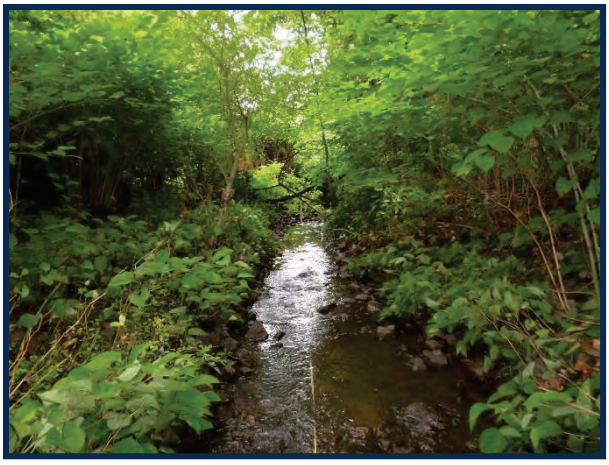
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Municipal Separate Storm Sewer System Discharge Permit
Permit Number MD0068306
Effective Date: February 12, 2014

FISCAL YEAR 2015 ANNUAL REPORT







Anne Arundel County
Department of Public Works
2662 Riva Road
Annapolis, Maryland 21401

February 12, 2016

2015 Annual Report for
Anne Arundel County
Storm Water National Pollutant
Discharge Elimination System

Permit Number MD0068306

Submitted to:

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

February 2016



Submitted by:
Anne Arundel County
Department of Public Works
2662 Riva Road
Annapolis, MD 21401



Prepared by:



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I. PURPOSE AND SCOPE

This Annual Report was assembled to detail the activities in Anne Arundel County for the County and State Fiscal Year (FY) beginning July 1, 2014 and ending June 30, 2015. These activities demonstrate compliance with the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit terms provided by 40 CFR 122.42(c). It describes the components of the stormwater management program and the associated implementation status. The County proposes no revision to the program at this time.

This report also summarizes the monitoring programs implemented by Anne Arundel County, including data collection and analysis. Digital data and specific reports for the major programs conducted during the reporting term can be found within the report's **Appendices**, which are provided in electronic format on the enclosed DVD. Digital data found in **Appendix A** is submitted in the format consistent with Attachment A to the Permit and Appendix B of the August 2014 document entitled *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated: Guidance for National Pollutant Discharge Elimination System Stormwater Permits (MDE 2014)*.

On February 12, 2014 the County was issued a new, Fourth-Generation, NPDES MS4 Permit. This report is the second Annual Report prepared under that permit.

II. IMPLEMENTATION STATUS – STORMWATER MANAGEMENT PROGRAM

Components of Anne Arundel County's stormwater management program were established to address the requirements outlined in the County's NPDES MS4 permit. The major components also address stormwater Waste Load Allocations (WLAs) associated with Total Maximum Daily Loads (TMDLs), and overall water quality improvement within the County's waterways. Program components include:

- Storm Drain Infrastructure and Impervious Area Inventory;
- Erosion and Sediment Control Program;
- Stormwater Management Program;
- Illicit Connection Detection and Elimination;
- Litter and Floatables;
- Management and Maintenance of County-owned Facilities (e.g., roads, parking lots);
- Public Education and Outreach;
- Watershed Assessment;
- Watershed Restoration Plans;
- TMDL Compliance;
- Watershed Restoration Assessment;
- Stormwater Management Assessment; and
- Program Funding.

The County feels the above programs address the major water quality concerns within County watersheds. Monitoring efforts have shown that the implementation of these programs results in the improvement of water quality, which motivates the County to continue its dedication to these programs. Efforts in these program areas during the reporting period are addressed under the appropriate permit conditions in **Part IV** of this report.

III. WATER QUALITY

The NPDES MS4 Permit issued to Anne Arundel County in February 2014 requires implementation of a stormwater management program to effectively prohibit pollutants in stormwater discharges, to attain applicable WLAs as set forth in approved TMDLs, and to comply with all provisions of the permit. Compliance with permit conditions shall constitute compliance with the Clean Water Act (§402(p)(3)(B)(iii)) and adequate progress toward compliance with Maryland's water quality standards and any U.S. Environmental Protection Agency (EPA) approved stormwater WLAs.

Anne Arundel County endeavors to manage, implement, and enforce a stormwater management program in accordance with the Clean Water Act and corresponding NPDES regulations. The activities undertaken in support of permit compliance, and documented herein, show progress toward reducing pollutants in stormwater discharges, prohibiting unauthorized discharges to the County's storm drain system, and attaining stormwater WLAs for established TMDLs.

IV. STANDARD PERMIT CONDITIONS

A. Permit Administration

Anne Arundel County shall designate an individual to act as a liaison with the Maryland Department of the Environment (MDE) for the implementation of this permit. The County shall provide the coordinator's name, title, address, phone number, and email address. Additionally, the County shall submit in its annual reports to MDE an organizational chart detailing personnel and groups responsible for major NPDES program tasks in this permit. MDE shall be notified of any changes in personnel or organization relative to NPDES program tasks.

