impervious treatment by fiscal year.

SHA's reduction requirements and projected progress in meeting pollution reduction waste load targets within each of the local watersheds by the listed end dates are summarized in Tables 3-2 and 3-3 within Part III, Section E of the SHA Implementation Plan.

ii. Cost Estimates

Lists of proposed practices and costs to achieve the required reductions are included in Part IV of the SHA Implementation Plan under each individual watershed section.

Detailed costs for specific construction projects are available on SHA's website:

http://www.roads.maryland.gov/pages/cic.aspx?PageId=857.

iii. Documenting Progress

Benchmarks and deadlines for meeting established WLA's are discussed in Parts III and IV of the SHA Implementation Plan. Information related specifically to reduction strategies and modeling to track progress are included in Part III, Section E – Pollution Reduction Strategies and the *SHA Restoration Modeling Protocol* included as Appendix E to this annual report.

iv. Adaptive Management

As discussed above, annual reports will be submitted to MDE that will document progress in meeting proposed benchmarks. Each report will include a database and written description of compliance measures. If benchmarks are not being met, both the Bay TMDL and the MDE MS4 permit allow for adjustments in the plan to accommodate shortages. This "adaptive management" concept is discussed in Part II, Section C of the SHA Implementation Plan.

SHA foresees adjustments in this plan being necessary and will provide an updated plan in each MS4 annual report that will identify new practices to be implemented while meeting the established overall 2020 restoration goal.

E.3 Public Participation

Requirements under this condition include:

SHA shall provide opportunity to the public regarding the development of its coordinated TMDL implementation plan by allowing for public participation, soliciting input, and incorporating any relevant ideas and program improvements that can aid in achieving TMDLs and water quality standards according to the actions below. SHA is required to provide:

a) Notice in a regional newspaper and SHA's website outlining how the public may obtain information on the development of the coordinated TMDL implementation plan and opportunities for comment;
b) Procedures for providing copies of the coordinated TMDL implementation plan to interested parties upon request;
c) A minimum 30 day comment period before finalizing the coordinated TMDL implementation plan; and
d) A summary in each annual report of how SHA addressed or will address any material comment received from the public.

During the reporting period, the SHA *Impervious Restoration and Coordinated TMDL Implementation Plan*, which SHA is referring to as the SHA Implementation Plan, was developed and notice was provided in a number of regional news sources. Advertisements were published in

The Baltimore Sun (7/26/16) and The Washington Post (7/27/16). These advertisements outlined the requirements of the MS4 permit, and how the public could review and comment upon the draft plan.

STATE HIGHWAY ADMINISTRATION

OPPORTUNITY FOR PUBLIC REVEW AND COMMENT

IMPERVIOUS RESTORATION AND COORDINATED TMDL IMPLEMENTATION PLAN

The State Highway Administration (SHA) was issued a National Pollutant Discharge Elimination System, Municipal Separate Storm Sewer System (MS4) permit (Permit No. 11-DP-3313) by the Maryland Department of the Environment (MDE) on October 9, 2015. This permit covers stormwater discharges from the storm drain system owned or operated by SHA within Anne Arundel, Baltimore, Carroll, Cecil, Charles, Frederick, Harford, Howard, Montgomery, Prince George's and Washington Counties. Permit requirements include treating or offsetting 20% of currently untreated baseline impervious surfaces, Chesapeake Bay restoration efforts and working toward meeting stormwater wasteload allocations for local water resources through the implementation of an Impervious Restoration and Coordinated TMDL Implementation Plan.

SHA is soliciting comments on its draft Plan as required under the SHA MS4 Permit. A 30-day public comment period will take place from August 1 to August 31, 2016. The draft Plan is available on SHA's web site at www.roads.maryland.gov (link included below). Hard copies will also be available at the main branch of Public Libraries in the above mentioned counties.

http://roads.maryland.gov/index.aspx?pageid=362

Comments should be submitted to SHA on or before August 31 by emailing to the SHA Office of Environmental Design at wpd@sha.state.md.us, faxing to (410) 209-5003, or mailing to:

State Highway Administration
Office of Environmental Design, C-303
707 North Calvert Street
Baltimore, MD 21202

Please note that comments should include the name and address of the person submitting the comments. Individual responses to comments will not be provided but a summary of material comments received will be included in the SHA MS4 annual report submitted to MDE on October 9, 2016. The annual report will also be posted on the MS4 Discharge Permit webpage accessed from www.roads.maryland.gov

Figure 1-23: Washington Post Ad

Articles covering the announcement of the 30-day comment period were written in *The Bay Times*, a weekly newspaper serving Kent Island, Grasonville, Queenstown, and all of southern Queen Anne's County. Notice was also included in *What's Up Magazine* which covers Anne Arundel County, Greater Chesapeake region and the Eastern Shore.

Notice was also provided through SHA social media feeds, such as Facebook and Instagram, as well as through OCRI issued press releases, and public meetings with elected officials and constituents.

The SHA website, which includes a full page of information and links related to the MS4 permit, was updated with a new page dedicated to soliciting comments on the draft TMDL Implementation Plan. This page made available for review and download the draft plan and included contact information for the public to submit comments.

This webpage remained on-line soliciting comments beyond the minimum 30-days mandated by the permit; the webpage was online from August 1, 2016 until the final plan was delivered to MDE on October 7, 2016.

A screenshot of this webpage during the review and comment period is presented in Figure 1-24 below.

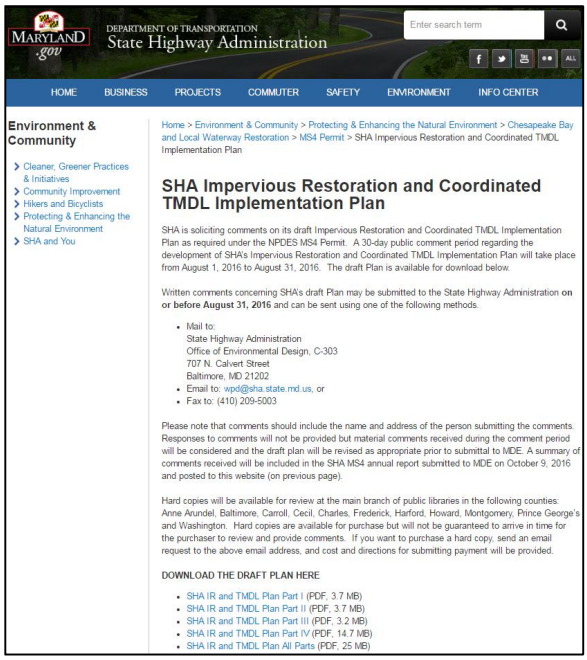


Figure 1-24: SHA TMDL Implementation Plan Webpage

In addition to the draft documents made available for review and download, this webpage included information related to hard copies of the draft report. These copies were made available for review at the main branch of public libraries in the following counties: Anne Arundel, Baltimore, Carroll, Cecil, Charles, Frederick, Harford, Howard, Montgomery, Prince George's and Washington.

Comments were received from a total of four people during the solicitation period. These

comments along with SHA's responses are included in Appendix D.

E.4 TMDL Compliance

Requirements under this condition include:

SHA shall evaluate and document its progress toward meeting all applicable stormwater WLAs included in EPA approved TMDLs. An annual TMDL assessment report with tables will be submitted to MDE. This assessment shall include complete descriptions of the analytical methodology used to evaluate the effectiveness of SHA's restoration plans and how these plans are working toward achieving compliance with EPA approved TMDLs. SHA shall further provide:

a) *Estimated net change in pollutant load reductions from all completed structural and nonstructural water quality improvement projects, enhanced stormwater management programs, and alternative stormwater control initiatives;*

b) *A comparison of the net change in pollutant load reductions detailed above with the established benchmarks, deadlines, and applicable stormwater WLAs;*

c) *Itemized costs for completed projects, programs, and initiatives to meet established pollutant reduction benchmarks and deadlines;*

d) *Cost estimates for completing all projects, programs, and alternatives necessary for meeting applicable stormwater WLAs; and*

e) *A description of a plan for implementing additional watershed restoration actions that can be enforced when benchmarks, deadlines, and applicable stormwater WLAs are not being met or when projected funding is inadequate.*

SHA has developed a restoration modeling protocol detailing the methods used to model reductions of SHA WLAs for the current TMDL pollutants. Different modeling methods are used depending upon the pollutants and current reduction practices in use. Brief descriptions of modeling methods are included in Part III of the SHA Implementation Plan, but the *SHA Restoration Modeling Protocol* in Appendix E should be consulted for detailed descriptions.

E.4.a Progress and Reductions Achieved

The progress reported here includes both impervious restoration and TMDL implementation efforts. All of the practices used to meet the impervious restoration goal were used to model TMDL reduction strategies. Additional practices were added to modeling of watersheds with local SHA WLAs when it was determined that the practices proposed to meet the 2020 impervious restoration goal would not be adequate to meet the local WLA reduction requirements. Also, the impervious restoration progress is included here because the MS4 permit Part VI.A, Chesapeake Bay Restoration by 2025, states that the MS4 permit is to be used for meeting the Chesapeake Bay TMDL for urban stormwater:

> *Therefore, Maryland's NPDES stormwater permits issued to SHA and other municipalities will require coordination with MDE's Watershed Implementation Plan and be used as the regulatory backbone for controlling urban pollutants toward meeting the Chesapeake Bay TMDL by 2025.*

SHA has developed a restoration plan to meet the 4,719 acre treatment requirements. Because SHA began these restoration projects in 2011 to comply with the Bay TMDL and Maryland WIP I, which were issued in December 2010 prior to the current SHA MS4 permit issued in October 2015, MDE has allowed SHA to claim runoff treatment credit for restoration practices constructed between October 2010 and September 2015 against the 20 percent treatment requirements in the current MS4 permit and pollutant load reductions for WLAs assigned SHA.

SHA's impervious restoration and implementation plan strategy includes a combination of built practices, maintenance activities, redevelopment credit, and credit trading (future practice). The SHA Implementation Plan includes Tables 2-2a – 2-2g, which provide a comprehensive list of annual operations practices and completed, programmed and planned built impervious restoration practices broken down by year. Each entry includes location information and estimated impervious runoff treatment acreage. Practices proposed to be built beyond the 2020 impervious

restoration deadline to meet local TMDL WLAs are included in the SHA Implementation Plan, Part IV, SHA Watershed TMDL Implementation Plans. Impervious restoration progress is discussed first and then progress for pollutant load reductions is discussed afterwards.

Impervious Restoration Progress

Tables 2-2a are 2-2g are summarized in Table 1-21 below which represents the total sum of impervious treated by best management practice type from 2011 through June 30, 2016. SHA is improving our methods for calculating restoration impervious credits, similar to the baseline accounting methodology described using improved drainage areas, impervious surfaces, and the derived Pe inches treated to determine the impervious treatment factored using the e BMP adjustor curve relationships incentive for extra credit defined in MDE's MS4 Accounting Guidance documentation. Future efforts will be initiated to revise crediting for consistency and any modifications to claimed credit in this report will be documented and adjusted in the 2017 NPDES Annual Report.

Table 1-21: Impervious Restoration Progress

Strategy	2011-2015 (acres)	2016 (acres)	Total (acres)
Impervious Surface Elimination (to Pervious)	0.49	0.00	0.49
New Stormwater	87.36	62.60	149.96
Outfall Stabilization	0.00	2.00	2.00
Retrofit	0.00	85.31	85.31
Stream Restoration	442.95	143.74	586.69
Tree Planting	438.76	68.89	507.65
Totals	**969.56**	**362.54**	**1,332.10**
		20% Restoration Target	**4,719**
		% Progress Towards Restoration Goal	**5.65%**

Figure 1-25 displays the impervious restoration credit achieved from 2011 to the end of this reporting period in graphical form.

Credit from maintenance activities such as inlet cleaning and street sweeping are not included in the figure. As discussed earlier in this report, SHA is working to determine appropriate crediting of these practices for TMDL compliance. Studies are underway to determine the amount and typical composition of materials collected from inlet cleaning and street sweeping. This data will be used to help determine the credit SHA can claim for TMDL-related pollutant removal and permit compliance needs. While these maintenance activities are actively performed, they are not included in current estimated pollutant load reductions from 2011 through the end of this reporting period.

These figures will be updated once these alternative BMP programs have been optimized and a crediting process validated. Moving forward, these maintenance activities will be increased to meet impervious credit acreage goals.

SHA plans to meet the 20 percent treatment requirement through a combination of built practices, maintenance activities, redevelopment credit and credit trading (future practice) which are all discussed in further detail in Part II, Section C of the Implementation Plan. Built practices, once in place, provide certain pollutant reduction and impervious restoration acreages each year. They must be inspected and maintained in order to ensure the original pollutant removal functions continue.

As discussed in D.1.d, SHA has provided the stormwater BMP inspection information in MDE's NPDES MS4 Stormwater Program geodatabase format. During this reporting period, restoration BMP inspections were performed for 56 tree planting sites, and 199 SWM facilities. All baseline and restoration BMPs submitted for

credit have a current inspection within the required three-year timeframe.

Figure 1-26 is a graphical comparison of the impervious restoration credit achieved (as detailed above in Table 1-22 and discussed in section E.4.a) with the established restoration benchmark of 4,719 acres. As discussed in the preceding section, this figure does not include restoration crediting achieved through active alternative BMPs such as inlet cleaning and street sweeping.

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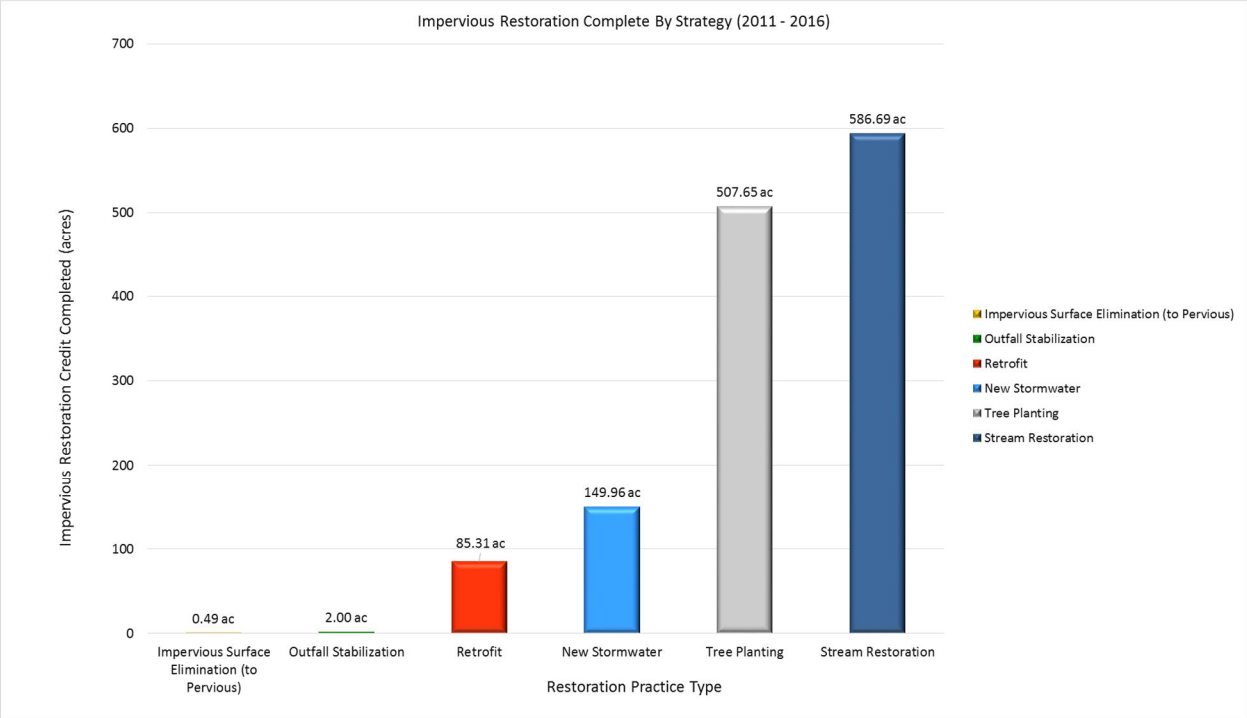


Figure 1-25: Impervious Restoration Complete (2011 - 2016)

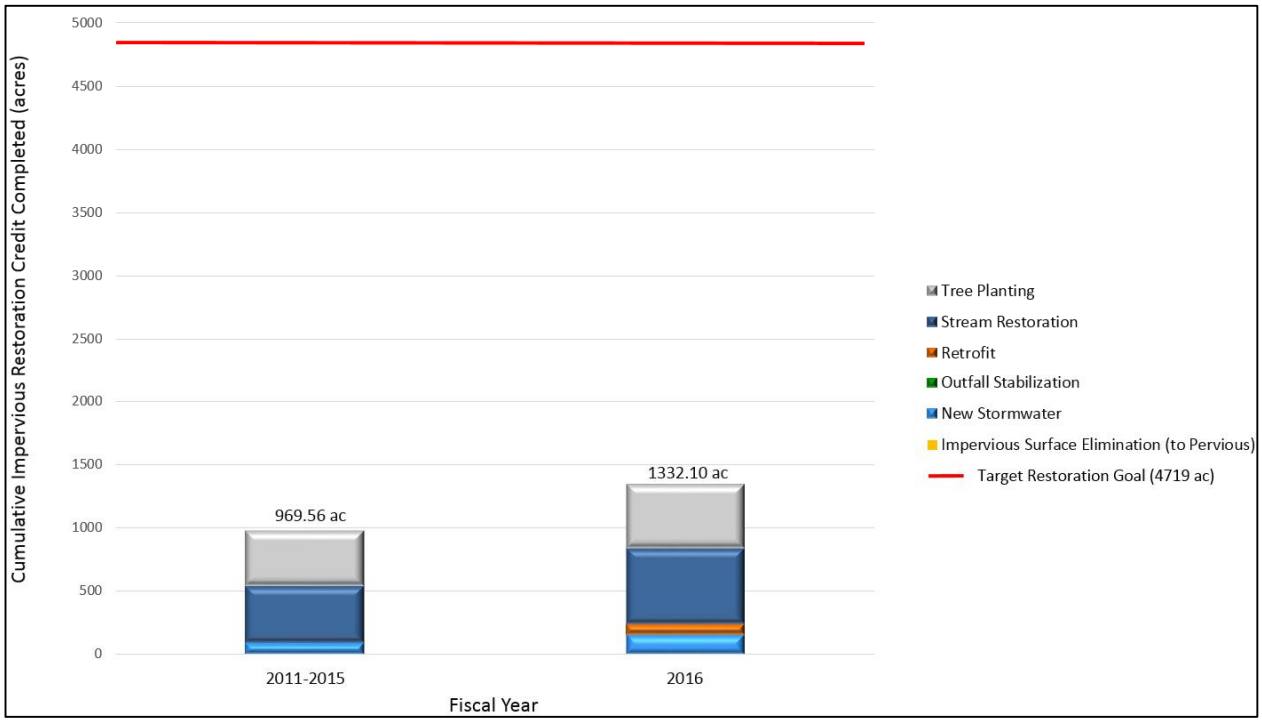


Figure 1-26: Cumulative Impervious Restoration Progress

E.4.b Benchmark Comparisons

Pollutant Load Reduction Progress

Tables 3-2 and 3-3, in the SHA Implementation Plan, present SHA's reduction requirements and projected progress in meeting pollutant reduction wasteload targets within each local watershed for the ultimate proposed set of restoration practices to be employed. Table 1-22 below, focusing on progress accomplished through June 30, 2016.

Figure 1-27 and Figure 1-28 illustrate the accomplished pollutant reduction loads (in pounds) for sediment and phosphorus within each watershed. As discussed in the preceding sections, these figures do not include progress related to active alternative BMP practices such as inlet cleaning and street sweeping; however, they will be updated to include these activities in future annual report updates.

Table 1-22: Local TMDL Pollutant Reduction Progress through June 30, 2016

Watershed Name	County	Pollutant	Baseline Year	SHA Baseline Load	SHA WLA	SHA % Reduction Target	SHA Reduction Target	2016 Model Results Achieved
Antietam Creek	Washington	Phosphorus	2000	1,473	1,158	21%	315	39
		Sediment	2000	1,085,521	454,833	58%	630,688	54,572
Bynum Run	Harford	Sediment	2005	463,600	374,000	19%	89,600	4,708
Cabin John Creek	Montgomery	Sediment	2005	695,600	539,600	23%	156,000	9,341
Catoctin Creek	Frederick	Phosphorus	2009	2,052	1,876	9%	176	59
		Sediment	2000	373,396	190,058	49%	183,338	75,644
Conococheague Creek	Washington	Sediment	2000	796,351	435,604	45%	360,747	49,970

Table 1-22: Local TMDL Pollutant Reduction Progress through June 30, 2016

Watershed Name	County	Pollutant	Baseline Year	SHA Baseline Load	SHA WLA	SHA % Reduction Target	SHA Reduction Target	2016 Model Results Achieved
Double Pipe Creek	Frederick	Phosphorus	2009	1,935	653	66%	1,282	17
	Carroll							
	Frederick	Sediment	2000	466,832	305,861	47%	160,971	7,359
	Carroll					34%		
Gwynns Falls	Baltimore	Sediment	2005	1,297,800	825,000	36%	472,800	17,757
Jones Falls	Baltimore	Sediment	2005	418,200	327,400	22%	90,800	3,998
Liberty Reservoir	Baltimore	Phosphorus	2009	1,231	677	45%	554	11
	Carroll							
	Baltimore	Sediment	2009	1,000,000	550,000	45%	450,000	11,174
	Carroll							
Little Patuxent River	Anne Arundel	Sediment	2005	2,742,600	1,751,600	36%	991,000	415,740
	Howard							
Lower Monocacy River	Carroll	Phosphorus	2009	5,650	4,222	25%	1,428	256
	Frederick							
	Montgomery							
	Frederick	Sediment	2000	1,041,056	407,912	61%	633,144	102,289
	Montgomery							
Patapsco LN Branch	Anne Arundel	Sediment	2005	3,118,600	2,557,200	18%	561,400	51,401
	Baltimore							
	Howard							
Patuxent River Upper	Anne Arundel	Sediment	2005	1,429,600	1,266,600	11%	163,000	10,739
	Howard							
	Prince George's							
Potomac River MO County	Montgomery	Sediment	2005	789,400	503,400	36%	286,000	33,024
Rock Creek	Montgomery	Phosphorus	2009	1,142	773	32%	369	955
		Sediment	2005	1,738,800	1,080,000	38%	658,800	659,731
Seneca Creek	Montgomery	Sediment	2005	1,276,800	703,400	45%	573,400	248,153
Upper Monocacy River	Frederick	Phosphorus	2009	2,469	2,404	3%	65	196
	Carroll							
	Frederick	Sediment	2000	386,811	200,467	49%	186,344	95,407
	Carroll							

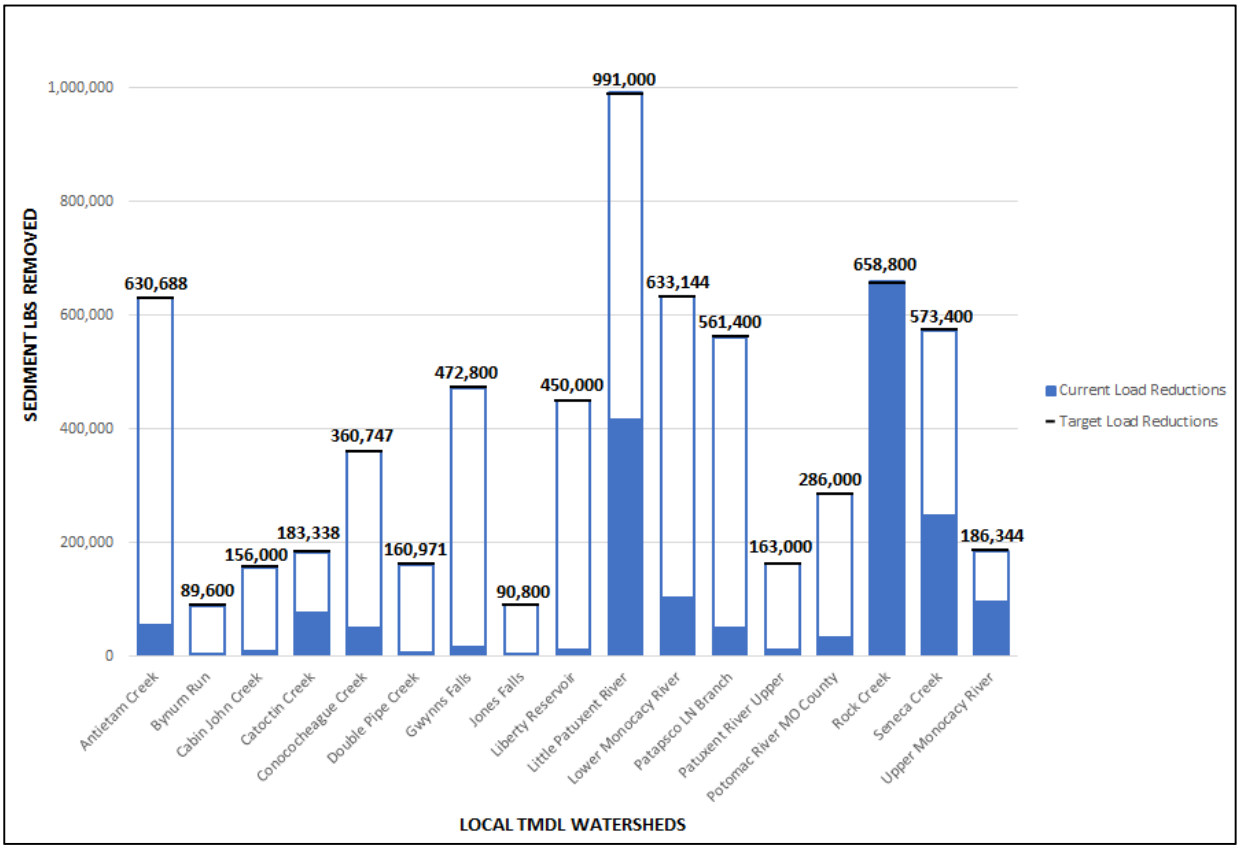


Figure 1-27: Achieved Sediment Reduction Loads

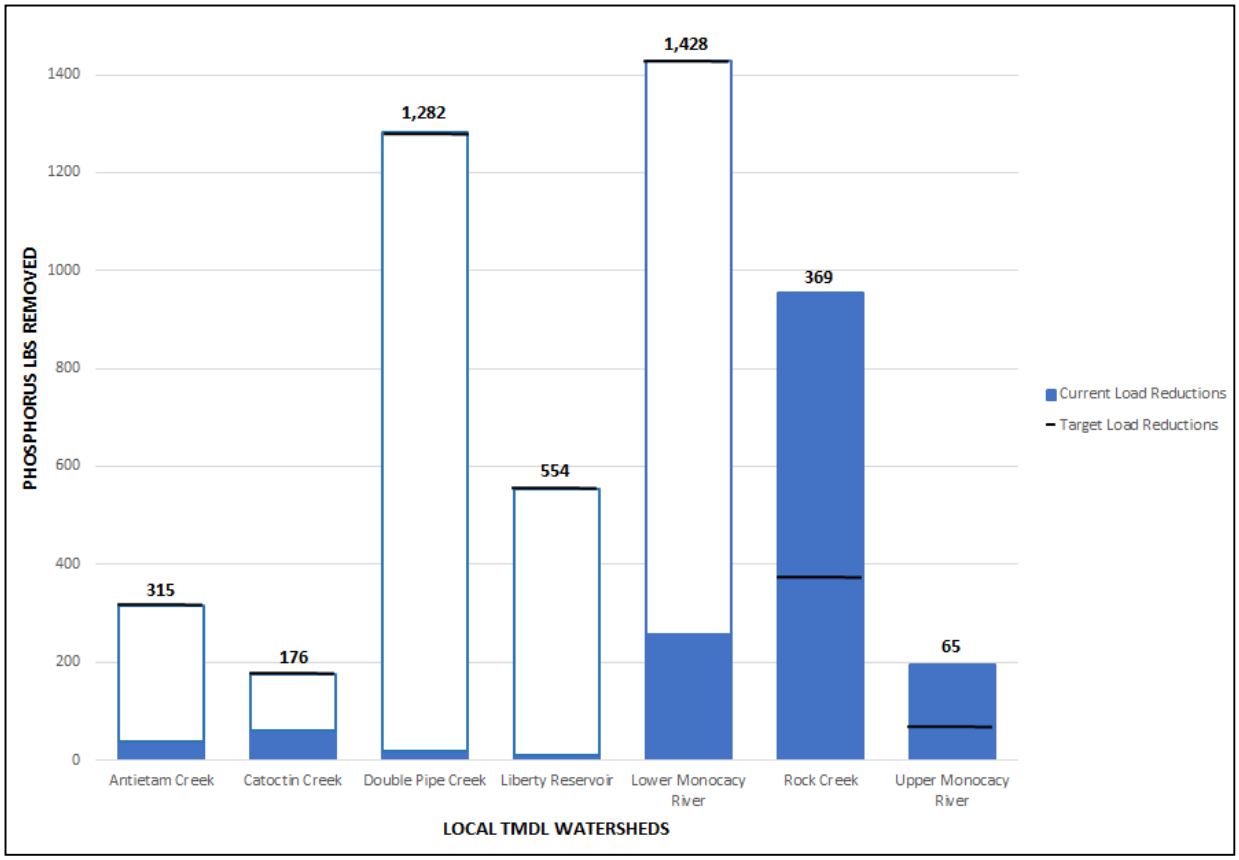


Figure 1-28: Achieved Phosphorus Reduction Loads

Table 1-23: FY 2011 to 2016 Itemized Costs for Completed Projects

FMIS	BMP Type	Project Name	Planning / Engineering Expenditures	ROW Expenditures	Construction Expenditures	Total Expenditures to Date	No. of BMPs in Project	No. of BMPs Constructed to Date	Impervious Treatment for Project (AC)	Impervious Treated to Date (AC)
AT0885182	SWM	TC56-TMDL AT VARIOUS LOCATIONS IN DIST 7	$1,048,097		$5,013,520	$6,061,617	69	69	32.91	32.91
AT0895182	SWM	TC56-AT VARIOUS LOCATIONS IN DIST 5	$500,038		$1,706,160	$2,206,198	24	24	12.91	12.91
AT7995382	SWM	TC70-SWM AT VARIOUS LOCATIONS IN DIST 5	$166,191		$3,332,597	$3,498,788	47	47	18.86	18.86
AX2645182	SWM	TC11-LEGACY PAVEMENT IMP-DIST 2/DIST 4	$1,245,680		$4,995,307	$6,240,987	60	60	30.44	30.44
AX2645282	SWM	TC11-LEGACY PAVEMENT IMP-DISTRICT 3	$419,335		$1,994,609	$2,413,945	17	17	6.01	6.01
AX2645382	SWM	TC11-LEGACY PAVEMENT IMP-DISTRICT 5	*Separate PP/PE Task*		$1,257,081	$1,257,081	14	14	5.57	5.57
AX2645482	SWM	LEGACY PAVEMENT IMP-DIST 7/SOME DIST 6	$327,282		$3,146,602	$3,473,885	54	54	22.94	22.94
AX9295182	SWM	TC70-SWM AT VARIOUS LOCATION IN DIST 3	$161,555		$1,698,237	$1,859,792	17	17	11.26	11.26
AT0445182	Swales	Grass Swale, Attenuation Swale or Dry Swale	$187,634		$2,481,288	$2,668,922	37	16	20.67	9.07
AT0425182	Trees	TREE PLANTING IN WASHINGTON COUNTY	*Separate PP/PE Task*		$1,281,794	$1,281,794	82	82	19.23	19.23
AT0685282	Trees	SRI-TREE PLANTING-VAR LOC BALTIMORE CO	*Separate PP/PE Task*		$1,312,486	$1,312,486	163	163	45.40	45.40
AT0685382	Trees	SRI-AT VARIOUS LOCATION - D4	*Separate PP/PE Task*		$1,769,630	$1,769,630	90	90	22.16	22.16
AT0685482	Trees	TREE PLANTING-VAR LOC IN AA AND CH	*Separate PP/PE Task*		$638,333	$638,333	62	62	14.77	14.77
AT0685582	Trees	SRI-TREE PLANTING-VAR LOC IN CECIL CO	*Separate PP/PE Task*		$682,896	$682,896	34	34	8.92	8.92
AT5025182	Trees	TC70-CHESAPEAKE BAY WATERSHED PROGRAM-	*Separate PP/PE Task*		$1,568,585	$1,568,585	105	105	33.00	33.00

Table 1-23: FY 2011 to 2016 Itemized Costs for Completed Projects

FMIS	BMP Type	Project Name	Planning / Engineering Expenditures	ROW Expenditures	Construction Expenditures	Total Expenditures to Date	No. of BMPs in Project	No. of BMPs Constructed to Date	Impervious Treatment for Project (AC)	Impervious Treated to Date (AC)
		D4								
AT5025282	Trees	TC70-CHESAPEAKE BAY WATERSHED PROGRAM D7	*Separate PP/PE Task*		$2,912,940	$2,912,940	136	136	42.92	42.92
AT5025382	Trees	TC70-CHESAPEAKE BAY WATERSHED PROG D-3,5	*Separate PP/PE Task*		$729,320	$729,320	44	44	22.97	22.97
AT5025482	Trees	TC70-CHESAPEAKE BAY WATERSHED PROGRAM-D6	*Separate PP/PE Task*		$1,212,257	$1,212,257	56	56	31.27	31.27
AW0825282	Trees	SRI-TREE PLANTING AT VAR LOC IN D-7	*Separate PP/PE Task*		$2,674,541	$2,674,541	174	174	53.24	53.24
AW0445182	Trees	TREE PLANTING AT VARIOUS LOC - DIST 7	$349,774		$113,285	$463,059	109	2	57.21	0.21
AW0465182	Trees	TREE PLANTING AT VARIOUS LOC - DIST 3	$238,924		$4,736	$243,660	14	1	4.68	0.36
AT0415182	Trees	SRI-TREE PLANT-VAR LOC IN DISTRICT 3	$947,676		$1,045,072	$1,992,748	104	104	21.72	21.72
Various	Trees	Tree Plantings Associated with Various Landscape/Sustainability Projects	*Exact Cost Unknown, Part of 12 Larger Planting Contracts*				153	153	57.35	57.35
DNR - Million Tree	Trees	Tree Plantings for Million Tree Initiative (Partnership with DNR)	*PE Unknown*		$1,389,650	$1,389,650	91	91	133.88	133.88
AA1665182	Streams	I-97 SB WEST OF EAST-WEST BOULEVARD	$227,411	$1,781,399	$551,527	$2,560,337	3	3	11.00	11.00
AA8955182	Streams	SRI - BROAD CREEK STREAM RESTORATION	$314,269		$1,688,099	$2,002,368	1	1	23.00	23.00
HO2065182	Streams	Upper Little Patuxent - TC 12	$239,689		$2,045,803	$2,285,492	1	1	45.00	45.00
HA4075182	Streams	Plumtree Run Stream Restoration	$127,012		$1,360,868	$1,487,880	1	1	21.00	21.00

Table 1-23: FY 2011 to 2016 Itemized Costs for Completed Projects

FMIS	BMP Type	Project Name	Planning / Engineering Expenditures	ROW Expenditures	Construction Expenditures	Total Expenditures to Date	No. of BMPs in Project	No. of BMPs Constructed to Date	Impervious Treatment for Project (AC)	Impervious Treated to Date (AC)
AX3765L60	Streams	STREAM RESTORATION OF CRICKET LAND TRIBUTARY (NW-4)	*Breakdown Unknown*			$2,886,457	1	1	51.71	51.71
AX3765F60	Streams	RESTORATION OF PB-119, PB-109	*Breakdown Unknown, Cost Estimated - Part of Larger Effort*			$1,184,596	2	2	27.26	27.26
AX3765360	Streams	RESTORATION OF NW-170	*Breakdown Unknown, Cost Estimated - Part of Larger Effort*			$3,431,044	1	1	60.11	60.11
AX3765K60	Streams	RESTORATION OF IC-62	*Breakdown Unknown*			$145,947	1	1	12.09	12.09
AX3765E60	Streams	RESTORATION OF PB-37, PB-108, PB-8	*Breakdown Unknown, Cost Estimated - Part of Larger Effort*			$1,078,402	3	3	53.61	53.61
AX3765D60	Streams	RESTORATION OF PB-85	*Breakdown Unknown*			$2,668,256	1	1	64.50	64.50
AX3765U60	Streams	RESTORATION OF RC-2	*Breakdown Unknown*			$1,590,079	1	1	48.55	48.55
AX3765560	Streams	RESTORATION OF NB-1	*Breakdown Unknown, Cost Estimated - Part of Larger Effort*			$2,379,935	2	2	89.10	89.10
AX3765N60	Streams	RESTORATION OF SC-2 - Goshan Branch	*Breakdown Unknown*			$3,958,336	1	1	39.91	39.91
HA4095182 SBR	Streams	MD 23 Magness Farm Stream Restoration at Tributary of Deer Creek	$107,549		$97,408	$204,957	1	1	11.60	11.60
HO4085174	Streams	MD 100 Red Hill Branch Brampton Hills	*Breakdown Unknown*			$579,272	1	1	10.44	10.44
HO3255124	Streams	Dorsey Run	$766,658		$303,050	$1,069,708	1	1	19.73	19.73
AT0865182	Retrofits	Drainage improvements at various locations in District 3	$30,000	$10,265	$4,246,372	$4,286,638	14	13	50.2	30.33
AT0875182	Retrofits	TMDL Stormwater Facility Enhancement in District 5 - Design Build		$108,076	$4,608,534	$4,716,609	12	10	61.06	54.98
N/A	Impervious Removal	N/A	N/A	N/A	N/A	N/A	3	3	0.49	0.49
						Totals:	1,807	**1,663**	1,431	**1,332**

E.4.c Actual Itemized Costs

BMPs completed from 2011 to June 30, 2016, along with their actual costs are listed in Table 1-23. Additionally, a comprehensive list of restoration practices completed from 2011 to June 30, 2016, broken down by FMIS contract, is included in Appendix F. Each entry includes location information and estimated impervious runoff treatment acreages. Data for the MDE NPDES Stormwater Program Geodatabase is also included for these completed restoration practices.

E.4.d Cost Estimates

Lists of proposed practices and costs to achieve required reductions are included in Part IV of the Implementation Plan. Detailed costs for specific construction projects are available on SHA's website through the SHA Contractors Information Center:

http://www.roads.maryland.gov/pages/cic.aspx?PageId=857

E.4.e Adaptive Management

SHA's plan for addressing adjustments and implementing additional actions to meet the established overall restoration goal is discussed in section E.2.b.iv of this report.

F. Assessment of Controls

SHA and ten other municipalities in Maryland have been conducting discharge characterization monitoring since the early 1990s. From this expansive monitoring, a statewide database has been developed that includes hundreds of storms across numerous land uses. Analyses of this dataset and other research performed nationally effectively characterize stormwater runoff in Maryland for NPDES municipal stormwater purposes. To build on the existing information and to better track progress toward meeting TMDLs, better data are needed on ESD performance and BMP efficiencies and effectiveness.

Assessment of controls is critical for determining the effectiveness of the NPDES stormwater management program and progress toward improving water quality. SHA shall use chemical, biological, and physical monitoring to assess watershed restoration efforts, document BMP effectiveness, or calibrate water quality models for showing progress toward meeting any applicable WLAs developed under EPA approved TMDLs identified above. Additionally, SHA shall propose a stream monitoring site to assess the implementation of the latest version of the 2000 Maryland Stormwater Design Manual.

F.1 Watershed Restoration Assessment

SHA is required to continue monitoring in the Montgomery County Seneca Creek watershed, or, select and submit for MDE's approval a new watershed restoration project for monitoring. Monitoring activities shall occur where the cumulative effects of watershed restoration activities can be assessed. One outfall and an associated in-stream station, or other locations based on a study design approved by MDE, shall be monitored. The minimum criteria for chemical, biological, and physical monitoring are as follows:

a) <u>Chemical Monitoring</u>:

i) Twelve (12) storm events shall be monitored per year at each monitoring location with at least three occurring per quarter. Quarters shall be based on the calendar year. If extended dry weather periods occur, baseflow samples shall be taken at least once per month at the monitoring stations if flow is observed;

ii) Discrete samples of stormwater flow shall be collected at the monitoring stations using automated or manual sampling methods. Measurements of pH and water temperature shall be taken;

iii) At least three (3) samples determined to be representative of each storm event shall be submitted to a laboratory for analysis according to methods listed under 40 CFR Part 136 and event mean concentrations (EMC) shall be calculated for:

1. *Biochemical Oxygen Demand*
2. *Total Kjeldahl Nitrogen (TKN)*
3. *Nitrate plus Nitrite*
4. *Total Suspended Solids*
5. *Petroleum Hydrocarbons (TPH)*
6. *E. coli or enterococcus*
7. *Total Lead*

8. Total Copper
9. Total Zinc
10. Total Phosphorus
11. Hardness

iv) Continuous flow measurements shall be recorded at the in-stream monitoring station or other practical locations based on the approved study design. Data collected shall be used to estimate annual and seasonal pollutant loads and reductions, and for the calibration of watershed assessment models. Pollutant load estimates shall be reported according to any EPA approved TMDLs with stormwater WLAs.

b) Biological Monitoring:

i) Benthic macroinvertebrate samples shall be gathered each Spring between the outfall and in-stream stations or other practical locations based on an MDE approved study design; and

ii) SHA shall use the EPA Rapid Bioassessment Protocols (RBP), Maryland Biological Stream Survey (MBSS), or other similar method approved by MDE.

c) Physical Monitoring:

i) A geomorphologic stream assessment shall be conducted between the outfall and in-stream monitoring locations or in a reasonable area based on the approved study design. This assessment shall include an annual comparison of permanently monumented stream channel cross-sections and the stream profile;

ii) A stream habitat assessment shall be conducted using techniques defined by the EPA's RBP, MBSS, or other similar method approved by MDE; and

iii) A hydrologic and/or hydraulic model shall be used (e.g., TR-20, HEC-2, HEC-RAS, HSPF, SWMM, etc.) in the fourth year of the permit to analyze the effects of rainfall; discharge rates; stage; and, if necessary, continuous flow on channel geometry.

d) Annual Data Submittal:

i) EMCs submitted on MDE's long-term monitoring database as specified in PART V below;

ii) Chemical, biological, and physical monitoring results and a combined analysis for the approved monitoring locations; and

iii) Any requests and accompanying justifications for proposed modifications to the monitoring program

SHA developed a proposal and received approval to change the biological, chemical, and physical monitoring locations from Long Draught Branch (See SHA 2015 MS4 Annual Report) to a new watershed restoration project for Little Catoctin Creek (LCC) near U.S. Route 340 in Frederick County, Maryland.

The purpose of the LCC Restoration Project is to enhance and improve the ecosystem of LCC throughout the project reach. The need for restoration originates with the anthropogenic influences on the active channel and overbank areas.

The overall design objective is to utilize stream and floodplain restoration to create an ecologically diverse valley bottom ecosystem which maintains stability through native wetland vegetation and provides increased sediment and nutrient processing. This project will restore currently impaired, vital ecosystems by returning hydrologic, hydraulic, geomorphic, physiochemical and biological functions to undevelopable land within the 100-year floodplain.

The project will enhance and improve the ecosystem of LCC while reducing streambank erosion and the associated nitrogen and phosphorus pollutants contributing to the degradation of the reach and ultimately of the Chesapeake Bay.

SHA will monitor the chemical, biological and physical features of the project stream system with the goals of determining:

- The response of aquatic macroinvertebrate populations to restoration efforts and if the

response will vary from on-site to downstream.

- The influence of restoration measures on water quality; particularly for temperature, N, P, and TSS.
- The influence that restoration will have on average and seasonal groundwater levels at varying distances from the active channel as well as the changes to groundwater chemistry.

The project is currently in the initial phases of assessment and design. Initial geomorphological measurements have been made as well as bank and bed material content (i.e., nutrients, bulk density). Collection of stage for the computation of discharge began on September 15, 2016. Observations are being collected and stored every 5 minutes. An image of the monitoring station can be found in Figure 1-29 below. Preliminary concepts have been developed, but have not progressed to schematic design phase.



Figure 1-29: Little Catoctin Creek Monitoring Station

The LCC monitoring plan for chemical, biological and physical data has been developed and is included in Appendix G.

F.1.a Chemical Monitoring

Chemical monitoring criteria, measurements, and processes can be found within Appendix G, Section 2.1.

A conceptual schedule of chemical, physical, and biological monitoring phases along with a monitoring plan site map can be found in Appendix G, Section 3.0.

Each phase of chemical monitoring activities is detailed in Appendix G, Section 3.1.

F.1.b Biological Monitoring

Biological monitoring criteria, measurements, and processes can be found within Appendix G, Section 2.3.

A conceptual schedule of monitoring phases along with a monitoring plan site map can be found in Appendix G, Section 3.0.

Each phase of biological monitoring activities is detailed in Appendix G, Section 3.2.

F.1.c Physical Monitoring

Physical monitoring criteria, measurements, and processes can be found within Appendix G, Section 2.2.

A conceptual schedule of monitoring phases along with a monitoring plan site map can be found in Appendix G, Section 3.0.

Each phase of physical monitoring activities is detailed in Appendix G, Section 3.3.

F.1.d Annual Data Submittal

Initial geomorphic measurements have been made as well as bank and bed material content determinations (i.e., nutrients, bulk density). These measurements will be included in initial monitoring results and are the basis for the physical monitoring portion of the monitoring plan (See Appendix G). SHA has provided the monitoring location information in the MDE NPDES MS4 Stormwater Program geodatabase format.

F.2 Stormwater Management Assessment

SHA is required to select a site to monitor, develop a monitoring plan, and submit for MDE's approval within 1 year of permit issuance for

determining the effectiveness of stormwater management practices for stream channel protection as implemented under the latest stormwater regulations. Physical stream monitoring protocols shall include:

a) *An annual stream profile and survey of permanently monumented cross-sections at the approved monitoring site to evaluate channel stability in conjunction with surrounding and on-going development;*
b) *A comparison of the annual stream profile and survey of the permanently monumented cross-sections with baseline conditions for assessing areas of aggradation and degradation; and*
c) *A hydrologic and/or hydraulic model shall be used (e.g., TR-20, HEC-2, HEC- RAS, HSPF, SWMM, etc.) in the fourth year of the permit to analyze the effects of rainfall; discharge rates; stage; and, if necessary, continuous flow on channel geometry.*

The State Highway Administration (SHA) is currently planning, designing, and constructing controls for stormwater quality and quantity. These efforts are towards implementing the Chesapeake Bay Total Maximum Daily Load and MS4 impervious restoration requirements.

In order to measure and quantify the effectiveness of these controls, SHA has proposed to monitor Interstate 70 (I-70) at the intersection with Marriottsville Road in Howard County, Maryland.

Stormwater controls are proposed for two areas within the I-70/Marriottsville Road interchange: Two bioswales and one bioretention. All facilities are located within the Little Patuxent River watershed.

SHA proposes to monitor the site with the primary goals of determining:

- Peak discharge and total catchment volume reductions following implementation of controls.
- The geomorphological response to the Little Patuxent River once controls are in place.
- The thresholds for stream stability and if catchment controls will improve stream stability through peak discharge/volume attenuation.

In early September 2016, SHA provided to MDE a copy of the Draft Stormwater Management Assessment of Controls Monitoring Plan. Following their review and discussion, MDE returned a number of comments for SHA to address.

At the time of this MS4 Annual Report submittal, SHA is working to address these comments. This includes re-assessing the project site with a focus on the size of the study area and how this may affect data confidence, the proposed timing of BMP implementation and monitoring schedules, methods of analysis and measurements, and a review of the planned QA/QC process.

Following this reassessment, SHA will submit a revised monitoring plan with an anticipated delivery date of late December, 2016.

G. Program Funding

This condition requires that a fiscal analysis of capital, operation, and maintenance expenditures necessary to comply with the conditions of this permit be submitted, and that adequate program funding be made available to ensure compliance. SHA is committed to appropriating the full funding amount necessary to meet these permit requirements.

SHA utilizes capital funds for inspection, data management, engineering, construction, and tracking and reporting activities associated with restoration BMPs. Funding has also been committed to forest establishment contracts for restoration tree planting sites. Capital funds are programmed for stormwater management; erosion and sediment control; illicit discharge detection and elimination; trash and litter educational source control; industrial facility pollution prevention plan development, implementation and training; public education programs; and assessment of controls. SHA OED currently maintains adequate capacity in architectural/engineering consultant contracts to support these activities. Additional procurements will be pursued as needed to sustain

the level of effort required to ensure SHA meets the restoration goals.

Operations and maintenance funds are budgeted for routine maintenance of structural stormwater control structures, and property management and maintenances activities for street sweeping, inlet cleaning, chemical application and winter deicing training, and other activities to foster minimization. As restoration practices increase, enhancements to the operations budget are routinely sought through the legislature to ensure adequate funding is in place to perform street sweeping, inlet cleaning, litter removal activities and maintain constructed restoration BMPs in optimal condition to ensure associated impervious restoration and pollutant load reduction credits are sustained.

The MDE geodatabase Fiscal Analysis (FIS) table is included with the data attached to this report. The geodatabase documents budget and cost for operations and capital funding. These values are also summarized in Table 1-24 below. The FIS table includes a mandatory field for watershed protection and restoration funds generated for the current fiscal year. Since SHA does not generate these funds, this field is not applicable.

Table 1-24: Fund 82 Programmed Funding by Fiscal Year

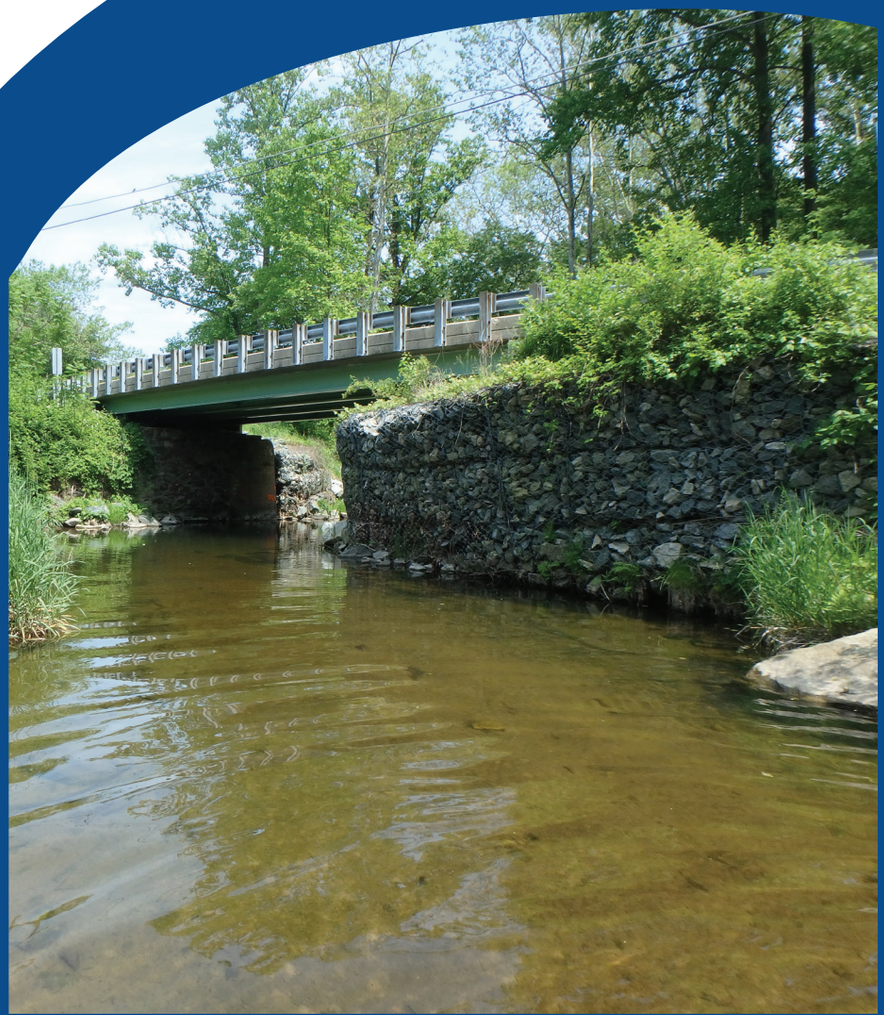
Fund	2016 Expenditures (Millions)	2017 Budget (Millions)*
Fund 82 – TMDL/MS4	$55.4	$77.6
Fund 74 – Drainage	$12.5	$16.0
Fund 49 – Industrial	$1.8	$3.0
Operations	$13.7	$15.6
Totals	$83.4	$112.2

1. Funding numbers are rounded to nearest $0.1 Million

Part Two

Stormwater Facilities Program





PART TWO

2. Stormwater and Drainage Asset Program

Introduction

Maryland Department of Transportation (MDOT) State Highway Administration (SHA) owns, operates, and maintains an extensive roadway network with a complex and expanding drainage and stormwater system. The Stormwater and Drainage Asset Management Program was established to construct, operate, maintain and remediate permanent drainage and stormwater assets to convey and treat highway runoff. The program goal is to provide preventive and remedial solutions for the drainage and stormwater infrastructure within the right-of-way. As of 2016, statewide, SHA owns and maintains approximately 5970 permanent stormwater management (SWM) facilities, 160,797 hydraulic structures, 131,908 conveyances including and 8,153,973 linear foot across 99,293 storm drain pipes. Since 1999, SHA has had a comprehensive asset management program to locate, inspect, evaluate, and remediate these assets to sustain their functionality, improve water quality and stability, protect sensitive water resources, and provide an aesthetic and safe transportation system. SHA has developed a detailed inspection and rating system to track, prioritize and plan the necessary activities for extending the life expectancy drainage and stormwater assets.

Business plan objectives have been established for the program that provide benchmarks for success and allow for result oriented actions. The business objective of the program is to have 90% of the assets functioning as originally intended. This primary goal, which is directly tied to the SHA Business Plan goal of providing a positive contribution to the water quality of the Chesapeake Bay, is to ensure that SHA's SWM facilities remain functional and perform as intended. In addition, the Program has a secondary goal of strategically enhancing the overall function of existing facilities to meet or exceed the latest SWM standards and regulatory requirements.

The Program, represented in Figure 2-1, is divided into five major components. These are, planning, design, construction, operations and future focus.

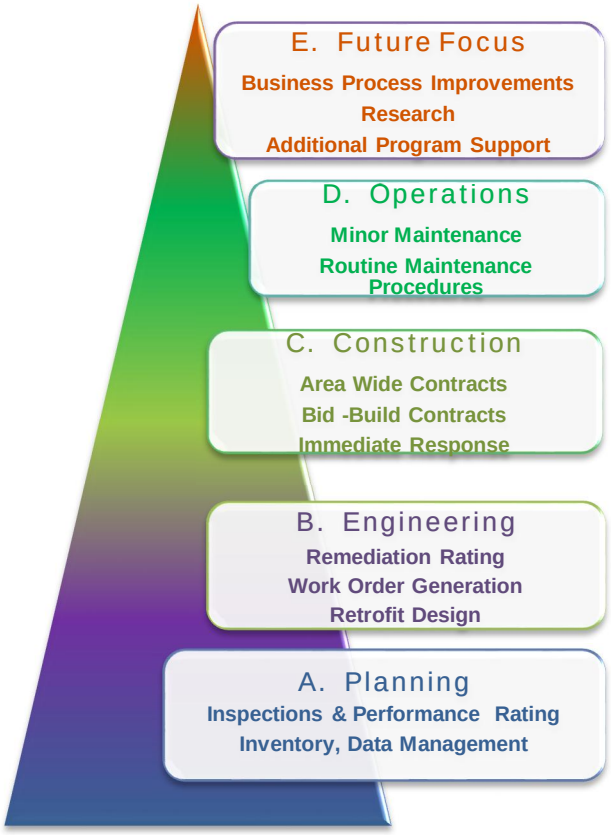


Figure 2-1: Stormwater and Drainage Asset Management Program

A. Planning

The NPDES Municipal Separate Storm Sewer System (MS4) permit requires SHA to identify all storm drainage infrastructure that captures, treats, and conveys stormwater runoff from SHA properties in certain areas of the State. SHA is strategically expanding its program to cover all areas of the State within its right-of-way. In the

past couple years we were able to make strides in this effort with the completion of SWM inventory inspections in all counties outside the NPDES Permit area with the exception of Allegany and Garrett Counties. Allegany County kicks off inspections in October 2016 and Garrett is in process to kick off in early 2017. In addition we have also expanded the drainage system inspection program by adding video inspections. It is difficult to evaluate entire pipe lengths so video inspection might be required for a full determination of structural integrity. The properties associated with this drainage infrastructure include roadways, welcome centers, SHA shops, parking lots, and park and rides. Data includes identification and inspection of hydraulic structures, pipe conveyances, stormwater management facilities, and outfalls.

SHA inspects drainage assets (pipes, channels, inlets, and manholes) and stormwater management assets (ponds, swales, infiltration and Environmental Site Design facilities) for functionality. The overall goal is to have the most current inventory, conduct inspections and perform rating assessments based on the *MD SHA Stormwater NPDES Program Standard Procedures Manual.* This enables SHA to prioritize the repair, remediation, and retrofit of SHA-owned SWM facilities and drainage infrastructure.

Assets receive a performance rating that is related to its asset type. Drainage assets, pipes and outfalls are rated based on the structural integrity while SWM assets are rated based on the specific facility type and functionality.

A.1. Inspection and Performance Ratings

Initial SWM facility field inspections and inventories have been completed for all counties, both MS4 and non-MS4 counties. The information is used to verify existing data in the SHA database as well as determine the SWM facilities functional rating and provide any necessary remedial action recommendations. The statewide inventory is continuously updated on a county-by-county basis. A tracking system is being put in place to streamline planning efforts for future inspections for all counties in the state.

The inspection protocol is documented in Chapter 3 of *"Maryland State Highway Administration Stormwater NPDES Program, Standard Procedures – Best Management Practice Field Inspections & Data Collection Procedures"*

During initial field assessments, individual parameters of each SWM facility are scored (on a scale 1 to 5). Scores are used to establish an overall SWM facility performance rating as follows:

A **No Issues.** The SWM facility is functioning as designed with no adverse conditions identified. There are no signs of impending deterioration.

B **Minor Problems.** The SWM facility functions as designed, but minor issues are observed that may worsen to the next rating level if not repaired in a reasonable timeframe.

C **Moderate Problems.** The SWM facility functions as designed, but efficiency, performance and function have been significantly compromised and may worsen to the next rating level if not repaired in a reasonable timeframe.

D **Major Problems.** The SWM facility no longer functions as designed and efficiency has been compromised. Repair or remediation should be performed.

E **Severe Problems.** The SWM facility no longer functions as designed and efficiency as well as several critical parameters have been compromised. The SWM facility shows signs of deterioration and/or failure, requiring immediate remedial action.

To maintain the most current status of the SWM assets inventory functionality a major effort was completed in 2016 to re-inspect Baltimore, parts of Carroll, Charles, Frederick, Harford, Howard,

Anne Arundel and Montgomery Counties. All updates are included in this report.

The inventory inspections are used to develop action ratings and prioritize remediation efforts. The remedial inspection protocol describing field assessment methodologies used for determining the observed functionality of a SWM facility and providing guidance for remedial actions is included in Chapter 7 of the "*Maryland State Highway Administration Stormwater NPDES Program Standard Procedures - Best Management Practice Assessment Guidelines for Maintenance and Remediation*". The assessments and recommended action ratings provide data that enables SHA to adequately allocate sufficient resources to ensure an appropriate schedule of remediation activities. The two teared rating system is used to prioritize maintenance activities, initiate remedial design, permitting and environmental clearance processes, develop and justify fiscal budget to requests for appropriate funding and to sufficiently plan area wide contracts procurement.

A.2. Inventory

The SHA SWM facility inventory includes all SWM facilities that intercept and manage runoff from SHA's highway network and roadway-related assets. It includes SWM facilities not owned or maintained by SHA, but by other entities, including but not limited to counties, municipalities, other state agencies, and private entities.

The facility inventory database is frequently updated as new facilities are brought online. Updates occur statewide for SHA's entire infrastructure in each Maryland County, including all Phase I and II MS4 locations as well as those locations outside these areas. Table 2-1 summarizes the total number of SWM facilities in MS4 jurisdictions that intercept and manage stormwater runoff from the SHA highway network and highway-related assets.

Compared to the previous reporting period, several counties show an increase in the total number of SWM facilities managing runoff from SHA roadway networks and assets. One large effort that was undertaken in 2016 was the implementation of the Grass Swale program that had been in development for many years. This program allowed SHA to add existing grass swales to the SWM inventory. Inspections and surveys of the existing swales were done to determine that they met current MDE criteria for grass swale design for SWM purposes. All swales that were along roadways that met this criteria were added to the inventory as in good condition and put on a minor maintenance list for mowing and trash removal activities in the near future.

Increases of the SWM and drainage inventory also occurred because of new developments adjacent to SHA roadways, construction of major highway improvement projects, safety improvement / system preservations projects. Often, to meet the regulatory requirements, these projects implement Environmental Site Deign to Maximum Extent Practicable (ESD to MEP) as well as require SWM treatment of any additional or reconstructed impervious surfaces. However, the major SWM inventory increase is due to the construction of new SWM facilities as part of watershed restoration projects in areas of the roadway network previously not serviced by adequate SWM treatment.

See Table 2-1 below for a summary of the Stormwater Asset Management Program within MS4 Counties.

Table 2-1: Stormwater Asset Management Program in MS4 Jurisdictions

County	No Action	Routine	Major Remedial	Retrofit Design	% Funct.	Total Invent.
Anne Arundel	354	285	82	21	86.1%	742
Baltimore	272	91	43	1	89.2%	407
Carroll	123	21	3	0	89.0%	147
Cecil	279	12	6	0	98.0%	297

Table 2-1: Stormwater Asset Management Program in MS4 Jurisdictions

County	No Action	Routine	Major Remedial	Retrofit Design	% Funct.	Total Invent.
Charles	313	10	3	0	99.1%	326
Frederick	523	19	3	0	99.4%	545
Harford	126	45	61	5	72.2%	237
Howard	627	82	40	2	94.4%	751
Montgomery	350	194	95	5	84.5%	644
Prince George's	704	153	48	1	94.6%	906
Washington	393	15	6	1	98.3%	415
Salisbury	5	8	0	0	100%	13
Cumberland	0	1	0	0	100%	1
Cambridge	0	1	0	0	100%	1
Totals	**4069**	**937**	**390**	**36**	**91.65%**	**5432**

SHA conducts Stormwater Asset Management Statewide, however, the information in this table represents MS4 Phase I and II jurisdictions only. Approximately 955 additional facilities exist throughout the state.

A.3. Data Management

SHA has developed an inventory of all SWM drainage infrastructure in each NPDES MS4 jurisdiction and performed SWM facility inspections in all twenty-three counties. The data collection effort is on-going in all the counties state-wide, and involves continuous updates of the GIS data for source identification and database records of inspection and remediation activities.

SHA has updated the structure of the ESRI geodatabase and detailed schema. The structure allows for the establishment and enforcement of topologic and/or network rules as well as unique data entry. Domain rules are updated as needed. The database format has resulted in improved data intelligence and integrity. SHA integrates the geodatabase with other organizational initiatives such as eGIS and iMAP (discussed below) to improve communication between offices. This is an ongoing process that continues to improve.

SHA uses two custom software programs to collect and store geospatial information: the Office Tool and the Field Tool. The Office Tool is used to input data as well as perform quality assurance (QA) reviews. The Field Tool is used with GPS coordinate units to collect and edit field data.

Updates to the data viewer tool known as the NPDES Viewer have taken place in recent years. The tool has included enhancements such as the Remediation Tool, the ability to view special data, images, reports, as-built plans, photos and more. This has also enhanced the tracking ability of various maintenance and remediation activities and associated costs. Reports can also be generated from these newer tools. Additional development of new technology and tools are being planned for 2017 and are discussed later in this report.

B. Engineering

Assets with major deficiencies that entail more than minor maintenance require a detailed remedial assessment to determine specific causes of deficiencies and to develop a remedial action plan. Procedures have been developed that assist with decisions on maintenance, repair, and remediation of drainage and SWM assets. These assessment guidelines document the methodologies to be used in the field for assessing and determining remedial actions necessary for restoring stability and functionality. Also, the procedures provide information on field preparation, data management of collected information, as well as development of remedial assessment reports and work orders for maintenance crews.

B.1. Remediation Rating System

Response actions are divided into various categories of activities: no action, minor or routine upkeep and preventative maintenance, major repair, and retrofit or enhancement. The following outlines the official ratings that help determine the next steps in the process.

I No Response Required - The asset is functioning as designed. Re-schedule for the next multi-year inspection assessment period or put on low priority minor maintenance list.



Figure 2-2: Infiltration Sand Filter Rated I

II Minor Maintenance - The asset is functioning as designed, but routine and preventative action should be performed to sustain effective performance.



Figure 2-3: Infiltration Trench Rated II requiring vegetation and trash removal

III Major Maintenance or Repair - The asset has severely compromised functionality and significant repair is necessary to restore original functionality. The facility repairs can be performed so they remain within the existing facility footprint.



Figure 2-4: Infiltration Basin Rated III (excessive ponding due to sediment accumulation and outfall structure blockage)

IV Retrofit Design - The asset is no longer functioning as designed and cannot be restored to the original function as designed without a complete re-design and re-construction of the facility with a larger footprint. Often reconstruction will also require a new facility type.



Figure 2-5: Infiltration Basin Rated IV (Significant flooding/ lack of infiltration due to the high ground water)

V Immediate Response - The SWM facility has catastrophically failed and public safety hazards exist that require immediate corrective action.



Figure 2-6: Dry Pond Rated V (severe flooding threatens nearby homes)

VI Abandonment - The SWM facility is unsustainable and no longer provides sufficient benefit to warrant remedial design.

B.2. Workorder Generation

This section summarizes the status of SHA repair and remediation activities in response to identified deficiencies of SWM facilities. Since SHA has a goal to ensure functionality and efficiency of all SHA owned and maintained SWM facilities, deficiencies are corrected through development of remedial work orders for area wide contracts in order to bring efficiency to the work.

SWM facilities that require major or remedial repair are assigned an action rating of "III" by SHA and prioritized by urgency and location. Based on this rating, construction activities are defined in prescriptive workorders and marked on the original design plans for the contractor to address all issues. The work typically falls under the General Approval for Erosion & Sediment control (ESC), the previous General Approval has expired and SHA has applied for a new General Approval for Statewide Stormwater Facility Maintenance General Statewide Erosion and Sediment Control Approval that is currently under review by Plan Review Division as well as MDE. Until that General Approval is received major repairs that disturb over 5,000 SF and 100 Cu. Yards of earth movement will require individual ESC approval. This will require additional time and coordination in order to perform the required major maintenance. In 2016 additional screening for environmental features was added to the process of developing workorders, as well. The screening was to verify the need for a Joint Permit Application under the regulations of MDE for natural environmental features. This screening process can take several months to complete and add permitting activities to the workorder generation. As a result of this screening process, the number of workorders generated in 2016 and projected for 2017 has seen a temporary decline.

In 2016 nearly remedial work orders have been developed and SHA expended approximately $1.4 million to perform major maintenance. A summary of these efforts is shown in Tables 2-2 and 2-3 below. An example of one of these projects follows in Figure 2-7.

Table 2-2: BMP Major Maintenance Summary

County	District	BMPs for Major Maintenance	BMPs Maintained 10/16-10/17
Montgomery	3	95	1
Prince George's	3	48	28
Somerset	1	2	2
St. Mary's	5	3	1
Total		**148**	**32**

Table 2-3: Major Maintenance Cost Year 2016 / 2017

Funding Allocation	Funding Amount
Montgomery County	$61,500
Prince George's County	$1,381,112
Somerset County	$42,760
St. Mary's County	$11,230
Total Costs	**$1,496,602**

Figure 2-7: Major Maintenance of BMP 160029 – Shallow Marsh



Before: Compromised Inflow & Conveyance Conditions



After: Fully Functioning

B.3. Retrofit Design for Functional Enhancement and Remediation Projects

SWM facilities that are not currently functioning as originally intended and require major repair that cannot remain in the original design footprint or location are assigned an action rating of "IV" by SHA and are placed on a list for retrofitting. Engineering solutions need to be developed to restore the treatment levels that had been provided by the original facility. These retrofitted facilities often require a SWM facility type change and new environmental permits. The project will involve detailed engineering design and coordination. Drainage assets deemed to need major remediation must also be addressed.

SHA continuously plans, designs and constructs functional enhancements and retrofits for SWM facilities. Projects are funded using state and federal funds. Site selection for enhancement projects are evaluated using several factors, including feasibility, permitting process complexity, and benefit analysis. SHA often seeks opportunities to improve the efficiencies of older SWM facilities that currently provide only minimum water quality treatment, this provides greater reduction of pollutant loads from highway runoff.

As a part of SHA's improvement efforts, projects to improve water quality can result in treatment of additional impervious areas as well as provide replacement or an upgrade to the existing drainage infrastructure. This provides increased benefits at smaller costs. Projects also include

rehabilitation of degraded outfalls, channel restoration, and slope stabilization. . Retrofit projects may include reconstruction of a facility to restore function based on the most recent design criteria, or to replace the older facility with modern SWM BMP or ESD. For example, a non-functional infiltration trench may be retrofitted to a bioretention facility with an enhanced filter to increase pollutant removal efficiency. A summary of these efforts is shown in Table 2-4 below. Examples of these types of projects follow in Figures 2-8, 2-9 and 2-10.

Table 2-4: BMP Enhancement and SWM Retrofit Projects Summary

No.	Project	County	No. of BMPs	Contract Number	Construction Cost Estimate	Status
1	MD 32: Infiltration Basins Retrofit	AA	9	AX9315174	$1.9M	Under construction to be completed Fall 2016
2	US 50: Infiltration Basins Retrofit	AA	3	AA822A21	Estimate $1.5M	Under design to be advertised in 2017
3	Enhancement of SWM Facility 150173 and Outfall Stabilization	MO	1	MO6735174	$1.4M	Under construction to be completed Fall 2016
4	I-270: SWM Facility 150556 Retrofit	MO	1	MO106A21	Estimate $0.5M	Under design
5	MD 235: SWM Retrofit and Drainage Improvement	SM	1	SM3565174	Estimate $0.5M	Under design to be advertised Fall 2016
6	I-695: Minebank Run Stream Restoration, Drainage and Water Quality Improvements	BA	1	BA7125174	Estimate for SWM portion $1.0M	Under design to be advertised in 2017
	Total		**14**		**$6.8M**	

C. Construction

Major repair activities are performed to address significant deficiencies of SWM facilities. Activity schedules are based on local needs. In addition, geospatial data is also used to help combine activities together so they can be performed on multiple facilities in proximity to one another. This allows work to be completed with greater efficiency and lower costs. Entire roadway corridors can often be completed within a few weeks. The purpose of the construction activities is to restore the performance of the asset as well as prevent failure of specific functional elements. Actions may include dredging, sediment removal, and obstruction removal within pipes. Work also may include removal of sediment from facilities to maintain the required water volume. Often larger scale activities include total reconstruction to upgrade a facility in an attempt to enhance function and increase treatment capacity.

Figure 2-8: Retrofit Construction of SWM Facility 020014



Before Construction-Overgrown and Stagnant



During Construction



After Retrofit Construction

Figure 2-9: SWM Retrofit Construction of SWM Facility 150173



Before Construction –Failed Infiltration Basin



During Construction



After Construction – Submerged Gravel Wetland

Figure 2-10: SWM Retrofit Construction of SWM Facility 020016



During Construction



After Construction

C.1. Area Wide Contracts

Many drainage systems and stormwater facilities remediation activities are performed through open-end construction contracts. Typically SHA administers concurrently 2-4 area wide (AW) contracts to address deficiencies of stormwater facilities, drainage system repairs or outfall channel stabilization. Over the years, this construction mechanism has been proven to be the most efficient and effective construction method to timely address urgent drainage and stormwater needs. The annual expenditures of the AW contracts vary from $5 to $7 million. SHA procured 2 new AW contracts in 2015 to keep up with the rapidly increasing demand of growing SWM inventory and the SWM facilities functionality, as well as the need to remediate and enhance aging drainage infrastructure, therefore an additional contract is under development for 2016 advertisement.

In the past year, SHA performed major remediation of 32 stormwater management facilities in Montgomery, Prince Georges Somerset, and St. Mary's Counties, The total construction cost of SWM Facilities major remediation under area wide contracts was $1.4 million**.**

C.2. Immediate Response

In the event of an emergency, SHA immediately performs work to ensure public safety. SHA responds to any outfall, pipe or SWM facility failure that requires immediate repair and remediation. Roadways are closed as necessary and detour routes are implemented as needed. Site assessment and investigation occurs at the subject location within hours by a multi-disciplinary team. Plan development is initiated within 24-hours and a contractor is mobilized within a few days. Maintenance crews will usually perform emergency stabilization immediately.

C.3. Bid -Build Contracts

Most of the SWM major retrofit projects have been implement through traditional bid-built contracts. Currently nine SWM facilities retrofits are under construction along MD 32 in Anne Arundel County. Five additional projects to restore the facilities' functionality are under design or construction in Anne Arundel, Montgomery and Saint Mary's Counties. Table 2-4 shows a summary of all of these projects and is shown earlier in this report.

SHA continues to search for potential SWM sites to provide treatment of currently untreated impervious surface and maintain positive balance in the SHA Water Quality Bank. Several suitable sites have been identified, retrofit projects are in planning stage and the design will be initiated in the upcoming years.

D. Operations

District operations are key in preventive maintenance of the SWM facilities to assure long term sustainability. A systematic approach over time is continually being developed. This system shifts the overall approach from one of reaction to drainage complaints to one of proactive asset management. Catching problems before they arise or become severe reduces costs, allows planning for better spending and ensures higher degrees of public safety.

D.1. Minor Maintenance

SWM facilities requiring minor upkeep are assigned "II" rating by SHA. Minor repair activities are performed by District Operational staff to better address the routine maintenance needs of the growing inventory. Routine upkeep or minor and preventive repairs are generally activities that address minor deficiencies and may include actions such as mowing, brush cutting, vegetative thinning, unwanted woody vegetation removal, invasive weed removal, and trash or debris removal. The purpose of the maintenance activities is to maintain the performance of the SWM facilities and prevent

or eliminate conditions that deteriorate function. SWM facilities that are functioning as designed are kept on a schedule with District Maintenance in order to maintain their assigned "I" rating.

D.2. Routine Maintenance Procedures

SHA completed an operational manual for stormwater and drainage assets. The first edition of this manual has been completed and distributed to all shops in the MS4 jurisdictions. The practices outlined in each manual are specific to facility type and input from several offices and divisions were pooled to provide good information on the proper procedures and equipment needed. This same format will be used for the shops statewide moving forward. Feedback from the shops will also be gathered to make periodic updates as needed to the manuals and redistribution will occur at those times. The manuals also contain maps of the locations of all SWM facilities within the area of influence of the shop so maps will also require updates to keep shops aware of the growing number of facilities. This will ensure that newly constructed facilities are maintained and retain their functional capacity in the long term.

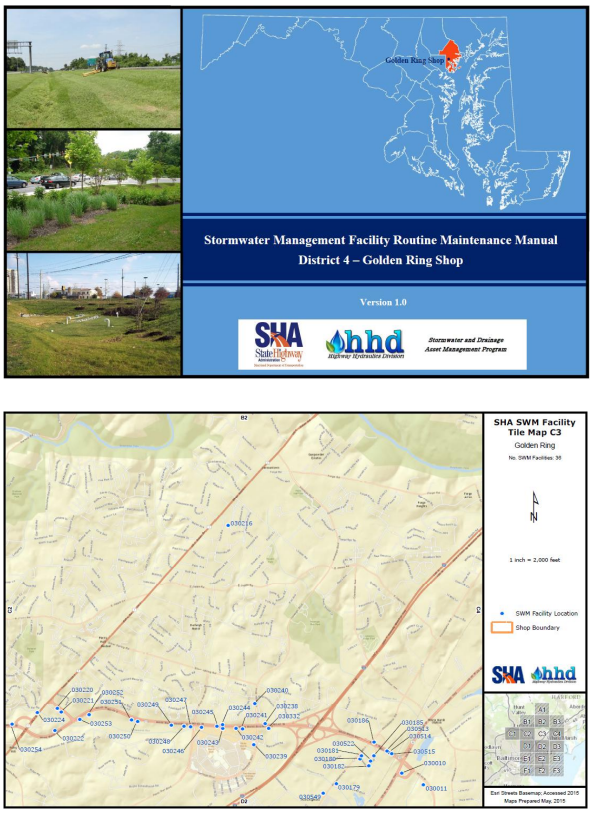


Figure 2-11: Cover and Mapping Examples from SWM Facility Routine Maintenance Manual

E. Future Focus

As SHA moves forward, the business goals continue to evolve and include additional environmental stewardship. This includes continuing to expand the size of the NPDES programming and meeting permitting goals more robustly. To do this, the program must be focused on the future at all times and undergo continuous planning efforts which include business process improvement, research and additional program support.

The schedule for future stormwater inspections, illicit discharge detection and elimination (IDDE) and infrastructure Source ID updates is detailed in Table 1-1 within Part I of this annual report.

E.1. Business Process Improvement

The future focus of the program includes strategic planning efforts to improve business processes, better serve our customers and develop new technological resources. The following includes plans for future development, improvement and expansion of the existing program.

- Technology upgrades will be performed on both hardware and software.
    - Servers housing GIS data will be upgraded in early 2017.
    - Upgraded servers will include software upgrades to more current technologies
    - Inspection Tools for SWM facilities will be reprogramed and upgraded to work with new and expanding technologies including servers, more real time data management and current and future portable devices including laptops, tablets and other devices as they are developed. Tool development will be in 2017 and pilot jurisdictional inspections will take place as tools come on line.
- GIS Data management procedures and database schema will be examined to increase efficiency and decrease potential conflicts or errors.
- A systematic corridor assessment of drainage systems utilizing the 9 video camera systems purchased in 2016 will be implemented. This system will allow inspection results to be added to the overall SWM and drainage asset database to identify deficiencies in advance of pipe failures so planning for repairs and replacements can occur concurrent with corridor paving projects. This will provide a proactive approach that was not available prior to the video inspection protocol.
- Updates to the *Maryland State Highway Administration Stormwater NPDES Program Standard Procedures Manual* to include new technology and procedures as well as answer frequently asked questions during inspection, work order development and engineering phases.

E.2. Research

Research to find new technology, procedures and materials for design was performed in 2016. Some continues for additional design criteria and other proved that there may not be sufficient technology to provide the data as needed currently. Two examples of research and future plans as a result are as follows:

- Highway Runoff Stormwater Management Potential Site Characterization Using NASA Public Domain Imagery was completed in April 2016. The program contributed to the work on the research by providing guidance on site selection for the research and remaining in contact with researchers throughout their work. The conclusion of the study did not provide additional planning resources at this time due to the low spatial resolution of the imagery provided by the public domain satellites. Additionally, the relatively static data due to fly-bys, also makes it less desirable. The data has potential at

this time only as a look into longer term evolution of facilities once constructed.

- Use of Compost in SWM facilities as a media replacement or enhancement. Ongoing conversations discussed at the SHA Recycled Materials Task Force include research efforts in conjunction with their Compost Subcommittee on the use of compost in permanent SWM facilities. Preliminary research showed potential issues with the use of compost, however research continues with in situ construction projects on small scales and additional specifications and blends using compost being explored.

E.3. Additional Program Support

Design and construction of facilities for Total Maximum Daily Load (TMDL) is an ongoing part of the programming for compliance with the MS4 Permit. Support activities within the Stormwater and Drainage Asset Management Program are offered on an ongoing basis for the following activities:

- Site Selection Research for tree planting and potential TMDL facility sites is supported. Geospatial queries are performed when a list of potential sites are provided in order to verify that no existing SWM or Drainage Assets will be impacted by planned facilities or tree plantings.
- Preliminary Plan review and processing for permitting activities for all TMDL designed facilities and stream restorations are provided.

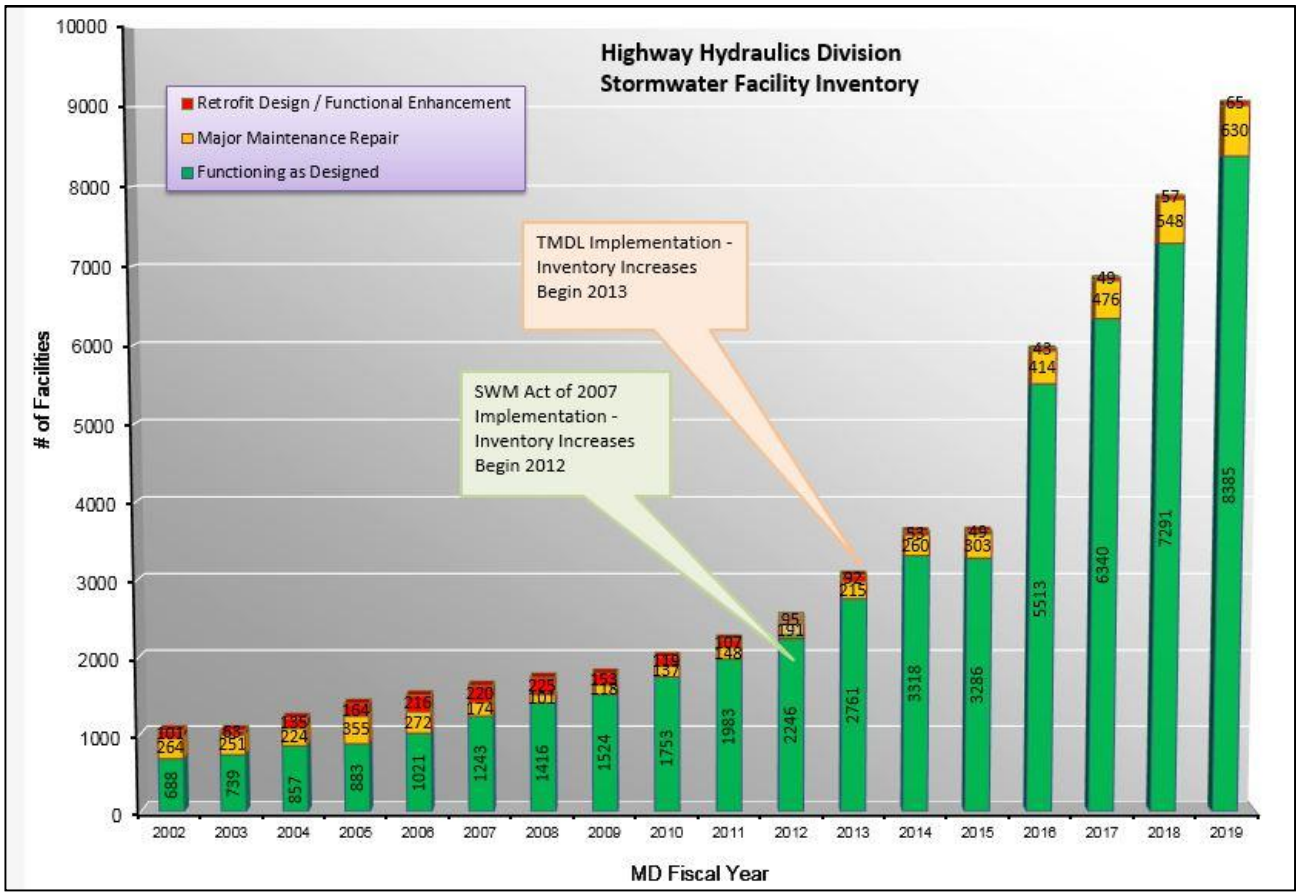
Summary

The NPDES MS4 permit requires SHA to identify all infrastructure that captures, treats, and conveys stormwater runoff from SHA facilities such as roadways, welcome centers, and park and rides, including hydraulic structures and stormwater management facilities that fall within the 14 designated MS4 jurisdictions. SHA owns and maintains approximately 5970 SWM facilities statewide and 5015 of those are located within the noted jurisdictions. Based on current estimates, SHA also owns and maintains 160,797 hydraulic structures, 131, 908 conveyances, that include 8,153,973 linear foot of storm drain pipes statewide. Since 1999, SHA has maintained and expanded a comprehensive asset management program to locate, inspect, evaluate, and remediate stormwater facilities to sustain their functionality, improve water quality, and protect sensitive water resources. SHA has developed a comprehensive inspection and rating system to prioritize and plan remedial activities and preventive maintenance to extend the life expectancy of each asset.

The SHA Business Plan goals exceed the NPDES Phase I permit requirements by promoting a complete statewide inventory and maintaining high-efficiency SWM facility performance. A key goal is to maintain 90 percent of all SHA-owned SWM facilities at full functionality. Currently, 92.3% of all SHA-owned and maintained facilities within the inventory meet the functionality goal. Within the MS4 jurisdictions, 91.65% of facilities meet the functionality goal. Figure 2-12 on the following page shows the functional ratings and the projected overall SWM inventory growth and trend.

Key program components and structures exemplify a strategic approach to meet NPDES permit requirements, allowing for the enhancement of SWM facility performance efficiency and reducing the pollutant loads contained in highway runoff. The integration of these components significantly improves water quality in the local waterways and the sensitive Chesapeake Bay Watershed overall.