Status:

Coordination of Anne Arundel County's NPDES MS4 Permit was performed by the Department of Public Works (DPW) Watershed Protection and Restoration Program (WPRP) for FY2015 (1 July 2014 – 30 June 2015). The program coordinators during this reporting year are:

Ms. Ginger Ellis
Environmental Planning Administrator
Watershed Protection and Restoration Program
Anne Arundel County Department of Public Works
2662 Riva Road, MS 7409
Annapolis, MD 21401
410-222-4240
pwelli16@aacounty.org

Ms. Janis Markusic
Program Manager/Senior Planner
Watershed Protection and Restoration Program
Anne Arundel County Department of Public Works
2662 Riva Road, MS 7409
Annapolis, MD 21401
(410) 222-4240
pwmark02@aacounty.org

Figure 1 shows the County's organizational chart for FY 2015. Several new positions were added within the Watershed Protection and Restoration Program (WPRP) structure to support compliance with the MS4 Permit. Information on specific positions and personnel responsible for permit compliance and stormwater program tasks follows.

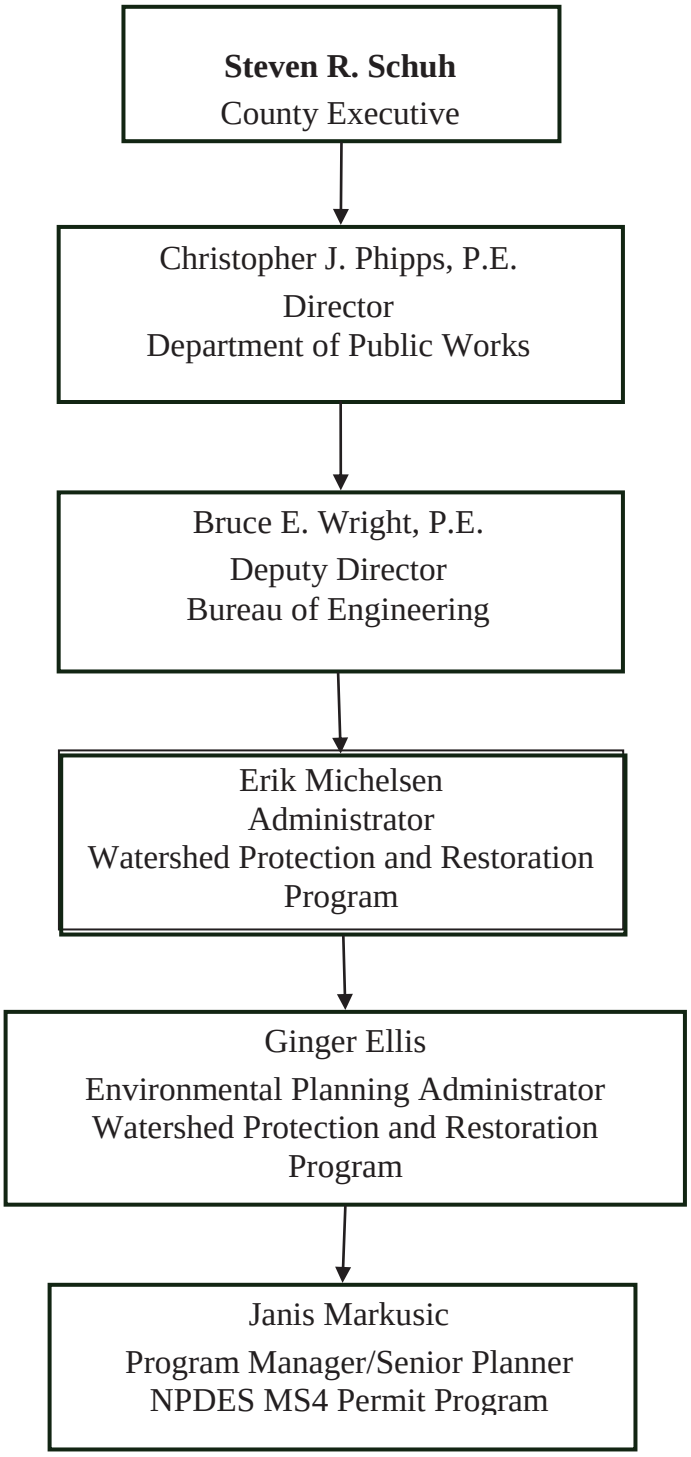


Figure 1. Organization Chart for NPDES Permit Administration (7/2014 through 6/2015)

Additional County staff members responsible for components of the NPDES MS4 Permit requirements during FY2015 are listed below.

Department of Public Works:

- Doug Burkhardt, Engineer Manager
  Bureau of Engineering, Technical Engineering
  Provides managerial support and oversight for geographic information systems (GIS) data collection and geodatabase development activities associated with urban best management practices (BMPs) and closed storm drain system records.

- Ramzi Bannura, Program Manager
  Bureau of Highways, Infrastructure Management Division
  Programs and maintains GIS databases for the closed storm drain system, associated infrastructure databases, and the County's roads inventory.

- Darryl Hockstra, Engineer Manager
  Bureau of Highways, Infrastructure Management Division
  Administers the Infrastructure Management Division and oversees the capital program associated with stormwater management pond inspection and repair; and emergency storm drain and stormwater system inspection and repair.

- Andy Watcher, Senior Engineer
  Bureau of Highways, Infrastructure Management Division
  Administers Inspection Program for publicly owned storm drain infrastructure and manages storm drain system repair program

- Ken Pensyl, Engineer III
  Bureau of Highways, Infrastructure Management Division
  Inspects publicly owned storm drain infrastructure and oversees public stormwater management inspection staff.