Figure 2-12: Statewide SWM Inventory Functional Rating and Projected Trend



Appendix A

Geospatial Database and Data Dictionary





Appendix A
SHA Annual Report GIS Database Submittal Data Dictionary

A Introduction

The NPDES Annual Report database submittal includes two ESRI geodatabases. SHA has provided the following geodatabases for submittal with the 2016 NPDES Annual Report:

Table A-1: SHA Geodatabases

Filename	Description	Specifications
SHA_MDE_2016geodatabase.mdb	MDE geodatabase for the 2016 NPDES Annual Report (personal geodatabase)	Detailed *National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4), Geodatabase Design and User's Guide*, Version 1.1 published in April 2015
SHA_NPDES_2016geodatabase.gdb	SWM Infrastructure and Impervious Accounting datasets (file geodatabase)	Detailed in the *SHA's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Discharge Permit, Part IV.C*, which was provided to SHA on October 9, 2015

This database dictionary for the submittal incorporates a summary of modifications to the 2016 MDE geodatabase framework as well as a description of entities and attributes for the SHA NPDES 2016 geodatabase. Supplemental information for each layer is provided, as necessary, to detail the lineage of the datasets.

B File Formats

The 2016 Annual Report submittal geodatabases are exported from the enterprise SDE geodatabase environment into an ESRI geodatabase compatible with ArcGIS 10.0+.

C Contents

Within the "Databases" folder on the CD deliverable, the following ESRI geodatabases may be found:

- **SHA_NPDES_2016geodatabase.gdb**
- **SHA_MDE_2016geodatabase.md**

D Data Projection

These geodatabase submittals have been re-projected from SHA's standard projection into the required projection for MDE, specifically NAD_1983_StatePlane_Maryland _FIPS_1900_Meters. The data within the submittal geodatabases are developed in the following original spatial projection: NAD_1983_StatePlane_Maryland _FIPS_1900_Feet.

E 2016 MDE Geodatabase (SHA_MDE_2016geodatabase.mdb)

Below is a table of minor alterations to the geodatabase schema performed in order to align the database framework with the key outcome of the discussions during the MDE-sponsored geodatabase meetings.

Table A-2: Alterations to Database Schema

Database Object *(Entity.Attribute or domain)*	**Description**
dConPurpose domain	Within the domain dConPurpose, altered the description for the domain "NEWD" to read as "New Development".
dConPurpose domain	Within the domain dConPrupose, added new domain code "REST" with a description of "New Restoration".
BMP_POI.IMP_ACRES	Set the IMP_ACRES to represent the total SHA Owned impervious within the drainage area of the facility.
RestBMP.IMP_ACRES	Set the IMP_ACRES to represent the total SHA Owned impervious within the drainage area of the facility.
AltBMPLine.ALTBMP_LN_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
AltBMPLineInspections.ALTBMP_LN_INSP_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
AltBMPPoly.ALTBMP_PY_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
BiologicalMonitoring.BIO_MON_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
BMP.BMP_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
BMPDrainageArea.BMP_DRAIN_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
BMPInspections.BMP_INSP_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
BMPPOI.BMPPOI_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
ChemicalApplication.CHEM_APPL_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
ChemicalMonitoring.CHEM_MON_ID	Altered the width of this primary key field to allow for the "SHA" prefix.

Table A-2: Alterations to Database Schema

Database Object *(Entity.Attribute or domain)*	**Description**
ErosionSedimentControl.ESC_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
FiscalAnalyses.FISCAL_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
IDDE.IDDE_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
ImperviousSurface.IMPERV_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
LocalStormwaterWatershedAssessment.LSW_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
MonitoringSite.MON_STATION_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
MunicipalFacilities.MUNI_FACILITIES_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
NarrativeFiles.MDE_DOC_NAME_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
Outfall.MDE_OUTFALL_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
OutfallDrainageArea.MDE_OUTFALL_DRAIN_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
QuarterlyGradingPermits.QGP_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
QuarterlyGradingPmtInfo.QPI_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
RestBMP.REST_BMP_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
RestBMPInspections.RESTBMP_INSP_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
SWM.SWM_ID	Altered the width of this primary key field to allow for the "SHA" prefix.
AltBMPLineInspections.ALTBMP_LN_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
AltBMPPolyInspections.ALTBMP_PY_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
BiologicalMonitoring.MON_STATION_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
BMP.BMPPOI_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
BMP.BMP_DRAIN_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
BMPDrainageArea.BMPPOI_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
BMPInspections.BMP_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.

Table A-2: Alterations to Database Schema

Database Object *(Entity.Attribute or domain)*	**Description**
ChemicalMonitoring.MON_STATION_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
ChemicalMonitoring.MDE_OUTFALL_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
IDDE.MDE_OUTFALL_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
NarrativeFiles.MON_STATION_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
OutfallDrainageArea.MDE_OUTFALL_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
QuarterlyGradingPmtInfo.QGP_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
RestBMP.BMP_DRAIN_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
RestBMPInspections.RESTBMP_ID	Altered the width of this foreign key field to allow for the "SHA" prefix.
AltBMPLine.PROJECT_CITY	Altered field properties to allow null values.
AltBMPLine.PROJECT_STATE	Altered field properties to allow null values.
AltBMPLine.PROJECT_ZIP	Altered field properties to allow null values.
AltBMPLine.LU_COUNTY	Altered field properties to allow null values.
AltBMPPoly.PROJECT_CITY	Altered field properties to allow null values.
AltBMPPoly.PROJECT_STATE	Altered field properties to allow null values.
AltBMPPoly.PROJECT_ZIP	Altered field properties to allow null values.
AltBMPPoly.IMPL_COST	Altered field properties to allow null values.
RestBMP.PROJECT_CITY	Altered field properties to allow null values.
RestBMP.PROJECT_STATE	Altered field properties to allow null values.
RestBMP.PROJECT_ZIP	Altered field properties to allow null values.
RestBMP.IMPL_COST	Altered field properties to allow null values.
AltBMPLineInspections.REINSP_STATUS	Altered field properties to allow null values.
AltBMPLineInspections.REINSP_DATE	Altered field properties to allow null values.
AltBMPLineInspections.LAST_INSP_DATE	Altered field properties to allow null values.
AltBMPPolyInspections.REINSP_STATUS	Altered field properties to allow null values.
AltBMPPolyInspections.REINSP_DATE	Altered field properties to allow null values.
AltBMPPolyInspections.LAST_INSP_DATE	Altered field properties to allow null values.
BMP.ADDRESS	Altered field properties to allow null values.
BMP.CITY	Altered field properties to allow null values.
BMP.STATE	Altered field properties to allow null values.
BMP.ZIP	Altered field properties to allow null values.
BMP.ON_OFF_SITE	Altered field properties to allow null values.
BMP.CON_PURPOSE	Altered field properties to allow null values.
BMPInspections.REINSP_STATUS	Altered field properties to allow null values.
BMPInspections.REINSP_DATE	Altered field properties to allow null values.

Table A-2: Alterations to Database Schema

Database Object *(Entity.Attribute or domain)*	Description
BMPInspections.LAST_INSP_DATE	Altered field properties to allow null values.
ErosionSedimentControlDIST_ACTIVE_OTH	Altered field properties to allow null values.

F 2016 SHA NPDES Geodatabase (SHA_NPDES_2016geodatabase.gdb)

The geodatabase contains two core feature classes containing the spatial data relating to stormwater structures and conveyances. Each feature class is related through defined relationship classes to a set of tables that further describe the structure or conveyance. Additionally, the impervious surface layer is provided here as a feature class. The contents of the SHA_NPDES_2016geodatabase.gdb are detailed below in Table A-1.

Table A-3: SHA NPDES Geodatabase Contents

DATABASE SPATIAL LAYERS	TYPE	DESCRIPTION
STRUCTURES	Feature Class	Point feature class that stores the spatial representation and tabular information pertaining to storm water structures (i.e., inlets, manholes, outfalls, control structures). Information includes structure type, feature status, major outfall (T/F), and other overlay attributes such as watershed.
CONVEYANCE	Feature Class	Line feature class that stores the spatial representation and tabular information pertaining to storm water conveyance (i.e., pipe and ditch). Information includes conveyance type, feature status, invert elevations, and other overlay attributes such as watershed.
IMPERVIOUS_SURFACES	Feature Class	Polygon feature class that stores the spatial representation and tabular information pertaining to impervious surfaces in the Phase 1 MS4 area. Information includes geographical indicators such as County, Watershed, and SHA Maintenance Shop, as well as date of last update and general comments as necessary.
DATABASE TABLES	**TYPE**	**DESCRIPTION**
END_HEADWALL	Table	Contains the outfall and open upstream structures for a storm drain system, such as endsections, projection pipes, headwall, and endwalls. Information includes the type and material of the end structure.
INLET	Table	Contains the inlet features within the storm drain systems. Information includes the type and material of the inlet, the top of grate, and the length for COG and COS type inlets.
MANHOLE_CONN	Table	Contains the manhole and other connection features within the storm drain system. Information includes the material and top of manhole lid, when applicable.
PUMPSTN	Table	Contains the pump stations within the storm drain system. Information includes the station name, install date, number of pumps, and maximum capacity for the station.
SWMRISER	Table	Contains the storm water BMP control structure, such as box risers and pipe barrel risers. Information includes the material, if a trash rack exists, riser type, and the stage storage elevation.
WEIR	Table	Contains the weirs and emergency spillways related to storm water BMP storage controls. Information includes the material, if a trash rack exists, and the stage storage elevation.

Table A-3: SHA NPDES Geodatabase Contents

DATABASE TABLES	TYPE	DESCRIPTION
DITCH	Table	Contains the ditch features within the storm drain conveyance. Information included includes ditch material and dimensions.
PIPES	Table	Contains the pipe features within the storm drain conveyance. Information includes the type, length, and dimension of the pipe.

E BMP / Structure System Numbering Convention

The BMP system numbering methodology applies a unique seven-digit identification number to each asset. The first two (2) digits indicate the county where the system is located. Table A-2 lists the county code numbers for Maryland. For county codes that begin with a zero (ex. Baltimore County 03), the leading zero is not dropped from any naming convention. The remaining five (5) digits represent the unique system number. For example, 130140 is system 140 located in Howard County (County Code 13).

Table A-4: Maryland County Codes

Code	Abbreviation	County Name	Code	Abbreviation	County Name
01	AL	Allegany	13	HO	Howard
02	AA	Anne Arundel	14	KE	Kent
03	BA	Baltimore	15	MO	Montgomery
04	CA	Calvert	16	PG	Prince Georges
05	CO	Caroline	17	QA	Queen Anne's
06	CL	Carroll	18	SM	St. Mary's
07	CE	Cecil	19	SO	Somerset
08	CH	Charles	20	TA	Talbot
09	DO	Dorchester	21	WA	Washington
10	FR	Frederick	22	WI	Wicomico
11	GA	Garrett	23	WO	Worcester
12	HA	Harford	24	BC	Baltimore City
			99	SW	Statewide

The individual drainage structures located within a system receive a unique three (3) digit identification number. For example, 1300140.007 is the seventh (.007) structure in the 140th drainage system in Howard County.

Numbering begins with the most downstream structure, usually the outfall, which is assigned the structure number of .001. Structures are then numbered as the system is traced upstream. For initial data collection or adding new systems, the most downstream structure in any system should be numbered .001. This is convention only, and structures may be numbered out of sequence in the existing geodatabase. Each system that flows into a BMP is a separate system. The control structure and outfall for a stormwater BMP also starts a new system. Figures A-1 and A-2 (on the following page) show examples of system, structure, and BMP numbering.

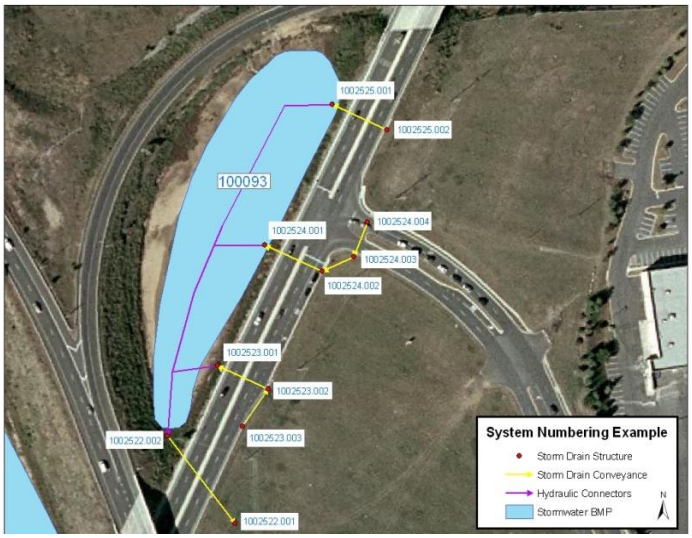


Figure A-1: System No. Ex. 1

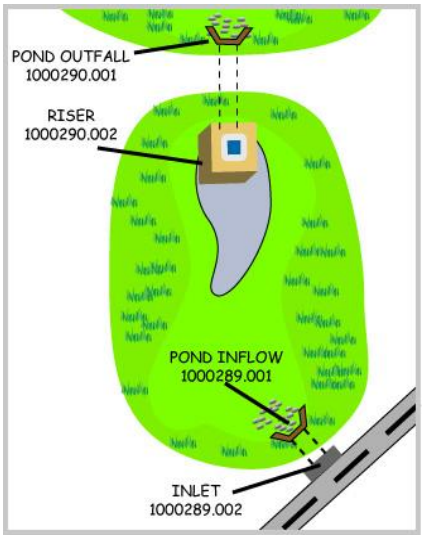


Figure A-2: System No. Ex. 2

Appendix B

Litter Reduction Education Initiative (2016–2020)





Maryland Department of Transportation
State Highway Administration
Litter Reduction Educational Initiative (2016-2020)

VISION:

The Maryland Department of Transportation's State Highway Administration will maintain litter-free highways.

MISSION:

The State Highway Administration will ensure that its infrastructure system is supported by successful environmental stewardship efforts. With a focus on clean waterways, trails, streams and storm water filtration systems, this initiative will work to reduce litter and contribute to healthier watersheds, tributaries and the Chesapeake Bay.

SITUATIONAL ANALYSIS:

The Maryland Department of Transportation's State Highway Administration (SHA) manages nearly 17,000 miles of highways, along which millions of people drive every day. Each year, SHA maintenance and contract crews clear thousands of bags of trash from Maryland's roadsides. This litter and debris clogs water filtration systems, impacts wildlife habitat, pollutes steams and ultimately hurts the numerous watersheds that support the local economies and waterways.

Bitgood et al (1988) describes four ways to control and reduce the amount of litter along the nation's highways: environmental education, prompting, environmental design, and consequence control.

Based on observations, customer service reports and correspondence sent to the agency, litter is placed along Maryland's roads via several mechanisms (unsecure loads, water runoff, illegal dumping, worn/weathered signs) – yet its singular cause is personal behavior.

As part of the MD Department of Environment (MDE) regulatory process, SHA operates under an overall permit called a "Municipal Separate Storm Sewer System Permit (MS4)." Within the permit, MDE establishes goals for SHA to address the effects of traffic and operations to reduce water pollution.

Additionally, SHA is actively engaged in Bay Restoration efforts to improve the water quality of the Bay. The most recent MD permit outlines actions for SHA related to litter reduction. Part of this commitment includes a public education and outreach program with specific performance goals to reduce litter. A focus on social marketing to change behavior must be integrated with supporting agency operations. Information on the issuance of fines, while shared and promoted, is challenging to enforce.

SHA will report annually on the effectiveness of the program components. With the appropriate allocation of resources and funding, the defined goals will be based on research related to

behavior and awareness campaigns and successes. It will allow SHA to address challenges and learn more about perception and behavior modification.
Some preliminary foci may include:

- Raising awareness of the negative impacts of littering.
- Changing behavior of those who litter Maryland roads and waterways.
- Advancing the State executive branch's initiatives of improving the quality of life for citizens and Changing Maryland for the Better.
- Promoting the public "good neighbor" image of MDOT/SHA.
- Recognizing volunteers in the Adopt-A-Highway program.
- Recognizing private business participants of the Sponsor-A-Highway program.
- Attracting partnerships with public and private businesses.

RESEARCH:

To narrow the focus areas for the anti-litter initiative, SHA will conduct statistically valid qualitative and quantitative research during 2016-2017 to establish baseline awareness, the associated costs, perceptions and personal behavior for littering, and behavioral motivations.

The research will refine target audiences and perceptions about littering laws and the problems associated with trash and debris discarded on roadways.

Additionally, SHA will use focus groups to identify barriers and develop potential messaging that might resonate with target audiences.

PLANNING:

Based on the research, SHA will segment audiences and develop relevant messages and tactics The next phase includes setting specific campaign goals that attempt to change behavior, and also decrease litter in the specific target areas.

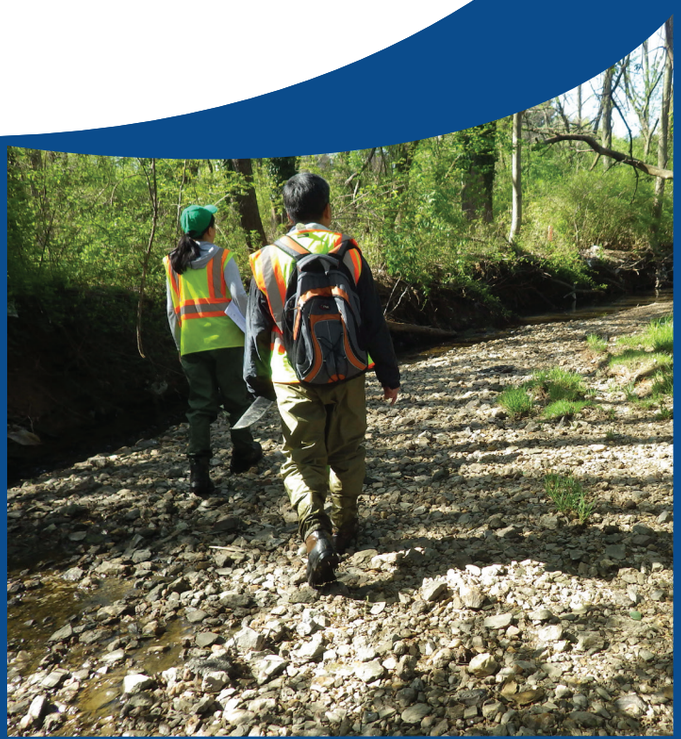
Reference:

Bitgood, S., Carnes, J. & Thompson, D. (1988). "Control of Littering: A Comparison of Three Approaches." Visitor Behavior *(2)*4, 7-8.

Adopt-A-Highway. Sponsor-A-Highway. Derived from www.roads.maryland.gov (30 September, 2016).

Appendix C

Research Activity





APPENDIX C
RESEARCH ACTIVITY

ASSESSMENT OF STREAM RESTORATION PROJECTS IN MARYLAND

2015 – 2016 MONITORING REPORT

Assessment of Stream Restoration Projects in Maryland

2015-2016 Report

Prepared for:

Maryland Department of Transportation
State Highway Administration
Highway Hydraulics Division
707 North Calvert Street
Baltimore, MD 21202

Prepared by:

Principal Investigator

R. P. Morgan II

Contributing Staff

J. D. Acord
J. E. Garlitz
D. M. Gates
K. M. Kline
B. C. Rice
I. M. Smith

University System of Maryland
Center for Environmental Science
Appalachian Laboratory
301 Braddock Road
Frostburg, MD 21532-2307

June 2016

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APPENDIX A. 69

Introduction

The Maryland Department of Transportation, State Highway Administration (SHA) receives state and federal funding for assessment of stream restoration projects in Maryland. SHA requires scientific support (primarily biological and stream physical habitat) to assess and/or to monitor a selected set of stream restoration projects already completed, or projected to be done in the future, by this administration. Information collected from these studies, undertaken by the Appalachian Laboratory of the University of Maryland Center for Environmental Science, provides a framework and historical database of recommendations for future SHA stream restoration projects, and for the assessment and potential revitalization of existing SHA restoration projects throughout the State of Maryland.

Rationale

Stream restoration is of critical importance to the State of Maryland, as well as to the entire Chesapeake Bay watershed. The overall quality of life, now and in the future, is highly dependent on aquatic ecosystem integrity for both the quantity and quality of freshwater resources (Simon 1999). The integrity of surface water resources is dependent on chemical variables, flow regimes, biotic factors, energy sources, and habitat structure (Karr et al. 1986). Over the last quarter century, numerous surveys of fish and benthic communities assessed freshwater ecosystem health (Simon 1999). Significant advances in this arena led to the development of integrative ecological indices, such as Indices of Biotic Integrity (IBIs), which relate fish communities to both biotic and abiotic ecosystem components (Karr 1981, Karr et al. 1986). Coupled with chemical-physical water quality attributes, habitat quality (and often quantity) is important to consider when examining fish and benthic communities, especially for any and all derived IBIs (Yoder and Smith 1999).

Stream restoration strongly focuses on revitalization of the physical habitat. However, indices of habitat quality to assess post-restoration processes have lagged behind both fish and benthic IBI development. In part, this is because of the difficulty in developing accurate, precise and complete methodologies that quantitatively and qualitatively assess habitat characteristics (Platts 1976, Platts et al. 1983). The impetus for including stream habitat as an important measure came initially from western U.S. restoration activities (reviewed in Platts et al. 1983). For example, Binns (1979) developed a Habitat Quality Index for trout streams, soon to be followed by both Habitat Evaluation Procedures models (HEP) and Habitat Suitability Index models (HSI) for use with the U. S. Fish and Wildlife Service in-stream flow models. Important improvements in more generalized habitat models came with the development of EPA's Rapid Bioassessment Protocols (Plafkin et al. 1989) and the Ohio EPA's Qualitative Habitat Evaluation (Rankin 1989).

Wallace (1990) points out that there are a number of factors to consider in looking at stream recovery, especially in light of recent restoration attempts for lotic systems. Recolonization of a disturbed or restored area is a function of many factors, often depending on stream size. Implicit in restoration is that long-term stream physical stability eventually recovers. However, benthic macroinvertebrates respond to many disturbances, and restoration processes directed towards only the physical habitat may not take into account other critical stressors present in the watershed. The importance of nearby biotic refugia, as a source for recolonization is also critical, especially upstream refugia and potentially the presence of either downstream or nearby lateral watershed refugia (Wallace 1990).

Hall et al. (1999, 2002) initially developed a Physical Habitat Index for Maryland using data collected from the first round of the Maryland Biological Stream Survey (MBSS), soon followed by the development of a revised Physical Habitat Index for Maryland (Paul et al. 2002). Coupled with the development of fish IBIs (Roth et al. 1998) and benthic IBIs (Stribling et al. 1998) from the MBSS data set, powerful analytical tools are now available to assess stream integrity in Maryland, and to examine stream restoration efficiency. These biotic indices were robust, and allowed inferences on stream integrity and stability, either regionally, statewide, or at site-specific levels. In addition, these indices were even more refined with additional MBSS rounds completed, especially with the development of coldwater fish IBIs and a finer level of benthic IBIs (Southerland et al. 2005, 2007).

Functional rehabilitation of degraded streams is critical, since streams provide multiple environmental benefits, as well as critical ecological services (Morris and Moses 1999, National Research Council 1992). Functional rehabilitation is the major key to stream restoration since a return to pre-colonization stream status is impossible, especially in Maryland, where complex patterns of land use have evolved since pre-colonial days. However, careful analytical evaluation of stream restoration or enhancement projects is often lacking (Downs and Kondolf 2002, Morgan 2005, Roberts et al. 2016). Monitoring these stream projects often serves as an important “first step” in evaluating effectiveness, and is essential to adaptive resource management (Bash and Ryan 2002). Downs and Kondolf (2002) and Morgan (2005) noted that post-project appraisals, or evaluations of restoration effectiveness, are critical to assess both the short-term and long-term performance attainment of stream restoration projects. Often, this critical step is lacking in the majority of stream restoration projects (Downs and Kondolf 2002).

For stream restoration activities, SHA project analyses completed from 1998 to 2010 for SHA were discussed in Morgan et al. (2010). Within this 2010 report, eight recommendations for the assessment improvement of SHA stream restoration projects were described.

Project Objective

The overall project objective is to assess and monitor completed and proposed SHA stream restoration projects and to make recommendations for future restoration projects, as well as for the improvement and revitalization of current restoration projects. In addition, a monitoring schedule for examining all completed stream restoration projects in the long-term (5, 10, and 25 years) was developed based on results for each SHA stream restoration site, and is in constant refinement with new sites added as needed, and old sites revisited (Morgan et al. 2010).

Materials and Methods

Site Locations

Site details for each SHA restoration location are described in the results and discussion section, with all benthic macroinvertebrate data summaries found in Appendix A. Control sites are often very difficult to find in highly developed urban watersheds or in headwater streams. We always attempted to find control sites upstream of pre-restoration or post-restoration sites; however, many of these restoration sites were in the extreme upper part of a watershed and did not reflect the restoration area, or there were changes in control sites during the study. To compensate for this problem, we employed data from all rounds of the MBSS for comparison to the restoration site. Normally, one would try to collect samples where the condition is present and where it is absent, with all other factors being the same (Green 1979). This approach determines an effect at a site relative to a control. However, there is so much anthropogenic activity in the landscape of the coastal plain and Piedmont, as well as other physiographic provinces of Maryland, that watersheds are strongly altered through time and space. It may be necessary at some sites to move downstream into the lower part of a watershed and then determine current conditions to assess the upstream site, or to assess if refugia are present for recolonization. However, this is not the preferred approach.

Benthic Macroinvertebrates

Assessment of benthic macroinvertebrates at each sampling site followed benthic macroinvertebrate protocols for MBSS sampling (Kazyak 1996, Stranko et al. 2010). At each pre-construction or post-construction project, two benthic samples (~ 10-20 sweeps each with D-nets depending on stream size) were taken within the project boundary after site surveys (lower and middle sections, if possible). One sample was always collected near the lower (downstream boundary) of the project. The middle sample was collected approximately one-third to one-half of the distance from the upper upstream boundary of the project (benthic sampling was frequently modified dependent on specific site characteristics). Two additional samples, serving as replicate controls, were collected upstream of the stream restoration project, assuming that the upstream area served as a suitable control area. If no suitable upstream control was present, one or two site samples were taken downstream. For any pre-construction sites, two benthic samples were taken within the proposed project boundaries, along with two controls from an upstream area (or

downstream area) if possible. We also identified a number of MBSS reference streams to provide biotic baselines for benthic invertebrate quality for the project.

Benthic Field Sampling Protocols

A series of D-net samples (a total of ~ 1-2 m^2) were taken at each sampling location (Kazyak 1996), with an emphasis on selecting riffle/run habitat. Benthic macroinvertebrate sampling was conducted in order to qualitatively describe the community composition and relative abundance in favorable habitats. All survey methods for benthic macroinvertebrates followed MBSS protocols (Kazyak 1996), with benthic samples, as often as possible, collected from stream riffle areas because this is typically the most productive habitat in stream ecosystems. When riffle habitat was not present, other habitats sampled in the following order of preference were: gravel/broken peat and/or clay lumps in run areas; snags/logs that create partial dams or are in run habitat; undercut banks and associated root mats in moving water; submerged aquatic vegetation and associated bottom substrate in moving water; and detritus/sand areas in moving water. In the field, samples were transferred to polyethylene bottles and preserved in denatured ethanol. These benthic samples were collected during the MBSS spring index period and during the MBSS fall index period (Kazyak 1996), weather conditions permitting.

Benthic Laboratory Protocols

In the laboratory, samples were washed, picked, and organisms stored in 70% isopropyl alcohol. The first 300 organisms (to the nearest grid) were picked for identification to the lowest taxon possible (Plafkin et al. 1989), with the first 100 organisms separated for the calculation of the MBSS BIBI. Only the 100 organism sample was used for MBSS metric calculations since the MBSS BIBI development was based on this sample number. The first 300 organisms were used for the EPA RBP III calculations. If the sample contained less than 300 organisms, the sample was picked completely. In any report table, an asterisk (or a mention in the report) denotes either a lack of 100 organisms for the MBSS BIBI, or a lack of 300 organisms for the EPA RBP III protocol.

Benthic Macroinvertebrate Statistical Protocols

MBSS - A revised Maryland benthic index of biotic integrity (BIBI) was employed for this project (Southerland et al. 2005, 2007). The new BIBI was broken into Coastal Plain, Eastern Piedmont and Combined Highlands (Table 1). For any of the three MBSS strata, BIBI scores were determined by adding the threshold score for each metric, and then dividing by the number of metrics for each stratum. The BIBI collected at each station was compared to the control area as well as to MBSS reference stations in the vicinity of the SHA project. A BIBI score range of 4.0 - 5.0 is rated as good, 3.0 - 3.9 is fair, 2.0 - 2.9 is poor, and 1.0 - 1.9 is very poor (Table 2).

EPA – Benthic metrics were derived using the EPA RBP III procedures using a 300 + organism count (Plafkin et al. 1989, Klemm et al. 1990, Barbour et al. 1999). The derived metrics are: taxa

richness = total number of taxa recognized; Hilsenhoff Biotic Index = tolerance value of each macroinvertebrate multiplied by the number of those individuals and then the sum of the products divided by the total number of specimens; ratio of scraper and filtering collector functional feeding groups; ratio of shredder functional feeding group to total number of individuals; ratio of total number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) individuals to total Chironomidae; EPT Index = number of distinct taxa within the orders Ephemeroptera, Plecoptera and Trichoptera; and the percent contribution of the dominant taxon in the riffle community.

Physical Habitat Assessment

Stream physical habitat data is an essential component of any biological assessment program. Habitat data is normally used to assess trends in water quality and to investigate the influence of land use practices that may affect stream water quality. Habitat assessments, based on an earlier MBSS protocol (Kazyak 1996), were performed at all SHA sites in order to determine biological integrity and fishability. Although there are now revised physical habitat metrics for the MBSS (Paul et al. 2002), the Maryland physical habitat index (MPHI), developed by Hall et al. (1999, 2002) based on MBSS fish IBI data sets, was calculated and compared to control areas and to MBSS reference data in the vicinity of the SHA project. This approach was used to maintain consistency in the physical habitat index measurement over time, especially for those SHA sites being revisited since the earliest sites were initiated in Fall 1998 (Morgan et al. 2010).

A number of variables were assessed qualitatively at each site. These include the following: instream habitat, epifaunal substrate, velocity/depth diversity, pool/glide/eddy quality, riffle quality, channel alteration, bank stability, embeddedness, channel flow status, and shading (scores assigned for each metric). Observations of the surrounding area were used to evaluate aesthetic value (based on amounts of human refuse) and remoteness (based on ease of access and presence of human activity). The presence, or absence, of other stream habitat features (i.e., morphological characteristics, stream channelization, woody debris, and land uses visible from each site) was also recorded for each site. In the field, physical habitat assessments were integrated across controls and across the stream restoration area.

Physical habitat metrics with the best discriminatory power for SHA coastal plain sites were: instream habitat, velocity/depth diversity, pool/glide/eddy quality, embeddedness, maximum depth and aesthetic rating. The final index calculations for the coastal plain weighed all metrics equally except embeddedness, maximum depth, and aesthetics that were weighted ½. The final equation used for the coastal plain habitat index (CPPHI) was:

CPPHI= (instream habitat + velocity/depth diversity + pool quality
– embeddedness/10+ maximum depth/10+ aesthetics/2)/ 6.

Physical habitat metrics with the best discriminatory power for SHA non-coastal plain sites (primarily Piedmont) were: instream habitat, velocity/depth diversity, riffle/run quality, embeddedness, number of rootwads and aesthetic rating. All metrics were weighted equally except embeddedness (weighted ½) and aesthetics (weighted $^1/_3$). The final equation used for the non-coastal plain habitat index (NCPHI) was:

NCPHI= [instream habitat + velocity/depth diversity + riffle/run quality – embeddedness/10 + 3(number of rootwads) + aesthetics/3]/ 6.

Each metric was calculated by site (metrics were integrated across the controls and the restoration sites) and a statistically based algorithm was used to convert the physical habitat score to centiles (Hall et al. 1999, 2002). Physical habitat categories were defined as: good being > 72 (> 50th centile), fair 42-72 (30th to 50th centile), poor 12-42 (10th to 30th centile) and very poor < 12 (10th centile).

In addition, digital images were periodically taken at each site to document selected stream habitat features, and then these images were forwarded to SHA for archiving. All site maps were generated through Google^{TM}earth and MS PowerPoint.

Water Quality

Baseflow water quality samples were taken at each SHA site for the determination of water quality parameters following the standard analyses performed for the MBSS, in addition to some new MBSS analytes for the fourth round of random sampling. These samples were taken following current MBSS protocols during the Spring and Fall sampling at each site, with samples transported to the Appalachian Laboratory for laboratory analyses. We calculated the 10th – 90th percentile range for each analyte based on the data base for all random sites in the MBSS program taken during the first three random site rounds.

For CY 2016, we installed an Onset HOBO® U24 temperature-conductivity probe in the uppermost section (south side of I-270) of the unnamed tributary to Seneca Creek (Watkins Mill) to estimate temporal changes in conductivity that were potentially related to road salt usage along I-270. Data from the probe was downloaded monthly and transferred to an Excel spreadsheet for graphical analysis using Statistica.

Table 1. MBSS BIBI for Maryland by stratum and with metric scoring thresholds.			
Stratum and Metric	**Thresholds**		
	1	**3**	**5**
Coastal Plain (7)			
Number of taxa	< 14	14-21	≥ 22
Number of EPT taxa	< 2	2-4	≥ 5
Number of Ephemeroptera taxa	< 1	1-1	≥ 2
Percent intolerant to urban	< 10	10-27	≥ 28
Percent Ephemeroptera	< 0.8	0.8-10.9	≥ 11
Number of scraper taxa	< 1	1-1	≥ 2
Percent climbers	< 0.9	0.9-7.9	≥ 8
Eastern Piedmont (6)			
Number of taxa	< 15	15-24	≥ 25
Number of EPT taxa	< 5	5-10	≥ 11
Number of Ephemeroptera taxa	< 2	2-3	≥ 4
Percent intolerant to urban	< 12	12-50	≥ 51
Percent Chironomidae	> 63	4.7-63	≤ 4.6
Percent clingers	< 31	31-73	≥ 74
Combined Highlands (8)			
Number of taxa	< 15	15-23	≥ 24
Number of EPT taxa	< 8	8-13	≥ 14
Number of Ephemeroptera taxa	< 3	3-4	≥ 5
Percent intolerant to urbanization	< 38	38-79	≥ 80
Percent Tanytarsini	< 0.1	0.1-3.9	≥ 4
Percent scrapers	< 3	3-12	≥ 13
Percent swimmers	< 3	3-17	≥ 18
Percent Diptera	> 50	27-49	≤ 26

Table 2. Narrative descriptions of stream biological integrity associated with each of the BIBI (or FIBI) scores.		
Good	BIBI score 4.0 - 5.0	Comparable to reference streams considered to be minimally impacted. Fall within the upper 50% of reference site conditions.
Fair	BIBI score 3.0 - 3.9	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of these minimally impacted streams. Fall within the lower portion of the range of reference sites.
Poor	BIBI score 2.0 - 2.9	Significant deviation from reference conditions, with many aspects of biological integrity not resembling the qualities of these minimally impacted streams, indicating some degradation.
Very Poor	BIBI score 1.0 - 1.9	Strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of these minimally impacted streams, indicating severe degradation.

Results and Discussion

Each current SHA restoration project evaluated in 2015-2016 will be reviewed, discussed and synthesized into the context of regional Maryland values, as derived from the Maryland Biological Stream Survey (all rounds). Basic information collected at each site for FY16 is included in each site summary.

In the past, summary lists of benthic invertebrates collected at each restoration site (all controls plus middle restoration and lower restoration samples) were included within each the discussion for that site. These benthic taxa lists are now placed in Appendix A to reduce excessive tables within each section. Any cell within the benthic summary tables marked with an asterisk indicates that fewer than 100 organisms (MBSS protocol) were present in the sample for that site. For the EPA RBP III 300 + samples, metric calculations were not done if less than 100 organisms were present in the sample. There were a few samples with greater than 100 organisms but less than 300 organisms.

Long Draught Branch (LDB)

Site Description: Long Draught Branch is a small first-order stream located in a very highly urbanized area of Montgomery Country that includes residential development, large and small office complexes, numerous shopping centers, apartment complexes and very large amounts of impervious surface due to parking lots, extensive road systems and numerous buildings (Figures LDB 1 and LDB 2). There is a small dam located in the upstream reach of Long Draught Branch. In lower Long Draught Branch, there is another small dam located along Rabbit Road that is slated for future removal to enhance downstream stream connectivity (Figure LDB 2).

A segment of Long Draught Run flows through a park area with a swimming pool and playground. Many of the parking areas adjacent to the numerous apartment units have direct flow pathways into the stream through rip-rapped drainage swales. In the spring, there is significant refuse found in the stream after winter. Often, this trash forms small blockage dams throughout the stream with significant pooling, especially in the area between the two restoration sites. The lower part of the restoration area is heavily wooded.

Throughout its stream course until it enters Clopper Lake, there are numerous storm drains discharging into the stream as well as overland drainage from parking lots and roads**.** There is also a major sewage line paralleling the stream throughout the proposed restoration area with a few surface seeps present.

Long Draught Branch Site Coordinates:

Site coordinates for Long Draught Branch (Figure LDB 1 and LDB2).			
Station	Latitude (N)	Longitude (W)	Comments:
Middle	39.142313	-77.225865	Projected middle restoration site.
Lower	39.144377	-77.228521	Projected lower restoration site.
Alpha Control	39.143820	-77.222785	Upstream Control One.
Beta Control	39.143660	-77.222066	Upstream Control Two.
Rabbit Road - Upper	39.141142	-77.233141	Downstream Control One.
Rabbit Road - Lower	39.139629	-77.235279	Downstream Control Two.



Figure LDB 1. Site locations for sampling of Long Draught Branch (LDB) in Montgomery County.

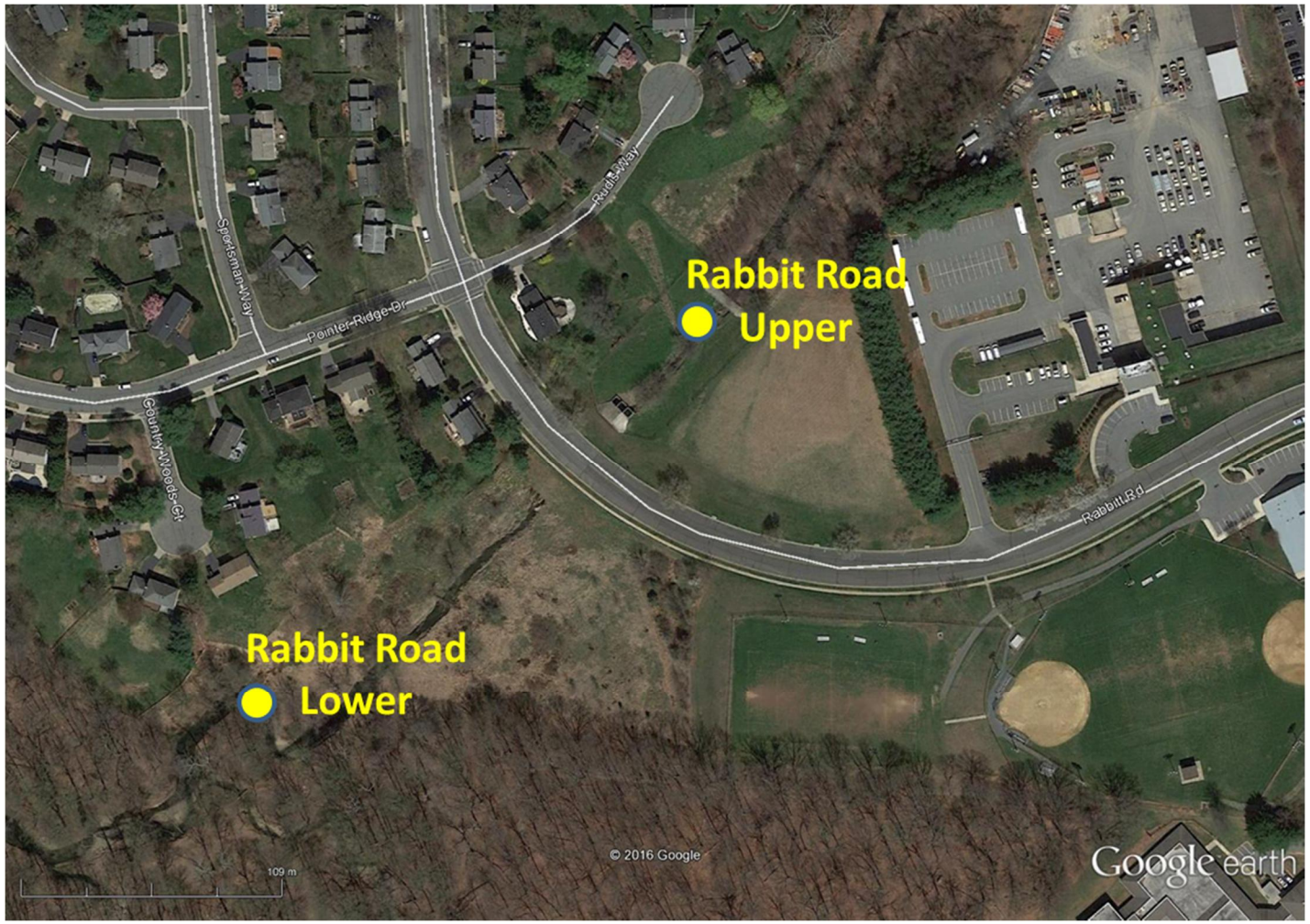

Figure LDB 2. Site locations for sampling of Long Draught Branch (LDB) along Rabbit Road in Montgomery County.

Fall 2015 Benthic Community (LDB) - For the benthic subsample with the MBSS 100 + macroinvertebrate count (Table LDB 1), taxa richness was moderate (22) at the Middle Restoration site and low at the remaining stations (12-15 taxa). The number of EPT taxa (0-4 taxa) and percent of intolerant macroinvertebrates were low at all stations, with *Cheumatopsyche* sp. being the dominant EPT taxon collected. Ephemeroptera taxa were not collected at five sites, with only one taxa present at the Middle Restoration site.

The percent of chironomids collected was high at the Upper Rabbit Road site and moderate at the remaining five stations (Table LDB 1). The percent of clingers was high at the Upper Rabbit Road and the Middle Restoration sites, and moderate at the four remaining stations, with hydropsychid larvae the most abundant clinger macroinvertebrate collected. BIBI values ranged from 1.0 at the Upper Rabbit Road site to 2.0 at the Lower Rabbit Road site. Five of the sites were in the very poor BIBI range.

Table LDB 1. Data summary of benthic macroinvertebrates collected in D-frame samples on September 2015 at six stations in Long Draught Branch**.**

MBSS Piedmont Metrics	Riffle Community (MBSS 100 + subsample)					
	Alpha Control	Beta Control	Rabbit Rd. Lower	Rabbit Rd. Upper	Lower Restoration	Middle Restoration
Taxa Richness	12	12	15	12	14	22
Total EPT Taxa	1	0	4	4	4	3
Ephemeroptera taxa	0	0	0	0	0	1
% Intolerant Urban	0.9%	0.0%	0.9%	1.8%	0.9%	3.7%
% Chironomidae	47.7%	24.8%	46.2%	81.4%	28.3%	51.4%
% Clingers	25.2%	9.2%	45.3%	17.7%	45.3%	20.2%
BIBI	1.3	1.3	2.0	1.0	1.7	1.7

For benthic subsamples with a 300 + count, the low abundance at the Beta Control station resulted in no 300-count sample for that site (Table LBD 2). Taxa richness ranged from 14 at the Alpha Control to 33 at the Middle Restoration site. The Hilsenhoff Biotic Index was lowest (5.9) at Lower Rabbit Road and highest (6.8) at the Middle Restoration site. The ratio of scraper to filtering collector functional feeding group ranged from 0.00 at the Lower Restoration site to 0.54 at the Middle Restoration station. Scraper taxa were in low numbers at all sites, while *Cheumatopsyche* sp. dominated the filtering collector functional feeding group. The number of shredder macroinvertebrates was low at all sites, with *Polypedilum* sp. the most commonly

collected shredder. The ratio of total EPT individuals to chironomids ranged from 0.17 at Upper Rabbit Road and Middle Restoration sites to 1.14 at the Lower Restoration station. The number of EPT taxa was lowest (1) at Alpha Control and highest (6) at Upper Rabbit Road. Hydropsychid larvae dominated the EPT macroinvertebrates. *Orthocladius* sp. larvae were most abundant macroinvertebrate seen at Alpha Control and Upper Rabbit Road while chironomid larvae (too small to identify further) were also most abundant at Lower Rabbit Road. *Cheumatopsyche* sp. larvae were the most abundant macroinvertebrate collected at the Lower Restoration site while Hoplonemertea oligochaetes and Tanytarsini larvae were most abundant at the Middle Restoration station.

Table LDB 2. Data summary of benthic macroinvertebrates collected in D-frame samples on September 2015 at stations in Long Draught Branch.

Metrics	Long Draught Branch Riffle Community (EPA RBP III 300 + subsample)				
	Alpha Control	**Rabbit Rd. Lower**	**Rabbit Rd. Upper**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	14	24	23	22	33
Hilsenhoff Biotic Index	6.1	5.9	6.0	6.2	6.8
Ratio Scrapers to Filtering Collectors	0.02 (2.3%)	0.01 (0.8%)	0.20 (19.6%)	0.00 (0.0%)	0.54 (53.8%)
Ratio Shredders to total Individuals	0.02 (2.4%)	0.06 (5.8%)	0.01 (0.5%)	0.02 (1.7%)	0.01 (1.0%)
Total EPT Individuals to Total Chironomids	0.57 (58%)	0.73 (73%)	0.17 (17%)	1.14 (114%)	0.17 (18%)
EPT Index	1	4	6	3	5
Percent Contribution of Dominant Taxon	18.1%	16.4%	45.8%	15.9%	14.5%

Spring 2016 Benthic Community (LDB) - For subsamples with a 100 + macroinvertebrate count, abundance was low for many sites at this sampling period (Table LDB 3). Taxa richness was moderate at the Lower Restoration site and low at the remaining stations. The number of EPT taxa was moderate at the Lower Rabbit Road station and low at the remaining sites, with the percent of intolerant macroinvertebrates low at all stations. *Cheumatopsyche* sp. was the dominant EPT taxon collected. Ephemeroptera taxa were essentially non-existent at the sites.

The percent of chironomids collected was moderate at all stations while the percent of clingers was low at all sites. Hydropsychid larvae were the dominant clinger macroinvertebrate collected. BIBI values were 1.3 at Alpha and Beta Control, Upper Rabbit Road, and Middle Restoration sites. Lower Rabbit Road and the Lower Restoration site had a BIBI value of 1.7. All BIBI values were in the MBSS very poor category.

Table LDB 3. Data summary of benthic macroinvertebrates collected in D-frame samples on 30 March 2016 at stations in Long Draught Branch**.**

MBSS Piedmont Metrics		Long Draught Branch Riffle Community (MBSS 100 + subsample)				
	Alpha Control	Beta Control	Rabbit Rd. Lower	Rabbit Rd. Upper	Lower Restoration	Middle Restoration
Taxa Richness	10	8*	14	14*	18*	11*
Total EPT Taxa	1	0*	5	2*	3*	1*
Ephemeroptera taxa	1	0*	0	0*	0*	0*
% Intolerant Urban	0.0%	0.0%*	1.0%	0.0%*	0.0%*	0.0%*
% Chironomidae	13.4%	29.7%*	44.0%	60.3%*	46.8%*	54.8%*
% Clingers	0.0%	0.0%*	26.0%	11.8%*	7.6%*	16.1%*
BIBI	1.3	1.3*	1.7	1.3*	1.7*	1.3*

For subsamples with a 300 + count, low abundance at many sites resulted in no subsamples available for Beta Control, Upper Rabbit Road, or the Lower and Middle Restoration stations (Table LDB 4). Additionally, although more than 100 macroinvertebrates were collected at the Lower Rabbit Road site, the total number of individuals was less than 300. Taxa richness was higher (18) at Lower Rabbit Road than at the Alpha Control (14) site. The Hilsenhoff Biotic Index was 6.5 at Lower Rabbit Road and 9.5 at the Alpha Control site. The ratio of scraper to filtering collector functional feeding group was 0.00 at the Alpha Control site and 0.10 at the Lower Rabbit Road station.

Trichopteran larvae were the most common scraper macroinvertebrates collected. Hydropsychid larvae dominated the filtering collector functional feeding group (Table LDB 4). Shredder macroinvertebrates were not found at these sites. The ratio of total EPT individuals to chironomids was 0.13 at Alpha Control and 0.59 at the Lower Rabbit Road station. The number of EPT taxa was lowest (1) at Alpha Control and highest (6) at Lower Rabbit Road. Hydropsychid larvae dominated the EPT macroinvertebrate assemblage. *Orthocladius* sp. larvae were the most abundant macroinvertebrate seen at Lower Rabbit Road while Naididae oligochaetes dominated the collection at the Alpha Control site.

Table LDB 4. Data summary of benthic macroinvertebrates collected in D-frame samples on 30 March 2016 at stations in Long Draught Branch**.**

Metrics	**Long Draught Branch Riffle Community (EPA RBP III 300 + subsample)**	
	Alpha Control	**Rabbit Rd.Lower**
Taxa Richness	14	18*
Hilsenhoff Biotic Index	9.5	6.5*
Ratio Scrapers to Filtering Collectors	0.00 (0.0%)	0.10 (10.4%)*
Ratio Shredders to total Individuals	0.00 (0.0%)	0.00 (0.0%)*
Total EPT Individuals to Total Chironomids	0.13 (13.0%)	0.59 (59%)*
EPT Index	1	6*
Percent Contribution of Dominant Taxon	74.8%	32.1%*

Physical Habitat: Physical habitat in the control area was good, although there was a limited buffer width along the stream. Shading was good for most of the control area. However, there were three problems that we observed during all benthic sampling in the upper control region, and reported on in earlier reports.

First, there was a dam upstream of the control area that formed a small pond clogged with cattails (dam coordinates: 39.142686° N; -77.219645° W). During the summer, this shallow pond could create high temperature spikes downstream during storm events and may even create excessive stream temperatures during the summer without storm events. In addition, there were several outfalls from paved surfaces discharging into the stream that would generate significant temperature spikes during summer rain events.

Second, Long Draught Branch flows underground through large culverts for a significant distance (an estimate of ~ 0.18 km) from its spring sources near I-270.

Third, the stream originated very close to I-270 and West Diamond Avenue from spring seeps in this area. Consequently, the upstream characteristics of Long Draught Branch affected both the control and the potential stream restoration area.

The stream area to be restored on Long Draught Branch remains an urban chaos. There were numerous, large (~1 m high) undercut banks and large amounts of large urban debris, including shopping carts, bicycles, mattresses and springs as well as smaller refuse such as bottles and cans. Again, more of this urban material was present than observed in earlier years. There was some shading along the stream, but the stream buffer was broken in most areas, with a fairly large expanse of grass in the park area. In past surveys, we observed some whitish-brown effluent draining from a culvert into the stream, as well as some surface drainage problems from a stream sewer system in the floodplain of Long Draught Branch.

The MPHI was 11 for the control area and 35 for the restoration area. For the two Rabbit Road sites, the MPHI was 60 for the lower site and 25 for the upper site. The lower Rabbit Road site was in a less disturbed area with better flows than found upstream, as well as more stable banks and adequate riparian vegetation. The upper Rabbit Road site had poor habitat, with little shading and lots of briars, and exotic plant species. Basically, the control and restoration areas were a classic example of the effects of extreme urbanization on stream physical habitat structure.

Assessment Recommendation: Long Draught Branch remains a contentious pre-restoration site. Prior to the construction of any proposed stream stabilization projects, it should be sampled until construction, and then 3-5 years after the completion of stream restoration construction activities.

Plumtree Run (PTR)

Site Description: Plumtree Run (pre-construction in the FY12-13 work, early post-construction in Spring 2014 and mostly completed in Fall 2014 and Spring 2015) is a first-order stream located in Harford County near Bel Air, MD (Figure PTR 1). It parallels Route 24 from its headwaters to West Ring Factory Road and then crosses under Route 24. The stream area restoration scheduled to be completed in 2014 is between West Ring Factory Road and Route 24. At the lower end of the restoration area, Plumtree Run crosses back under Route 24 (a high-density roadway with a significant median) and then eventually flows into the Atkisson Reservoir (the headwaters of Winters Run draining into the Bush River).

Plumtree Run presented a past problem in benthic analyses since it is located on the Fall Line in Maryland, with the Piedmont to the west and the western Coastal Plain to the east of the site. After consultation with MBSS personnel and examining the MBSS data base for the region, we assigned Plumtree Run to the eastern Piedmont for all current and future reports.

The upper headwaters of Plumtree Run are heavily affected by urbanization, with numerous, large residential and commercial developments on either side of the stream, along with a large hospital complex, road infrastructure, and numerous shopping centers. There is extensive parking for the hospital, MD DMV and the shopping centers, as well as an overall high road density in the Atkisson Run watershed (~ 4.0 km/km^2).

Site Coordinates:

Site coordinates for Plumtree Run (Figure PTR 1).			
Station	Latitude (N)	Longitude (W)	Comments:
Middle	39.509828	-76.339641	Middle site.
Lower	39.507872	-76.338807	Lower site.
Alpha Control	39.511721	-76.342286	Upstream control one.
Beta Control	39.512320	-76.342612	Upstream control two.
Gamma Control	39.506910	-76.339581	Downstream control one.
Delta Control	39.506712	-76.339755	Downstream control two.



Figure PTR 1. Site locations for sampling on Plumtree Run (Harford County).

Fall 2015 Benthic Community: For benthic subsamples with a MBSS 100 + macroinvertebrate count and Piedmont metrics, taxa richness (16-24 taxa) was moderate at all sites (Table PTR 1). The total number of EPT taxa was low at the Alpha Control and the Middle Restoration sites and moderate at the four remaining sites. C*heumatopsyche* sp. and *Symphytopsyche* sp. larvae were the dominant EPT taxa collected; however, no Ephemeroptera taxa were found at any of the stations, potentially due to the site position in the watershed and the degree of impervious surface present in the upstream watershed.

The percent of intolerant urban macroinvertebrates was low at all sites while the percent of chironomids and the percent of clingers were moderate at all stations (Table PTR 1). Hydropsychid larvae were also the dominant clinger organism collected. The BIBI for Piedmont metrics ranged from 2.0 at Alpha Control to 2.7 at Gamma Control – all values being in the poor range for the BIBI.

Table PTR 1. Data summary of benthic macroinvertebrates collected in D-frame samples on September 2015 at six stations on Plumtree Run**.**

Piedmont Metrics	Plumtree Run Riffle Community (MBSS 100 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Taxa Richness	17	23	24	22	21	16
Total EPT Taxa	4	5	6	5	5	4
Ephemeroptera Taxa	0	0	0	0	0	0
% Intolerant Urban	2.8%	8.6%	15.9%	1.8%	5.6%	3.5%
% Chironomidae	57.0%	35.2%	44.9%	33.0%	31.8%	17.7%
% Clingers	40.2%	67.6%	57.9%	67.9%	71.0%	79.6%
BIBI	2.0	2.3	2.7	2.3	2.3	2.3

For subsamples with an EPA RBP III 300 + count, taxa richness ranged from 25 at the Alpha Control and Middle Restoration sites to 34 at the Gamma Control site (Table PTR 2). The Hilsenhoff Index ranged from 4.0 at the Gamma Control to 5.7 at the Alpha Control. The ratio of scrapers to filtering collectors was lowest (0.02) at the Lower Restoration site and highest (0.12) at the Beta Control. *Stenelmis* sp. was the most common scraper collected while hydropsychid and philotomatid larvae were the dominant filtering collectors observed in the samples. The ratio of shredders to total number of macroinvertebrates collected ranged from 0.03 at Delta Control and the Middle Restoration site to 0.12 at Gamma Control.

The chironomid larva, *Polypedilum* sp., was the dominant shredder collected (Table PTR 2). The ratio of EPT macroinvertebrates to total chironomids ranged from 0.75 at Alpha Control to 3.03 at the Middle Restoration site. The number of EPT taxa ranged from 5 to 6 with hydropsychid and philopotomatid larvae dominating the EPT macroinvertebrate collections. The percent contribution of the dominant taxon ranged from 14.0% (*Chimarra* sp.) at Beta Control to 20.2% (hydropsychid larvae) at Alpha Control.

Table PTR 2. Data summary of benthic macroinvertebrates collected in D-frame samples on 22 September 2014 at control stations in Plumtree Run**.**

Metrics	Plumtree Run Riffle Community (EPA RBP III 300 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Taxa Richness	25	27	34	31	28	25
Hilsenhoff Biotic Index	5.7	5.0	4.0	5.4	4.9	5.0
Ratio Scrapers to Filtering Collectors	0.05 (5.0%)	0.12 (12.3%)	0.04 (3.5%)	0.04 (4.0%)	0.02 (2.0%)	0.10 (9.8%)
Ratio Shredders to total Individuals	0.04 (4.2%)	0.05 (5.2%)	0.12 (11.9%)	0.03 (3.4%)	0.09 (9.0%)	0.03 (2.6%)
Total EPT Individuals to Total Chironomids	0.75 (75%)	1.50 (150%)	0.86 (86%)	1.62 (162%)	1.72 (172%)	3.03 (303%)
EPT Index	5	5	6	6	6	6
Percent Contribution of Dominant Taxon	20.2%	14.0%	15.6%	17.4%	19.8%	19.1%

Spring 2016 Benthic Community: For subsamples with a MBSS 100 + macroinvertebrate count and the Piedmont MBSS metrics, taxa richness was moderate at all six sites (Table PTR 3). The total number of EPT taxa was low at the Beta Control and the Lower Restoration sites and moderate at remaining sites. *Cheumatopsyche* sp. and *Chimarra* sp. larvae were the dominant EPT taxa collected. Baetid nymphs, when present, were few in number. The percent of intolerant macroinvertebrates was low at all sites.

The percent of chironomids was high at Delta Control and moderate at the remaining stations. The percent of clingers was low at Delta Control and moderate at the remaining stations (Table PTR 3). *Cheumatopsyche* sp., *Chimarra* sp., and *Antocha* sp., larvae were the dominant clingers collected. The BIBI for the Piedmont metrics ranged from 1.7 at Delta Control to 2.3 at the Gamma Control and Middle Restoration stations.

Table PTR 3. Data summary of benthic macroinvertebrates collected in D-frame samples on March 2016.

Piedmont Metrics	Plumtree Run Riffle Community (MBSS 100 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Taxa Richness	17	18	20	18	18	16
Total EPT Taxa	5	4	6	5	4	5
Ephemeroptera Taxa	0	0	1	1	0	0
% Intolerant Urban	2.9%	0.0%	1.9%	0.0%	4.8%	1.0%
% Chironomidae	34.0%	36.2%	61.5%	72.2%	58.1%	41.8%
% Clingers	57.3%	47.6%	34.6%	21.3%	34.3%	39.8%
BIBI	1.8	2.0	2.3	1.7	2.0	2.3

For subsamples with a 300 + count, taxa richness ranged from 23 at the Middle Restoration site to 30 at the Gamma Control site (Table PTR 4). The Hilsenhoff Index ranged from 5.6 at the Alpha and Gamma Control stations to 6.2 at Beta Control. The ratio of scrapers to filtering collectors was lowest (0.03) at the Lower Restoration site and highest (0.21) at Beta Control. *Stenelmis* sp. was the most common scraper, with *Cheumatopsyche* sp. and *Chimarra* sp. larvae being the dominant filtering collectors observed. The ratio of shredders to total number of macroinvertebrates collected ranged from 0.003 at the Gamma and Delta Control sites to 0.03 at the Beta Control and Lower Restoration stations.

The dipteran larva, *Tipula* sp., was the dominant shredder collected (Table PTR 4). The ratio of EPT macroinvertebrates to total chironomids ranged from 0.35 at the Delta Control to 1.04 at the Alpha Control site. The number of EPT taxa ranged from 5 to 7 with hydropsychid and philopotomid larvae dominating the EPT macroinvertebrate collections. The percent contribution of the dominant taxon ranged from 14.7% (*Cheumatopsyche* sp.) at the Beta Control to 19.6% (*Orthocladius* sp. larvae) at the Delta Control.

Table PTR 4. Data summary of benthic macroinvertebrates collected in D-frame samples on March 2016 at stations in Plumtree Run.

Metrics	Plumtree Run Riffle Community (EPA RBP III 300 + subsample)					
	Alpha Control	**Beta Control**	**Gamma Control**	**Delta Control**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	25	24*	30	27	25	23
Hilsenhoff Biotic Index	5.6	6.2*	5.6	5.7	5.7	5.8
Ratio Scrapers to Filtering Collectors	0.09 (9.3%)	0.21 (21.2%)*	0.08 (8.5%)	0.11 (10.7%)	0.03 (3.4%)	0.09 (8.8%)
Ratio Shredders to total Individuals	0.01 (1.4%)	0.03 (2.7%)*	0.003 (0.3%)	0.003 (0.3%)	0.03 (2.7%)	0.003 (0.3%)
Total EPT Individuals to Total Chironomids	1.04 (104.1%)	0.65 (64.6%)*	0.47 (46.9%)	0.35 (35.3%)	0.42 (42.3%)	0.78 (78.0%)
EPT Index	5	5*	7	7	5	5
Percent Contribution of Dominant Taxon	15.4%	14.7%*	19.2%	19.6%	19.3%	16.8%

Physical Habitat: For Plumtree Run, the upstream control area (Figure PTR 1) is bounded by heavy development for a distance of ~ 1.2 km upstream to its approximate spring source. For most of the stream length, the stream is well shaded with relatively good stability along the banks, and with a variety of plant species present (both native and introduced). This stream corridor varies greatly in width as a function of housing developments and commercial properties. The eastern bank of Plumtree Run is in close proximity to Route 24 in the lower section, and is effectively forced into a channel with some gradient. There appeared to be some minimal stream stabilization work in the past when Route 24 was constructed. In the control area, the stream bottom is a mixture of boulders, cobble, gravel, and some fine sediment.

The restoration area, ~ 0.64 km in length, is downstream of the junction of Route 24 and West Ring Factory Road, and ends where Plumtree Run crosses under Route 24 again. In this area, Plumtree Run has more of a distinct flood plain than in the control area. Substrate throughout this control area was quite variable, ranging from large cobble to fine silt and clay.

Before restoration work, there were a number of large root wads present along the banks with deep pools present that provided adequate fish habitat (fishes were observed throughout the restoration area). Shading was good throughout the restoration reach, but bank stability was poor reflecting the flashy nature of the stream. There was an abundance of multiflora rose as well as other native and non-native plant species.

During the Fall 2014 benthic collections, fishes were present throughout the restoration area, with numerous fish present near the in-stream structures. In Fall 2015, fish abundance in the restoration area was not as evident. The restoration work completely changed the nature of the stream, and bank stability was significantly improved. The MPHI was 22 for the control area (poor) and 59 for the restoration area (fair). The MPHI for the downstream sites was 63 (fair).

Assessment Recommendation: Now that the construction phase is completed for the Plumtree Run stream restoration, future repeat sampling efforts should be performed in five years (2020 – 2021, FY21).

Upper Little Patuxent River (ULPR)

Site Description: The Upper Little Patuxent River (ULPR) was a pre-restoration site sampled in the 2012 – 2013 work (FY 13), immediately prior to the initiation of stream restoration work. It is located to the south of Route 144 (Old Frederick Road) in Ellicott City, with one control site near Route 144 and one near Route 40 (Figure ULPR 1). The restoration area is located in a broad floodplain, with residential housing on both sides of the stream. There is some commercial development along Route 40 at the junctions of Bethany Lane, Centennial Lane, Route 144 and Route 40 that may potentially affect the Upper Little Patuxent River.

This site was resampled in the 2014 – 2015 work. In Fall 2014, we observed some construction activities near Frederick Road, essentially the construction of a stormwater management pond. The site was sampled (Fall and Spring) in 2015 – 2016, with most stream restoration activities completed.

Site Coordinates:

Site coordinates for Upper Little Patuxent River (Figure ULPR 1).			
Station	Latitude	Longitude	Comments:
Middle	39.268047	-76.850976	Middle site.
Lower	39.265114	-76.851296	Lower site.
Alpha Control	39.275718	-76.852465	Upstream control I.
Beta Control	39.278771	-76.852984	Upstream control II.



Figure ULPR 1. Site locations for sampling of Upper Little Patuxent River (Howard County).

Fall ULPR 2015 Benthic Community – For subsamples with the MBSS 100 + macroinvertebrate count (Table ULPR 1), taxa richness was moderate at all four stations. The total number of EPT Taxa was low at the Middle Restoration site and moderate at remaining sites. Hydropsychid larva dominated the EPT collections at all sites. Some baetid nymphs were also collected, but in low numbers.

The percent intolerant urban macroinvertebrates was low at all stations. The percent of chironomid larvae and the percent of clingers were moderate at all the stations. Dominant clingers collected were hydropsychid larvae. The BIBI ranged from 1.7 at the Middle Restoration site to 2.3 at the remaining stations, with three of the stations in the poor category and one in the very poor category.

Table ULPR 1. Data summary of benthic macroinvertebrates collected in D-frame samples on September 2015 at stations in Upper Little Patuxent**.**

Piedmont Metrics	**Upper Little Patuxent Riffle Community (MBSS 100 + subsample)**			
	Alpha Control	**Beta Control**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	17	17	21	21
Total EPT Taxa	7	5	6	4
Ephemeroptera taxa	1	1	1	1
% Intolerant Urban	5.9%	0.9%	0.9%	0.0%
% Chironomidae	35.3%	49.5%	33.3%	66.0%
% Clingers	72.3%	50.5%	67.5%	39.2%
BIBI	2.3	2.3	2.3	1.7

For subsamples using the RBP III 300 + count, taxa richness ranged from 25 at Alpha Control to 32 at the Middle Restoration site (Table ULPR 2). The Hilsenhoff Biotic Index was lowest (5.5) at Alpha Control and highest (6.0) at the Middle Restoration site. The dominant scrapers, *Ferrissia* sp. (Physidae) and Hydrophilidae (Trichoptera) larvae were more plentiful at the Lower Restoration site than at the other stations. Hydropsychid larvae were the most abundant filtering collector seen. The ratio of scrapers to filtering collector functional feeding groups was lowest (0.03) at the Alpha Control site and highest (0.14) at the Middle Restoration site. The ratio of

shredders was highest (0.16) at the Middle Restoration site, with *Polypedilum* sp. the most abundant shredder collected. The ratio of total EPT to chironomids was highest (1.43) at the Alpha Control site and lowest (0.29) at the Middle Restoration site. The dominant EPT macroinvertebrates collected were hydropsychid larvae at all the sites, although some baetid nymphs were found at the two restoration sites.

The number of EPT taxa collected was highest (8) at the Alpha Control station and lowest (4) at the two restoration sites. Hydropsychid larvae dominated the collections at the two control stations while chironomid larvae were the dominant macroinvertebrates collected at the two restoration stations.

Table ULPR 2. Data summary of benthic macroinvertebrates collected in D-frame samples on September 2015 at stations in Upper Little Patuxent.

Metrics	Upper Little Patuxent Riffle Community (EPA RBP III 300 + subsample)			
	Alpha Control	**Beta Control**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	25	31	30	32
Hilsenhoff Biotic Index	5.5	5.8	5.8	6.0
Ratio Scrapers to Filtering Collectors	0.03 (3.2%)	0.04 (4.0%)	0.20 (19.7%)	0.14 (14.0%)
Ratio Shredders to total Individuals	0.10 (10.1%)	0.03 (2.8%)	0.08 (8.3%)	0.16 (16.1%)
Total EPT Individuals to Total Chironomids	1.43 (143%)	0.82 (82%)	1.11 (111%)	0.29 (29%)
EPT Index	8	6	4	4
Percent Contribution of Dominant Taxon	16.5%	21.3%	12.4%	28.8%

Spring ULPR 2016 Benthic Community - For subsamples with the MBSS 100 + macroinvertebrate count, taxa richness and total EPT taxa were moderate at all stations (Table ULPR 3). Hydropsychid larva dominated the EPT collections at all sites. Some heptageniid nymphs were also collected, but in low numbers.

The percent intolerant macroinvertebrates was low to non-existent at all stations. The percent of chironomid larvae ranged from 70.0% at the Middle Restoration site to 0.5% at the Beta Control. The percent of clingers was moderate at the Alpha Control site and low at the three remaining stations. The dominant macroinvertebrate clinger found was *Cheumatopsyche* sp. The BIBI ranged from 1.7 at the Middle Restoration site to 2.3 at the two control stations.

Table ULPR 3. Data summary of benthic macroinvertebrates collected in D-frame samples on 31 March 2016 at stations in Upper Little Patuxent River**.**

	Upper Little Patuxent Riffle Community (MBSS 100+ subsample)			
Piedmont Metrics	**Alpha Control**	**Beta Control**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	16	20	22	23
Total EPT Taxa	5	6	6	6
Ephemeroptera taxa	1	1	1	0
% Intolerant Urban	0.0%	0.9%	0.0%	2.0%
% Chironomidae	44.8%	0.5%	55.6%	70.0%
% Clingers	46.9%	0.3%	29.3%	16.0%
BIBI	2.3	2.3	2.0	1.7

For subsamples with the RBP III 300 + count, taxa richness ranged from 28 at Alpha Control to 39 at the Middle Restoration site (Table ULPR 4). The Hilsenhoff Biotic Index was lowest (5.5) at Alpha Control and highest (6.2) at the two restoration sites. The ratio of scrapers to filtering collector functional feeding groups was lowest (0.09) at the Alpha Control site and highest (0.40) at the Lower Restoration site.

The dominant scraper observed was the elmid larva, *Stenelmis* sp. *Cheumatopsyche* sp. larvae were the most abundant filtering collectors seen. The ratio of shredders to total number of individuals was highest (0.04) at the Middle Restoration site and lowest (0.002) at the Beta Control station. The chironomid larva, *Brillia* sp., was the most numerous shredder collected. The ratio of total EPT to chironomids was highest (1.18) at the Alpha Control site and lowest (0.26) at the Lower and Middle Restoration sites. The number of EPT taxa collected was highest (9) at the Middle Restoration station and lowest (7) at the Alpha Control site. The dominant EPT macroinvertebrate collected was *Cheumatopsyche* sp. larvae. The trichopteran larva, *Chimarra* sp., was the dominant macroinvertebrate collected at the Alpha Control site while chironomid larvae dominated the collections at the remaining stations.

Table ULPR 4. Data summary of benthic macroinvertebrates collected in D-frame samples on March 2016 at stations in Upper Little Patuxent River**.**

Metrics	Upper Little Patuxent Riffle Community (EPA RBP III 300 + subsample)			
	Alpha Control	**Beta Control**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	28	30	36	39
Hilsenhoff Biotic Index	5.5	5.8	6.2	6.2
Ratio Scrapers to Filtering Collectors	0.09 (9.6%)	0.13 (12.7%)	0.40 (40.0%)	0.27 (26.8%)
Ratio Shredders to total Individuals	0.01 (0.9%)	0.002 (0.2%)	0.01 (1.3%)	0.04 (3.7%)
Total EPT Individuals to Total Chironomids	1.18 (118%)	0.59 (59%)	0.26 (26%)	0.26 (26%)
EPT Index	7	8	8	9
Percent Contribution of Dominant Taxon	15.6%	33.8%	14.1%	30.2%

Physical Habitat: For the Upper Little Patuxent River stream restoration project, the entire proposed restoration area below MD Route 144 is in a broad flood plain, suggesting historical existence of a small dam and associated reservoir. Before the initiation of stream restoration, the stream bottom was primarily fine sands and clay with very little solid substrate present. Due to the impervious surface in the upper watershed, there were areas with deep entrenchment of the stream into the softer bank materials present. Also, there was great difficulty in finding riffle areas suitable for benthic sampling, not only in the restoration site, but also in the control area (Figure ULPR 2-A). There was poor shading in the proposed restoration area since most of the vegetation was low understory plants. A number of exotic plants were observed throughout the proposed restoration area.

For both the control and restoration areas, there was a gas pipeline located along the eastern side of the stream. In addition, there was also a sewage line running through both the control and restoration areas, as well as the presence of older, broken lines. It appears that the area between Route 40 and Route 144 is mowed frequently, and there is evidence of human disturbance throughout both sites. There continues to be construction activities upstream of the site along Route 40 that will potentially affect the restoration in the future.

The completed stream restoration area (Figure ULPR 2 – B-D) is far different than what was observed before work was started. The deep incision of the streambank is no longer present and there are well-placed stream structures as well as extensive riparian plantings. In particular, it will be interesting to sample some of the constructed riffle areas in the next sampling cycle (Figure ULPR 2-D).

For 2015-2016, the physical habitat evaluation was done for the Alpha Control (very similar habitat to the upstream Beta Control). In the restoration area, a complete habitat survey was done both for the lower and middle restoration areas (usually only the middle restoration area is evaluated). These habitat measures were weighted in the overall MPHI calculation The MPHI was 68 for the Alpha control area (fair) and 74 for the restoration area (good). It will be important to see how the MPHI changes in both the Alpha Control and throughout the stream restoration site.

Assessment Recommendation: The ULPR sites should be assessed after the stream restoration is finished for one complete sample cycle (completed in 2015-2016), and then be placed on a revisit schedule of 5 years (2020-2021).









Figure ULPR 2A-D. Selected images of the Upper Little Patuxent River stream restoration taken in Spring 2016.

Watkins Mill Road (UTSC)

Site Description: This SHA pre-restoration site is located in Montgomery County, and is adjacent to I-270 – the major high-traffic density road between Frederick, MD and I-495 – the Washington Beltway (Figure UTSC 1). Additionally, it is close to the interchange of I-270 and SR 124 (Quince Orchard Road), and also close to the SHA pre-restoration site on Long Draught Branch. The current construction plan is for the building of a bridge across I-270 that will link the current southern and northern extensions of Watkins Mill Road. During the bridge construction, stream restoration work will be done with the upper limit of work being close to where the stream crosses under I-270. The lower limit of stream work is the power line corridor that crosses I-270 to the west of SR 124. The UTSC flows into Seneca Creek just to the west of Game Preserve Road.

During the 2014-2015 work, we noted that this unnamed tributary flows under I-270 through a large culvert. During the Fall 2015 work, we assessed the feasibility of sampling UTSC to the north of I-270. However, there was very limited access to the stream since it was located next to the westbound on-ramp for I-270, creating multiple safety and security problems. In addition, a downstream UTSC site, serving as an indicator of downstream refugia, was added (Gamma Control) close to where the stream flows across the power line corridor. In the future, another site closer to Seneca Creek (or upper Seneca Creek itself, unless MBSS data are available) may be assessed to better determine the potential adequacy of downstream benthic refugia.

Site Coordinates:

Site coordinates for the Unnamed Tributary to Seneca Creek (UTSC) site at Watkins Mill Road (Figure UTSC 1).

Station	Latitude	Longitude	Comments:
Middle	39.156352	-77.226806	Projected middle site.
Lower	39.158406	-77.229986	Projected lower site.
Alpha Control	39.152463	-77.221602	Upstream control I.
Beta Control	39.151496	-77.220157	Upstream control II.
Gamma Control	39.158529	-77.230156	Downstream Control
Potential Control Area	39.150461	-77.217267	Control area

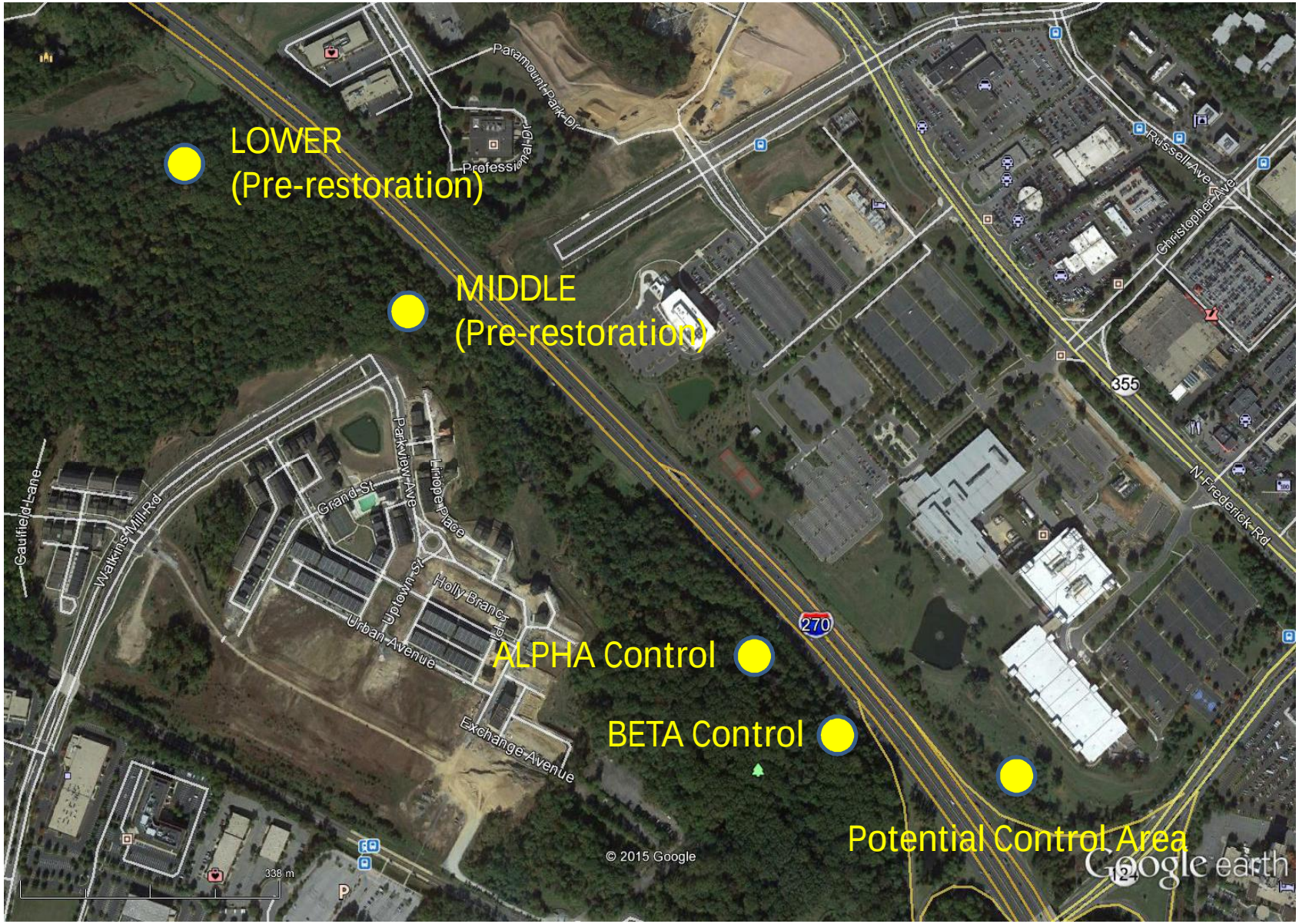

Figure UTSC 1. Site locations for sampling of unnamed tributary to Seneca Creek at Watkins Mill Road (Montgomery County). (Gamma Control not placed on figure).

Fall 2015 UTSC Benthic Community – The Alpha Control and Beta Control sites were sampled in September 2015 but streams were too low for any collecting at riffles at the two downstream restoration sites (pools present). All four stations were resampled again in December 2015 when stream flow was adequate for benthic sampling. For subsamples with a MBSS 100 + macroinvertebrate count, no Ephemeroptera taxa were found at any of the sites and the percent of intolerant urban macroinvertebrates was low to nonexistent (Table UTSC 1). Taxa richness was generally low at control sites and moderate at the two restoration sites. The number of EPT taxa was generally low and the percent of chironomids was moderate at most sites. The percent of clinger macroinvertebrates was moderate at all stations but high at the September Alpha Control site. The trichopterans, *Cheumatopsyche* sp. and *Chimarra* sp. (at some of the stations), dominated the EPT taxa collected.

The BIBI value ranged from 1.3 at the September Beta Control site to 2.3 at the Middle Restoration site (Table UTSC 1). A greater number of clingers were collected at the September Alpha site which contributed to a slightly higher BIBI value compared to the December Alpha collection. A higher percentage of chironomids were collected at the Beta Control station in September compared to the December collection and this contributed to the lower BIBI observed.

Table UTSC 1. Data summary of benthic macroinvertebrates collected in D-frame samples on September 2015 at stations in an unnamed tributary to Seneca Creek at Watkins Mill Rd.

Piedmont Metrics	**Watkins Mill Rd. Riffle Community (MBSS 100 + subsample)**					
	September 2015		**December 2015**			
	Alpha Control	**Beta Control**	**Alpha Control**	**Beta Control**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	14	14	14	18	17	21
Total EPT Taxa	3	3	3	3	4	5
Ephemeroptera taxa	0	0	0	0	0	0
% Intolerant Urban	0.9%	0.0%	0.0%	0.0%	1.0%	1.0%
% Chironomidae	25.6%	76.1%	24.0%	32.7%	26.5%	19.4%
% Clingers	76.3%	34.9%	61.5%	50.9%	36.3%	60.2%
BIBI	2.0	1.3	1.7	2.0	2.0	2.3

For subsamples with a RBP III 300 + macroinvertebrate count (Table ULPR 2), taxa richness was higher (29) at the two restoration sites than at any of the control sites (20, 23). The Hilsenhoff Biotic Index ranged from 5.7 at the September Alpha Control site to 6.5 at the Lower Restoration site. The scraper functional feeding group was dominated by Physidae macroinvertebrates while filtering collectors were primarily trichopteran larvae. The ratio of scrapers to filtering collectors was higher at the September Alpha Control, September Beta Control and December Beta Control than at the remaining stations. The shredder, *Polypedilum* sp. (Chironomidae), was more plentiful in the September sampling and accounted for the higher number of shredders seen then compared to the sampling collected in December.

Table UTSC 2. Data summary of benthic macroinvertebrates collected in D-frame samples on September and December 2015 at stations in an unnamed tributary to Seneca Creek at Watkins Mill Rd.

Metrics	Watkins Mill Rd. Riffle Community (EPA RBP III 300 + subsample)					
	September 2015		December 2015			
	Alpha Control	Beta Control	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Taxa Richness	20	23	20	23	29	29
Hilsenhoff Biotic Index	5.7	6.1	6.0	6.2	6.5	5.9
Ratio Scrapers to Filtering Collectors	0.09 (8.5%)	0.20 (20.3%)	0.05 (4.7%)	0.10 (9.9%)	0.04 (4.1%)	0.04 .(4.5%)
Ratio Shredders to total Individuals	0.6 (6.3%)	0.18 (17.6%)	0.01 (0.5%)	0.00 (0.4%)	0.01 (0.7%)	0.00 (0.3%)
Total EPT Individuals to Total Chironomids	1.32 (132.4%)	0.22 (21.6%)	2.28 (228.3%)	1.33 (132.6%)	1.41 (141.0%)	1.99 (198.7%)
EPT Index	4	4	4	4	6	5
Percent Contribution of Dominant Taxon	25.4%	16.1%	37.8%	29.8%	22.2%	27.1%

The EPT macroinvertebrates collected consisted of a number of Trichopteran general, with no Ephemeroptera or Plecoptera taxa found (Table ULPR 2). However, the total number of trichopteran macroinvertebrates collected at the September Beta Control station was low compared to other stations resulting in the low ratio of Total EPT to Total Chironomids seen there. This observation is also reflected in the percent contribution of the dominant taxon. *Cheumatopsyche* sp. was the dominant macroinvertebrate collected at all sites, except the September Beta Control station where chironomids dominated that sampling.

Spring 2016 UTSC Benthic Community - For subsamples with a MBSS 100 + macroinvertebrate count, taxa richness was low at the Alpha Control station but moderate at the remaining stations (Table UTSC 3). The number of EPT taxa was moderate at Gamma Control and low at remaining stations. *Cheumatopsyche* sp. larvae were the most commonly seen EPT taxon. Ephemeropteran taxa were largely non-existent at all sites. The percent of intolerant urban macroinvertebrates was low to nonexistent at all stations. The percent of chironomids was moderate at the Alpha Control and Gamma Control sites and low at the remaining stations. The percent of clingers was low at all stations. However, *Cheumatopsyche* sp. larvae were the most commonly seen clinger macroinvertebrate. The BIBI value was 2.0 at the Gamma Control and 1.3 at the remaining sites.

Table UTSC 3. Data summary of benthic macroinvertebrates collected in D-frame samples on March 2016 at stations in an unnamed tributary to Seneca Creek at Watkins Mill Rd.