- Rick Davis, Engineer III
  Bureau of Highways, Infrastructure Management Division
  Northern District storm drainage and culverts project manager

- Robert Savidge, Engineer III
  Bureau of Highways, Infrastructure Management Division
  Southern District storm drainage and culverts project manager

- Ron Rose, Construction Inspector Supervisor, Northern District
  Bureau of Highways, Infrastructure Management Division
  Investigates storm drainage complaints and provides construction inspection services for drainage projects in the northern district

- Clark Rosendale, Construction Inspector Supervisor, Central & Southern Districts
  Bureau of Highways, Infrastructure Management Division
  Investigates storm drainage complaints and provides construction inspection services for drainage projects in the central and southern districts

- Chuck Henney, Program Specialist II
  Bureau of Highways, Infrastructure Management Division
  Investigates BMP and SWM pond complaints and provides construction inspection services for resulting projects

- Rich Olsen, Program Specialist II
  Bureau of Highways, Infrastructure Management Division
  Inspects and maintains a subset of urban stormwater BMPs that are the responsibility of DPW.

- Alex Baquie, Assistant Chief Road Operations
  Bureau of Highways, Road Operation Division
  Administers the County's Road Operation Division; maintains the Bureau's permit coverage under the MDE General Permit No. 12-SW (General Discharge Permit for Stormwater Associated with Industrial Activity); develops and implements Stormwater Pollution Prevention Plans (SWPPPs) associated with Road Operations district yard facilities; documents the use of pesticides, herbicides, fertilizers, and de-icing materials associated with road maintenance activities; implements the County's street sweeping and inlet cleaning programs; conducts roadside litter clean-up activities; and provides support for volunteer watershed and stream clean-up activities.

- Raghu Badami, Engineer Manager
  Bureau of Engineering, Watershed Protection and Restoration Program
  Administers the Modeling and Analysis Unit responsible for providing water quality, pollutant loading, and impervious area data management, analysis, tracking and reporting for NPDES MS4 permit, TMDL and the County's Phase II Watershed Implementation Plan (WIP); and Stormwater Remediation Fee oversight and support.

- Rick Fisher, Senior Engineer
  Bureau of Engineering, Watershed Protection and Restoration Program
  Administers the Watershed Assessment Program; manages watershed assessment contracts; manages the technical engineering and water quality models in support of NPDES MS4 Permit activities, individual TMDL compliance, and the Phase II WIP; coordinates data, tracking, and reporting of impervious surface reduction and pollutant load credit; manages the County's impervious surface and land cover GIS layers; and documents the locations and descriptions of watershed restoration projects.

- Jeff Cox, Engineer III
  Bureau of Engineering, Watershed Protection and Restoration Program
  Maintains, updates, and provides quality control of GIS data layers (e.g., impervious surfaces, land cover) that support the engineering and water quality models utilized for supporting NPDES MS4 and TMDL Restoration Plan activities.

- Melissa Bragg, GIS Specialist
  Bureau of Engineering, Watershed Protection and Restoration Program
  Provides GIS analysis to support the engineering and water quality models utilized for supporting NPDES MS4 and TMDL compliance activities. Maintains, updates and provides quality control of GIS data.

- Lisa Fraley-McNeal, Program Specialist II,
  Bureau of Engineering, Watershed Protection and Restoration Program
  Provides program management support to the Modeling and Analysis Stormwater Remediation Fee Unit carrying out assignments related to fee assessment, appeals and credit processing and tracking, and stormwater Best Management Practice (BMP) performance review.

- Jason Torres, GIS Specialist,
  Bureau of Engineering, Watershed Protection and Restoration Program
  Assists the Modeling and Analysis Stormwater Remediation Fee Unit with researching and tracking fee assessment, appeals and credits.

- Sheri Lott, Engineer Manager
  Bureau of Engineering, Watershed Protection and Restoration Program
  Administers the CIP Restoration Project Implementation unit responsible for design and construction of WPRP restoration projects.

- Nasrin Dahlgen, Engineer III
  Bureau of Engineering, Watershed Protection and Restoration Program
  Manages design and construction of watershed restoration projects.

- Erica Jackson, Engineer III
  Bureau of Engineering, Watershed Protection and Restoration Program
  Manages design and construction of watershed restoration projects.

- Khadija Abdur-Rahman, Engineer III
  Bureau of Engineering, Watershed Protection and Restoration Program
  Manages design and construction of watershed restoration projects.

- Dennis McMonigle, Engineer III
  Bureau of Engineering, Watershed Protection and Restoration Program
  Manages design and construction of watershed restoration projects.

- Ken Weeks, Engineer III
  Bureau of Engineering, Watershed Protection and Restoration Program
  Manages design and construction of watershed restoration projects.

- Masoud Ghatineh, Senior Engineer
  Bureau of Engineering, General Engineering
  Manages design and construction of watershed restoration projects as required through the County's tidal waters dredging program.

- Chris Victoria, Planner II
  Bureau of Engineering, Watershed Protection and Restoration Program
  Provides consultant oversight for stormwater monitoring, biological monitoring, and geomorphic assessment of County stream reaches including those identified in **Part F** of this permit. Assists Program Manager with implementation of the Illicit Discharge Detection and Elimination (IDDE) Program as identified in **Part D.3** of this permit.

- Robb Fish, Program Specialist II
  Bureau of Engineering, Watershed Protection and Restoration Program
  Fulfills the public education and outreach requirements of the County's NPDES MS4 permit ensuring that continual outreach to the public regarding the development of its watershed assessments and restoration plans is achieved and public input is solicited and incorporated.

- Kim Cluney, Management Assistant II
  Bureau of Engineering, Watershed Protection and Restoration Program
  Provides management, oversight and accountability for all revenue and expenditures associated with the Watershed Protection and Restoration Fund (WPRF). Ensures that the integrity of the dedicated revenue fund and structure is maintained to support compliance with the MS4 permit.

- Kurt Svendsen, Management Assistant I
  Bureau of Engineering, Watershed Protection and Restoration Program
  Serves as office manager for the WPRP responsible for the oversight and execution of the division's operating budget.

- Maria Ramallosa, Financial Clerk II
  Bureau of Engineering, Watershed Protection and Restoration Program
  Supports the Financial Management Assistants in tracking revenues and expenditures associated with the WPRF, processing procurements for restoration work, and maintaining established reports to ensure Fund integrity.

- Christian Tait, Program Manager, Regulatory Compliance Officer
  Bureau of Utility Operations
  Responsible for maintaining the Utilities Operations facilities' permit coverage under the MDE General Permit No. 12-SW (General Discharge Permit for Stormwater

Associated with Industrial Activity) and the development/implementation of SWPPPs associated with Water Reclamation Facilities.

- Rhody Holthaus, Assistant Director
  Bureau of Waste Management Services
  Responsible for ensuring implementation of the Waste Management Services facilities' permit coverage under the MDE General Permit No. 12-SW (General Discharge Permit for Stormwater Associated with Industrial Activity) for the County's three landfill facilities.

- Chandra Chithaluru, Environmental Monitoring Manager
  Bureau of Waste Management Services
  Responsible for maintaining the Waste Management Services facilities' permit coverage under the MDE General Permit No. 12-SW (General Discharge Permit for Stormwater Associated with Industrial Activity), and for the development and implementation of SWPPPs associated with the County's three landfill facilities.

Office of Planning & Zoning:

- Chris Soldano, Assistant Planning & Zoning Officer
  Development Division
  Oversees components of the County's Stormwater Management Program to ensure consistency with State requirements, including the updating of County stormwater legislation and of the County's Stormwater Practices and Procedures Manual.

- David Braun, Chief Engineer
  Development Division
  Oversees the review of stormwater management on new development and redevelopment projects.

Department of Inspections & Permits:

- Eva Kerchner, Assistant Director
  Oversees components of the County's Erosion and Sediment Control Program and Stormwater Management Program that are the responsibility of the Department of Inspections and Permits

- John Peacock, Chief of Environmental Enforcement
  Environmental Programs
  Administers the County's Stormwater Management Program and the County's Erosion and Sediment Control Program to ensure compliance with State regulations. Tracks, inspects, and enforces all permits for private and public stormwater management BMPs related to new development and redevelopment projects. Oversees triennial inspection of stormwater BMPs. Tracks development projects disturbing more than one acre and reports this information to MDE as required by the Program

and the NPDES MS4 Permit. Oversees staff who respond to County Environmental Compliance Hotline and provides follow-up enforcement for IDDE Program.

- Stephen Trumpler, Environmental Programs Supervisor
  Manages stormwater inspection staff responsible for inspecting private stormwater BMPs.

  - Stormwater Inspection Staff
    During FY14 and into FY15 the County hired new stormwater management program inspectors bringing the total number of dedicated inspectors to six (6). Those inspectors are:

Gerry Inglesby	Bradlee Burnham
Ron Walters	Joseph Maxwell
Mike Schindler	Dennis Gills

Anne Arundel Soil Conservation District:

- John Czajkowski, District Manager
  Oversees development plan review for erosion and sediment control compliance.

Anne Arundel Department of Health:

- Don Curtian, Deputy Director
  Bureau of Environmental Health
  Oversees the Housing and Food Protection Services and Sanitary Engineering divisions of the Environmental Health Bureau, including Environmental Sanitarian response to hotspots associated with food service facilities that are identified through the IDDE program. Oversees programs associated with administering the Bay Restoration Fund within the County, and recreational water quality monitoring at designated bathing beaches.

B. Legal Authority

Anne Arundel County shall maintain adequate legal authority in accordance with NPDES regulations 40 CFR Part 122.26 throughout the term of this permit. In the event that any provision of its legal authority is found to be invalid, the County shall notify MDE within 30 days and make the necessary changes to maintain adequate legal authority. All changes shall be included in the County's annual report.

Status:

Anne Arundel County maintains the authority to comply with the terms of this permit. As documented in prior Annual Reports, this includes implementation of the 2000 Maryland Stormwater Design Manual (MDE 2000) as well as the 2007 Stormwater Management Act. The County Code has been revised to incorporate these stormwater management requirements, and subsequently renumbered, over the past 10 years. As of November

2010, Article 16 of the County Code contains the stormwater management program and erosion and sediment control regulations. Article 17 contains the subdivision and development requirements. Article 18 contains the zoning regulations. A copy of the final approved implementing legislation and other associated documentation was provided in a prior years' Annual Report.