Piedmont Metrics	**Watkins Mill Rd. Riffle Community (MBSS 100 + subsample)**				
	Alpha Control	**Beta Control**	**Gamma Control**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	13	17	20	15	17
Total EPT Taxa	3	2	5	3	3
Ephemeroptera taxa	0	0	1	0	0
% Intolerant Urban	0.0%	0.0%	7.0%	0.0%	0.0%
% Chironomidae	63.0%	63.6%	53.0%	70.0%	64.6%
% Clingers	26.9%	18.7%	20.0%	14.5%	17.2%
BIBI	1.3	1.3	2.0	1.3	1.3

For subsamples with a RBP III 300 + count, abundance was low at the three control stations resulting in less than a 300 count subsample (Table UTSC 4). The taxa richness was highest (25) at the Gamma Control station and lowest (17) at the Beta Control site. The Hilsenhoff Biotic Index ranged from 6.1 at the Alpha Control to 6.6 at the Middle Restoration station. The ratio of scrapers to filtering collectors ranged from 0.21 at the Middle Restoration site to 0.00 at the three control stations. The scraper functional feeding group, when present, was dominated by *Stenelmis* sp. larvae and *Hydrobaenus* sp. larvae. Filtering collectors were primarily trichopteran larvae, with *Tipula* sp. the most commonly collected shredder at all the sites. The EPT macroinvertebrates collected consisted of a number of Trichopteran genera, primarily *Cheumatopsyche* sp. No Ephemeroptera and only a few Plecoptera taxa were found. The EPT to

Chironomid ratio was lowest (0.19) at the Gamma Control site and highest (0.39) at the Alpha Control site. The chironomid, *Orthocladius* sp., was the dominant macroinvertebrate collected at all five stations.

Table UTSC 4. Data summary of benthic macroinvertebrates collected in D-frame samples on March 2016 at stations in an unnamed tributary to Seneca Creek at Watkins Mill Rd.

Metrics	Watkins Mill Rd. Riffle Community (EPA RBP III 300 + subsample)				
	Alpha Control	**Beta Control**	**Gamma Control**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	18*	17*	25*	21	24
Hilsenhoff Biotic Index	6.1*	6.4*	6.5*	6.2	6.6
Ratio Scrapers to Filtering Collectors	0.00 (0.0%)*	0.00 (0.0%)*	0.00 (0.0%)*	0.05 (5.5%)	0.21 (20.9%)
Ratio Shredders to total Individuals	0.02 (1.5%)*	0.05 (5.0%)*	0.03 (2.7%)*	0.01 (0.6%)	0.00 (0.3%)
Total EPT Individuals to Total Chironomids	0.39 (39%)*	0.25 (25%)*	0.19 (19%)*	0.26 (26%)	0.19 (19%)
EPT Index	4*	2*	5*	5	4
Percent Contribution of Dominant Taxon	40.4%*	29.8%*	22.9%*	43.2%	41.5%

Conductivity/Temperature – Specific conductivity at the Watkins Mill site ranged from 62 µS/cm on 5.2.16 to 30,846 µS/cm on 2.16.16 (Figure UTSC 2). Average monthly specific conductivity values for 2016 were: 3245 µS/cm in February, 1661 µS/cm in March, 1234 µS/cm in April, 1119 µS/cm in May, and 1448 µS/cm in June. From February to June 2016, the mean monthly values substantially exceed the EPA regional specific conductivity criteria of 300 µS/cm for streams (U. S. EPA 2011).

During February, one storm event was measured for specific conductance (see arrow on Figure UTSC 2). In this event, stream conductivity rapidly increased to 30,846 µS/cm within a short time interval, and then decreased quickly. Precipitation at the Watkins Mill site was low in April, followed by rainfall events in May 2016.

The presence of high specific conductivity, a function of elevated chloride presumably from road salt, in the stream water could potentially affect biotic resources, especially important to consider in any restoration activities (Morgan et al 2012). With the potential for future regional conductivity criteria (based on ecoregions) to be proposed by EPA, the high specific conductivity observed in the Seneca Creek watershed could be of concern for stream restoration and maintenance of water quality (Cormier and Suter 2013, US EPA 2011).

Of particular importance to SHA would be those restoration sites in close proximity to major roadways, e.g. Downes site, Little Paint Branch, Long Draught Branch, Minebank Run, Plumtree Run, Piney Creek, Upper Little Patuxent and White Marsh Run. It may be necessary to install temperature/conductivity probes to monitor water quality from November to April at these sites to determine water quality from storm events as well as establishing baseline data.

Stream temperature at Watkins Mill (UTSC) showed an ascending pattern from February through June (Figure UTSC 2); typical of what would be expected for the region and a function of local climatic conditions. For this period, stream temperatures ranged from 0.9 to 24.9 C. During March and April, there were some large fluctuations in daily stream temperature.

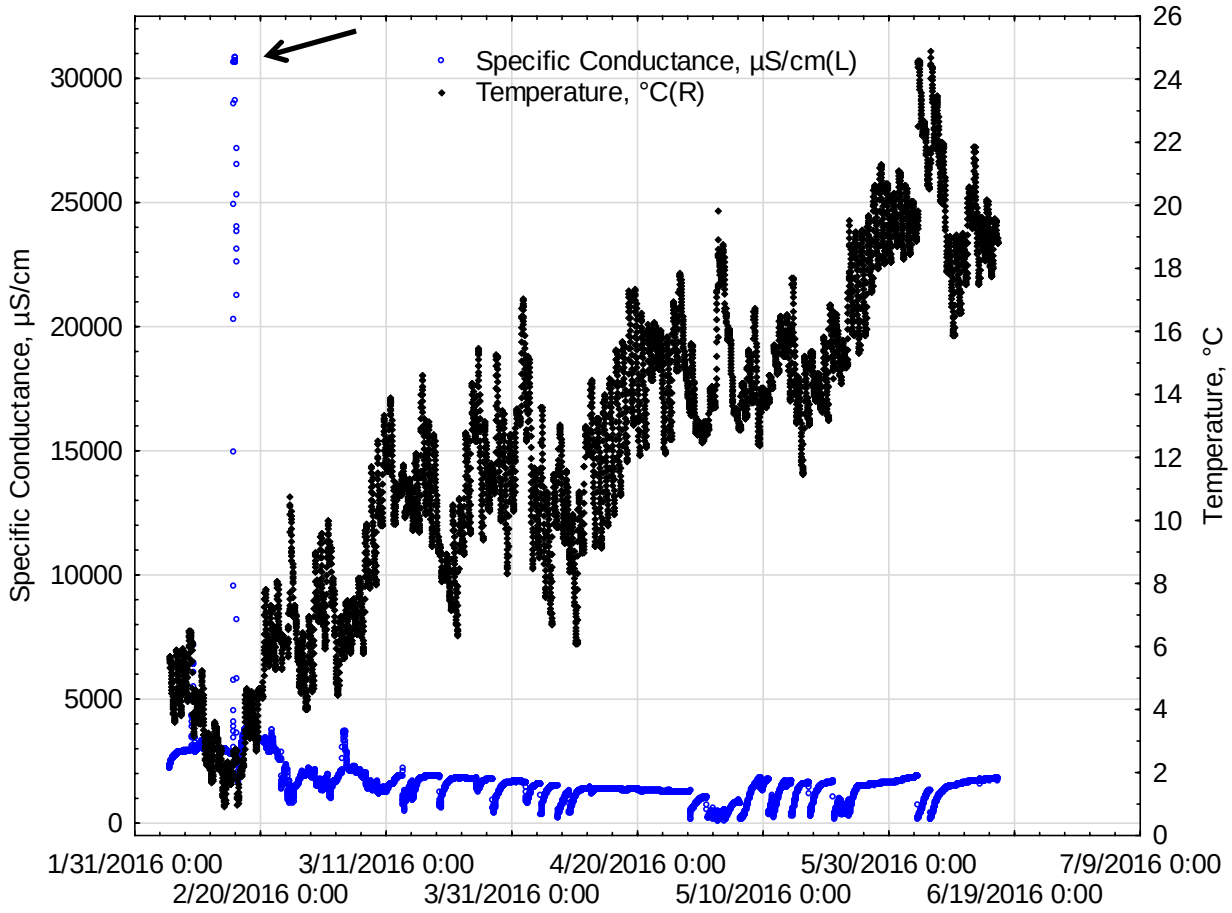

Figure UTSC 2. Temperature (C) and specific conductance (µS/cm) at the unnamed tributary to Seneca Creek from 2.5.16 to 6.16.16.

Physical Habitat: The UTSC arises from a series of springs on the north side of I-270 adjacent to Quince Orchard Road, and then flows under I-270 through a long culvert. After passing under I-270, the stream is well-shaded until it reaches the treeless power line corridor (~ 113 m in width at stream crossing of corridor). Through the proposed restoration reach, there are mature trees present of several species, as well as significant undergrowth and several exotic species. Numerous trees have fallen into the stream, creating a number of stable pools. In the upper part of the stream reach, there is strong evidence of impervious surface effects with erosion of bed material down to bedrock, as well as deep incisions into bed material throughout the entire restoration reach. There are abundant debris bars, of small stones to moderate cobble, formed in the stream. Numerous pool-riffle zones are present, with many of the larger, deeper pools having fishes present.

Bank slumping was observed in the upper reaches, as well as numerous perched tree roots in many areas, indicating a severing of the riparian zone from the stream. Sections of the stream appeared to have had some past stabilization work, with several rip-rap areas present. In addition, there was also a sewage line running through the stream reach. The MPHI was 60 for the control area (fair) and 57 for the restoration area (fair).

Assessment Recommendation: The UTSC site should be assessed for one more cycle (2016-2017). After the bridge is finished and all stream restoration work is completed and stabilized, the site should be visited for two complete FY sample cycles, and then be placed on a revisit schedule of either 5 or 10 years.

White Marsh Run (WMR)

Site Description: White Marsh Run is a second order stream, located within the Maryland Western Coastal Plain that flows into the tidal Bird River in northern Chesapeake Bay. Its source is located in Parkville, MD, and White Marsh Run parallels Route 43 through much of its stream course until reaching I-95. The upper part of White Marsh Run is heavily urbanized – there are highly significant areas of impervious surface throughout the watershed, including a major shopping complex, hotels/motels, roadways, numerous small and large industrial facilities, and parking lots. Based on GIS estimates for the White Marsh Run watershed in 2010, the % altered landscape was 85.9%, the % impervious surface was 27.3%, and the % natural landscape was 14.1% (Morgan et al. 2010).

Stream assessment work on White Marsh Run started in 1998 and concluded in 2005. In 1998 and 1999, the 75 m fish transect was located within a wetland area. Construction of a new meandering stream section to which the sampled stream reach was to be diverted was flooded and construction was not yet completed. In 2000-2001, the 75 m fish transect sampled within the restoration area was located within the newly restored stream channel. The substrate within this channel was very unstable and was mostly gravel and fine sand. Benthic stations were also established in this area as well as the upstream control.

The 75 m fish control site was located upstream, adjacent to a shopping mall. A restoration project, by Baltimore County, was under construction at the control site that was sampled in 1998 and 1999. A new control site was selected immediately upstream from the stream section that was under construction. It should also be noted that there is a series of large culverts, from the shopping complex, discharging at the upper end of the Baltimore County restoration site, as well as at the upper end of the SHA site. Fish, benthic and physical habitat sampling were not conducted on this site in 2004. Several trips were made to the site, but abnormal flows precluded sampling during the Spring sample period.

Site Coordinates:

Site coordinates for White Marsh Run (Figure WMR 1).			
Station	Latitude	Longitude	Comments:
Middle	39.375876	-76.457626	Middle restoration site.
Lower	39.375396	-76.455498	Lower restoration site.
Alpha Control	39.377553	-76.464195	Upstream control I.
Beta Control	39.377999	-76.465393	Upstream control II.

For the 2015-2016 assessment on White Marsh Run, four stations were sampled for benthic organisms (Figure WMR 1). The middle and lower restoration sites were roughly similar to the previously sampled benthic sites, but an additional upstream control (Beta Control) was added. Physical habitat was assessed in both the restoration site and the upstream control.

Landscape Perspectives – Historical imagery of White Marsh Run is available from Google™earth (Figure WMR 2 – 2014, Figure WMR 3 – 2005 and Figure WMR 4 – 1994, with the SHA stream restoration reach marked with a yellow double arrow). Throughout this entire 20 year period, there have been subtle changes in the White Marsh Run watershed, although the entire watershed itself contained significant amounts of altered landscape prior to the 1994 imagery.

The imagery from 2014 (Figure WMR 2) indicates that there is development of a riparian zone in the SHA restoration area (yellow arrow) as well as upstream of Honeygo Boulevard. In 2014, development along White Marsh Run has essentially ceased since all potential land for development has been used, and there is no current building allowed within the flood plain or 100 year floodplain (although there are some structures present in the 100 year floodplain). However, there is also the potential that any current undeveloped land, outside of the 100 year floodplain, in the watershed may eventually be utilized, as well as redevelopment of existing altered land.

Images from 2005 (just after the restoration work was completed) and 1994 (prior to restoration work) clearly illustrate the movement of sand and silt (Figure WMR 3 and 4), with large deposits present upstream of the SHA restoration site (yellow arrow). Over time, these deposits appear to be diminishing (or covered by increasing riparian vegetation). In addition, the upstream sources of silt, sand and fine gravel may be diminishing over time. Development around the White Marsh shopping complex, a focal point in the watershed, continues with the addition of numerous businesses since 1994.

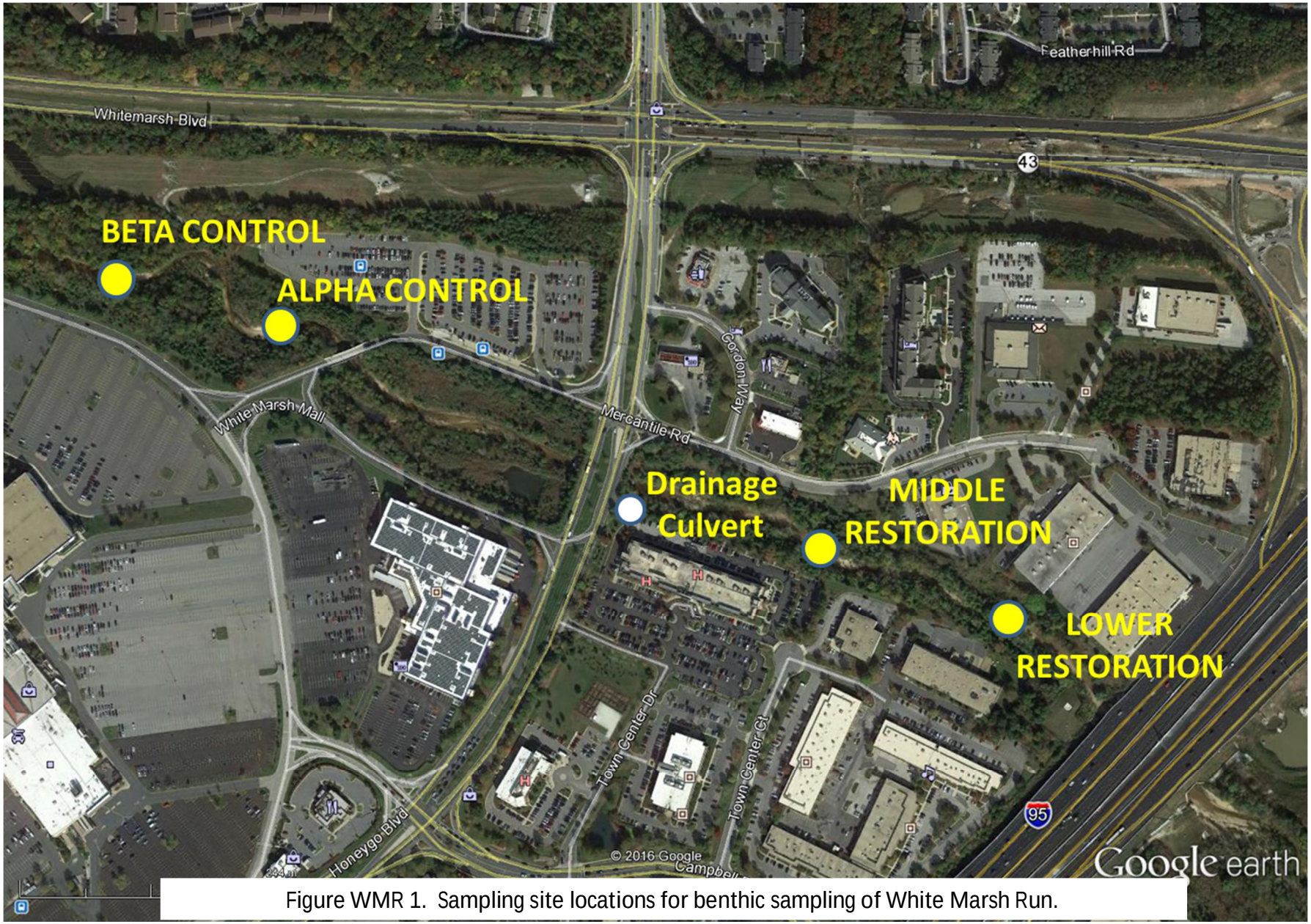

Figure WMR 1. Sampling site locations for benthic sampling of White Marsh Run.

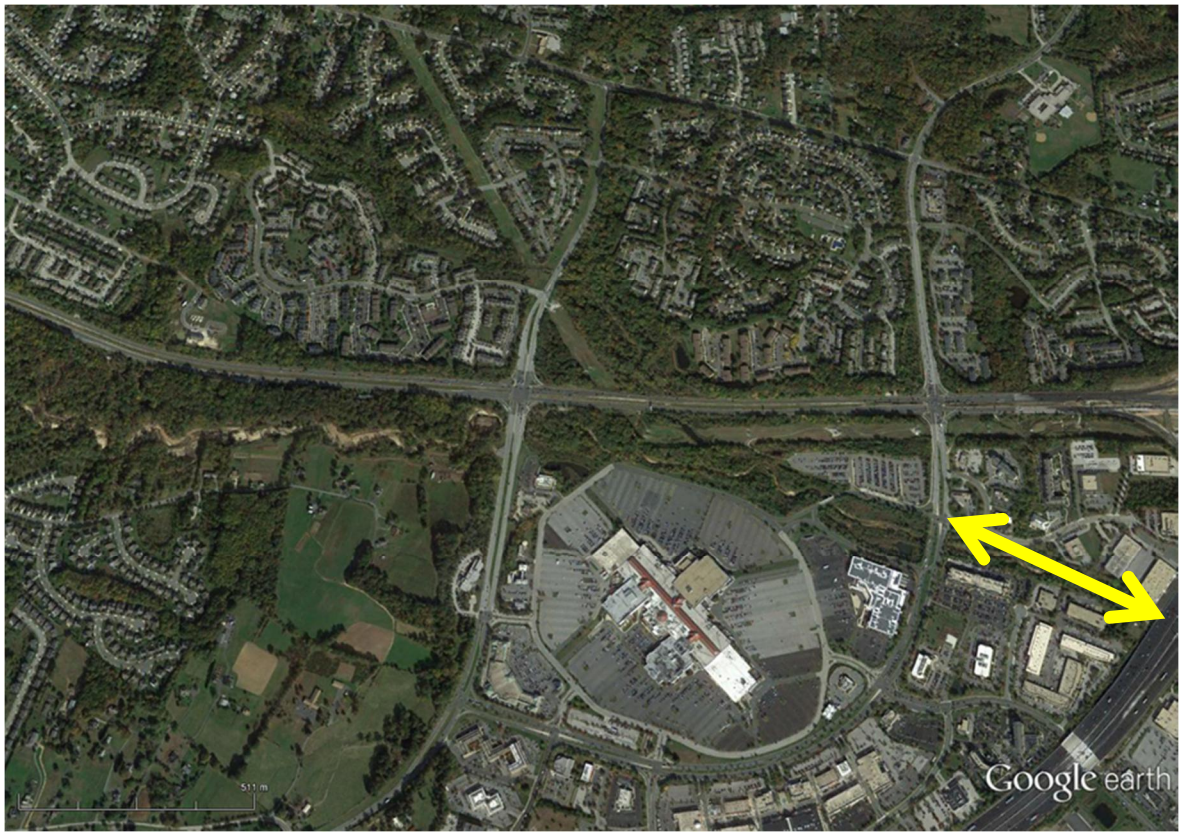

Figure WMR 2. Landscape characteristics for White Marsh Run in October 2014.



Figure WMR 3. Landscape characteristics for White Marsh Run in September 2005.

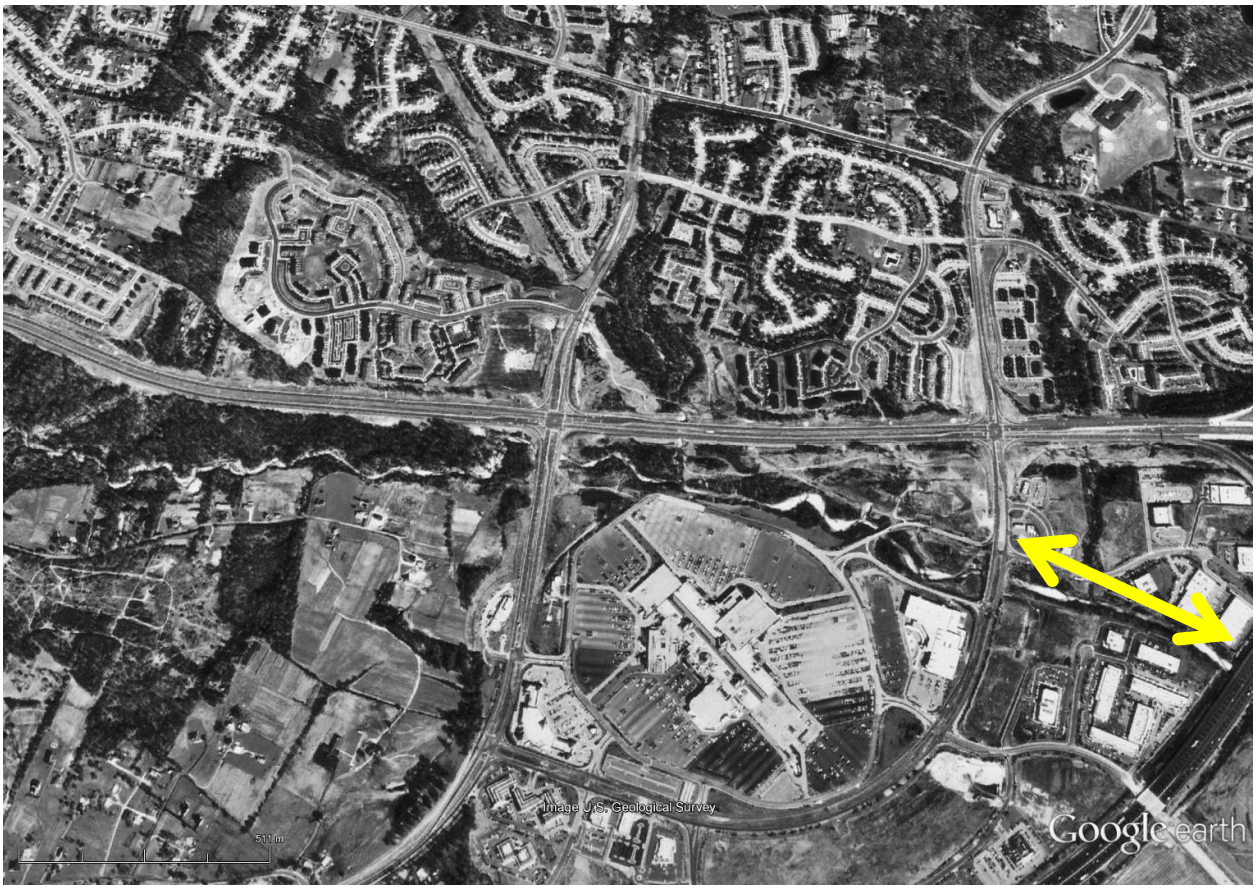

Figure WMR 4. Landscape characteristics for White Marsh Run in April 1994.

Fall 2016 WMR Benthic Community – For subsamples with a MBSS 100 + macroinvertebrate count, taxa richness was moderate at Alpha Control but low at the remaining stations. The number of EPT taxa and percent of chironomids and clingers was moderate at the two control sites but low at the restoration sites. Hydropsychid larvae dominated the EPT macroinvertebrate collection. Ephemeroptera taxa and the percent of intolerant taxa were low at all stations. The BIBI was highest at Alpha Control (2.3) and lowest at the two restoration sites (1.0)

Table WMR 1. Data summary of benthic macroinvertebrates collected in D-frame samples on September 2015 at stations on White Marsh Run.

	White Marsh Run Riffle Community (MBSS 100 + subsample)			
Piedmont Metrics	**Alpha Control**	**Beta Control**	**Lower Restoration**	**Middle Restoration**
Taxa Richness	17	14	13	13
Total EPT Taxa	6	5	4	3
Ephemeroptera taxa	0	1	0	0
% Intolerant Urban	0.9%	0.0%	0.0%	0.0%
% Chironomidae	55.2%	53.0%	90.0%	78.9%
% Clingers	50.0%	67.0%	22.5%	23.7%
BIBI	2.3	2.0	1.0	1.0

For subsamples with a RBP III 300 + macroinvertebrate count (Table WMR 2), taxa richness ranged from 22 at the Alpha Control site to 14 at the two restoration sites. The Hilsenhoff Biotic Index was lowest (5.2) at the Lower Restoration site and highest (5.8) at Middle Restoration site. Scraper taxa were in low numbers at all sites. Filtering collectors were primarily trichopteran and Tanytarsini (Chironomidae) larvae. The ratio of scrapers to filtering collector functional feeding groups was lowest (0.00) at the Beta Control and Lower Restoration sites and highest (0.19) at Alpha Control site. Shredder numbers were generally low at all stations. EPT macroinvertebrates were dominated by trichopteran larvae (primarily Hydropsychidae).

Although a few baetid mayflies were collected at the Beta Control site, none were collected at the remaining stations. The ratio of total EPT to Chironomids was highest (1.14) at the Alpha Control site and lowest (0.05) at the Lower Restoration site. The number of EPT taxa was highest (6) at the Alpha Control site and lowest (4) at the two restoration sites. *Cheumatopsyche* sp.

larvae were the dominant (16.8% and 13.7%, respectively) macroinvertebrate collected at the two control sites. *Saetheria* sp. and *Orthocladius* sp., both chironomid larvae, dominated (49.7% and 17.4%, respectively) the two restoration sites.

Table WMR 2. Data summary of benthic macroinvertebrates collected in D-frame samples on September 2015 at stations on White Marsh Run.

Metrics	White Marsh Run Riffle Community (EPA RBP III 300 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Taxa Richness	22	20	14	14
Hilsenhoff Biotic Index	5.4	5.6	5.2	5.8
Ratio Scrapers to Filtering Collectors	0.19 (19.0%)	0.0 (0.0%)	0.0 (0.0%)	0.02 (1.5%)
Ratio Shredders to total Individuals	0.09 (8.7%)	0.12 (12.2%)	0.16 (15.6%)	0.13 (13.4%)
Total EPT Individuals to Total Chironomids	1.14 (113.8%)	0.96 (96.4%)	0.05 (4.5%)	0.10 (10.0%)
EPT Index	6	5	4	4
Percent Contribution of Dominant Taxon	16.8%	13.7%	49.7%	17.4%

Spring 2016 WMR - For subsamples with a MBSS 100 + macroinvertebrate count, abundance at the Middle Restoration site was low (Table WMR 3), resulting in less than a 100 count subsample at that station.. Taxa richness was moderate at the restoration sites but low at the control stations. The number of EPT taxa was moderate at the Beta Control station and low at the remaining sites. Hydropsychid larvae dominated the EPT macroinvertebrate collection. The number of Ephemeroptera taxa and percent of intolerant macroinvertebrates was low or non-existent at all sites. The percent of chironomids was moderate at the Beta Control station and high at the remaining stations. The percent of clingers was moderate at the Beta Control site and low at the remaining stations. The most commonly collected clinger macroinvertebrate was *Hydropsyche* sp. The BIBI was highest at Beta Control (2.3) and lowest at the two restoration sites (1.0).

Table WMR 3. Data summary of benthic macroinvertebrates collected in D-frame samples on March 2016 at stations on White Marsh Run.

Piedmont Metrics	White Marsh Run Riffle Community (MBSS 100 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Taxa Richness	18	20	10	8*
Total EPT Taxa	4	5	2	0*
Ephemeroptera taxa	0	1	0	0*
% Intolerant Urban	1.0%	0.0%	0.0%	0.0%*
% Chironomidae	73.5%	58.9%	83.8%	88.2%*
% Clingers	17.3%	31.8%	16.7%	0.0%*
BIBI	1.3	2.3	1.0	1.0*

For subsamples with a RBP III 300 + count, low abundance resulted in less than a 300 count subsample for the Alpha Control site and no additional macroinvertebrates for the remaining sites (Table WMR 4). Taxa richness at the Alpha Control station was 18 with a Hilsenhoff Biotic Index of 6.3. No scraper taxa were collected, while filtering collectors were primarily trichopteran larvae. The ratio of scrapers to filtering collector functional feeding groups, therefore, was 0.00. Likewise, no shredder macroinvertebrates were collected resulting in a shredder to total individuals of 0.00. EPT macroinvertebrates were dominated by trichopteran larvae (primarily Hydropsychidae). The ratio of total EPT to Chironomids was 0.07. The number of EPT taxa collected was 4. Chironomidae larvae, too immature to identify further, were the dominant (59.3%) macroinvertebrate collected.

Table WMR 4. Data summary of benthic macroinvertebrates collected in D-frame samples on March 2016 at stations on White Marsh Run.

Metrics	White Marsh Run Riffle Community (EPA RBP III 300 subsample)
	Alpha Control
Taxa Richness	18*
Hilsenhoff Biotic Index	6.3*
Ratio Scrapers to Filtering Collectors	0.00(0.0%)*
Ratio Shredders to total Individuals	0.00(0.0%)*
Total EPT Individuals to Total Chironomids	0.07(6.9%)*
EPT Index	4*
Percent Contribution of Dominant Taxon	59.3%*

Comparative BIBI Scores – Benthic scores for the Alpha and Beta Control sites in the 2015 – 2016 sampling ranged from 1.3 to 2.3 (Table WMR 5), a decrease from what was observed in the Fall benthic sampling from 1998 – 2005 (mean = 2.6), but close to the Spring BIBI (mean = 2.2). Both the Fall and Spring BIBI values decreased at the Lower Restoration site from the values observed earlier. For the Fall BIBI, the average value was 2.4 and for the Spring 1.7, versus a BIBI observed in 2015–16 of 1.0 for each sampling period at this site.

Both the Fall and Spring BIBI values also decreased at the Middle Restoration site from the values observed earlier in 2015-16 (Table WMR 5). For the Fall BIBI, the average value was 2.5 and for the Spring 1.7, versus a BIBI observed in 2015-16 of 1.0 for each sampling period at this site, with the Spring 2016 sampling having less than 100 organisms present in the benthic sample.

Part of the overall decline in the BIBI scores may be attributed to unstable stream habitat (in both the control and restoration areas), and presumably a flashy hydrograph due to the large percentage of altered landscape and imperious surface present in the White Marsh Run watershed. Water quality in White Marsh Run may also an important factor affecting the benthic community (discussed in the water quality section).

Table WMR 5. Summary of IBI values for benthic macroinvertebrates (MBSS BIBI) and physical habitat (MBSS MPHI) by station (site) for White Marsh Run from 1998 – 2005, and for 2015 – 2016 (bold). The MPHI for the control area was assessed at the Alpha Control (* indicates sample size of less than 100 organisms, NA = non-applicable).

Station	Fall BIBI	Spring BIBI	MPHI
Control Site	2.4 (98-99) 1.6* (99-00) 3.3 (00-01) 3.6 (01-02) 2.3 (02-03) NS	1.3 (98-99) 2.0 (99-00) 2.7 (00-01) 2.1 (01-02) 2.4 (02-03) 1.9 (03-04) 2.7 (04-05)	86.4 (98-99) 77.4 (99-00) 33.0 (00-01) 20.6 (01-02) 77.2 (02-03) 77.8 (03-04)
Alpha Control (15-16)	**2.3**	**1.3**	**47.1**
Beta Control (15-16)	**2.0**	**2.3**	
Lower Restoration Site	2.7 (98-99) 1.6* (99-00) 1.6 (00-01) 2.7 (01-02) 3.3 (02-03) Not Sampled	1.0* (98-99) 1.3 (99-00) 1.3 (00-01) 1.9 (01-02) 2.7 (02-03) 1.3 (03-04) 2.7 (04-05)	
2015 - 2016	**1.0**	**1.0**	**NA**
Middle Restoration Site	1.9 (98-99) 1.0* (99-00) 3.6 (00-01) 2.7 (01-02) 3.3 (02-03) Not Sampled	1.0* (98-99) 1.0* (99-00) 1.6 (00-01) 1.6 (00-01) 2.1 (02-03) 1.9 (03-04) 2.4 (04-05)	47.0 (98-99) 3.5 (99-00) 27.2 (00-01) 64.4 (01-02) 81.5 (02-03) 62.1 (03-04)
2015 - 2016	**1.0**	**1.0***	**25.9**

Comparative Physical Habitat: From 1998 to 2004, the average control MPHI for White Marsh Run was 62.1 and 47.1 for 2015 – 2016, which reflects a decrease in the score (Table WMR 5). For the Middle Restoration site, the average MPHI was 47.6 for 1998 – 1999 and for 2015 – 2016 the value was 25.9. Consequently, both the control and restoration site have declined over 11 years. In part, this decrease in the quality of stream habitat may be attributed to the movement of bed material (bed load movement) throughout the entire stream length of White Marsh Run.

In Fall 2015, the entire SHA stream restoration project was assessed for the efficiency of the stream structures utilized in this project, including riprap, rootwads, gabions, rock vanes, vortex rock weirs and cross vanes. One immediate observation was the presence of very fine material deposited about 1-2 m away from the stream bank, and estimated to be 0.5-1.0 m deep in some areas of the riparian zone. This deposited material was present throughout most of the restoration area, but was more prevalent on the south side of the stream. In some places, the fine material was trapped by the dense riparian vegetation in many areas of the stream bank. Basically, the stream structures were functioning as designed, but simply overwhelmed by the sediment loading in White Marsh Run.

The following are some additional observations on the physical habitat of White Marsh Run.

Figure WMR 5A. – The presence of bed material deposited in the stream bed of White Marsh Run. Throughout the stream restoration area, there were several areas with a wide deposition of the bed material, frequently occupying over 75-90% of the width of the stream bed. This bed material was a mixture of small cobble, gravel and fine sand, along with some silty material. Note the dense riparian vegetation present, which is stabilizing the stream bank and providing good shading to the stream, as well as being a major contributor of allochthonous material in the fall.

Figure WMR 5B – This stream structure (rock vane or cross vane?) was entirely smothered with a mixture of small cobble, gravel and fine sand. This was common throughout the entire stream restoration reach.

Figure WMR 5C – One of the stream structures not affected by bed material. These were more common along the north bank of White Marsh Run. It was often difficult to discern the type of structure due to the bedload material

Figure WMR 5D - The upstream section of the stream restoration project, with the bridge carrying Honeygo Boulevard across White Marsh Run visible to the west of the project. Just upstream of this point is a large culvert carrying storm water from the shopping complex. There is a very deep and long pool present, with a deep scour into the substrate. Note that

the upper north bank is composed of larger material (and some fines) that has moved downstream from upstream to the west of Honeygo Boulevard (Figure WMR 1).

Figure WMR 6A and 6B – These images were taken in 2002 and display the visible construction of the rootwad structures along White Marsh Run. There is gravel material present in the stream bed and the stream is following a meandering course due to the stream engineering design. Note the lack of riparian vegetation in 2002 that would create thermal problems for the stream.

Figure WMR 6C – Fine material (whitish deposits) deposited along the bank. In some places, the material was extensive with riparian vegetation starting to stabilize the material.

Figure WMR 6D – Current image of one of the root wad structures along White Marsh Run (compare to WMR 6B). There is extensive riparian vegetation and a well-defined channel is present, with scour pools frequently seen along the root wad base that provide cover. These structures along White Marsh Run were generally stable, with some deterioration of the root wad material.

Recommendations: We suggest that the White Marsh Run site continue to be monitored on a ten-year cycle, with repeat sampling in 2025-2026.









Figure WMR 5A –D. Selected images (A-D) of White Marsh Run taken during Fall 2015.









Figure WMR 6A –D. Selected images (A-D) of White Marsh Run. Images A and B were taken in Spring 2002; images C and D were taken in Fall 2015.

SHA Site Water Chemistry

Water Quality (WQ): All FY 16 sites were sampled for MBSS water quality parameters during the September 2015 (four sites only) and March 2016 (five sites) SHA field work. The UTSC (Watkins Mill) site was not sampled in September due to virtually non-existent flows (only residual pools in the stream were observed), and water quality was not sampled in the repeat visit later in 2015.

All conductivity and seven ANC values for these SHA sites fell outside of the upper MBSS 90th percentile (Table WQ 1). All TN and TP values fell within the 10 - 90th percentile range, both in the Fall and Spring sampling. Closed pH was within the 10 - 90th percentile for most sites, both in the Fall and Spring water quality sampling, except for a pH value of 8.0 for White Marsh Run in September 2015. ANC was generally elevated at all SHA sites, with the highest ANC observed of 2137 µeq/L at White Marsh Run (consistent with the observed elevated pH).

Stream conductivity exceeded the 25th percentile (145 µS/cm) for the Northern Piedmont (EPA Level III) ecoregion sites (four SHA sites except for White Marsh Run which falls into the EPA Level III Southeastern Plains) by a factor of 3.2 - 11.7 times (Morgan et al. 2012). White Marsh Run exceeded the Southeastern Plains 25th percentile (103 µS/cm) by a factor of approximately 9.8 times (Table WQ 1).

These elevated stream conductivity values, and conceivably the high ANC levels, observed for the five SHA restoration sites potentially reflect the urban stream syndrome (Walsh et al. 2005) in which stream conductivity is high due to considerable inputs from road salt usage (primarily sodium chloride) and many other urban-related sources. In particular, many of these SHA sites are in very close proximity to several major metropolitan road systems (I-270, I-70, I-97, I-495, I-695, I-95, Route 40, Route 144, Route 355, Route 24 and many others) that are often excessively salted during icing and snow events in Maryland. Other potential sources of stream conductivity may be leaking sewage pipes, runoff from impervious surfaces and fertilizers, as well as legacy salt accumulation along roads and in shallow groundwater (Walsh et al. 2005). The mean difference in specific conductance between the September 2015 and the March 2016 site values was 126 µS/cm, with Spring values consistently higher than those observed in the Fall.

Although all TN and TP values fell within the 10 - 90th MBSS percentile range (Table WQ I), several sites exceeded the TN 25th percentile estimates (Morgan et al. 2013) for the Northern Piedmont (1.6 mg/L) and Southeastern Plains (0.33 mg/L) ecoregions of Maryland for both the Fall and Spring sampling. In addition, a few sites also exceeded the TP 25th percentile estimates (Morgan et al. 2013) for the Northern Piedmont (0.010 mg/L) ecoregion of Maryland, again also for both the Fall and Spring sampling. Indeed, many SHA sites exceeded both the TN and TP values similarly derived using the EPA Y-intercept and 75th percentile estimations (Morgan et al. 2013). These exceedances of the derived TN and TP criteria, based on scientifically acceptable EPA

methodology, may be a major concern for any stream restoration project since eutrophic stream conditions would not be advantageous for functional stream recovery, benthic recolonization and re-establishment of fish and amphibian populations over time (Morgan et al. 2013, Ashton et al. 2014).

For DOC, ortho-phosphate, ammonia, nitrite and nitrate (Table WQ 2), none of the values exceeded the calculated 90th MBSS percentile value for the analyte. Nitrate was elevated at several sites, mimicking the TN levels also observed at the SHA sites, and possibly a strong signal for urban effects.

Chloride concentrations at the SHA sites exceeded the MBSS 10 - 90th percentile ranges for all September and March sites (Table WQ 3). These chloride levels correlate to the specific conductance measurements at these sites (Table WQ 1). This was expected since there is a strong relationship between chloride concentration and stream conductivity in Maryland non-tidal streams (Morgan et al 2012). For the Northern Piedmont SHA sites, chloride exceeded the derived 25th Cl percentile (17.8 mg/L) by factors ranging from 4.5 to 24.0. For the Southeastern Plains SHA site, chloride exceeded the derived 25th Cl percentile (10.9 mg/L) by a factor of 20. In the SHA stream restoration sites, these elevated chloride levels illustrate the latent salt effects observed in September and March, presumably from the over-salting of road systems. These elevated chloride levels could have a number of potential biological effects at SHA restoration sites.

For sulfate, there were no exceedances of the 90th percentile at all SHA sites (Table WQ 3). Bromide values exceeded the MBSS 90th percentile at four site/date combinations, with Watkins Mill (UTSC) having the highest bromide (1.02 mg/L), followed by Long Draught Branch, White Marsh Run and Plumtree Run in the Spring sample period (Table WQ 3) – there were no exceedances of bromide in the Fall. Calcium and magnesium concentrations (from many potential urban and agricultural sources) exceeded the MBSS 90th percentile for many sites in both Spring and Fall, with Long Draught Branch having the highest values for both calcium (109 mg/L) and magnesium (41 mg/L), both observed in the Spring samples (Table WQ 3).

Although elevated at several SHA sites, copper did not exceed the MBSS 90th percentile at any site for Fall or Spring sampling (Table WQ 3). Three exceedances of zinc (from many potential urban sources) were observed in the Spring sampling, with values ranging from 22.2 to 40.0 mg/L.

Water Quality Summary: Conductivity and ANC values for several SHA sites fell outside of the upper 90th percentile for MBSS random site data. ANC was generally elevated at all SHA sites, with White Marsh Run having the highest ANC observed of 2137 µeq/L and Long Draught Run having the highest specific conductance of over 1600 µS/cm. Stream conductivity exceeded the 25th percentile (145 µS/cm) for the Northern Piedmont (EPA Level III) ecoregion sites by a factor

of 3.2 - 11.7 times (Morgan et al. 2012). For the Northern Piedmont SHA sites, chloride exceeded the derived 25th Cl percentile (17.8 mg/L) by factors ranging from 4.5 to 24.0. Elevated stream conductivity, ANC and chloride for the SHA restoration sites potentially reflect the urban stream syndrome (Walsh et al. 2005), and are of concern for all past, present and future SHA stream restoration projects.

Several sites SHA exceeded the TN 25th percentile estimates (Morgan et al. 2013) for the Northern Piedmont and Southeastern Plains ecoregions of Maryland for both the Fall and Spring sampling. In addition, numerous sites also exceeded the TP 25th percentile estimates (Morgan et al. 2013) for the Northern Piedmont (0.010 mg/L) and Southeastern Plains (0.016 mg/L) ecoregions of Maryland. These TN and TP exceedances may be a major concern for any stream restoration project since eutrophic stream conditions would not be favorable for either stream recovery or biotic recolonization over time (Morgan et al. 2013, Ashton et al. 2014).

Water Quality Recommendations: It is recommended that the MBSS chemistry be continued at all scheduled FY 17 SHA sites for both Fall and Spring site efforts, with the potential to expand the chemical analyses of transportation-linked chemicals in the future if funding allows. Successful stream restoration is dependent on a number of factors, including acceptable water quality.

Table WQ 1. Summary of total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), specific conductance (SPC), closed pH and acid neutralizing capacity (ANC) parameters for FY 15 SHA stream restoration sites (Bold = outside of 10-90th percentile range; NA = not applicable).

Sample ID/Date	**TN (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**	**SPC (µS/cm)**	**Closed pH (STU)**	**ANC (µeq/L)**
10-90th Percentile Range (MBSS)	*0.29-4.6*	*0.007-0.092*	*NA*	*62-416*	*6.07-7.85*	*71-1292*
Long Draught Run 9.9.15	2.46	0.017	2.2	**1624**	7.38	**1597**
Plumtree Run 9.21.15	2.34	0.0096	0.6	**721**	7.34	1021
Upper Little Patuxent 9.9.15	1.25	0.026	2.7	**464**	7.89	**1715**
White Marsh Run 9.21.15	0.59	0.0071	1.3	**807**	**8.00**	**2137**
Long Draught Run 3.8.16	2.0	0.0158	5.4	**1690**	7.43	**1490**
Plumtree Run 3.7.16	2.5	0.013	9.3	**896**	7.30	871
Upper Little Patuxent 3.7.16	1.6	0.015	2.1	**529**	7.49	**1390**
Watkins Mill - UTSC 3.8.16	1.9	0.016	5.6	**1520**	7.61	**1349**
White Marsh Run 3.7.16	1.1	0.0094	2.3	**1005**	7.67	**1755**

Table WQ 2. Summary of dissolved organic carbon (DOC), orthophosphate (Ortho-PO4), ammonia-N, nitrite-N, and nitrate-N for SHA stream restoration sites (Bold = outside of 10-90 th percentile range; NA = not applicable).

Sample ID/Date	**DOC (mg/L)**	**Ortho-PO_4 (mg/L)**	**Ammonia-N (mg/L)**	**Nitrite-N (mg/L)**	**Nitrate-N + Nitrite-N (mg/L)**	**Nitrate-N (mg/L)**
10 - 90th Percentile Range (MBSS)	*1.0-9.0*	*0.0007-0.023*	*0.0033-0.085*	*0.0004-0.016*	*NA*	*0.13-4.6*
Long Draught Run 9.9.15	1.00	0.0063	0.016	0.013	2.6	2.5
Plumtree Run 9.21.15	1.24	0.0069	0.0065	0.0031	2.5	2.4
Upper Little Patuxent 9.9.15	1.43	0.012	0.017	0.0056	1.2	1.2
White Marsh Run 9.21.15	3.36	0.0019	0.0095	0.0047	0.43	0.43
Long Draught Run 3.8.16	0.65	0.0024	0.0046	0.014	2.06	2.1
Plumtree Run 3.7.16	0.73	0.0041	0.017	0.0025	2.53	2.5
Upper Little Patuxent 3.7.16	1.05	0.0045	0.014	0.0032	1.77	1.8
Watkins Mill - UTSC 3.8.16	0.68	0.0023	0.0081	0.0066	1.92	2.1
White Marsh Run 3.7.16	1.38	0.0028	0.021	0.0025	1.01	1.0

Table WQ 3. Summary of chloride, bromide, sulfate, magnesium, calcium, copper and zinc levels for SHA stream restoration sites (Bold = outside of 10-90th percentile range; NA = not applicable).

Sample ID/Date	Chloride (mg/L)	Bromide (mg/L)	Sulfate (mg/L)	Mg (mg/L)	Ca (mg/L)	Cu (µg/L)	Zn (µg/L)
10 - 90th Percentile Range (MBSS)	*3.8-68*	*0.0032-0.062*	*5.5-28*	*1.1-13*	*2.6-40*	*0.40-2.4*	*0.8-19*
Long Draught Run 9.9.15	**382**	0.13	24.5	**41.0**	**108.5**	1.5	12.9
Plumtree Run 9.21.15	**166**	0.12	23.9	**19.7**	**52.6**	0.92	14.7
Upper Little Patuxent 9.9.15	**80**	0.036	9.5	11.8	**40.4**	0.68	8.3
White Marsh Run 9.21.15	**154**	0.057	16.9	12.7	**41.6**	1.63	8.0
Long Draught Run 3.8.16	**430**	**0.16**	23.4	**33.7**	**76.1**	1.48	**27.7**
Plumtree Run 3.7.16	**207**	**0.081**	23.9	**17.5**	**45.4**	1.79	**22.4**
Upper Little Patuxent 3.7.16	**113**	0.045	12.8	12.1	37.0	0.49	8.9
Watkins Mill - UTSC 3.8.16	**385**	**1.02**	19.3	**27.3**	**64.8**	1.58	**40.0**
White Marsh Run 3.7.16	**214**	**0.088**	24.1	**13.0**	38.1	1.54	14.1

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APPENDIX A

Basic benthic invertebrate summary sheets for all SHA restoration sites sampled in 2015-2016 throughout the Maryland Piedmont and Coastal Plain.

LDB 1. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately ~ 1 m^2) at sites in Long Draught Branch on September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Long Draught Branch Sampling Sites (100 + subsample)					
Taxa	Alpha Control	Beta Control	Rabbit Road Lower	Rabbit Road Upper	Lower Restoration	Middle Restoration
Turbellaria						
Planariidae	21	57	17		23	8
Hoplonemertea	3					10
Nematoda			1			
Annelida						
Oligochaeta						
Naididae		2				
Lumbricidae						
Eiseniella sp.		2		1		
Lumbriculidae		7		1	1	3
Hirudinae					3	
Erpobdellidae						
Erpobdella sp.		1				
Gastropoda						
Planorbidae		1				1
Pelecypoda						
Sphaeridae		3				
Insecta						
Collembola						1
Ephemeroptera						
Baetidae						1
Trichoptera						
Hydropsychidae	13		12	8	10	7
Cheumatopsyche sp.	14		4		19	2
Hydropsyche sp.			1		6	
Symphytopsyche sp.			6	1	5	
Hydrophilidae				3		1
Hydroptila sp.				1		3
Philopotamidae			1	2	1	
Chimarra sp.			12			
Coleoptera						
Elmidae						
Stenelmis sp.						

LDB 1 (continued).

Taxa	Long Draught Branch Sampling Sites (100 + subsample)					
	Alpha Control	Beta Control	Rabbit Road Lower	Rabbit Road Upper	Lower Restoration	Middle Restoration
Ceratopogonidae						1
Atrichopogon sp.					1	2
Culicoides sp.	2					
Chironomidae	12	3	16	28	12	13
Tanypodinae			2	2		6
Nilotanypus sp.	1	1		2		
Thienemannimyia sp.						
Orthocladinae			1	8	2	3
Corynoneura sp.	1		2	9		
Limnophyes sp.		1				
Orthocladius sp.	25			39	2	10
Thienemanniella sp.	7				7	
Chironomini		1	2		1	
Dicrotendipes sp.			1			1
Polypedilum sp.	1		4			1
Pseudochironomus sp.	4	19	10	2	2	3
Tanytarsini	2	1	6	1	3	17
Micropsectra sp.			2	1	1	
Rheotanytarsus sp.		1				
Tanytarsus sp.			3			2
Empididae						1
Chelifera sp.	3					2
Hemerodromia sp.		8	1		3	2
Ephydridae						1
Simuliidae					1	
Simulium sp.		1		4	2	1
Tipulidae	1		1			
Antocha sp.			1			1
Limonia sp.						1
Pseudolimnophila sp.	1					4
Tipula sp.					1	

LDB 2. Number of macroinvertebrates (EPA RBP III 300 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately ~ 1 m^2) at sites in Long Draught Branch on September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Long Draught Branch Sampling Sites (300 + subsample)				
Taxa	Alpha Control	Rabbit Road Lower	Rabbit Road Upper	Lower Restoration	Middle Restoration
Turbellaria					
Planariidae	30	45	5	58	25
Dugesia sp.		7		6	
Hoplonemertea	4			1	44
Nematoda		1			
Annelida					
Oligochaeta					
Naididae					11
Lumbricidae					
Eiseniella sp.			1		1
Lumbriculidae			1	7	6
Hirudinae					
Erpobdellidae					
Erpobdella sp.			2	6	
Gastropoda					
Ancylidae					
Ferrissia sp.	1				
Lymnaeidae		1			1
Physidae					1
Planorbidae					5
Helisoma sp.					1
Pelecypoda					
Sphaeridae		1			
Insecta					
Collembola				1	2
Ephemeroptera					
Baetidae			1		5
Trichoptera					
Hydropsychidae	24	45	24	16	11
Cheumatopsyche sp.	19	7	3	46	1
Hydropsyche sp.		11	2	18	
Symphytopsyche sp.		15	4	21	1

LDB 2 (continued).

Taxa	Long Draught Branch Sampling Sites (300 + subsample)				
	Alpha Control	Rabbit Road Lower	Rabbit Road Upper	Lower Restoration	Middle Restoration
Hydrophilidae			5		3
Hydroptila sp.			4		3
Stactobiella sp.					1
Philopotamidae		2	3	1	
Chimarra sp.		29	3	4	
Diptera					
Ceratopogonidae					1
Atrichopogon sp.		1		2	3
Culicoides sp.	3				
Chironomidae	14	54	57	37	40
Tanypodinae	1	3	5	3	10
Ablabesmyia sp.			1		
Nilotanypus sp.	1		2		
Thienemannimyia sp.		7	1	1	2
Orthocladinae	2	2	14	2	6
Brillia sp.					
Corynoneura sp.	1	5	14	1	
Eukiefferiella sp.				1	
Nanocladius sp.					1
Orthocladius sp.	30	3	169	6	21
Rheocricotopus sp.					1
Thienemanniella sp.	13	1	19	22	3
Chironomini	1	3		2	1
Chironomus sp.					1
Crypytochironomus sp.			1		
Dicrotendipes sp.		3			1
Polypedilum sp.	3	19	2	1	1
Pseudochironomus sp.	7	24	6	7	6
Tanytarsini	2	8	7	7	44
Micropsectra sp.		2	1	3	1
Paratanytarsus sp.		1			
Tanytarsus sp.		14			4
Culicidae					
Anopheles sp.		1			
Empididae				2	3
Hemerodromia sp.	7	6	3	5	5
Chelifera sp.				1	4

LDB 2 (continued).

Taxa	Long Draught Branch Sampling Sites (300 + subsample)				
	Alpha Control	Rabbit Road Lower	Rabbit Road Upper	Lower Restoration	Middle Restoration
Ephydridae					2
Simuliidae		2	1	5	5
Simulium sp.		4	6	12	4
Tipulidae	1	1			
Antocha sp.		1	2		2
Limonia sp.	1				1
Pseudolimnophila sp.	1	1			8
Tipula sp.				4	

LDB 3. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites in Long Draught Branch on March 2016. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Long Draught Branch Sampling Sites (100 + subsample)					
Taxa	Alpha Control	Beta Control	Rabbit Road Lower	Rabbit Road Upper	Lower Restoration	Middle Restoration
Turbellaria						
Planariidae	21	57	17		23	8
Hoplonemertea	3					10
Nematoda			1			
Annelida						
Oligochaeta						
Naididae		2				
Lumbricidae						
Eiseniella sp.		2		1		
Lumbriculidae		7		1	1	3
Hirudinae					3	
Erpobdellidae						
Erpobdella sp.		1				
Gastropoda						
Planorbidae		1				1
Pelecypoda						
Sphaeridae		3				
Insecta						
Collembola						1
Ephemeroptera						
Baetidae						1
Trichoptera						
Hydropsychidae	13		12	8	10	7
Cheumatopsyche sp.	14		4		19	2
Hydropsyche sp.			1		6	
Symphytopsyche sp.			6	1	5	
Hydrophilidae				3		1
Hydroptila sp.				1		3
Philopotamidae			1	2	1	
Chimarra sp.			12			

LDB 3 (continued).

Taxa	Long Draught Branch Sampling Sites (100 + subsample)					
	Alpha Control	Beta Control	Rabbit Road Lower	Rabbit Road Upper	Lower Restoration	Middle Restoration
Ceratopogonidae						1
Atrichopogon sp.					1	2
Culicoides sp.	2					
Chironomidae	12	3	16	28	12	13
Tanypodinae			2	2		6
Nilotanypus sp.	1	1		2		
Thienemannimyia sp.						
Orthocladinae			1	8	2	3
Corynoneura sp.	1		2	9		
Limnophyes sp.		1				
Orthocladius sp.	25			39	2	10
Thienemanniella sp.	7				7	
Chironomini		1	2		1	
Dicrotendipes sp.			1			1
Polypedilum sp.	1		4			1
Pseudochironomus sp.	4	19	10	2	2	3
Tanytarsini	2	1	6	1	3	17
Micropsectra sp.			2	1	1	
Rheotanytarsus sp.		1				
Tanytarsus sp.			3			2
Empididae						1
Chelifera sp.	3					2
Hemerodromia sp.		8	1		3	2
Ephydridae						1
Simuliidae					1	
Simulium sp.		1		4	2	1
Tipulidae	1		1			
Antocha sp.			1			1
Limonia sp.						1
Pseudolimnophila sp.	1					4
Tipula sp.					1	

LDB 4. Number of macroinvertebrates (EPA RBP III 300 organism sample) collected in benthic samples by combining 9 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites in Long Draught Branch on March 2016. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Long Draught Branch Sampling Sites (300 + subsample)	
Taxa	Alpha Control	Rabbit Road Lower
Turbellaria		
Planariidae	6	41
Cura sp.		6
Hoplonemertea	4	5
Nematoda	3	
Annelida		
Oligochaeta		
Enchytraeidae	5	
Naididae	228	9
Lumbricidae		
Eiseniella sp.	2	
Lumbriculidae	19	2
Tubificidae	9	4
Gastropoda		
Lymnaeidae		1
Pelecypoda		
Sphaeriidae	2	2
Insecta		
Ephemeroptera		
Caenidae	3	
Trichoptera		
Glossosomatidae		
Glossosoma sp.		1
Hydropsychidae		6
Cheumatopsyche sp.		15
Hydropsyche sp.		14
Symphytopsyche sp.		7
Hydrophilidae		1
Hydroptila sp.		2
Philopotomatidae		
Chimarra sp.		4

LDB 4 (Continued).

Taxa	Long Draught Branch Sampling Sites (300 + subsample)	
	Alpha Control	Rabbit Road Lower
Diptera		
Chironomidae	4	5
Tanypodinae		
Thienemannimyia sp.		
Orthocladinae	4	5
Eukiefferiella sp.	1	2
Orthocladius sp.	13	67
Thienemanniella sp.		
Chironomini	1	
Pseudochironomus sp.		6
Empididae		
Chelifera sp.		1
Simuliidae	1	
Tipulidae		
Antocha sp.		3

PTR 1. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites in Plumtree Run in September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Plumtree Run Sampling Sites (100 + subsample)					
Taxa	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Turbellaria						
Planariidae		2			3	3
Annelida						
Oligochaeta						
Lumbricidae						
Eiseniella sp.				1		
Lumbriculidae	2		1			1
Naididae				1		
Tubificidae		1				
Gastropoda						
Ancylidae						
Ferrissia sp.	1					
Pelecypoda						
Sphaeridae			1			
Crustacea						
Amphipoda						
Crangonyctidae			2	1	1	1
Isopoda						
Aesilidae						
Caecidotea sp.					1	
Insecta						
Odonata						
Calyopterygidae						
Calopteryx sp.	1					
Gomphidae					1	
Megaloptera						
Corydalidae						
Corydalis sp.				1		

PTR 1 (continued).

Taxa	Plumtree Run Sampling Sites (100 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Trichoptera						
Hydropsychidae	24	14	4	9	8	13
Cheumatopsyche sp.	6	10	2	23	15	9
Hydropsyche sp.	2	5	5	8	7	11
Symphytopsyche sp.	1	1	3	13	6	16
Hydroptilidae				1		
Philopotamidae	3	8	10	1	5	4
Chimarra sp.		12	18	8	21	25
Dolophilodes sp.		1	5	1		
Rhyacophilidae						
Rhyacophila sp.			1		1	
Coleoptera						
Elmidae			1			
Oulimnius sp.						
Stenelmis sp.		8	2	2	2	7
Psephenidae						
Psephenus sp.		2				
Diptera						
Chironomidae	8	7	7	8	6	4
Tanypodinae		1	2		2	
Nilotanypus sp.			1			
Thienemannimyia grp.			1	1		
Orthocladinae	2	3	4	2	3	
Brillia sp.	3					
Corynoneura sp.	7	2	3	1	2	6
Eukiefferiella sp.	5	3				
Orthocladius sp.		5	2	5	4	2
Parametriocnemus sp.		2	2	2		
Thienemanniella sp.	18	1	1	4	1	1
Tvetenia sp.	3	3	3		1	1
Chironomini		1		1		2
Polypedilum sp.	2	6	10	5	10	1
Pseudochironomus sp.	9		2	4	2	1

PTR 1 (continued).

Taxa	Plumtree Run Sampling Sites (100 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Tanytarsini	4	1	10	3	2	1
Micropsectra sp.		1				
Paratanytarsus sp.					1	
Rheotanytarsus sp.						1
Tanytarsus sp.		1				
Empididae						
Chelifera sp.			1			
Hemerodromia sp.		1	1			
Simuliidae	3	1				2
Simulium sp.	2	1	1	1	1	
Tipulidae				1		
Antocha sp.		1		1		1
Pseudolimnophila sp.			1			
Tipula sp.	1			1	1	

PTR 2. Number of macroinvertebrates (EPA RBP III 300 organism sample) collected in benthic samples by combining 9 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites in Plumtree Run on 22 September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Plumtree Run Sampling Sites (300 + subsample)					
Taxa	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Turbellaria						
Planariidae		5	1	4		7
Hoplonemertea			1			
Annelida						
Oligochaeta						
Lumbricidae						
Eiseniella sp.				1		
Lumbriculidae	5	1	5	7	3	1
Naididae			1	4		
Tubificidae		1		1		
Gastropoda						
Ancylidae						
Ferrissia sp.	1					
Pelecypoda						
Sphaeridae			2			
Crustacea						
Amphipoda						
Crangonyctidae	1	3	3	1	2	4
Isopoda						
Aesilidae						
Caecidotea sp.	1	1	4	1	1	2
Insecta						
Collembola			1			
Ephemeroptera						
Baetidae	1					
Odonata						
Gomphidae					1	
Calyopterygidae						
Calopteryx sp.	2					
Megaloptera						
Corydalidae						
Corydalis sp.				1		

PTR 2 (continued).

Taxa	Plumtree Run Sampling Sites (300 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Trichoptera						
Hydropsychidae	68	45	15	19	18	36
Cheumatopsyche sp.	32	31	11	57	45	40
Hydropsyche sp.	7	14	8	20	17	23
Symphytopsyche sp.	8	5	15	30	27	37
Hydrophilidae				1		
Philopotamidae	6	22	21	6	18	22
Chimarra sp.	10	46	58	40	65	67
Dolophilodes sp.	1	7	20	2	2	1
Psychomyidae						
Psychomyia sp.				2		
Rhyacophilidae						1
Rhyacophila sp.			1		1	
Lepidoptera						
Noctuidae						1
Coleoptera						
Elmidae			1			1
Optioservus sp.						1
Oulimnius sp.				1		
Stenelmis sp.	6	15	4	6	3	21
Psephenidae						
Psephenus sp.		7	1		1	
Diptera						
Chironomidae	44	13	20	19	12	12
Tanypodinae	4	2	4		2	2
Nilotanypus sp.			1			
Thienemannimyia grp.	2	1	1	2	1	1
Orthocladinae	29	7	7	5	3	2
Brillia sp.	3					
Corynoneura sp.	14	7	11	5	8	12
Eukiefferiella sp.	11	9	2		1	
Orthocladius sp.		20	23	26	25	15

PTR 2 (continued).

Taxa	Plumtree Run Sampling Sites (300 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Parametriocnemus sp.	1	2	6	10		
Synorthocladius sp.	1			4		
Thienemanniella sp.	25	18	9	8	7	9
Tvetenia sp.	6	8	3	4	6	5
Xylotopus sp.						
Chironomini	1	2	5	1	3	2
Apedilum sp.					1	
Polypedilum sp.	10	16	44	10	28	9
Pseudochironomus sp.	9	2	17	6	6	3
Tanytarsini	17	3	17	8	6	1
Micropsectra sp.		1	2			
Paratanytarsus sp.					1	
Rheotanytarsus sp.			1	1		1
Tanytarsus sp.		2	1		2	1
Empididae			1			
Chelifera sp.			1			
Clinocera sp.					1	
Hemerodromia sp.		1	2	1	3	2
Simuliidae	4		16		1	3
Simulium sp.	5	5	3	3	3	3
Tipulidae				1		
Antocha sp.		4		8	3	2
Pseudolimnophila sp.			1			
Tipula sp.	1	1		1	1	

PTR 3. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites in Plumtree Run on March 2016. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Plumtree Run Riffle Community (100 + subsample)					
Taxa	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Turbellaria						
Planariidae			1	1	1	
Nematoda		3			1	
Hoplonemertea					1	
Annelida						
Oligochaeta						
Naididae	5	2		1	1	13
Lumbricidae						
Eiseniella sp.						
Lumbriculidae		3	1			
Tubificidae		2				
Gastropoda						
Ancylidae						
Ferrissia sp.		1				
Pelecypoda						
Sphaeriidae						
Crustacea						
Amphipoda			1			
Crangonyctidae						
Crangonyx sp.			2	1		1
Isopoda						
Aesilidae						
Caecidotea sp.						
Insecta						
Ephemeroptera						
Baetidae			1	2		
Trichoptera						
Hydropsychidae	3	6		2	2	1
Cheumatopsyche sp.	14	20	7	1	7	7
Hydropsyche sp.	3	7	3	2		3
Symphytopsyche sp.	4	2	4	1	4	3

PTR 3 (continued).

Taxa	Plumtree Run Riffle Community (100 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Hydrophilidae						
Philopotomatidae		1				
Chimarra sp.	13	5	2	9	9	9
Dolophilodes sp.						
Psychomyidae						
Psychomyia sp.	3		2		5	1
Coleoptera						
Elmidae						
Stenelmis sp.	5	4	2	1	1	3
Diptera						
Chironomidae	11	20	12	16	9	9
Tanypodinae			3			
Nilotanypus sp.						
Thienemannimyia grp.	1					
Diamesinae						
Diamesa sp.	1		1	1	1	
Orthocladinae	4	2	4	4	8	1
Eukiefferiella sp.	4	5	2	4	9	2
Orthocladius sp.	7	9	12	35	21	14
Parametriocnemus sp.	3			15	6	6
Thienemanniella sp.			2			
Tvetenia sp.		1	10		4	6
Chironomini	2		2			
Apedilum sp.			3			
Pseudochironomus sp.			1	2	1	3
Tanytarsini	2	1	11	1	2	
Micropsectra sp.						
Paratanytarsus sp.						
Rheotanytarsus sp.			1			
Tanytarsus sp.						
Empididae						
Hemerodromia sp.	2	5		3	4	3
Simuliidae						
Simulium sp.		1	1			

PTR 3 (continued).

Taxa	Plumtree Run Riffle Community (100 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Tipulidae						
Antocha sp.	14	4	13	5	8	12
Pseudolimnophila sp.						
Tipula sp.	2	1		1		1

PTR 4. Number of macroinvertebrates (EPA RBP III 300 organism sample) collected in benthic samples by combining 9 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites in Plumtree Run in March 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Plumtree Run Plumtree Run Sampling Sites (300 + subsample)					
Taxa	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Turbellaria						
Planariidae			1	2	3	5
Hoplonemertea	6				2	2
Nematoda		5			2	1
Annelida						
Oligochaeta				1		
Naididae	14	7		5	10	32
Lumbricidae						
Eiseniella sp.						
Lumbriculidae	1	6	1	3		
Tubificidae	1	2			1	
Gastropoda						
Ancylidae						
Ferrissia sp.		1				
Lymnaeidae			1			
Pelecypoda						
Sphaeriidae			1			
Crustaceae						
Amphipoda			3	1	1	
Crangonyctidae						
Crangonyx sp.	3	1	6	5	3	
Isopoda						
Aesilidae						
Caecidotea sp.	1		3		1	
Insecta						
Ephemeroptera						
Baetidae			1	5		
Plecoptera						
Nemouridae						
Amphinemura sp.					4	

PTR 4 (continued).

Taxa	Plumtree Run Plumtree Run Sampling Sites (300 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Trichoptera						
Glossosomatidae						
Glossosoma sp.				1		
Hydropsychidae	12	15	4	6	6	9
Cheumatopsyche sp.	36	33	25	9	12	24
Hydropsyche sp.	4	6	7	8	5	14
Symphytopsyche sp.	8	4	17	10	14	6
Hydrophilidae						
Leucotrichia sp.			1			
Philopotomatidae		1				
Chimarra sp.	36	4	13	22	21	37
Dolophilodes sp.						
Psychomyidae						2
Psychomyia sp.	5	1	8	5	9	11
Coleoptera						
Elmidae				1	1	
Optioservus sp.				1		
Stenelmis sp.	7	13	3	3	1	7
Psephenidae						
Psephenus sp.	2		1			1
Diptera						
Ceratopogonidae						
Atrichopogon sp.						1
Chironomidae	28	39	36	49	23	26
Tanypodinae			3			
Thienemannimyia grp.	1	3	1	2		2
Diamesinae						
Diamesa sp.	1		2	1	1	
Orthocladinae	6		8	6	10	1
Eukiefferiella sp.	4	22	3	11	12	6
Orthocladius sp.	30	15	56	59	57	56
Parametriocnemus sp.	18	3	4	39	28	14
Thienemanniella sp.			6			
Tvetenia sp.		2	10	11	15	13

PTR 4 (continued).

Taxa	Plumtree Run Plumtree Run Sampling Sites (300 + subsample)					
	Alpha Control	Beta Control	Gamma Control	Delta Control	Lower Restoration	Middle Restoration
Chironomini	2	2	2	1	1	1
Apedilum sp.			5	1		
Dicrotendipes sp.		1				
Polypedilum sp.	1		1		3	
Pseudochironomus sp.	1	4	4	5	3	4
Tanytarsini	5	8	17	2	15	8
Micropsectra sp.			1			
Rheotanytarsus sp.			3			1
Empididae				1		
Chelifera sp.	1	1			1	
Hemerodromia sp.	5	9	2	8	6	12
Simuliidae						
Simulium sp.		3	1	1		
Tipulidae						1
Antocha sp.	44	8	31	15	24	35
Pseudolimnophila sp.						
Tipula sp.	3	6		1	1	1

ULPR 1. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on the Upper Little Patuxent River on September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Upper Little Patuxent Sampling Sites (100 + subsample)			
Taxa	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Nematoda			1	
Hoplonemertea		1		
Annelida				
Oligochaeta				
Enchytraeidae				3
Lumbriculidae				1
Tubificidae			1	2
Gastropoda				
Ancylidae				
Ferrissia sp.		1		
Pelecypoda				
Sphaeridae		1	1	2
Insecta				
Ephemeroptera				
Baetidae	3		12	8
Heptageniidae		1		
Plecoptera				
Leuctridae			1	
Hemiptera				
Veliidae				
Rhagovelia sp.			1	
Trichoptera				
Hydropsychidae	18	19	9	2
Cheumatopsyche sp.	9	10	10	2
Diplectrona sp.	5			
Hydropsyche sp.	12	7		1
Symphytopsyche sp.	15	7	24	4
Hydrophilidae				1
Hydroptila sp.			5	
Stactobiella sp.	2			
Philopotomatidae	1	3	1	
Chimarra sp.	3	2		

ULPR 1 (continued).

Taxa	Upper Little Patuxent Sampling Sites (100+ subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Elmidae			2	
Ancyronx sp.		1		
Stenelmis sp.	3	1		
Diptera				
Ceratopogonidae				
Forcipomyia sp.	1			
Chironomidae	7	2	4	20
Tanypodinae		1		
Nilotanypus sp.				
Thienemannimyia grp.	6	1	2	2
Orthocladinae			1	
Corynoneura sp.	1			4
Eukiefferiella sp.	1	1		
Limnophyes sp.		1		
Orthocladius sp.			3	1
Thienemanniella sp.			2	1
Chironomini	9		2	3
Apedilum sp.	1		3	7
Crypytochironomus sp.				1
Dicrotendipes sp.				2
Polypedilum sp.	10	2	6	15
Pseudochironomus sp.	4	29	5	5
Tanytarsini	2	18	10	3
Rheotanytarsus sp.			1	
Tanytarsus sp.			4	4
Empididae			2	
Hemerodromia sp.				1
Tipulidae				
Antocha sp.	5	2	4	1
Tipula sp.	1			1

ULPR 2. Number of macroinvertebrates (EPA RBP III 300 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on the Upper Little Patuxent River on September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Upper Little Patuxent Sampling Sites (300 + subsample)			
Taxa	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Turbellaria				
Planariidae		1	1	1
Nematoda			3	1
Hoplonemertea		2		1
Annelida				
Oligochaeta				
Naididae		1	1	1
Enchytraeidae			2	4
Lumbricidae				
Eiseniella sp.		1	1	
Lumbriculidae			2	2
Tubificidae			7	4
Gastropoda				
Ancylidae				
Ferrissia sp.		2	8	
Pelecypoda				
Sphaeridae	4	3	3	6
Insecta				
Ephemeroptera				
Baetidae	5		45	23
Heptageniidae		1		
Stenonema sp.		1		
Odonata				
Gomphidae				
Stylogomphus sp.		1		
Plecoptera				
Leuctridae			1	
Hemiptera				
Veliidae				
Rhagovelia sp.			1	1
Megaloptera				
Corydalidae				
Nigronia sp.		1		

ULPR 2 (continued).

Taxa	Upper Little Patuxent Sampling Sites (300 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Hydropsychidae	57	65	47	13
Cheumatopsyche sp.	34	41	24	8
Diplectrona sp.	10			
Hydropsyche sp.	21	21		1
Symphytopsyche sp.	46	18	49	17
Hydrophilidae			9	2
Hydroptila sp.	2		6	
Stactobiella sp.	2			
Leptoceridae		1		
Oecetis sp.		1		
Philopotomatidae	3	4	1	
Chimarra sp.	5	14		
Coleoptera				
Elmidae	1		3	2
Ancyronyx sp.		1		
Oulimnius sp.				1
Stenelmis sp.	3	2		2
Hydrophilidae				1
Diptera				
Ceratopogonidae				
Atrichopogon sp.				1
Forcipomyia sp.	1			
Chironomidae	15	21	29	93
Tanypodinae	3	10		5
Thienemannimyia grp.	9	10	5	7
Orthocladinae	5	5	2	2
Corynoneura sp.	5	2		4
Eukiefferiella sp.	1	1		
Limnophyes sp.		1		
Orthocladius sp.	6		15	3
Rheocricotopus sp.	1			
Synorthocladius sp.				1
Thienemanniella sp.	3	5	4	3
Tvetenia sp.			1	

ULPR 2 (continued).

Taxa	Upper Little Patuxent Sampling Sites (300 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Apedilum sp.	6		23	12
Crypytochironomus sp.				1
Dicrotendipes sp.		2	5	2
Polypedilum sp.	30	9	32	51
Pseudochironomus sp.	22	84	12	10
Saetheria sp.				5
Tanytarsini	9	41	21	15
Micropsectra sp.		1	2	
Rheotanytarsus sp.			3	
Tanytarsus sp.	1	10	5	5
Empididae	1		3	1
Chelifera sp.		2		
Hemerodromia sp.	2	1	2	3
Simuliidae	2	1		
Simulium sp.	3			
Tipulidae				
Antocha sp.	12	2	14	2
Pseudolimnophila sp.		1		
Tipula sp.	3	2		1

ULPR 3. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on the Upper Little Patuxent River on March 2016. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Upper Little Patuxent Sampling Sites (100 + subsample)			
Taxa	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Turbellaria				
Planariidae	1			
Nematoda			4	2
Annelida				
Oligochaeta				
Enchytraeidae				1
Lumbricidae				
Eiseniella sp.			1	
Lumbriculidae			1	
Naididae	6	4		6
Tubificidae		2	5	1
Pelecypoda				
Corbiculidae		3	1	1
Sphaeriidae		1		
Insecta				
Ephemeroptera				
Heptageniidae			1	
Stenonema sp.	1	1		
Trichoptera				
Hydropsychidae	3	6	2	
Cheumatopsyche sp.	14	18	1	3
Hydropsyche sp.	6	2	2	1
Symphytopsyche sp.	7	3	7	2
Hydrophilidae			1	
Hydroptila sp.			1	1
Philopotomatidae				
Chimarra sp.	14	2	1	1
Psychomyidae				
Lype sp.				1
Uenoidae				
Neophylax sp.		1		

ULPR 3 (continued).

Taxa	Upper Little Patuxent Sampling Sites (100 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Coleoptera				
Stenelmis sp.		1	3	
Ceratopogonidae				
Probezzia sp.			1	
Chironomidae	6	18	25	12
Diamesinae				
Diamesa sp.		1		
Tanypodinae	2			1
Thienemannimyia grp.	1			1
Orthocladinae	3	3	3	9
Brillia sp.	3		1	
Eukiefferiella sp.	4			
Orthocladius sp.	5	33	6	28
Parametriocnemus sp.	12			4
Tvetenia sp.	3		2	4
Chironomini			4	2
Apedilum sp.		1	11	6
Dicrotendipes sp.			1	
Pseudochironomus sp.	1	2	1	1
Tanytarsini	3		1	1
Micropsectra sp.				1
Empididae				
Chelifera sp.		2		
Clinocera sp.		1		
Hemerodromia sp.	1	2	2	
Simuliidae				
Prosimulium sp.				1
Simulium sp.		1		
Tipulidae				1
Antocha sp.		1	10	4
Dicranota sp.				2
Tipula sp.				1

ULPR 4. Number of macroinvertebrates (EPA RBP III 300 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on the Upper Little Patuxent River on March 2016. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Upper Little Patuxent Sampling Sites (300 + subsample)			
Taxa	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Turbellaria				
Planariidae	1		1	1
Nematoda			12	6
Hoplonemertea				
Annelida				
Oligochaeta				
Enchytraeidae				1
Lumbricidae				
Eiseniella sp.	1		1	
Lumbriculidae			3	
Naididae	14	9	3	18
Tubificidae		2	10	10
Gastropoda				
Ancylidae				
Ferrissia sp.		1	1	
Pelecypoda				
Corbiculidae		5	2	1
Sphaeridae	1	2	2	1
Crustacea				
Amphipoda			1	
Insecta				
Ephemeroptera				
Heptageniidae			1	
Stenonema sp.	2	5	2	
Plecoptera				
Nemouridae				
Amphinemura sp.				1
Ostrocerca sp.		1	1	1
Odonata				
Gomphidae				
Hagenius sp.		1		

ULPR 4 (continued).

Taxa	Upper Little Patuxent Sampling Sites (300 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Glossosomatidae			1	
Hydropsychidae	11	15	2	3
Cheumatopsyche sp.	36	62	10	10
Diplectrona sp.			1	
Hydropsyche sp.	15	11	4	7
Symphytopsyche sp.	23	16	18	11
Hydrophilidae		1	1	1
Hydroptila sp.	3		3	5
Leptoceridae	1			
Philopotomatidae	3			
Chimarra sp.	50	3	1	5
Psychomyidae				
Lype sp.				1
Uenoidae				
Neophylax sp.		2		1
Coleoptera				
Elmidae	3			
Ancyronyx sp.	2			1
Macronychus sp.		2		
Optioservus sp.	1			
Stenelmis sp.	2	4	7	2
Diptera				
Ceratopogonidae				
Probezzia sp.			2	4
Chironomidae	30	45	55	23
Tanypodinae	3	1		2
Thienemannimyia grp.	2		1	2
Diamesinae				
Diamesa sp.			2	
Potthastia sp.		1		
Orthocladinae	5	4	9	13
Brillia sp.	3		1	5
Diplocladius sp.	4			
Eukiefferiella sp.	4	5		1
Orthocladius sp.	21	122	33	90

ULPR 4 (continued).

Taxa	Upper Little Patuxent Sampling Sites (300 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Parametriocnemus sp.	37		4	4
Rheocricotopus sp.		1		
Thienemanniella sp.				5
Tvetenia sp.	3		6	4
Apedilum sp.		1	42	18
Crypytochironomus sp.			8	1
Dicrotendipes sp.			1	
Polypedilum sp.			1	2
Pseudochironomus sp.	4	12	5	2
Stenochironomus sp.				1
Tanytarsini	4	4	3	2
Micropsectra sp.	1			1
Rheotanytarsus sp.	12	2		
Empididae				
Chelifera sp.	2	4		
Clinocera sp.		3		1
Hemerodromia sp.	9	7	7	1
Simuliidae				
Prosimulium sp.	1	1		2
Simulium sp.		1		1
Dicranota sp.	1		1	3
Tipulidae				
Antocha sp.	5	5	23	18
Tipula sp.			1	1

UTSC 1. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on an unnamed tributary (UT) to Seneca Creek (Watkins Mill Road) on September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Watkins Mill Rd. Sampling Sites (100 + Subsample)					
	September 2015		December 2015			
Taxa	Alpha Control	Beta Control	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Turbellaria						
Planariidae				1	2	5
Hoplonemertea				1	3	3
Nematoda					2	
Annelida						
Oligochaeta						
Enchytraeidae				1		1
Naididae			1	7	32	7
Lumbricidae						
Eiseniella sp.		1		2		1
Lumbriculidae	1	3	5	2		2
Tubificidae			2			
Hirudinae						
Glossiphoniidae						
Gastropoda						
Ancylidea						
Ferrissia sp.				1		
Physidae	7	3	4	2		2
Insecta						
Collembola						
Sminthuridae			4			
Megaloptera						
Corydalidae						
Corydalus sp.	1			1	1	
Trichoptera						
Hydropsychidae	18	8	13	8	4	5
Cheumatopsyche sp.	33	5	36	30	17	35
Diplectrona sp.					1	1
Hydropsyche sp.	9	1	1	5	5	1
Symphytopsyche sp.	6			4		2

UTSC 1 (continued).

Taxa	Watkins Mill Rd. Sampling Sites (100 + Subsample)					
	September 2015		December 2015			
	Alpha Control	Beta Control	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Philopotamidae						
Chimarra sp.			7		6	15
Diptera						
Chironomidae	3	18	10	3	9	4
Tanypodinae	5	6	4	8		
Pentaneura sp.	1					
Thienemannimyia sp.	11	26	8	14	6	8
Zavrelimyia sp.						
Orthocladinae			1	4	1	3
Eukiefferiella sp.						1
Orthocladius sp.	1	2	1	5	2	
Parametriocnemus sp.					1	1
Thienemanniella sp.						
Tvetenia sp.					1	1
Chironomini	1	8	1	1	1	
Chironomus sp.		1				
Dicrotendipes sp.		2				
Pseudochironomus sp.				1	2	1
Polypedilum sp.	6	19			1	
Stenochironomus sp.						1
Tanytarsini		1			3	
Micropsectra sp.						
Empididae	1					
Clinocera sp.	1					
Hemerodromia sp.	2	3	2	2		
Simuliidae				1		1
Prosimulium sp.					2	
Simulium sp.	6	1	3	5		
Stratiomyidae						
Odontomyia sp.				1		
Tabanidae						
Chrysops sp.						1
Tipulidae						
Pseudolimnophila sp.	1					
Tipula sp.			1			1

UTSC 2. Number of macroinvertebrates (RBP III 300 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on an unnamed tributary (UT) to Seneca Creek (Watkins Mill Road) on September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Watkins Mill Rd. Sampling Sites (300 + subsample)					
	September 2015		December 2015			
Taxa	Alpha Control	Beta Control	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Turbellaria						
Planariidae			1	1	4	10
Hoplonemertea				1	6	4
Nematoda					6	1
Annelida						
Oligochaeta						
Naididae		1	2	24	68	24
Enchytraeidae		2	1	2		1
Lumbricidae						
Eiseniella sp.		1	1	3		1
Lumbriculidae	2	6	32	3	5	8
Tubificidae			3			2
Gastropoda						
Ancylidae						
Ferrissia sp.				1		
Physidae	17	6	8	11	1	4
Planorbidae		1			1	
Insecta						
Collembola						
Sminthuridae			16			1
Megaloptera						
Corydalidae						
Corydalus sp.	1			1	2	
Trichoptera						
Hydropsychidae	44	23	44	21	16	18
Cheumatopsyche sp.	97	23	143	82	67	80
Diplectrona sp.					1	1
Hydropsyche sp.	21	3	3	7	10	4
Symphytopsyche sp.	21	3	3	7	4	4
Hydrophilidae						
Hydroptila sp.	1	4				

UTSC 2 (continued).

Taxa	Watkins Mill Rd. Sampling Sites (300 + subsample)					
	September 2015		December 2015			
	Alpha Control	Beta Control	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Dolophilodes sp.					1	
Lepidoptera						
Noctuidae	1					
Coleoptera						
Elmidae						
Stenelmis sp.					2	1
Diptera						
Culicidae						
Anopheles sp.		5				
Ceratopogonidae						
Culicoides sp.		1				
Chironomidae	6	57	27	6	26	27
Tanypodinae	6	17	12	10	1	2
Pentaneura sp.	1					
Thienemannimyia grp.	48	89	19	46	13	26
Zavrelimyia sp.						
Orthocladinae			7	12	9	6
Brillia sp.					1	
Corynoneura sp.						
Eukiefferiella sp.			1	2	1	2
Orthocladius sp.	1	7	18	10	10	6
Parametriocnemus sp.					1	3
Thienemanniella sp.	48				1	
Tvetenia sp.					1	1
Chironomini	2	16	4	1	4	
Chironomus sp.		7	1			
Pseudochironomus sp.	3		1	1	4	1
Polypedilum sp.	22	62	2	1	1	
Stenochironomus sp.						1
Tanytarsini	2	2			10	1
Dicrotendipes sp.		2				
Micropsectra sp.						
Rheotanytarsus sp.						
Ephydridae		1				

UTSC 2 (continued).

Taxa	Watkins Mill Rd. Sampling Sites (300 + subsample)					
	September 2015		December 2015			
	Alpha Control	Beta Control	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Empididae	3					
Chelifera sp.		1			1	
Clinocera sp.	1					
Hemerodromia sp.	3	5	6	5		1
Psychodidae						
Psychoda sp.				1		
Sciomyzidae						
Sepedon sp.	1					
Simuliidae	3		1	2		2
Prosimulium sp.					3	
Simulium sp.	25	7	3	11	2	3
Statiomyidae						
Odontomyia sp.				1		
Tabanidae						
Chrysops sp.						2
Tipulidae						
Limonia sp.	1					
Pseudolimnophila sp.	1					1
Tipula sp.		1	2	1	1	2

UTSC 3. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on an unnamed tributary (UT) to Seneca Creek (Watkins Mill Road) on March 2016. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Watkins Mill Rd. Sampling sites (100 + Subsample)				
Taxa	Alpha Control	Beta Control	Gamma Control	Lower Restoration	Middle Restoration
Hoplonemertea			1		2
Nematoda			4		1
Annelida					
Oligochaeta					
Enchytraeidae		3		3	
Naididae	1		13	1	1
Lumbricidae					
Eiseniella sp.		8		6	3
Lumbriculidae	7	4	2	4	3
Tubificidae	1	1	3		3
Insecta					
Collembola					
Isotomidae		1			
Insecta					
Ephemeroptera					
Amelitidae					
Ameletus sp.			5		
Plecoptera					
Leuctridae			1		
Perlodidae			1		
Hemiptera					
Gerridae					
Gerris sp.			1		
Trichoptera					
Hydropsychidae	2	2		1	1
Cheumatopsyche sp.	22	13	8	11	8
Diplectrona sp.					
Hydropsyche sp.				2	1
Symphytopsyche sp.	1				
Philopotomatidae					
Chimarra sp.	3	1	2	2	6

UTSC 3 (continued).