During FY15, MDE conducted a triennial review of the County's stormwater management program and found the program to be acceptable. Recommendations regarding non-legislative actions were included in the review summary document, but there were no changes or recommended modifications pertained to the County's legal authority to implement this program.

The County Stormwater Management Practices and Procedures Manual was updated and became effective on November 22, 2010. A letter was received from MDE in September 2011 stating that Article 16 and the County Stormwater Management Practices and Procedures Manual have been approved. During FY15, revisions to the Rapid Stream Assessment protocols and the Stormwater Management Data Sheet were made. Documentation of these revisions is attached (**Appendix B**).

The State's biannual review of the County's delegated erosion and sediment control program was conducted in during FY15. As a result of this review, the County was required to update the erosion and sediment control ordinance to maintain delegation of authority. The County introduced a revised ordinance for County Council approval in July 2015 (Bill #83-15). The legislation was approved in late September 2015 and became effective on November 13, 2015. A copy of the approved and signed legislation was provided to MDE in October 2015 and the County's delegation of authority for this program was subsequently continued through June 30, 2017. See **Appendix B**.

Also updated during the reporting period was the County Floodplain Code. This portion of County code was modified via Bill #9-15 to comply with the most recent State legislative changes and associated new floodplain maps. See **Appendix B**.

As reported in the 2014 Annual Report, Anne Arundel County established a Watershed Protection and Restoration Program in 2013 as mandated by §4-202.1 of the Environment Article of the State Code for the purpose of supporting compliance with the requirements of the County's NPDES MS4 permit, the Chesapeake Bay TMDL, local watershed TMDLs, and stormwater WIPs through stormwater management practices and stream and wetland restoration activities. The Program also maintains and administers the Watershed Protection and Restoration Special Revenue Fund established under Article 13. Title 7. §4-11-119 of the Anne Arundel County Code. During FY15 no changes were made to this enabling legislation.

The entire County Code, including Articles 13, 16, and 17, can be found online through the County website at http://www.aacounty.org/CountyCode/index.cfm, under the link for the County Code.

C. Source Identification

Sources of pollutants in stormwater runoff countywide shall be identified and linked to specific water quality impacts on a watershed basis. The source identification process shall be used to develop watershed restoration plans. The following information shall be submitted annually for all County watersheds within the permit area in geographic information system (GIS) format with associated tables as required in PART V of this permit.

1. ***Storm drain system: all infrastructure, major outfalls, inlets, and associated drainage areas delineated;***

Status:

In 2008, Anne Arundel County completed a Countywide inventory of storm drain inlets, manholes, outfalls, culverts, and pipes for all County watersheds. In 2015, the County continued to capture updates for incorporation into the County storm drain maps and the County GIS. Furthermore, the County continues to populate the drainage area information for the County outfalls, following the watershed study schedule as presented in **Part IV.E** of this permit. To maintain accuracy of the closed storm drain system mapping, the County has been conducting a re-inspection of the Countywide system on a regular basis. The storm drain inlet and outfall database was prepared in the format required by MDE and is included in **Appendix A.**

The County is able to identify which storm drain structures are outfalls by querying the GIS for structures with no hydraulic connection to any other structure downstream. The County then focuses on these discharge points for delineation of contributing drainage area. As of June 30, 2015, there are a total of 5,567 closed storm drain outfalls in the County. As reported previously, the County has the ability to delineate drainage areas using desktop GIS ArcHydro model and assess hydrologic conditions at any storm drain outfall within the County. Currently, delineation of drainage areas to all storm outfalls within ten of the twelve County watersheds (Severn River, South River, Upper Patuxent, Magothy River, Patapsco Non-Tidal, Patapsco Tidal, Bodkin Creek, Little Patuxent, Rhode River, and West River) have been completed. This drainage area coverage constitutes 4,812 structures out of the total 5,567 closed storm drain outfalls.

Regarding the number of major outfalls in the County, it should be noted that there was an error in the total number of major outfalls reported in the 2014 Annual Report. The number of major outfalls for the 2014 reporting period should have been 2,018. The discrepancies in the 2014 reported values are a result of inadvertently not including 16 new major outfalls identified in 2013 and 592 existing major outfalls draining commercial and industrial land uses.

For FY2015, the County closed storm drain system includes 2,046 major outfalls. As noted above, the County continually reviews and edits the storm drain geospatial coverage to maintain accuracy. In FY15, this ongoing maintenance resulted in 9 outfalls being removed from the major outfall inventory. This was due to identification of duplicate records, incorrectly attributed features, and the removal of storm drain structures that were proposed but never built. The total number of major outfalls reported for FY15 (2,046) is now accurate and includes previously identified major outfalls as well as newly identified major outfalls in FY15.

Regarding storm drain inlets, in 2014 the County reported 35,551 inlets. In FY15, the total number of storm drain inlets is 35,105 storm drain inlets. Through ongoing review and maintenance of the geospatial coverage, 446 inlets have been removed from the County's inventory due to reasons mentioned above.

In 2015, the County completed the delineation of drainage areas to all outfalls within the West and Rhode River Watersheds**.** A GIS layer containing outfalls and the drainage areas for the Severn, South, Magothy, Upper Patuxent River, Patapsco Non-Tidal, Patapsco Tidal, Bodkin Creek, and Little Patuxent Watersheds were provided in the 2007, 2008, 2009, and 2010 reports. The GIS layer will be reviewed and updated on an annual basis, and as a result of re-inspections, to reflect future development and retrofits. During the last fiscal year, the County identified 37 new major outfalls. The drainage areas for these new outfalls have been delineated and added to the inventory of major outfall drainage areas submitted in **Appendix A**.

The County will continue to develop and report drainage areas for outfalls as the watershed assessments are completed.

2. <u>Industrial and commercial sources</u>: industrial and commercial land uses and sites that the County has determined have the potential to contribute significant pollutant:

Status:

The NPDES MS4 Permit requires that sources of pollutants in stormwater runoff be identified and linked to specific water quality impacts on a watershed basis. Compliance with this permit requirement includes the annual submittal, in GIS format with associated tables, of the "…industrial and commercial land uses and sites that the County has determined have the potential to contribute significant pollutants." A methodology for determining these land uses is described below. The data and GIS coverage are found in **Appendix A**.

Attachment 2 to the Basis for Final Determination to Issue Anne Arundel County's NPDES MS4 Permit (11-DP-3316; MD0068306) is a memorandum from the U.S.EPA to MDE dated November 29, 2012. This memorandum lists

specific objections to draft language proposed for the 4th generation NPDES MS4 Permits. Specific to the development of the above methodology, is a paragraph on Page 4 of this memorandum that addresses Industrial/Commercial Monitoring as a component of the MS4 permit. In this paragraph, EPA objects to the permit on the basis that it does not require the permittee to maintain an inventory of industrial and commercial sites having the potential to contribute pollutants to the storm drain system. EPA proposes the language (above) included in the permit as part of the Source Identification Section (**Part IV.C.2**), further indicating that these identified sites correlate to the required visual surveys of commercial and industrial areas that are conducted under the Illicit Discharge Detection and Elimination (IDDE) program as described in the NPDES MS4 Permit (**Part IV.D.3**)

Page 6 of the Anne Arundel County NPDES MS4 Permit Fact Sheet, developed by MDE as a companion document to the Permit, describes requirements for an effective IDDE program. Included in this program description, is the requirement that the County routinely survey commercial and industrial areas, and monitor major storm drain outfalls to identify illicit discharges. Major storm drain outfalls are defined by the Clean Water Act (40 CFR 122.26) as:

> A municipal separate storm sewer outfall that discharges from a single pipe with an inside diameter of 36 inches or more or its equivalent (discharge from a single conveyance other than circular pipe which is associated with a drainage area of more than 50 acres); or for municipal separate storm sewers that receive storm water from lands zoned for industrial activity (based on comprehensive zoning plans or the equivalent), an outfall that discharges from a single pipe with an inside diameter of 12 inches or more or from its equivalent (discharge from other than a circular pipe associated with a drainage area of two acres or more).

To meet the **Part IV.C.2** requirement of identifying commercial and industrial land uses and sites that have the potential to contribute pollutants to the storm drain system, and to correlate this requirement with that found in **Part IV.D.3.b**, the County has developed a GIS coverage and geodatabase predicated on intersecting the following GIS layers and data:

- Industrial and commercial polygons from Anne Arundel County 2011 Land Cover
- County closed storm drain system inlets, pipes, and outfalls

Specifically, inlets in designated Industrial and Commercial land cover polygons were identified and the closed storm drain pipes intersecting these inlets were selected. Closed storm drain pipes connecting to the already selected pipes were also selected to provide the closed storm drain system network connected to the chosen inlets. Once this network was identified, the outfalls intersecting the

closed storm drain pipes were selected. All outfalls not meeting the definition of a "major outfall" were removed from the selected set of outfalls. This resulted in 896 outfalls that would drain Commercial and Industrial lands in the County as reported in the 2014 Annual Report. In 2015 Anne Arundel County updated this list to include 33 new major outfalls draining Commercial and Industrial lands, bringing the total to 929 outfalls. These outfalls are a subset of the major outfalls GIS layer found in **Appendix A** of this report.

3. ***Urban best management practices (BMPs): stormwater management facility data including outfall locations and delineated drainage areas;***

Status:

During FY15, the Anne Arundel County Department of Inspection and Permits (I&P) maintained the Urban BMP Database which contains information related to all stormwater management BMPs within County's jurisdiction.

The Urban BMP Database is provided in **Appendix A**. The County is continuing efforts to improve the quality of the data in this database and addressing the required enhancements associated with the August 2014 guidance (MDE 2014). To that end, efforts to update a subset of BMP facility data began during the reporting year. Those efforts will be combined with a much more comprehensive County/Consultant effort – Urban Stormwater BMP Database: Historic Record Review and Update – that will begin in the latter half of FY2016. A copy of the scope of work for this effort is attached to this report (**Appendix C)**. The County anticipates issuing a Notice to Proceed to a qualified consultant no later than 30 June 2016 and completing Phase I of the project by the end of FY2017.

For FY15, the total number of BMP records in the database increased by 1,144 to 11,597. All but five of these records have either an approval or a built date and, of those five, two were inspected in 2012. The review and update of historic BMP records will include research into these BMPs and review/confirmation of approval, built date, and inspection data. The County has updated the structure type of all existing BMPs to comply with the latest MDE guidance on urban BMP data reporting (MDE 2014).