Taxa	Watkins Mill Rd. Sampling sites (100 + Subsample)				
	Alpha Control	Beta Control	Gamma Control	Lower Restoration	Middle Restoration
Diptera					
Ceratopogonidae					
Monohelea sp.					1
Chironomidae	5	7	13	6	8
Tanypodinae	2	7		3	
Thienemannimyia sp.	7	10	6	6	5
Zavrelimyia sp.					
Orthocladinae	3	4	5	3	5
Corynoneura sp.		1	2		
Diplocladius sp.			1		
Eukiefferiella sp.	3	1	5	2	3
Orthocladius sp.	43	33	19	51	40
Tvetenia sp.				4	
Chironomini	1	1			1
Dicrotendipes sp.					1
Pseudochironomus sp.	3		2	1	1
Polypedilum sp.	1	4			
Tanytarsini				1	
Empididae					
Chelifera sp.		1			
Hemerodromia sp.	1	3	1	2	4
Simuliidae					
Simulium sp.			3		1
Statiomyidae					
Stratiomys sp.		1			
Tipulidae					
Tipula sp.	2	1	2	1	

UTSC 4. Number of macroinvertebrates (EPA RBP III 300 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on an unnamed tributary to Seneca Creek (Watkins Mill Road) on March 2016. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	Watkins Mill Rd. Sampling Sites (300 + subsample)				
Taxa	Alpha Control	Beta Control	Gamma Control	Lower Restoration	Middle Restoration
Turbellaria					2
Hoplonemertea			1		2
Nematoda			5		3
Annelida					
Oligochaeta					
Naididae	1		40	4	15
Enchytraeidae		3		3	
Lumbricidae			1		
Eiseniella sp.	3	8		7	10
Lumbriculidae	10	4	3	16	16
Tubificidae	1	2	4	1	6
Hirudinae					
Glossiphoniidae					1
Crustacea					
Amphipoda					
Crangonyctidae					
Crangonyx sp.	1		2		
Insecta					
Collembola	1				
Isotomidae		1			
Insecta					
Ephemeroptera					
Amelitidae					
Ameletus sp.			10		
Caenidae					1
Plecoptera					
Leuctridae			2		
Perlodidae			1		
Hemiptera					
Gerridae					
Gerris sp.			1		

UTSC 4 (continued).

Taxa	Watkins Mill Rd. Sampling Sites (300 + subsample)				
	Alpha Control	Beta Control	Gamma Control	Lower Restoration	Middle Restoration
Trichoptera					
Hydropsychidae	2	2		5	2
Cheumatopsyche sp.	41	15	10	36	24
Diplectrona sp.				1	
Hydropsyche sp.	2			3	1
Symphytopsyche sp.	1			1	
Philopotomatidae					
Chimarra sp.	4	2	4	9	14
Coleoptera					
Elmidae					
Stenelmis sp.				3	1
Diptera					
Ceratopogonidae					
Monohelea sp.					1
Chironomidae	13	9	17	26	12
Tanypodinae	3	8		6	8
Thienemannimyia grp.	14	12	6	17	14
Orthocladinae	4	4	6	4	7
Corynoneura sp.		1	5		
Diplocladius sp.			4		
Eukiefferiella sp.	5	1	7	10	15
Hydrobaenus sp.					8
Orthocladius sp.	80	36	43	137	135
Tvetenia sp.				5	
Chironomini	1	1		1	4
Dicrotendipes sp.	2				1
Pseudochironomus sp.	4		2	1	6
Polypedilum sp.	1	5			
Tanytarsini				2	2
Empididae				1	
Chelifera sp.		2	1	1	
Hemerodromia sp.	2	3	1	14	11
Simuliidae					
Prosimulium sp.			1		
Simulium sp.			6		2
Stegopturna sp.			1		

UTSC 4 (continued).

Taxa	Watkins Mill Rd. Sampling Sites (300 + subsample)				
	Alpha Control	Beta Control	Gamma Control	Lower Restoration	Middle Restoration
Statiomyidae					
Stratiomys sp.		1			
Tipulidae					
Antocha sp.				1	
Tipula sp.	2	1	3	2	1

WMR 1. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on White Marsh Run on September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	White Marsh Run Sampling Sites (100 + subsample)			
Taxa	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Turbellaria				
Planariidae		1	1	9
Annelida				
Oligochaeta				
Lumbriculidae	1		4	3
Crustacea				
Amphipoda				
Crangonyctidae	1			
Insecta				
Ephemeroptera				
Baetidae		3		
Trichoptera				
Hydropsychidae	8	13	1	2
Cheumatopsyche sp.	20	15	1	6
Hydropsyche sp.	3	4	3	1
Symphytopsyche sp.	4	4	1	
Hydrophilidae				1
Hydroptila sp.	1			
Philopotamidae	3	1		
Chimarra sp.	9	11	1	2
Dolophilodes sp.	1			
Diptera				
Chironomidae	6	2	4	6
Tanypodinae				1
Pentaneura sp.				2
Orthocladinae	1			1
Corynoneura sp.	1	2		4
Eukiefferiella sp.			1	
Orthocladius sp.	16	7	4	27
Parametriocnemus sp.	1			
Thienemanniella sp.	6		3	

WMR 1 (continued).

Taxa	White Marsh Run Sampling Sites (100 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Chironomini	2	2	5	2
Apedilum sp.		1		
Polypedilum sp.	5	15	19	14
Pseudochironomus sp.	6	21	3	3
Saetheria sp.	3		65	20
Tanytarsini	14	2	3	9
Tanytarsus sp.	3	9	1	1
Empididae				
Hemerodromia sp.		1		
Simuliidae				
Simulium sp.		1		
Tipulidae				
Antocha sp.	1			

WMR 2. Number of macroinvertebrates (EPA RBP III 300 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on White Marsh Run on September 2015. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	White Marsh Run Sampling Sites (300 + subsample)			
Taxa	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Turbellaria				
Planariidae	4	4	1	17
Annelida				
Oligochaeta				
Enchytraeidae			1	
Lumbriculidae	2		4	7
Crustaceae				
Amphipoda				
Crangonyctidae	2			
Insecta				
Ephemeroptera				
Baetidae		5		
Trichoptera				
Hydropsychidae	24	37	1	7
Cheumatopsyche sp.	52	46	1	12
Hydropsyche sp.	18	18	3	2
Symphytopsyche sp.	18	16	1	1
Hydrophilidae				1
Hydroptila sp.	2			
Philopotamidae	9	9		1
Chimarra sp.	31	29	1	5
Dolophilodes sp.	3			
Coleoptera				
Elmidae				
Stenelmis sp.	1			
Diptera				
Chironomidae	10	9	9	19
Diamesinae				
Tanypodinae				2
Pentaneura sp.				5
Thienemannimyia sp.	1		3	

WMR 2 (continued).

Taxa	White Marsh Run Sampling Sites (300 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Orthocladinae	2	1		2
Corynoneura sp.	1	2		9
Eukiefferiella sp.	1	1	2	
Orthocladius sp.	49	23	5	60
Parametriocnemus sp.	1			
Thienemanniella sp.	14	1		
Chironomini	2	4	9	4
Apedilum sp.		1		
Polypedilum sp.	27	41	26	46
Pseudochironomus sp.	6	36	10	36
Saetheria sp.	6	4	83	58
Tanytarsini	15	13	4	12
Micropsectra sp.		9		
Rheotanytarsus sp.				4
Tanytarsus sp.	3	21	3	34
Empididae				
Hemerodromia sp.	2	2		
Simuliidae				
Simulium sp.		2		
Tipulidae				
Antocha sp.	3	1		
Pseudolimnophila sp.		1		

WMR 3. Number of macroinvertebrates (MBSS 100 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on White Marsh Run on March 2016. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	White Marsh Run Sampling Sites (100 + subsample)			
Taxa	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Turbellaria				
Planariidae		5		1
Nematoda	1			
Annelida				
Oligochaeta				
Enchytraeidae		1	1	
Lumbricidae				
Eiseniella sp.		1	1	
Lumbriculidae	2	1		1
Naididae	5	3		1
Tubificidae				1
Gastropoda				
Lymnaeidae		1		
Insecta				
Ephemeroptera				
Baetidae		1		
Trichoptera				
Hydropsychidae	1	1	1	
Cheumatopsyche sp.	3	2	2	
Hydropsyche sp.	4	11	5	
Symphytopsyche sp.	1	2		
Hydrophilidae				
Hydroptila sp.				
Philopotomatidae				
Chimarra sp.	1	1		
Dolophilodes sp.				
Diptera				
Chironomidae	36	19	42	13
Diamesinae				
Diamesa sp.	1			

WMR 2 (continued).

Taxa	White Marsh Run Sampling Sites (100 + subsample)			
	Alpha Control	Beta Control	Lower Restoration	Middle Restoration
Orthocladinae		4		2
Corynoneura sp.				
Eukiefferiella sp.	4	18	4	3
Orthocladius sp.	6	10	4	1
Parametriocnemus sp.	1			
Tvetenia sp.		2		
Chironomini	2	1		3
Dicrotendipes sp.	2	1		
Polypedilum sp.			1	
Pseudochironomus sp.	14	1		
Saetheria sp.	2		13	7
Tanytarsini	3	6	5	1
Micropsectra sp.	1		1	
Tanytarsus sp.		1		
Empididae	1			
Hemerodromia sp.	3	4		
Simuliidae	1	1		
Tipulidae	1			
Antocha sp.	2	9	4	

WMR 4. Number of macroinvertebrates (EPA RBP III 300 organism sample) collected in benthic samples by combining 9-15 D-frame aquatic net samplings (total sampling area approximately 1 m^2) at sites on White Marsh Run on March 2016. Insect quantities represent numbers of larvae or nymphs unless designated otherwise by a P for pupa or A for adult.

	White Marsh Run Sampling Sites (300 + subsample)
Taxa	Alpha Control
Nematoda	1
Annelida	
Oligochaeta	
Naididae	6
Lumbriculidae	2
Insecta	
Trichoptera	
Hydropsychidae	1
Cheumatopsyche sp.	3
Hydropsyche sp.	4
Symphytopsyche sp.	1
Philopotomatidae	
Chimarra sp.	1
Diptera	
Chironomidae	102
Diamesinae	
Diamesa sp.	1
Thienemannimyia sp.	
Orthocladinae	2
Eukiefferiella sp.	5
Orthocladius sp.	7
Parametriocnemus sp.	1
Chironomini	2
Dicrotendipes sp.	2
Pseudochironomus sp.	15
Saetheria sp.	2
Tanytarsini	5
Micropsectra sp.	1
Empididae	1
Hemerodromia sp.	3
Simuliidae	1
Tipulidae	1
Antocha sp.	2

APPENDIX C
RESEARCH ACTIVITY

POLYCHORINATED BIPHENYLS IN STORMWATER RUN-OFF

PROGRESS REPORT

Progress Report

Polychlorinated Biphenyls in Stormwater Run-off

PI: Allen P. Davis
PI: Birthe V. Kjellerup
Graduate Student: Siqi Cao
University of Maryland

Submitted to: Ryan H. Doran, Maryland State Highway Administration

Background

This report summarizes the planned and ongoing activities related to the project "Meeting Local TMDLs for PCBs".

The most recent National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) discharge permit issued to SHA requires addressing local TMDLs (Total Maximum Daily Loads) for specific pollutants of concern including polychlorinated biphenyls (PCBs) in various watersheds throughout the central part of Maryland. SHA has not had to address these pollutants previously.

Goals and objectives

The goal for this project is to provide information and guidance to SHA on biphenyls (PCBs) in SHA watersheds and stormwater so that SHA can successfully meet the requirements of their most recent MS4 permit. In this project focus will be on:

- PCB concentrations
- Relationships to sediment concentrations and sediment grain sizes
- PCB removal with sediment removal.

This information will assist in the establishment of benchmarks and timeframes for TMDL program implementation.

Progress – individual tasks

Task 1: Obtain Background Information on the PCBs TMDL from SHA and Full Literature Review

- A Ph.D. student (Ms. Siqi Cao) started at UMD in August and is currently in the process of performing a literature review focusing on the relationship between PCBs, particles, adsorption and desorption.
- As a part of this study Siqi will request information from SHA regarding previous studies, existing data and the methods that have been applied to establish a background level of PCB contamination in the watersheds that we will be investigating in this project.
- Seven stormwater retention sites at the UMD campus (which is in the Anacostia watershed, Figures 1 and 2) have been evaluated and two sites have been identified to serve at test sites for establishing the analytical methods that will be applied in this project (Figure 3).

- The analytical methods will include: representative sampling of sediment entering bioretention cells, grain size distribution of the sediment, extraction of total sediment PCBs using a microwave extraction method for low PCB concentrations and identification of individual PCB congeners as well as the total concentration of PCBs in the sediment using GC-MS.

Task 2: Sampling and Analyzing SHA and Anacostia River Watershed Stormwater for PCBs and Sediment.

- When the analytical methods (Task 1) have been established sample collection and analysis from SHA locations and locations in the Anacostia Watershed will take place. We are currently identifying these locations and are aiming at collecting samples in the 4th quarter of 2016.

Task 3: Sampling and Analyzing Accumulated SHA Stormwater Sediment for PCBs

- Samples will be collected for this task at the locations identified in Task 2 and at the same time.

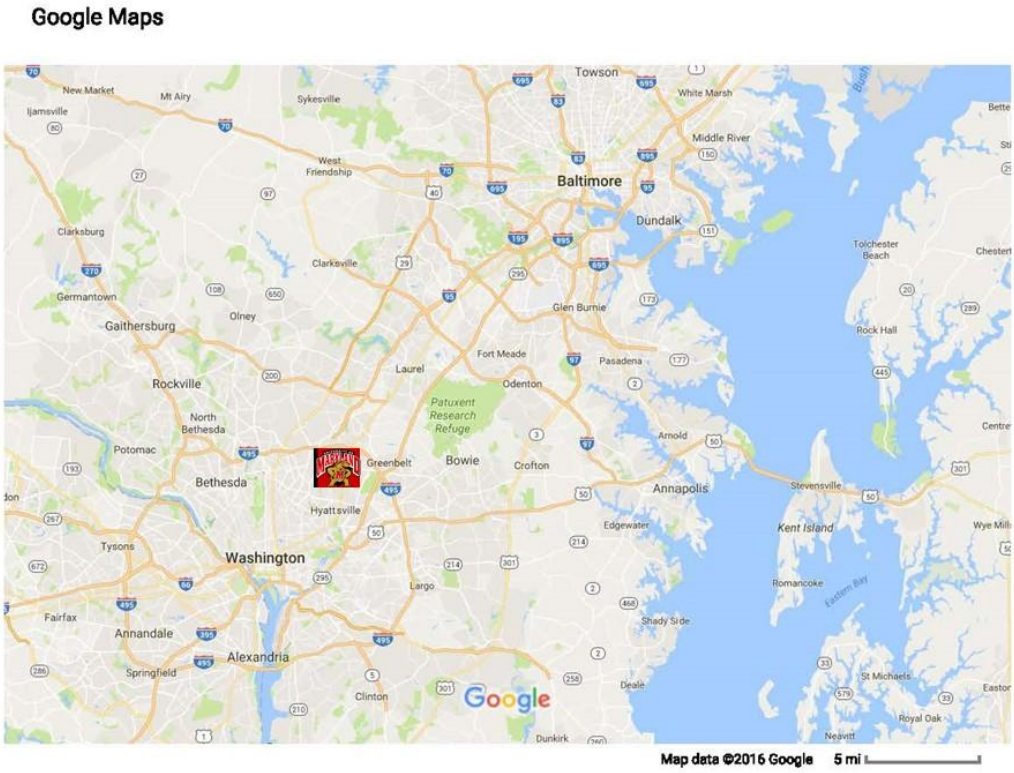


Figure 1. Location of the University of Maryland, in the Anacostia watershed, where initial sediment testing will occur.

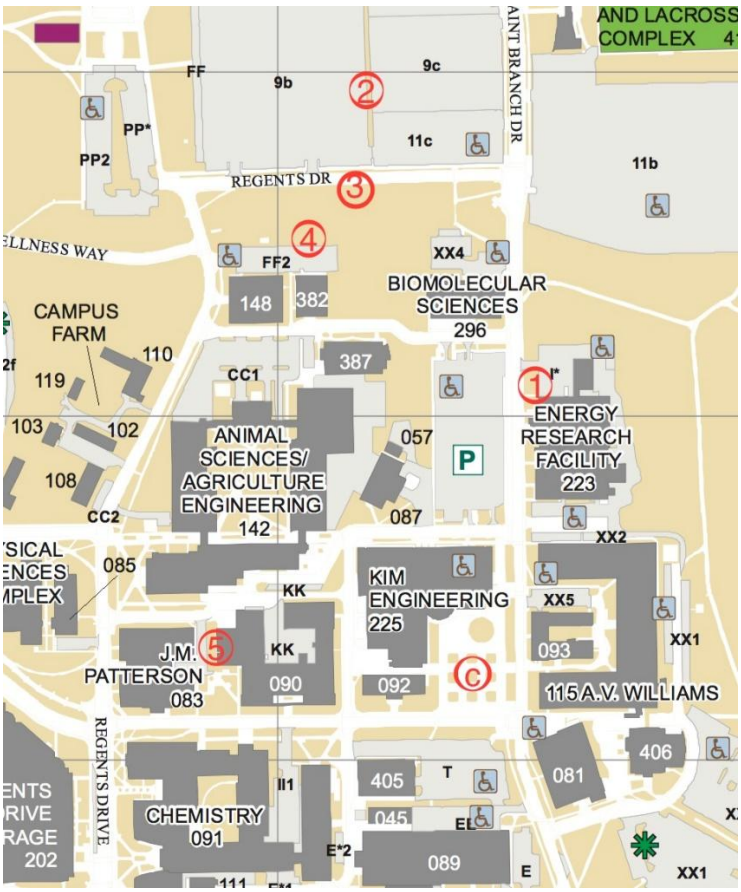


Figure 2. The bioretention sites at the UMD campus that were selected for the initial study, where the PCB analytical methods will be developed.



Figure 3. Accumulated stormwater sediment from road (Left) and parking lots (Right) at UMD campus with anticipated high levels of PCBs.

APPENDIX C
RESEARCH ACTIVITY

INLET CLEANING POLLUTANT CHARACTERIZATION STUDY FOR TOTAL MAXIMUM DAILY LOAD (TMDL) COMPLIANCE

PROGRESS REPORT

Morgan State University

Department of Civil Engineering

1700 E. Cold Spring Lane

Baltimore, MD 21251

Center for Watershed Protection

3290 North Ridge Road, Suite 290

Ellicott City, MD 21043

Inlet Cleaning Pollutant Characterization Study for Total Maximum Daily Load (TMDL) Compliance

Progress Report

In March 2016, SHA contracted with Morgan State University in partnership with the Center for Watershed Protection, Inc. to evaluate its inlet cleaning operations. Inlet cleaning operations are credited by MDE for NPDES and TMDL compliance as an alternative BMP with current crediting methods not well-defined. Existing methods rely upon a State-wide average amount of material removed from an inlet. The Chesapeake Bay Program provided an updated protocol to credit inlet cleaning practices in May 2016. This method relies upon direct measurement of material removed from inlets and literature-based nutrient enrichment factors to determine the nitrogen and phosphorus pollutant load reduction credits. There is an option for jurisdictions to substitute their own enrichment factor if they sample the nutrient and carbon content of the materials they physically remove from the storm drain.

The purpose of the study is to determine appropriate crediting of this practice for TMDL compliance and to collect information that could support enhancements to the existing credit allowed by MDE. The primary goals of the study are to:

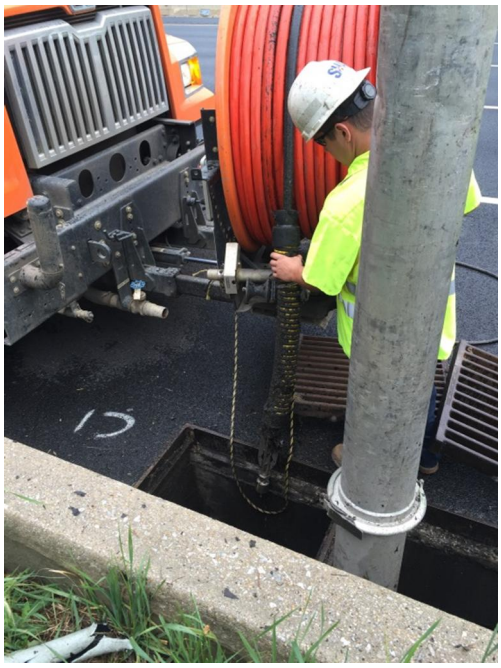
- *Determine the mass of pollutants removed by inlet cleaning by removal of stormwater-borne solids*
- *Quantify the mass and accumulation rate of target pollutant loads related to gross, coarse, and fine solids entering highway catch basins*
- *Provide SHA highly valued data required to justify regulatory credit regarding inlet cleaning practices, and*
- *Provide guidance to optimize maintenance operations*

A prime challenge of meeting TMDL requirements is the mandate to quantify the pollutants captured and removed from inlets and road surface. Defining the composition of those

captured solids is of major interest for SHA for compliance reporting. Therefore, characterization of stormwater-borne gross, coarse, and fine solids is needed.

Morgan State University and the Center for Watershed Protection is working with SHA on a two-year study that includes the following tasks: 1) a programmatic evaluation of current inlet cleaning operations and 2) development and implementation of a monitoring study design to quantify nutrients, sediment and trash removed from the inlets. The results for these two task will inform recommendations to optimize the inlet cleaning program for TMDL compliance. This research will investigate SHA maintained roadways to evaluate the inlet cleaning activities with interest relevant to nearby impaired waterways. Data obtained from this study will inform recommendations to optimize pollutant load reduction credits for SHA inlet cleaning via programmatic decision support and provide information that can potentially improve the credit allowed by MDE. The result will also facilitate reporting pollutant removal from inlet cleaning activities Statewide as well as at the watershed-scale.

To date, the project team (MSU and CWP) has completed on-site visits with SHA Maintenance crews to review current practices for cleanout and disposal, and reviewed the SHA geodatabases relevant to the study. This information informed development of a programmatic survey to SHA District and Maintenance Shops is planned for distribution in September 2016. The QAPP and Monitoring Plan describes the methods and sampling design to quantify material removed from inlets using SHA-owned Vactor trucks. The selection of inlets will be based on a representative set of inlets and samples to provide assurance that results will characterize statewide practices. Additional monitoring activities will include measurements from selected inlets to estimate accumulation rates of materials within the inlets on a seasonal and annual basis. The QAPP will follow EPA guidance and approved methods for materials analysis. Monitoring of the inlets is planned to begin in October 2016 through September 2016.



Vactor truck cleaning inlet



At disposal site



Disposal of liquid

APPENDIX C
RESEARCH ACTIVITY

ASSESSMENT OF BIOSWALE PERFORMANCE

OCTOBER 2015 PROGRESS REPORT

DECEMBER 2015 PROGRESS REPORT

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
APPALACHIAN LABORATORY

301 BRADDOCK ROAD
FROSTBURG, MD 21532-2307
GENERAL NUMBER (301) 689-7100
FAX (301) 689-7200
http://www.umces.ed
Dr. Raymond P. Morgan II
301-689-7172 (Direct Line)
rmorgan@al.umces.edu

To: **Mr. Armaud J. DeRosset**
From: **Dr. Ray Morgan, Dr. Keith Eshleman and Mr. Ian Smith**
Subject: **FY 16 Bioswale Project - State Highway Administration**
Date: **October 2015**

Introduction

This document serves as a FY 16 Q1 progress report between the Appalachian Laboratory and the State Highway Administration, detailing laboratory/field activities in support of "Assessment of Bioswale Performance – Phase II."

Work Schedule

1) Since the site was not fully operational until September 2014, we will continue our normal collection protocols at the two bioswales and the current control site through calendar year 2015 (Tasks 3.2-3.5). After the end of the year, we will prepare a report detailing our hydrological findings on the bioswale performance and the control at the Hagerstown site.

2) We will make an effort to determine the water table in the vicinity of the bioswales and the control. This may be influencing the response of the bioswales and control to storm events. In addition, it would be helpful to have SHA pull the plan or design maps in order that we may examine the details of site elevations along the roadway. This data would be extremely helpful in looking at all potential flow patterns in the Dual Highway medians. Also, we intend – upon approval – to add one rain runoff collector along the median in order to assess road runoff during storm events.

3) Following the report, we may make a recommendation to pull the Beta bioswale site for relocation. The equipment could then be moved to another site, either in the Piedmont (Route 15 near Frederick, Route 40 near Ellicott City, or Route 340 near Frederick, or another site of interest to SHA) or the Western Coastal Plain. The fiscal liability here would be for the purchase of an additional storm event sampling array (~ 20K) which we would request from SHA via a contract addendum. The benefit would be that a second site would be established.

4) Following the report, we may make a recommendation to relocate the Dual Highway control site, moving it westward to one of two potential median sites which may serve as a better control than the current site, unless these two areas are slated to have bioswales installed.

Projected Tasks

1) We sampled the bioswales and the control site for soil chemistry in September 2015. This sampling was about 15 months after the last soil sampling in May 2014 (Task 4.4).

2) We will assess vegetation structure during November (Task 4.4).

3) We will measure infiltration rates (Task 4.2) and recharge rate in November as well (Task 4.3).

Unexpected Developments and Major Problems

1) We do not have the checkdams in place at the Beta bioswale (perhaps a moot point depending on the proposed schedule).

2) Soils material was extremely compacted limiting sample collection to the upper and middle soil profile in some sub-locations.

3) We need to determine if the two bioswale sites are lined or unlined. Although we are in possession of a bioswale design (dated 2013) for the US 15 – Monocacy Boulevard Interchange that shows the positioning of a PVC liner, we are unsure if the Alpha and Beta sites are either lined or unlined. SHA may be able to determine this for us from the plan maps for the Dual Highway bioswales.

4) There was damage due to mowing operations to the Beta site which we repaired. Bioswales are being frequently mowed which may influence various soil properties (e.g. permeability).

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
APPALACHIAN LABORATORY

301 BRADDOCK ROAD
FROSTBURG, MD 21532-2307
GENERAL NUMBER (301) 689-7100
FAX (301) 689-7200
http://www.umces.ed
Dr. Raymond P. Morgan II
301-689-7172 (Direct Line)
rmorgan@al.umces.edu

Project Timetable - Project started as of 1 July 2015, and we received the ORAA project summary sheet.

Project Completion Status - Project is underway (1st quarter of 18 months).

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
APPALACHIAN LABORATORY

301 BRADDOCK ROAD
FROSTBURG, MD 21532-2307
GENERAL NUMBER (301) 689-7100
FAX (301) 689-7200
http://www.umces.ed
Dr. Raymond P. Morgan II
301-689-7172 (Direct Line)
rmorgan@al.umces.edu

To: **Mr. Armaud J. DeRosset**
From: **Dr. Ray Morgan, Dr. Keith Eshleman and Mr. Ian Smith**
Subject: **FY 16 Bioswale Project (Q2) - State Highway Administration**
Date: **December 2015**

Introduction

This document serves as a FY 16 Q2 progress report between the Appalachian Laboratory and the State Highway Administration, detailing laboratory/field activities in support of "Assessment of Bioswale Performance – Phase II."

Work Schedule

1) Since the site was not fully operational until September 2014, we continued our normal collection protocols at the two bioswales and the current control site through the end of calendar year 2015 (Tasks 3.2-3.5). After the end of CY 15, we will prepare a report detailing our hydrological findings on the bioswales and the control at the Hagerstown Dual Highway site.

2) We will make an effort to determine the water table in the vicinity of the bioswales and the control. This may be influencing the response of the bioswales and the control to storm events. In addition, we may install zero-tension lysimeters and a run-off collector at the Alpha bioswale upon approval.

3) We are making a recommendation to pull the Beta bioswale site for relocation (to be marked as Beta bioswale and Delta control). The equipment could then be moved to another site in the Piedmont (Route 15 near Frederick, Route 40 near Ellicott City, or Route 340 near Frederick, or another Piedmont site of interest to SHA). We would like to obtain a listing of three to six potential sites in order to examine them during early Q3. Establishment of the site would take place as soon as possible once a site is selected. We envision a smaller Parshall flume and we have enough equipment from previous work to set up the site. There is adequate money in the contract to currently support this work.

4) We will relocate the Dual Highway control site, moving it westward to one of two potential median sites which may serve as a better control than the current site (unless these two areas are slated to have bioswales installed). The Alpha site (and Gamma control) will be retained as a long-term site.

Projected Tasks

1) We sampled the bioswales and the control site for soil chemistry in September 2015. Sampling occurred approximately 15 months after the last soil sampling in May 2014 (Task 4.4). These samples are currently being processed for metals and nutrients as well as physical soil properties.

2) We tried to assess vegetation structure during November (Task 4.4). However, this was not possible due to maintenance/mowing of the bioswales.

3) We measured infiltration rates (Task 4.2) and recharge rate in November (Task 4.3) – analysis is complete and will be included in the upcoming report.

Unexpected Developments and Major Problems

1) We still do not have the checkdams in place at the Beta bioswale (perhaps a moot point depending on the proposed schedule).

2) Soil material was extremely compacted during September sampling, limiting collection to the upper and middle soil profile in some sub-locations. Soil compaction is assumed to be due to mowing activities which would affect various soil properties (e.g. permeability), although climatic conditions may be having an influence as well.

3) There was damage to one wing wall, and breakage of one electrical wire. All damage was repaired.

Project Timetable - Project started as of 1 July 2015 after receiving the ORAA project summary sheet.

Project Completion Status - Project is ongoing (2st quarter of 18 months).

Appendix D

SHA TMDL Implementation Plan:

Response to Public Comments





SHA Impervious Restoration and Coordinated TMDL Implementation Plan

Public Comments and Responses
October 9, 2016

This report documents comments received for the SHA *Impervious Restoration and Coordinated TMDL Implementation Plan* that was placed on www.roads.maryland.gov for public notice beginning August 1, 2016. This plan was developed under the SHA MS4 permit requirement under Part IV.E, Restoration Plans and Total Maximum Daily Loads, and 30 days of public notice was required. Comments received are documented in the table below, repeated below with SHA responses and copies of comments are also attached. Comments were received from four separate commenters as listed.

List of Commenters

Comment	Commenter/Author	Affiliation	Date Submitted
1	Sam Owings	Private Citizen	8-12-2016
2	Mary Jeanne Marken	Private Citizen	8-12-2016
3	Ronald H. Fithian	Clean Chesapeake Coalition	8-31-2016
4	Greg Golden	MD DNR	9-01-2016

Comment - 1:

SHA should embrace the use of the "Cascading System" of Floodway Stormwater Containment Basins, like they did on the 301/304 intersection overpass (in Queen Anne's County) construction project.

The Cascading System reduces sediment, nutrient and pollution movement from entering state waters and also works as flood control, creates wildlife habitat and replenishes the ground water system.

www.highimpactenvironmental.org

SHA Response - 1:

Thank you for bringing this strategy to our attention. SHA will make use of all feasible practices in reaching our impervious surface restoration and pollutant reduction goals.

Comment - 2:

Anne Arundel county executive Schuh wants a 100 foot dog beach park on the Chesapeake Bay. Does this help the Chesapeake Bay? The dogs will poop I'm the water and right on the beach! The proposed development also includes construction in a resource conservation area of pavilions on an already eroded beach. The plan will negatively impact 30 migratory bird species. Does the County answer to anyone on the State or national level? RK&K did a study and Tritom Beach is considered highly sensitive archaeologically and historically. To support the public park they want to build a 152 car parking lot a bathhouse picnic pavilions etc. Which does the county answer to regarding the environmental impacts?

SHA Response - 2:

The Maryland Department of the Environment (MDE) should be contacted regarding this matter. This comment is not relevant to the SHA implementation plan and the project is not within SHA's jurisdiction.

Comment - 3:

A. The implementation of such restoration and water quality improvement activities along State highways and roads should not be limited to the eleven jurisdictions subject to MS4 permitting requirements. Pursuant to Maryland's Phase II Watershed Implementation Plan (WIP), each county developed a local WIP and each county is contributing significantly to Maryland's collective efforts and expenditures to meet the Chesapeake Bay TMDL goals. When one utilizes the "SHA Bay Restoration Viewer" tool online to locate completed and proposed SHA water quality improvement projects, the exclusion of Eastern Shore counties and Southern Maryland counties that boarder the Chesapeake Bay and Bay tributaries is striking. The estimated 40,000 acres of impervious surfaces that comprise the State's highway system and contribute to runoff pollution to the Bay are obviously not all located in the eleven more urbanized counties subject to MS4 permitting requirements. Simply put, the SHA Plan should encompass all counties under mandate to help the State meet Bay TMDL goals.

SHA Response – 3A:

The SHA *Impervious Restoration and Coordinated TMDL Implementation Plan* was developed as a response to requirements of the SHA MS4 permit that covers conditions placed on SHA storm drain systems that lie within MS4 jurisdictions. SHA was issued a municipal separate storm sewer system (MS4) discharge permit on October 9, 2015. In the permit SHA is instructed to complete the implementation of restoration efforts for twenty percent of SHA's untreated impervious surface. Thus, SHA is bound by the permit to a specific geographical location with this plan.

Also, geographic focus for the urban stormwater sector was set by the MD WIP to meet urban impervious restoration goals and assigned load reductions within the MS4 areas. SHA meets State stormwater and erosion and sediment regulations for roadway development throughout the state and would like to focus more restoration efforts on the eastern shore and southern Maryland. For this reason, SHA is working with the MDE, MDA and the Water Quality Trading Advisory Committee (WQTAC) in support of credit trading that will allow the MS4 community to move beyond the MS4 geographic areas into other areas of the State to meet the assigned restoration goals.

B. Regarding structural controls, particularly those BMPs that retain surface water for an extended period of time (by design or otherwise), we recommend more detail about facility monitoring, management and maintenance to prevent the creation of nuisances and/or potential health threats (i.e., growing concerns about Zika virus transported by mosquitos),

SHA Response – 3B:

SHA is very concerned about potential health risks posed by structural stormwater controls and is utilizing more open grassed channels, bioretention, submerged gravel wetlands and filter type facilities than wet facilities in implementing restoration projects. These types of facilities have little to no intentionally ponded surface waters. Occasionally, SHA uses wet ponds, wetlands and wet swales but these BMPs are designed to convey flowing water, are characterized by varying depths, and aquatic vegetation. According to MDE these design features create natural habit for predators of mosquitos and mosquito larva such as dragon flies, birds, fish, turtles, bats and frogs. More information about mosquitoes and stormwater management can be found on the MDE website at this link:

http://mde.maryland.gov/programs/Water/StormwaterManagementProgram/SedimentandStormwaterHome/Documents/Mosquitoes%20Stormwater%20Management%20Fact%20Sheet.pdf.

The Maryland Department of Agriculture (MDA) has a Mosquito Control Program in which they seek to prevent mosquito-borne diseases in humans, pets and domestic livestock. Please visit their webpage here:

http://mda.maryland.gov/Documents/ag_brief/AgBrief_Mosquito-Control.pdf.

MDA has also developed a Zika awareness and prevention information page in which it provides residents, homeowners and organizations with simple ways to eliminate mosquito breeding sites and avoid mosquito bites located here:

http://mda.maryland.gov/plants-pests/Pages/Zika.aspx.

C. We support stream restoration that reestablishes the general structure, function and self-sustaining ecology of the stream system in existence prior to disturbance,

SHA Response – 3C:

SHA implements a variety of stream restoration and stabilization techniques, including returning the stream corridor to pre-development condition. SHA bases its stream designs on the characteristics of the stream site in particular, ability to acquire necessary environmental and waterway permits, the nature of stream degradation, size of drainage area, stream order and many other factors.

D. Regarding tree planting, be it afforestation or reforestation, we commend to your attention recent studies concerning adverse impacts on water quality attributable to sapropel or sapropelic mud,

SHA Response – 3D:

According to the article that was referred to in the comments, sapropelic mud forms when organic matter is trapped in the bottom of deep water with reduced oxygen concentration. SHA's tree planting projects are unlikely to contribute to this water quality issue. Tree

planting takes place on upland areas drained by flowing streams, so any leaf fall is unlikely to migrate to deeper waters where sapropel could be formed. Instead, leaves from SHA tree planting projects will either decay on the ground or be transported to a stream where they break down and are consumed by macroinvertebrates as part of the aquatic food chain.

E. In the context of watershed planning and water quality improvement efforts, it is imperative that SHA coordinate to extent practicable with local government officials and agencies in project planning, design, construction and maintenance. Implementation of the SHA Plan should be in harmony with local WIPs and other county land use plans.

SHA Response – 3E:

SHA has established an outreach program tasked with coordinating impervious restoration and pollution reduction strategies with each of the MS4 jurisdictions and counties. Please refer to Part I.E.4 of the plan for details on coordination with other MS4 jurisdictions.

Comment - 4:

A. Documents could include reference to conservation of local aquatic natural resource values simply and right up front within TMDL goals and objectives (or considerations) text.

SHA Response – 4A:

SHA recognizes the importance of conserving local aquatic and riparian resources where conservation benefits outweigh the benefits of restoration activities. SHA coordinates with federal and state resource agencies to identify resources to avoid or enhance where possible. SHA is neutral regarding preference on stream restoration design approaches. Site conditions and existing resources drive design approach selection. SHA generally prioritizes dysfunctional stream systems to maximize ecosystem lift and avoid affects to high function resources.

B. Stormwater management discussion, especially in text referring to facility design options, could reference the importance of coldwater conservation efforts through thermal regime protection.

SHA Response – 4B:

SHA notes your concern of including a reference in the Impervious Restoration and Coordinated TMDL Implementation Plan to the importance of coldwater conservation efforts through thermal regime protection and importance of coldwater conservation of local aquatic natural resource values during stream restoration. On page 1-10 of the plan SHA does point out the importance of obtaining a permit from Maryland Dam Safety for thermal impacts related to construction in Use III waters and certain stormwater embankments.

For SWM projects in Use III Waters (designated coldwater streams), SHA takes thermal regime into consideration when selecting the BMP type appropriate for the site. BMP types that have permanent pools (e.g. wet ponds, wet swales) which can absorb energy from sunlight and increase the water temperature of discharging from the BMP are avoided. BMP

types that are used include filtering practices (bioretention and surface sand filters), grass/bio swales, infiltration practices, and submerged gravel wetlands.

In future SHA will make an attempt to include further reference to the benefits of thermal regime in updates to the plan where necessary.

C. Text on stream restoration approaches could include upfront a reference to the importance of conserving local aquatic and riparian natural resources during stream restoration planning and implementation.

SHA Response – 4C:

See response to 4A.

From: Sam Owings
To: SHA OED WPD
Subject: office of environmental design, comment
Date: Friday, August 12, 2016 8:02:17 AM

SHA should embrace the use of the “Cascading System” of Floodway Stormwater Containment Basins, like they did on the 301/304 intersection overpass (in Queen Anne’s County) construction project.

The Cascading System reduces sediment, nutrient and pollution movement from entering state waters and also works as flood control, creates wildlife habitat and replenishes the ground water system.

Sam Owings
www.highimpactenvironmental.org
443-282-4141

From: MARY JEANNE MARKEN
To: SHA OED WPD
Subject: Triton Beach Priposed Devekopment
Date: Friday, August 12, 2016 9:38:47 AM

Anne Arundel county executive Schuh wants a 100 foot dog beach park on the Chesapeake Bay. Does this help the Chesapeake Bay? The dogs will poop I'm the water and right on the beach! The proposed development also includes construction in a resource conservation area of pavilions on an already eroded beach. The plan will negatively impact 30 migratory bird species. Does the County answer to anyone on the State or national level ? RK&K did a study and Tritom Beach is considered highly sensitive archaeologically and historically. To support the public park they want to build a 152 car parking lot a bathhouse picnic pavilions etc. Whi does the county answer to regarding the environmental impacts?
Sent from my iPhone

210 S. Cross Street, Suite 101
Chestertown, Maryland 21620
Phone: (410) 810-1381
Fax: (410) 810-1383
www.CleanChesapeakeCoalition.com

August 31, 2016

VIA Electronic Mail
Gregory C. Johnson, P.E, Administrator
State Highway Administration
Office of Environmental Design, C-303
707 North Calvert Street
Baltimore, Maryland 21202
wpd@sha.state.md.us

Re: Comments on SHA Plan to Improve Chesapeake Bay Water Quality

Dear Administrator Johnson:

The Clean Chesapeake Coalition ("Coalition") appreciates this opportunity to provide comments on the proposed policies, plans and methods of the Maryland Department of Transportation's State Highway Administration (SHA) to meet mandated pollution reduction requirements under the federal Clean Water Act and to improve the water quality of the Chesapeake Bay ("SHA Plan").

The Coalition is an evolving association of Maryland county governments – currently including Caroline, Carroll, Cecil, Dorchester, Kent, Queen Anne's and Wicomico – whose local elected officials have coalesced to raise awareness and pursue improvement to the water quality of the Chesapeake Bay in the most cost-effective and fiscally responsible manner possible – through research, coordination and advocacy. True to the Coalition's mission, we recommend that the SHA Plan be focused on the most cost-effective projects, programs and activities that are proven to yield measurable and lasting improvements to water quality.

According to the SHA Plan, the restoration focus area includes systems, conveyances and drainage areas along State maintained roads. We understand that SHA maintains its MS4 (Municipal Storm Sewer System) permit coverage for its roadway storm drain systems in nine Maryland MS4 Phase I counties (Anne Arundel, Baltimore, Carroll, Charles, Frederick, Harford, Howard, Montgomery and Prince George's) and in the two MS4 Phase II counties (Cecil and Washington). Restoration projects highlighted in the SHA Plan include tree planting, stormwater control structures, stream restoration, outfall stabilization and pavement removal.

The implementation of such restoration and water quality improvement activities along State highways and roads should not be limited to the eleven jurisdictions subject to MS4 permitting requirements. Pursuant to Maryland's Phase II Watershed Implementation Plan

(WIP), each county developed a local WIP and each county is contributing significantly to Maryland's collective efforts and expenditures to meet the Chesapeake Bay TMDL goals. When one utilizes the "SHA Bay Restoration Viewer" tool online to locate completed and proposed SHA water quality improvement projects, the exclusion of Eastern Shore counties and Southern Maryland counties that boarder the Chesapeake Bay and Bay tributaries is striking. The estimated 40,000 acres of impervious surfaces that comprise the State's highway system and contribute to runoff pollution to the Bay are obviously not all located in the eleven more urbanized counties subject to MS4 permitting requirements. Simply put, the SHA Plan should encompass all counties under mandate to help the State meet Bay TMDL goals.

With respect to SHA's Bay Restoration Strategies (aka Best Management Practices or BMPs) to reduce nutrient and sediment loading to the Bay, including structural and nonstructural stormwater controls, source control and land use changes, we offer the following comments:

- regarding structural controls, particularly those BMPs that retain surface water for an extended period of time (by design or otherwise), we recommend more detail about facility monitoring, management and maintenance to prevent the creation of nuisances and/or potential health threats (i.e., growing concerns about Zika virus transported by mosquitos);

- we support stream restoration that reestablishes the general structure, function and self-sustaining ecology of the stream system in existence prior to disturbance;

- regarding tree planting, be it afforestation or reforestation, we commend to your attention recent studies concerning adverse impacts on water quality attributable to sapropel or sapropelic mud.[1]

In the context of watershed planning and water quality improvement efforts, it is imperative that SHA coordinate to extent practicable with local government officials and agencies in project planning, design, construction and maintenance. Implementation of the SHA Plan should be in harmony with local WIPs and other county land use plans.

Sincerely,

Ronald H. Fithian,
Chairman and Kent County Commissioner

cc: Clean Chesapeake Coalition
Maryland Rural Counties Coalition

[1] "What About Sapropel and the Conowingo Dam," Tim Vissel 09/24/14. *See* link: https://www.bluecrab.info/forum/index.php?topic=73525

From:	Greg Golden -DNR-
To:	Karen Coffman; SHA OED WPD
Cc:	Robert Shreeve; Tony Redman -DNR-
Subject:	discussion points and comments Re: SHA Bay Restoration Plan
Date:	Thursday, September 01, 2016 3:57:17 PM

Karen
Thanks for your info back. As you know from my previous message, we saw this notice halfway through the period, and I had jotted down to get back to you by 9/1, but I see today that the published deadline was 8/31. I'm not too worried about how you need to handle it as far as the deadline, this message is viewed as collaborative and supportive interagency coordination, and please consider as you see appropriate. I would appreciate a chance to discuss directly when you or your designee has the opportunity.

I am commenting/coordinating officially from my review position, but we ran a little short on being able to coordinate a full agency comment; the direct coordination and partnering approach is likely optimal in any case.

Obviously we strongly support SHA's TMDL efforts, and we know and support that SHA is put in a leadership and innovator role State and Region wide. The scale of your efforts and expertise that you are able to apply makes that a well deserved responsibility (and challenge!). We enjoy and get strong conservation value out of our collaboration and partnership.

A conservation point we often work on, and would like to make again to you as an updated comment for your current documents at this time, is that TMDL work and its associated documents and outreach should actively acknowledge the importance of conserving local aquatic resources while conducting restoration and water quality efforts. We realize that SHA already does this in action, through scoping letters, project review, and other coordination. We feel it is important to also emphasize in documents precisely because of that leadership role SHA holds; so that others are made aware of the importance of local important resources (such as RTE species: bog turtles and rare darter species as just two examples, coldwater wild trout populations, etc.). Documented references to local resources in various literature, plans, and outreach also help agency planners, incoming trainees, and even managers stay plugged in.

Regarding the online public notice information itself, we read through to the degree that we could in the remaining review period. Although our review office does not have specific locations to recommend edits or added references to local natural resources, we did believe such references could be incorporated within the document and future documents, in a relatively smooth manner.

For example, thermal regime protection efforts in designated coldwater streams (MD State Use Classifications III and III-P) are important, an issue our agencies have partnered on before. But this issue is still missed or misunderstood by many planners throughout the region. Multi-agency efforts to bring a higher profile to thermal regime protection in coldwater systems is both beneficial to the resource and will help streamline planning and review of projects. This issue might be referenced in any of several locations where program goals are referenced. Also, when various specific stormwater management Best Management Practices are referenced, it would be an excellent opportunity to simply add the thermal benefits of both the infiltration and the underground filtering designs in their descriptions. Those references could range from just a few words on thermal benefits of the filter and infiltration designs, to a possible few additional sentences on the values of coldwater habitats and the methods in

which they can be protected.

We did recognize that MDE's Small Pond Flow Chart was references as one of the review requirements in Use III waters. We view this as an excellent reference to the requirement, but we also advocate the benefit of referencing the goals and objectives regarding thermal regime. In other words, the good intent and stewardship value, in addition to just the requirement.

It may be difficult to include references to multiple specific local resources in your documents; we understand that, and we may have even missed some existing references. Because thermal review has such direct relationship with stormwater management practices and design, our idea was focus on that issue, and to conclude with the following recommendations:

1. Documents could include reference to conservation of local aquatic natural resource values simply and right up front within TMDL goals and objectives (or considerations) text.

2. Stormwater management discussion, especially in text referring to facility design options, could reference the importance of coldwater conservation efforts through thermal regime protection.

3. Text on stream restoration approaches could include upfront a reference to the importance of conserving local aquatic and riparian natural resources during stream restoration planning and implementation.

Since there are many possible locations to include edits, but only a few references would be needed, we chose to leave the comment general. We would be glad to discuss further if you wish.

In conclusion, the SHA TMDL efforts overall are strongly supported, and ongoing aspects to conserve local aquatic resources should be noted for the benefit of others where appropriate, and are also always worthwhile for tuning and update considerations as programs continue.

Thank you for the opportunity to coordinate on these important issues.

If you have any questions on the comments above, please contact me at your convenience.

Greg Golden
Environmental Review Program
MD Department of Natural Resources
410-260-8331
please note my new email address: greg.golden@maryland.gov

Appendix E

SHA Restoration Modeling Protocol





SHA RESTORATION MODELING PROTOCOL

Developed for Chesapeake Bay and Local Waters
TMDL Requirements
for NPDES MS4 Permit Compliance

October 2016



State Highway Administration
Office of Environmental Design - Water Programs Division

707 N. Calvert Street
Baltimore, MD 21202

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I. PURPOSE

The purpose of this document is to describe State Highway Administration (SHA) processes and procedures used in determining SHA load reduction requirements, modeling load reductions achieved, and programming future projects and end dates. These processes and procedures will also be used to satisfy SHA's MS4 permit conditions of "modeling to document the progress towards meeting established benchmarks, deadlines, and stormwater WLAs" and "descriptions of the analytical methodology used to evaluate the effectiveness of SHA's restoration plans and how these plans are working toward achieving compliance with EPA approved TMDLs".

This protocol addresses pollutants with approved TMDL allocations to SHA under NPDES regulated stormwater point sources as stormwater wasteload allocations (SW-WLAs). Current WLAs assigned to SHA include total phosphorus (TP), total suspended solids (TSS), bacteria, polychlorinated biphenyls (PCBs), and trash. If TMDLs for additional pollutants are issued with SHA load reductions, this protocol will be updated to describe new modeling methods used in instances where the methods currently included are not applicable to new pollutants. SW-WLAs assigned to other NPDES regulated stormwater permittees are not addressed here.

Section II describes reduction target derivation procedures used prior to modeling load reductions achieved.

Section III describes the databases which SHA uses to manage its restoration BMPs for planning through compliance reporting.

Sections IV through VII present the methodologies used to model load reductions and progress towards compliance for TP, TSS, bacteria, PCB, and trash TMDLs.

II. REDUCTION TARGET DERIVATION

II.A Calculating Required Reductions

For point sources, most TMDLs list a baseline loading, wasteload allocation, and margin of safety (MOS) for each source sector. The reduction target can be derived by subtracting the WLA from the baseline loading and then adding the MOS which is usually a percent of the reduction requirement. If the baseline is not published, a reduction percent is usually published in the TMDL that can be applied to the WLA using the following formula.

$$Reqd\ Reduction_{SHA} = \left[\frac{WLA}{(1 - Reqd\ Reduction\ \%)} - WLA\right](1 + \%\ MOS)$$

Where

Reqd Reduction $_{SHA}$ = Reduction required for SHA in units prescribed by the TMDL;

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

Reqd Reduction % = Published percent reduction

% MOS = percent of reduction requirement used to calculate the margin of safety in the TMDL document. This should only be applied if it is not included in the published percent reduction.

II.B Disaggregated Reductions

Allocations assigned in approved TMDLs can be either an individual or aggregate SW-WLA. SHA is included in various aggregate SW-WLAs and is considered a part of an aggregate SW-WLA if one of the following items is included in the report text or report Appendix:

- SHA is included in a list of permittees in the report or Appendix
- SHA was named in the following text: "…the SW-WLA category includes any other Phase I and Phase II NPDES regulated stormwater entities in the watershed, including the MD SHA Phase I MS4, Phase II State and federal MS4s, and industrial stormwater permittees."

In order to derive the SHA-specific load reduction targets from aggregate SW-WLAs, the aggregate SW-WLAs need to be *disaggregated* before the percent reduction is applied to calculate the load reduction required. Aggregate WLAs are disaggregated following steps outlined in MDE's TMDL Stormwater Toolkit (MDE, 2016a). Aggregate SW-WLAs are disaggregated by applying the percent of SHA land (both impervious and pervious) within SHA right-or-way (ROW) within the local TMDL watershed to the published aggregate WLA according to the equation below. It is important to note, local TMDLs with individual SW-WLAs require a specified percent reduction of pollutant loads from baseline levels to achieve the target SW-WLA and no disaggregation is necessary.

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

Where

WLA_{SHA} = Disaggregated WLA for SHA

A_{SHA} = Area of SHA-owned land

A_{TMDL} = Area of aggregate TMDL urban land area

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

The SHA MS4 urban land area and aggregate TMDL urban land area is calculated by the following method:

a. To find the aggregate urban land area, TMDL watershed boundaries were intersected with Maryland Department of Planning (MDP) 2010 land use (LU) data (MDP, 2010). The sum of watershed area classified as urban land use categories "Urban" and "Transportation" from the MDP land use data were used to define each jurisdiction's urban area.

b. To find the SHA-owned land, SHA Right-of-Way (ROW) pervious and impervious land area from SHA spatial data as of June 2014 is intersected with TMDL watershed boundaries to calculate SHA ROW by watershed. SHA's urban footprint has been delineated using ROW boundaries derived from the best available information from SHA's property management staff.

An example illustrating a disaggregated WLA can be seen in Tables 1and 2. Here SHA is issued a TMDL for sediment in the Catoctin Creek watershed as part of a larger aggregated load to the county. SHA has to determine how much urban land use it owns in the watershed as a part of the total urban land use in the 8-digit watershed. SHA's WLA and reduction target responsibility are determined using the steps outlined above.

Table 1: Example Calculation of Percent of SHA Land Use used to Disaggregate the WLA

8-Digit Watershed Name	Watershed Number	Total Watershed Area[1] (sq. ft)	Total Watershed Area[1] (ac)	Total Urban Area[2] (sq. ft.)	Total Urban Area[2] (ac)	SHA Landuse Area[3] (sq.ft.)	SHA Landuse Area[3] (ac)	Calculated SHA Landuse[4] %
Catoctin Creek	02140305	3,356,886,511	77,063.5103	828,855,635	19,027.9071	56,548,098	1,298.1657	**6.82%**

1. GIS export: Intersect of 8-digit watersheds with counties and the MDP 2010 landuse data; this list only includes 8-digit watersheds that are located within MS4 counties.
2. Landuse Source: MDP 2010, Urban landuse = Urban + Transportation MDP landuse categories
3. SHA landuse data
4. Calculated SHA Landuse % = SHA Landuse / Total Urban Area

Table 2: Example Calculation for SHA WLA Disaggregation

Watershed Name	Watershed Number	Pollutant	Published Aggregate WLA[1] (EOS-lbs/yr)	Published Reduction[2] %	SHA Landuse[3] %	Calculated Disaggregated SHA WLA[4] (lbs/yr)	Calculated Disaggregated SHA Baseline Load[5] (lbs/yr)	Calculated Disaggregated SHA Reduction[6] (lbs/yr)
Catoctin Creek	02140305	Sediment	2,784,000	49.1	**6.82%**	189,868.8	373,023.2	183,154.4

1. Aggregate WLA attributed to County MS4 or "Other SW" as published in the Local TMDL Main Report and/or Local TMDL Point Source Tech Memo and as published in the MDE TMDL Data Center WLA Search tool (http://wlat.mde.state.md.us/WLASearch.aspx)
2. Percent reduction attributed to County MS4 or "Other SW" as published in the Local TMDL Main Report and/or Local TMDL Point Source Tech Memo and as published in the MDE TMDL Data Center WLA Search tool (http://wlat.mde.state.md.us/WLASearch.aspx). The published reduction is computed using (Baseline-WLA)/Baseline.
3. See Table 1
4. Disaggregate WLA is calculated by multiplying MDE published aggregate WLAs by the percentage of SHA ROW within the urban landuse of the 8-digit watershed.
5. Disaggregate baseline loads was calculated using the disaggregate SHA WLA and MDE published reduction %: Baseline is WLA/(1 - Reduction %)
6. Disaggregate load reduction targets were calculated from the disaggregate baseline loads and disaggregate WLA using the following equation: (Disaggregate SHA Baseline Load) - (Disaggregate SHA WLA)

III. DATA SOURCES

III.A Restoration BMPs

The core of the local TMDL modeling is the databases, both spatial and tabular, which SHA uses to manage its restoration BMPs from planning through compliance reporting. They are listed below.

- TMDL Database: Structural and ESD restoration BMPs that are completed, under construction or in-design are stored within a geospatial data management system. This geodatabase includes spatial locations and drainage areas for stormwater treatment. The database also contains tables with and operational information for alternative load reduction BMPs, along with regulatory information. Each BMP type has individual attributes, design criteria, inspection criteria, pollutant load reduction potential, establishment, verification, and maintenance requirements that are addressed in the data management system.

- NPDES Database: Restoration BMPs that are structural and ESD stormwater controls are housed in a separate geodatabase that also contains structures built in association with highway projects. This is SHA's traditional NPDES MS4 geodatabase with all SHA storm sewer system assets. Prior to model runs, relevant treatment data will be exported to a table in the TMDL Database.

- Task Management Database. Planned projects are stored within a non-spatial MS Access database. For these projects, the database includes information on the type of planned restoration, target watershed, amount of anticipated credit and target milestone year.

III.B Pollutant Reduction Planning Scenarios

For planning and reporting purposes, SHA tracks implementation progress against the permit and TMDL goals. Progress is based on planning, design, and construction of structural, environmental site design (ESD), and alternative BMPs including operational practices such as inlet cleaning. This information is stored in the databases with the project development status for each restoration BMP identified as completed, under construction, or in-design. Tracking the status of each BMP in this way allows SHA to assess pollutant reduction progress in near real time and plan BMPs needed to meet the remaining reduction goals. A series of database queries related to BMP status allows the BMPs to be grouped according to the amount of unit treatment for each BMP type and land use according to the following:

- Completed BMPs: Queries TMDL geospatial database for functioning, built sites.

- Under Construction or Design: Queries TMDL geospatial database for sites currently in design and construction phases.

- Planned BMPs: Determined through a query that evaluates the delta between existing and programmed BMP projects compared to estimates for planned projects derived from the non-spatial Task Management Access database, which would prevent over counting.

IV. NUTRIENT AND SEDIMENT MODELING

IV.A SHA Automated Modeling Tool (AMT)

When the Bay TMDL and associated watershed implementation plans were under development (2010-2012), SHA developed its WIP and milestone reports by modeling nutrient and sediment reductions using MAST. The complexity of modeling local TMDLs that involve multiple counties, baselines and watersheds has resulted in the need for a significant number of exports of treatment data from SHA's geodatabases, as well as a burdensome number of MAST scenarios. In addition, MAST does not account for the revised BMP treatment reductions in MDE 2014.

As described in Section III, SHA is managing restoration BMP 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, different levels of data and tracking are required. The level of effort over the eleven counties has resulted in extensive and complex data tracking. Developing and preparing input data for model runs was proving to be overwhelming and fraught with error. In order to reduce the effort, improve the data management process and increase accuracy, SHA developed the Automated Modeling Tool (AMT) that uses scripts within a geographical information system (GIS) to extract BMP treatment data from multiple sources and then apply algorithms derived from MAST and MDE guidance documents to calculate loads and load reductions.

The AMT uses current data from several production databases in order to estimate pollutant load reductions for various BMP menus and to adhere to approved modeling parameters defined in *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE 2014). The modeling tool will be used to produce planning scenarios and to track progress towards meeting non-tidal waters and Chesapeake Bay (Bay) TMDLs. Although this is a custom model, it draws on BMP efficiencies, loading rates and delivery factors from MDE 2014, Maryland Assessment and Scenario Tool (MAST), and published Chesapeake Bay Program (CBP) BMP protocols. MDE 2014 allows for alternative modeling methods to be employed to demonstrate permit compliance. The AMT has been designed to comply with MDE 2014 guidance as stated below.

> *While different models may generate different baseline pollutant loads, the reductions from implementing water quality improvement projects will be the same because they will all be based on the approved set of CBP urban BMPs and pollutant reduction efficiencies. As a result, all models will be comparable on a percent reduction basis as long as one model is consistently used throughout the permit term.*

The AMT is based on CBP loading rates by land-river segment for edge of stream (EOS) for non-tidal waters and delivered (DEL) loads for direct drainage to the Bay and can calculate reductions from BMPs using the removal rates from the urban stormwater retrofit Expert Panel report (Schueler and Lane, 2012) which are given in Table 6 of MDE 2014. An EOS load is the amount of a pollutant load that is transported from a source to the nearest stream annually.

This model has multiple benefits:

- Uses SHA production stormwater infrastructure and restoration BMP databases for the most up-to-date source of constructed, under-design and planned BMPs at any given time.
- Allows flexibility to easily develop, test and adjust planning scenarios at the Bay and non-tidal watershed levels.
- Utilizes the latest MAST loading and MDE 2014 load reduction data. If necessary revisions to these parameters can be made easily within the AMT by updating a table.
- By including loads in a table by land-river segment and land use, the AMT provides the ability to assess the effects of potential 2017 changes in the Phase 6 Chesapeake Bay Watershed Model with a table modification, so that SHA can quickly determine if changes in restoration strategies or approaches would be warranted.

IV.B Modeling Approach

Two modeling approaches are used within the AMT that address differing TMDL components and challenges for the Bay TMDL versus local TMDLs. Each modeling approach is briefly described in the following sections.

Chesapeake Bay TMDL

This model is based upon pre-determined reduction requirements that are derived using the method described in Section II. These reduction requirements are input by watershed or county and then the AMT calculates and subtracts annual BMP reductions from those requirements. The result is an assessment as to whether the reduction requirement has been reduced to zero. It does not seek to determine the current level of loading compared to a SW-WLA. Reduction requirements for SHA have been developed based on MDE's guidance (MDE 2014, MDE 2014d) regarding the process for determining whether WLA 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 its best land use and treatment data to develop baseline loads consistent with TMDL dates published by MDE on the TMDL Data Center (MDE 2016b). It is understood that the absolute loads listed in the TMDL and load reductions developed by SHA will vary, because the modeling used to develop the TMDL is different from what is

currently available, and may not be available in any case. Demonstrating progress by percent reduced will allow SHA to meet the TMDL based on the best and most accurate data available on land use, sources, loading rates, and removal efficiencies.

Individual SHA load reduction targets are published on the MDE Data Center by Bay segment, County, and pollutant.

Local TMDLs

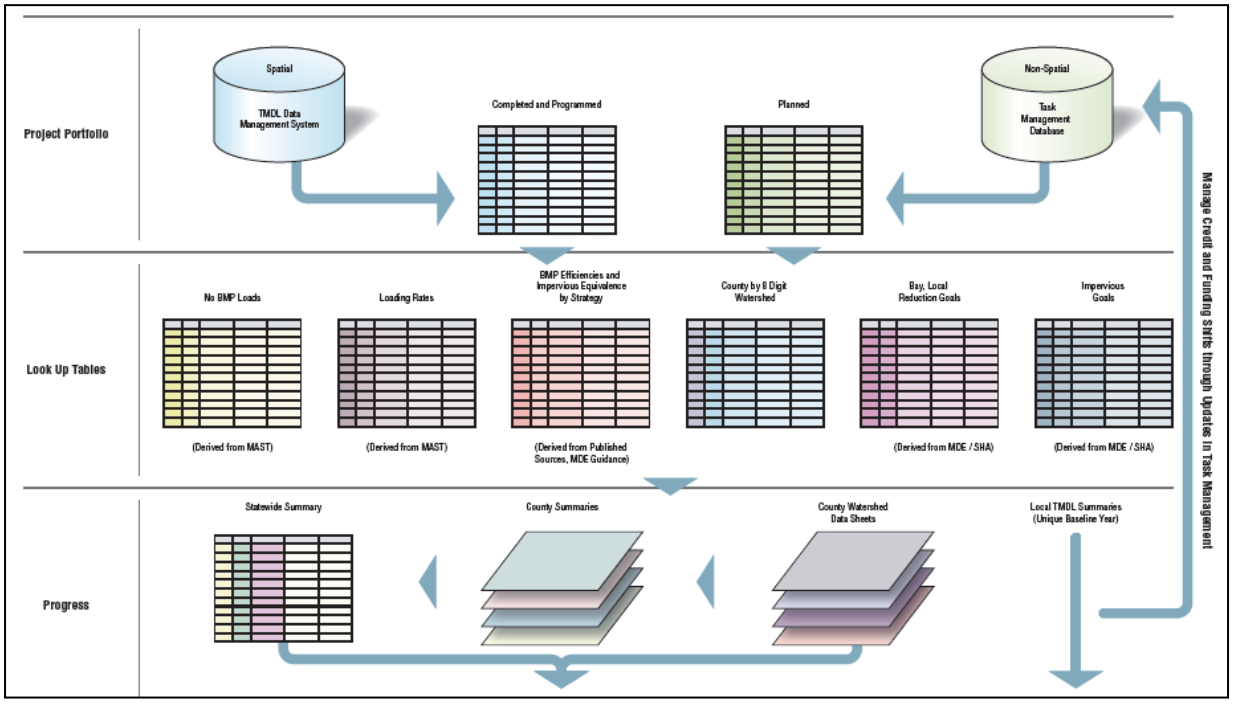
SHA is responsible for local TMDL SW-WLAs located in multiple watersheds and counties with varying baseline years. To track progress towards achieving local TMDL SW-WLAs, the AMT uses the reduction target for SHA as published in the TMDL document or disaggregated and compares this target to the reductions achieved from the suite of restoration BMPs. This method relies on the fact that the Bay model parameters in the version used to write the TMDL are sufficiently close to the ones in the AMT that a reasonable calibration can be assumed. The methods for calculating reduction goals are discussed in Section II.

For SHA, non-tidal local TMDLs are modeled by watershed geographic extents provided on MDE's Data Center.

IV.C Model Description

Process and Workflow

The diagram below shows a schematic of the AMT modeling process, organized into three workflow areas: Project Portfolio, Look up Tables and Progress Workbooks.



Project Portfolio

The Project Portfolio stores and exports the restoration treatment to be modeled. It is based on the databases described in Section III.

The TMDL Data Management System is a spatial database that incorporates projects far enough along in the planning stage that a specific location is known. These projects have been sited and are in either concept design, design, or construction. Data are exported from this database into a table that describes completed and programmed treatment.

The Task Management Database is a non-spatial MS Access database which stores information on planned projects which have not yet advanced to more concrete design phases. Many of these projects are defined by the need for a certain amount of treatment in a particular geographic area, without yet being sited. Data are exported from this database into a table that describes planned treatment

Lookup Tables

These tables, described in Section IV.D, provide the pollutant loading, pollutant removal rates, and goals for impervious area restoration and TMDL compliance. The information in these tables is applied to the amount of treatment in the tables exported from the Project Portfolio to calculate loads and load reductions.

When the Bay Program revises modeling parameters, or Expert Panels define new BMPs, the lookup tables can be updated easily to keep the AMT current with Bay Program or MDE standards.

Progress Workbooks

The outcome / output of the automated modeling process is the creation of a series of Excel workbooks which calculate total reductions (nutrients and sediments) by various geographic extents (watershed, state, and county). The composition of the model automation workbooks are described in Section IV.E.

IV.D Lookup Tables

Four lookup tables are incorporated in the AMT to provide input parameters for model calculations, as follows:

- LOADING RATE LOOKUP TABLE
- NO BMPS 2010 LOADS LOOKUP TABLE
- BMP EFFICIENCIES AND LOAD REDUCTION LOOKUP TABLE
- BAY TMDL AND LOCAL TMDL REDUCTION GOALS LOOKUP TABLES

Pollutant Loading Rates by Land Use

LOADING RATE LOOKUP TABLE for EOS and DEL total nitrogen (TN), total phosphorus (TP), and total suspended sediment (TSS) was 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 and are expressed as lbs/acre/year. The loading rates are linked to county Bay TMDL and local TMDL model automation workbooks to calculate loads prior to implementing BMPs. 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. The table is included in Appendix A.

SHA Baseline Loads

NO BMPS 2010 LOADS LOOKUP TABLE for EOS and DEL TN, TP, and TSS SHA Phase I/II MS4 County and Statewide loads was created from a MAST scenario run on 4/7/2016 (v. 5.3.2) with '2010, revised: 10/2014' initial conditions and processed water base data, and no BMPs. These No BMP land use loads will be used to calculate SHA's reduction requirements in lb/yr for the Bay TMDL. SHA's reduction requirements are calculated by applying the percent reduction goals to SHA's baseline loads which are the No BMPs 2010 Loads with pollutant reductions from SHA baseline BMP treatment derived from the Automated Model Process. The table is included in Appendix B.

Pollutant Removal Rates by BMP Type

BMP EFFICIENCIES AND LOAD REDUCTION LOOKUP TABLE for structural and ESD stormwater control BMP efficiencies (ESD/Runoff Reduction (RR) and Stormwater Treatment (ST) practices), and alternative BMPs (e.g. stream restoration, catch basin cleaning, and street sweeping) in addition to impervious accounting equivalences per BMP type was created following MDE 2014a. The BMP efficiencies in the lookup table are used in conjunction with the loads developed for each land-river segment to determine specific amount-removed for individual BMP types within a land-river segment.

For determining BMP efficiencies using MDE 2014, the first version of the model assumes 1.0 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 1.0 inch treatment. The expected pollutant removal from land use change BMPs (e.g., tree planting – converting pervious land to forest) is accounted within the efficiency percentage. The table is included in Appendix C.

Bay TMDL and Local TMDL Reduction Goals

BAY TMDL AND LOCAL TMDL REDUCTION GOALS LOOKUP TABLES document previously determined TN, TP, and TSS reduction goals which will be used to gauge progress completed for nutrients and sediment once the site specific BMPs are applied. These are reported by county for the Bay TMDL and at the watershed level for non-tidal TMDLs. Bay TMDL target 2025 percent reductions are specific to SHA and were calculated from loads and allocated loads assigned by MDE on September 14, 2011. While not a permit requirement, SHA will track pollutant reduction progress against these targets.

IV.E Progress Workbooks

Bay TMDL Model Automation Workbooks

There are 11 Bay TMDL model automation workbooks - one for each SHA MS4 county. Each workbook has one-to-many worksheets depending upon the number of watersheds associated to that county. The years of data presented for a county or workbook are dependent upon the baseline year. For the Bay TMDL, it is always 2010, with 2011 and beyond presented as restoration.

- **Worksheet Tabs by Watershed** – Sum up to the County Summary tab for the respective workbook. An example of the Baltimore Harbor watershed tab in the Anne Arundel County workbook is included in Appendix D1-A and D1-B.

- **County Summary Tab** – Sums all of the watershed data and presents it as pounds reduced for TN, TP, and TSS by watershed and by BMP phase (i.e., construction complete, under construction, under design, and planned) for EOS and DEL loads. An example of the Anne Arundel County – County Summary Tab is included in Appendix D2.

A 12th workbook presents Bay TMDL model automation information at a statewide level. This statewide workbook includes cumulative BMP treatment totals by county, which are also summed to the statewide level, and percentages for nutrient and sediment reduction. The summary tab of this workbook is included in Appendix D3.

Local TMDL Model Automation Workbooks

Individual model automation worksheets track progress for local TMDLs at the watershed level. Within each worksheet, the data are presented similarly to the Bay TMDL workbook for all BMPs.

The Local TMDL workbook contains worksheet tabs organized by watershed-County, listed pollutant, and baseline year, which will vary based on a particular local TMDL. The baseline year will vary depending on the local TMDL (e.g., 2000, 2005, 2009) and therefore, restoration treatment and pollutant removal data is presented from the baseline year through the target year for scheduled implementation. An example of the summary tab of this workbook is included in Appendix D4.

IV.F Pollutant Reduction Calculations

Within each county-watershed, pollutant reduction is calculated by determining the removal in pounds per unit for each specific BMP type and land use (e.g., impervious, pervious). The logic uses lookup tables to multiply Loading Rate by BMP Efficiency:

Step 1: Calculate Load Removed for Each Type of BMP and Land Use:

1A. Look up specific county, watershed, and land use (impervious/pervious) loading rates for TN EOS/DEL, TP EOS/DEL, TSS EOS/DEL from LOADING RATE LOOKUP TABLE

1B. Look up BMP efficiency rates for each BMP type from BMP EFFICIENCIES AND LOAD REDUCTION LOOKUP TABLE

1C. Multiply loading rates by BMP efficiency rates to find removal in lb/unit of each BMP within the specific county or-watershed

Step 2: Calculate Pollutant Pounds Removed by Each BMP

2A. Multiply removal lb/unit calculated in 1C by the BMP Impervious/Pervious area treated

Example 1: Stormwater Management

A bioswale and sand filter each treat 0.5 acres of impervious area and 0.8 acres of pervious area in the Anne Arundel County portion of the Little Patuxent River Watershed. Using the steps outlined above, the load removed for each land use and BMP is derived:

1A. Loading rate lookup value is queried which aggregates land-river segments within Little Patuxent River in Anne Arundel County for SHA MS4 Phase I/II Impervious and SHA MS4 Phase I/II Pervious.

Loading Rates for Example 1, Step 1A

County	Watershed	MAST Land Use	TSS-EOS lb/ac
Anne Arundel	Little Patuxent River	SHA Phase I/II MS4 Impervious	495.3
Anne Arundel	Little Patuxent River	SHA Phase I/II MS4 Pervious	75.9

1B. BMP efficiency lookup value is queried for each BMP type. In this case the efficiencies for sediment removal are used, assuming 1.0 inch treatment over the impervious area:

BMP Efficiencies for Example 1, Step 1B

BMP Type	BMP Category	TSS Removal
Bioswale	RR	70%
Sand Filter	ST	66%

1C. Multiply loading rates by BMP efficiencies to obtain reduction by lb/unit:

Results for Example 1, Step 1C

BMP Type	Land use	TSS-EOS lb/unit	TSS Removal Efficiency	Calculation	TSS Reduction (lb/unit)
Bioswale	Impervious	495.3	70%	495.3 x .70	346.5
	Pervious	75.9	70%	75.9 x .70	53.1
Sand Filter	Impervious	495.3	66%	495.3 x .66	326.7
	Pervious	75.9	66%	75.9 x .66	50.1

2. Multiply reduction by lb/unit by units treated by BMP. In this case the units treated are acres of impervious and pervious area.

Results for Example 1, Step 2

BMP Type	Land use	TSS Reduction (lb/unit)	Unit Treated (Acres)	Calculation	TSS Reduction (lb)
Sand Filter	Impervious	346.7	0.5	346.7 x 0.5	173.4
	Pervious	53.1	0.8	53.1 x 0.8	42.5
Bioswale	Impervious	326.9	0.5	326.9 x 0.5	163.5
	Pervious	50.1	0.8	50.1 x 0.8	40.1
				Total	**419.5**

For these two facilities, 419.5 lbs. of sediment are removed annually, counting as progress towards the local sediment TMDL for Little Patuxent Watershed. DEL loads are calculated in the same manner, but with the appropriate loading rates to track progress towards the Chesapeake Bay TMDL.

Example 2: Stream Restoration

A stream restoration project is programmed to treat 2,000 linear feet to reduce phosphorus loads in the Double Pipe Creek Watershed in Frederick County. Using steps similar to the ones outlined above, the load removed is derived:

1A. Loading rate lookup value is not required for load reduction BMPs such as this one. Reductions are based on a fixed amount of pollutant removed instead of a percentage of the load delivered to the BMP. Therefore, the first step in this analysis is the same as the second step in Example 1.

1B. BMP load reduction is queried for stream restoration. In this case, the project is not far enough along in design to estimate reductions from the Expert Panel protocols (Schueler and Stack, 2014) so the interim rate per linear foot is used.

BMP Load Reduction for Example 2, Step 1B

BMP Type	TP Removal (lb/LF)
Stream Restoration	0.068

1C. It is also not necessary to determine reduction by lb/unit by multiplying loading rates by BMP efficiencies. This reduction factor is given in the lookup table.

2. Multiply reduction by lb/unit by units treated by BMP. In this case the units treated are linear feet of restoration.

Results for Example 1, Step 2

BMP Type	TP Reduction (lb/unit)	Unit Treated (LF)	Calculation	TP Reduction (lb)
Stream Restoration	0.068	2,000	2,000 x 0.068	136.0
			Total	**136.0**

For this project, 136.0 lbs. of phosphorus are removed annually, counting as progress towards the local phosphorus TMDL for Double Pipe Creek Watershed.

V. PCB MODELING

A review of PCB TMDLs showed that SHA's only source of PCBs is stormwater. As a result, modeling will focus on runoff loads and reductions from stormwater BMPs. This approach to modeling PCB reductions is based on the results of a literature review of PCB sources and treatment.

Two documents from the Chesapeake Bay Program 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. Land use was also a factor.

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 older industrial areas tended to have a higher concentration of PCBs in runoff and in sediments.

V.A PCB Modeling Approach

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 TSS loading and reduction calculations based on approved rates from MAST (2016) and MDE (2014). This approach has also been documented by Interstate Commission on the Potomac River Basin in the Tidal Potomac PCB TMDL (Haywood et al., 2007).

SHA is responsible for PCB TMDLs located in multiple watersheds and counties with varying baseline years. This poses a challenge for SHA because accurate SHA data for ROW area, land use and impervious area prior to 2011 is unavailable; and, 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, a different modeling approach has been used; the same one implemented for nutrient and sediment TMDLs.

To track progress 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.

Local data is available to derive the PCB concentration. Six PCB TMDLs have sufficient information on monitored sediment concentrations to estimate an average value by watershed, shown in Table 3. 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 has been used.

V.B PCB Data Sources

PCB Concentration

In order to estimate PCB reductions, a concentration factor for PCBs in sediment will be applied to the TSS reductions. Schueler and Youngk (2015) summarized concentrations in ng/g from nationwide studies and reported results that varied from 7 to 7,650 ng/g.

Table 3: PCB Concentration Factors for Listed Watersheds

Watershed	Concentration (ng/g)	Source
Back River	124.9	Back River TMDL Table K-1
Baltimore Harbor	196.8	Baltimore Harbor TMDL, Tables K-1 and K-2
Lake Roland	84.3	Lake Roland TMDL, Table J-1
Magothy River	19.6	Magothy River TMDL, Table J-1
South River	24.1	South River TMDL, Table I-1
Tidal Potomac - Anacostia	212.0	Tidal Potomac TMDL, Figure A-3A
Tidal Potomac - Fresh	42.0	Tidal Potomac TMDL, Figure A-3A

Table 3: PCB Concentration Factors for Listed Watersheds

Watershed	Concentration (ng/g)	Source
Tidal Potomac - Oligohaline	15.0	Tidal Potomac TMDL, Figure A-3A
Tidal Potomac - Mesohaline	9.0	Tidal Potomac TMDL, Figure A-3A

Restoration BMP Databases

The local TMDLs have been 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.

As described in Section III, SHA is managing restoration BMP 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, different levels of data and tracking are required.

PCB Pollutant Loading Rates by Land Use

Loading rates for total suspended sediment (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 2014 (Table 4). For determining BMP efficiencies using MDE 2014, 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.

Table 4: PCB Removal Efficiencies by BMP Type

MAST BMP Description	Unit	BMP Type	TSS Removal
SWM Structural / ESD BMPs			
Bioretention/Rain Garden	AC	RR/ESD	70%
Bioswale	AC	RR/ESD	70%

Table 4: PCB Removal Efficiencies by BMP Type

MAST BMP Description	Unit	BMP Type	TSS Removal
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%
Outfall Stabilization	LF	Alt	15/45
Stream Restoration - Urban, Coastal Plain	LF	Alt	15
Stream Restoration - Urban, Non-Coastal Plain	LF	Alt	45
Catch Basin Cleaning	TON	Alt	420

V.C PCB Model Description

The model is based on the AMT's programming, look up tables and workbooks. It is presented in an Excel spreadsheet format, using data derived from MAST and SHA's stormwater geodatabases. The spreadsheet calculates load reductions by all BMPs in all TMDL watersheds in a single worksheet, then sums the reduction by watershed with a pivot table. Load reductions are calculated separately for efficiency BMPs and one load reduction BMP, inlet cleaning.

Efficiency BMPs

TSS load reductions for these BMPs are based on calculations of the amount generated from the BMP drainage area, followed by a calculation of the amount reduced through treatment. 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). The load removal rate (lb/ac/yr) is calculated for pervious and impervious area by multiplying land use loading rate by TSS removal rate for each BMP. TSS removed (lb/yr) is then calculated by multiplying load removal by pervious and impervious area within the BMP drainage area. This calculation is summarized in the *EFF_BMP_PCB_QUERY2* worksheet.

Inlet Cleaning

Inlet cleaning data is recorded by SHA Shop area, not by watershed. This calculation is summarized in the *ROW_LOCALS_SHOP_RESULTS* worksheet. The number of inlets cleaned is pro-rated as follows:

1 The fraction of SHA ROW within each shop boundary within each TMDL watershed is calculated through GIS analysis.
2 The dry weight of material collected from each shop is determined by quantifying the number of inlets cleaned per shop; then multiplying the number of inlets cleaned per shop by 300 pounds per inlet. A dry weight factor of 0.7 is then multiplied by the total moist weight of material collected in each shop. SHA's Office of Construction estimates that 300 pounds of material is cleaned per inlet.
3 The material collected within the TMDL watershed is calculated by multiplying the fraction of TMDL ROW by the total material collected.
4 From this calculation of dry weight, the amount of TSS removed is calculated using parameters from MDE Guidance (MDE 2014)

V.D PCB Load Reduction Calculations

PCB load reduction calculations are based on the TSS removal calculated for efficiency BMPs and inlet cleaning and is summarized in the *PCB REDUCTION* worksheet. Calculations are as follows:

1 Add stormwater BMP and inlet cleaning pounds removed to find total TSS removed in each TMDL watershed. Convert to grams
2 Multiply by PCB concentration factor (see Table 3) to find PCB load removed.
3 Multiply by 50% to account for inconsistency in BMP removal.
4 Results are in g/yr.

VI. BACTERIA TMDLS

As part of the permit conditions SHA has a responsibility to address bacteria TMDLs in MS4 watersheds in which SHA has a WLA. For some of these TMDLs, the impairment and TMDL are for subwatersheds within the 8-digit watershed others are at the larger 8-digit watershed level.

The TMDLs have been 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.

As described in Section III of this protocol, SHA is managing restoration BMP 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, different levels of data and tracking are required.

VI.A Bacteria Modeling Approach

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 2014a) 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.

VI.B Bacteria Model Description

Model Selection

MDE recommended the Watershed Treatment Model (Caraco, 2013) as one of the models which could be used for implementation modeling for nutrients, sediment, and bacteria. It is a spreadsheet-based model which is capable of modeling loads from runoff and also other secondary sources that in general 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, as well.

The model was selected based on these factors. It was recommended by MDE, it could model almost all of the sources and controls that SHA would require, and as a spreadsheet, it was relatively easy to use.

There are a number of more complex models which can model bacteria loads, including HSPF, LPSC, and SWAT, but the additional effort required to assemble input data and run these models was not considered justified based on MDE's recommendation to compare reductions by percentages rather than loads.

Model Function

The watershed treatment model (WTM) models a single watershed. Loads from runoff and other sources are calculated individually, then added to find the total untreated load for the watershed. Load reductions from source controls and stormwater BMPs are calculated individually, then summed to find the total reduction. For stormwater BMPs, load reductions are calculated based

on percent removal by BMP against the lumped total load in the watershed. Loads to each BMP are not based on the type of land use in the treated drainage area, just total drainage area and percent impervious.

Three scenarios can be modeled. *Existing Loads* include current land use and treatment. *Loads with Future Practices* consist of current land use and proposed (future) treatment. *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, described in Table 5 from the 2013 User's Guide (Caraco, 2013). Not all of them have been used for this analysis.

Table 5: WTM Worksheets used for Bacteria Model

Worksheet	Description
Primary Sources	This worksheet summarizes the loads from sources that can be determined solely by land cover or land use. It requires basic land use information, and calculates surface runoff loads. In addition, it requires watershed data, such as annual rainfall, stream length, and soils distribution. This loads calculated in this worksheet incorporate data from the "turf management" section of the "Existing Management Practices" tab, and model default values reflect typical lawn care practices.
Secondary Sources (Not Used)	Secondary sources are pollutant sources that cannot be calculated based on land use information alone. Some of these sources, such as septic systems, CSOs and SSOs, are at least partially composed of wastewater Other secondary bacteria sources include illicit discharges, livestock, and marinas.
Existing Management Practices	This sheet reflects programs currently in place to control loads from urban land, including both source controls and stormwater BMPs. Users need to input information about the effectiveness and level of implementation of various programs and practices.
Retrofit Worksheet	Stormwater retrofits are BMP put in place after development has occurred. The retrofit worksheet allows the user to input individual stormwater retrofit practices. These are then reported in the "Future Management Practices" sheet.
Stream Restoration (Not Used)	This sheet summarizes load reductions from future stream restoration projects. Results are shown in the "Future Management Practices" sheet if the assessment option "Option 2. Enter Removal from Stream Restoration Worksheet" is selected.
Future Management Practices	This sheet reflects the planned extent of programs to control loads from urban land. By default, the model populates this sheet with values from the "Existing Management Practices" sheet. The user then enters data that describe proposed or "future" management practices.
New Development (Not Used)	This sheet calculates the loads from future development, based changes in land use and proposed future treatment. The sheet calculates new "primary source" loadings based on the increase in area of certain land uses, then asks the user to describe the types of stormwater controls on new development. Next, it adds secondary sources, such as loads from new septic customers and wastewater treatment plant loads. Finally, it calculates the loads from active construction as land is developed.

IV.C Bacteria Data Sources

Databases

The TMDLs have been written at different times, based on monitoring data from different years. The baseline year published on the MDE Data Center has been used for SHA's implementation planning. This usually correlates to the time period when monitoring data was collected for MDE's TMDL analysis.

As described in Section III, SHA is managing restoration BMP 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, different levels of data and tracking are required.

Additionally, baseline BMPs are needed for bacteria load reduction modeling. Baseline BMPs were selected using all BMPs in place as of the baseline year and earlier. Restoration BMPs were selected using all BMPs with the purpose coded as restoration which were in place after, but not including, the baseline year. For example, if the baseline is 2006, BMPs from 2006 and earlier would be counted against the baseline. Restoration BMPs would be those constructed in 2007 and later.

Land Use and Impervious Area

The best source for land use mapping in Maryland is the LANDSAT-derived GIS coverage developed by the Maryland Department of Planning (MDP) (MDP, 2010). The land use layer was first published as of 1997 and has since been updated twice, in 2002 and 2010.

Two approaches to mapping SHA's land were investigated, in light of the pollutant loading rates available. The first was to treat the ROW of all roadway classifications as a single land use, Transportation, which would result in one loading rate for all of SHA's land. After review of mapping and aerial photography, SHA decided that land use within and adjacent to the ROW was more accurately described by using the wider variety of land use classifications, (i.e. residential, commercial, industrial, forest, agriculture) mapped by MDP.

None of the TMDL baselines matched either of the land use mapping dates. For baseline modeling, the land use layer with the closest date was used.

SHA has mapped its impervious cover using remote sensing methods, specifically an Esri application called Feature Analyst. 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 Pollutant 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 for fecal coliform were used in the model, shown in Table 6, which also cross-references land use categories from MDP and the NSQD.

Table 6: EMCs Used for Bacteria 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 Pollutant Removal Rates by BMP Type

A literature review was conducted for reports that summarized the results of BMP performance sampling for bacteria removal. Two major reports were found:

International Stormwater BMP Database (Leisenring, et al., 2014)– This study, sponsored by Water Environment Research Foundation, Federal Highway Administration and American Society of Civil Engineers/Environmental & Water Resources Institute, presents a statistical analysis of BMP performance, reporting influent and effluent concentrations. The database was first published in 2010 and has been updated a number of times, with the most recent results published in 2014. The report does not provide removal as a percent. For this analysis, percent removal was derived from the reported median inflow and outflow at the 95% confidence interval.

National Pollutant Removal Performance Database (CWP, 2007)– Center for Watershed Protection (CWP) first prepared this study in 2000 summarizing the results of 139 BMP performance studies and has updated it periodically since that time. The latest version 3.0 includes 27 additional studies. The study consolidates the results of sampling research on stormwater BMPs, providing the median, minimum, and maximum removal percentage for each, as well as the 25th and 75th percentile values. Note that a few of the 2012 results were dropped in 2014 with a reevaluation because there were only 3 or fewer studies available.

Table 7 shows the BMPs in each report with the number of studies represented in each. The International Stormwater BMP Database consolidates a larger number of studies and thus appears to be a better 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.

Table 7: Sources of BMP Pollutant Removal Rates with Number of Sampling Studies

	ISWBMPDB			CWP 2007	
BMP Name	Entero-coccus	E. coli	Fecal Coliform	BMP Name	All bacteria
Grass Strip			2	Open Channel	3
Bioswale / Grass Swale		5	11		
Bioretention	3	4		Bioretention	
Composite			4		
Detention Basin		3	15	Dry Pond	2
Green Roof		1			
Infiltration				Infiltration	
Media Filter				Filtering	6
Retention Pond		4	11	Wet Pond	11
Wetland Basin	4	5	5	Wetland	3
Wetland Basin / Retention Pond	6	9	15		

Three of the four bacteria 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 BMP Database, alternate sources were used and noted.

Removal efficiencies were calculated as follows:

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

Table 8 shows the BMP efficiencies to be used for implementation planning.

Table 8: Bacteria Removal Efficiencies by BMP Type

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

Table 8: Bacteria Removal Efficiencies by BMP Type

BMP	MDE Codes	SW BMP Database Type	Bacteria Type	Bacteria Reduction	Note
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

1. Source is the 2014 International Stormwater BMP Database; 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

VII. TRASH TMDLs

SHA has the responsibility to model its progress in meeting trash WLAs as part of the MS4 permit. The process and methods outlined in the proceeding paragraphs will be used to demonstrate that SHA is meeting its WLAs for current and future trash TMDLs assigned to SHA.

The trash TMDLs have been 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 and modeling reduction. This usually correlates to the time period when monitoring data was collected for MDE's TMDL analysis.

Trash Modeling Approach

The allocations for trash TMDLs are written differently than the TMDLs discussed above. Rather than meeting the WLA by reducing loading down to the WLA level, these WLAs represent amounts that must be collected and removed at 100 percent in addition to the amount of trash that was being collected during the TMDL baseline year. This does not mean that zero trash is left in the watershed, but that the assigned loads are to be removed in their entirety annually. Thus, SHA will first determine the baseline loading of trash in the watershed in lbs/yr at the year of publishing according to the MDE Data Center. The trash baseline load can be calculated by summing all of the trash pickup activities used by SHA at the time of TMDL monitoring. Next, SHA will use the specific trash TMDL to determine the trash WLA. SHA will increase its trash collection in certain areas as a means to reach its trash WLA. To model progress in meeting the WLA, SHA will tabulate the baseline load in lbs/yr and then add the increase of trash pickup in the watershed in a typical excel chart to illustrate progress on meeting the trash WLA.

Example WLAs assigned to SHA are shown in Table 9 by watershed.

Table 9: Anacostia River Watershed SHA Trash Allocations

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

According to the Anacostia TMDL, 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. SHA has currently been assigned only WLAs for trash in its watersheds and not LAs. 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.

VII.A SHA Trash Baseline Activities

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

- Maintenance Crew Clean-ups – SHA's maintenance crews are 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 included 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.

In addition to trash pickup along the roadside SHA also conducts trash pickup from structurals such as:

- 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 each inlet (210 lbs dry weight) of which 8.9% is assumed to be trash (based on CWP 2008a). Based on these two factors, SHA estimates that it cleans 27 lbs/yr of trash from every inlet it cleans. This estimate of the percentage of trash that is produced by cleaning an inlet comes from a study conducted by the Center for Watershed Protection in which material the from the Baltimore City inlet cleaning program was studied and categorized as either leaves, sediment, or trash. This study found that an average of 8.9% of the material removed from an inlet will most likely be trash. In the future SHA plans to conduct a more extensive literature review to determine an average percentage of trash cleaning from each inlet.

- Structural Stormwater Control Routine Maintenance – 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, 2014c). Estimating progress with this method requires a land use loading rate; however, the rates used for TMDL modeling

are not consistent with SHA's trash removal experience. Thus, in the absence of technical data on trash loading and reduction efficiencies for the various land uses and stormwater controls 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 others in conjunction with future 20% reduction requirements anticipated to be included in the next MS4 permit.

SHA Trash Baseline Loading Shop ROW Reduction

The baseline loads for these TMDLs are the amount of litter and trash removal that was being performed at the time the monitoring upon which the TMDL is based was conducted. SHA currently collects a substantial amount of litter and trash including pick-up along state roads, through inlet cleaning and structural stormwater controls. SHA does not currently characterize trash picked up along roadsides as qualifying as either WLA or load allocation (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. Thus, to quantify the amount of trash that was being picked up during the time of monitoring SHA prorated by using the percent of SHA shop ROW that lies within the watershed multiplied by the number of truckloads of trash picked up for the shop area. Table 10 illustrates the percentage of SHA shop ROW that lies within the current Anacostia Trash TMDL watershed boundaries.

Table 10: Example Maintenance Shop Percent ROW within Watershed Calculation

Watershed	County	SHA Maintenance Shop	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%
Totals			**12,311**	**4,063**	

Trash Baseline Roadside Trash Pick-up

Current SHA roadside trash pick-up data does not differentiate between WLA and LA. SHA thinks that a significant portion of trash currently collected may qualify as LA and therefore should not be counted towards the trash TMDL baseline WLA. As part of the Implementation 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 watershed is used as defined in Table 11.

Table 11: Example Trash TMDL Baseline Years and WLA Percentages

Watershed	County	Baseline Year	TMDL[1] (Lbs/Yr)	WLA[2] (Lbs/Yr)	% WLA of TMDL
Anacostia	Montgomery	2009	309,200	243,256	79%
	Prince George's	2009	662,013	314,055	47%

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 baseline loads for roadside trash pick-up have been reduced to equal these percentages and are included in Table 11. 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 at the time monitoring was conducted are as listed in Table 12 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 as truckloads.

Baseline trash pick-up 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 10. This number is then translated to pounds from truckloads based on 350 lbs/truckload and is listed per shop in Table 12 in the column labeled 'Calculated Trash Pick-up per Watershed (Lbs)'. SHA estimates 350 pounds of trash per truck load.

Table 12: Example Baseline Roadside Trash Pick-up Calculation

Watershed[1]	County	SHA Maintenance Shop	Reported Trash Pick-up per Shop[2] (Truckloads)	Calculated Trash Pick-up per Watershed[3] (Truckloads)	Calculated Trash Pick-up per Watershed (Lbs)[4]	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
Totals			**2,591**	**809**	**283,362**		**158,158**

1. Small portions of the 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.
2. Trash collection that should be continued annually to ensure baseline trash collection component of the TMDLs are met.
3. This is calculated using the percentage of SHA shop boundary that lies within the watershed, as seen in **Table 10**, multiplied by reported trash pick-up in truck loads by the shop
4. 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.
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 11**.

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 each inlet (210 lbs dry weight) of which 8.9% is assumed to be trash (based on CWP 2008a). See Table 13 for baseline inlet cleaning trash removal reductions.

Table 13: Example Baseline Inlet Cleaning for Trash Removal Calculation

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
Totals			**4,776**	**2,003**	**54,081**

1. Derived from 2015 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 10**, 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.

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, 2014c). Estimating progress with this method requires a land use loading rate; however, the rates used for TMDL modeling are not consistent with SHA's trash removal experience.

The absence of technical data on trash loading and reduction efficiencies for the various land uses and stormwater controls makes it difficult to model reductions accurately, so 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 others in conjunction with future 20% reduction requirements anticipated to be included in the next MS4 permit. See Table 14 for estimated baseline structural stormwater control trash reductions using 27 lbs/yr assumption.

Table 14: SHA Baseline Structural SW Control for Trash Removal

Watershed	County	SHA Maintenance Shop	Number of 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
Totals			**100**	**2,700**

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

VII.B Trash Model Description

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 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. The results of the increased trash pickup activates plus current trash pickup data will be modeled in an excel sheet.

SHA proposes increasing current practices beyond baselines and adding a few new ones to capture the WLA loads. As an example, the current trash TMLD for the Anacostia watershed is modeled below in Table 15 using the following increases in current practices:

- 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
- Implement annual stream clean-ups

Table 15: Example Summary of Activities to Meet SHA Trash WLAs

				Increased Inlet Cleaning		New Public Education Program		New Stream Clean Up		New Structural SW Controls		Increased Roadside Pick-up		Total Proposed Reduction Activities	
Watershed	**County**	**SHA Shop**	**WLA (lbs/yr)**	**(Lbs/Yr)**	**(%)**	**(Lbs/Yr)**	**(%)**	**(Lbs/Yr)**	**(%)**	**(Lbs/Yr)**	**(%)**	**(Lbs/Yr)**	**(%)**	**(Lbs/ Yr)**	**(%)**
Anacostia	MO	Fairland	6,044	2,670	44%	725	12%	0	0%	108	2%	2,765	46%	6,268	104%
	PG	Laurel	14,134	7,343	63%	1,696	12%	525	4%	189	1%	3,784	27%	14,204	100%
		Marlboro		668	26%										
Totals			**20,178**	**10,681**		**2,421**		**525**		**297**		**6,549**		**20,472**	**101%**

Table 16: Example Increase in Roadside Pickup to Meet WLA

Watershed	County	SHA Maintenance Shop	Increased Roadside Trash Pick-up to Meet WLA (Lbs)	WLA Percent of TMDL (%)	Total Increased Roadside Trash Pickup - LA + WLA (Lbs)
Anacostia	Montgomery	Fairland	2,765	79%	3,500
	Prince George's	Laurel	3,784	47%	8,051
		Marlboro			
Totals			**6,549**		**11,551**

Table 17: Example Increase in Inlet Cleaning to Meet WLA

Watershed	County	SHA Maintenance Shop	Increased Inlet Cleaning (lbs/yr)	Pounds Removed per Inlet	Number Increased Inlets to be Cleaned	Number Inlets Cleaned for Baseline	Total Inlets to be Cleaned (Baseline+WLA)
Anacostia	Montgomery	Fairland	2,670	27	99	3,082	3,181
	Prince George's	Laurel	7,343	27	271	2,240	2,511
		Marlboro	668	27	25	1,131	1,156
Totals			**10,681**		**395**	**6,453**	**6,848**

Table 18: Example Increased Structural SW Control Maintenance to Meet WLA

Watershed	County	SHA Maintenance Shop	Increased Structural SWM to meet WLA (lbs/yr)	Pounds Removed per Inlet	Number Increase Inlets to Meet WLA	Number of Structural SW Cleaned for Baseline	Total Number Structural SWM to be Cleaned to meet (Baseline+WLA)
Anacostia	Montgomery	Fairland	108	27	4	49	53
	Prince George's	Laurel	189	27	7	47	58
		Marlboro				4	
Totals			**297**		**11**	**100**	**111**

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Appendix A: Loading Rates Lookup Table

County Name	Watershed Name	Landuse	TN-EOS lbs/ac	TN-DEL lbs/ac	TP-EOS lbs/ac	TP-DEL lbs/ac	TSS-EOS lbs/ac	TSS-DEL lbs/ac
Anne Arundel, MD	Baltimore Harbor	SHA Phase I/II MS4 Impervious	9.70	9.70	1.50	1.50	468.24	468.24
Anne Arundel, MD	Baltimore Harbor	SHA Phase I/II MS4 Pervious	8.33	8.33	0.41	0.41	71.69	71.69
Anne Arundel, MD	Bodkin Creek	SHA Phase I/II MS4 Impervious	9.70	9.70	1.50	1.50	742.82	742.82
Anne Arundel, MD	Bodkin Creek	SHA Phase I/II MS4 Pervious	8.33	8.33	0.41	0.41	113.83	113.83
Anne Arundel, MD	Little Patuxent River	SHA Phase I/II MS4 Impervious	15.36	12.32	1.70	1.26	495.31	530.78
Anne Arundel, MD	Little Patuxent River	SHA Phase I/II MS4 Pervious	13.26	10.64	0.46	0.34	75.89	81.33
Anne Arundel, MD	Magothy River	SHA Phase I/II MS4 Impervious	9.70	9.70	1.50	1.50	563.25	563.25
Anne Arundel, MD	Magothy River	SHA Phase I/II MS4 Pervious	8.33	8.33	0.41	0.41	86.21	86.21
Anne Arundel, MD	Patapsco River L N Br	SHA Phase I/II MS4 Impervious	9.70	6.75	1.50	0.41	1,396.79	660.55
Anne Arundel, MD	Patapsco River L N Br	SHA Phase I/II MS4 Pervious	8.33	5.80	0.41	0.11	214.02	101.21
Anne Arundel, MD	Patuxent River lower	SHA Phase I/II MS4 Impervious	9.70	9.70	1.50	1.50	227.86	227.86
Anne Arundel, MD	Patuxent River lower	SHA Phase I/II MS4 Pervious	8.34	8.34	0.41	0.41	34.91	34.91
Anne Arundel, MD	Patuxent River middle	SHA Phase I/II MS4 Impervious	9.70	9.70	1.50	1.50	406.96	406.96
Anne Arundel, MD	Patuxent River middle	SHA Phase I/II MS4 Pervious	8.33	8.33	0.40	0.40	62.82	62.82
Anne Arundel, MD	Patuxent River upper	SHA Phase I/II MS4 Impervious	11.44	9.81	1.56	1.43	534.47	549.18
Anne Arundel, MD	Patuxent River upper	SHA Phase I/II MS4 Pervious	9.80	8.37	0.42	0.39	81.80	83.99
Anne Arundel, MD	Severn River	SHA Phase I/II MS4 Impervious	9.70	9.70	1.50	1.50	524.78	524.78
Anne Arundel, MD	Severn River	SHA Phase I/II MS4 Pervious	8.33	8.33	0.40	0.40	80.76	80.76
Anne Arundel, MD	South River	SHA Phase I/II MS4 Impervious	9.70	9.70	1.50	1.50	501.33	501.33
Anne Arundel, MD	South River	SHA Phase I/II MS4 Pervious	8.33	8.33	0.41	0.41	78.63	78.63
Anne Arundel, MD	West Chesapeake Bay	SHA Phase I/II MS4 Impervious	9.70	9.70	1.50	1.50	592.83	592.83
Anne Arundel, MD	West Chesapeake Bay	SHA Phase I/II MS4 Pervious	8.33	8.33	0.41	0.41	90.91	90.91
Anne Arundel, MD	West River	SHA Phase I/II MS4 Impervious	9.70	9.70	1.50	1.50	635.98	635.98
Anne Arundel, MD	West River	SHA Phase I/II MS4 Pervious	8.33	8.33	0.41	0.41	97.53	97.53
Baltimore, MD	Back River	SHA Phase I/II MS4 Impervious	9.64	8.99	1.48	1.45	543.45	621.16
Baltimore, MD	Back River	SHA Phase I/II MS4 Pervious	6.39	5.96	0.22	0.21	75.09	85.59
Baltimore, MD	Baltimore Harbor	SHA Phase I/II MS4 Impervious	9.64	9.64	1.48	1.48	675.85	675.85
Baltimore, MD	Baltimore Harbor	SHA Phase I/II MS4 Pervious	6.39	6.39	0.22	0.22	92.31	92.31
Baltimore, MD	Bird River	SHA Phase I/II MS4 Impervious	9.64	7.88	1.48	1.38	629.04	907.45
Baltimore, MD	Bird River	SHA Phase I/II MS4 Pervious	6.39	5.26	0.22	0.20	86.00	123.04
Baltimore, MD	Deer Creek	SHA Phase I/II MS4 Impervious	17.36	9.97	1.51	1.14	2,158.66	1,717.62
Baltimore, MD	Deer Creek	SHA Phase I/II MS4 Pervious	11.55	6.63	0.23	0.18	294.82	234.58
Baltimore, MD	Gunpowder River	SHA Phase I/II MS4 Impervious	9.64	9.64	1.48	1.48	766.75	766.75
Baltimore, MD	Gunpowder River	SHA Phase I/II MS4 Pervious	6.39	6.39	0.22	0.22	104.71	104.71
Baltimore, MD	Gwynns Falls	SHA Phase I/II MS4 Impervious	17.36	7.25	1.51	1.01	2,065.05	2,117.86
Baltimore, MD	Gwynns Falls	SHA Phase I/II MS4 Pervious	11.55	4.74	0.23	0.16	281.82	289.03
Baltimore, MD	Jones Falls	SHA Phase I/II MS4 Impervious	17.36	3.23	1.51	0.34	968.39	768.98
Baltimore, MD	Jones Falls	SHA Phase I/II MS4 Pervious	11.55	2.15	0.23	0.05	132.26	105.02
Baltimore, MD	Liberty Reservoir	SHA Phase I/II MS4 Impervious	17.36	0.00	1.51	0.00	1,704.82	0.00
Baltimore, MD	Liberty Reservoir	SHA Phase I/II MS4 Pervious	11.55	0.00	0.23	0.00	232.83	0.00
Baltimore, MD	Little Gunpowder Falls	SHA Phase I/II MS4 Impervious	17.36	12.30	1.51	1.27	2,128.44	2,261.94
Baltimore, MD	Little Gunpowder Falls	SHA Phase I/II MS4 Pervious	11.55	8.18	0.23	0.20	290.70	308.93
Baltimore, MD	Loch Raven Reservoir	SHA Phase I/II MS4 Impervious	17.36	4.99	1.51	0.54	1,573.47	354.17
Baltimore, MD	Loch Raven Reservoir	SHA Phase I/II MS4 Pervious	11.55	3.29	0.23	0.08	216.17	48.66
Baltimore, MD	Lower Gunpowder Falls	SHA Phase I/II MS4 Impervious	17.36	15.41	1.51	1.20	1,946.95	1,285.38
Baltimore, MD	Lower Gunpowder Falls	SHA Phase I/II MS4 Pervious	11.55	10.25	0.23	0.19	265.90	175.55
Baltimore, MD	Middle River - Browns	SHA Phase I/II MS4 Impervious	9.64	9.64	1.48	1.48	716.16	716.16
Baltimore, MD	Middle River - Browns	SHA Phase I/II MS4 Pervious	6.39	6.39	0.22	0.22	97.82	97.82
Baltimore, MD	Patapsco River L N Br	SHA Phase I/II MS4 Impervious	17.36	11.56	1.51	0.41	1,934.10	914.65
Baltimore, MD	Patapsco River L N Br	SHA Phase I/II MS4 Pervious	11.55	7.60	0.23	0.06	262.53	124.15
Baltimore, MD	Prettyboy Reservoir	SHA Phase I/II MS4 Impervious	17.36	0.95	1.51	0.12	1,644.44	6.25
Baltimore, MD	Prettyboy Reservoir	SHA Phase I/II MS4 Pervious	11.55	0.63	0.23	0.02	224.55	0.85
Carroll, MD	Conewago Creek	SHA Phase I/II MS4 Impervious	30.27	14.10	1.12	0.43	570.15	193.08
Carroll, MD	Conewago Creek	SHA Phase I/II MS4 Pervious	20.12	9.38	0.24	0.09	88.30	29.97
Carroll, MD	Double Pipe Creek	SHA Phase I/II MS4 Impervious	31.25	7.41	3.02	1.42	1,930.49	1,250.75
Carroll, MD	Double Pipe Creek	SHA Phase I/II MS4 Pervious	20.64	4.91	0.59	0.28	301.57	195.38
Carroll, MD	Liberty Reservoir	SHA Phase I/II MS4 Impervious	17.16	0.00	1.55	0.00	1,463.16	0.00
Carroll, MD	Liberty Reservoir	SHA Phase I/II MS4 Pervious	11.34	0.00	0.31	0.00	227.11	0.00
Carroll, MD	Loch Raven Reservoir	SHA Phase I/II MS4 Impervious	17.17	2.79	1.55	0.56	2,130.34	479.52
Carroll, MD	Loch Raven Reservoir	SHA Phase I/II MS4 Pervious	11.34	1.84	0.31	0.11	330.49	74.39
Carroll, MD	Lower Monocacy River	SHA Phase I/II MS4 Impervious	31.25	11.43	3.02	1.42	1,746.86	1,131.78
Carroll, MD	Lower Monocacy River	SHA Phase I/II MS4 Pervious	20.64	7.55	0.59	0.28	271.17	175.69
Carroll, MD	Patapsco River L N Br	SHA Phase I/II MS4 Impervious	0.00	0.00	0.00	0.00	0.00	0.00
Carroll, MD	Patapsco River L N Br	SHA Phase I/II MS4 Pervious	0.00	0.00	0.00	0.00	0.00	0.00
Carroll, MD	Prettyboy Reservoir	SHA Phase I/II MS4 Impervious	17.16	0.94	1.55	0.13	1,757.90	6.68
Carroll, MD	Prettyboy Reservoir	SHA Phase I/II MS4 Pervious	11.34	0.62	0.31	0.02	272.87	1.04
Carroll, MD	S Branch Patapsco	SHA Phase I/II MS4 Impervious	17.16	1.94	1.55	0.42	1,965.45	929.48
Carroll, MD	S Branch Patapsco	SHA Phase I/II MS4 Pervious	11.34	1.28	0.31	0.08	305.07	144.27
Carroll, MD	Upper Monocacy River	SHA Phase I/II MS4 Impervious	31.25	9.49	3.02	1.42	1,179.26	764.03
Carroll, MD	Upper Monocacy River	SHA Phase I/II MS4 Pervious	20.64	6.27	0.59	0.28	183.04	118.59
Cecil, MD	Back Creek	SHA Phase I/II MS4 Impervious	9.74	9.74	1.03	1.03	621.11	621.11
Cecil, MD	Back Creek	SHA Phase I/II MS4 Pervious	5.53	5.53	0.16	0.16	86.64	86.64

County Name	Watershed Name	Landuse	TN-EOS lbs/ac	TN-DEL lbs/ac	TP-EOS lbs/ac	TP-DEL lbs/ac	TSS-EOS lbs/ac	TSS-DEL lbs/ac
Cecil, MD	Big Elk Creek	SHA Phase I/II MS4 Impervious	10.97	10.20	1.04	1.00	1,017.21	1,068.47
Cecil, MD	Big Elk Creek	SHA Phase I/II MS4 Pervious	6.13	5.75	0.16	0.15	135.05	141.05
Cecil, MD	Bohemia River	SHA Phase I/II MS4 Impervious	9.74	9.74	1.03	1.03	427.67	427.67
Cecil, MD	Bohemia River	SHA Phase I/II MS4 Pervious	5.53	5.53	0.16	0.16	59.66	59.66
Cecil, MD	Conowingo Dam Susq R	SHA Phase I/II MS4 Impervious	31.35	28.55	1.13	0.91	2,118.17	1,541.55
Cecil, MD	Conowingo Dam Susq R	SHA Phase I/II MS4 Pervious	17.95	16.34	0.19	0.15	295.42	215.00
Cecil, MD	Furnace Bay	SHA Phase I/II MS4 Impervious	14.94	14.94	1.05	1.05	1,357.08	1,357.08
Cecil, MD	Furnace Bay	SHA Phase I/II MS4 Pervious	8.76	8.76	0.16	0.16	186.84	186.84
Cecil, MD	L Susquehanna River	SHA Phase I/II MS4 Impervious	17.76	17.76	1.56	1.56	640.12	640.12
Cecil, MD	L Susquehanna River	SHA Phase I/II MS4 Pervious	10.11	10.11	0.24	0.24	92.25	92.25
Cecil, MD	Little Elk Creek	SHA Phase I/II MS4 Impervious	17.64	17.64	1.07	1.07	285.09	285.09
Cecil, MD	Little Elk Creek	SHA Phase I/II MS4 Pervious	10.07	10.07	0.17	0.17	39.77	39.77
Cecil, MD	Lower Elk River	SHA Phase I/II MS4 Impervious	9.74	9.74	1.03	1.03	649.53	649.53
Cecil, MD	Lower Elk River	SHA Phase I/II MS4 Pervious	5.53	5.53	0.16	0.16	89.84	89.84
Cecil, MD	Northeast River	SHA Phase I/II MS4 Impervious	16.11	13.11	1.06	0.97	1,705.87	1,814.82
Cecil, MD	Northeast River	SHA Phase I/II MS4 Pervious	9.33	7.55	0.17	0.15	243.42	259.22
Cecil, MD	Octoraro Creek	SHA Phase I/II MS4 Impervious	17.76	12.09	1.56	1.22	1,751.33	1,835.87
Cecil, MD	Octoraro Creek	SHA Phase I/II MS4 Pervious	10.11	6.88	0.24	0.19	244.28	256.08
Cecil, MD	Sassafras River	SHA Phase I/II MS4 Impervious	9.74	9.74	1.03	1.03	675.86	675.86
Cecil, MD	Sassafras River	SHA Phase I/II MS4 Pervious	5.53	5.53	0.16	0.16	94.05	94.05
Cecil, MD	Upper Elk River	SHA Phase I/II MS4 Impervious	9.74	9.74	1.03	1.03	596.91	596.91
Cecil, MD	Upper Elk River	SHA Phase I/II MS4 Pervious	5.53	5.53	0.16	0.16	82.91	82.91
Charles, MD	Gilbert Swamp	SHA Phase I/II MS4 Impervious	7.63	5.32	1.40	1.33	534.51	1,118.52
Charles, MD	Gilbert Swamp	SHA Phase I/II MS4 Pervious	5.71	3.98	0.31	0.30	78.81	164.92
Charles, MD	Mattawoman Creek	SHA Phase I/II MS4 Impervious	7.63	5.00	1.40	1.18	509.40	461.84
Charles, MD	Mattawoman Creek	SHA Phase I/II MS4 Pervious	5.71	3.52	0.31	0.26	75.04	67.23
Charles, MD	Nanjemoy Creek	SHA Phase I/II MS4 Impervious	7.63	6.90	1.40	1.31	481.56	447.53
Charles, MD	Nanjemoy Creek	SHA Phase I/II MS4 Pervious	5.71	5.24	0.31	0.29	69.84	65.46
Charles, MD	Patuxent River lower	SHA Phase I/II MS4 Impervious	7.63	7.63	1.40	1.40	282.39	282.39
Charles, MD	Patuxent River lower	SHA Phase I/II MS4 Pervious	5.71	5.71	0.31	0.31	41.64	41.64
Charles, MD	Port Tobacco River	SHA Phase I/II MS4 Impervious	7.63	7.63	1.40	1.40	426.45	426.45
Charles, MD	Port Tobacco River	SHA Phase I/II MS4 Pervious	5.71	5.71	0.31	0.31	62.19	62.19
Charles, MD	Potomac River L tidal	SHA Phase I/II MS4 Impervious	7.63	7.63	1.40	1.40	734.13	734.13
Charles, MD	Potomac River L tidal	SHA Phase I/II MS4 Pervious	5.71	5.71	0.31	0.31	108.45	108.45
Charles, MD	Potomac River M tidal	SHA Phase I/II MS4 Impervious	7.63	7.63	1.40	1.40	494.21	494.21
Charles, MD	Potomac River M tidal	SHA Phase I/II MS4 Pervious	5.71	5.71	0.31	0.31	72.87	72.87
Charles, MD	Potomac River U tidal	SHA Phase I/II MS4 Impervious	0.00	0.00	0.00	0.00	0.00	0.00
Charles, MD	Potomac River U tidal	SHA Phase I/II MS4 Pervious	0.00	0.00	0.00	0.00	0.00	0.00
Charles, MD	Wicomico River	SHA Phase I/II MS4 Impervious	7.63	7.63	1.40	1.40	575.09	575.09
Charles, MD	Wicomico River	SHA Phase I/II MS4 Pervious	5.71	5.71	0.31	0.31	84.76	84.76
Charles, MD	Zekiah Swamp	SHA Phase I/II MS4 Impervious	7.63	5.73	1.40	1.15	476.02	630.59
Charles, MD	Zekiah Swamp	SHA Phase I/II MS4 Pervious	5.71	4.21	0.31	0.25	68.64	91.31
Frederick, MD	Catoctin Creek	SHA Phase I/II MS4 Impervious	30.33	8.83	3.13	1.47	2,312.37	1,498.17
Frederick, MD	Catoctin Creek	SHA Phase I/II MS4 Pervious	22.82	7.10	0.65	0.31	367.75	238.26
Frederick, MD	Double Pipe Creek	SHA Phase I/II MS4 Impervious	28.97	7.20	2.88	1.35	1,897.27	1,229.23
Frederick, MD	Double Pipe Creek	SHA Phase I/II MS4 Pervious	20.08	4.98	0.57	0.27	299.18	193.83
Frederick, MD	Lower Monocacy River	SHA Phase I/II MS4 Impervious	29.08	16.91	2.90	1.36	1,411.54	914.52
Frederick, MD	Lower Monocacy River	SHA Phase I/II MS4 Pervious	20.30	11.74	0.58	0.27	226.77	146.92
Frederick, MD	Potomac River FR Cnty	SHA Phase I/II MS4 Impervious	30.19	22.10	3.10	1.46	2,105.66	1,364.24
Frederick, MD	Potomac River FR Cnty	SHA Phase I/II MS4 Pervious	22.55	16.49	0.65	0.30	348.79	225.98
Frederick, MD	Potomac River MO Cnty	SHA Phase I/II MS4 Impervious	0.00	0.00	0.00	0.00	0.00	0.00
Frederick, MD	Potomac River MO Cnty	SHA Phase I/II MS4 Pervious	0.00	0.00	0.00	0.00	0.00	0.00
Frederick, MD	Upper Monocacy River	SHA Phase I/II MS4 Impervious	29.53	12.34	2.98	1.40	1,487.18	963.53
Frederick, MD	Upper Monocacy River	SHA Phase I/II MS4 Pervious	20.82	8.73	0.59	0.28	253.17	164.03
Harford, MD	Aberdeen Proving Ground	SHA Phase I/II MS4 Impervious	9.82	9.82	1.57	1.57	516.81	516.81
Harford, MD	Aberdeen Proving Ground	SHA Phase I/II MS4 Pervious	7.40	7.40	0.30	0.30	76.74	76.74
Harford, MD	Atkisson Reservoir	SHA Phase I/II MS4 Impervious	17.69	10.89	1.61	1.09	2,335.87	2,414.10
Harford, MD	Atkisson Reservoir	SHA Phase I/II MS4 Pervious	13.41	8.02	0.32	0.21	345.71	357.29
Harford, MD	Broad Creek	SHA Phase I/II MS4 Impervious	31.21	23.07	1.16	0.93	2,344.87	1,706.53
Harford, MD	Broad Creek	SHA Phase I/II MS4 Pervious	23.76	17.56	0.25	0.20	347.52	252.91
Harford, MD	Bush River	SHA Phase I/II MS4 Impervious	16.45	16.45	1.60	1.60	538.03	538.03
Harford, MD	Bush River	SHA Phase I/II MS4 Pervious	12.54	12.54	0.31	0.31	79.62	79.62
Harford, MD	Bynum Run	SHA Phase I/II MS4 Impervious	17.69	11.81	1.61	1.28	744.15	1,072.15
Harford, MD	Bynum Run	SHA Phase I/II MS4 Pervious	13.41	8.95	0.32	0.25	110.50	159.20
Harford, MD	Conowingo Dam Susq R	SHA Phase I/II MS4 Impervious	31.22	28.43	1.16	0.93	1,777.80	1,293.84
Harford, MD	Conowingo Dam Susq R	SHA Phase I/II MS4 Pervious	23.76	21.64	0.25	0.20	263.98	192.12
Harford, MD	Deer Creek	SHA Phase I/II MS4 Impervious	17.69	12.71	1.61	1.21	1,899.93	1,511.75
Harford, MD	Deer Creek	SHA Phase I/II MS4 Pervious	13.41	9.71	0.32	0.24	282.25	224.58
Harford, MD	Gunpowder River	SHA Phase I/II MS4 Impervious	9.82	9.82	1.57	1.57	599.42	599.42
Harford, MD	Gunpowder River	SHA Phase I/II MS4 Pervious	7.40	7.40	0.30	0.30	89.02	89.02
Harford, MD	L Susquehanna River	SHA Phase I/II MS4 Impervious	17.69	17.69	1.61	1.61	537.45	537.45
Harford, MD	L Susquehanna River	SHA Phase I/II MS4 Pervious	13.41	13.41	0.32	0.32	79.81	79.81

County Name	Watershed Name	Landuse	TN-EOS lbs/ac	TN-DEL lbs/ac	TP-EOS lbs/ac	TP-DEL lbs/ac	TSS-EOS lbs/ac	TSS-DEL lbs/ac
Harford, MD	Little Gunpowder Falls	SHA Phase I/II MS4 Impervious	17.69	12.53	1.61	1.34	2,377.14	2,526.24
Harford, MD	Little Gunpowder Falls	SHA Phase I/II MS4 Pervious	13.41	9.50	0.32	0.26	352.98	375.12
Harford, MD	Loch Raven Reservoir	SHA Phase I/II MS4 Impervious	17.70	4.73	1.61	0.58	1,147.87	258.37
Harford, MD	Loch Raven Reservoir	SHA Phase I/II MS4 Pervious	13.39	3.57	0.31	0.11	170.09	38.29
Harford, MD	Lower Winters Run	SHA Phase I/II MS4 Impervious	9.82	8.21	1.57	1.06	2,604.53	2,691.77
Harford, MD	Lower Winters Run	SHA Phase I/II MS4 Pervious	7.40	6.19	0.30	0.20	386.75	399.70
Harford, MD	Swan Creek	SHA Phase I/II MS4 Impervious	17.69	17.69	1.61	1.61	392.73	392.73
Harford, MD	Swan Creek	SHA Phase I/II MS4 Pervious	13.41	13.41	0.32	0.32	58.32	58.32
Howard, MD	Brighton Dam	SHA Phase I/II MS4 Impervious	14.77	0.02	1.71	0.04	1,294.02	57.24
Howard, MD	Brighton Dam	SHA Phase I/II MS4 Pervious	9.93	0.02	0.29	0.01	183.76	8.13
Howard, MD	Little Patuxent River	SHA Phase I/II MS4 Impervious	14.77	11.43	1.71	1.26	1,641.51	1,759.07
Howard, MD	Little Patuxent River	SHA Phase I/II MS4 Pervious	9.93	7.63	0.29	0.22	266.78	285.89
Howard, MD	Middle Patuxent River	SHA Phase I/II MS4 Impervious	14.77	10.55	1.71	1.26	2,303.83	2,468.83
Howard, MD	Middle Patuxent River	SHA Phase I/II MS4 Pervious	9.93	7.09	0.29	0.22	330.44	354.10
Howard, MD	Patapsco River L N Br	SHA Phase I/II MS4 Impervious	9.71	6.48	1.51	0.41	1,848.56	874.20
Howard, MD	Patapsco River L N Br	SHA Phase I/II MS4 Pervious	6.74	4.33	0.26	0.07	270.34	127.85
Howard, MD	Patuxent River upper	SHA Phase I/II MS4 Impervious	14.77	5.56	1.71	1.26	785.85	842.13
Howard, MD	Patuxent River upper	SHA Phase I/II MS4 Pervious	9.93	3.74	0.29	0.22	112.72	120.79
Howard, MD	Rocky Gorge Dam	SHA Phase I/II MS4 Impervious	14.77	0.37	1.71	0.31	2,831.25	628.56
Howard, MD	Rocky Gorge Dam	SHA Phase I/II MS4 Pervious	9.93	0.25	0.29	0.05	406.09	90.15
Howard, MD	S Branch Patapsco	SHA Phase I/II MS4 Impervious	16.80	1.90	1.54	0.42	2,110.02	997.84
Howard, MD	S Branch Patapsco	SHA Phase I/II MS4 Pervious	11.32	1.28	0.27	0.07	302.64	143.12
Montgomery, MD	Anacostia River	SHA Phase I/II MS4 Impervious	24.97	12.20	2.42	1.63	601.83	1,416.23
Montgomery, MD	Anacostia River	SHA Phase I/II MS4 Pervious	15.27	7.38	0.37	0.25	92.19	208.63
Montgomery, MD	Brighton Dam	SHA Phase I/II MS4 Impervious	13.86	0.01	1.60	0.03	1,937.78	85.72
Montgomery, MD	Brighton Dam	SHA Phase I/II MS4 Pervious	8.40	0.01	0.24	0.01	301.64	13.34
Montgomery, MD	Cabin John Creek	SHA Phase I/II MS4 Impervious	28.71	11.30	2.81	1.32	2,317.81	1,501.70
Montgomery, MD	Cabin John Creek	SHA Phase I/II MS4 Pervious	17.43	6.86	0.43	0.20	355.29	230.19
Montgomery, MD	Lower Monocacy River	SHA Phase I/II MS4 Impervious	28.71	18.63	2.81	1.32	762.00	493.69
Montgomery, MD	Lower Monocacy River	SHA Phase I/II MS4 Pervious	17.43	11.31	0.43	0.20	116.81	75.68
Montgomery, MD	Potomac River MO Cnty	SHA Phase I/II MS4 Impervious	28.71	25.57	2.81	1.32	1,508.34	977.25
Montgomery, MD	Potomac River MO Cnty	SHA Phase I/II MS4 Pervious	17.43	15.53	0.43	0.20	228.36	147.95
Montgomery, MD	Rock Creek	SHA Phase I/II MS4 Impervious	15.76	5.85	1.45	0.72	2,357.36	2,088.94
Montgomery, MD	Rock Creek	SHA Phase I/II MS4 Pervious	9.58	3.56	0.22	0.11	361.27	320.13
Montgomery, MD	Rocky Gorge Dam	SHA Phase I/II MS4 Impervious	13.85	0.35	1.60	0.29	1,428.78	317.20
Montgomery, MD	Rocky Gorge Dam	SHA Phase I/II MS4 Pervious	8.40	0.21	0.24	0.04	219.01	48.62
Montgomery, MD	Seneca Creek	SHA Phase I/II MS4 Impervious	28.71	14.19	2.81	1.32	1,864.61	1,208.07
Montgomery, MD	Seneca Creek	SHA Phase I/II MS4 Pervious	17.43	8.64	0.43	0.20	285.56	185.01
Prince Georges, MD	Anacostia River	SHA Phase I/II MS4 Impervious	11.01	8.55	1.53	1.25	417.82	1,683.80
Prince Georges, MD	Anacostia River	SHA Phase I/II MS4 Pervious	5.95	4.57	0.24	0.19	73.14	306.23
Prince Georges, MD	Mattawoman Creek	SHA Phase I/II MS4 Impervious	8.68	3.48	1.37	1.00	536.02	449.67
Prince Georges, MD	Mattawoman Creek	SHA Phase I/II MS4 Pervious	4.65	1.86	0.21	0.16	93.24	78.22
Prince Georges, MD	Oxon Creek	SHA Phase I/II MS4 Impervious	8.68	8.68	1.37	1.37	1,129.48	1,129.48
Prince Georges, MD	Oxon Creek	SHA Phase I/II MS4 Pervious	4.65	4.65	0.21	0.21	196.48	196.48
Prince Georges, MD	Patuxent River lower	SHA Phase I/II MS4 Impervious	8.69	8.69	1.37	1.37	310.18	310.18
Prince Georges, MD	Patuxent River lower	SHA Phase I/II MS4 Pervious	4.65	4.65	0.21	0.21	54.23	54.23
Prince Georges, MD	Patuxent River middle	SHA Phase I/II MS4 Impervious	8.68	8.68	1.37	1.37	405.90	405.90
Prince Georges, MD	Patuxent River middle	SHA Phase I/II MS4 Pervious	4.65	4.65	0.21	0.21	81.26	81.26
Prince Georges, MD	Patuxent River upper	SHA Phase I/II MS4 Impervious	12.39	7.41	1.51	1.21	470.06	495.06
Prince Georges, MD	Patuxent River upper	SHA Phase I/II MS4 Pervious	6.79	3.98	0.24	0.19	82.05	86.68
Prince Georges, MD	Piscataway Creek	SHA Phase I/II MS4 Impervious	8.68	7.48	1.37	1.30	427.19	493.20
Prince Georges, MD	Piscataway Creek	SHA Phase I/II MS4 Pervious	4.65	3.96	0.21	0.20	75.44	87.75
Prince Georges, MD	Potomac River M tidal	SHA Phase I/II MS4 Impervious	8.68	8.68	1.37	1.37	286.95	286.95
Prince Georges, MD	Potomac River M tidal	SHA Phase I/II MS4 Pervious	4.64	4.64	0.21	0.21	49.90	49.90
Prince Georges, MD	Potomac River U tidal	SHA Phase I/II MS4 Impervious	8.68	8.68	1.37	1.37	331.19	331.19
Prince Georges, MD	Potomac River U tidal	SHA Phase I/II MS4 Pervious	4.65	4.65	0.21	0.21	58.30	58.30
Prince Georges, MD	Rocky Gorge Dam	SHA Phase I/II MS4 Impervious	13.33	0.33	1.50	0.33	2,942.33	653.17
Prince Georges, MD	Rocky Gorge Dam	SHA Phase I/II MS4 Pervious	7.56	0.17	0.22	0.06	541.28	120.17
Prince Georges, MD	Western Branch	SHA Phase I/II MS4 Impervious	8.68	7.05	1.37	1.10	402.76	603.73
Prince Georges, MD	Western Branch	SHA Phase I/II MS4 Pervious	4.65	3.78	0.21	0.17	69.87	104.55
Prince Georges, MD	Zekiah Swamp	SHA Phase I/II MS4 Impervious	8.69	5.84	1.37	1.08	497.79	664.47
Prince Georges, MD	Zekiah Swamp	SHA Phase I/II MS4 Pervious	4.65	3.13	0.21	0.17	86.58	115.57
Washington, MD	Antietam Creek	SHA Phase I/II MS4 Impervious	25.66	16.47	1.44	0.67	1,820.19	1,179.29
Washington, MD	Antietam Creek	SHA Phase I/II MS4 Pervious	17.70	11.40	0.23	0.11	382.20	247.62
Washington, MD	Conococheague Creek	SHA Phase I/II MS4 Impervious	25.97	14.24	2.78	1.30	1,937.66	1,255.40
Washington, MD	Conococheague Creek	SHA Phase I/II MS4 Pervious	17.87	9.81	0.41	0.19	404.86	262.31
Washington, MD	Licking Creek	SHA Phase I/II MS4 Impervious	25.97	11.83	2.76	1.30	2,643.97	1,713.01
Washington, MD	Licking Creek	SHA Phase I/II MS4 Pervious	17.87	8.14	0.41	0.19	553.25	358.45
Washington, MD	Little Conococheague	SHA Phase I/II MS4 Impervious	25.97	9.13	2.76	1.30	3,013.16	1,952.21
Washington, MD	Little Conococheague	SHA Phase I/II MS4 Pervious	17.87	6.28	0.41	0.19	630.66	408.60
Washington, MD	Little Tonoloway Creek	SHA Phase I/II MS4 Impervious	25.97	9.19	2.76	1.30	2,307.57	1,495.06
Washington, MD	Little Tonoloway Creek	SHA Phase I/II MS4 Pervious	17.87	6.32	0.41	0.19	482.98	312.92

County Name	Watershed Name	Landuse	TN-EOS lbs/ac	TN-DEL lbs/ac	TP-EOS lbs/ac	TP-DEL lbs/ac	TSS-EOS lbs/ac	TSS-DEL lbs/ac
Washington, MD	Marsh Run	SHA Phase I/II MS4 Impervious	25.97	10.68	2.76	1.30	2,464.36	1,596.64
Washington, MD	Marsh Run	SHA Phase I/II MS4 Pervious	17.87	7.35	0.41	0.19	515.79	334.18
Washington, MD	Potomac River AL Cnty	SHA Phase I/II MS4 Impervious	25.97	12.80	2.76	1.30	3,215.15	2,083.07
Washington, MD	Potomac River AL Cnty	SHA Phase I/II MS4 Pervious	17.87	8.81	0.41	0.19	672.95	436.00
Washington, MD	Potomac River FR Cnty	SHA Phase I/II MS4 Impervious	25.97	18.86	2.76	1.30	1,624.16	1,052.28
Washington, MD	Potomac River FR Cnty	SHA Phase I/II MS4 Pervious	17.87	12.97	0.41	0.19	339.96	220.25
Washington, MD	Potomac River WA Cnty	SHA Phase I/II MS4 Impervious	25.97	15.26	2.76	1.30	2,585.22	1,674.95
Washington, MD	Potomac River WA Cnty	SHA Phase I/II MS4 Pervious	17.87	10.78	0.41	0.19	530.71	343.84
Washington, MD	Sideling Hill Creek	SHA Phase I/II MS4 Impervious	25.97	6.46	2.76	1.30	2,475.56	1,603.90
Washington, MD	Sideling Hill Creek	SHA Phase I/II MS4 Pervious	17.87	4.45	0.41	0.19	518.13	335.70
Washington, MD	Tonoloway Creek	SHA Phase I/II MS4 Impervious	25.98	6.06	2.76	1.30	4,100.81	2,656.89
Washington, MD	Tonoloway Creek	SHA Phase I/II MS4 Pervious	17.87	4.17	0.41	0.19	858.17	556.00

Appendix B: No BMPs 2010 MAST Loads

No BMP 2010 MAST Loads (lbs)

	TN-EOS	TN-DEL	TP-EOS	TP-DEL	TSS-EOS	TSS-DEL
Anne Arundel	76,716	71,264	7,273	6,344	2,619,142	2,194,064
Baltimore	108,747	55,802	7,248	4,370	6,550,246	4,554,103
Carroll	64,285	11,076	3,367	1,088	2,478,283	999,358
Cecil	36,654	32,499	1,705	1,601	1,732,404	1,796,003
Charles	23,512	19,791	2,493	2,297	782,642	861,781
Frederick	156,915	78,289	9,325	4,375	4,917,380	3,185,937
Harford	63,217	51,602	3,003	2,531	2,624,015	2,541,530
Howard	68,989	41,021	5,025	2,758	5,311,690	4,301,449
Montgomery	124,347	66,634	8,339	4,135	5,814,678	4,637,375
Prince George's	64,999	51,606	6,947	5,882	2,151,869	4,822,423
Washington	139,351	79,796	6,764	3,173	6,755,128	4,376,602
Statewide	927,732	559,379	61,488	38,553	41,737,477	34,270,625

Source:

MAST scenario: SW_2010_NoBMPs_SHA_20160407

MAST scenario date: 4/7/2016

Initial conditions: 2010, revised: 10/2014; Processed Water Base Data: 2010 Loads

Chesapeake Bay Model: Version 5.3.2

Landuse: SHA Phase I/II MS4 Impervious and SHA Phase I/II MS4 Pervious

Appendix C: BMP Efficiencies

BMP Efficiencies and Impervious Accounting Equivalences

MAST Description	Unit	BMP Type	TN Removal	TP Removal	TSS Removal	Impervious Acre Equivalent
Structural / ESD BMPs			Removal Rate			
Bioretention/Rain Garden AB Soils	AC	RR/ESD	57%	66%	70%	1.00
Bioretention/Rain Garden CD Soils	AC	RR/ESD	57%	66%	70%	1.00
Bioswale	AC	RR/ESD	57%	66%	70%	1.00
Dry Detention	AC	N/A	0%	0%	0%	0.00
Dry Extended Detention Pond	AC	N/A	0%	0%	0%	0.00
Retrofits[1]	AC	-	25%	35%	65%	1.00
Urban Filtering	AC	ST	33%	52%	66%	1.00
Urban Infiltration with Sand, Veg. - AB soils, no underdrain	AC	RR	57%	66%	70%	1.00
Urban Infiltration without Sand, Veg. - AB soils, no underdrain	AC	RR	57%	66%	70%	1.00
Vegetated Open Channels	AC	RR/ESD	57%	66%	70%	1.00
Wet Pond	AC	ST	33%	52%	66%	1.00
Wetlands	AC	ST	33%	52%	66%	1.00
Alternative BMPs			Efficiency Per Acre			
Mechanical Street Sweeping[2]	AC	Alternative	4%	4%	10%	0.07
Regenerative/Vacuum Sweeping[2]	AC	Alternative	5%	6%	25%	0.13
Pavement Removal	AC	Alternative	13%	72%	84%	0.75
Regenerative Stormwater Conveyance	AC	Alternative	57%	66%	70%	1.00
Trees - Urban	AC	Alternative	66%	77%	57%	0.38
Alternative BMPs			Lbs Reduced / Linear Ft			
Outfall Stabilization[3]	AC	Alternative	0.075	0.068	15/45	0.01
Stream Restoration - Urban, Coastal Plain	LF	Alternative	0.075	0.068	15	0.01
Stream Restoration - Urban, Non-Coastal Plain	LF	Alternative	0.075	0.068	45	0.01
Alternative BMPs			Lbs Reduced / Ton			
Catch Basin Cleaning	TON	Alternative	3.5	1.4	420	0.40

Source:
Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated - NPDES Guidance, MDE August 2014

Notes:

[1]Retrofits were listed in the 6/2011 MDE Guidance as a BMP type; however, they are not included in the current 8/2014 version. At this time, MAST efficiencies will be used for retrofit strategies.

[2]SHA is calculating street sweeping as an efficiency BMP

[3]TN/TP/TSS pounds removed per linear foot are not available for outfall stabilization in the August 2014 version of the MDE guidance document. At this time, load reductions from outfall stabilizations were calculated using stream restoration removals up to a maximum of 200 linear feet of restoration

Appendix D: Model Automation Workbook Examples

D1-A,B: Anne Arundel County – Watershed Tab

D2: Anne Arundel County – County Summary Tab

D3: Statewide 12th Workbook – Statewide Summary Tab

D4: Local TMDL Workbook – Local TMDL Summary Tab

County:	Anne Arundel
Watershed:	Baltimore Harbor
Bay TMDL Baseline:	10/21/2010

Removal Lbs/Unit = (Watershed Loading Rate) x (BMP Efficiency)
The script will reference and multiply the Loading Rate for the specific County-watershed and unique land use (see Loading Rate Lookup Table - Appendix A) by the BMP Efficiencies for the unique BMP type (see BMP Efficiency Reference Table - Appendix C).
Example:
(AA County Baltimore Harbor SHA Impervious Loading Rate: 9.70 lbs/ac) x (Bioretention AB Soils TN Removal: 33%) = 3.20 TN EOS Lbs/AC

Treatment pulled from SHA's databases that are from Baseline BMPs constructed prior to 10/21/2010.
Note:
Unit Treated are not actual data in this appendix

Lbs Removed = (Unit Treated) x (Removal Lbs/Unit)
The script will calculate lbs removed separately for each pollutant type (i.e., TN, TP, TSS / EOS and DEL)
Example:
(Bioretention AB Soils Baseline: 5AC Impervious) x (TN DEL Removal Rate: 3.20 Lbs/AC) = 16.00 TN DEL Lbs Removed

	Removal Lbs/Unit [1]						Baseline (constructed prior to October 21, 2010)							Unit Treated (2010)			
BMP	TN-EOS	TP-EOS	TSS-EOS	TN-DEL	TP-DEL	TSS-DEL	Unit Treated	Lbs Removed - TN EOS	Lbs Removed - TP EOS	Lbs Removed - TSS EOS	Lbs Removed - TN DEL	Lbs Removed - TP DEL	Lbs Removed - TSS DEL	Construction Complete	Programmed	Planned	Total
Bioretention/Rain Garden AB Soils (AC)																	
SHA Phase I/II MS4 Impervious	3.20	0.78	309.49	3.20	0.78	309.49	5.00	16.00	3.90	1,547.44	16.00	3.90	1,547.44	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	2.75	0.21	47.39	2.75	0.21	47.39	5.00	13.75	1.05	236.94	13.75	1.05	236.94	6.00	6.00	6.00	18.00
Bioretention/Rain Garden CD Soils (AC)																	0.00
SHA Phase I/II MS4 Impervious	3.20	0.78	309.49	3.20	0.78	309.49	5.00	16.00	3.90	1,547.44	16.00	3.90	1,547.44	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	2.75	0.21	47.39	2.75	0.21	47.39	5.00	13.75	1.05	236.94	13.75	1.05	236.94	6.00	6.00	6.00	18.00
Bioswale (AC)																	0.00
SHA Phase I/II MS4 Impervious	3.20	0.99	243.84	3.20	0.99	243.84	5.00	16.00	4.95	1,219.20	16.00	4.95	1,219.20	4.00	4.00	4.00	
SHA Phase I/II MS4 Pervious	2.75	0.27	37.34	2.75	0.27	37.34	5.00	13.75	1.34	186.68	13.75	1.34	186.68	6.00	6.00	6.00	
Dry Detention (AC)																	
SHA Phase I/II MS4 Impervious	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00	4.00	
SHA Phase I/II MS4 Pervious	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.00	6.00	18.00
Dry Extended Detention Pond (AC)																	0.00
SHA Phase I/II MS4 Impervious	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.00	6.00	18.00
Outfall Stabilization (AC)																	0.00
SHA Phase I/II MS4 Impervious	9.70	1.50	468.92	9.70	1.50	468.92	5.00	48.49	7.50	2,344.61	48.49	7.50	2,344.61	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	8.33	0.41	71.80	8.33	0.41	71.80	5.00	41.67	2.03	358.99	41.67	2.03	358.99	6.00	6.00	6.00	18.00
Pavement Removal (AC)																	0.00
SHA Phase I/II MS4 Impervious	1.26	1.08	393.89	1.26	1.08	393.89	5.00	6.30	5.40	1,969.47	6.30	5.40	1,969.47	10.00	10.00	10.00	30.00
Regenerative Stormwater Conveyance (AC)																	0.00
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	5.00	27.64	4.95	1,641.23	27.64	4.95	1,641.23	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	5.00	23.75	1.34	251.30	23.75	1.34	251.30	6.00	6.00	6.00	18.00
Retrofits (AC)																	0.00
SHA Phase I/II MS4 Impervious	2.42	0.53	304.80	2.42	0.53	304.80	5.00	12.12	2.63	1,524.00	12.12	2.63	1,524.00	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	2.08	0.14	46.67	2.08	0.14	46.67	5.00	10.42	0.71	233.35	10.42	0.71	233.35	6.00	6.00	6.00	18.00
Stream Restoration - Urban (LF)																	0.00
Linear feet	0.08	0.07	15.00	0.08	0.07	15.00	100.00	7.50	6.80	1,500.00	7.50	6.80	1,500.00	100.00	100.00	100.00	300.00
Trees - Urban (AC)																	0.00
SHA Phase I/II MS4 Pervious	5.50	0.31	40.93	5.50	0.31	40.93	50.00	275.05	15.59	2,046.27	275.05	15.59	2,046.27	100.00	100.00	100.00	300.00
Urban Filtering (AC)																	0.00
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	5.00	27.64	4.95	1,641.23	27.64	4.95	1,641.23	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	5.00	23.75	1.34	251.30	23.75	1.34	251.30	6.00	6.00	6.00	18.00
Urban Infiltration with sand, Veg., no underdrain (AC)																	0.00
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	5.00	27.64	4.95	1,641.23	27.64	4.95	1,641.23	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	5.00	23.75	1.34	251.30	23.75	1.34	251.30	6.00	6.00	6.00	18.00
Urban Infiltration w/o Sand, Veg., no underdrain (AC)																	0.00
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	5.00	27.64	4.95	1,641.23	27.64	4.95	1,641.23	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	5.00	23.75	1.34	251.30	23.75	1.34	251.30	6.00	6.00	6.00	18.00
Vegetated Open Channels (AC)																	0.00
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	5.00	27.64	4.95	1,641.23	27.64	4.95	1,641.23	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	5.00	23.75	1.34	251.30	23.75	1.34	251.30	6.00	6.00	6.00	18.00
Wet Pond (AC)																	0.00
SHA Phase I/II MS4 Impervious	3.20	0.78	309.49	3.20	0.78	309.49	5.00	16.00	3.90	1,547.44	16.00	3.90	1,547.44	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	2.75	0.21	47.39	2.75	0.21	47.39	5.00	13.75	1.05	236.94	13.75	1.05	236.94	6.00	6.00	6.00	18.00
Wetlands (AC)																	0.00
SHA Phase I/II MS4 Impervious	3.20	0.78	309.49	3.20	0.78	309.49	5.00	16.00	3.90	1,547.44	16.00	3.90	1,547.44	4.00	4.00	4.00	12.00
SHA Phase I/II MS4 Pervious	2.75	0.21	47.39	2.75	0.21	47.39	5.00	13.75	1.05	236.94	13.75	1.05	236.94	6.00	6.00	6.00	18.00
Catch Basin Cleaning (TON)																	0.00
Tons collected	3.50	1.40	420.00	3.50	1.40	420.00	10.00	35.00	14.00	4,200.00	35.00	14.00	4,200.00	100.00	100.00	100.00	300.00
Mechanical Street Sweeping (AC)																	0.00
Acres swept	0.39	0.06	46.89	0.39	0.06	46.89	10.00	3.88	0.60	468.92	3.88	0.60	468.92	100.00	100.00	100.00	300.00
Total								**846.18**	**112.82**	**32,651.59**	**846.18**	**112.82**	**32,651.59**				

Start of restoration treatment and pollutant reduction sections.

Refer to Appendix F1-B for details.

Lbs removed for each pollutant type from Baseline BMP treatment.

County:	Anne Arundel
Watershed:	Baltimore Harbor
Bay TMDL Baseline:	10/21/2010

Removal Lbs/Unit = (Watershed Loading Rate) x (BMP Efficiency)
The script will reference and multiply the Loading Rate for the specific County-watershed and unique land use (see Loading Rate Lookup Table - Appendix A) by the BMP Efficiencies for the unique BMP type (see BMP Efficiency Reference Table - Appendix C).
Example:
(AA County Baltimore Harbor SHA Impervious Loading Rate: 9.70 lbs/ac) x (Bioretention AB Soils TN Removal: 33%) = 3.20 TN EOS Lbs/AC

Treatment pulled from SHA's databases by project phase and year for Restoration BMPs post 10/21/2010.
Note:
These values are not actual data in this appendix

Lbs Removed = (Unit Treated) x (Removal Lbs/Unit)
The script will calculate lbs removed separately for each project phase and then summed together as Total Removed.
Example:
(Bioretention AB Soils Construction Complete: 4AC Impervious) x (TN EOS Removal Rate: 3.20 Lbs/AC) = 12.80 TN EOS Lbs Removed

Lbs Removed columns for all three project phases and total removed continue for each pollutant type - TN, TP, TSS / EOS and DEL for each restoration year through 2025.

	Removal Lbs/Unit [1]						Unit Treated (2010)				Lbs Removed - TN EOS (2010)				Lbs Removed - TP EOS (2010)			
BMP	TN-EOS	TP-EOS	TSS-EOS	TN-DEL	TP-DEL	TSS-DEL	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total
Bioretention/Rain Garden AB Soils (AC)																		
SHA Phase I/II MS4 Impervious	3.20	0.78	309.49	3.20	0.78	309.49	4.00	4.00	4.00	12.00	12.80	12.80	12.80	38.41	3.12	3.12	3.12	9.37
SHA Phase I/II MS4 Pervious	2.75	0.21	47.39	2.75	0.21	47.39	6.00	6.00	6.00	18.00	16.50	16.50	16.50	49.51	1.26	1.26	1.26	3.79
Bioretention/Rain Garden CD Soils (AC)										0.00								
SHA Phase I/II MS4 Impervious	3.20	0.78	309.49	3.20	0.78	309.49	4.00	4.00	4.00	12.00	12.80	12.80	12.80	38.41	3.12	3.12	3.12	9.37
SHA Phase I/II MS4 Pervious	2.75	0.21	47.39	2.75	0.21	47.39	6.00	6.00	6.00	18.00	16.50	16.50	16.50	49.51	1.26	1.26	1.26	3.79
Bioswale (AC)										0.00								
SHA Phase I/II MS4 Impervious	3.20	0.99	243.84	3.20	0.99	243.84	4.00	4.00	4.00	12.00	12.80	12.80	12.80	38.41	3.96	3.96	3.96	11.89
SHA Phase I/II MS4 Pervious	2.75	0.27	37.34	2.75	0.27	37.34	6.00	6.00	6.00	18.00	16.50	16.50	16.50	49.51	1.60	1.60	1.60	4.81
Dry Detention (AC)										0.00								
SHA Phase I/II MS4 Impervious	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00	4.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SHA Phase I/II MS4 Pervious	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.00	6.00	18.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dry Extended Detention Pond (AC)										0.00								
SHA Phase I/II MS4 Impervious	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00	4.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SHA Phase I/II MS4 Pervious	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.00	6.00	18.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Outfall Stabilization (AC)										0.00								
SHA Phase I/II MS4 Impervious	9.70	1.50	468.92	9.70	1.50	468.92	4.00	4.00	4.00	12.00	38.79	38.79	38.79	116.38	6.00	6.00	6.00	18.01
SHA Phase I/II MS4 Pervious	8.33	0.41	71.80	8.33	0.41	71.80	6.00	6.00	6.00	18.00	50.01	50.01	50.01	150.03	2.43	2.43	2.43	7.29
Pavement Removal (AC)										0.00								
SHA Phase I/II MS4 Impervious	1.26	1.08	393.89	1.26	1.08	393.89	10.00	10.00	10.00	30.00	12.61	12.61	12.61	37.82	10.81	10.81	10.81	32.42
Regenerative Stormwater Conveyance (AC)										0.00								
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	4.00	4.00	4.00	12.00	22.11	22.11	22.11	66.34	3.96	3.96	3.96	11.89
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	6.00	6.00	6.00	18.00	28.50	28.50	28.50	85.51	1.60	1.60	1.60	4.81
Retrofits (AC)										0.00								
SHA Phase I/II MS4 Impervious	2.42	0.53	304.80	2.42	0.53	304.80	4.00	4.00	4.00	12.00	9.70	9.70	9.70	29.10	2.10	2.10	2.10	6.30
SHA Phase I/II MS4 Pervious	2.08	0.14	46.67	2.08	0.14	46.67	6.00	6.00	6.00	18.00	12.50	12.50	12.50	37.51	0.85	0.85	0.85	2.55
Stream Restoration - Urban (LF)										0.00								
Linear feet	0.08	0.07	15.00	0.08	0.07	15.00	100.00	100.00	100.00	300.00	7.50	7.50	7.50	22.50	6.80	6.80	6.80	20.40
Trees - Urban (AC)										0.00								
SHA Phase I/II MS4 Pervious	5.50	0.31	40.93	5.50	0.31	40.93	100.00	100.00	100.00	300.00	550.09	550.09	550.09	1,650.28	31.19	31.19	31.19	93.56
Urban Filtering (AC)										0.00								
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	4.00	4.00	4.00	12.00	22.11	22.11	22.11	66.34	3.96	3.96	3.96	11.89
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	6.00	6.00	6.00	18.00	28.50	28.50	28.50	85.51	1.60	1.60	1.60	4.81
Urban Infiltration with sand, Veg., no underdrain (AC)										0.00								
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	4.00	4.00	4.00	12.00	22.11	22.11	22.11	66.34	3.96	3.96	3.96	11.89
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	6.00	6.00	6.00	18.00	28.50	28.50	28.50	85.51	1.60	1.60	1.60	4.81
Urban Infiltration w/o Sand, Veg., no underdrain (AC)										0.00								
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	4.00	4.00	4.00	12.00	22.11	22.11	22.11	66.34	3.96	3.96	3.96	11.89
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	6.00	6.00	6.00	18.00	28.50	28.50	28.50	85.51	1.60	1.60	1.60	4.81
Vegetated Open Channels (AC)										0.00								
SHA Phase I/II MS4 Impervious	5.53	0.99	328.25	5.53	0.99	328.25	4.00	4.00	4.00	12.00	22.11	22.11	22.11	66.34	3.96	3.96	3.96	11.89
SHA Phase I/II MS4 Pervious	4.75	0.27	50.26	4.75	0.27	50.26	6.00	6.00	6.00	18.00	28.50	28.50	28.50	85.51	1.60	1.60	1.60	4.81
Wet Pond (AC)										0.00								
SHA Phase I/II MS4 Impervious	3.20	0.78	309.49	3.20	0.78	309.49	4.00	4.00	4.00	12.00	12.80	12.80	12.80	38.41	3.12	3.12	3.12	9.37
SHA Phase I/II MS4 Pervious	2.75	0.21	47.39	2.75	0.21	47.39	6.00	6.00	6.00	18.00	16.50	16.50	16.50	49.51	1.26	1.26	1.26	3.79
Wetlands (AC)										0.00								
SHA Phase I/II MS4 Impervious	3.20	0.78	309.49	3.20	0.78	309.49	4.00	4.00	4.00	12.00	12.80	12.80	12.80	38.41	3.12	3.12	3.12	9.37
SHA Phase I/II MS4 Pervious	2.75	0.21	47.39	2.75	0.21	47.39	6.00	6.00	6.00	18.00	16.50	16.50	16.50	49.51	1.26	1.26	1.26	3.79
Catch Basin Cleaning (TON)										0.00								
Tons collected	3.50	1.40	420.00	3.50	1.40	420.00	100.00	100.00	100.00	300.00	350.00	350.00	350.00	1,050.00	140.00	140.00	140.00	420.00
Mechanical Street Sweeping (AC)										0.00								
Acres swept	0.39	0.06	46.89	0.39	0.06	46.89	100.00	100.00	100.00	300.00	38.79	38.79	38.79	116.38	6.00	6.00	6.00	18.01
Total											**1,469.60**	**1,469.60**	**1,469.60**	**4,408.81**	**257.12**	**257.12**	**257.12**	**771.37**

Hid all Baseline treatment columns described in Appendix F1-A from view to show Restoration Credit for this appendix

Lbs removed for each project phase and BMP type is summed by restoration year.
Example:
Construction Complete strategies within AA County Baltimore Harbor for 2010 have treated 1,469.60 TN EOS lbs

Maryland State Highway Administration Bay TMDL and Impervious Accounting Progress

County: Anne Arundel *Modeled on:* _____

Bay TMDL 2025 Reduction and Impervious Accounting Goals and Progress - County Level, Programmed and Planned BMPs through 2025

	TN-EOS	TN-DEL	TP-EOS	TP-DEL	TSS-EOS	TSS-DEL
No BMP 2010 Loads (lbs)	69,057	64,859	6,613	5,923	2,325,716	2,024,398
Baseline BMP Loads (lbs)	68,211	64,013	6,500	5,810	2,293,065	1,991,746
Target 2025 % Reduction	29.0%	29.8%	42.1%	43.5%	26.1%	26.1%
Target 2025 Reduction (lbs)	19,805	19,045	2,735	2,525	599,503	519,326
Reduction Achieved (lbs)	4,409	4,409	771	771	226,163	226,163
% Progress (Goal 100%)	22.3%	23.1%	28.2%	30.6%	37.7%	43.5%

	Acres
Impervious Restoration 2020 Goal	690
Impervious Restoration Achieved	437
% Progress	63.3%
Impervious Restoration Beyond 2020	0

	Bay TMDL Reduction - 2025											
	TN - EOS lbs				TP - EOS lbs				TSS - EOS lbs			
Watershed	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total
Baltimore Harbor	1,470	1,470	1,470	4,409	257	257	257	771	75,388	75,388	75,388	226,163
Bodkin Creek												
Little Patuxent River												
Magothy River												
Patapsco River L N Br												
Patuxent River lower												
Patuxent River middle												
Patuxent River upper												
Severn River												
South River												
West Chesapeake Bay												
West River												
Anne Arundel County	**1,470**	**1,470**	**1,470**	**4,409**	**257**	**257**	**257**	**771**	**75,388**	**75,388**	**75,388**	**226,163**

	Bay TMDL Reduction - 2025											
	TN - DEL lbs				TP - DEL lbs				TSS - DEL lbs			
Watershed	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total
Baltimore Harbor	1,470	1,470	1,470	4,409	257	257	257	771	75,388	75,388	75,388	226,163
Bodkin Creek												
Little Patuxent River												
Magothy River												
Patapsco River L N Br												
Patuxent River lower												
Patuxent River middle												
Patuxent River upper												
Severn River												
South River												
West Chesapeake Bay												
West River												
Anne Arundel County	**1,470**	**1,470**	**1,470**	**4,409**	**257**	**257**	**257**	**771**	**75,388**	**75,388**	**75,388**	**226,163**

	Impervious Restoration Acres - 2020				Impervious Restoration Acres - Beyond 2020			
Watershed	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total
Baltimore Harbor	146	146	146	437	0	0	0	0
Bodkin Creek								
Little Patuxent River								
Magothy River								
Patapsco River L N Br								
Patuxent River lower								
Patuxent River middle								
Patuxent River upper								
Severn River								
South River								
West Chesapeake Bay								
West River								
Anne Arundel County	**146**	**146**	**146**	**437**	**0**	**0**	**0**	**0**

Maryland State Highway Administration
Statewide Bay TMDL Progress

Modeled on: _____

Bay TMDL 2025 Reduction Goals and Progress - Statewide

	TN-EOS	TN-DEL	TP-EOS	TP-DEL	TSS-EOS	TSS-DEL
No BMP 2010 Loads (lbs)	1,002,338	592,616	64,523	39,686	43,754,509	35,295,970
Baseline BMP Loads (lbs)	1,001,491	591,769	64,410	39,574	43,721,857	35,263,318
Target 2025 % Reduction	16.5%	20.0%	28.8%	32.8%	24.4%	26.1%
Target 2025 Reduction (lbs)	164,959	118,402	18,525	12,997	10,648,382	9,193,277
Reduction Achieved (lbs)	4,409	4,409	771	771	226,163	226,163
% Progress (Goal 100%)	2.7%	3.7%	4.2%	5.9%	2.1%	2.5%

	Bay TMDL Reduction											
	TN - EOS lbs				TP - EOS lbs				TSS - EOS lbs			
County	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total
Anne Arundel	1,470	1,470	1,470	4,409	257	257	257	771	75,388	75,388	75,388	226,163
Baltimore												
Carroll												
Cecil												
Charles												
Frederick												
Harford												
Howard												
Montgomery												
Prince George's												
Washington												
Statewide	**1,470**	**1,470**	**1,470**	**4,409**	**257**	**257**	**257**	**771**	**75,388**	**75,388**	**75,388**	**226,163**

	Bay TMDL Reduction											
	TN - DEL lbs				TP - DEL lbs				TSS - DEL lbs			
County	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total
Anne Arundel	1,470	1,470	1,470	4,409	257	257	257	771	75,388	75,388	75,388	226,163
Baltimore												
Carroll												
Cecil												
Charles												
Frederick												
Harford												
Howard												
Montgomery												
Prince George's												
Washington												
Statewide	**1,470**	**1,470**	**1,470**	**4,409**	**257**	**257**	**257**	**771**	**75,388**	**75,388**	**75,388**	**226,163**

Maryland State Highway Administration
Local Nutrient and Sediment

Modeled on: 6/8/2016
Data as of: 4/29/2016

Run 7C - All Completed BMPs and Design BMPs (from GIS) - (With Inlet Cleaning and Outfalls)

Local TMDL Reduction Goals and Progress

Watershed	TP			TSS		
	SHA Reduction Required (EOS-lbs/yr)	Reduction Achieved (EOS-lbs/yr)	% Progress	SHA Reduction Required (EOS-lbs/yr)	Reduction Achieved (EOS-lbs/yr)	% Progress
Antietam Creek	315	139	44%	630,688	140,232	22%
Bynum Run		140	0.0	89,600	82,808	92%
Cabin John Creek		201	0.0	156,000	94,134	60%
Catoctin Creek	176	237	135%	183,337	184,169	100%
Conococheague Creek		125	0.0	360,747	87,813	24%
Double Pipe Creek	1,282	369	29%	160,971	196,437	122%
Gwynns Falls		354	0.0	472,800	230,798	49%
Jones Falls		164	0.0	90,800	57,147	63%
Liberty Reservoir	554	411	74%	450,000	223,843	50%
Little Patuxent River		1,229	0.0	991,000	799,393	81%
Lower Monocacy River	1,428	814	57%	633,145	471,864	75%
Patapsco LN Branch		557	0.0	561,400	332,291	59%
Patuxent River Upper		111	0.0	163,000	34,588	21%
Potomac River MO County		329	0.0	286,000	134,750	47%
Rock Creek	369	1,298	352%	658,800	812,170	123%
Seneca Creek		662	0.0	573,400	382,943	67%
Upper Monocacy River	65	282	433%	186,344	151,569	81%

	Local TMDL Reduction - 2020							
	TP - EOS lbs				TSS - EOS lbs			
Watershed	Construction Complete	Programmed	Planned	Total	Construction Complete	Programmed	Planned	Total
Antietam Creek	52	41	45	139	21,812	54,915	63,504	140,232
Bynum Run	20	9	111	140	5,726	7,216	69,866	82,808
Cabin John Creek	145	6	51	201	43,601	8,872	41,662	94,134
Catoctin Creek	11	31	195	237	42,143	13,333	128,692	184,169
Conococheague Creek	43	12	71	125	19,437	12,477	55,899	87,813
Double Pipe Creek	88	58	223	369	27,859	22,038	146,540	196,437
Double Pipe Creek - CL	88	58	223	369	27,859	22,038	146,540	196,437
Double Pipe Creek - FR	0	0	0	0	0	0	0	0
Gwynns Falls	295	21	38	354	94,843	50,442	85,514	230,798
Jones Falls	141	0	23	164	42,831	0	14,316	57,147
Liberty Reservoir	162	8	241	411	48,788	4,517	170,538	223,843
Liberty Reservoir - BA	39	0	1	41	11,938	0	1,495	13,433
Liberty Reservoir - CL	122	8	240	370	36,850	4,517	169,043	210,410
Little Patuxent River	672	15	542	1,229	413,435	22,451	363,508	799,393
Little Patuxent River - AA	50	2	514	565	14,868	221	334,428	349,517
Little Patuxent River - HO	622	14	29	664	398,567	22,230	29,080	449,876
Lower Monocacy River	135	368	310	814	36,998	246,292	188,574	471,864
Lower Monocacy River - CL	6	0	5	11	1,765	68	2,800	4,634
Lower Monocacy River - FR	95	368	299	762	24,911	246,224	183,875	455,010
Lower Monocacy River - MO	35	0	7	41	10,322	0	1,899	12,221
Patapsco LN Branch	433	56	68	557	196,127	44,679	91,485	332,291
Patapsco LN Branch - AA	80	5	49	134	24,280	1,848	67,736	93,863
Patapsco LN Branch - BA	230	2	6	238	69,825	4,289	7,973	82,087
Patapsco LN Branch - HO	122	49	13	185	102,022	38,543	15,776	156,341
Patuxent River Upper	98	10	4	111	29,363	3,414	1,810	34,588
Patuxent River Upper - AA	14	2	3	19	4,289	358	1,211	5,857
Patuxent River Upper - HO	8	0	1	9	2,256	0	600	2,856
Patuxent River Upper - PG	76	7	0	83	22,819	3,057	0	25,876
Potomac River MO County	262	22	45	329	78,461	21,485	34,804	134,750
Rock Creek	783	414	101	1,298	426,946	287,130	98,093	812,170
Seneca Creek	501	24	137	662	249,375	25,153	108,415	382,943
Upper Monocacy River	56	63	162	282	22,569	31,307	97,693	151,569
Upper Monocacy River - CL	19	4	125	148	5,258	1,040	79,446	85,744
Upper Monocacy River - FR	37	59	37	134	17,310	30,267	18,247	65,824

Appendix F

Comprehensive List of Restoration Practices by FMIS Contract





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Comprehensive List of Restoration Practices By FMIS Contract						
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Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA15RST130544	Bio-Swale	Little Patuxent River	02131105	1359485.56	544810.13	0.31
SHA15RST130546	Bio-Swale	Little Patuxent River	02131105	1362676.87	539429.52	0.49
SHA15RST130549	Bio-Swale	Little Patuxent River	02131105	1364223.71	537209.08	0.95
SHA15RST130551	Bio-Swale	Little Patuxent River	02131105	1364899.58	536671.23	0.38
SHA15RST130552	Bio-Swale	Little Patuxent River	02131105	1367619.88	534617.46	0.20
SHA15RST130568	Bio-Swale	Little Patuxent River	02131105	1355275.72	548315.94	0.12
SHA15RST130569	Bio-Swale	Little Patuxent River	02131105	1355416.62	548449.12	0.37
SHA15RST130570	Bio-Swale	Little Patuxent River	02131105	1357538.11	546839.34	0.30
SHA15RST130571	Bio-Swale	Little Patuxent River	02131105	1355416.62	548449.12	0.39
SHA15RST130572	Bio-Swale	Little Patuxent River	02131105	1353636.62	549070.28	0.44
SHA15RST130573	Bio-Swale	Little Patuxent River	02131105	1354038.46	548876.19	0.20
SHA15RST130574	Bio-Swale	Little Patuxent River	02131105	1354334.68	548742.53	0.20
SHA15RST130575	Bio-Swale	Little Patuxent River	02131105	1354788.31	548536.87	0.20
SHA15RST130576	Bio-Swale	Little Patuxent River	02131105	1353742.58	549214.79	0.36
SHA15RST130577	Bio-Swale	Little Patuxent River	02131105	1352791.07	549651.66	0.31
SHA16RST130619	Micro-Bioretention	Little Patuxent River	02131105	1364737.88	573025.38	0.57
SHA16RST130620	Micro-Bioretention	Little Patuxent River	02131105	1365271.06	570266.74	0.31
SHA16RST100319	Bio-Swale	Lower Monocacy River	02140302	1205265.46	632546.84	0.24
SHA16RST100320	Bio-Swale	Lower Monocacy River	02140302	1206547.92	632003.33	0.32
SHA16RST100321	Bio-Swale	Lower Monocacy River	02140302	1207318.51	631673.53	0.27
SHA16RST100322	Bio-Swale	Lower Monocacy River	02140302	1209737.48	630440.46	0.31
SHA16RST100323	Bio-Swale	Lower Monocacy River	02140302	1211368.36	630323.28	0.62
SHA16RST100324	Bio-Swale	Lower Monocacy River	02140302	1212132.04	630332.50	0.33
SHA16RST100325	Bio-Swale	Lower Monocacy River	02140302	1212673.94	630341.20	0.36
SHA16RST100326	Bio-Swale	Lower Monocacy River	02140302	1213038.64	630343.90	0.68
SHA16RST100327	Bio-Swale	Lower Monocacy River	02140302	1213748.17	630296.20	0.41
SHA16RST100328	Bio-Swale	Lower Monocacy River	02140302	1214332.80	630218.14	0.59
SHA16RST100329	Bio-Swale	Lower Monocacy River	02140302	1215166.87	630095.26	0.58
SHA16RST100330	Bio-Swale	Lower Monocacy River	02140302	1216061.39	629949.48	0.68
SHA16RST100331	Bio-Swale	Lower Monocacy River	02140302	1216918.44	629725.17	0.65
SHA16RST100332	Bio-Swale	Lower Monocacy River	02140302	1217732.23	629471.98	0.53
SHA16RST100333	Bio-Swale	Lower Monocacy River	02140302	1218400.68	629256.00	0.71
SHA16RST100334	Bio-Swale	Lower Monocacy River	02140302	1219098.71	629039.44	0.46
SHA16RST100335	Bio-Swale	Lower Monocacy River	02140302	1219833.84	628801.17	0.81
SHA15RST130555	Bio-Swale	Middle Patuxent River	02131106	1347054.07	552099.62	0.64
SHA15RST130557	Bio-Swale	Middle Patuxent River	02131106	1329568.35	560788.51	0.29
SHA15RST130559	Bio-Swale	Middle Patuxent River	02131106	1330196.99	560366.15	1.11
SHA15RST130561	Bio-Swale	Middle Patuxent River	02131106	1335461.85	556353.97	0.54
SHA15RST130562	Bio-Swale	Middle Patuxent River	02131106	1335811.65	556232.51	0.05
SHA15RST130563	Bio-Swale	Middle Patuxent River	02131106	1335877.09	556209.76	0.12
SHA15RST130564	Bio-Swale	Middle Patuxent River	02131106	1338419.72	555116.91	0.70
SHA15RST130566	Bio-Swale	Middle Patuxent River	02131106	1340187.71	553807.04	0.19
SHA16RST130621	Micro-Bioretention	Patapsco River L N Br	02130906	1368406.02	566432.36	0.47
SHA16RST130622	Micro-Bioretention	Patapsco River L N Br	02130906	1368709.61	566353.46	0.29
SHA16RST130623	Micro-Bioretention	Patapsco River L N Br	02130906	1369661.69	566076.33	0.39
SHA16RST130624	Micro-Bioretention	Patapsco River L N Br	02130906	1371129.79	561766.16	0.30
SHA16RST130625	Micro-Bioretention	Patapsco River L N Br	02130906	1374330.55	561366.94	0.16
SHA16RST130627	Micro-Bioretention	Patapsco River L N Br	02130906	1377354.40	558686.65	0.49
SHA16RST130628	Micro-Bioretention	Patapsco River L N Br	02130906	1377847.19	558140.21	0.31
SHA16RST130629	Micro-Bioretention	Patapsco River L N Br	02130906	1379061.15	556810.39	0.47
SHA16RST130630	Micro-Bioretention	Patapsco River L N Br	02130906	1379739.30	556062.22	0.49
SHA16RST130631	Micro-Bioretention	Patapsco River L N Br	02130906	1384161.52	552371.03	0.11
SHA16RST130632	Micro-Bioretention	Patapsco River L N Br	02130906	1384542.58	552113.48	0.29
SHA16RST100299	Bio-Swale	Upper Monocacy River	02140303	1198921.25	656805.86	0.72
SHA16RST100300	Bio-Swale	Upper Monocacy River	02140303	1199270.44	657984.43	0.73
SHA16RST100301	Bio-Swale	Upper Monocacy River	02140303	1199685.15	658825.51	0.87
SHA16RST100304	Bio-Swale	Upper Monocacy River	02140303	1200159.89	659999.46	0.80
SHA16RST100306	Bio-Swale	Upper Monocacy River	02140303	1200030.95	663643.38	0.92
SHA16RST100309	Bio-Swale	Upper Monocacy River	02140303	1199950.91	666353.75	0.32
SHA16RST100310	Bio-Swale	Upper Monocacy River	02140303	1199574.54	668369.27	1.54
SHA16RST100311	Bio-Swale	Upper Monocacy River	02140303	1198839.61	669749.76	0.40
SHA16RST100312	Bio-Swale	Upper Monocacy River	02140303	1198230.56	670685.25	0.44
SHA16RST100313	Bio-Swale	Upper Monocacy River	02140303	1197869.70	671231.80	0.40
SHA16RST100314	Bio-Swale	Upper Monocacy River	02140303	1197509.53	671784.32	0.42
SHA16RST100315	Bio-Swale	Upper Monocacy River	02140303	1197145.18	672344.04	0.33
SHA16RST100316	Bio-Swale	Upper Monocacy River	02140303	1196805.65	672863.05	0.45