BMP drainage area delineations for ESD techniques and practices follow the Point of Investigation (POI) guidance; the POI contains the drainage area of all BMPs to that study point. As the database is not yet fully compliant with the new MDE Geodatabase, POI drainage area has been referenced to one particular BMP within the POI, and all BMPs within the POI have been referenced in the comments section of that BMP. In other words, there is not a one-to-one match between new drainage areas and BMPs (i.e., many new drainage areas contain multiple BMPs – 437 polygons encompass 820 BMPs), and the drainage area and impervious area calculations provided are for the overall polygons. The associated geodatabase and shapefile (Table B) for this section will denote the drainage area

and impervious area values for the larger polygon on one of the BMP records and a note in the General Comments field that lists all other BMPs included in that drainage area and impervious area value (e.g., "Area Includes AA13021 - AA13024"). Similarly for each of the other effected BMPs, the affected drainage area and impervious area values were set to 0 (or null) and the General Comments field for those records will be appropriately annotated (e.g., "Area included in AA13021 with AA13021 – AA13024").

4. ***<u>Impervious surfaces</u>: public and private land use delineated, controlled and uncontrolled impervious areas based on, at a minimum, Maryland's hierarchical eight-digit sub-basins;***

Status:

During FY15, the County continued efforts to maintain an accurate impervious surface dataset.

- As previously reported, the County initiated a contract with Axis Geospatial in spring of 2014 to update the Countywide impervious surface and land cover datasets utilizing imagery captured during spring 2014 for the state of Maryland's High Resolution Aerial Ortho-photography. The impervious surface dataset has been completed and accepted by the County; the land cover data set is pending completion.
- Impervious surface calculations for this reporting year are based on the updated 2014 impervious surface layer. It should be noted that the total impervious surface acreage has increased by 3,103 acres since the 2011 impervious surface dataset was developed. Total impervious acres documented in the 2011 dataset were 39,209 acres while the 2014 dataset documents 42,312 impervious acres Countywide.
    - In addition to new development, the increase in impervious area is attributed to capturing impervious area features not previously captured (e.g., gravel driveways and unpaved parking areas subject to soil compaction due to vehicular use), and developing more consistent and comprehensive data for attributes not fully identified in the 2011 coverage (e.g., sidewalks, patios, decks, paved pathways through community property).

<u>Impervious Cover</u>

The impervious surface layer is crucial to the County's Watershed Management Tool (WMT). The WMT consists of many watershed analysis models for characterizing the existing conditions of the watershed. The WMT also provides predictive modeling for future conditions, restoration approaches, and preservation scenarios. These models are fully integrated with GIS and currently use the 2014 impervious layer for many different watershed and planning analyses,

including hydrologic analysis, Rosgen Level 1 stream classification, pollutant loading estimates, and stream sediment loading estimates.

Non-Jurisdictional Land within the County

For NPDES reporting, the County is responsible for accounting for all impervious and BMP information pertaining to County-owned land and private lands directly under the jurisdiction of the Anne Arundel County government. The City of Annapolis, the Baltimore Washington International Thurgood Marshall Airport (BWI), Fort George G. Meade (FGGM), the Patuxent Research Refuge, State Highway and Federal Highway roads, State and Federal facilities are examples of land areas that are outside the stormwater authority of Anne Arundel County.

Using the County's parcel layer along with the Consolidated Property File (CPF), a GIS layer of parcels not considered the responsibility of Anne Arundel County was developed. Data analyses indicate that approximately seven percent of the land within the County boundary is owned by the State Government, seven percent is owned by the Federal Government, twelve percent is owned by the County local government, two percent is under the jurisdiction of the City of Annapolis, and seventy-two percent is privately owned.

Digging deeper into this information reveals that approximately twenty percent of the impervious acres within the County boundary are outside the jurisdictional authority of the County with respect to stormwater management. A breakdown of impervious surfaces within Anne Arundel County, based on the 2014 impervious area dataset, is listed in Table 1 below.