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-1: FMIS # AT0885182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16RST100302	Micro-Bioretention	Upper Monocacy River	02140303	1199958.59	659399.35	0.33
SHA16RST100303	Micro-Bioretention	Upper Monocacy River	02140303	1199994.07	659490.44	0.49
SHA16RST100305	Micro-Bioretention	Upper Monocacy River	02140303	1200319.80	661602.49	1.71
					Complete BMP Acreage Total	**32.91**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-2: FMIS # AT7995382						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA15RST021449	Bio-Swale	Little Patuxent River	02131105	1397152.19	484147.70	1.00
SHA15RST021450	Bio-Swale	Little Patuxent River	02131105	1397285.41	484794.66	0.37
SHA15RST021451	Bio-Swale	Little Patuxent River	02131105	1397362.06	485178.52	0.23
SHA14RST082122	Bio-Swale	Patuxent River lower	02131101	1376774.82	306683.57	0.45
SHA14RST082123	Bio-Swale	Patuxent River lower	02131101	1376779.02	306937.73	0.27
SHA14RST082124	Bio-Swale	Patuxent River lower	02131101	1376784.57	307295.66	0.17
SHA14RST082125	Bio-Swale	Patuxent River lower	02131101	1376795.09	307858.97	0.26
SHA14RST082126	Bio-Swale	Patuxent River lower	02131101	1376800.01	308213.09	0.26
SHA14RST082127	Bio-Swale	Patuxent River lower	02131101	1376805.99	308716.11	0.44
SHA14RST082128	Bio-Swale	Patuxent River lower	02131101	1376809.92	309100.91	0.75
SHA14RST021338	Bio-Swale	Patuxent River middle	02131102	1409923.38	401099.35	0.29
SHA14RST021341	Bio-Swale	Patuxent River middle	02131102	1407482.27	408797.80	0.64
SHA14RST021343	Bio-Swale	Patuxent River middle	02131102	1407250.96	409240.15	0.42
SHA14RST021348	Bio-Swale	Patuxent River middle	02131102	1402931.88	412620.67	0.49
SHA14RST021349	Bio-Swale	Patuxent River middle	02131102	1402764.55	412735.39	0.06
SHA14RST021351	Bio-Swale	Patuxent River middle	02131102	1402660.04	412811.43	0.05
SHA14RST021354	Bio-Swale	Patuxent River middle	02131102	1402537.28	412896.32	0.31
SHA14RST021359	Bio-Swale	Patuxent River middle	02131102	1402158.97	413160.60	0.18
SHA14RST021364	Bio-Swale	Patuxent River middle	02131102	1401787.06	413430.10	0.35
SHA14RST021370	Bio-Swale	Patuxent River middle	02131102	1398454.45	415884.33	0.34
SHA14RST021371	Bio-Swale	Patuxent River middle	02131102	1397273.64	416425.36	0.50
SHA14RST021374	Bio-Swale	Patuxent River middle	02131102	1395883.26	416777.76	0.68
SHA15RST021298	Bio-Swale	Patuxent River upper	02131104	1403223.03	469711.51	0.32
SHA15RST021299	Bio-Swale	Patuxent River upper	02131104	1404699.84	469879.00	0.41
SHA13RST080525	Bio-Swale	Potomac River L tidal	02140101	1321149.17	277093.44	0.43
SHA15RST021282	Bio-Swale	South River	02131003	1415460.31	472560.04	0.67
SHA15RST021283	Bio-Swale	South River	02131003	1411806.10	471785.86	0.31
SHA15RST021295	Bio-Swale	South River	02131003	1413878.03	472202.53	0.33
SHA15RST021302	Bio-Swale	South River	02131003	1420974.72	476597.39	0.35
SHA14RST080517	Bioretention	Wicomico River	02140106	1325854.37	267807.16	0.44
SHA14RST080516	Bio-Swale	Wicomico River	02140106	1325853.70	267715.68	0.28
SHA14RST080518	Bioretention	Zekiah Swamp	02140108	1325028.85	271599.81	0.19
SHA13RST080520	Bio-Swale	Zekiah Swamp	02140108	1323634.76	273712.44	0.26
SHA13RST080521	Bio-Swale	Zekiah Swamp	02140108	1323373.89	274070.06	0.45
SHA13RST080522	Bio-Swale	Zekiah Swamp	02140108	1321794.36	276216.00	0.31
SHA13RST080523	Bio-Swale	Zekiah Swamp	02140108	1321474.23	276644.87	0.21
SHA13RST080524	Bio-Swale	Zekiah Swamp	02140108	1321410.30	276729.72	0.23
SHA13RST082136	Bio-Swale	Zekiah Swamp	02140108	1358998.06	322984.29	0.52
SHA13RST082138	Bio-Swale	Zekiah Swamp	02140108	1352047.74	327819.04	0.25
SHA13RST082139	Bio-Swale	Zekiah Swamp	02140108	1351975.93	328826.72	0.43
SHA13RST082140	Bio-Swale	Zekiah Swamp	02140108	1348894.87	340145.49	0.16
SHA13RST082141	Bio-Swale	Zekiah Swamp	02140108	1348774.81	340499.27	0.98
SHA14RST080519	Bio-Swale	Zekiah Swamp	02140108	1324979.83	271698.93	0.80
SHA14RST082133	Bio-Swale	Zekiah Swamp	02140108	1364234.35	321993.99	0.65
SHA14RST082134	Bio-Swale	Zekiah Swamp	02140108	1363853.17	322019.66	0.62
SHA14RST021369	Bio-Swale	Patuxent River middle	02131102	1400222.12	414626.52	0.32
SHA14RST082135	Bio-Swale	Zekiah Swamp	02140108	1362540.63	322125.22	0.43
					Complete BMP Acreage Total	**18.86**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-3: FMIS # AX2645182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA12RST120311	Bio-Swale	Atkisson Reservoir	02130703	1502376.61	665487.15	0.28
SHA12RST120312	Bio-Swale	Atkisson Reservoir	02130703	1502271.51	665734.93	0.15
SHA12RST120313	Bio-Swale	Atkisson Reservoir	02130703	1502070.85	666145.22	0.37
SHA12RST120314	Bio-Swale	Atkisson Reservoir	02130703	1501662.19	666988.51	0.24
SHA12RST120315	Bio-Swale	Atkisson Reservoir	02130703	1500831.05	668543.22	0.47
SHA12RST120317	Bio-Swale	Atkisson Reservoir	02130703	1500628.11	668852.22	0.28
SHA12RST120318	Bio-Swale	Atkisson Reservoir	02130703	1499725.25	669892.21	0.11
SHA12RST120321	Bio-Swale	Atkisson Reservoir	02130703	1498022.85	672843.42	0.29
SHA12RST120323	Bio-Swale	Atkisson Reservoir	02130703	1493501.31	678717.20	0.14
SHA12RST120324	Bio-Swale	Atkisson Reservoir	02130703	1491955.09	680092.26	0.21
SHA12RST120328	Bio-Swale	Atkisson Reservoir	02130703	1497203.17	675653.58	0.41
SHA13RST120341	Bio-Swale	Atkisson Reservoir	02130703	1498279.45	671823.76	0.85
SHA13RST120343	Bio-Swale	Atkisson Reservoir	02130703	1497857.42	673508.61	0.23
SHA13RST120345	Bio-Swale	Atkisson Reservoir	02130703	1496434.64	676471.63	0.73
SHA13RST120347	Bio-Swale	Atkisson Reservoir	02130703	1495875.08	676867.14	0.62
SHA13RST120349	Bio-Swale	Atkisson Reservoir	02130703	1492766.64	679362.50	0.35
SHA12RST120319	Micro-Bioretention	Atkisson Reservoir	02130703	1499156.95	670517.08	0.15
SHA12RST120320	Micro-Bioretention	Atkisson Reservoir	02130703	1499091.68	670589.61	0.94
SHA13RST070081	Bioretention	Furnace Bay	02130609	1585505.86	698599.62	0.55
SHA13RST070088	Bioretention	Furnace Bay	02130609	1591643.02	700416.58	0.67
SHA13RST070073	Bio-Swale	Furnace Bay	02130609	1581682.43	697593.18	0.53
SHA13RST070074	Bio-Swale	Furnace Bay	02130609	1582259.29	697744.61	0.46
SHA13RST070075	Bio-Swale	Furnace Bay	02130609	1582840.27	697890.42	0.64
SHA13RST070076	Bio-Swale	Furnace Bay	02130609	1583412.82	698048.16	0.56
SHA13RST070077	Bio-Swale	Furnace Bay	02130609	1584798.54	698411.17	1.15
SHA13RST070082	Bio-Swale	Furnace Bay	02130609	1586032.87	698739.02	0.82
SHA13RST070083	Bio-Swale	Furnace Bay	02130609	1587029.82	699002.22	0.37
SHA13RST070084	Bio-Swale	Furnace Bay	02130609	1587645.10	699168.23	0.74
SHA13RST070085	Bio-Swale	Furnace Bay	02130609	1589116.93	699557.42	0.92
SHA13RST070086	Bio-Swale	Furnace Bay	02130609	1590795.71	700053.92	0.69
SHA13RST070087	Bio-Swale	Furnace Bay	02130609	1591241.96	700235.96	0.27
SHA13RST030570	Bio-Swale	Loch Raven Reservoir	02130805	1413320.53	739954.12	0.12
SHA13RST030571	Bio-Swale	Loch Raven Reservoir	02130805	1413156.72	739336.72	0.23
SHA13RST030572	Bio-Swale	Loch Raven Reservoir	02130805	1412562.54	737140.97	0.25
SHA13RST030573	Bio-Swale	Loch Raven Reservoir	02130805	1412454.70	736705.59	0.07
SHA13RST030574	Bio-Swale	Loch Raven Reservoir	02130805	1412419.92	736552.19	0.39
SHA13RST030575	Bio-Swale	Loch Raven Reservoir	02130805	1412282.22	735556.97	1.04
SHA13RST030576	Bio-Swale	Loch Raven Reservoir	02130805	1412344.63	734022.19	0.23
SHA13RST030577	Bio-Swale	Loch Raven Reservoir	02130805	1412394.37	733262.69	0.77
SHA13RST030580	Bio-Swale	Loch Raven Reservoir	02130805	1411816.14	729999.99	0.16
SHA13RST030581	Bio-Swale	Loch Raven Reservoir	02130805	1411505.04	729047.72	0.20
SHA13RST030582	Bio-Swale	Loch Raven Reservoir	02130805	1411182.01	728052.18	0.19
SHA13RST030583	Bio-Swale	Loch Raven Reservoir	02130805	1410826.25	726956.62	0.22
SHA13RST030584	Bio-Swale	Loch Raven Reservoir	02130805	1410585.32	726215.33	0.21
SHA13RST030585	Bio-Swale	Loch Raven Reservoir	02130805	1410311.41	725567.14	1.24
SHA13RST030587	Bio-Swale	Loch Raven Reservoir	02130805	1412115.28	730895.41	0.70
SHA14RST030567	Bio-Swale	Loch Raven Reservoir	02130805	1413043.62	742148.82	0.97
SHA14RST030568	Bio-Swale	Loch Raven Reservoir	02130805	1413413.70	740855.27	1.30
SHA14RST030569	Bio-Swale	Loch Raven Reservoir	02130805	1413351.34	740068.30	0.25
SHA13RST070053	Bioretention	Lower Susquehanna River	02120201	1577774.70	696342.84	1.23
SHA13RST070046	Bio-Swale	Lower Susquehanna River	02120201	1575770.55	695189.89	0.44
SHA13RST070051	Bio-Swale	Lower Susquehanna River	02120201	1576219.22	695465.33	0.44
SHA13RST070052	Bio-Swale	Lower Susquehanna River	02120201	1576863.42	695843.10	0.45
SHA13RST070071	Bio-Swale	Lower Susquehanna River	02120201	1578498.76	696654.43	0.21
SHA13RST070072	Bio-Swale	Lower Susquehanna River	02120201	1579176.02	696901.10	1.45
SHA13RST030578	Bio-Swale	Loch Raven Reservoir	02130805	1412392.93	732267.44	1.08
SHA12RST120310	Bio-Swale	Lower Winters Run	02130702	1504460.55	660868.12	0.55
SHA13RST120333	Bio-Swale	Lower Winters Run	02130702	1504558.67	660509.45	0.31
SHA13RST120335	Bio-Swale	Lower Winters Run	02130702	1503838.05	662430.67	0.30
SHA13RST120337	Bio-Swale	Lower Winters Run	02130702	1503283.33	663593.21	0.24
				Complete BMP Acreage Total		**30.44**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-4: FMIS # AX2645282						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15RST160827	Bio-Swale	Anacostia River	02140205	1351407.50	465774.38	0.71
SHA15RST160830	Other filtering	Anacostia River	02140205	1350635.97	471414.65	0.73
SHA15RST160831	Other filtering	Anacostia River	02140205	1350393.04	471576.67	0.63
SHA13RST150449	Other SWM	Potomac River MO Cnty	02140202	1246092.78	531181.45	0.23
SHA13RST150450	Other SWM	Potomac River MO Cnty	02140202	1247085.54	530399.12	0.22
SHA13RST150451	Other SWM	Potomac River MO Cnty	02140202	1248873.26	528943.45	0.29
SHA13RST150452	Other SWM	Potomac River MO Cnty	02140202	1252264.64	525116.50	0.16
SHA13RST150459	Other SWM	Potomac River MO Cnty	02140202	1245872.85	531416.73	0.40
SHA13RST150460	Other SWM	Potomac River MO Cnty	02140202	1247366.39	530244.76	0.22
SHA13RST150444	Other open channel system	Seneca Creek	02140208	1235644.31	537066.67	0.16
SHA13RST150445	Other SWM	Seneca Creek	02140208	1236925.15	535928.37	0.14
SHA13RST150446	Other SWM	Seneca Creek	02140208	1236753.94	535984.43	0.23
SHA13RST150447	Other SWM	Seneca Creek	02140208	1243883.36	533611.40	0.20
SHA13RST150448	Other SWM	Seneca Creek	02140208	1244030.04	533471.24	0.17
SHA13RST150456	Other SWM	Seneca Creek	02140208	1239190.06	535767.94	0.21
SHA13RST150457	Other SWM	Seneca Creek	02140208	1243378.10	533955.01	0.58
SHA15RST160319	Bio-Swale	Western Branch	02131103	1355119.89	455167.25	0.74
					Complete BMP Acreage Total	**6.01**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-5: FMIS # AX2645382						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13RST130532	Micro-Bioretention	Little Patuxent River	02131105	1345711.80	589881.24	0.46
SHA16RST080500	Bioretention	Potomac River L tidal	02140101	1322281.21	255025.23	0.46
SHA12RST080501	Bio-Swale	Potomac River L tidal	02140101	1322594.68	255240.38	0.25
SHA12RST080502	Bio-Swale	Potomac River L tidal	02140101	1322924.36	255516.39	0.28
SHA12RST080503	Bio-Swale	Potomac River L tidal	02140101	1323359.28	255958.11	0.31
SHA12RST080506	Bioretention	Wicomico River	02140106	1324266.16	257532.79	0.62
SHA12RST080504	Bio-Swale	Wicomico River	02140106	1323686.19	256379.84	0.44
SHA12RST080505	Bio-Swale	Wicomico River	02140106	1324010.08	256938.03	0.33
SHA14RST080507	Bio-Swale	Wicomico River	02140106	1324867.84	260900.65	0.48
SHA14RST080508	Bio-Swale	Wicomico River	02140106	1325016.26	261866.53	0.50
SHA14RST080512	Bio-Swale	Wicomico River	02140106	1325383.51	264292.54	0.36
SHA14RST080513	Bio-Swale	Wicomico River	02140106	1325475.81	264871.79	0.44
SHA14RST080515	Bio-Swale	Wicomico River	02140106	1325815.61	267170.55	0.29
SHA16RST080510	Bio-Swale	Wicomico River	02140106	1325157.87	262796.90	0.35
					Complete BMP Acreage Total	**5.57**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-6: FMIS # AX2645482						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA14RST210208	Bio-Swale	Antietam Creek	02140502	1104369.94	723750.35	0.04
SHA14RST210209	Bio-Swale	Antietam Creek	02140502	1104220.60	723833.27	0.30
SHA16RST210210	Bio-Swale	Antietam Creek	02140502	1104420.23	723898.36	0.07
SHA16RST210211	Bio-Swale	Antietam Creek	02140502	1104244.43	723982.08	0.19
SHA14RST210199	Bio-Swale	Conococheague Creek	02140504	1100536.87	724394.35	0.29
SHA14RST210201	Bio-Swale	Conococheague Creek	02140504	1099538.18	724403.26	0.43
SHA14RST210202	Bio-Swale	Conococheague Creek	02140504	1099370.34	724396.24	0.19
SHA14RST210203	Bio-Swale	Conococheague Creek	02140504	1098562.08	724400.22	0.69
SHA14RST210204	Bio-Swale	Conococheague Creek	02140504	1099055.21	724417.05	0.17
SHA14RST210205	Bio-Swale	Conococheague Creek	02140504	1099019.33	724373.66	0.09
SHA14RST210216	Bio-Swale	Conococheague Creek	02140504	1103284.27	724310.12	0.28
SHA16RST210193	Bio-Swale	Conococheague Creek	02140504	1101947.03	724390.85	0.17
SHA16RST210194	Bio-Swale	Conococheague Creek	02140504	1102198.40	724389.83	0.30
SHA16RST210195	Bio-Swale	Conococheague Creek	02140504	1101891.33	724391.44	0.07
SHA16RST210196	Bio-Swale	Conococheague Creek	02140504	1101781.35	724391.03	0.17
SHA16RST210197	Bio-Swale	Conococheague Creek	02140504	1100129.07	724393.53	0.32
SHA16RST210198	Bio-Swale	Conococheague Creek	02140504	1100029.91	724393.78	0.13
SHA16RST210206	Bio-Swale	Conococheague Creek	02140504	1094411.06	724149.91	0.19
SHA16RST210207	Bio-Swale	Conococheague Creek	02140504	1094325.84	724113.83	0.19
SHA12RST130533	Bio-Swale	Little Patuxent River	02131105	1345933.32	589747.30	0.54
SHA12RST130536	Bio-Swale	Little Patuxent River	02131105	1347398.57	588812.45	0.37
SHA13RST130520	Bio-Swale	Little Patuxent River	02131105	1337694.83	595387.16	0.27
SHA13RST130521	Bio-Swale	Little Patuxent River	02131105	1338359.95	594794.79	0.42
SHA13RST130522	Bio-Swale	Little Patuxent River	02131105	1339273.01	593986.16	0.73
SHA13RST130524	Bio-Swale	Little Patuxent River	02131105	1340679.88	592936.85	0.48
SHA13RST130525	Bio-Swale	Little Patuxent River	02131105	1341143.35	592657.97	0.41
SHA13RST130526	Bio-Swale	Little Patuxent River	02131105	1341850.72	592227.52	0.35
SHA13RST130527	Bio-Swale	Little Patuxent River	02131105	1342405.47	591891.33	0.51
SHA13RST130528	Bio-Swale	Little Patuxent River	02131105	1343023.06	591514.63	0.54
SHA13RST130529	Bio-Swale	Little Patuxent River	02131105	1343215.82	591399.68	0.45
SHA13RST130530	Bio-Swale	Little Patuxent River	02131105	1345255.29	590173.09	0.42
SHA13RST130534	Bio-Swale	Little Patuxent River	02131105	1346897.27	589154.67	0.94
SHA13RST130539	Bio-Swale	Little Patuxent River	02131105	1340511.57	593045.12	0.42
SHA16RST130531	Bio-Swale	Little Patuxent River	02131105	1343664.79	591125.39	0.27
SHA16RST100461	Bio-Swale	Upper Monocacy River	02140303	1196529.25	673287.64	0.19
SHA16RST100463	Bio-Swale	Upper Monocacy River	02140303	1194967.87	675679.41	0.09
SHA16RST100464	Bio-Swale	Upper Monocacy River	02140303	1193919.05	677284.26	0.60
SHA16RST100465	Bio-Swale	Upper Monocacy River	02140303	1193609.20	677757.00	0.39
SHA16RST100466	Bio-Swale	Upper Monocacy River	02140303	1193087.41	678994.12	0.56
SHA16RST100467	Bio-Swale	Upper Monocacy River	02140303	1192932.49	679660.85	0.75
SHA16RST100468	Bio-Swale	Upper Monocacy River	02140303	1192654.77	681458.23	0.33
SHA16RST100469	Bio-Swale	Upper Monocacy River	02140303	1192508.90	682410.80	1.20
SHA16RST100474	Bio-Swale	Upper Monocacy River	02140303	1190970.33	688530.19	0.67
SHA16RST100475	Bio-Swale	Upper Monocacy River	02140303	1190947.48	689536.92	0.71
SHA16RST100476	Bio-Swale	Upper Monocacy River	02140303	1190846.10	690902.57	0.80
SHA16RST100479	Bio-Swale	Upper Monocacy River	02140303	1190565.01	692526.95	0.26
SHA16RST100480	Bio-Swale	Upper Monocacy River	02140303	1190465.81	693060.22	0.74
SHA16RST100481	Bio-Swale	Upper Monocacy River	02140303	1190279.92	694112.75	0.48
SHA16RST100462	Other filtering	Upper Monocacy River	02140303	1195488.40	674884.14	0.44
SHA16RST100470	Other filtering	Upper Monocacy River	02140303	1191871.55	685192.05	0.77
SHA16RST100471	Other filtering	Upper Monocacy River	02140303	1191712.17	685632.16	0.48
SHA16RST100472	Other filtering	Upper Monocacy River	02140303	1191273.99	686838.18	0.18
SHA16RST100473	Other filtering	Upper Monocacy River	02140303	1191054.44	687712.27	0.94
SHA16RST100477	Other filtering	Upper Monocacy River	02140303	1190701.68	691767.08	0.96
					Complete BMP Acreage Total	**22.94**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-7: FMIS # AX9295182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA14RST160412	Bio-Swale	Patuxent River upper	02131104	1391281.16	449045.36	0.73
SHA14RST160415	Bio-Swale	Patuxent River upper	02131104	1392049.13	448855.47	0.38
SHA14RST160416	Bio-Swale	Patuxent River upper	02131104	1393205.32	448568.91	0.63
SHA14RST160418	Bio-Swale	Patuxent River upper	02131104	1393552.52	448483.77	0.75
SHA14RST160390	Bio-Swale	Western Branch	02131103	1383657.31	450257.36	0.46
SHA14RST160391	Bio-Swale	Western Branch	02131103	1384437.94	450391.07	0.50
SHA14RST160394	Bio-Swale	Western Branch	02131103	1385757.93	450232.54	0.65
SHA14RST160396	Bio-Swale	Western Branch	02131103	1386597.02	449817.14	0.48
SHA14RST160397	Bio-Swale	Western Branch	02131103	1387280.55	449620.98	0.58
SHA14RST160398	Bio-Swale	Western Branch	02131103	1387718.42	449568.63	0.27
SHA14RST160399	Bio-Swale	Western Branch	02131103	1387985.23	449539.16	0.60
SHA14RST160400	Bio-Swale	Western Branch	02131103	1388866.45	449440.09	0.91
SHA14RST160410	Bio-Swale	Western Branch	02131103	1389593.28	449358.69	0.46
SHA14RST160411	Bio-Swale	Western Branch	02131103	1390190.31	449278.19	0.73
SHA15RST160886	Bio-Swale	Western Branch	02131103	1361081.68	446923.86	0.99
SHA16RST161120	Bio-Swale	Western Branch	02131103	1358040.97	419327.94	1.63
SHA16RST161121	Bio-Swale	Western Branch	02131103	1358754.79	419112.63	0.51
				Complete BMP Acreage Total		**11.26**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-8: FMIS # AT0445182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16RST021571	Grass Swale	Baltimore Harbor	02130903	1416480.67	556430.00	0.30
SHA16RST021575	Grass Swale	Baltimore Harbor	02130903	1416465.57	552561.36	0.25
SHA16RST021576	Grass Swale	Baltimore Harbor	02130903	1412953.56	543764.81	0.97
SHA16RST021577	Grass Swale	Baltimore Harbor	02130903	1412831.95	542953.48	0.40
SHA16RST021579	Grass Swale	Baltimore Harbor	02130903	1413265.49	536152.60	1.14
SHA16RST021580	Grass Swale	Baltimore Harbor	02130903	1413343.40	535403.58	0.56
SHA16RST021583	Grass Swale	Baltimore Harbor	02130903	1414977.89	529830.10	0.76
SHA16RST021584	Grass Swale	Baltimore Harbor	02130903	1415210.52	529200.48	0.55
SHA16RST021585	Grass Swale	Baltimore Harbor	02130903	1415475.54	528551.78	1.06
SHA16RST021586	Grass Swale	Baltimore Harbor	02130903	1416257.89	526813.71	0.35
SHA16RST021587	Grass Swale	Baltimore Harbor	02130903	1416424.68	526441.34	0.42
SHA16RST021588	Grass Swale	Severn River	02131002	1415345.23	511308.09	0.53
SHA16RST021591	Grass Swale	Severn River	02131002	1414369.05	509165.69	0.60
SHA16RST021592	Grass Swale	Severn River	02131002	1417291.09	506019.80	0.40
SHA16RST021593	Grass Swale	Severn River	02131002	1417615.10	505588.78	0.23
SHA16RST021617	Grass Swale	Severn River	02131002	1415941.31	511761.74	0.55
				Complete BMP Acreage Total		**9.07**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-9: FMIS # AT0895182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16RST021222	Bio-Swale	Magothy River	02131001	1446837.28	506302.66	0.79
SHA16RST021232	Bio-Swale	Magothy River	02131001	1451102.12	499895.69	0.28
SHA16RST080767	Bio-Swale	Port Tobacco River	02140109	1315064.57	290858.26	0.26
SHA16RST080772	Bio-Swale	Port Tobacco River	02140109	1315241.42	292685.73	0.50
SHA16RST080777	Bio-Swale	Port Tobacco River	02140109	1315486.27	295237.39	0.82
SHA16RST080780	Bio-Swale	Port Tobacco River	02140109	1315676.22	297331.77	0.96
SHA16RST080785	Bio-Swale	Port Tobacco River	02140109	1315883.96	299476.12	0.37
SHA16RST080786	Bio-Swale	Port Tobacco River	02140109	1315926.45	299955.41	0.32
SHA16RST080788	Bio-Swale	Port Tobacco River	02140109	1316040.99	301129.27	0.37
SHA16RST080796	Bio-Swale	Port Tobacco River	02140109	1317198.11	307797.61	0.25
SHA16RST080797	Bio-Swale	Port Tobacco River	02140109	1317310.14	308341.86	0.44
SHA16RST080750	Bio-Swale	Potomac River L tidal	02140101	1319613.90	279174.69	0.83
SHA16RST080764	Bio-Swale	Potomac River L tidal	02140101	1320607.51	277820.86	0.48
SHA16RST021238	Bio-Swale	Severn River	02131002	1452953.08	497021.88	0.67
SHA16RST021239	Bio-Swale	Severn River	02131002	1453614.66	495994.68	0.46
SHA16RST021241	Bio-Swale	Severn River	02131002	1455031.70	493786.57	0.65
SHA16RST021244	Bio-Swale	Severn River	02131002	1455640.08	492844.95	0.33
SHA16RST021223	Other filtering	Severn River	02131002	1451983.34	498527.34	0.58
SHA16RST021225	Other filtering	Severn River	02131002	1452212.24	498171.50	0.56
SHA16RST021237	Other filtering	Severn River	02131002	1452607.44	497557.71	0.29
SHA16RST021240	Other filtering	Severn River	02131002	1454108.52	495224.27	0.46
SHA16RST080756	Bio-Swale	Zekiah Swamp	02140108	1317300.56	282309.40	0.67
SHA16RST080758	Bio-Swale	Zekiah Swamp	02140108	1316482.36	283417.53	0.43
SHA16RST080760	Bio-Swale	Zekiah Swamp	02140108	1315787.65	284431.88	1.14
				Complete BMP Acreage Total		**12.91**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-10: FMIS # AX3765360						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA12ALN150011UR	Stream Restoration	Anacostia River	02140205	1301934.45	522509.00	60.11
				Complete BMP Acreage Total		**60.11**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-11: FMIS # AX3765560						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA14ALN150008UR	Stream Restoration	Rock Creek	02140206	1285998.17	533059.76	29.07
SHA16ALN150009UR	Stream Restoration	Rock Creek	02140206	1283957.54	525615.68	60.03
					Complete BMP Acreage Total	**89.10**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-12: FMIS # AX3765D60						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15ALN160001UR	Stream Restoration	Anacostia River	02140205	1331333.63	488003.24	64.50
				Complete BMP Acreage Total		**64.50**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-13: FMIS # AX3765E60						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13ALN150001UR	Stream Restoration	Anacostia River	02140205	1318992.20	523679.42	20.26
SHA13ALN150005UR	Stream Restoration	Anacostia River	02140205	1316576.33	525649.66	5.46
SHA13ALN150007UR	Stream Restoration	Anacostia River	02140205	1317227.15	521754.47	27.89
					Complete BMP Acreage Total	**53.61**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-14: FMIS # AX3765F60						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15ALN150002UR	Stream Restoration	Anacostia River	02140205	1314568.18	520991.45	7.12
SHA15ALN150006UR	Stream Restoration	Anacostia River	02140205	1314484.95	519141.73	20.14
					Complete BMP Acreage Total	**27.26**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-15: FMIS # AX3765K60						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15ALN160006UR	Stream Restoration	Anacostia River	02140205	1339961.33	496289.99	12.09
				Complete BMP Acreage Total		**12.09**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-16: FMIS # AX3765N60						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13ALN150017UR	Stream Restoration	Seneca Creek	02140208	1259876.93	561514.79	39.91
				Complete BMP Acreage Total		**39.91**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-17: FMIS # AX3765U60						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13ALN150012UR	Stream Restoration	Rock Creek	02140206	1269958.61	534818.91	48.54
				Complete BMP Acreage Total		**48.55**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-18: FMIS # HA4075182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15ALN120001UR	Stream Restoration	Atkisson Reservoir	02130703	1498492.68	671619.73	21.00
				Complete BMP Acreage Total		**21.00**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-19: FMIS # HA4095182SBR						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13ALN120002UR	Stream Restoration	Deer Creek	02120202	1446856.99	726476.19	11.60
				Complete BMP Acreage Total		**11.60**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-20: FMIS # HO2065182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15ALN130001UR	Stream Restoration	Little Patuxent River	02131105	1354631.24	581541.76	45.00
				Complete BMP Acreage Total		**45.00**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-21: FMIS # HO3255124						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA12ALN130002UR	Stream Restoration	Little Patuxent River	02131105	1373209.42	539038.06	19.73
				Complete BMP Acreage Total		**19.73**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-22: FMIS # HO4085174						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA12ALN130004UR	Stream Restoration	Little Patuxent River	02131105	1365244.13	571640.31	10.44
				Complete BMP Acreage Total		**10.44**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-23: FMIS # AA1665182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16ALN020002UR	Stream Restoration	Severn River	02131002	1417239.86	523287.28	4.50
SHA16ALN020004UR	Step Pool Storm Conveyance	Severn River	02131002	1417239.86	523287.28	4.50
SHA16RST0200013UO	Outfall Stabilization	Severn River	02131002	1417422.84	523307.64	2.00
					Complete BMP Acreage Total	**11.00**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-24: FMIS # AA8955182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16ALN020003UR	Stream Restoration	South River	02131003	1439457.83	478723.62	23.00
				Complete BMP Acreage Total		**23.00**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-25: FMIS # AX3765L60						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16ALN150010UR	Stream Restoration	Anacostia River	02140205	1306211.04	517192.68	51.71
				Complete BMP Acreage Total		**51.71**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-26: FMIS # AT0685382						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA15APY120048UT	Tree Planting	Atkisson Reservoir	02130703	1477769.21	675145.34	0.13
SHA15APY120049UT	Tree Planting	Atkisson Reservoir	02130703	1480743.59	670767.10	0.25
SHA15APY120060UT	Tree Planting	Atkisson Reservoir	02130703	1460006.70	684545.19	0.48
SHA15APY120063UT	Tree Planting	Atkisson Reservoir	02130703	1488797.63	691580.73	0.06
SHA15APY120080UT	Tree Planting	Atkisson Reservoir	02130703	1477386.82	675308.51	0.39
SHA15APY120089UT	Tree Planting	Atkisson Reservoir	02130703	1489143.02	690950.11	0.04
SHA15APY120124UT	Tree Planting	Atkisson Reservoir	02130703	1498698.47	671219.80	0.11
SHA15APY120131UT	Tree Planting	Atkisson Reservoir	02130703	1488926.55	691357.13	0.05
SHA15APY120132UT	Tree Planting	Atkisson Reservoir	02130703	1472040.14	677979.89	0.12
SHA15APY120143UT	Tree Planting	Atkisson Reservoir	02130703	1471565.21	678216.40	0.12
SHA15APY120150UT	Tree Planting	Atkisson Reservoir	02130703	1457191.17	686954.66	0.05
SHA15APY120151UT	Tree Planting	Atkisson Reservoir	02130703	1459494.80	684984.19	0.13
SHA15APY120155UT	Tree Planting	Atkisson Reservoir	02130703	1453805.21	690718.24	0.13
SHA15APY120244UT	Tree Planting	Atkisson Reservoir	02130703	1499000.72	670838.59	0.15
SHA14APY120023UT	Tree Planting	Broad Creek	02120205	1509934.36	736519.68	0.12
SHA14APY120024UT	Tree Planting	Broad Creek	02120205	1508305.21	737956.11	0.40
SHA14APY120025UT	Tree Planting	Broad Creek	02120205	1507899.78	738209.45	0.11
SHA14APY120026UT	Tree Planting	Broad Creek	02120205	1495795.18	748796.05	0.16
SHA14APY120037UT	Tree Planting	Broad Creek	02120205	1503638.29	739989.74	0.10
SHA14APY120040UT	Tree Planting	Broad Creek	02120205	1498331.34	742938.63	0.05
SHA14APY120050UT	Tree Planting	Broad Creek	02120205	1497121.17	748775.19	0.03
SHA14APY120070UT	Tree Planting	Broad Creek	02120205	1507296.18	738491.35	0.03
SHA14APY120071UT	Tree Planting	Broad Creek	02120205	1505694.95	739173.86	0.10
SHA14APY120072UT	Tree Planting	Broad Creek	02120205	1505652.78	739136.00	0.22
SHA14APY120074UT	Tree Planting	Broad Creek	02120205	1488840.43	739118.13	0.59
SHA14APY120075UT	Tree Planting	Broad Creek	02120205	1495877.79	746146.00	0.12
SHA14APY120076UT	Tree Planting	Broad Creek	02120205	1510563.41	736132.45	0.05
SHA14APY120084UT	Tree Planting	Broad Creek	02120205	1484811.21	734077.40	0.07
SHA14APY120086UT	Tree Planting	Broad Creek	02120205	1503616.45	740069.79	0.03
SHA14APY120091UT	Tree Planting	Broad Creek	02120205	1496834.23	747662.71	0.03
SHA14APY120093UT	Tree Planting	Broad Creek	02120205	1497016.82	748315.90	0.01
SHA14APY120094UT	Tree Planting	Broad Creek	02120205	1488194.86	736375.06	0.31
SHA14APY120102UT	Tree Planting	Broad Creek	02120205	1509657.17	736685.98	0.02
SHA14APY120103UT	Tree Planting	Broad Creek	02120205	1505088.08	739363.91	0.06
SHA14APY120104UT	Tree Planting	Broad Creek	02120205	1501044.11	741361.86	0.09
SHA14APY120105UT	Tree Planting	Broad Creek	02120205	1490038.53	741275.96	0.36
SHA14APY120107UT	Tree Planting	Broad Creek	02120205	1484480.20	733924.14	0.25
SHA14APY120109UT	Tree Planting	Broad Creek	02120205	1495362.16	745621.08	0.18
SHA14APY120118UT	Tree Planting	Broad Creek	02120205	1507268.95	738447.42	0.07
SHA14APY120121UT	Tree Planting	Broad Creek	02120205	1486600.84	734519.33	1.61
SHA14APY120126UT	Tree Planting	Broad Creek	02120205	1504854.03	739486.99	0.05
SHA14APY120157UT	Tree Planting	Broad Creek	02120205	1495573.49	748642.61	0.22
SHA14APY120158UT	Tree Planting	Broad Creek	02120205	1495315.52	748630.37	0.46
SHA14APY120238UT	Tree Planting	Broad Creek	02120205	1487925.49	735451.20	0.61
SHA14APY120243UT	Tree Planting	Broad Creek	02120205	1489781.45	741229.96	0.05
SHA15APY120036UT	Tree Planting	Bush River	02130701	1528001.39	658675.28	0.12
SHA15APY120055UT	Tree Planting	Bush River	02130701	1526373.69	660131.26	0.89
SHA15APY120079UT	Tree Planting	Bush River	02130701	1526167.52	662873.35	0.10
SHA15APY120125UT	Tree Planting	Bush River	02130701	1522978.63	664224.59	0.08
SHA15APY120240UT	Tree Planting	Bush River	02130701	1525985.69	662636.47	0.17
SHA15APY120241UT	Tree Planting	Bush River	02130701	1525651.11	662201.37	0.53
SHA15APY120242UT	Tree Planting	Bush River	02130701	1525040.28	661916.83	0.04
SHA15APY120033UT	Tree Planting	Bynum Run	02130704	1491521.85	688697.84	0.24
SHA15APY120034UT	Tree Planting	Bynum Run	02130704	1494135.63	692014.57	1.32
SHA15APY120039UT	Tree Planting	Bynum Run	02130704	1495498.87	693595.13	0.63
SHA15APY120051UT	Tree Planting	Bynum Run	02130704	1495794.24	694345.10	0.20
SHA15APY120064UT	Tree Planting	Bynum Run	02130704	1488473.04	692141.85	0.05
SHA15APY120090UT	Tree Planting	Bynum Run	02130704	1497812.60	696181.64	0.15
SHA15APY120098UT	Tree Planting	Bynum Run	02130704	1487910.41	692960.72	0.18
SHA15APY120115UT	Tree Planting	Bynum Run	02130704	1495301.20	693231.55	0.46
SHA15APY120123UT	Tree Planting	Bynum Run	02130704	1493333.78	694030.34	0.21
SHA15APY120160UT	Tree Planting	Bynum Run	02130704	1487379.13	693555.09	0.16
SHA16APY120032UT	Tree Planting	Bynum Run	02130704	1489651.02	695151.83	0.39
SHA14APY120020UT	Tree Planting	Deer Creek	02120202	1535949.90	696567.77	0.54
SHA15APY120116UT	Tree Planting	Deer Creek	02120202	1498736.28	696961.68	0.63
SHA15APY120041UT	Tree Planting	Little Gunpowder Falls	02130804	1470473.86	678739.87	0.15
SHA15APY120047UT	Tree Planting	Little Gunpowder Falls	02130804	1476810.60	675652.46	0.17
SHA15APY120058UT	Tree Planting	Little Gunpowder Falls	02130804	1469037.07	679527.80	0.31
SHA15APY120073UT	Tree Planting	Little Gunpowder Falls	02130804	1473085.02	677477.29	0.57
SHA15APY120092UT	Tree Planting	Little Gunpowder Falls	02130804	1469826.22	679098.11	0.22
SHA15APY120096UT	Tree Planting	Little Gunpowder Falls	02130804	1458410.01	685938.33	0.15
SHA15APY120128UT	Tree Planting	Little Gunpowder Falls	02130804	1458952.69	685472.50	0.02
SHA15APY120129UT	Tree Planting	Little Gunpowder Falls	02130804	1470115.49	678954.77	0.02

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-26: FMIS # AT0685382						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15APY120135UT	Tree Planting	Little Gunpowder Falls	02130804	1463243.82	682814.07	0.09
SHA15APY120136UT	Tree Planting	Little Gunpowder Falls	02130804	1461137.34	683838.35	0.31
SHA15APY120137UT	Tree Planting	Little Gunpowder Falls	02130804	1466884.66	680756.88	0.05
SHA15APY120138UT	Tree Planting	Little Gunpowder Falls	02130804	1467947.54	680159.68	0.05
SHA15APY120239UT	Tree Planting	Little Gunpowder Falls	02130804	1469430.04	679305.14	0.03
SHA14APY120022UT	Tree Planting	Lower Susquehanna River	02120201	1547959.31	695626.61	0.87
SHA14APY120029UT	Tree Planting	Lower Susquehanna River	02120201	1553908.55	695745.28	0.33
SHA14APY120031UT	Tree Planting	Lower Susquehanna River	02120201	1547009.82	695219.82	0.30
SHA14APY120065UT	Tree Planting	Lower Susquehanna River	02120201	1546213.10	695194.45	0.38
SHA14APY120085UT	Tree Planting	Lower Susquehanna River	02120201	1547606.80	695376.26	0.11
SHA14APY120113UT	Tree Planting	Lower Susquehanna River	02120201	1546988.89	695361.70	0.85
SHA14APY120120UT	Tree Planting	Lower Susquehanna River	02120201	1552497.84	696193.12	0.30
SHA15APY120054UT	Tree Planting	Lower Winters Run	02130702	1497904.07	645476.71	0.33
SHA15APY120077UT	Tree Planting	Lower Winters Run	02130702	1510296.05	648302.23	0.23
SHA14APY120021UT	Tree Planting	Swan Creek	02130706	1536685.42	696873.09	0.20
SHA14APY120099UT	Tree Planting	Swan Creek	02130706	1536420.16	696763.99	0.10
SHA15APY120057UT	Tree Planting	Swan Creek	02130706	1549497.90	674025.38	0.19
				Complete BMP Acreage Total		**22.16**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-27: FMIS # AT0685582						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15APY070006UT	Tree Planting	Back Creek	02130604	1646149.21	678224.48	0.11
SHA15APY070007UT	Tree Planting	Back Creek	02130604	1645948.10	678261.61	0.17
SHA15APY070013UT	Tree Planting	Little Elk Creek	02130605	1634640.75	727993.36	0.43
SHA15APY070014UT	Tree Planting	Little Elk Creek	02130605	1634794.05	727288.83	0.23
SHA15APY070017UT	Tree Planting	Little Elk Creek	02130605	1626486.41	743236.13	0.04
SHA15APY070019UT	Tree Planting	Little Elk Creek	02130605	1634989.79	726929.55	0.12
SHA15APY070031UT	Tree Planting	Little Elk Creek	02130605	1636001.99	725455.96	0.05
SHA15APY070045UT	Tree Planting	Little Elk Creek	02130605	1621901.57	741429.27	0.34
SHA15APY070049UT	Tree Planting	Little Elk Creek	02130605	1635214.24	726643.91	0.22
SHA15APY070050UT	Tree Planting	Little Elk Creek	02130605	1636164.27	724979.33	0.13
SHA15APY070051UT	Tree Planting	Little Elk Creek	02130605	1636549.67	710679.22	0.13
SHA15APY070053UT	Tree Planting	Little Elk Creek	02130605	1634590.72	728649.32	0.06
SHA15APY070020UT	Tree Planting	Northeast River	02130608	1607688.67	715495.07	0.03
SHA15APY070024UT	Tree Planting	Northeast River	02130608	1607714.59	715421.05	0.04
SHA15APY070035UT	Tree Planting	Northeast River	02130608	1605621.49	731166.71	0.12
SHA15APY070037UT	Tree Planting	Northeast River	02130608	1605501.53	731398.04	0.04
SHA15APY070054UT	Tree Planting	Northeast River	02130608	1607799.48	715050.80	0.21
SHA15APY070088UT	Tree Planting	Northeast River	02130605	1624285.72	722056.77	0.31
SHA15APY070090UT	Tree Planting	Northeast River	02130608	1607422.49	719588.91	2.86
SHA15APY070008UT	Tree Planting	Octoraro Creek	02120203	1585012.20	749772.22	0.47
SHA15APY070009UT	Tree Planting	Octoraro Creek	02120203	1580893.24	747128.59	0.31
SHA15APY070010UT	Tree Planting	Octoraro Creek	02120203	1571822.00	717147.80	0.07
SHA15APY070025UT	Tree Planting	Octoraro Creek	02120203	1581599.78	747378.47	0.07
SHA15APY070027UT	Tree Planting	Octoraro Creek	02120203	1581662.75	747244.49	0.13
SHA15APY070040UT	Tree Planting	Octoraro Creek	02120203	1574495.64	745104.60	0.24
SHA15APY070041UT	Tree Planting	Octoraro Creek	02120203	1580611.72	746855.06	0.54
SHA15APY070042UT	Tree Planting	Octoraro Creek	02120203	1573141.73	733076.99	0.10
SHA15APY070044UT	Tree Planting	Octoraro Creek	02120203	1567736.98	740088.93	0.38
SHA15APY070052UT	Tree Planting	Octoraro Creek	02120203	1573055.27	731320.63	0.16
SHA15APY070057UT	Tree Planting	Octoraro Creek	02120203	1572182.82	717492.10	0.04
SHA15APY070061UT	Tree Planting	Octoraro Creek	02120203	1571310.45	716638.79	0.09
SHA15APY070071UT	Tree Planting	Octoraro Creek	02120203	1575609.00	745172.46	0.30
SHA15APY070076UT	Tree Planting	Octoraro Creek	02120203	1568139.93	740437.78	0.06
SHA15APY070078UT	Tree Planting	Octoraro Creek	02120203	1584787.63	749521.60	0.34
				Complete BMP Acreage Total		**8.92**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-28: FMIS # AT5025182						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA13APY120004UT	Tree Planting	Atkisson Reservoir	02130703	1489570.20	676160.32	0.34
SHA13APY120005UT	Tree Planting	Atkisson Reservoir	02130703	1490437.63	682264.78	0.40
SHA13APY120015UT	Tree Planting	Atkisson Reservoir	02130703	1490195.97	682807.29	0.39
SHA13APY030074UT	Tree Planting	Back River	02130901	1457628.91	602891.93	0.24
SHA13APY030075UT	Tree Planting	Back River	02130901	1452598.80	593477.62	0.30
SHA13APY030076UT	Tree Planting	Back River	02130901	1452968.09	593189.54	0.12
SHA13APY030077UT	Tree Planting	Back River	02130901	1453194.21	591601.21	0.15
SHA13APY030078UT	Tree Planting	Back River	02130901	1453131.45	591305.95	0.27
SHA13APY030079UT	Tree Planting	Back River	02130901	1454757.63	590267.30	0.28
SHA13APY030080UT	Tree Planting	Back River	02130901	1454810.83	590582.59	0.18
SHA13APY030081UT	Tree Planting	Back River	02130901	1455610.41	590027.32	0.80
SHA13APY030082UT	Tree Planting	Back River	02130901	1456972.23	589030.59	0.16
SHA13APY030084UT	Tree Planting	Back River	02130901	1461351.07	587583.47	0.22
SHA13APY030086UT	Tree Planting	Back River	02130901	1461871.51	586785.33	0.63
SHA13APY030088UT	Tree Planting	Back River	02130901	1464713.54	582732.88	0.11
SHA13APY030089UT	Tree Planting	Back River	02130901	1464701.47	583453.75	0.22
SHA13APY030090UT	Tree Planting	Back River	02130901	1466020.36	579013.55	0.11
SHA13APY030091UT	Tree Planting	Back River	02130901	1465637.31	578779.47	0.17
SHA13APY030092UT	Tree Planting	Back River	02130901	1466713.53	575886.19	0.27
SHA13APY030096UT	Tree Planting	Back River	02130901	1439600.40	630364.70	0.72
SHA13APY030098UT	Tree Planting	Back River	02130901	1439394.12	630642.89	0.42
SHA13APY030102UT	Tree Planting	Back River	02130901	1440456.81	630149.33	0.11
SHA13APY030103UT	Tree Planting	Back River	02130901	1440198.06	630401.47	0.24
SHA13APY030111UT	Tree Planting	Back River	02130901	1465548.57	602235.51	0.11
SHA13APY030112UT	Tree Planting	Back River	02130901	1465864.82	602344.28	0.14
SHA13APY030113UT	Tree Planting	Back River	02130901	1465809.04	601608.54	0.73
SHA13APY030114UT	Tree Planting	Back River	02130901	1452855.40	594583.82	0.30
SHA13APY030115UT	Tree Planting	Back River	02130901	1448436.59	592814.51	0.36
SHA13APY030116UT	Tree Planting	Back River	02130901	1449475.31	592798.14	0.26
SHA13APY030117UT	Tree Planting	Back River	02130901	1448959.12	592642.10	0.19
SHA13APY030118UT	Tree Planting	Back River	02130901	1448997.94	593028.67	0.31
SHA13APY030119UT	Tree Planting	Back River	02130901	1457183.43	606797.96	0.11
SHA13APY030120UT	Tree Planting	Back River	02130901	1456990.24	607519.61	0.16
SHA13APY030121UT	Tree Planting	Back River	02130901	1457215.22	607340.08	0.31
SHA13APY030125UT	Tree Planting	Back River	02130901	1461820.18	587235.68	0.12
SHA13APY030126UT	Tree Planting	Back River	02130901	1461214.03	587286.59	0.29
SHA13APY030128UT	Tree Planting	Back River	02130901	1474764.03	586174.13	0.83
SHA13APY030136UT	Tree Planting	Back River	02130901	1461684.09	586849.16	0.23
SHA13APY030137UT	Tree Planting	Back River	02130901	1461227.35	587355.56	0.06
SHA13APY030138UT	Tree Planting	Back River	02130901	1464619.62	583526.50	0.01
SHA13APY030083UT	Tree Planting	Baltimore Harbor	02130903	1461558.06	586668.11	0.11
SHA13APY030087UT	Tree Planting	Baltimore Harbor	02130903	1463652.13	584694.14	0.11
SHA13APY120006UT	Tree Planting	Bynum Run	02130704	1490643.90	687365.42	0.41
SHA13APY120007UT	Tree Planting	Bynum Run	02130704	1490816.40	687997.22	0.26
SHA13APY120008UT	Tree Planting	Bynum Run	02130704	1490918.08	688304.21	0.18
SHA13APY120009UT	Tree Planting	Bynum Run	02130704	1491151.45	688593.95	0.52
SHA13APY120010UT	Tree Planting	Bynum Run	02130704	1491307.73	689025.17	1.28
SHA13APY120011UT	Tree Planting	Bynum Run	02130704	1490835.08	688818.01	0.29
SHA13APY120012UT	Tree Planting	Conowingo Dam	02120204	1537326.38	723257.59	0.23
SHA12APY030052UT	Tree Planting	Deer Creek	02120202	1409381.70	747721.02	0.43
SHA12APY030070UT	Tree Planting	Deer Creek	02120202	1411585.40	744495.85	0.49
SHA12APY030072UT	Tree Planting	Deer Creek	02120202	1410132.97	747803.45	0.19
SHA13APY120003UT	Tree Planting	Gunpowder River	02130801	1507331.04	639625.43	0.07
SHA12APY030037UT	Tree Planting	Gwynns Falls	02130905	1382911.44	622499.44	0.20
SHA12APY030105UT	Tree Planting	Gwynns Falls	02130905	1384022.61	622383.23	0.38
SHA12APY030122UT	Tree Planting	Gwynns Falls	02130905	1387161.10	625552.59	0.28
SHA12APY030123UT	Tree Planting	Gwynns Falls	02130905	1387334.27	625355.74	0.28
SHA13APY030036UT	Tree Planting	Gwynns Falls	02130905	1364286.78	643730.81	0.24
SHA13APY030038UT	Tree Planting	Gwynns Falls	02130905	1382763.26	622893.45	0.33
SHA13APY030039UT	Tree Planting	Gwynns Falls	02130905	1382548.12	623509.66	1.41
SHA13APY030040UT	Tree Planting	Gwynns Falls	02130905	1379942.07	627413.40	0.59
SHA13APY030041UT	Tree Planting	Gwynns Falls	02130905	1377848.81	632976.56	0.26
SHA13APY030042UT	Tree Planting	Gwynns Falls	02130905	1374112.34	634596.81	0.30
SHA13APY030043UT	Tree Planting	Gwynns Falls	02130905	1373333.72	634905.71	0.13
SHA13APY030044UT	Tree Planting	Gwynns Falls	02130905	1371878.01	635692.93	0.50
SHA13APY030045UT	Tree Planting	Gwynns Falls	02130905	1370796.42	636421.96	0.18

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-28: FMIS # AT5025182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13APY030046UT	Tree Planting	Gwynns Falls	02130905	1362911.37	645868.21	0.19
SHA13APY030047UT	Tree Planting	Gwynns Falls	02130905	1362709.03	646094.39	0.09
SHA13APY030048UT	Tree Planting	Gwynns Falls	02130905	1360689.98	649166.45	0.27
SHA13APY030049UT	Tree Planting	Gwynns Falls	02130905	1371247.73	635138.80	0.64
SHA13APY030101UT	Tree Planting	Gwynns Falls	02130905	1384705.93	600013.96	0.25
SHA13APY030104UT	Tree Planting	Gwynns Falls	02130905	1384228.36	599366.12	0.41
SHA13APY030131UT	Tree Planting	Gwynns Falls	02130905	1384174.52	597592.82	1.55
SHA12APY030056UT	Tree Planting	Jones Falls	02130904	1415474.85	645427.75	0.11
SHA12APY030099UT	Tree Planting	Jones Falls	02130904	1415304.64	638180.76	0.45
SHA12APY030106UT	Tree Planting	Jones Falls	02130904	1414503.67	638930.77	0.38
SHA12APY030107UT	Tree Planting	Jones Falls	02130904	1399793.01	629937.54	0.14
SHA13APY030100UT	Tree Planting	Jones Falls	02130904	1413560.40	638671.58	0.64
SHA13APY120014UT	Tree Planting	Little Gunpowder Falls	02130804	1481637.40	668001.92	0.25
SHA12APY030053UT	Tree Planting	Loch Raven Reservoir	02130805	1411815.49	742449.77	0.35
SHA12APY030055UT	Tree Planting	Loch Raven Reservoir	02130805	1406460.82	665436.86	0.22
SHA12APY030059UT	Tree Planting	Loch Raven Reservoir	02130805	1406103.72	685711.86	0.55
SHA12APY030060UT	Tree Planting	Loch Raven Reservoir	02130805	1408471.96	705797.61	0.24
SHA12APY030061UT	Tree Planting	Loch Raven Reservoir	02130805	1407257.31	709819.99	0.12
SHA12APY030062UT	Tree Planting	Loch Raven Reservoir	02130805	1405554.97	714138.10	0.62
SHA12APY030063UT	Tree Planting	Loch Raven Reservoir	02130805	1407808.22	723464.93	0.17
SHA12APY030065UT	Tree Planting	Loch Raven Reservoir	02130805	1411079.99	727364.07	0.13
SHA12APY030066UT	Tree Planting	Loch Raven Reservoir	02130805	1411997.47	730192.92	0.47
SHA12APY030067UT	Tree Planting	Loch Raven Reservoir	02130805	1412206.50	730817.96	0.10
SHA12APY030068UT	Tree Planting	Loch Raven Reservoir	02130805	1412482.14	731855.16	0.10
SHA12APY030069UT	Tree Planting	Loch Raven Reservoir	02130805	1412207.83	734283.31	0.32
SHA12APY030071UT	Tree Planting	Loch Raven Reservoir	02130805	1412533.31	742288.28	0.93
SHA12APY030073UT	Tree Planting	Loch Raven Reservoir	02130805	1408024.75	677708.83	0.31
SHA12APY030127UT	Tree Planting	Loch Raven Reservoir	02130805	1411703.94	651517.24	0.15
SHA12APY030129UT	Tree Planting	Loch Raven Reservoir	02130805	1409320.15	658328.33	0.10
SHA12APY030307UT	Tree Planting	Loch Raven Reservoir	02130805	1409240.57	658537.19	0.04
SHA12APY030310UT	Tree Planting	Loch Raven Reservoir	02130805	1408086.04	657215.97	0.05
SHA13APY030058UT	Tree Planting	Loch Raven Reservoir	02130805	1405965.33	666769.67	0.29
SHA13APY030097UT	Tree Planting	Loch Raven Reservoir	02130805	1425486.16	636086.25	0.28
SHA13APY030108UT	Tree Planting	Loch Raven Reservoir	02130805	1421535.64	636689.69	0.19
SHA13APY030109UT	Tree Planting	Loch Raven Reservoir	02130805	1424599.72	636431.86	0.12
SHA13APY030093UT	Tree Planting	Lower Gunpowder Falls	02130802	1435233.02	631847.59	0.19
SHA13APY030110UT	Tree Planting	Lower Gunpowder Falls	02130802	1431186.38	635278.11	0.24
SHA13APY120002UT	Tree Planting	Lower Winters Run	02130702	1507317.30	640311.86	0.25
SHA13APY120017UT	Tree Planting	Lower Winters Run	02130702	1507242.18	640000.66	0.04
				Complete BMP Acreage Total		**33.00**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-29: FMIS # AT5025282						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA14APY100118UT	Tree Planting	Catoctin Creek	02140305	1167919.06	655530.58	0.23
SHA14APY100119UT	Tree Planting	Catoctin Creek	02140305	1157919.84	644787.44	0.21
SHA14APY100120UT	Tree Planting	Catoctin Creek	02140305	1157086.24	644166.66	0.19
SHA14APY100121UT	Tree Planting	Catoctin Creek	02140305	1145840.64	635692.70	0.14
SHA14APY100423UT	Tree Planting	Catoctin Creek	02140305	1168086.11	655209.43	0.15
SHA14APY100424UT	Tree Planting	Catoctin Creek	02140305	1158187.73	645235.99	0.62
SHA13APY060002UT	Tree Planting	Double Pipe Creek	02140304	1308122.59	694886.22	0.30
SHA13APY060003UT	Tree Planting	Double Pipe Creek	02140304	1303126.02	689293.82	0.23
SHA13APY060004UT	Tree Planting	Double Pipe Creek	02140304	1300840.47	688426.20	0.28
SHA13APY060005UT	Tree Planting	Double Pipe Creek	02140304	1285460.90	684002.07	0.22
SHA13APY060006UT	Tree Planting	Double Pipe Creek	02140304	1299048.09	703987.47	0.69
SHA13APY060007UT	Tree Planting	Double Pipe Creek	02140304	1296471.54	705577.44	0.80
SHA13APY060012UT	Tree Planting	Double Pipe Creek	02140304	1309853.57	698690.08	0.34
SHA13APY060013UT	Tree Planting	Double Pipe Creek	02140304	1309206.75	696189.24	0.17
SHA13APY060265UT	Tree Planting	Double Pipe Creek	02140304	1308493.22	695230.87	0.05
SHA13APY060266UT	Tree Planting	Double Pipe Creek	02140304	1306827.72	692969.45	0.14
SHA13APY060267UT	Tree Planting	Double Pipe Creek	02140304	1307700.12	694345.76	0.18
SHA13APY060268UT	Tree Planting	Double Pipe Creek	02140304	1307288.09	693649.58	0.14
SHA13APY060269UT	Tree Planting	Double Pipe Creek	02140304	1301748.38	688753.70	0.01
SHA13APY060270UT	Tree Planting	Double Pipe Creek	02140304	1299448.26	687435.74	0.09
SHA13APY060271UT	Tree Planting	Double Pipe Creek	02140304	1300285.66	688106.02	0.11
SHA13APY060272UT	Tree Planting	Double Pipe Creek	02140304	1299778.90	687722.43	0.08
SHA14APY060019UT	Tree Planting	Double Pipe Creek	02140304	1265638.37	693231.46	0.19
SHA14APY060020UT	Tree Planting	Double Pipe Creek	02140304	1276465.32	688476.39	0.43
SHA14APY060021UT	Tree Planting	Double Pipe Creek	02140304	1289081.45	684643.98	0.25
SHA14APY060022UT	Tree Planting	Double Pipe Creek	02140304	1293808.56	685322.46	0.73
SHA14APY060026UT	Tree Planting	Double Pipe Creek	02140304	1304418.98	690253.75	0.86
SHA14APY060027UT	Tree Planting	Double Pipe Creek	02140304	1306095.99	692076.39	0.45
SHA14APY060028UT	Tree Planting	Double Pipe Creek	02140304	1308682.09	695445.56	0.06
SHA14APY060038UT	Tree Planting	Double Pipe Creek	02140304	1290388.55	655446.27	0.27
SHA14APY060049UT	Tree Planting	Double Pipe Creek	02140304	1282106.55	715141.95	0.14
SHA14APY060273UT	Tree Planting	Double Pipe Creek	02140304	1305485.53	691444.67	0.39
SHA13APY130068UT	Tree Planting	Little Patuxent River	02131105	1365258.77	555678.64	0.25
SHA13APY130069UT	Tree Planting	Little Patuxent River	02131105	1365378.45	555341.76	0.59
SHA13APY130070UT	Tree Planting	Little Patuxent River	02131105	1365854.20	555023.24	0.14
SHA13APY130077UT	Tree Planting	Little Patuxent River	02131105	1366018.46	536340.40	0.71
SHA13APY130078UT	Tree Planting	Little Patuxent River	02131105	1365144.06	536032.87	0.79
SHA13APY130079UT	Tree Planting	Little Patuxent River	02131105	1365655.39	535662.39	0.61
SHA13APY130081UT	Tree Planting	Little Patuxent River	02131105	1357994.03	572832.87	0.49
SHA13APY130082UT	Tree Planting	Little Patuxent River	02131105	1356483.77	568419.86	0.05
SHA13APY130083UT	Tree Planting	Little Patuxent River	02131105	1356610.45	568745.86	0.15
SHA13APY130084UT	Tree Planting	Little Patuxent River	02131105	1356461.76	568076.43	0.08
SHA13APY130085UT	Tree Planting	Little Patuxent River	02131105	1349779.71	555036.18	0.07
SHA13APY130088UT	Tree Planting	Little Patuxent River	02131105	1348272.21	552223.10	0.07
SHA13APY130089UT	Tree Planting	Little Patuxent River	02131105	1348087.24	551226.72	0.24
SHA13APY130090UT	Tree Planting	Little Patuxent River	02131105	1336770.69	596491.28	0.24
SHA13APY130091UT	Tree Planting	Little Patuxent River	02131105	1336224.60	596627.44	0.34
SHA13APY130095UT	Tree Planting	Little Patuxent River	02131105	1348253.30	536247.79	0.06
SHA13APY130096UT	Tree Planting	Little Patuxent River	02131105	1345708.18	537722.38	0.20
SHA13APY130097UT	Tree Planting	Little Patuxent River	02131105	1343117.37	538304.47	0.06
SHA13APY130098UT	Tree Planting	Little Patuxent River	02131105	1343552.15	538280.83	0.05
SHA13APY130099UT	Tree Planting	Little Patuxent River	02131105	1343789.62	538225.91	0.01
SHA14APY130135UT	Tree Planting	Little Patuxent River	02131105	1364928.70	536327.04	0.43
SHA14APY130137UT	Tree Planting	Little Patuxent River	02131105	1347388.32	551564.59	0.68
SHA14APY130189UT	Tree Planting	Little Patuxent River	02131105	1347561.29	551504.66	0.29
SHA14APY130190UT	Tree Planting	Little Patuxent River	02131105	1347560.32	551689.87	0.25
SHA14APY130219UT	Tree Planting	Little Patuxent River	02131105	1365160.94	535759.84	0.09
SHA13APY100037UT	Tree Planting	Lower Monocacy River	02140302	1194566.37	631083.07	0.75
SHA13APY100038UT	Tree Planting	Lower Monocacy River	02140302	1204688.76	632737.12	2.17
SHA13APY100040UT	Tree Planting	Lower Monocacy River	02140302	1212760.59	633353.08	0.25
SHA13APY100042UT	Tree Planting	Lower Monocacy River	02140302	1224246.29	677781.87	0.28
SHA13APY100043UT	Tree Planting	Lower Monocacy River	02140302	1223790.65	682624.39	0.22
SHA13APY100044UT	Tree Planting	Lower Monocacy River	02140302	1198218.56	646990.67	0.17
SHA13APY100045UT	Tree Planting	Lower Monocacy River	02140302	1198701.96	647712.18	0.43
SHA13APY100046UT	Tree Planting	Lower Monocacy River	02140302	1198491.58	647184.66	0.25
SHA14APY060044UT	Tree Planting	Lower Monocacy River	02140302	1280082.76	654131.77	0.17

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-29: FMIS # AT5025282						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA14APY100117UT	Tree Planting	Lower Monocacy River	02140302	1189177.24	637039.80	0.38
SHA14APY100122UT	Tree Planting	Lower Monocacy River	02140302	1230916.38	625508.52	0.04
SHA14APY100123UT	Tree Planting	Lower Monocacy River	02140302	1234610.77	624218.92	0.42
SHA14APY100124UT	Tree Planting	Lower Monocacy River	02140302	1254221.59	620510.65	0.12
SHA14APY100125UT	Tree Planting	Lower Monocacy River	02140302	1255552.46	619754.17	0.12
SHA14APY100126UT	Tree Planting	Lower Monocacy River	02140302	1170718.46	619507.94	0.59
SHA14APY100127UT	Tree Planting	Lower Monocacy River	02140302	1172566.18	621001.17	0.28
SHA14APY100129UT	Tree Planting	Lower Monocacy River	02140302	1182975.09	626332.18	0.13
SHA14APY100130UT	Tree Planting	Lower Monocacy River	02140302	1251155.81	661337.64	0.31
SHA14APY100131UT	Tree Planting	Lower Monocacy River	02140302	1247216.63	661633.64	0.08
SHA14APY100132UT	Tree Planting	Lower Monocacy River	02140302	1224457.83	678569.69	0.76
SHA14APY100134UT	Tree Planting	Lower Monocacy River	02140302	1263999.22	616544.62	0.36
SHA14APY100247UT	Tree Planting	Lower Monocacy River	02140302	1247477.27	661556.03	0.08
SHA14APY100425UT	Tree Planting	Lower Monocacy River	02140302	1250755.72	661336.15	0.02
SHA14APY100426UT	Tree Planting	Lower Monocacy River	02140302	1224549.36	679494.75	0.14
SHA13APY130072UT	Tree Planting	Middle Patuxent River	02131106	1315892.29	585442.25	0.49
SHA13APY130073UT	Tree Planting	Middle Patuxent River	02131106	1316143.98	585291.93	0.21
SHA13APY130086UT	Tree Planting	Middle Patuxent River	02131106	1347375.38	551069.55	0.23
SHA13APY130087UT	Tree Planting	Middle Patuxent River	02131106	1347192.12	551784.63	0.26
SHA13APY130092UT	Tree Planting	Middle Patuxent River	02131106	1325455.00	597803.62	0.79
SHA13APY130093UT	Tree Planting	Middle Patuxent River	02131106	1324887.81	598379.73	0.30
SHA13APY130208UT	Tree Planting	Middle Patuxent River	02131106	1317133.24	586969.56	0.61
SHA13APY130209UT	Tree Planting	Middle Patuxent River	02131106	1319279.02	588426.39	0.87
SHA14APY130130UT	Tree Planting	Middle Patuxent River	02131106	1342039.27	552836.11	0.17
SHA14APY130131UT	Tree Planting	Middle Patuxent River	02131106	1343398.01	543458.15	0.26
SHA14APY130132UT	Tree Planting	Middle Patuxent River	02131106	1345710.73	552528.51	0.06
SHA14APY130133UT	Tree Planting	Middle Patuxent River	02131106	1341296.16	552874.68	0.31
SHA14APY130136UT	Tree Planting	Middle Patuxent River	02131106	1340687.80	553163.59	0.54
SHA14APY130138UT	Tree Planting	Middle Patuxent River	02131106	1338625.83	554689.55	0.67
SHA14APY130220UT	Tree Planting	Middle Patuxent River	02131106	1341387.42	552571.52	0.08
SHA14APY130221UT	Tree Planting	Middle Patuxent River	02131106	1339616.63	554094.24	0.13
SHA14APY130222UT	Tree Planting	Middle Patuxent River	02131106	1345279.97	552553.93	0.09
SHA13APY130063UT	Tree Planting	Patapsco River L N Br	02130906	1372978.97	561535.95	0.39
SHA13APY130064UT	Tree Planting	Patapsco River L N Br	02130906	1373634.04	561497.51	0.11
SHA13APY130065UT	Tree Planting	Patapsco River L N Br	02130906	1374049.16	561526.39	0.09
SHA13APY130066UT	Tree Planting	Patapsco River L N Br	02130906	1381939.41	554124.73	0.22
SHA13APY130067UT	Tree Planting	Patapsco River L N Br	02130906	1381346.92	554697.94	0.24
SHA13APY130094UT	Tree Planting	Patapsco River L N Br	02130906	1361127.84	593749.10	0.08
SHA13APY130121UT	Tree Planting	Patapsco River L N Br	02130906	1390837.95	554490.26	0.77
SHA13APY130218UT	Tree Planting	Patapsco River L N Br	02130906	1390619.21	554632.73	0.61
SHA14APY130134UT	Tree Planting	Patapsco River L N Br	02130906	1370354.46	563628.06	0.20
SHA14APY130187UT	Tree Planting	Patapsco River L N Br	02130906	1369727.16	563120.04	0.77
SHA14APY130188UT	Tree Planting	Patapsco River L N Br	02130906	1369310.50	562504.77	0.57
SHA14APY130210UT	Tree Planting	Patapsco River L N Br	02130906	1369905.59	562503.67	0.72
SHA14APY100128UT	Tree Planting	Potomac River FR Cnty	02140301	1132555.05	610851.44	0.07
SHA14APY100422UT	Tree Planting	Potomac River FR Cnty	02140301	1132882.35	611133.21	0.06
SHA13APY060008UT	Tree Planting	S Branch Patapsco	02130908	1271818.15	623851.28	0.06
SHA13APY060009UT	Tree Planting	S Branch Patapsco	02130908	1270936.79	620709.00	0.22
SHA13APY060010UT	Tree Planting	S Branch Patapsco	02130908	1268572.06	618649.89	0.12
SHA13APY060011UT	Tree Planting	S Branch Patapsco	02130908	1321924.08	618065.03	0.16
SHA14APY060023UT	Tree Planting	S Branch Patapsco	02130908	1272071.22	625082.60	1.14
SHA14APY060030UT	Tree Planting	S Branch Patapsco	02130908	1272391.31	626050.85	0.16
SHA14APY060032UT	Tree Planting	S Branch Patapsco	02130908	1270130.00	617350.41	0.21
SHA14APY060041UT	Tree Planting	S Branch Patapsco	02130908	1290965.96	650941.40	0.22
SHA14APY060042UT	Tree Planting	S Branch Patapsco	02130908	1272471.68	628786.18	0.34
SHA14APY060045UT	Tree Planting	S Branch Patapsco	02130908	1294705.50	649244.01	0.16
SHA14APY060150UT	Tree Planting	S Branch Patapsco	02130908	1272242.52	626293.30	0.46
SHA14APY060151UT	Tree Planting	S Branch Patapsco	02130908	1272283.93	627001.03	0.51
SHA13APY100047UT	Tree Planting	Upper Monocacy River	02140303	1192231.16	706526.78	0.20
SHA13APY100048UT	Tree Planting	Upper Monocacy River	02140303	1197131.33	717520.68	0.33
SHA13APY100049UT	Tree Planting	Upper Monocacy River	02140303	1225080.63	741282.72	0.04
SHA13APY100050UT	Tree Planting	Upper Monocacy River	02140303	1224444.65	741642.36	0.21
SHA13APY100253UT	Tree Planting	Upper Monocacy River	02140303	1196787.30	717320.00	0.11
SHA14APY060033UT	Tree Planting	Upper Monocacy River	02140303	1265884.13	728643.52	1.04
SHA14APY060034UT	Tree Planting	Upper Monocacy River	02140303	1267332.25	730544.38	0.62
SHA14APY060037UT	Tree Planting	Upper Monocacy River	02140303	1276859.11	744248.83	0.12

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-29: FMIS # AT5025282						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA14APY060039UT	Tree Planting	Upper Monocacy River	02140303	1271591.27	737415.89	0.30
SHA14APY060040UT	Tree Planting	Upper Monocacy River	02140303	1277398.04	746923.69	0.30
SHA14APY060141UT	Tree Planting	Upper Monocacy River	02140303	1271332.04	736946.57	0.18
SHA14APY060152UT	Tree Planting	Upper Monocacy River	02140303	1265087.86	727720.01	0.17
					Complete BMP Acreage Total	**42.92**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-30: FMIS # AT5025382						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13APY150031UT	Tree Planting	Anacostia River	02140205	1308005.37	491609.49	0.21
SHA13APY150033UT	Tree Planting	Anacostia River	02140205	1307349.92	491249.56	0.07
SHA13APY150034UT	Tree Planting	Anacostia River	02140205	1307474.08	491606.14	0.18
SHA13APY150035UT	Tree Planting	Anacostia River	02140205	1310770.67	490992.78	0.09
SHA13APY150036UT	Tree Planting	Anacostia River	02140205	1310487.31	491465.89	0.13
SHA13APY160102UT	Tree Planting	Anacostia River	02140205	1354524.14	456314.66	0.09
SHA13APY020049UT	Tree Planting	Baltimore Harbor	02130903	1402585.94	540581.70	0.19
SHA13APY020050UT	Tree Planting	Baltimore Harbor	02130903	1412512.19	542357.03	0.72
SHA13APY020051UT	Tree Planting	Baltimore Harbor	02130903	1412517.48	541771.95	1.68
SHA13APY020052UT	Tree Planting	Baltimore Harbor	02130903	1413154.92	541661.42	0.65
SHA13APY020053UT	Tree Planting	Baltimore Harbor	02130903	1413289.47	540913.19	1.03
SHA13APY020054UT	Tree Planting	Baltimore Harbor	02130903	1413192.67	540500.48	0.74
SHA13APY020057UT	Tree Planting	Baltimore Harbor	02130903	1414041.14	547442.75	0.59
SHA13APY020058UT	Tree Planting	Baltimore Harbor	02130903	1415702.56	550692.61	0.08
SHA13APY020059UT	Tree Planting	Baltimore Harbor	02130903	1415504.09	550400.47	0.32
SHA13APY020060UT	Tree Planting	Baltimore Harbor	02130903	1407286.18	541636.60	0.39
SHA13APY020061UT	Tree Planting	Baltimore Harbor	02130903	1407739.82	541927.35	3.01
SHA13APY150030UT	Tree Planting	Lower Monocacy River	02140302	1220769.29	587282.86	0.47
SHA13APY020048UT	Tree Planting	Patapsco River L N Br	02130906	1389145.33	547816.86	1.07
SHA13APY020062UT	Tree Planting	Patapsco River L N Br	02130906	1399111.44	540789.29	1.16
SHA13APY080012UT	Tree Planting	Patuxent River lower	02131101	1375830.25	315220.77	0.24
SHA13APY080013UT	Tree Planting	Patuxent River lower	02131101	1376209.80	315226.55	0.15
SHA13APY080014UT	Tree Planting	Patuxent River lower	02131101	1376318.12	314698.03	0.14
SHA13APY080015UT	Tree Planting	Patuxent River lower	02131101	1376081.12	315667.45	0.08
SHA13APY080016UT	Tree Planting	Patuxent River lower	02131101	1373383.20	318487.70	0.15
SHA13APY080017UT	Tree Planting	Patuxent River lower	02131101	1375547.38	316480.88	0.53
SHA13APY080018UT	Tree Planting	Patuxent River lower	02131101	1374759.60	316968.64	0.29
SHA13APY160095UT	Tree Planting	Piscataway Creek	02140203	1320018.04	386541.27	1.54
SHA13APY160096UT	Tree Planting	Piscataway Creek	02140203	1321186.53	388936.09	0.15
SHA13APY160091UT	Tree Planting	Potomac River U tidal	02140201	1334702.42	420340.95	0.21
SHA13APY160092UT	Tree Planting	Potomac River U tidal	02140201	1334842.16	420240.07	0.33
SHA13APY160093UT	Tree Planting	Potomac River U tidal	02140201	1335205.61	420543.40	0.46
SHA13APY160094UT	Tree Planting	Potomac River U tidal	02140201	1335439.14	420297.18	0.37
SHA13APY160098UT	Tree Planting	Potomac River U tidal	02140201	1312942.44	412788.99	0.70
SHA13APY150038UT	Tree Planting	Seneca Creek	02140208	1260942.56	562604.62	0.34
SHA13APY150039UT	Tree Planting	Seneca Creek	02140208	1261357.21	563098.03	0.13
SHA13APY150040UT	Tree Planting	Seneca Creek	02140208	1260690.60	563048.05	0.31
SHA13APY150041UT	Tree Planting	Seneca Creek	02140208	1260107.52	562280.71	0.17
SHA13APY020047UT	Tree Planting	Severn River	02131002	1398848.06	522266.16	0.37
SHA13APY020055UT	Tree Planting	Severn River	02131002	1418104.74	519272.22	1.77
SHA13APY020056UT	Tree Planting	Severn River	02131002	1418330.45	520708.15	0.37
SHA13APY160087UT	Tree Planting	Western Branch	02131103	1354626.52	456128.88	0.51
SHA13APY160088UT	Tree Planting	Western Branch	02131103	1355479.59	446885.83	0.58
SHA13APY160089UT	Tree Planting	Western Branch	02131103	1355781.65	447105.99	0.21
				Complete BMP Acreage Total		**22.97**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-31: FMIS # AT5025482						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13APY210013UT	Tree Planting	Antietam Creek	02140502	1120152.83	705259.65	0.65
SHA13APY210014UT	Tree Planting	Antietam Creek	02140502	1120408.82	704610.64	0.79
SHA13APY210015UT	Tree Planting	Antietam Creek	02140502	1140984.11	684443.07	0.52
SHA13APY210047UT	Tree Planting	Antietam Creek	02140502	1107164.41	706575.28	0.80
SHA13APY210048UT	Tree Planting	Antietam Creek	02140502	1107151.94	707459.48	0.91
SHA13APY210052UT	Tree Planting	Antietam Creek	02140502	1106616.81	706574.73	0.56
SHA13APY210429UT	Tree Planting	Antietam Creek	02140502	1120601.94	705206.92	0.29
SHA13APY210006UT	Tree Planting	Conococheague Creek	02140504	1072509.60	723658.47	1.04
SHA13APY210007UT	Tree Planting	Conococheague Creek	02140504	1074084.26	723195.89	0.55
SHA13APY210008UT	Tree Planting	Conococheague Creek	02140504	1076886.54	721768.06	0.49
SHA13APY210009UT	Tree Planting	Conococheague Creek	02140504	1090882.04	710895.17	0.58
SHA13APY210010UT	Tree Planting	Conococheague Creek	02140504	1091413.00	711161.86	0.70
SHA13APY210011UT	Tree Planting	Conococheague Creek	02140504	1091695.87	711421.33	0.35
SHA13APY210016UT	Tree Planting	Conococheague Creek	02140504	1066291.58	724040.98	1.30
SHA13APY210017UT	Tree Planting	Conococheague Creek	02140504	1068711.04	723767.43	0.84
SHA13APY210019UT	Tree Planting	Conococheague Creek	02140504	1064093.97	724014.56	0.18
SHA13APY210043UT	Tree Planting	Conococheague Creek	02140504	1101668.22	724620.22	0.56
SHA13APY210044UT	Tree Planting	Conococheague Creek	02140504	1103932.88	741712.89	0.37
SHA13APY210045UT	Tree Planting	Conococheague Creek	02140504	1104211.98	741218.01	1.15
SHA13APY210046UT	Tree Planting	Conococheague Creek	02140504	1104570.74	741452.21	0.45
SHA13APY210051UT	Tree Planting	Conococheague Creek	02140504	1102214.45	724547.94	0.19
SHA13APY210053UT	Tree Planting	Conococheague Creek	02140504	1087345.70	725787.57	0.63
SHA13APY210110UT	Tree Planting	Conococheague Creek	02140504	1063971.73	723990.32	0.09
SHA13APY210113UT	Tree Planting	Conococheague Creek	02140504	1094937.81	707479.90	0.37
SHA13APY210018UT	Tree Planting	Little Conococheague	02140505	1063047.06	724036.45	0.43
SHA13APY210020UT	Tree Planting	Little Conococheague	02140505	1054405.60	724680.78	0.88
SHA13APY210021UT	Tree Planting	Little Conococheague	02140505	1062391.50	724084.84	0.44
SHA13APY210022UT	Tree Planting	Little Conococheague	02140505	1052796.97	723693.70	0.27
SHA13APY210025UT	Tree Planting	Little Conococheague	02140505	1052006.52	723813.46	1.78
SHA13APY210049UT	Tree Planting	Little Conococheague	02140505	1057511.84	724301.54	0.93
SHA13APY210112UT	Tree Planting	Little Conococheague	02140505	1049386.12	722843.92	0.07
SHA13APY210030UT	Tree Planting	Little Tonoloway Creek	02140509	978823.74	745019.85	0.54
SHA13APY210032UT	Tree Planting	Little Tonoloway Creek	02140509	978353.52	747032.93	0.70
SHA13APY210033UT	Tree Planting	Little Tonoloway Creek	02140509	977343.26	747663.24	0.73
SHA13APY210034UT	Tree Planting	Little Tonoloway Creek	02140509	979015.13	745822.10	0.37
SHA13APY210035UT	Tree Planting	Little Tonoloway Creek	02140509	978877.40	745543.61	0.33
SHA13APY210036UT	Tree Planting	Little Tonoloway Creek	02140509	978138.84	748539.34	0.85
SHA13APY210037UT	Tree Planting	Little Tonoloway Creek	02140509	977759.70	748016.10	0.48
SHA13APY210038UT	Tree Planting	Little Tonoloway Creek	02140509	952177.36	748190.91	0.91
SHA13APY210039UT	Tree Planting	Little Tonoloway Creek	02140509	961255.58	742141.56	0.27
SHA13APY210040UT	Tree Planting	Little Tonoloway Creek	02140509	961696.52	742116.85	0.25
SHA13APY210041UT	Tree Planting	Little Tonoloway Creek	02140509	966262.36	747703.80	0.25
SHA13APY210042UT	Tree Planting	Little Tonoloway Creek	02140509	966684.76	747751.22	0.12
SHA13APY210012UT	Tree Planting	Marsh Run	02140503	1099272.78	707143.97	0.53
SHA13APY210050UT	Tree Planting	Marsh Run	02140503	1098492.68	707473.66	0.53
SHA13APY210412UT	Tree Planting	Marsh Run	02140503	1099429.67	707041.69	0.28
SHA13APY210432UT	Tree Planting	Marsh Run	02140503	1096159.95	707437.97	0.39
SHA13APY210023UT	Tree Planting	Potomac River WA Cnty	02140501	1048834.32	722601.22	0.54
SHA13APY210024UT	Tree Planting	Potomac River WA Cnty	02140501	1046074.24	721113.55	1.37
SHA13APY210026UT	Tree Planting	Potomac River WA Cnty	02140501	1043173.61	718906.54	0.33
SHA13APY210027UT	Tree Planting	Potomac River WA Cnty	02140501	1000540.97	737516.86	0.95
SHA13APY210028UT	Tree Planting	Potomac River WA Cnty	02140501	979574.25	745344.35	0.19
SHA13APY210029UT	Tree Planting	Potomac River WA Cnty	02140501	979230.18	745207.19	0.31
SHA13APY210031UT	Tree Planting	Potomac River WA Cnty	02140501	992670.02	739639.95	0.44
SHA13APY210109UT	Tree Planting	Potomac River WA Cnty	02140501	979407.25	745221.96	0.16
SHA13APY210426UT	Tree Planting	Potomac River WA Cnty	02140501	1042837.24	718730.52	0.28
				Complete BMP Acreage Total		**31.27**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-32: FMIS # AW0445182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA11APY100099UT	Tree Planting	Catoctin Creek	02140305	1169505.74	651984.53	0.08
SHA11APY100101UT	Tree Planting	Catoctin Creek	02140305	1168349.27	652883.15	0.13
				Complete BMP Acreage Total		**0.21**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-33: FMIS # AW0825282						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA15APY100135UT	Tree Planting	Catoctin Creek	02140305	1156195.64	616196.40	0.26
SHA15APY100136UT	Tree Planting	Catoctin Creek	02140305	1161084.22	616643.31	0.31
SHA15APY100140UT	Tree Planting	Catoctin Creek	02140305	1164888.96	660266.32	0.03
SHA15APY100144UT	Tree Planting	Catoctin Creek	02140305	1154858.25	664082.42	0.22
SHA15APY100145UT	Tree Planting	Catoctin Creek	02140305	1149897.42	668870.11	0.33
SHA15APY100147UT	Tree Planting	Catoctin Creek	02140305	1159176.02	616705.93	0.51
SHA15APY100148UT	Tree Planting	Catoctin Creek	02140305	1163363.89	617783.32	0.33
SHA15APY100152UT	Tree Planting	Catoctin Creek	02140305	1164640.61	660726.45	0.08
SHA15APY100155UT	Tree Planting	Catoctin Creek	02140305	1162065.32	616862.74	0.11
SHA15APY100164UT	Tree Planting	Catoctin Creek	02140305	1164972.33	656483.98	1.40
SHA15APY100165UT	Tree Planting	Catoctin Creek	02140305	1149437.35	668950.97	0.15
SHA15APY100178UT	Tree Planting	Catoctin Creek	02140305	1147460.79	615909.49	0.05
SHA15APY100179UT	Tree Planting	Catoctin Creek	02140305	1142710.12	615419.00	0.08
SHA15APY100180UT	Tree Planting	Catoctin Creek	02140305	1153628.89	615971.48	0.20
SHA15APY100194UT	Tree Planting	Catoctin Creek	02140305	1161795.23	616788.20	0.08
SHA15APY100202UT	Tree Planting	Catoctin Creek	02140305	1163356.30	657594.29	0.52
SHA15APY100213UT	Tree Planting	Catoctin Creek	02140305	1161741.33	617039.45	0.24
SHA15APY100224UT	Tree Planting	Catoctin Creek	02140305	1162055.75	617140.37	0.06
SHA15APY100234UT	Tree Planting	Catoctin Creek	02140305	1164442.06	617853.47	0.42
SHA15APY100434UT	Tree Planting	Catoctin Creek	02140305	1148259.76	615571.83	0.06
SHA15APY100435UT	Tree Planting	Catoctin Creek	02140305	1164455.73	660754.12	0.48
SHA15APY100437UT	Tree Planting	Catoctin Creek	02140305	1165324.90	655804.10	0.42
SHA15APY100438UT	Tree Planting	Catoctin Creek	02140305	1165851.93	655318.74	0.11
SHA15APY100439UT	Tree Planting	Catoctin Creek	02140305	1164287.44	656753.71	0.53
SHA15APY060050UT	Tree Planting	Double Pipe Creek	02140304	1264650.12	693924.96	0.08
SHA15APY060051UT	Tree Planting	Double Pipe Creek	02140304	1265982.56	693176.79	0.18
SHA15APY060052UT	Tree Planting	Double Pipe Creek	02140304	1265750.75	693377.12	0.05
SHA15APY060053UT	Tree Planting	Double Pipe Creek	02140304	1267809.27	693124.20	0.82
SHA15APY060055UT	Tree Planting	Double Pipe Creek	02140304	1269719.68	692105.77	0.31
SHA15APY060073UT	Tree Planting	Double Pipe Creek	02140304	1287811.56	684369.33	0.54
SHA15APY060075UT	Tree Planting	Double Pipe Creek	02140304	1265149.11	693520.20	0.05
SHA15APY060077UT	Tree Planting	Double Pipe Creek	02140304	1266594.04	693318.08	0.11
SHA15APY060091UT	Tree Planting	Double Pipe Creek	02140304	1289553.89	684833.17	0.30
SHA15APY060092UT	Tree Planting	Double Pipe Creek	02140304	1285329.38	684008.75	0.08
SHA14APY130140UT	Tree Planting	Little Patuxent River	02131105	1356066.11	567066.90	0.30
SHA14APY130142UT	Tree Planting	Little Patuxent River	02131105	1364028.02	575301.83	0.23
SHA14APY130143UT	Tree Planting	Little Patuxent River	02131105	1363921.13	575087.14	0.19
SHA14APY130144UT	Tree Planting	Little Patuxent River	02131105	1364310.73	575645.04	0.23
SHA14APY130148UT	Tree Planting	Little Patuxent River	02131105	1364815.95	573736.95	0.09
SHA14APY130150UT	Tree Planting	Little Patuxent River	02131105	1365326.96	556165.38	0.95
SHA14APY130155UT	Tree Planting	Little Patuxent River	02131105	1361910.44	541057.01	0.11
SHA14APY130156UT	Tree Planting	Little Patuxent River	02131105	1368873.47	533226.82	1.60
SHA14APY130157UT	Tree Planting	Little Patuxent River	02131105	1369147.12	533554.69	0.15
SHA14APY130158UT	Tree Planting	Little Patuxent River	02131105	1366330.77	535969.98	0.57
SHA14APY130159UT	Tree Planting	Little Patuxent River	02131105	1357379.13	547196.81	0.37
SHA14APY130164UT	Tree Planting	Little Patuxent River	02131105	1363230.29	576120.40	1.69
SHA14APY130165UT	Tree Planting	Little Patuxent River	02131105	1364054.08	576151.36	0.73
SHA14APY130166UT	Tree Planting	Little Patuxent River	02131105	1370532.16	552301.61	0.70
SHA14APY130167UT	Tree Planting	Little Patuxent River	02131105	1341758.17	538738.58	1.94
SHA14APY130168UT	Tree Planting	Little Patuxent River	02131105	1370783.47	532269.20	0.40
SHA14APY130170UT	Tree Planting	Little Patuxent River	02131105	1348784.92	553769.45	0.12
SHA14APY130171UT	Tree Planting	Little Patuxent River	02131105	1364133.42	557201.29	0.50
SHA14APY130179UT	Tree Planting	Little Patuxent River	02131105	1360767.52	543021.38	0.39
SHA14APY130180UT	Tree Planting	Little Patuxent River	02131105	1370842.25	531851.41	0.85
SHA14APY130181UT	Tree Planting	Little Patuxent River	02131105	1367692.74	534780.41	0.45
SHA14APY130191UT	Tree Planting	Little Patuxent River	02131105	1364106.10	557830.58	0.15
SHA15APY060088UT	Tree Planting	Lower Monocacy River	02140302	1285984.53	653047.24	0.28
SHA15APY100137UT	Tree Planting	Lower Monocacy River	02140302	1189592.01	636877.20	0.41
SHA15APY100138UT	Tree Planting	Lower Monocacy River	02140302	1189274.41	637415.49	0.13
SHA15APY100139UT	Tree Planting	Lower Monocacy River	02140302	1198666.76	648559.57	0.27
SHA15APY100141UT	Tree Planting	Lower Monocacy River	02140302	1177594.76	637555.43	0.15
SHA15APY100142UT	Tree Planting	Lower Monocacy River	02140302	1211246.22	603848.01	0.26
SHA15APY100143UT	Tree Planting	Lower Monocacy River	02140302	1183764.20	632648.24	0.06
SHA15APY100146UT	Tree Planting	Lower Monocacy River	02140302	1180564.58	633418.76	0.49
SHA15APY100149UT	Tree Planting	Lower Monocacy River	02140302	1189422.56	636481.81	0.13
SHA15APY100150UT	Tree Planting	Lower Monocacy River	02140302	1189430.09	637674.87	0.07

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-33: FMIS # AW0825282						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA15APY100153UT	Tree Planting	Lower Monocacy River	02140302	1211436.04	603342.67	0.20
SHA15APY100161UT	Tree Planting	Lower Monocacy River	02140302	1209558.20	604273.58	0.22
SHA15APY100162UT	Tree Planting	Lower Monocacy River	02140302	1223981.11	627442.01	0.11
SHA15APY100163UT	Tree Planting	Lower Monocacy River	02140302	1198609.52	632260.79	0.12
SHA15APY100172UT	Tree Planting	Lower Monocacy River	02140302	1189762.11	637726.13	0.17
SHA15APY100173UT	Tree Planting	Lower Monocacy River	02140302	1194176.32	642073.83	0.39
SHA15APY100181UT	Tree Planting	Lower Monocacy River	02140302	1174570.79	621696.52	0.29
SHA15APY100182UT	Tree Planting	Lower Monocacy River	02140302	1194460.45	642305.01	0.22
SHA15APY100188UT	Tree Planting	Lower Monocacy River	02140302	1239005.18	624439.47	0.22
SHA15APY100190UT	Tree Planting	Lower Monocacy River	02140302	1201677.69	613150.73	0.27
SHA15APY100191UT	Tree Planting	Lower Monocacy River	02140302	1220950.64	628601.90	0.41
SHA15APY100197UT	Tree Planting	Lower Monocacy River	02140302	1224223.90	681277.64	0.16
SHA15APY100199UT	Tree Planting	Lower Monocacy River	02140302	1189865.03	636936.41	0.05
SHA15APY100200UT	Tree Planting	Lower Monocacy River	02140302	1227374.64	626347.94	0.32
SHA15APY100201UT	Tree Planting	Lower Monocacy River	02140302	1185333.72	632634.96	0.42
SHA15APY100221UT	Tree Planting	Lower Monocacy River	02140302	1182542.05	626331.17	0.40
SHA15APY100225UT	Tree Planting	Lower Monocacy River	02140302	1170933.89	620031.22	0.22
SHA15APY100227UT	Tree Planting	Lower Monocacy River	02140302	1181731.37	625828.27	0.36
SHA15APY100228UT	Tree Planting	Lower Monocacy River	02140302	1180914.50	625315.19	0.12
SHA15APY100232UT	Tree Planting	Lower Monocacy River	02140302	1187922.26	630961.61	0.73
SHA15APY100233UT	Tree Planting	Lower Monocacy River	02140302	1187194.56	632025.45	0.50
SHA15APY100235UT	Tree Planting	Lower Monocacy River	02140302	1187387.20	631109.05	0.61
SHA15APY100236UT	Tree Planting	Lower Monocacy River	02140302	1181174.46	625476.00	0.12
SHA15APY100243UT	Tree Planting	Lower Monocacy River	02140302	1188421.38	630406.41	1.49
SHA15APY100244UT	Tree Planting	Lower Monocacy River	02140302	1207042.29	606202.45	0.33
SHA15APY100245UT	Tree Planting	Lower Monocacy River	02140302	1208265.26	604903.73	0.21
SHA15APY100430UT	Tree Planting	Lower Monocacy River	02140302	1181516.40	633015.73	0.28
SHA15APY100431UT	Tree Planting	Lower Monocacy River	02140302	1182627.97	632805.29	0.28
SHA14APY130139UT	Tree Planting	Middle Patuxent River	02131106	1331926.28	558981.54	0.30
SHA14APY130153UT	Tree Planting	Middle Patuxent River	02131106	1329153.59	560892.24	0.31
SHA14APY130154UT	Tree Planting	Middle Patuxent River	02131106	1335890.69	556083.54	0.09
SHA14APY130160UT	Tree Planting	Middle Patuxent River	02131106	1333584.24	557439.16	0.17
SHA14APY130161UT	Tree Planting	Middle Patuxent River	02131106	1330638.47	560177.27	0.34
SHA14APY130172UT	Tree Planting	Middle Patuxent River	02131106	1347168.29	551652.36	0.43
SHA14APY130177UT	Tree Planting	Middle Patuxent River	02131106	1316513.79	585666.26	0.25
SHA14APY130178UT	Tree Planting	Middle Patuxent River	02131106	1332404.18	558214.85	0.06
SHA14APY130182UT	Tree Planting	Middle Patuxent River	02131106	1333974.35	557148.63	0.13
SHA14APY130141UT	Tree Planting	Patapsco River L N Br	02130906	1363221.64	587211.96	0.40
SHA14APY130145UT	Tree Planting	Patapsco River L N Br	02130906	1370635.42	562337.62	0.12
SHA14APY130147UT	Tree Planting	Patapsco River L N Br	02130906	1371552.50	561772.52	0.11
SHA14APY130149UT	Tree Planting	Patapsco River L N Br	02130906	1378494.83	556978.28	0.75
SHA14APY130151UT	Tree Planting	Patapsco River L N Br	02130906	1370309.09	562729.83	0.09
SHA14APY130152UT	Tree Planting	Patapsco River L N Br	02130906	1362740.04	586213.55	0.28
SHA14APY130162UT	Tree Planting	Patapsco River L N Br	02130906	1363993.86	587268.07	0.11
SHA14APY130169UT	Tree Planting	Patapsco River L N Br	02130906	1377936.16	557469.73	0.40
SHA14APY130174UT	Tree Planting	Patapsco River L N Br	02130906	1373600.73	561631.72	0.17
SHA14APY130175UT	Tree Planting	Patapsco River L N Br	02130906	1379562.51	556499.17	0.15
SHA14APY130176UT	Tree Planting	Patapsco River L N Br	02130906	1375384.03	560640.28	0.23
SHA14APY130146UT	Tree Planting	Patuxent River upper	02131104	1351779.05	531703.06	1.30
SHA14APY130173UT	Tree Planting	Patuxent River upper	02131104	1352331.77	531664.11	0.07
SHA15APY100151UT	Tree Planting	Potomac River FR Cnty	02140301	1169294.56	612592.04	0.53
SHA15APY100187UT	Tree Planting	Potomac River FR Cnty	02140301	1135514.04	613104.27	0.17
SHA15APY100189UT	Tree Planting	Potomac River FR Cnty	02140301	1166601.99	598452.17	0.33
SHA15APY100192UT	Tree Planting	Potomac River FR Cnty	02140301	1137597.91	613946.20	0.05
SHA15APY060062UT	Tree Planting	S Branch Patapsco	02130908	1264842.40	616196.00	0.45
SHA15APY060063UT	Tree Planting	S Branch Patapsco	02130908	1265809.01	616916.49	0.46
SHA15APY060068UT	Tree Planting	S Branch Patapsco	02130908	1269686.74	619040.26	0.14
SHA15APY060069UT	Tree Planting	S Branch Patapsco	02130908	1272379.09	628058.78	0.08
SHA15APY060070UT	Tree Planting	S Branch Patapsco	02130908	1298013.50	647707.10	0.18
SHA15APY060071UT	Tree Planting	S Branch Patapsco	02130908	1290504.04	651101.46	0.11
SHA15APY060083UT	Tree Planting	S Branch Patapsco	02130908	1270779.99	620036.78	0.13
SHA15APY060084UT	Tree Planting	S Branch Patapsco	02130908	1271629.16	623279.27	0.38
SHA15APY060086UT	Tree Planting	S Branch Patapsco	02130908	1272434.96	626717.12	0.23
SHA15APY060089UT	Tree Planting	S Branch Patapsco	02130908	1291576.80	650727.57	0.13
SHA15APY060093UT	Tree Planting	S Branch Patapsco	02130908	1321176.74	623829.13	0.12
SHA15APY060094UT	Tree Planting	S Branch Patapsco	02130908	1322230.08	622197.28	0.04

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-33: FMIS # AW0825282						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15APY060058UT	Tree Planting	Upper Monocacy River	02140303	1268660.70	732457.78	0.15
SHA15APY060059UT	Tree Planting	Upper Monocacy River	02140303	1269137.31	733160.86	0.18
SHA15APY060060UT	Tree Planting	Upper Monocacy River	02140303	1271785.66	737822.04	0.13
SHA15APY060061UT	Tree Planting	Upper Monocacy River	02140303	1276403.80	741761.87	0.14
SHA15APY060080UT	Tree Planting	Upper Monocacy River	02140303	1268469.77	732137.31	0.15
SHA15APY060119UT	Tree Planting	Upper Monocacy River	02140303	1273544.52	739648.27	0.05
SHA15APY060120UT	Tree Planting	Upper Monocacy River	02140303	1273976.32	739920.15	0.28
SHA15APY060121UT	Tree Planting	Upper Monocacy River	02140303	1275706.19	740949.66	0.16
SHA15APY060122UT	Tree Planting	Upper Monocacy River	02140303	1269313.07	733444.30	0.07
SHA15APY060123UT	Tree Planting	Upper Monocacy River	02140303	1269931.77	734500.87	0.46
SHA15APY060125UT	Tree Planting	Upper Monocacy River	02140303	1276004.69	741223.34	0.02
SHA15APY060127UT	Tree Planting	Upper Monocacy River	02140303	1277060.62	745655.58	0.25
SHA15APY060128UT	Tree Planting	Upper Monocacy River	02140303	1272184.18	738417.31	0.19
SHA15APY060129UT	Tree Planting	Upper Monocacy River	02140303	1272860.89	739102.25	0.66
SHA15APY060130UT	Tree Planting	Upper Monocacy River	02140303	1270769.61	735960.97	0.64
SHA15APY100156UT	Tree Planting	Upper Monocacy River	02140303	1193858.52	709352.75	0.14
SHA15APY100157UT	Tree Planting	Upper Monocacy River	02140303	1218736.30	736365.85	0.22
SHA15APY100158UT	Tree Planting	Upper Monocacy River	02140303	1223707.86	740546.77	0.03
SHA15APY100166UT	Tree Planting	Upper Monocacy River	02140303	1225822.76	747235.56	0.06
SHA15APY100167UT	Tree Planting	Upper Monocacy River	02140303	1225599.05	747161.97	0.16
SHA15APY100168UT	Tree Planting	Upper Monocacy River	02140303	1224115.70	742853.06	0.12
SHA15APY100169UT	Tree Planting	Upper Monocacy River	02140303	1206729.59	726297.70	0.27
SHA15APY100170UT	Tree Planting	Upper Monocacy River	02140303	1197227.58	717344.15	0.44
SHA15APY100171UT	Tree Planting	Upper Monocacy River	02140303	1198254.73	718100.25	0.11
SHA15APY100174UT	Tree Planting	Upper Monocacy River	02140303	1198894.23	669873.12	0.34
SHA15APY100175UT	Tree Planting	Upper Monocacy River	02140303	1190859.41	688691.25	0.09
SHA15APY100176UT	Tree Planting	Upper Monocacy River	02140303	1209717.46	655620.43	0.23
SHA15APY100177UT	Tree Planting	Upper Monocacy River	02140303	1211169.86	658551.87	0.42
SHA15APY100183UT	Tree Planting	Upper Monocacy River	02140303	1200069.51	666437.98	0.13
SHA15APY100184UT	Tree Planting	Upper Monocacy River	02140303	1190632.26	691491.13	0.35
SHA15APY100186UT	Tree Planting	Upper Monocacy River	02140303	1215088.22	661897.97	0.74
SHA15APY100195UT	Tree Planting	Upper Monocacy River	02140303	1194461.59	712764.75	0.09
SHA15APY100196UT	Tree Planting	Upper Monocacy River	02140303	1194205.10	709921.43	0.08
SHA15APY100203UT	Tree Planting	Upper Monocacy River	02140303	1224761.79	744655.84	0.16
SHA15APY100204UT	Tree Planting	Upper Monocacy River	02140303	1193573.38	708700.20	0.31
SHA15APY100205UT	Tree Planting	Upper Monocacy River	02140303	1224003.91	741339.07	0.05
SHA15APY100206UT	Tree Planting	Upper Monocacy River	02140303	1224312.58	741457.71	0.88
SHA15APY100210UT	Tree Planting	Upper Monocacy River	02140303	1203167.91	722539.67	0.28
SHA15APY100255UT	Tree Planting	Upper Monocacy River	02140303	1190517.49	690164.54	0.22
SHA15APY100417UT	Tree Planting	Upper Monocacy River	02140303	1190843.04	689961.85	0.04
SHA15APY100432UT	Tree Planting	Upper Monocacy River	02140303	1225211.93	746261.97	0.12
SHA15APY100433UT	Tree Planting	Upper Monocacy River	02140303	1224888.56	745542.97	0.11
				Complete BMP Acreage Total		**53.24**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-34: FMIS # DNR - Million Tree						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA12APY070001UT	Tree Planting	Big Elk Creek	02130606	1638458.05	748375.32	0.94
SHA12APY070002UT	Tree Planting	Big Elk Creek	02130606	1635514.30	745256.89	1.32
SHA12APY120189UT	Tree Planting	Deer Creek	02120202	1517710.12	713190.20	2.81
SHA12APY120190UT	Tree Planting	Deer Creek	02120202	1516818.98	713696.61	4.94
SHA12APY030002UT	Tree Planting	Gunpowder River	02130801	1493177.29	617527.67	7.64
SHA12APY210001UT	Tree Planting	Little Conococheague	02140505	1044026.31	739608.82	1.62
SHA12APY210411UT	Tree Planting	Little Conococheague	02140505	1045260.24	739742.41	0.58
SHA11APY120192UT	Tree Planting	Little Gunpowder Falls	02130804	1491059.15	636864.44	1.10
SHA11APY120193UT	Tree Planting	Little Gunpowder Falls	02130804	1491093.65	636473.82	0.56
SHA12APY030001UT	Tree Planting	Lower Gunpowder Falls	02130802	1474510.95	639702.36	17.15
SHA11APY120175UT	Tree Planting	Lower Susquehanna River	02120201	1556322.72	704619.91	1.23
SHA11APY120176UT	Tree Planting	Lower Susquehanna River	02120201	1556274.41	704366.32	1.19
SHA11APY120177UT	Tree Planting	Lower Susquehanna River	02120201	1556995.41	704586.61	1.16
SHA11APY120178UT	Tree Planting	Lower Susquehanna River	02120201	1555557.54	703416.88	1.81
SHA11APY120179UT	Tree Planting	Lower Susquehanna River	02120201	1555062.52	702822.13	3.65
SHA11APY120184UT	Tree Planting	Lower Susquehanna River	02120201	1552839.06	705144.86	2.80
SHA11APY120185UT	Tree Planting	Lower Susquehanna River	02120201	1552570.92	704745.79	2.84
SHA11APY120186UT	Tree Planting	Lower Susquehanna River	02120201	1553308.04	704791.68	1.91
SHA11APY120187UT	Tree Planting	Lower Susquehanna River	02120201	1553543.33	704399.56	5.74
SHA11APY120188UT	Tree Planting	Lower Susquehanna River	02120201	1552456.36	704329.54	2.88
SHA11APY120194UT	Tree Planting	Lower Susquehanna River	02120201	1555478.04	704447.77	2.81
SHA12APY080002UT	Tree Planting	Mattawoman Creek	02140111	1267863.33	331504.16	8.85
SHA12APY080004UT	Tree Planting	Mattawoman Creek	02140111	1287933.76	328364.58	0.35
SHA12APY080064UT	Tree Planting	Mattawoman Creek	02140111	1288522.40	326247.51	0.25
SHA12APY080066UT	Tree Planting	Mattawoman Creek	02140111	1288840.62	326025.48	0.15
SHA12APY080067UT	Tree Planting	Mattawoman Creek	02140111	1288622.68	325692.35	0.05
SHA12APY080068UT	Tree Planting	Mattawoman Creek	02140111	1288638.89	324574.37	0.46
SHA12APY080069UT	Tree Planting	Mattawoman Creek	02140111	1288617.67	322507.15	0.32
SHA12APY080070UT	Tree Planting	Mattawoman Creek	02140111	1288334.81	321514.06	0.08
SHA12APY080071UT	Tree Planting	Mattawoman Creek	02140111	1288484.28	321415.49	0.02
SHA12APY080106UT	Tree Planting	Mattawoman Creek	02140111	1288687.86	323703.06	0.24
SHA12APY080020UT	Tree Planting	Nanjemoy Creek	02140110	1290298.94	284541.79	1.23
SHA12APY080097UT	Tree Planting	Nanjemoy Creek	02140110	1288896.90	283270.61	1.01
SHA12APY080098UT	Tree Planting	Nanjemoy Creek	02140110	1289500.70	283340.44	0.56
SHA12APY080100UT	Tree Planting	Nanjemoy Creek	02140110	1288561.75	283662.08	0.21
SHA12APY080101UT	Tree Planting	Nanjemoy Creek	02140110	1289325.66	283778.03	0.12
SHA11APY130211UT	Tree Planting	Patapsco River L N Br	02130906	1385258.29	566291.12	2.82
SHA12APY160002UT	Tree Planting	Patuxent River lower	02131101	1399383.57	352777.64	1.41
SHA12APY160216UT	Tree Planting	Patuxent River lower	02131101	1400034.07	351976.48	0.73
SHA12APY160218UT	Tree Planting	Patuxent River lower	02131101	1399354.35	350288.08	1.08
SHA12APY160219UT	Tree Planting	Patuxent River lower	02131101	1397997.21	351034.45	0.50
SHA12APY160001UT	Tree Planting	Patuxent River middle	02131102	1395987.00	391085.70	0.49
SHA12APY160221UT	Tree Planting	Patuxent River middle	02131102	1395163.26	391184.81	0.27
SHA12APY160225UT	Tree Planting	Patuxent River middle	02131102	1394369.47	388261.32	1.00
SHA12APY160226UT	Tree Planting	Patuxent River middle	02131102	1393048.28	387009.91	2.64
SHA12APY080021UT	Tree Planting	Port Tobacco River	02140109	1298178.82	284951.58	0.04
SHA12APY080022UT	Tree Planting	Port Tobacco River	02140109	1298421.47	283083.49	1.67
SHA12APY080024UT	Tree Planting	Port Tobacco River	02140109	1299872.18	284193.68	0.32
SHA12APY080103UT	Tree Planting	Port Tobacco River	02140109	1297319.91	283470.06	1.05
SHA12APY080104UT	Tree Planting	Port Tobacco River	02140109	1291798.72	283327.56	0.27
SHA12APY080105UT	Tree Planting	Port Tobacco River	02140109	1290177.85	283494.14	0.18
SHA12APY080019UT	Tree Planting	Potomac River L tidal	02140101	1296476.20	280694.22	1.66
SHA12APY080072UT	Tree Planting	Potomac River L tidal	02140101	1292753.79	279722.88	2.72
SHA12APY080073UT	Tree Planting	Potomac River L tidal	02140101	1298167.04	281916.28	0.95
SHA12APY080074UT	Tree Planting	Potomac River L tidal	02140101	1291573.36	278075.03	0.81
SHA12APY080075UT	Tree Planting	Potomac River L tidal	02140101	1293622.62	278083.02	0.84
SHA12APY080076UT	Tree Planting	Potomac River L tidal	02140101	1294870.23	279332.92	1.03
SHA12APY080077UT	Tree Planting	Potomac River L tidal	02140101	1292464.11	278282.65	0.48
SHA12APY080078UT	Tree Planting	Potomac River L tidal	02140101	1299235.46	282629.40	0.64
SHA12APY080081UT	Tree Planting	Potomac River L tidal	02140101	1293551.45	279142.75	0.39
SHA12APY080082UT	Tree Planting	Potomac River L tidal	02140101	1292563.98	276937.67	0.32
SHA12APY080083UT	Tree Planting	Potomac River L tidal	02140101	1291970.20	277936.30	0.37
SHA12APY080086UT	Tree Planting	Potomac River L tidal	02140101	1292318.06	279183.75	0.24
SHA12APY080088UT	Tree Planting	Potomac River L tidal	02140101	1293532.26	279479.74	0.10
SHA12APY080089UT	Tree Planting	Potomac River L tidal	02140101	1293144.24	279794.87	0.19
SHA12APY080090UT	Tree Planting	Potomac River L tidal	02140101	1297479.30	281329.66	0.13

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-34: FMIS # DNR - Million Tree						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA12APY080091UT	Tree Planting	Potomac River L tidal	02140101	1291392.05	277530.75	0.04
SHA12APY080092UT	Tree Planting	Potomac River L tidal	02140101	1297106.48	280998.40	0.09
SHA12APY080001UT	Tree Planting	Potomac River M tidal	02140102	1236533.41	288607.60	1.34
SHA12APY080003UT	Tree Planting	Potomac River M tidal	02140102	1279272.17	347446.58	2.16
SHA12APY080063UT	Tree Planting	Potomac River M tidal	02140102	1278140.65	346718.85	2.71
SHA12APY150114UT	Tree Planting	Potomac River MO Cnty	02140202	1206967.74	515626.64	0.81
SHA12APY150115UT	Tree Planting	Potomac River MO Cnty	02140202	1206656.91	514962.50	2.15
SHA12APY150116UT	Tree Planting	Potomac River MO Cnty	02140202	1206128.24	514297.87	1.16
SHA12APY150117UT	Tree Planting	Potomac River MO Cnty	02140202	1205043.18	514879.30	0.39
SHA12APY150118UT	Tree Planting	Potomac River MO Cnty	02140202	1204042.74	513052.88	2.09
SHA12APY150119UT	Tree Planting	Potomac River MO Cnty	02140202	1201691.91	511443.60	1.28
SHA12APY150120UT	Tree Planting	Potomac River MO Cnty	02140202	1201842.20	511933.93	1.68
SHA12APY150121UT	Tree Planting	Potomac River MO Cnty	02140202	1202039.94	512850.89	2.38
SHA12APY150123UT	Tree Planting	Potomac River MO Cnty	02140202	1200636.01	513802.86	1.77
SHA12APY150124UT	Tree Planting	Potomac River MO Cnty	02140202	1201848.92	514162.79	1.35
SHA12APY150125UT	Tree Planting	Potomac River MO Cnty	02140202	1198463.02	513342.96	0.33
SHA12APY150126UT	Tree Planting	Potomac River MO Cnty	02140202	1198213.52	513168.18	0.22
SHA12APY150127UT	Tree Planting	Potomac River MO Cnty	02140202	1195787.17	513943.53	0.39
SHA12APY150128UT	Tree Planting	Potomac River MO Cnty	02140202	1195689.18	513597.32	1.12
SHA12APY150129UT	Tree Planting	Potomac River MO Cnty	02140202	1195756.77	513362.86	1.01
SHA12APY150130UT	Tree Planting	Potomac River MO Cnty	02140202	1193762.08	513413.65	0.73
SHA12APY150131UT	Tree Planting	Potomac River MO Cnty	02140202	1193555.55	513223.58	0.57
SHA12APY150132UT	Tree Planting	Potomac River MO Cnty	02140202	1202113.30	512158.33	0.37
SHA12APY020385UT	Tree Planting	Severn River	02131002	1425002.68	511597.89	0.63
SHA12APY210002UT	Tree Planting	Sideling Hill Creek	02140510	934363.15	729387.00	1.18
				Complete BMP Acreage Total		**133.88**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-35: FMIS # AT0425182						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA15APY210132UT	Tree Planting	Antietam Creek	02140502	1133525.41	691613.66	0.05
SHA15APY210133UT	Tree Planting	Antietam Creek	02140502	1130380.19	694054.42	0.37
SHA15APY210134UT	Tree Planting	Antietam Creek	02140502	1132358.29	692501.98	0.11
SHA15APY210160UT	Tree Planting	Antietam Creek	02140502	1139428.88	687005.86	0.07
SHA15APY210165UT	Tree Planting	Antietam Creek	02140502	1131751.81	692962.96	0.14
SHA15APY210166UT	Tree Planting	Antietam Creek	02140502	1129934.36	694629.57	0.09
SHA15APY210179UT	Tree Planting	Antietam Creek	02140502	1140341.44	685079.99	0.37
SHA15APY210180UT	Tree Planting	Antietam Creek	02140502	1139101.25	687111.63	0.16
SHA15APY210181UT	Tree Planting	Antietam Creek	02140502	1135284.92	690385.58	0.16
SHA15APY210182UT	Tree Planting	Antietam Creek	02140502	1128055.28	696281.29	0.15
SHA15APY210183UT	Tree Planting	Antietam Creek	02140502	1127036.98	697176.29	0.03
SHA15APY210184UT	Tree Planting	Antietam Creek	02140502	1125387.72	698623.13	0.12
SHA15APY210185UT	Tree Planting	Antietam Creek	02140502	1124882.92	699067.62	0.11
SHA15APY210186UT	Tree Planting	Antietam Creek	02140502	1124421.27	699473.96	0.08
SHA15APY210198UT	Tree Planting	Antietam Creek	02140502	1139267.80	687148.71	0.02
SHA15APY210200UT	Tree Planting	Antietam Creek	02140502	1132098.70	692678.97	0.23
SHA15APY210207UT	Tree Planting	Antietam Creek	02140502	1127681.36	702730.63	0.13
SHA15APY210322UT	Tree Planting	Antietam Creek	02140502	1132042.94	699774.17	0.02
SHA16APY210078UT	Tree Planting	Antietam Creek	02140502	1122714.25	705135.25	0.12
SHA16APY210080UT	Tree Planting	Antietam Creek	02140502	1120441.61	705261.48	0.05
SHA16APY210116UT	Tree Planting	Antietam Creek	02140502	1125310.64	654089.00	0.33
SHA16APY210117UT	Tree Planting	Antietam Creek	02140502	1124402.89	649168.45	0.28
SHA16APY210118UT	Tree Planting	Antietam Creek	02140502	1124393.76	648528.91	0.04
SHA16APY210119UT	Tree Planting	Antietam Creek	02140502	1124454.50	647975.22	0.23
SHA16APY210120UT	Tree Planting	Antietam Creek	02140502	1124777.43	646754.06	0.05
SHA16APY210121UT	Tree Planting	Antietam Creek	02140502	1125557.91	641732.33	1.77
SHA16APY210122UT	Tree Planting	Antietam Creek	02140502	1125068.72	640371.24	0.32
SHA16APY210124UT	Tree Planting	Antietam Creek	02140502	1125000.15	637664.48	0.86
SHA16APY210131UT	Tree Planting	Antietam Creek	02140502	1129472.57	665684.80	0.05
SHA16APY210137UT	Tree Planting	Antietam Creek	02140502	1129573.51	665530.89	0.50
SHA16APY210138UT	Tree Planting	Antietam Creek	02140502	1129270.36	664531.78	1.03
SHA16APY210139UT	Tree Planting	Antietam Creek	02140502	1128101.12	661260.13	0.08
SHA16APY210141UT	Tree Planting	Antietam Creek	02140502	1127822.96	660341.97	0.08
SHA16APY210158UT	Tree Planting	Antietam Creek	02140502	1124714.73	646944.04	0.07
SHA16APY210176UT	Tree Planting	Antietam Creek	02140502	1124980.69	646708.38	0.84
SHA16APY210177UT	Tree Planting	Antietam Creek	02140502	1124408.81	649758.80	0.04
SHA16APY210178UT	Tree Planting	Antietam Creek	02140502	1125853.07	654618.27	0.99
SHA16APY210187UT	Tree Planting	Antietam Creek	02140502	1128002.56	660929.52	0.04
SHA16APY210188UT	Tree Planting	Antietam Creek	02140502	1125269.24	653594.32	0.13
SHA16APY210196UT	Tree Planting	Antietam Creek	02140502	1127906.23	660623.60	0.05
SHA16APY210199UT	Tree Planting	Antietam Creek	02140502	1124759.56	638467.71	0.22
SHA16APY210210UT	Tree Planting	Antietam Creek	02140502	1132158.17	699287.40	0.19
SHA16APY210223UT	Tree Planting	Antietam Creek	02140502	1127928.40	696199.80	0.63
SHA16APY210310UT	Tree Planting	Antietam Creek	02140502	1127817.24	702917.68	0.13
SHA16APY210312UT	Tree Planting	Antietam Creek	02140502	1133463.13	698524.96	0.18
SHA16APY210320UT	Tree Planting	Antietam Creek	02140502	1127286.94	703350.29	0.11
SHA16APY210321UT	Tree Planting	Antietam Creek	02140502	1127086.13	703513.63	0.12
SHA16APY210323UT	Tree Planting	Antietam Creek	02140502	1131934.89	699859.73	0.17
SHA16APY210379UT	Tree Planting	Antietam Creek	02140502	1122874.97	704948.30	0.14
SHA16APY210417UT	Tree Planting	Antietam Creek	02140502	1125265.65	645879.60	0.13
SHA16APY210424UT	Tree Planting	Antietam Creek	02140502	1131380.49	700153.73	0.14
SHA15APY210215UT	Tree Planting	Conococheague Creek	02140504	1095074.91	707230.63	0.69
SHA16APY210393UT	Tree Planting	Conococheague Creek	02140504	1101392.76	724138.66	0.56
SHA16APY210422UT	Tree Planting	Conococheague Creek	02140504	1122412.67	701088.00	0.10
SHA16APY210202UT	Tree Planting	Marsh Run	02140503	1102786.74	706925.36	0.28
SHA16APY210203UT	Tree Planting	Marsh Run	02140503	1102235.44	707001.12	0.25
SHA16APY210123UT	Tree Planting	Potomac River FR Cnty	02140301	1126787.95	632134.24	0.54
SHA16APY210125UT	Tree Planting	Potomac River FR Cnty	02140301	1125292.29	636710.62	0.59
SHA16APY210128UT	Tree Planting	Potomac River FR Cnty	02140301	1127539.10	630292.90	0.08
SHA16APY210129UT	Tree Planting	Potomac River FR Cnty	02140301	1127421.27	629425.52	0.34
SHA16APY210142UT	Tree Planting	Potomac River FR Cnty	02140301	1127093.31	628477.20	0.10
SHA16APY210143UT	Tree Planting	Potomac River FR Cnty	02140301	1127007.58	628256.78	0.17
SHA16APY210144UT	Tree Planting	Potomac River FR Cnty	02140301	1126888.39	627961.49	0.22
SHA16APY210145UT	Tree Planting	Potomac River FR Cnty	02140301	1126546.19	627053.38	0.21
SHA16APY210146UT	Tree Planting	Potomac River FR Cnty	02140301	1122835.39	620447.81	0.26
SHA16APY210147UT	Tree Planting	Potomac River FR Cnty	02140301	1122668.10	619979.80	0.04

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-35: FMIS # AT0425182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16APY210148UT	Tree Planting	Potomac River FR Cnty	02140301	1122623.80	619862.78	0.06
SHA16APY210149UT	Tree Planting	Potomac River FR Cnty	02140301	1122250.70	618976.52	0.13
SHA16APY210150UT	Tree Planting	Potomac River FR Cnty	02140301	1120366.24	615271.76	0.30
SHA16APY210151UT	Tree Planting	Potomac River FR Cnty	02140301	1119380.09	611318.88	0.15
SHA16APY210152UT	Tree Planting	Potomac River FR Cnty	02140301	1118954.60	609743.42	0.11
SHA16APY210153UT	Tree Planting	Potomac River FR Cnty	02140301	1114917.13	607456.82	0.24
SHA16APY210155UT	Tree Planting	Potomac River FR Cnty	02140301	1119616.87	612514.76	0.06
SHA16APY210156UT	Tree Planting	Potomac River FR Cnty	02140301	1119532.34	612172.02	0.33
SHA16APY210157UT	Tree Planting	Potomac River FR Cnty	02140301	1120437.51	615866.90	0.16
SHA16APY210201UT	Tree Planting	Potomac River FR Cnty	02140301	1119014.92	609859.04	0.04
SHA16APY210418UT	Tree Planting	Potomac River FR Cnty	02140301	1126638.48	627328.05	0.08
SHA16APY210419UT	Tree Planting	Potomac River FR Cnty	02140301	1126787.09	627673.27	0.17
SHA15APY210427UT	Tree Planting	Antietam Creek	02140502	1132094.99	699853.38	0.02
SHA16APY210421UT	Tree Planting	Antietam Creek	02140502	1125400.21	653805.43	0.08
SHA16APY210423UT	Tree Planting	Potomac River FR Cnty	02140301	1127532.05	630611.20	0.09
SHA16APY160121UT	Tree Planting	Western Branch	02131103	1355278.51	446296.66	0.29
					Complete BMP Acreage Total	**19.23**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-36: FMIS # AW0465182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13APY150037UT	Tree Planting	Seneca Creek	02140208	1260612.33	562095.36	0.36
				Complete BMP Acreage Total		**0.36**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-37: FMIS # AT0685482						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16APY020391UT	Tree Planting	Baltimore Harbor	02130903	1419247.60	560805.64	1.64
SHA16APY080026UT	Tree Planting	Mattawoman Creek	02140111	1348346.90	359902.55	0.16
SHA16APY080107UT	Tree Planting	Mattawoman Creek	02140111	1348226.79	360456.05	0.19
SHA16APY020065UT	Tree Planting	Patuxent River lower	02131101	1427976.05	389410.53	0.14
SHA16APY020096UT	Tree Planting	Patuxent River lower	02131101	1427369.92	388006.66	0.38
SHA16APY020187UT	Tree Planting	Patuxent River lower	02131101	1426336.94	386418.45	0.17
SHA16APY080007UT	Tree Planting	Patuxent River lower	02131101	1375466.69	316308.36	0.49
SHA16APY080060UT	Tree Planting	Patuxent River lower	02131101	1376153.45	314000.06	0.29
SHA16APY080061UT	Tree Planting	Patuxent River lower	02131101	1372039.62	319340.24	0.19
SHA16APY020068UT	Tree Planting	Patuxent River middle	02131102	1397189.16	416341.81	0.12
SHA16APY020069UT	Tree Planting	Patuxent River middle	02131102	1418766.19	406084.56	0.09
SHA16APY020073UT	Tree Planting	Patuxent River middle	02131102	1414980.61	407855.39	0.45
SHA16APY020074UT	Tree Planting	Patuxent River middle	02131102	1426615.06	402480.92	0.16
SHA16APY020075UT	Tree Planting	Patuxent River middle	02131102	1428673.41	408222.13	0.15
SHA16APY020078UT	Tree Planting	Patuxent River middle	02131102	1424520.57	420117.61	0.09
SHA16APY020081UT	Tree Planting	Patuxent River middle	02131102	1415679.85	407367.68	0.95
SHA16APY020082UT	Tree Planting	Patuxent River middle	02131102	1413417.61	408501.90	0.33
SHA16APY020083UT	Tree Planting	Patuxent River middle	02131102	1419595.00	405898.18	0.20
SHA16APY020086UT	Tree Planting	Patuxent River middle	02131102	1424383.67	420351.97	0.09
SHA16APY020087UT	Tree Planting	Patuxent River middle	02131102	1426691.62	413616.97	0.05
SHA16APY020095UT	Tree Planting	Patuxent River middle	02131102	1419178.44	405997.28	0.31
SHA16APY020099UT	Tree Planting	Patuxent River middle	02131102	1418889.93	406067.87	0.08
SHA16APY020103UT	Tree Planting	Patuxent River middle	02131102	1424613.83	419897.71	0.05
SHA16APY020104UT	Tree Planting	Patuxent River middle	02131102	1427356.11	407633.71	0.21
SHA16APY020109UT	Tree Planting	Patuxent River middle	02131102	1426662.69	411915.35	0.46
SHA16APY020111UT	Tree Planting	Patuxent River middle	02131102	1421418.27	406230.34	0.52
SHA16APY020113UT	Tree Planting	Patuxent River middle	02131102	1425451.37	417063.89	0.09
SHA16APY020114UT	Tree Planting	Patuxent River middle	02131102	1420169.77	405844.16	0.51
SHA16APY020120UT	Tree Planting	Patuxent River middle	02131102	1426668.16	411290.65	0.19
SHA16APY020153UT	Tree Planting	Patuxent River middle	02131102	1423025.87	421504.21	0.04
SHA16APY020274UT	Tree Planting	Patuxent River middle	02131102	1414588.59	408030.49	0.19
SHA16APY020386UT	Tree Planting	Patuxent River middle	02131102	1426913.48	407581.98	0.09
SHA16APY020393UT	Tree Planting	Patuxent River middle	02131102	1423844.01	421017.17	0.16
SHA16APY020394UT	Tree Planting	Patuxent River middle	02131102	1423954.35	420856.41	0.06
SHA16APY020395UT	Tree Planting	Patuxent River middle	02131102	1424009.39	420786.16	0.03
SHA16APY020396UT	Tree Planting	Patuxent River middle	02131102	1424111.41	420660.81	0.12
SHA16APY020281UT	Tree Planting	Severn River	02131002	1456221.01	490655.82	0.08
SHA16APY020309UT	Tree Planting	Severn River	02131002	1456407.63	491455.06	0.18
SHA16APY020311UT	Tree Planting	Severn River	02131002	1457129.48	490863.15	0.42
SHA16APY020313UT	Tree Planting	Severn River	02131002	1457019.82	491373.42	0.14
SHA16APY020314UT	Tree Planting	Severn River	02131002	1456098.47	490818.48	0.15
SHA16APY020315UT	Tree Planting	Severn River	02131002	1456197.31	491418.54	0.23
SHA16APY020316UT	Tree Planting	Severn River	02131002	1462282.64	494270.62	0.22
SHA16APY020320UT	Tree Planting	Severn River	02131002	1468586.28	496134.75	0.12
SHA16APY020322UT	Tree Planting	Severn River	02131002	1461066.99	493827.28	0.16
SHA16APY020323UT	Tree Planting	Severn River	02131002	1457427.19	490254.23	0.06
SHA16APY020324UT	Tree Planting	Severn River	02131002	1441658.73	480191.79	0.13
SHA16APY020067UT	Tree Planting	South River	02131003	1414029.46	469048.82	0.15
SHA16APY020071UT	Tree Planting	South River	02131003	1438832.20	451422.28	0.23
SHA16APY020085UT	Tree Planting	South River	02131003	1438996.75	451806.13	0.16
SHA16APY020098UT	Tree Planting	South River	02131003	1411059.12	470920.34	0.14
SHA16APY020388UT	Tree Planting	South River	02131003	1442758.16	476147.62	0.11
SHA16APY020389UT	Tree Planting	South River	02131003	1443066.03	475745.92	0.15
SHA16APY020077UT	Tree Planting	West Chesapeake Bay	02131005	1425217.36	417765.16	0.62
SHA16APY020092UT	Tree Planting	West Chesapeake Bay	02131005	1428897.18	408297.18	0.16
SHA16APY020112UT	Tree Planting	West Chesapeake Bay	02131005	1424951.71	418586.65	0.27
SHA16APY020116UT	Tree Planting	West Chesapeake Bay	02131005	1422416.62	422017.48	0.41
SHA16APY020392UT	Tree Planting	West Chesapeake Bay	02131005	1422786.97	421783.99	0.30
SHA16APY020070UT	Tree Planting	West River	02131004	1435440.10	446302.87	0.06
SHA16APY020076UT	Tree Planting	West River	02131004	1435021.10	444371.62	0.12
SHA16APY020084UT	Tree Planting	West River	02131004	1435268.39	445988.95	0.24
SHA16APY080110UT	Tree Planting	Zekiah Swamp	02140108	1348117.45	346248.34	0.35
				Complete BMP Acreage Total		**14.77**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-38: FMIS # AT0685282						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA16APY120027UT	Tree Planting	Atkisson Reservoir	02130703	1468229.97	697271.58	0.40
SHA16APY120082UT	Tree Planting	Atkisson Reservoir	02130703	1474209.20	695591.80	0.28
SHA16APY120144UT	Tree Planting	Atkisson Reservoir	02130703	1475136.21	695606.09	1.78
SHA16APY120154UT	Tree Planting	Atkisson Reservoir	02130703	1474634.54	695512.04	0.51
SHA16APY120171UT	Tree Planting	Atkisson Reservoir	02130703	1478642.48	695463.91	0.85
SHA16APY120173UT	Tree Planting	Atkisson Reservoir	02130703	1461184.92	700032.76	1.75
SHA16APY120230UT	Tree Planting	Atkisson Reservoir	02130703	1473728.48	695648.81	0.21
SHA16APY120231UT	Tree Planting	Atkisson Reservoir	02130703	1457772.95	696725.58	0.70
SHA16APY120235UT	Tree Planting	Atkisson Reservoir	02130703	1483720.49	685529.81	0.23
SHA15APY030147UT	Tree Planting	Back River	02130901	1453622.43	591496.70	0.22
SHA15APY030161UT	Tree Planting	Back River	02130901	1466152.86	578255.28	0.08
SHA15APY030162UT	Tree Planting	Back River	02130901	1465044.41	582711.07	1.12
SHA15APY030166UT	Tree Planting	Back River	02130901	1458144.44	606071.28	0.22
SHA15APY030167UT	Tree Planting	Back River	02130901	1463947.77	603483.10	0.17
SHA15APY030174UT	Tree Planting	Back River	02130901	1452493.91	617234.54	0.67
SHA15APY030179UT	Tree Planting	Back River	02130901	1452503.73	593503.27	0.24
SHA15APY030180UT	Tree Planting	Back River	02130901	1466619.21	600375.55	0.09
SHA15APY030181UT	Tree Planting	Back River	02130901	1466286.66	601142.73	0.12
SHA15APY030183UT	Tree Planting	Back River	02130901	1466359.98	601560.86	0.24
SHA15APY030186UT	Tree Planting	Back River	02130901	1466244.78	574372.59	0.82
SHA15APY030193UT	Tree Planting	Back River	02130901	1455652.58	609198.47	0.08
SHA15APY030196UT	Tree Planting	Back River	02130901	1449357.19	620682.41	0.78
SHA15APY030202UT	Tree Planting	Back River	02130901	1464555.53	583623.77	0.03
SHA15APY030213UT	Tree Planting	Back River	02130901	1452599.74	593859.59	0.15
SHA15APY030215UT	Tree Planting	Back River	02130901	1466481.50	600714.70	0.19
SHA15APY030217UT	Tree Planting	Back River	02130901	1466918.72	600266.97	0.14
SHA15APY030218UT	Tree Planting	Back River	02130901	1457873.89	606447.13	0.07
SHA15APY030222UT	Tree Planting	Back River	02130901	1464555.42	583701.67	0.05
SHA15APY030224UT	Tree Planting	Back River	02130901	1455725.71	609047.21	0.08
SHA15APY030226UT	Tree Planting	Back River	02130901	1463119.05	610805.60	0.06
SHA15APY030237UT	Tree Planting	Back River	02130901	1457922.37	589022.16	0.13
SHA15APY030240UT	Tree Planting	Back River	02130901	1456803.75	607288.21	0.10
SHA15APY030246UT	Tree Planting	Back River	02130901	1456145.26	608731.99	0.69
SHA16APY030333UT	Tree Planting	Back River	02130901	1453876.81	590811.49	0.09
SHA16APY030335UT	Tree Planting	Back River	02130901	1450188.43	620926.78	0.08
SHA15APY030220UT	Tree Planting	Baltimore Harbor	02130903	1461139.05	586968.08	0.12
SHA15APY030158UT	Tree Planting	Bird River	02130803	1474334.16	619452.14	0.09
SHA15APY030164UT	Tree Planting	Bird River	02130803	1454997.80	624888.45	0.31
SHA15APY030176UT	Tree Planting	Bird River	02130803	1448378.18	625044.69	0.31
SHA15APY030187UT	Tree Planting	Bird River	02130803	1472948.15	621919.42	0.10
SHA15APY030190UT	Tree Planting	Bird River	02130803	1463071.03	624348.18	0.03
SHA15APY030200UT	Tree Planting	Bird River	02130803	1474734.80	618935.84	0.31
SHA15APY030204UT	Tree Planting	Bird River	02130803	1462751.74	624374.83	0.04
SHA15APY030212UT	Tree Planting	Bird River	02130803	1449896.59	624838.90	0.32
SHA16APY030322UT	Tree Planting	Bird River	02130803	1454338.28	625785.66	0.17
SHA16APY030323UT	Tree Planting	Bird River	02130803	1474673.34	619766.37	0.68
SHA16APY030336UT	Tree Planting	Bird River	02130803	1454157.06	625593.08	0.04
SHA16APY030337UT	Tree Planting	Bird River	02130803	1455761.80	627230.50	0.14
SHA16APY120083UT	Tree Planting	Broad Creek	02120205	1487879.68	735551.12	0.46
SHA16APY120117UT	Tree Planting	Broad Creek	02120205	1487370.52	734716.68	0.43
SHA15APY120019UT	Tree Planting	Bynum Run	02130704	1488290.94	692453.92	0.09
SHA16APY120066UT	Tree Planting	Bynum Run	02130704	1485328.79	696986.01	0.07
SHA16APY120067UT	Tree Planting	Bynum Run	02130704	1485289.28	697191.08	0.06
SHA16APY120068UT	Tree Planting	Bynum Run	02130704	1485146.18	697784.18	0.04
SHA16APY120100UT	Tree Planting	Bynum Run	02130704	1485207.67	697541.86	0.04
SHA16APY120101UT	Tree Planting	Bynum Run	02130704	1485252.17	697374.94	0.06
SHA16APY120108UT	Tree Planting	Bynum Run	02130704	1485343.04	696281.10	0.19
SHA16APY120112UT	Tree Planting	Bynum Run	02130704	1486729.00	695890.12	0.55
SHA15APY030141UT	Tree Planting	Deer Creek	02120202	1412550.27	743570.70	1.02
SHA15APY030211UT	Tree Planting	Deer Creek	02120202	1410837.00	745808.99	0.02
SHA15APY030243UT	Tree Planting	Deer Creek	02120202	1409613.12	747772.10	0.08
SHA15APY030317UT	Tree Planting	Deer Creek	02120202	1410958.15	745567.74	0.19
SHA16APY120233UT	Tree Planting	Deer Creek	02120202	1469397.87	732201.07	0.44
SHA16APY120234UT	Tree Planting	Deer Creek	02120202	1470115.38	732688.61	0.35
SHA16APY120236UT	Tree Planting	Deer Creek	02120202	1470026.50	732504.82	0.02
SHA16APY120237UT	Tree Planting	Deer Creek	02120202	1469769.21	732382.73	0.10

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-38: FMIS # AT0685282						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA12APY030050UT	Tree Planting	Gwynns Falls	02130905	1379843.60	626869.94	2.95
SHA12APY030051UT	Tree Planting	Gwynns Falls	02130905	1380948.20	625708.52	1.29
SHA15APY030143UT	Tree Planting	Gwynns Falls	02130905	1372460.78	635941.35	0.70
SHA15APY030146UT	Tree Planting	Gwynns Falls	02130905	1370638.83	635408.94	0.18
SHA15APY030148UT	Tree Planting	Gwynns Falls	02130905	1369610.36	633240.85	0.23
SHA15APY030149UT	Tree Planting	Gwynns Falls	02130905	1383714.50	597472.94	0.08
SHA15APY030156UT	Tree Planting	Gwynns Falls	02130905	1381243.04	625266.58	0.11
SHA15APY030169UT	Tree Planting	Gwynns Falls	02130905	1382284.04	597378.67	0.14
SHA15APY030170UT	Tree Planting	Gwynns Falls	02130905	1380912.34	626380.35	0.50
SHA15APY030173UT	Tree Planting	Gwynns Falls	02130905	1378882.49	631283.42	0.09
SHA15APY030175UT	Tree Planting	Gwynns Falls	02130905	1381800.33	624006.27	0.02
SHA15APY030194UT	Tree Planting	Gwynns Falls	02130905	1384354.59	597766.16	0.26
SHA15APY030201UT	Tree Planting	Gwynns Falls	02130905	1379450.22	628308.94	0.13
SHA15APY030203UT	Tree Planting	Gwynns Falls	02130905	1369882.12	636897.95	0.09
SHA15APY030210UT	Tree Planting	Gwynns Falls	02130905	1379166.37	628366.94	0.15
SHA15APY030221UT	Tree Planting	Gwynns Falls	02130905	1379999.68	627450.88	0.31
SHA15APY030230UT	Tree Planting	Gwynns Falls	02130905	1362486.94	646628.28	0.78
SHA15APY030236UT	Tree Planting	Gwynns Falls	02130905	1385053.54	597375.67	0.06
SHA15APY030239UT	Tree Planting	Gwynns Falls	02130905	1385570.62	597344.22	0.59
SHA15APY030245UT	Tree Planting	Gwynns Falls	02130905	1381980.09	624625.24	0.12
SHA15APY030247UT	Tree Planting	Gwynns Falls	02130905	1380295.75	627108.12	0.31
SHA15APY030248UT	Tree Planting	Gwynns Falls	02130905	1374033.83	634899.64	0.20
SHA15APY030314UT	Tree Planting	Gwynns Falls	02130905	1385118.33	597975.00	0.13
SHA15APY030315UT	Tree Planting	Gwynns Falls	02130905	1385265.15	597662.14	0.67
SHA15APY030318UT	Tree Planting	Gwynns Falls	02130905	1378968.77	631022.82	0.14
SHA15APY030319UT	Tree Planting	Gwynns Falls	02130905	1379039.77	630769.44	0.03
SHA15APY030320UT	Tree Planting	Gwynns Falls	02130905	1381769.43	624219.96	0.16
SHA15APY030321UT	Tree Planting	Gwynns Falls	02130905	1372460.61	636316.48	0.08
SHA16APY030144UT	Tree Planting	Gwynns Falls	02130905	1385364.49	596991.77	0.20
SHA16APY030188UT	Tree Planting	Gwynns Falls	02130905	1382048.20	624426.83	0.09
SHA16APY030207UT	Tree Planting	Gwynns Falls	02130905	1384425.47	596246.69	0.37
SHA16APY030219UT	Tree Planting	Gwynns Falls	02130905	1381718.75	624479.16	0.09
SHA16APY030234UT	Tree Planting	Gwynns Falls	02130905	1383446.77	597295.53	0.78
SHA16APY030238UT	Tree Planting	Gwynns Falls	02130905	1385284.64	596314.19	0.05
SHA16APY030312UT	Tree Planting	Gwynns Falls	02130905	1385199.37	596668.49	0.50
SHA16APY030313UT	Tree Planting	Gwynns Falls	02130905	1385513.07	596655.19	0.51
SHA16APY030324UT	Tree Planting	Gwynns Falls	02130905	1383999.85	612630.15	1.01
SHA12APY030003UT	Tree Planting	Jones Falls	02130904	1407771.07	636532.76	0.22
SHA15APY030157UT	Tree Planting	Jones Falls	02130904	1407488.38	634610.33	0.34
SHA15APY030177UT	Tree Planting	Jones Falls	02130904	1406266.91	634161.31	0.06
SHA15APY030178UT	Tree Planting	Jones Falls	02130904	1404489.46	633360.85	0.54
SHA15APY030199UT	Tree Planting	Jones Falls	02130904	1393906.85	628298.24	0.13
SHA15APY030229UT	Tree Planting	Jones Falls	02130904	1394000.31	628464.66	0.15
SHA15APY030252UT	Tree Planting	Jones Falls	02130904	1390816.27	628012.66	0.06
SHA16APY030330UT	Tree Planting	Jones Falls	02130904	1407535.73	636257.67	0.13
SHA16APY030331UT	Tree Planting	Jones Falls	02130904	1407395.62	635961.64	0.09
SHA16APY030332UT	Tree Planting	Jones Falls	02130904	1407127.16	636500.89	0.16
SHA15APY030277UT	Tree Planting	Liberty Reservoir	02130907	1358223.99	657324.72	0.15
SHA16APY030274UT	Tree Planting	Liberty Reservoir	02130907	1360290.34	659093.35	0.20
SHA16APY030338UT	Tree Planting	Liberty Reservoir	02130907	1358378.97	656915.88	0.25
SHA16APY120042UT	Tree Planting	Little Gunpowder Falls	02130804	1464427.64	682118.20	0.03
SHA16APY120043UT	Tree Planting	Little Gunpowder Falls	02130804	1464159.44	682301.00	0.10
SHA16APY120146UT	Tree Planting	Little Gunpowder Falls	02130804	1464516.13	681950.35	0.30
SHA16APY120156UT	Tree Planting	Little Gunpowder Falls	02130804	1463906.55	682435.56	0.46
SHA12APY030309UT	Tree Planting	Loch Raven Reservoir	02130805	1408183.26	655345.66	0.34
SHA12APY030311UT	Tree Planting	Loch Raven Reservoir	02130805	1407897.87	656759.13	0.03
SHA15APY030253UT	Tree Planting	Loch Raven Reservoir	02130805	1404517.66	701918.30	0.27
SHA15APY030254UT	Tree Planting	Loch Raven Reservoir	02130805	1405964.81	715462.82	0.23
SHA15APY030255UT	Tree Planting	Loch Raven Reservoir	02130805	1430692.32	635065.85	0.85
SHA15APY030256UT	Tree Planting	Loch Raven Reservoir	02130805	1404261.17	701486.29	0.10
SHA15APY030257UT	Tree Planting	Loch Raven Reservoir	02130805	1425691.20	636436.58	0.11
SHA15APY030258UT	Tree Planting	Loch Raven Reservoir	02130805	1406005.28	712348.77	0.19
SHA15APY030259UT	Tree Planting	Loch Raven Reservoir	02130805	1406464.37	684817.21	0.13
SHA15APY030272UT	Tree Planting	Loch Raven Reservoir	02130805	1413024.08	738378.41	0.42
SHA15APY030275UT	Tree Planting	Loch Raven Reservoir	02130805	1405319.49	714083.07	0.15
SHA15APY030282UT	Tree Planting	Loch Raven Reservoir	02130805	1394912.25	662684.25	0.09

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-38: FMIS # AT0685282						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15APY030287UT	Tree Planting	Loch Raven Reservoir	02130805	1412441.75	734463.58	0.16
SHA15APY030288UT	Tree Planting	Loch Raven Reservoir	02130805	1413292.82	739361.92	0.19
SHA15APY030289UT	Tree Planting	Loch Raven Reservoir	02130805	1409867.20	725289.55	0.09
SHA16APY030281UT	Tree Planting	Loch Raven Reservoir	02130805	1394901.91	662229.99	0.11
SHA16APY030283UT	Tree Planting	Loch Raven Reservoir	02130805	1394904.66	663464.00	0.10
SHA16APY030308UT	Tree Planting	Loch Raven Reservoir	02130805	1407910.96	656089.26	0.30
SHA16APY030340UT	Tree Planting	Loch Raven Reservoir	02130805	1395189.07	662783.26	0.03
SHA16APY030341UT	Tree Planting	Loch Raven Reservoir	02130805	1395253.57	662843.91	0.01
SHA15APY030155UT	Tree Planting	Lower Gunpowder Falls	02130802	1441213.37	632522.40	0.15
SHA15APY030205UT	Tree Planting	Lower Gunpowder Falls	02130802	1431627.70	635652.63	0.07
SHA15APY030241UT	Tree Planting	Lower Gunpowder Falls	02130802	1433851.33	632767.45	0.24
SHA15APY030249UT	Tree Planting	Lower Gunpowder Falls	02130802	1431623.19	635423.15	0.03
SHA14APY120046UT	Tree Planting	Lower Susquehanna River	02120201	1550107.44	696199.66	0.36
SHA15APY030165UT	Tree Planting	Patapsco River L N Br	02130906	1396978.25	566787.87	0.26
SHA15APY030168UT	Tree Planting	Patapsco River L N Br	02130906	1372721.62	597668.98	0.14
SHA15APY030172UT	Tree Planting	Patapsco River L N Br	02130906	1376957.28	597281.90	0.02
SHA15APY030235UT	Tree Planting	Patapsco River L N Br	02130906	1401404.81	575685.40	0.09
SHA15APY030266UT	Tree Planting	Patapsco River L N Br	02130906	1402334.05	576313.96	0.02
SHA15APY030273UT	Tree Planting	Patapsco River L N Br	02130906	1402388.10	576391.29	0.06
SHA15APY030291UT	Tree Planting	Patapsco River L N Br	02130906	1402164.86	576235.93	0.16
SHA15APY030316UT	Tree Planting	Patapsco River L N Br	02130906	1377144.41	597307.21	0.08
SHA16APY030142UT	Tree Planting	Patapsco River L N Br	02130906	1403186.21	577127.01	0.21
SHA16APY030154UT	Tree Planting	Patapsco River L N Br	02130906	1397645.09	564688.77	0.12
SHA16APY030171UT	Tree Planting	Patapsco River L N Br	02130906	1401671.16	576276.54	0.25
SHA16APY030208UT	Tree Planting	Patapsco River L N Br	02130906	1402437.64	577149.79	0.30
SHA16APY030209UT	Tree Planting	Patapsco River L N Br	02130906	1404085.65	578445.78	0.29
SHA16APY030214UT	Tree Planting	Patapsco River L N Br	02130906	1403122.67	577992.89	0.14
SHA16APY030225UT	Tree Planting	Patapsco River L N Br	02130906	1402269.05	577111.46	0.30
SHA16APY030228UT	Tree Planting	Patapsco River L N Br	02130906	1403072.28	576534.84	0.27
SHA16APY030244UT	Tree Planting	Patapsco River L N Br	02130906	1402977.65	576797.05	0.11
SHA16APY030342UT	Tree Planting	Patapsco River L N Br	02130906	1402902.01	576952.93	0.04
					Complete BMP Acreage Total	**45.40**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-39: FMIS # AT0415182						
Unique BMP #	BMP Type	8-Digit Watershed Name	8-Digit Watershed Code	Northing	Easting	Impervious Treated (acres)
SHA12APY150003UT	Tree Planting	Anacostia River	02140205	1314488.31	501046.15	0.27
SHA12APY150004UT	Tree Planting	Anacostia River	02140205	1332389.18	525914.43	0.14
SHA13APY150032UT	Tree Planting	Anacostia River	02140205	1307813.51	491135.91	0.14
SHA16APY150001UT	Tree Planting	Anacostia River	02140205	1314376.65	501450.75	0.33
SHA16APY150002UT	Tree Planting	Anacostia River	02140205	1314809.58	501781.97	0.70
SHA16APY150144UT	Tree Planting	Anacostia River	02140205	1300059.35	490713.45	0.11
SHA16APY150147UT	Tree Planting	Anacostia River	02140205	1324898.31	513604.78	0.31
SHA16APY150148UT	Tree Planting	Anacostia River	02140205	1300188.88	490811.14	0.03
SHA16APY150149UT	Tree Planting	Anacostia River	02140205	1319958.37	529288.19	4.43
SHA16APY150158UT	Tree Planting	Anacostia River	02140205	1332301.74	525315.04	0.16
SHA16APY150159UT	Tree Planting	Anacostia River	02140205	1332488.11	525690.82	0.13
SHA16APY160097UT	Tree Planting	Anacostia River	02140205	1344289.05	482962.69	0.10
SHA16APY160124UT	Tree Planting	Anacostia River	02140205	1350090.32	465603.52	0.47
SHA16APY160140UT	Tree Planting	Anacostia River	02140205	1348417.34	459054.65	0.06
SHA16APY160158UT	Tree Planting	Anacostia River	02140205	1347917.89	458150.41	0.08
SHA16APY160159UT	Tree Planting	Anacostia River	02140205	1347648.36	459045.36	0.12
SHA16APY160163UT	Tree Planting	Anacostia River	02140205	1350378.74	471527.44	0.17
SHA16APY160164UT	Tree Planting	Anacostia River	02140205	1348178.26	459189.15	0.12
SHA16APY160190UT	Tree Planting	Anacostia River	02140205	1342617.84	487820.13	0.06
SHA16APY160207UT	Tree Planting	Anacostia River	02140205	1343001.37	488819.54	0.06
SHA16APY160213UT	Tree Planting	Anacostia River	02140205	1342498.64	487865.35	0.25
SHA11APY150042UT	Tree Planting	Cabin John Creek	02140207	1279339.67	504922.27	0.01
SHA11APY150163UT	Tree Planting	Cabin John Creek	02140207	1279067.27	504584.49	0.11
SHA11APY150164UT	Tree Planting	Cabin John Creek	02140207	1279475.82	504668.49	0.11
SHA16APY150051UT	Tree Planting	Cabin John Creek	02140207	1267677.49	483012.01	0.11
SHA16APY150084UT	Tree Planting	Cabin John Creek	02140207	1262118.11	485812.93	0.07
SHA16APY150085UT	Tree Planting	Cabin John Creek	02140207	1262502.05	485608.35	0.04
SHA16APY150136UT	Tree Planting	Cabin John Creek	02140207	1267750.05	482856.98	0.13
SHA16APY160123UT	Tree Planting	Mattawoman Creek	02140111	1297339.43	353544.35	0.04
SHA16APY160138UT	Tree Planting	Mattawoman Creek	02140111	1309637.14	361048.44	0.11
SHA16APY160143UT	Tree Planting	Mattawoman Creek	02140111	1297773.96	353994.80	0.03
SHA16APY160149UT	Tree Planting	Mattawoman Creek	02140111	1297109.90	353375.78	0.02
SHA16APY160156UT	Tree Planting	Mattawoman Creek	02140111	1307776.96	362360.18	0.06
SHA16APY160125UT	Tree Planting	Patuxent River upper	02131104	1355621.76	521259.02	0.30
SHA16APY160139UT	Tree Planting	Patuxent River upper	02131104	1344102.26	522264.56	0.24
SHA16APY160134UT	Tree Planting	Piscataway Creek	02140203	1310439.35	366993.66	0.19
SHA16APY160133UT	Tree Planting	Potomac River M tidal	02140102	1296577.05	352999.99	0.04
SHA16APY160236UT	Tree Planting	Potomac River M tidal	02140102	1296862.78	353200.34	0.04
SHA16APY150065UT	Tree Planting	Potomac River MO Cnty	02140202	1260193.58	521848.73	0.11
SHA16APY150091UT	Tree Planting	Potomac River MO Cnty	02140202	1245551.13	497592.75	0.05
SHA16APY150093UT	Tree Planting	Potomac River MO Cnty	02140202	1245243.57	497783.42	0.01
SHA16APY150094UT	Tree Planting	Potomac River MO Cnty	02140202	1245130.13	497854.46	0.01
SHA16APY150135UT	Tree Planting	Potomac River MO Cnty	02140202	1261679.54	530902.99	1.10
SHA16APY150141UT	Tree Planting	Potomac River MO Cnty	02140202	1245951.74	497351.40	0.03
SHA16APY160127UT	Tree Planting	Potomac River U tidal	02140201	1313264.43	413796.73	0.07
SHA16APY160128UT	Tree Planting	Potomac River U tidal	02140201	1312516.88	413011.51	0.06
SHA16APY160132UT	Tree Planting	Potomac River U tidal	02140201	1346648.10	422736.86	0.51
SHA16APY160142UT	Tree Planting	Potomac River U tidal	02140201	1312796.02	413725.36	0.13
SHA16APY160145UT	Tree Planting	Potomac River U tidal	02140201	1349869.61	427490.48	0.04
SHA16APY160150UT	Tree Planting	Potomac River U tidal	02140201	1349440.20	427283.05	0.40
SHA16APY160160UT	Tree Planting	Potomac River U tidal	02140201	1312874.66	413348.06	0.30
SHA16APY160165UT	Tree Planting	Potomac River U tidal	02140201	1312440.75	413181.72	0.10
SHA16APY160174UT	Tree Planting	Potomac River U tidal	02140201	1329045.13	425398.24	0.08
SHA16APY160230UT	Tree Planting	Potomac River U tidal	02140201	1312455.11	413332.32	0.09
SHA16APY160231UT	Tree Planting	Potomac River U tidal	02140201	1312449.94	413252.44	0.03
SHA16APY160232UT	Tree Planting	Potomac River U tidal	02140201	1312986.59	413199.61	0.17
SHA11APY150043UT	Tree Planting	Rock Creek	02140206	1279515.74	504728.50	0.30
SHA11APY150160UT	Tree Planting	Rock Creek	02140206	1279419.85	504925.30	0.07
SHA11APY150161UT	Tree Planting	Rock Creek	02140206	1279713.35	504799.96	0.16
SHA11APY150165UT	Tree Planting	Rock Creek	02140206	1279498.43	505024.65	0.30
SHA12APY150005UT	Tree Planting	Rocky Gorge Dam	02131107	1332624.28	526620.54	0.14
SHA12APY150007UT	Tree Planting	Rocky Gorge Dam	02131107	1333456.69	529961.77	0.08
SHA12APY150011UT	Tree Planting	Rocky Gorge Dam	02131107	1333561.89	530333.18	0.11
SHA12APY150012UT	Tree Planting	Rocky Gorge Dam	02131107	1333842.20	530796.25	0.56
SHA12APY150013UT	Tree Planting	Rocky Gorge Dam	02131107	1334425.80	531788.03	0.33
SHA16APY150074UT	Tree Planting	Rocky Gorge Dam	02131107	1295252.76	545822.39	0.03

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-39: FMIS # AT0415182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16APY150075UT	Tree Planting	Rocky Gorge Dam	02131107	1295302.74	546082.91	0.07
SHA16APY150155UT	Tree Planting	Rocky Gorge Dam	02131107	1333400.42	530678.73	0.07
SHA16APY150156UT	Tree Planting	Rocky Gorge Dam	02131107	1333544.16	530929.86	0.10
SHA16APY150157UT	Tree Planting	Rocky Gorge Dam	02131107	1332386.14	526676.33	0.32
SHA16APY150017UT	Tree Planting	Seneca Creek	02140208	1242569.09	549425.25	0.20
SHA16APY150052UT	Tree Planting	Seneca Creek	02140208	1237858.03	557213.05	0.07
SHA16APY150057UT	Tree Planting	Seneca Creek	02140208	1239776.69	552350.11	0.10
SHA16APY150058UT	Tree Planting	Seneca Creek	02140208	1232018.71	569608.51	0.05
SHA16APY150062UT	Tree Planting	Seneca Creek	02140208	1239027.50	555160.10	0.22
SHA16APY150063UT	Tree Planting	Seneca Creek	02140208	1207101.51	531006.78	0.20
SHA16APY150064UT	Tree Planting	Seneca Creek	02140208	1251278.62	538672.32	0.06
SHA16APY150066UT	Tree Planting	Seneca Creek	02140208	1251868.76	536297.95	0.24
SHA16APY150072UT	Tree Planting	Seneca Creek	02140208	1231768.61	570480.33	0.10
SHA16APY150073UT	Tree Planting	Seneca Creek	02140208	1239295.52	552517.88	0.24
SHA16APY150086UT	Tree Planting	Seneca Creek	02140208	1237224.65	558009.55	0.16
SHA16APY150087UT	Tree Planting	Seneca Creek	02140208	1237283.57	557759.57	1.02
SHA16APY150088UT	Tree Planting	Seneca Creek	02140208	1237418.60	558423.11	0.13
SHA16APY150089UT	Tree Planting	Seneca Creek	02140208	1237090.86	558712.04	0.04
SHA16APY150090UT	Tree Planting	Seneca Creek	02140208	1236067.10	559855.92	0.18
SHA16APY150109UT	Tree Planting	Seneca Creek	02140208	1232500.62	546253.93	0.04
SHA16APY150113UT	Tree Planting	Seneca Creek	02140208	1243401.14	556695.71	0.44
SHA16APY150137UT	Tree Planting	Seneca Creek	02140208	1237961.68	557049.39	0.07
SHA16APY150138UT	Tree Planting	Seneca Creek	02140208	1237054.47	557715.00	0.15
SHA16APY150139UT	Tree Planting	Seneca Creek	02140208	1236966.11	557783.47	0.15
SHA16APY150140UT	Tree Planting	Seneca Creek	02140208	1236933.75	557902.14	0.03
SHA16APY150142UT	Tree Planting	Seneca Creek	02140208	1251266.35	538575.75	0.04
SHA16APY150143UT	Tree Planting	Seneca Creek	02140208	1240995.21	529677.29	0.51
SHA16APY150145UT	Tree Planting	Seneca Creek	02140208	1236844.41	557377.63	0.18
SHA16APY150146UT	Tree Planting	Seneca Creek	02140208	1240940.85	529452.09	0.06
SHA16APY160137UT	Tree Planting	Western Branch	02131103	1386398.95	417210.28	0.03
SHA16APY160195UT	Tree Planting	Western Branch	02131103	1373903.35	439867.78	0.17
SHA16APY160198UT	Tree Planting	Western Branch	02131103	1392105.74	444578.82	0.16
SHA16APY160209UT	Tree Planting	Western Branch	02131103	1355925.15	436143.15	0.12
SHA16APY160227UT	Tree Planting	Western Branch	02131103	1386228.50	417774.51	0.13
SHA16APY160228UT	Tree Planting	Western Branch	02131103	1350807.03	427720.58	0.36
SHA16APY160233UT	Tree Planting	Western Branch	02131103	1383694.26	417622.72	0.07
SHA16APY160234UT	Tree Planting	Western Branch	02131103	1383891.62	417699.10	0.08
SHA16APY160235UT	Tree Planting	Western Branch	02131103	1386488.51	417095.45	0.04
				Complete BMP Acreage Total		**21.72**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-40: FMIS # AX4885324 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA14APY020414UT	Tree Planting	Bodkin Creek	02130902	1451420.59	529462.88	0.38
SHA14APY020419UT	Tree Planting	Bodkin Creek	02130902	1451596.19	529249.73	0.03
SHA15APY150169UT	Tree Planting	Rock Creek	02140206	1290028.96	487336.74	0.53
SHA15APY150170UT	Tree Planting	Rock Creek	02140206	1290175.15	487059.01	0.12
				Complete BMP Acreage Total		**1.05**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-41: FMIS # AT0625124 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15APY160237UT	Tree Planting	Anacostia River	02140205	1333406.54	504299.74	0.06
SHA15APY160240UT	Tree Planting	Anacostia River	02140205	1333231.02	506671.31	0.22
SHA15APY160241UT	Tree Planting	Anacostia River	02140205	1337796.26	509916.92	0.22
SHA15APY160242UT	Tree Planting	Anacostia River	02140205	1337515.33	509504.18	0.02
					Complete BMP Acreage Total	**0.52**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-42: FMIS # BA9775A72 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA13APY030035UT	Tree Planting	Jones Falls	02130904	1417102.52	637401.46	0.05
SHA13APY030382UT	Tree Planting	Jones Falls	02130904	1416860.49	636905.62	0.08
				Complete BMP Acreage Total		**0.13**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-43: FMIS # PG7455168 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA11APY160026UT	Tree Planting	Anacostia River	02140205	1352061.19	467688.94	0.49
SHA11APY160027UT	Tree Planting	Anacostia River	02140205	1352141.80	467418.88	0.68
SHA11APY160028UT	Tree Planting	Anacostia River	02140205	1351455.52	468071.17	0.41
SHA11APY160029UT	Tree Planting	Anacostia River	02140205	1351690.17	467482.25	0.33
SHA11APY160030UT	Tree Planting	Anacostia River	02140205	1352075.65	466380.48	0.01
SHA11APY160031UT	Tree Planting	Anacostia River	02140205	1352596.87	466642.38	0.83
SHA11APY160035UT	Tree Planting	Anacostia River	02140205	1352692.09	466700.81	0.02
SHA11APY160036UT	Tree Planting	Anacostia River	02140205	1352206.69	466394.37	0.29
SHA11APY160038UT	Tree Planting	Anacostia River	02140205	1352000.63	465975.88	0.34
SHA11APY160039UT	Tree Planting	Anacostia River	02140205	1352290.23	466025.48	0.33
SHA11APY160040UT	Tree Planting	Anacostia River	02140205	1352122.73	465896.17	0.30
SHA11APY160041UT	Tree Planting	Anacostia River	02140205	1352841.96	466064.61	0.82
SHA11APY160042UT	Tree Planting	Anacostia River	02140205	1352678.26	466347.94	0.40
SHA11APY160044UT	Tree Planting	Anacostia River	02140205	1353211.28	466060.52	0.58
SHA11APY160046UT	Tree Planting	Anacostia River	02140205	1353390.69	466206.86	0.16
SHA11APY160047UT	Tree Planting	Anacostia River	02140205	1353034.15	466596.61	0.02
SHA11APY160048UT	Tree Planting	Anacostia River	02140205	1353454.88	465968.37	0.11
SHA11APY160050UT	Tree Planting	Anacostia River	02140205	1352342.82	465492.74	0.50
SHA11APY160051UT	Tree Planting	Anacostia River	02140205	1352530.70	465609.45	0.09
SHA11APY160052UT	Tree Planting	Anacostia River	02140205	1352624.04	465228.68	0.43
SHA11APY160054UT	Tree Planting	Anacostia River	02140205	1352757.80	465033.64	0.03
SHA11APY160055UT	Tree Planting	Anacostia River	02140205	1352245.90	465318.31	0.03
SHA11APY160057UT	Tree Planting	Anacostia River	02140205	1352812.46	464484.61	0.88
SHA11APY160058UT	Tree Planting	Anacostia River	02140205	1353067.60	465262.81	0.75
SHA11APY160062UT	Tree Planting	Anacostia River	02140205	1353029.12	465501.68	0.25
SHA11APY160066UT	Tree Planting	Anacostia River	02140205	1352959.16	465646.41	0.40
SHA11APY160070UT	Tree Planting	Anacostia River	02140205	1353298.37	464685.52	1.10
SHA11APY160073UT	Tree Planting	Anacostia River	02140205	1351734.36	465450.41	0.32
SHA11APY160075UT	Tree Planting	Anacostia River	02140205	1351939.56	465558.21	0.09
SHA11APY160076UT	Tree Planting	Anacostia River	02140205	1351250.14	465739.18	0.15
SHA11APY160080UT	Tree Planting	Anacostia River	02140205	1351883.65	466056.02	0.14
				Complete BMP Acreage Total		**11.28**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-44: FMIS # FR6255168 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA11APY100009UT	Tree Planting	Lower Monocacy River	02140302	1190925.12	630962.66	2.22
SHA11APY100010UT	Tree Planting	Lower Monocacy River	02140302	1191292.78	631513.36	1.92
SHA11APY100011UT	Tree Planting	Lower Monocacy River	02140302	1191191.05	631993.07	0.62
SHA11APY100012UT	Tree Planting	Lower Monocacy River	02140302	1191717.16	631373.90	0.23
SHA11APY100013UT	Tree Planting	Lower Monocacy River	02140302	1192294.49	631267.92	0.60
SHA11APY100017UT	Tree Planting	Lower Monocacy River	02140302	1193159.80	630197.33	2.11
SHA11APY100018UT	Tree Planting	Lower Monocacy River	02140302	1193662.74	630317.92	0.44
SHA11APY100019UT	Tree Planting	Lower Monocacy River	02140302	1193424.04	630552.22	1.16
SHA11APY100023UT	Tree Planting	Lower Monocacy River	02140302	1193026.74	630882.83	0.22
SHA11APY100024UT	Tree Planting	Lower Monocacy River	02140302	1192345.29	630636.38	0.52
SHA11APY100026UT	Tree Planting	Lower Monocacy River	02140302	1192548.16	630927.45	0.42
SHA11APY100028UT	Tree Planting	Lower Monocacy River	02140302	1192026.38	630918.57	0.12
SHA11APY100029UT	Tree Planting	Lower Monocacy River	02140302	1191905.93	631127.85	0.13
SHA11APY100032UT	Tree Planting	Lower Monocacy River	02140302	1190892.96	631305.18	0.43
				Complete BMP Acreage Total		**11.14**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-45: FMIS # AX0715124 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15APY020417UT	Tree Planting	Baltimore Harbor	02130903	1429327.48	534651.05	0.16
SHA15APY020416UT	Tree Planting	Patapsco River L N Br	02130906	1388753.58	547303.90	1.40
SHA15APY020418UT	Tree Planting	Patapsco River L N Br	02130906	1386567.60	550541.38	0.27
				Complete BMP Acreage Total		**1.83**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-46: FMIS # BA6375124R (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA12APY030004UT	Tree Planting	Jones Falls	02130904	1407075.62	636451.23	0.01
SHA12APY030005UT	Tree Planting	Jones Falls	02130904	1406772.53	636888.01	0.08
SHA12APY030006UT	Tree Planting	Jones Falls	02130904	1406836.51	636377.15	0.31
SHA12APY030007UT	Tree Planting	Jones Falls	02130904	1407503.52	634585.38	0.74
SHA12APY030008UT	Tree Planting	Jones Falls	02130904	1407707.87	635185.25	0.55
SHA12APY030009UT	Tree Planting	Jones Falls	02130904	1407878.61	635296.45	0.03
SHA12APY030010UT	Tree Planting	Jones Falls	02130904	1408132.35	634394.62	0.07
SHA12APY030012UT	Tree Planting	Jones Falls	02130904	1407700.95	633455.23	0.21
SHA12APY030013UT	Tree Planting	Jones Falls	02130904	1407270.96	631607.30	0.50
SHA12APY030014UT	Tree Planting	Jones Falls	02130904	1407640.60	631563.44	0.15
SHA12APY030015UT	Tree Planting	Jones Falls	02130904	1407108.26	631201.08	0.12
SHA12APY030016UT	Tree Planting	Jones Falls	02130904	1407264.45	627141.72	0.22
SHA12APY030017UT	Tree Planting	Jones Falls	02130904	1407509.06	626403.36	0.07
SHA12APY030018UT	Tree Planting	Jones Falls	02130904	1408099.47	624373.54	0.24
SHA12APY030019UT	Tree Planting	Jones Falls	02130904	1408257.61	623943.75	0.20
SHA12APY030020UT	Tree Planting	Jones Falls	02130904	1410226.44	622327.44	0.22
SHA12APY030381UT	Tree Planting	Jones Falls	02130904	1407929.56	634852.75	0.23
				Complete BMP Acreage Total		**3.96**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-47: FMIS # AX7235168 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA12APY020026UT	Tree Planting	Baltimore Harbor	02130903	1414073.09	560508.99	0.21
SHA12APY020027UT	Tree Planting	Baltimore Harbor	02130903	1416479.51	559141.25	0.25
SHA12APY020031UT	Tree Planting	Baltimore Harbor	02130903	1414819.95	548502.18	0.20
SHA12APY020032UT	Tree Planting	Baltimore Harbor	02130903	1412892.87	539411.06	0.06
SHA12APY020033UT	Tree Planting	Baltimore Harbor	02130903	1412892.18	539107.64	0.06
SHA12APY020034UT	Tree Planting	Baltimore Harbor	02130903	1412745.77	538097.93	0.94
SHA12APY020036UT	Tree Planting	Baltimore Harbor	02130903	1425259.14	559338.16	0.46
SHA12APY020037UT	Tree Planting	Baltimore Harbor	02130903	1424728.08	543776.64	0.71
SHA12APY020038UT	Tree Planting	Baltimore Harbor	02130903	1428988.45	535027.01	0.10
SHA12APY020039UT	Tree Planting	Baltimore Harbor	02130903	1425999.10	534883.09	0.30
SHA12APY020022UT	Tree Planting	Patapsco River L N Br	02130906	1409211.18	566011.47	0.37
SHA12APY020023UT	Tree Planting	Patapsco River L N Br	02130906	1409391.61	565518.28	0.47
SHA12APY020024UT	Tree Planting	Patapsco River L N Br	02130906	1408967.44	565347.30	0.52
SHA12APY020041UT	Tree Planting	Patapsco River L N Br	02130906	1390990.82	546430.14	0.04
SHA12APY020042UT	Tree Planting	Patapsco River L N Br	02130906	1391170.59	546869.07	0.01
SHA12APY080005UT	Tree Planting	Patuxent River lower	02131101	1372930.42	318885.17	0.41
SHA12APY080006UT	Tree Planting	Patuxent River lower	02131101	1375260.20	316228.12	0.32
SHA12APY080008UT	Tree Planting	Patuxent River lower	02131101	1375715.99	315623.29	0.08
SHA12APY080009UT	Tree Planting	Patuxent River lower	02131101	1375884.06	315672.25	0.27
SHA12APY080010UT	Tree Planting	Zekiah Swamp	02140108	1347093.63	344336.50	0.16
SHA12APY080011UT	Tree Planting	Zekiah Swamp	02140108	1347496.31	343789.14	0.50
				Complete BMP Acreage Total		**6.46**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-48: FMIS # MO8305171 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA11APY150166UT	Tree Planting	Cabin John Creek	02140207	1278858.86	505316.28	0.08
SHA11APY150167UT	Tree Planting	Cabin John Creek	02140207	1278961.58	505134.96	0.04
				Complete BMP Acreage Total		**0.12**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-49: FMIS # AX6325324 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA11APY130011UT	Tree Planting	Little Patuxent River	02131105	1351515.73	550115.79	1.66
SHA11APY130012UT	Tree Planting	Little Patuxent River	02131105	1354022.50	548424.49	0.11
SHA11APY130017UT	Tree Planting	Little Patuxent River	02131105	1343014.55	597000.63	0.14
SHA11APY130019UT	Tree Planting	Little Patuxent River	02131105	1362439.59	577061.48	1.69
SHA11APY130020UT	Tree Planting	Little Patuxent River	02131105	1365151.86	570751.60	0.43
SHA11APY130024UT	Tree Planting	Little Patuxent River	02131105	1364544.19	573107.68	0.32
SHA11APY130025UT	Tree Planting	Little Patuxent River	02131105	1341228.50	539134.59	0.64
SHA11APY130029UT	Tree Planting	Little Patuxent River	02131105	1342308.41	538172.84	0.12
SHA11APY130030UT	Tree Planting	Little Patuxent River	02131105	1343770.92	538418.84	0.03
SHA11APY130031UT	Tree Planting	Little Patuxent River	02131105	1344035.47	538362.82	0.02
SHA11APY130032UT	Tree Planting	Little Patuxent River	02131105	1344717.82	537996.32	0.05
SHA11APY130033UT	Tree Planting	Little Patuxent River	02131105	1344817.70	538101.19	0.06
SHA11APY130034UT	Tree Planting	Little Patuxent River	02131105	1345460.12	537678.87	0.09
SHA11APY130035UT	Tree Planting	Little Patuxent River	02131105	1346559.31	537122.67	0.15
SHA11APY130036UT	Tree Planting	Little Patuxent River	02131105	1347915.78	536413.72	0.09
SHA11APY130038UT	Tree Planting	Little Patuxent River	02131105	1364344.40	575127.98	0.25
SHA11APY130039UT	Tree Planting	Little Patuxent River	02131105	1354039.91	548973.24	1.98
SHA11APY130040UT	Tree Planting	Little Patuxent River	02131105	1340985.54	538725.67	1.16
SHA11APY130126UT	Tree Planting	Little Patuxent River	02131105	1340772.84	538551.82	0.05
SHA11APY130200UT	Tree Planting	Little Patuxent River	02131105	1344069.27	543054.47	0.44
SHA11APY130202UT	Tree Planting	Little Patuxent River	02131105	1355233.61	548430.86	2.00
SHA11APY130205UT	Tree Planting	Little Patuxent River	02131105	1352516.62	549662.74	1.54
SHA11APY130207UT	Tree Planting	Little Patuxent River	02131105	1364920.91	572001.85	0.28
SHA11APY130214UT	Tree Planting	Little Patuxent River	02131105	1364557.08	573386.61	0.21
SHA11APY030130UT	Tree Planting	Loch Raven Reservoir	02130805	1409275.84	658549.89	0.21
SHA11APY130013UT	Tree Planting	Middle Patuxent River	02131106	1342951.25	552485.47	0.27
SHA11APY130014UT	Tree Planting	Middle Patuxent River	02131106	1305578.79	605493.78	0.07
SHA11APY130015UT	Tree Planting	Middle Patuxent River	02131106	1319341.34	600649.93	0.09
SHA11APY130016UT	Tree Planting	Middle Patuxent River	02131106	1321142.04	599682.60	0.26
SHA11APY130203UT	Tree Planting	Middle Patuxent River	02131106	1343890.30	552424.91	0.10
SHA11APY130204UT	Tree Planting	Middle Patuxent River	02131106	1319905.45	600350.48	0.07
SHA11APY130217UT	Tree Planting	Middle Patuxent River	02131106	1321679.72	599404.34	0.03
SHA11APY130028UT	Tree Planting	Patapsco River L N Br	02130906	1376121.33	554859.72	0.44
SHA11APY130037UT	Tree Planting	Patapsco River L N Br	02130906	1376158.90	559854.46	0.48
SHA11APY130026UT	Tree Planting	Patuxent River upper	02131104	1350741.82	532643.22	0.94
SHA11APY130027UT	Tree Planting	Patuxent River upper	02131104	1352164.63	531879.87	0.10
SHA11APY130021UT	Tree Planting	Rocky Gorge Dam	02131107	1340064.78	538372.43	0.34
SHA11APY130022UT	Tree Planting	Rocky Gorge Dam	02131107	1339651.21	537736.27	0.12
SHA11APY130023UT	Tree Planting	Rocky Gorge Dam	02131107	1339177.87	538684.66	0.24
SHA11APY130041UT	Tree Planting	Rocky Gorge Dam	02131107	1341271.25	538330.78	0.08
SHA11APY130018UT	Tree Planting	S Branch Patapsco	02130908	1312796.64	602935.79	0.14
				Complete BMP Acreage Total		**17.53**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-50: FMIS # AX1555D24 (Various)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA12APY130002UT	Tree Planting	Little Patuxent River	02131105	1343569.47	543312.92	0.11
SHA12APY130004UT	Tree Planting	Little Patuxent River	02131105	1347683.40	551012.61	0.21
SHA12APY130005UT	Tree Planting	Little Patuxent River	02131105	1351756.12	558300.91	0.23
SHA12APY130008UT	Tree Planting	Little Patuxent River	02131105	1362794.92	577518.81	0.72
SHA12APY130009UT	Tree Planting	Little Patuxent River	02131105	1363140.76	576922.21	0.40
SHA12APY130010UT	Tree Planting	Little Patuxent River	02131105	1362360.17	577588.24	0.75
SHA12APY130125UT	Tree Planting	Little Patuxent River	02131105	1347562.77	550790.87	0.08
SHA12APY130215UT	Tree Planting	Little Patuxent River	02131105	1343408.37	542917.17	0.00
SHA12APY130216UT	Tree Planting	Little Patuxent River	02131105	1343485.31	543004.26	0.01
SHA12APY130122UT	Tree Planting	Middle Patuxent River	02131106	1343626.68	543420.26	0.14
SHA12APY150006UT	Tree Planting	Rocky Gorge Dam	02131107	1332925.98	527720.97	0.12
SHA12APY150008UT	Tree Planting	Rocky Gorge Dam	02131107	1333219.93	530073.68	0.11
SHA12APY150009UT	Tree Planting	Rocky Gorge Dam	02131107	1333360.36	530400.83	0.31
SHA12APY150010UT	Tree Planting	Rocky Gorge Dam	02131107	1333185.34	530404.45	0.15
				Complete BMP Acreage Total		**3.33**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-51: FMIS # AX0725124 (No Contract)						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA15APY130223UT	Tree Planting	Patapsco River L N Br	02130906	1369255.85	562723.03	0.11
				Complete BMP Acreage Total		**0.11**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-52: FMIS # AT0865182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16RST150023	Retrofit	Anacostia River	02140205	1291753.50	530812.73	7.50
SHA16RST160101	Retrofit	Anacostia River	02140205	1340561.18	435834.55	5.36
SHA16RST160702	Retrofit	Anacostia River	02140205	1340270.33	483867.63	2.35
SHA16RST150026	Retrofit	Cabin John Creek	02140207	1268867.05	506302.09	2.69
SHA16RST150029	Retrofit	Cabin John Creek	02140207	1268327.78	505812.90	1.43
SHA16RST160170	Retrofit	Patuxent River upper	02131104	1355421.36	521281.40	0.11
SHA16RST160171	Retrofit	Patuxent River upper	02131104	1355574.52	521464.11	0.14
SHA16RST160189	Retrofit	Piscataway Creek	02140203	1346623.30	397714.19	0.61
SHA16RST160190	Retrofit	Piscataway Creek	02140203	1346761.01	392907.93	0.36
SHA16RST150021	Retrofit	Rock Creek	02140206	1291010.18	526599.21	2.56
SHA16RST150342	Retrofit	Rock Creek	02140206	1289986.04	525354.20	2.78
SHA16RST150343	Retrofit	Rock Creek	02140206	1290942.58	526011.39	2.50
SHA16RST160210	Retrofit	Western Branch	02131103	1357628.35	466123.94	1.94
					Complete BMP Acreage Total	**30.33**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-53: FMIS # AT0875182						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA16RST020547	Retrofit	Baltimore Harbor	02130903	1413802.79	532307.32	18.14
SHA16RST020337	Retrofit	Patuxent River middle	02131102	1400944.50	413922.11	1.93
SHA16RST020090	Retrofit	Severn River	02131002	1412617.93	510265.24	2.45
SHA16RST020221	Retrofit	Severn River	02131002	1418936.85	504058.38	4.46
SHA16RST020438	Retrofit	Severn River	02131002	1414976.76	508445.02	10.19
SHA16RST020163	Retrofit	South River	02131003	1422665.76	490012.09	1.40
SHA16RST020252	Retrofit	South River	02131003	1439401.26	480675.17	3.34
SHA16RST020262	Retrofit	South River	02131003	1440637.47	479910.63	4.73
SHA16RST020266	Retrofit	South River	02131003	1440181.90	479799.26	1.47
SHA16RST020269	Retrofit	South River	02131003	1438172.45	480023.12	6.87
				Complete BMP Acreage Total		**54.98**

Comprehensive List of Restoration Practices By FMIS Contract						
Table F-54: NO SPENDING DATA						
Unique BMP #	**BMP Type**	**8-Digit Watershed Name**	**8-Digit Watershed Code**	**Northing**	**Easting**	**Impervious Treated (acres)**
SHA12APY060001UI	Impervious Surface Elimination (to Pervious)	Liberty Reservoir	02130907	1337206.16	659925.07	0.12
SHA12APY060002UI	Impervious Surface Elimination (to Pervious)	Upper Monocacy River	02140303	1267920.58	731364.86	0.21
SHA12APY060003UI	Impervious Surface Elimination (to Pervious)	Upper Monocacy River	02140303	1276894.66	745472.07	0.16
					Complete BMP Acreage Total	**0.49**

Appendix G

Watershed Restoration Assessment

Monitoring Plan







STATE HIGHWAY ADMINISTRATION

NPDES/MS4 ASSESSMENT OF CONTROLS

for

Stream Restoration of

Little Catoctin Creek at U.S. 340

Frederick County, Maryland

October 9, 2016

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1.0 INTRODUCTION

The stream restoration of Little Catoctin Creek (LCC) is currently under design by the State Highway Administration (SHA) Water Programs Division (WPD). The restoration extent originates at SHA bridge structure number 10081 at MD 180 (Jefferson Pike) and continues downstream approximately 3,100 linear feet (LF) of the existing channel. SHA is proposing to monitor the physical, chemical and biological features of the project stream system for four years (first year during pre-construction, second during construction, and the last two post-construction).

SHA is currently pursuing agreements with the U.S. Geological Survey (USGS) and the Maryland Department of Natural Resources (DNR) to perform this work. We propose to utilize USGS to perform chemical monitoring and DNR to perform biological monitoring. SHA and its consultants will perform physical monitoring.



Little Catoctin Creek

1.1 – Monitoring Plan Objectives

The monitoring plan objectives are as follows:

- Measure stream flow and select chemical, physical & biological constituents
- Sample aquatic macroinvertebrate populations, develop BIBI scores
- Monitor stream habitat via MBSS protocols
- Compare annual measurements of stream cross-sections and stream profiles
- Develop a hydrologic and/or hydraulic model to attempt to gage flow effects on channel morphology
- Report applicable data and results annually

1.2 – Restoration Project Purpose, Goals, & Description

The purpose of the LCC Restoration Project is to enhance and improve the ecosystem of LCC throughout the project reach. The need for restoration originates with the anthropogenic influences on the active channel and overbank areas. Long-standing, adjacent property owners described dynamite blasting into bedrock to utilize the valley bottom as pastureland.

The programmatic goal of the project is to reduce streambank erosion and the associated nitrogen and phosphorus pollutants contributing to the degradation of water quality in this reach and ultimately of the Chesapeake Bay.

The overall design objective is to utilize stream and floodplain restoration methodologies to create an ecologically diverse valley bottom ecosystem that maintains stability through native wetland vegetation and provides increased sediment and nutrient processing. Stream and floodplain restoration can restore impaired, vital ecosystems by returning natural hydrologic, hydraulic, geomorphic, physicochemical and biological functions to undevelopable land within the 100-year floodplain. Please refer to the appendix of this plan for a representation of the Preliminary Investigation (PI) plans (Proposed Conditions Site Map).

Initial geomorphic measurements have been conducted as well as bank and bed material content determinations (i.e., nutrients, bulk density). These measurements will be included in initial monitoring results and represent the baseline reference point for the physical monitoring portion of this plan. These measurements will be included in the NPDES database. Preliminary concepts have been developed but have not progressed to the schematic design phase.

The restoration reach runs in a southeasterly direction from MD 180 and is within the Blue Ridge physiographic province. Total length of stream channel proposed to be restored is approximately 3,100 LF of the LCC mainstem. Please reference the proximity map below and the vicinity map in the Appendix for additional location details.

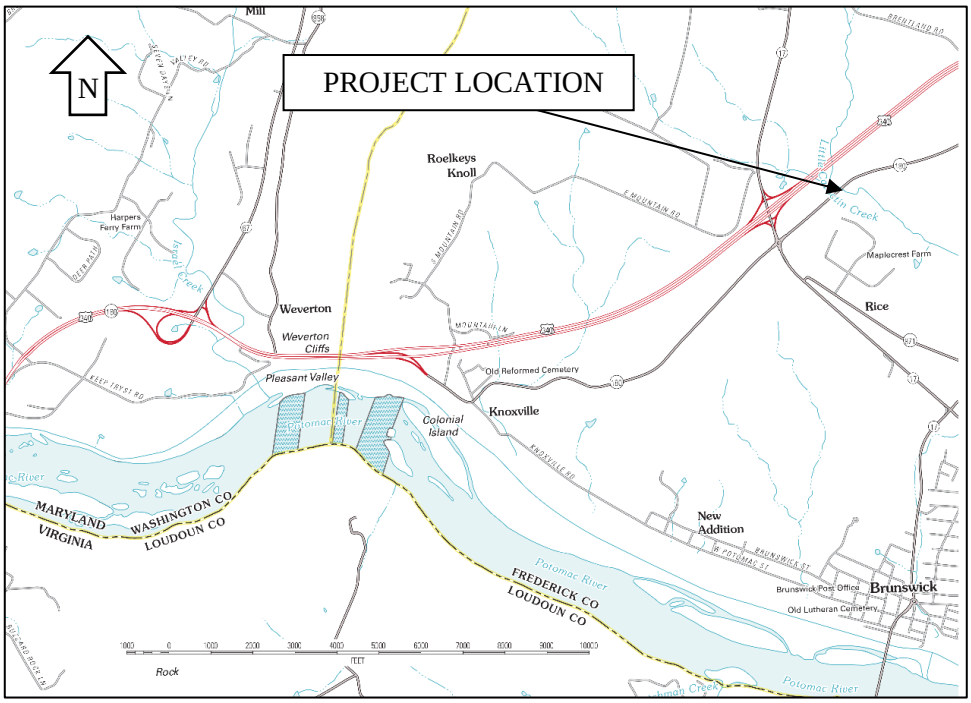


Figure 1: *Proximity Map*

Table 1: *General Coordinates for the Project Location*

Coordinate System	*Northing/Latitude*	*Easting/Longitude*
State Plane NAD 83	610,490	1,133,000
Geographic WGS 84	N 39° 20' 28.6"	W 77° 38' 03.1"

1.3 – Project Reach Stream Classification & Project Watershed 303(d) Impairments

LCC is classified as surface water use designation I-P, *Water Contact Recreation, and Protection of Aquatic Life* by the Code of Maryland Regulations §26.08.02 (COMAR). Use I-P waters allow any reasonable and lawful use provided that surface water quality is not adversely affected. Legal use may include water contact sports, leisure time activities, fishing, propagation of fish (other than trout), agricultural water supply, industrial water supply, and public water supply.

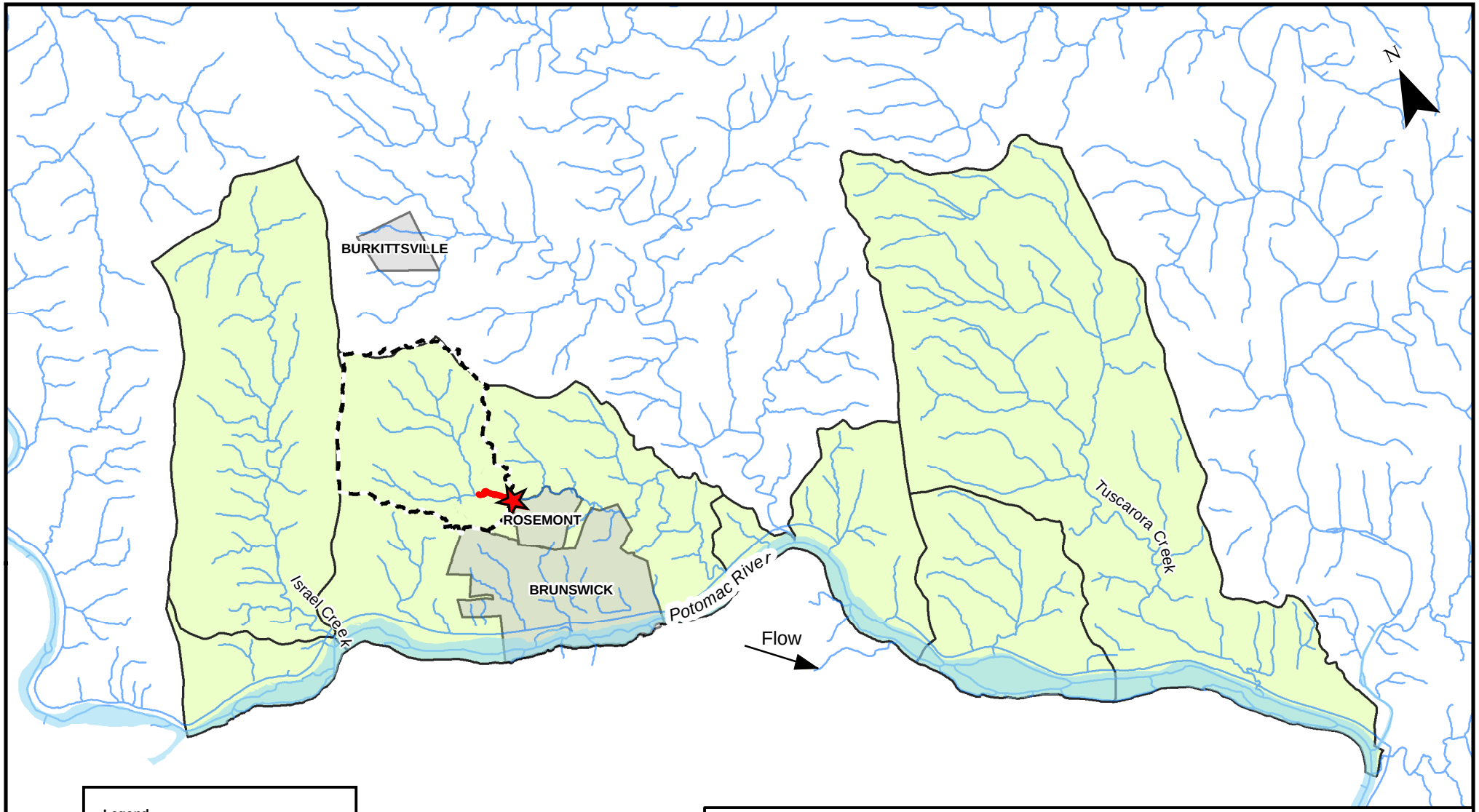
Use I-P waters have in-stream construction restrictions from March 1 through June 15, inclusive.

The LCC watershed is within the 02140301 (Middle Potomac River/Potomac River FR County) MDE watershed. This watershed is comprised of six separate sub-watersheds that drain directly to the Potomac River. No local TMDLs exist for this watershed. Four impairments exist for 02140301 (pollutants listed are cause unknown, mercury in fish tissue, PCB in fish tissue, temperature/water). Of the four impairments, two are exclusive to the Potomac River mainstem and one is exclusive to Tuscarora Creek. The last is a 2006 impairment that applies to all 1st through 4th order streams. The pollutant listed for the 2006 impairment is "cause unknown."

Please refer to Table 2 and Figure 2 (following pages) for the listing of all impaired streams in watershed 02140301.

Table 2: Streams on 303(D) List for Watershed 02140301

Cycle First Listed	2014	2014	2014		2006
AU_ID	MD-02140301010211-UTTuscarora_Crk	MD-02140301-Mainstem	MD-02140301-Mainstem	MD-02140301	MD-02140301-Wadeable_Streams
Basin Name	Potomac River Frederick County	Potomac River Frederick County	Potomac River Frederick County	Potomac River Frederick County	Potomac River Frederick County
Basin Code	2140301	2140301	2140301	2140301	2140301
HUC	2070008	2070008	2070008	2070008	2070008
County	FR	FR, WA	FR, WA	FR, WA	FR, WA
Water Type	RIVER	RIVER	RIVER	RIVER	RIVER
Water Type Detail	Non-tidal Segment(s)	River Mainstem	River Mainstem	Non-tidal 8-digit watershed	1st thru 4th order streams
Designated Use	Aquatic Life and wildlife	Fishing	Fishing	Water Contact Sports	Aquatic Life and Wildlife
Listing Category	5 - Impaired, TMDL Required	5 - Impaired, TMDL Required	5 - Impaired, TMDL Required	2 - Meets water quality criteria for the pollutant specified	5 - Impaired, TMDL Required
Pollutant	Temperature, water	PCB in Fish Tissue	Mercury in Fish Tissue	Fecal Coliform	Cause Unknown
Indicator	Direct Measurement	Direct Measurement	Direct Measurement	Direct Measurement	Fish and Benthic IBIs
Priority	Low	Low	Low		Low
Impairment Addressed In Two Years?	No	No	No	No	No
Delisting Cycle				2004	
Approval Date					
Notes	Temperature measurements exceed criteria and no cold water obligate taxa were found.	New channel catfish data exceeds the PCB contaminant threshold.	New data conclusively shows high mercury in fish tissue value.	Meets recreational water quality criteria.	



Legend

MDE 8 DIGIT WATERSHED

02140301

PROJECT WATERSHED OUTLET

Project Reach

PROJECT WATERSHED

MARYLAND TOWNS

0 1 2 4 6 Miles

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

NPDES/MS4 ASSESSMENT OF CONTROLS
for
Stream Restoration of Little Catoctin Creek at U.S. 340
FIGURE 2: SUBWATERSHEDS IN BASIN CODE 2140301

Frederick County, Maryland

Oct 9, 2016 **1 inch = 10,000 feet**

1.4 - Watershed Description

Please refer to the appendix of this report for mapping, which provides visual representation of data provided here.

The project watershed was determined at two points of interest (POI). The first is the MD 180 crossing of LCC. The second POI is at the downstream limit of the restoration reach. The 1858 Isaac Bond Atlas of Frederick County evidences a 19th century road crossing LLC.

Total drainage area to the MD 180 POI is 4.12 mi². Total drainage area to the downstream POI is 4.47 mi². Table 3 quantifies important characteristics of the watershed.

Table 3: *LCC Watershed*

	To MD 180	***From MD 180 to DS End of Project***	***OVERALL PROJECT WATERSHED***
Total DA	2,637.89 Acres	221.90 Acres	2,859.79 Acres
	4.12 mi²	0.35 mi²	4.47 mi²
SHA Impervious Area	27.32 Acres	5.58 Acres	32.89 Acres
	1.04%	2.51%	1.15%
Total Impervious Area	61.80 Acres	17.34 Acres	79.14 Acres
	2.34% of sub watershed	7.81% of sub watershed	2.77% of watershed
2010 MDP RCN	73.06	74.21	73.15
Zoning RCN	66.84	73.39	72.54
Forest Cover	528.69 Acres	11.21 Acres	539.90 Acres
	20.04% of sub watershed	5.05% of sub watershed	18.88% of watershed
SHA Tree Planting Efforts	3.79 Acres	0.46 Acres	4.25 Acres
	0.14% of sub watershed	0.21% of sub watershed	0.15% of watershed

Land use data was obtained from the 2010 Maryland Department of Planning (MDP) data and was visually verified against recent aerial imagery. In conjunction with SSURGO hydrologic soil group (HSG) classifications, the MDP land use categories were correlated to similar land use descriptions from NRCS' Technical Release 55 (TR55) to develop Runoff Curve Number (RCN)

values. Soil data for the hydrologic soil group (HSG) was obtained from NRCS' Web Soil Survey, which is based on the SSURGO soils database.

Zoning land cover was obtained from Frederick County's Planning and Permitting Division GIS data with small areas at the top of South Mountain obtained from Washington County, the western-most portion of LCC's watershed. The county boundary traverses the ridgeline of South Mountain. The calculated zoning RCN was lower than the 2010 MDP-derived RCN, which is common when using Maryland's Hydrology Panel methodology. As stated in the Panel's report, zoning is often a poor indicator of ultimate land use.

The 2010 MDP Land Use, County Zoning, and SSURGO HSG soils are all summarized for the LCC watershed in Figures 3, 4 and 5:

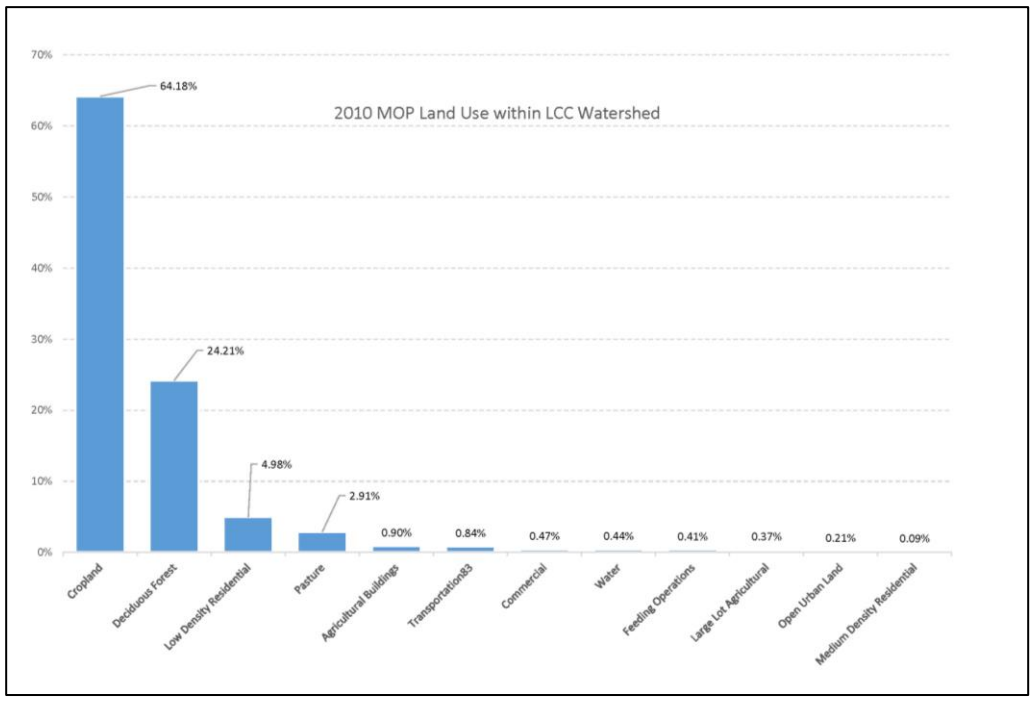


Figure 3: *LCC 2010 MDP Land Use Categories*

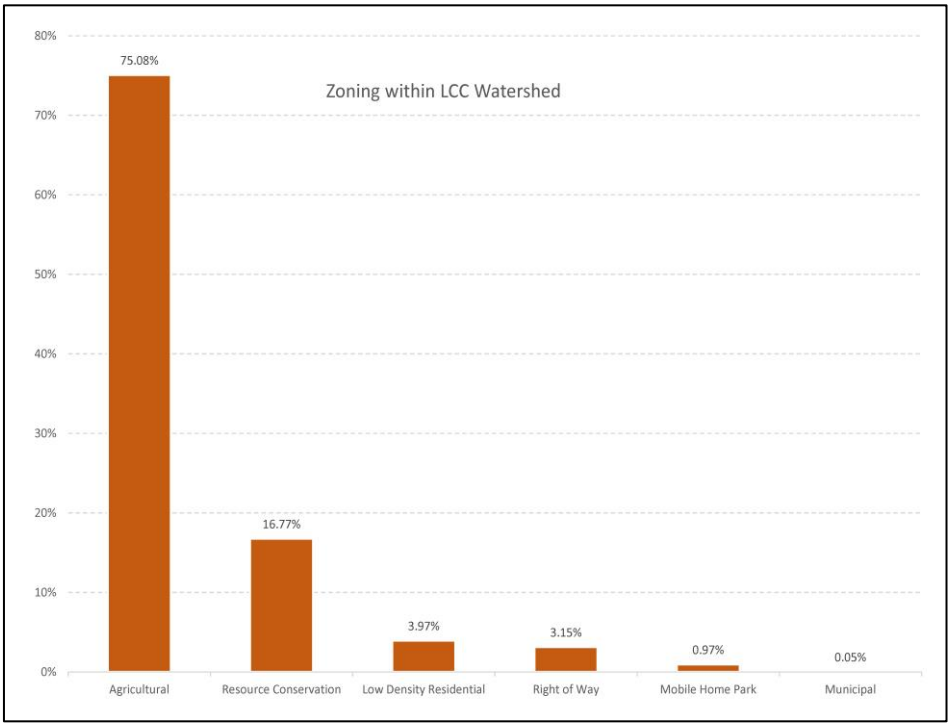


Figure 4: *LCC Zoning Land Use Percentages by Categories*

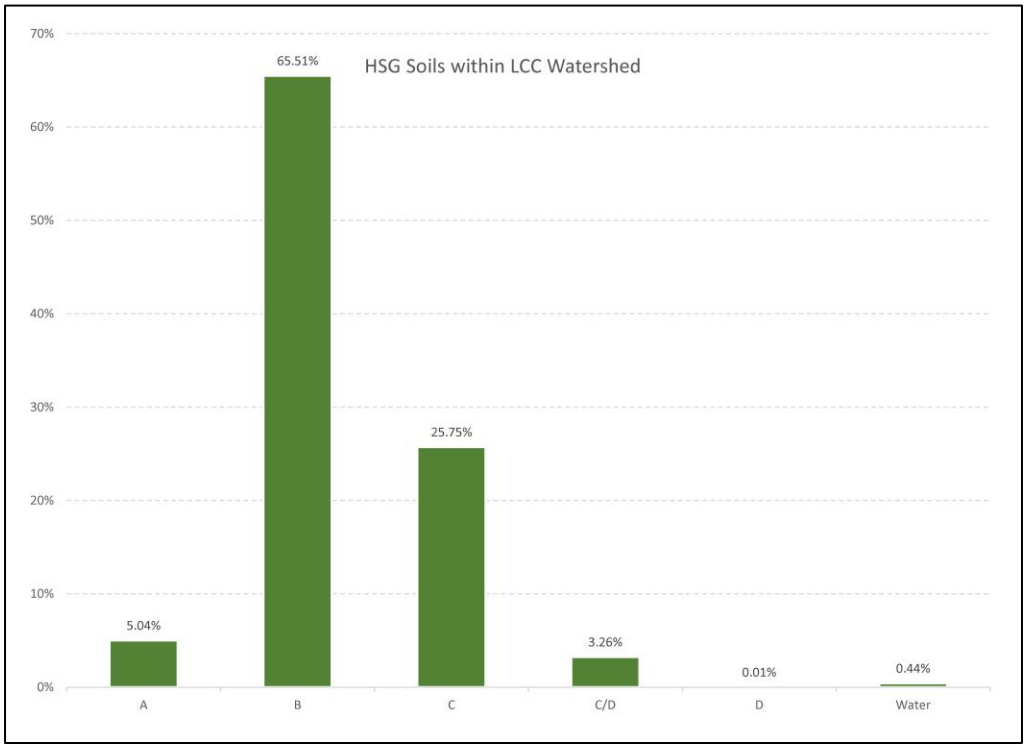


Figure 5: *LCC SSURGO Soil Percentages by HSG Categories*

As shown in Figures 3, 4, and 5, the LCC watershed is predominantly agricultural land use, both in current conditions and future conditions. Soils are predominantly 'B' HSG soil group. Aerial imagery from 1959 confirms that the watershed has been principally agricultural use for decades if not centuries.

A review of Frederick County agricultural preservation data was performed for the LCC watershed. The Rural Legacy (1,529 acres), Maryland Agricultural Land Preservation (322 acres) and Installment Purchase (27 acres) Programs account for 65.63% of the LCC watershed land area. This percentage is consistent with the 2010 MDP and Zoning data. Please refer to mapping in the appendix of this plan for locations of preservations areas.

1.5 – Physiographic Province and Region for the LCC Watershed

The LCC watershed is fully within the Blue Ridge Physiographic Province. Two regions comprise the watershed area: The Catoctin-South Mountain and Middletown Valley Regions. South Mountain is the western boundary of the watershed, which continues the Blue Ridge northward through Maryland. This region is characterized as mainly granodiorite and biotite granite gneiss. The Middletown Valley is comprised of Quartzite, sandstone, siltstone, graywacke, phyllite, and shale. The Middletown Valley Region has a moderately rolling valley floor and bowl-shaped transverse profile, punctuated by the incised valley of Catoctin Creek.

1.6 - Additional SHA Watershed Initiatives

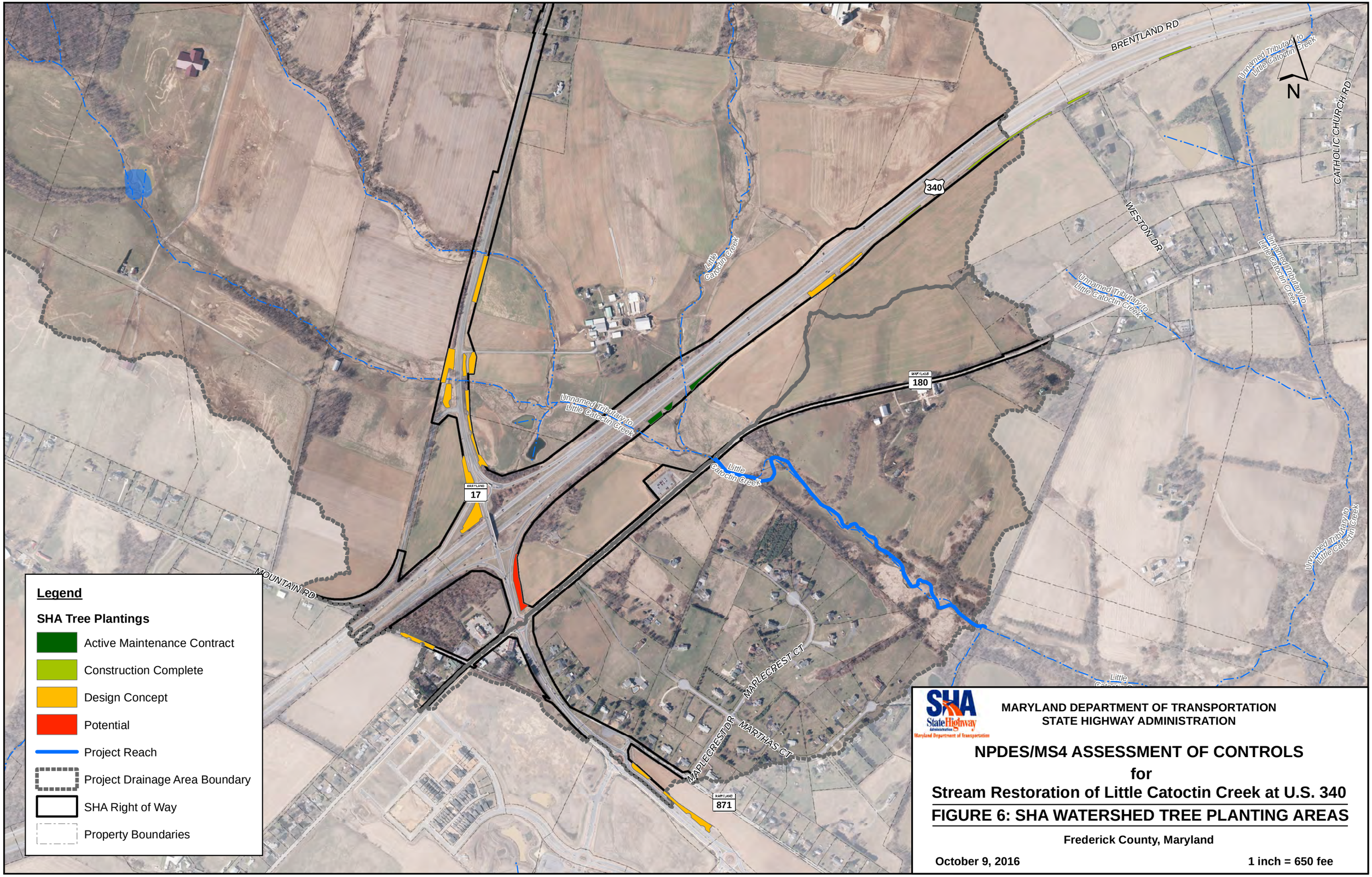
SHA has ongoing watershed restoration projects in the form of stormwater BMPs and tree planting. SHA right-of-way (ROW) land area within the LCC watershed is 79.33 acres or 2.77% of the total watershed. As shown in table 2, SHA impervious areas within the LCC watershed are 32.89 acres or 1.15%. This ROW and associated impervious area is primarily within the US 340, MD 180 and MD 17 road corridors.

Stormwater investigations are ongoing and stormwater BMPs are currently being evaluated for water quality improvements in the MD 17 and US 340 corridors. US 340, with a wide median and some flatter shoulder areas, may have potential for implementation.

SHA may proceed with monitoring beyond the four year monitoring proposed if further investigation of SWM BMPs leads to implementation. This approach may provide the opportunity to determine effects by individual BMP, instead of composite effects from all watershed restoration efforts.

SHA tree planting restoration projects within the LCC watershed area are ongoing. Currently, 0.32 acres are under active management, an additional 0.44 acres has completed construction, 3.11 acres are in design, and 0.37 acres are potential areas for planting. Total SHA tree planting efforts account for 0.15% of the LCC watershed area. Please refer to Figure 6 (next page) for all pertinent SHA tree planting areas.

SHA continues to reach out to the upstream property owner in hopes of implementing additional BMPs. Cattle exclusion fencing has been installed on the upstream property through private and NRCS funding.



Legend

SHA Tree Plantings

- Active Maintenance Contract
- Construction Complete
- Design Concept
- Potential
- Project Reach
- Project Drainage Area Boundary
- SHA Right of Way
- Property Boundaries

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

NPDES/MS4 ASSESSMENT OF CONTROLS
for
Stream Restoration of Little Catoctin Creek at U.S. 340
FIGURE 6: SHA WATERSHED TREE PLANTING AREAS

Frederick County, Maryland

October 9, 2016 **1 inch = 650 fee**

2.0 CHEMICAL, PHYSICAL & BIOLOGICAL MONITORING METHODOLOGY

2.1 - Chemical Monitoring Methodology

Continuous and discrete water-quality and quantity monitoring locations

In-stream chemical, constituent, water temperature, pH & Escherichia coli (E.coli) monitoring will take place at two locations, one site upstream of the proposed restoration and the other downstream of the proposed restoration. Monitoring at both locations will begin prior to the start of restoration efforts, continue throughout the restoration, and terminate two years after the restoration is completed. The upstream site will be located near the Jefferson Pike stream crossing. The second site will be located approximately 2,500 linear feet down valley near a utility line crossing. An alternate site downstream at the Petersville Road crossing may be used for discrete monitoring during times of extreme flood conditions. Continuous discharge monitoring will only take place at the upstream site near the Jefferson Pike stream crossing. The position for each of the sampling locations is presented in Figure 7.

Continuous stage monitoring location

Stage, for the computation of discharge, will only be monitored at an upstream site near the Jefferson Pike stream crossing under the assumption that there is no appreciable contribution to discharge within the restoration area. The stage monitoring location is presented in Figure 7.

Continuous Stage Monitoring

Discharge will be estimated from river stage returned from bubbler-style equipment (Sutron Accububble) or a non-contact water level sensor (OTT RADAR Level Sensor) every 5 minutes or less. Discrete measures of flow will be observed using acoustic Doppler current profilers. Discrete measures made across a range of stages will be used to develop a stage-discharge relation which will be maintained throughout the project. Differences in discharge between the upstream and downstream sites are assumed to be insignificant. Any discrete water-quality sample collected from the Petersville Road crossing due to extreme conditions will be accompanied by a discrete discharge sample to ensure the above assumption holds true for conditions further downstream.

Discrete Water-quality Monitoring

Discrete, manual sample collection for chemical constituents, water temperature, pH & E.coli monitoring will take place on a 4-week, fixed-frequency (FF) interval and target 12 unique storm events throughout a year. Discrete monitoring will be augmented by the use of automatic samplers to facilitate sampling during storm events. Automatic samplers will be configured to collect 15 sets of samples across 15 different storm hydrographs spaced throughout the year; a sample set equals two samples. Storm samples will target rising, peak, and receding stream conditions to ensure monitoring occurs across several orders of flow. By distributing storm-sample collection throughout the year seasonal variability will be captured in the dataset.

Discrete, manual sampling will occur at the identified upstream and downstream monitoring stations shown in Figure 7. Water-quality samples will represent discharge-weighted concentrations of the stream cross-section during collection. Protocols outlined in the USGS National Field Manual (http://water.usgs.gov/FieldManual/index.html) will be followed to collect such representative samples. All samples will be collected by a two-person team using USGS "clean hands, dirty hands" protocols to preserve sample integrity. Isokinetic depth-integrated samples will be collected using equal-width-increment (EWI) sampling techniques which require sampling depths greater than 1 foot, and flow velocities exceeding 1.5 feet per second. If conditions do not meet the isokinetic EWI thresholds, for example during base-flow or low-flow conditions, then sample-collection techniques will be modified and non-isokinetic EWI samples will be collected. The collection of storm samples may be modified depending on hydrological and meteorological conditions. All manually collected discrete samples from both locations will be analyzed for the parameters listed in Table 4.

Event-triggered, automated sampling will occur at identified upstream and downstream monitoring stations shown in Figure 7. Automatic samplers will be installed and configured in accordance with manufacturer specifications and programmed to initiate sampling when preset thresholds are exceeded. Each automatically collected sample will have associated in-stream values of water temperature & pH. However, fouling or optical black-out conditions may result in some parameters reporting unrepresentative data, or no data, at the time of sample collection. Traditional automatic samplers should not be used to collect volatile organic carbons due to degassing of the sample over time. For this reason, only vials from manually collected samples will be submitted to the lab for Total Petroleum Hydrocarbon analysis.

Table 4: Select Constituents for Discrete Water-quality Monitoring

Parameter
Biochemical Oxygen Demand (5 days, 20oC) +
Total Nitrogen
Nitrate plus Nitrite
Total Suspended Solids
Total Petroleum Hydrocarbons*+
Escherichia coli+
Total Lead
Total Copper
Total Zinc
Total Phosphorus
Hardness
Suspended Sediment (optional)
Chloride (optional)

* Applicable to discrete, manual sampling protocols only
+) Single-point sample from center of flow

Discrete sample processing

Collected samples will remain chilled - less than 4°C (degrees Celsius) - and transported on ice for processing at the USGS MD-DE-DC Water Science Center (MD-DE-DC WSC) laboratory in Catonsville, Maryland to avoid environmental contamination. Subsamples of whole water for metals and nutrients will be dispensed first into clean polyethylene bottles, while churning at a constant prescribed rate. Samples for dissolved analysis will then be collected from the churn splitter using a peristaltic pump with an in-line polycarbonate capsule filter [0.45 µm (micrometer) effective pore size]. Samples for whole-water analysis of nutrients require preservation with 1 mL 4.5 N H2SO4 (pH < 2). Samples for particulate and dissolved metals require preservation with 2 mL 7.5N Ultrex HNO3 (sample pH < 2). All processed samples will be chilled to less than 4°C and shipped on ice overnight to the USGS National Water Quality Lab in Denver, Colorado. Separate samples for suspended-sediment concentration will be stored in a cool dark location prior to being shipped to a USGS sediment laboratory for analysis.

Escherichia coli and BOD5 processing

E.coli samples will remain chilled - less than 4°C (degrees Celsius) - and transported on ice for processing and analysis at the USGS MD-DE-DC WSC laboratory. The Colilert-18 bacteria test will be used to obtain in-stream E.coli counts returned in units of Most Probable Number per 100

ml. Samples will be processed using applicable dilutions to provide accurate counts and reduce the chance of having to qualify results. Protocols for bacterial analysis can be found at: http://www.idexx.com/resource-library/water/colilert-procedure-en.pdf.

Samples for biochemical oxygen demand analysis will remain chilled - less than 4°C (degrees Celsius) - and transported on ice for processing and analysis at the USGS MD-DE-DC WSC laboratory. Environmental Protection Agency (EPA) test method 405.1 will be used to quantify Biochemical Oxygen Demand (5 Days, 20°C).

Electronic field forms and sample sheets

Details from site visits for equipment servicing and maintenance will be logged onsite using app-style software. USGS developed Personal Computer Field Form (PCFF) software will be used to log details of every water-quality sample manually or automatically collected. All e-files will be uploaded and archived as .pdf files on a national USGS server that is backed-up regularly.

Quality Assurance and Quality Control

Detection and reporting limits for most monitored constituents fall within a range of milligrams per liter to as low as micrograms per liter (Table 5). These low detection levels require quality assurance/quality control (QA/QC) sampling to ensure in-stream concentrations are not biased by such factors as environmental conditions, contaminated equipment, or sample-collection methods. An adequate QA/QC program, including the collection of replicates and blanks, will be employed to identify, quantify, and rectify any sample bias associated with ambient environmental conditions, sample collection and processing techniques, and analysis. Results from QA/QC sampling will be reviewed and assessed in a timely fashion so that any needed changes can be implemented accordingly. QA/QC planning is dynamic and may need to be adjusted depending on observed levels and nature of any sample bias.

Automatic sample intake efficiency will be quantified by comparing results from EWI and automatic sampling methods. These quality-control samples will be collected simultaneously using both techniques over a range of hydrologic conditions. Constituent concentrations may need to be adjusted using an empirically derived coefficient to remove bias imparted by automatic-sample intake efficiency.

Table 5: Reporting Limits for Discrete Water-quality Monitoring Constituents

Parameter	Reporting Limit
Biochemical Oxygen Demand	2 mg/L
Total Nitrogen	0.06
Total Nitrogen	0.05
Total Particulate Nitrogen	0.06
Nitrate plus Nitrite	0.01
Total Suspended Solids	15 mg/L
Total Petroleum Hydrocarbons	
Benzene	0.1 µg/L
Toluene	0.032 µg/L
Ethylbenzene	0.02 µg/L
Xylene	0.02 µg/L
Escherichia coli	1 MPN/100
Total Lead	
Particulate Lead	0.04 µg/L
Dissolved Lead	0.04 µg/L
Total Copper	
Particulate Copper	0.8 µg/L
Dissolved Copper	0.8 µg/L
Total Zinc	
Particulate Zinc	2.0 µg/L
Dissolved Zinc	2.0 µg/L
Total Phosphorus	0.020 µg/L
Hardness	1 mg/L
Calcium	0.022 mg/L
Magnesium	0.01 mg/L
Strontium	0.8 µg/L
Barium	0.3 µg/L
Suspended Sediment	1 mg/L
Chloride	0.02mg/L

2.2 – Physical Monitoring Methodology

A geomorphic stream assessment will be performed on LCC. An annual comparison of permanently monumented cross sections and stream profile will be executed.

Monumented cross sections will be established during the initial geomorphic assessment. Bank samples, to determine bulk density as well as nutrient content, were taken from upper, mid, and lower bank locations at each cross section location. Permanently monumented cross sections will be established and measured at 6 locations (P-1 through P-6) with stream profiles collected both up and downstream of each cross section. Additionally, the Modified BANCS method will be

performed to quantify predictions of bank recession, pre-construction. Photo documentation will be established using GPS coordinate for each photo. A photo map will be established for visual verification of site conditions (both pre- and post-construction).

At least one additional mobilization is planned immediately ahead of construction to measure final bank recession to quantify sediment and nutrient loss from bank contents. An estimation of total load will be calculated. This last mobilization will be timed immediately prior to construction, which will maximize the time that stream channel changes are being documented.

A hydraulic model using HEC RAS 4.2 (or most current version at that time, if applicable), will be performed on the project reach in the fourth year of monitoring. Land Survey efforts will be performed to collect appropriate cross section locations for acceptable modeling standards. Hydrologic inputs may be from the hydrographs collected during monitoring for unsteady analysis. If this input is not possible, hydrologic results performed for the original analysis (in support of design efforts) will be used. HEC RAS output will be compared to the existing and proposed conditions model from design efforts to inform design intent through velocity, shear, water surface elevations, etc.

Adjustments to the physical monitoring locations may be made to accommodate final design geometry. Stations both upstream (P-1) and downstream (P-5, P-6) will remain in the same location throughout monitoring efforts.

2.3 – Biological Monitoring Methodology

Biological monitoring (benthic macroinvertebrates and physical habitat) will be conducted using the Maryland Biological Stream Survey (MBSS) protocols (DNR, 2014). Sampling will be conducted using a 540 μm mesh D-shaped net within 20, 0.09 m² sub-samples of proportionally available optimal habitat. Twenty sub-samples will be combined into one composite sample and sent to DNR's laboratory where a minimum of 100 organisms will be randomly selected and identified to genus or the lowest practical taxonomic level. A benthic macroinvertebrate index of biotic integrity (BIBI) will be calculated based on these data. Sampling stations will be in 75 meter increments. From the monitoring plan exhibit provided, one station is planned for upstream (site B-1), two within the restoration reach (B-2 and B-3), and two downstream (B-4 and B-5).

3.0 PHASES OF CHEMICAL, PHYSICAL & BIOLOGICAL MONITORING

The phases of this monitoring plan are designated by the year of the plan. Chemical monitoring will occur October 2016 until June 2020. Biological and Physical monitoring will follow separate tracts since they are not continuous efforts. The conceptual schedule by phase is shown below. Adjustments to dates may be required to accommodate construction and other contracting schedules.

MONITORING PHASE	DATE	CONSTRUCTION PHASE
CHEM 1	October 2016 - October 2017	Pre-construction
BIO 1	March 2016	Pre-construction
PHYS 1	April 2015	Pre-construction
CHEM 2	October 2017 - October2018	Construction
BIO 2	Not to be performed during construction	Construction
PHYS 2	Not to be performed during construction	Construction
CHEM 3&4	October 2018 - October2020	Post-construction
BIO 3&4	March 2018 - March 2020	Post-construction
PHYS 3&4	March 2018 - March 2020	Post-construction

Please refer to Figure 7 (next page) for the monitoring plan site map.



MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

NPDES/MS4 ASSESSMENT OF CONTROLS
for
Stream Restoration of Little Catoctin Creek at U.S. 340

FIGURE 7: MONITORING SITE MAP

Frederick County, Maryland

October 9, 2016

1 inch = 300 feet

3.1 - Phases of Chemical Monitoring

Phase CHEM 1: Water-quality monitoring (discrete and continuous) will be carried out prior to the start of restoration efforts in Little Catoctin Creek. CHEM 1 serves to establish a pre-restoration baseline of in-stream physical, chemical, and biological constituent concentrations. CHEM 1 will occur between October 2016 and October 2017.

Phase CHEM 2: Water-quality monitoring (discrete and continuous) will be carried out during restoration efforts of Little Catoctin Creek. CHEM 2 serves to monitor in-stream physical, chemical, and biological constituent concentrations throughout construction. CHEM 2 will occur October 2017 and October 2018.

Phase CHEM 3 & 4: Water-quality monitoring (discrete and continuous) will be carried out after the Little Catoctin Creek restoration is complete. CHEM 3 & 4 serve to establish a new baseline for in-stream physical, chemical, and biological constituent concentrations. This new baseline will be used in an attempt to assess the efficacy of the restoration to improve water quality. CHEM 3 & 4 will occur between October 2018 and October 2020.

Continuous discharge monitoring will be conducted during all four phases (Phase CHEM 1, Phase CHEM 2, and Phase CHEM 3 & 4). Time series of discharge will be used, in part, to compute loads of select constituents across various temporal scales. Discharge monitoring will be conducted under the assumption that there is no appreciable contribution to discharge between the upstream and downstream sites. Therefore, discharge will only be monitored at one location throughout the study.

3.2 - Phases of Biological Monitoring

Phase BIO 1 included pre-construction monitoring of benthic invertebrates (spring index period) and stream habitat assessments for sites B-1 through B-5 (B-1 upstream of the restoration areas; B-2 and B-3 within the restoration areas; B-4 and B-5 downstream of the restoration area). Two additional locations have been sampled by DNR upstream of the restoration areas to serve as added control.

Biological monitoring will not be performed during construction. BIO 3 & BIO 4 will monitor post construction at all established MBSS reaches. BIO 3 may need to be suspended or modified if construction activities overlap the spring index period.

Monitoring reports that include data analysis will be completed annually. Information will be compiled and included in the subsequent annual NPDES Report SHA submits to MDE.

3.3 - Phases of Physical Monitoring

Physical monitoring stations have been established and PHYS 1 data has been collected. Physical monitoring will not be performed during construction. PHYS 3 & 4 will occur after construction.

For PHYS 4, the model described above will be developed to analyze hydrologic/hydraulic effects.

3.4 – Optional Monitoring Efforts Dependent upon Available Funding

SHA recognizes that this overall monitoring effort creates opportunity to collect important information beyond the requirements of the NPDES/MS4 permit. The following describes efforts under consideration if funding is available after permit required activities are allotted budgets.

Groundwater

To better understand the influence of restoration efforts on groundwater, three transects with at least three wells each will be installed pre and post construction to measure stage and content of groundwater. Maximum floodplain area is measured at 12 acres, resulting in one transect per 4 acres. Wetlands on the existing southern floodplain have been delineated and groundwater monitoring will inform success of wetland expansion in the design. At a minimum, SHA will install enough wells (3) to sufficiently document created wetland hydrology (mitigation site protocols).

Groundwater levels will be continuously monitored using date-logging piezometers to measure elevations of subsurface flow in the existing and proposed floodplain areas. Periodic chemical sampling of the groundwater may be taken to determine nutrient and chemical content.

Additional Biological monitoring

SHA will perform biological (benthic macroinvertebrates) and limited physical (stream habitat assessments) monitoring through 2024, corresponding to the first two BMP verification events.

Floodplain sediment accretion monitoring

Transects of artificial markers (clay pads or tiles) will be established to measure short-term net vertical accretion. Sediment samples collected near markers at the beginning and end of each phase may be analyzed for bulk density, size class composition, organic fraction, and sediment texture (particle size). To explore the relation between phosphorus concentrations, particle size, and organic matter select floodplain samples may be submitted for total phosphorus analysis; phosphorus is nutrient known to significantly contribute to eutrophic conditions in aquatic systems. Results will be used to quantify the restoration's ability to significantly enhance active sinking of phosphorous onto the floodplain thus improving the water quality of Little Catoctin Creek.

Water-quality Modeling

The optional modeling objective for this project is to investigate the use of surrogates to estimate concentrations of nutrient, suspended-sediment, and bacteria within Little Catoctin Creek. Ordinary least squares regression analysis will be used to identify which of the above independent variables are significant predictors of total nitrogen, total phosphorus, suspended-sediment, and E. coli concentrations. Equations from this statistical analysis will be used to compute daily, monthly, and annual loads of total nitrogen, total phosphorus, suspended-sediment, and E. coli.

4.0 FIELD DOCUMENTATION

For all PHYS, CHEM, and BIO mobilizations, field logbooks will be maintained, serving as a record of observations during sampling activities. Pages will be numbered sequentially and entries will include:

- *Names of the field crew*
- *Sampling location*
- *Date and time of sample collection*
- *Number and volume of samples collected*
- *Sample identification numbers*
- *Preservatives used*
- *Weather Conditions*
- *Physical Conditions*

5.0 REFERENCES

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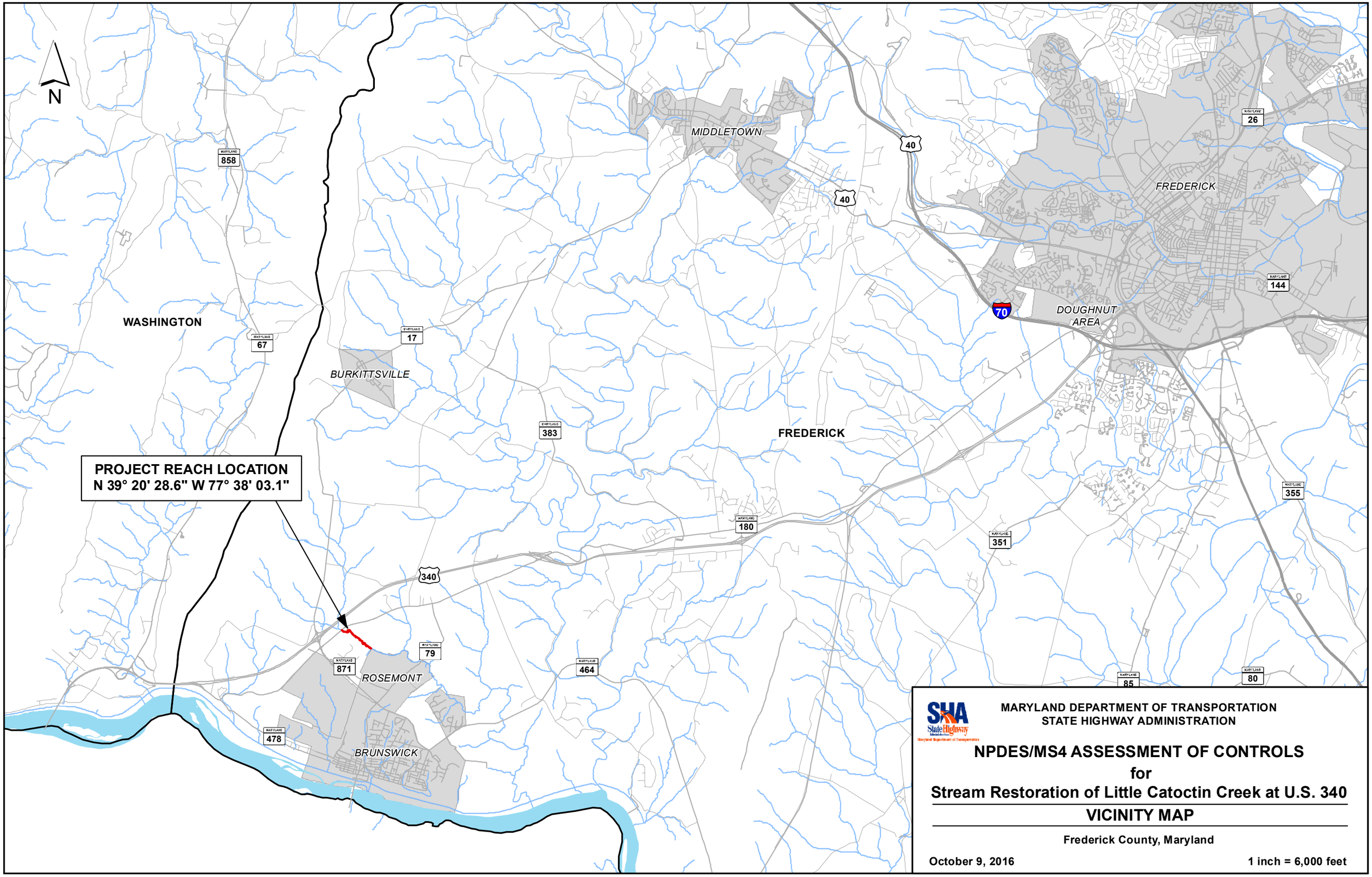

MARYLAND DEPARTMENT OF TRANSPORTATION
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NPDES/MS4 ASSESSMENT OF CONTROLS
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Stream Restoration of Little Catoctin Creek at U.S. 340

VICINITY MAP

Frederick County, Maryland

October 9, 2016

1 inch = 6,000 feet



MARYLAND DEPARTMENT OF TRANSPORTATION
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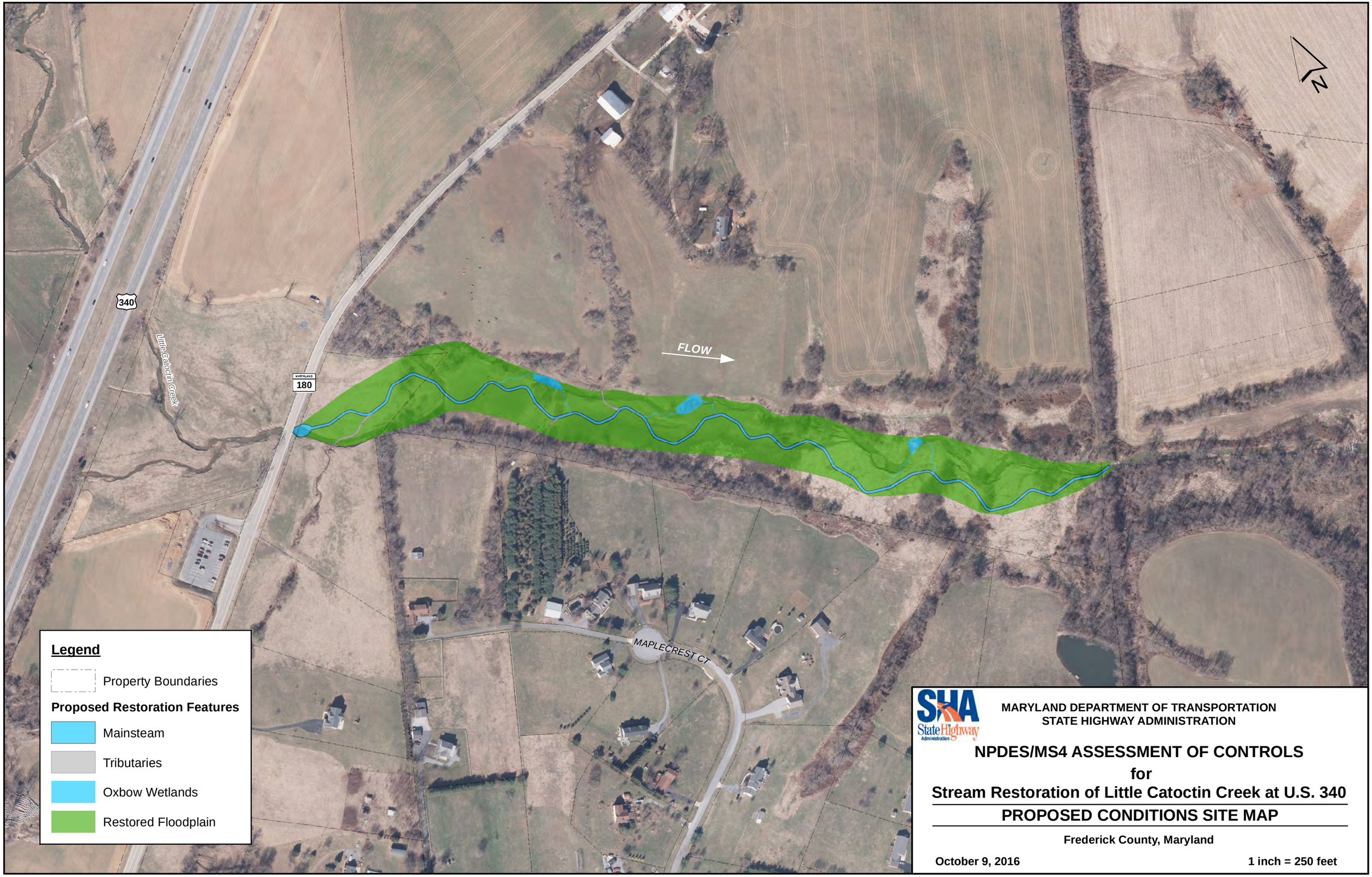
NPDES/MS4 ASSESSMENT OF CONTROLS
for
Stream Restoration of Little Catoctin Creek at U.S. 340
EXISTING CONDITIONS SITE MAP

Frederick County, Maryland

October 9, 2016 1 inch = 250 feet



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NPDES/MS4 ASSESSMENT OF CONTROLS
for
Stream Restoration of Little Catoctin Creek at U.S. 340
PROPOSED CONDITIONS SITE MAP

Frederick County, Maryland

October 9, 2016 **1 inch = 250 feet**

N

MARYLAND 67

MARYLAND 17

MARYLAND 180

MARYLAND 871

MARYLAND 180

340

MARYLAND 79

MARYLAND 871

MARYLAND 180

Legend

Project Reach

Watershed Boundary

Downstream End of Project

To MD 180

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WATERSHED BOUNDARY - 2014

Frederick County, Maryland

October 9, 2016

1 inch = 1,500 feet

N

MARYLAND 17

MARYLAND 180

340

MARYLAND 180

Legend

Project Reach

Watershed Boundary

Downstream End of Project

To MD 180

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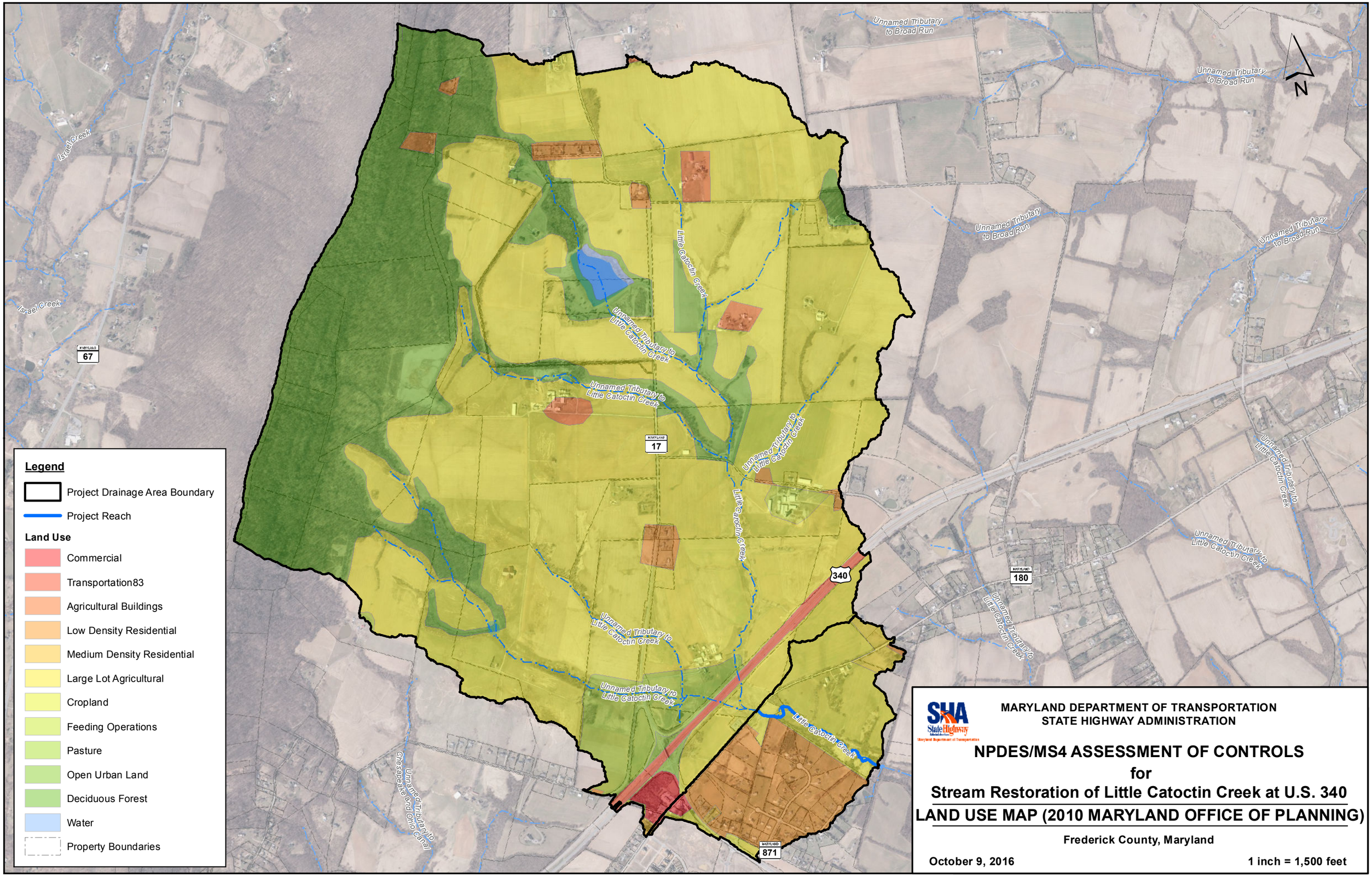
Stream Restoration of Little Catoctin Creek at U.S. 340

WATERSHED BOUNDARY - Dec. 4, 1959

Frederick County, Maryland

October 9, 2016

1 inch = 1,500 feet



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NPDES/MS4 ASSESSMENT OF CONTROLS
for
Stream Restoration of Little Catoctin Creek at U.S. 340
LAND USE MAP (2010 MARYLAND OFFICE OF PLANNING)

Frederick County, Maryland

October 9, 2016

1 inch = 1,500 feet

N

MARYLAND 67

MARYLAND 17

340

MARYLAND 180

MARYLAND 871

Legend

- Project Drainage Area Boundary
- Project Reach

Zoning

- ROW-Right of Way
- R1-Low Density Residential
- GC-Mobile Home Park
- Agriculture
- RC-Resource Conservation
- Property Boundaries

SHA State Highway Administration
Maryland Department of Transportation

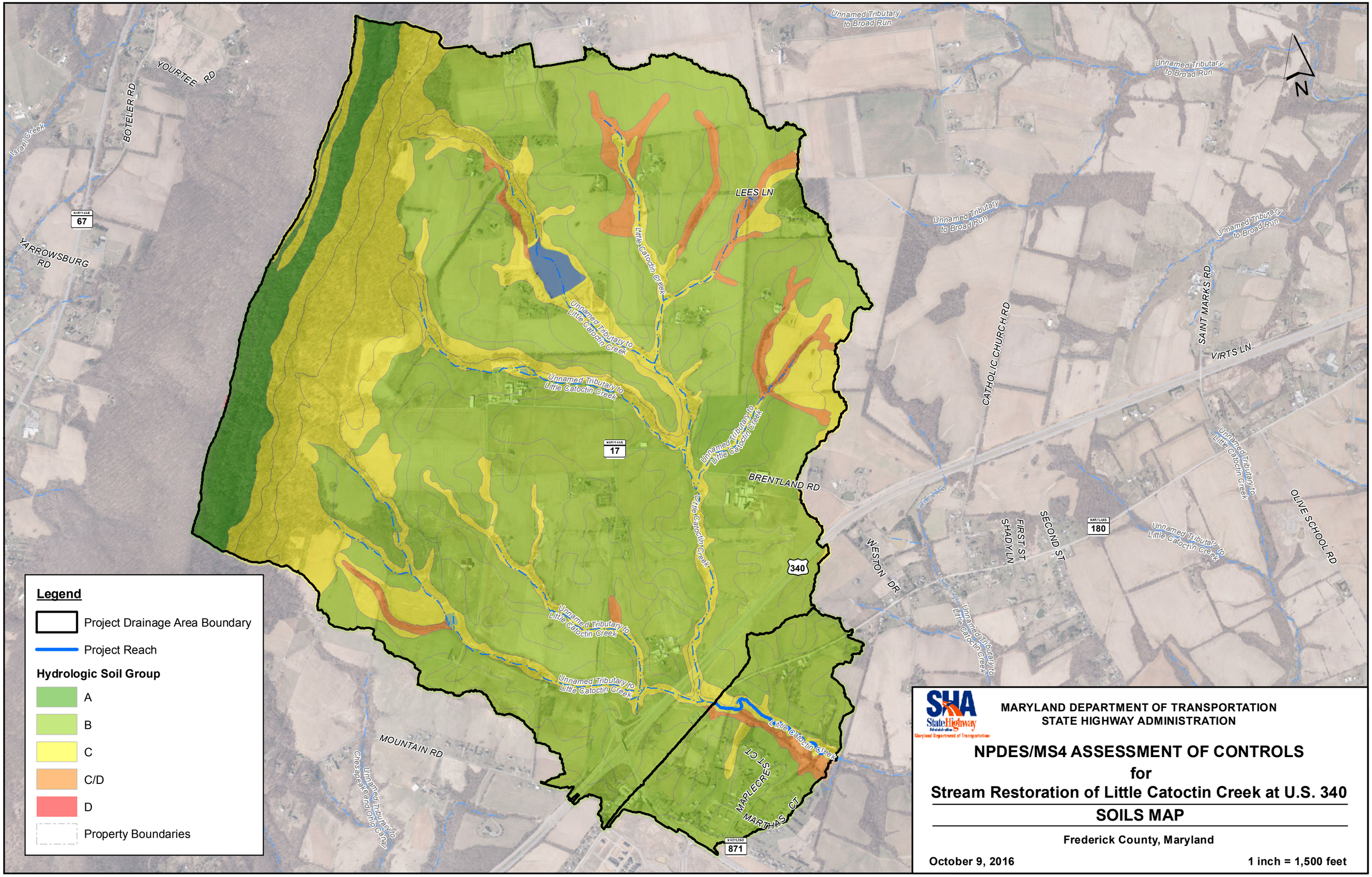
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

NPDES/MS4 ASSESSMENT OF CONTROLS
for
Stream Restoration of Little Catoctin Creek at U.S. 340
ZONING MAP

Frederick County, Maryland

October 9, 2016

1 inch = 1,500 feet



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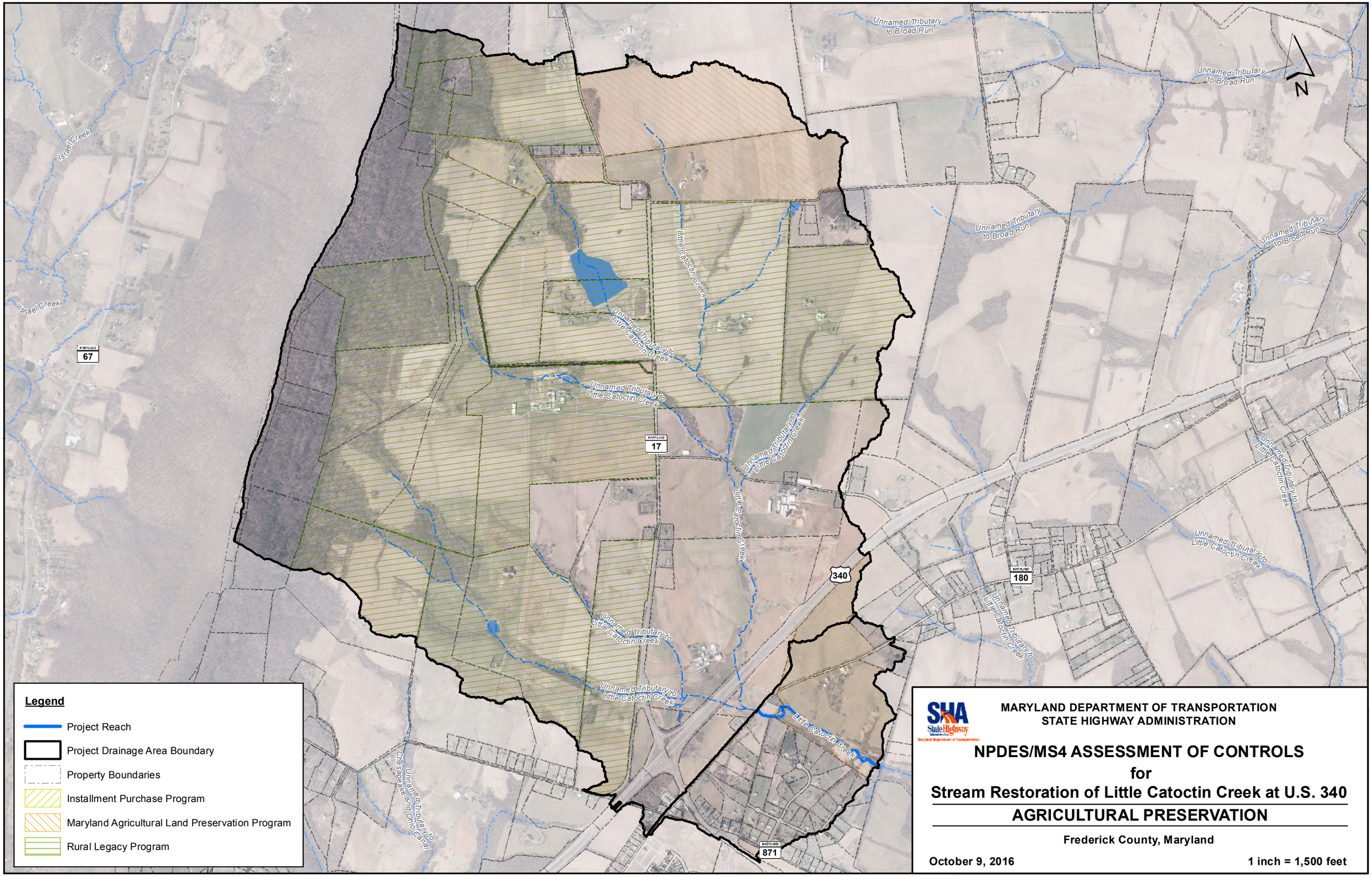
for
Stream Restoration of Little Catoctin Creek at U.S. 340

SOILS MAP

Frederick County, Maryland

October 9, 2016 — 1 inch = 1,500 feet


Unnamed Tributary to Broad Run
Unnamed Tributary to Broad Run
Unnamed Tributary to Broad Run
Unnamed Tributary to Broad Run
Israel Creek
Israel Creek
Little Catoctin Creek
Unnamed Tributary to Little Catoctin Creek
Unnamed Tributary to Little Catoctin Creek
Unnamed Tributary to Little Catoctin Creek
Little Catoctin Creek
Unnamed Tributary to Little Catoctin Creek
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Unnamed Tributary to Little Catoctin Creek
Unnamed Tributary to Little Catoctin Creek
Unnamed Tributary to Little Catoctin Creek
Unnamed Tributary to Little Catoctin Creek
Unnamed Tributary to Chesapeake and Ohio Canal
Little Catoctin Creek
MARYLAND 67
MARYLAND 17
340
MARYLAND 180
MARYLAND 871
N
Legend
Project Reach
Project Drainage Area Boundary
Property Boundaries
Installment Purchase Program
Maryland Agricultural Land Preservation Program
Rural Legacy Program
SHA State Highway Administration
Maryland Department of Transportation
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
NPDES/MS4 ASSESSMENT OF CONTROLS
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AGRICULTURAL PRESERVATION
Frederick County, Maryland
October 9, 2016
1 inch = 1,500 feet

Ridge and Valley Province

Blue Ridge Province

Piedmont Plateau Province

Legend

Project Reach

Project Watershed

Physiographic Region

Catoctin-South Mountain Region

Middletown Valley Region

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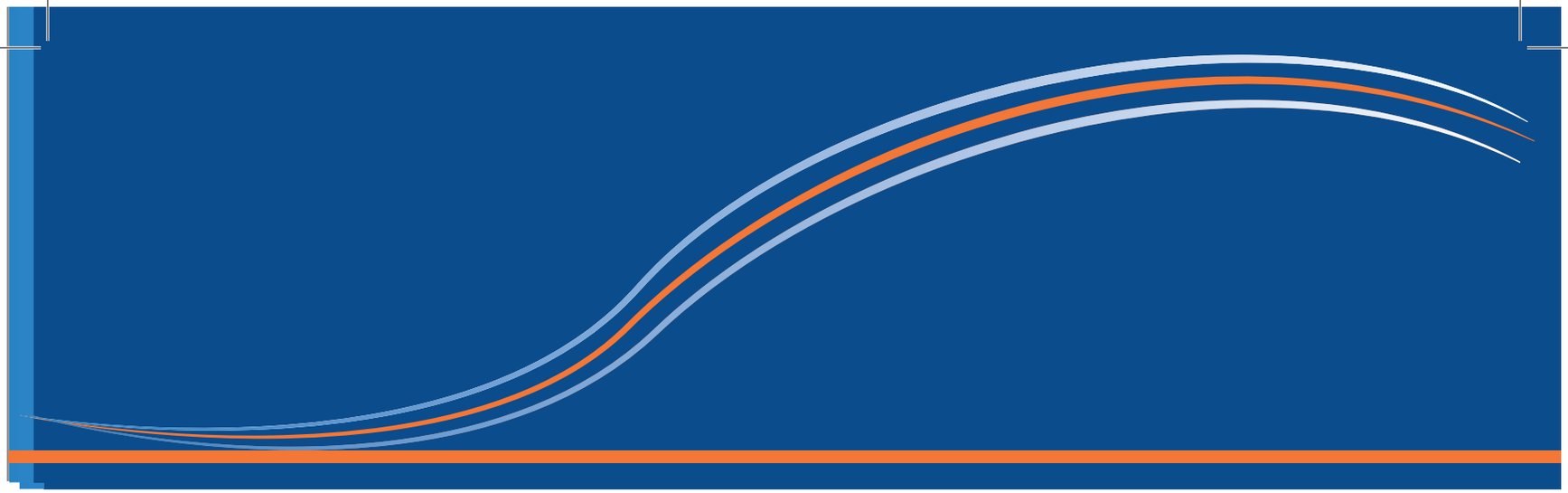
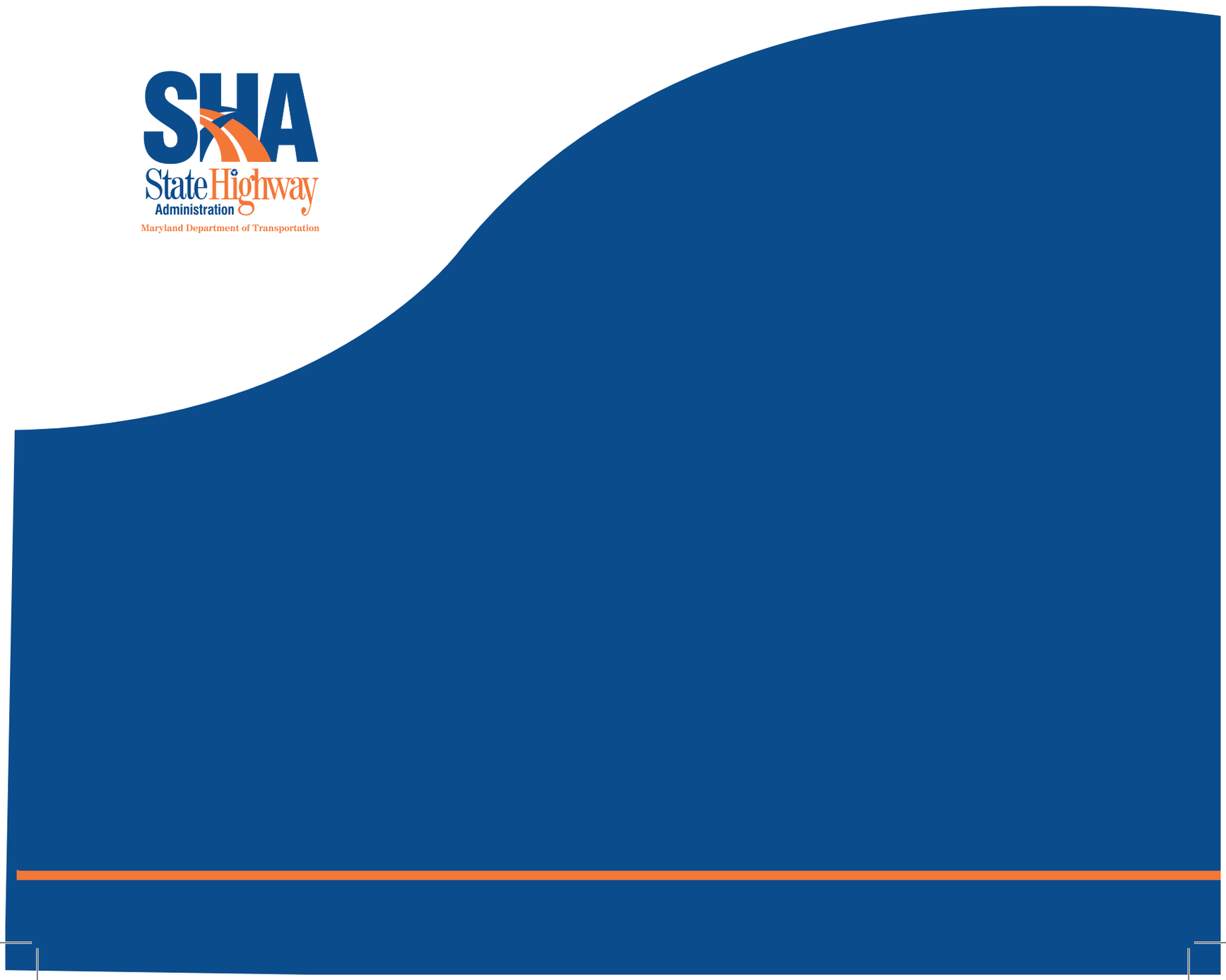
Stream Restoration of Little Catoctin Creek at U.S. 340
PHYSIOGRAPHIC PROVINCE & REGION MAP

Frederick County, Maryland

October 9, 2016

1 inch = 6,000 feet





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State Highway
Administration
Maryland Department of Transportation