Table 1. Land Cover and Impervious Distribution by Land Ownership/Jurisdiction

Anne Arundel County Land Cover Categories	City of Annapolis	State	Federal	County	Private	City of Annapolis	State	Federal	County	Private	City of Annapolis	State	Federal	County	Private
	Land Acres					Impervious Acres					Percent Impervious				
Airport	0	1,032	0	68	105	0	832	0	47	74	0%	81%	13%	69%	71%
Commercial	976	653	1,410	1,832	7,687	671	319	861	1,070	5,202	69%	49%	61%	58%	68%
Industrial	39	346	349	419	4,087	13	233	168	213	2,636	34%	67%	48%	51%	65%
Transportation	191	3,886	707	3,304	1,551	151	2,865	381	2,193	423	79%	74%	54%	66%	27%
Pasture/Hay	0	111	362	229	5,312	0	1	5	9	46	0%	1%	1%	4%	1%
Row Crops	0	135	477	253	11,208	0	3	1	13	110	0%	2%	0%	5%	1%
Residential 1/2-acre	112	47	39	1,191	9,475	30	10	11	649	1,851	27%	22%	27%	55%	20%
Residential 1/4-acre	1,786	89	112	2,724	14,779	677	11	28	1,635	3,621	38%	13%	25%	60%	24%
Residential 1/8-acre	569	111	624	3,071	15,707	251	22	201	1,744	5,053	44%	20%	32%	57%	32%
Residential 1-acre	46	87	2	846	10,614	9	10	0	376	1,654	21%	12%	5%	44%	16%
Residential 2-acre	32	172	15	1,020	22,471	10	20	1	379	2,897	30%	12%	7%	37%	13%
Open Space	242	2,975	2,653	3,618	11,358	13	183	176	394	609	5%	6%	7%	11%	5%
Water	22	185	198	365	1,594	1	0	0	2	11	3%	0%	0%	1%	1%
Open Wetland	6	242	29	400	903	0	0	0	0	1	0%	0%	0%	0%	0%
Forested Wetland	0	64	93	53	75	0	0	1	0	0	0%	0%	1%	0%	0%
Woods	798	8,361	11,002	13,229	72,404	12	93	92	282	668	1%	1%	1%	2%	1%
Utility	0	33	220	48	1,630	0	1	7	6	67	0%	4%	3%	12%	4%
SubTotal	4,818	18,529	18,292	32,670	190,959	1,837	4,605	1,934	9,012	24,924	38%	25%	11%	28%	13%
Total	**265,268**					**42,312**						**16%**			

Note: Impervious area distribution based on Anne Arundel County 2014 impervious surface dataset.

5. ***Monitoring locations: locations established for chemical, biological, and physical monitoring of watershed restoration efforts and the 2000 Maryland Stormwater Design Manual; and***

Status:

a. Parole Plaza, Church Creek, and Picture Spring Branch

The County maintains three monitoring sites, Parole Plaza, Church Creek, and Picture Spring Branch, where the required chemical, physical, and biological monitoring of watershed restoration efforts and stormwater management application is conducted. A summary of the 2015 permit year monitoring efforts at these sites is found in **Part IV.F**, and the complete monitoring reports for the reporting year are included in **Appendix D** (*Chemical, Biological, and Physical Characterization of the Church Creek and Parole Plaza NPDES Monitoring Stations: 2014-2015*) and **Appendix E** (*Biological and Geomorphological Conditions in the Picture Spring Branch Subwatershed: 2014-2015*).

The feature class contained in **Appendix A** gives the location of the Parole Plaza, Church Creek, and Picture Spring Branch monitoring sites.

b. Countywide Biological Monitoring Program

Since 2004, the County has implemented a Countywide biological monitoring program focusing on benthic macroinvertebrates and modeled after the Maryland Biological Stream Survey (MBSS). The program uses a probability-based stratified random sampling design so that overall watershed condition can be evaluated and comparisons between different watershed units can be made. A total of 24 Primary Sampling Units (PSUs) are sampled in a five-year rotation called a Round. Round 1 began in 2004 and ended in 2008. Round 2 began in 2009 and concluded in 2013.

The results of Rounds 1 and 2 have been reported in prior years' Annual Reports. During the 2014 and 2015 reporting periods, the program underwent a complete re-evaluation and re-design to better meet the current needs of the County. This update to the program will be completed during the 2016 reporting period and the program will be re-implemented during the 2017 spring index period.

c. Town Center Water Quality Monitoring Program

In addition to the work performed in the Church Creek watershed, the County assesses water quality in Cowhide Branch, a tributary to Weems Creek and the Severn River and a stream that receives runoff from the Parole Town Center drainage area. One continuous monitoring station is maintained by the County on Cowhide Branch. As part of the Parole Town Center, Weems Creek has been monitored since the late 1980s. Continuous flow data and rainfall are collected at

this station, and monthly stormwater and baseflow monitoring is performed at this site. Parameters sampled include:

Calcium	TKN	Hardness
Copper	NH3	Alkalinity
Lead	TP	Total Phenols
Zinc	TSS	Oil and Grease
Magnesium	PO4	*E. coli*
Iron	COD	VOC (EPA 624)
BOD5	Turbidity	
NO_3/NO_2	TOC	

During the reporting period, 12 storm events and 14 baseflow samples were collected.

The Chemical Monitoring Site Locations Database is included in **Appendix A**.

6. Water quality improvement projects: projects proposed, under construction, and completed with associated drainage areas delineated.

Status:

The NPDES MS4 Permit requires the reporting of watershed restoration/retrofit projects in the design or construction phase as well as projects completed during the reporting year. In FY15 the County continued ramping up restoration efforts and hiring additional project managers to manage the implementation of restoration projects.

During the reporting period 25 restoration projects were completed. Documentation of these projects as well as one additional project completed in FY14, but not reported in the 2014 Annual Report, is found in Table D of the Attachment A database. These 26 completed restoration projects have an equivalent impervious treatment area of 169 acres with equivalent load reductions of 3,253 lbs. per year of total nitrogen (TN), 461 lbs. per year of total phosphorus (TP), and 258 tons per year of suspended solids (TSS). The cumulative total of completed restoration projects (during the current permit term) is 37, with an equivalent impervious surface treatment of 198 acres and total equivalent load reductions of 3,968 lbs. per year of total nitrogen (TN), 526.1 lbs. per year of total phosphorus (TP), and 276 tons per year of suspended solids (TSS).

In addition to the completed projects, 36 water quality improvement projects were in the construction or design phase by the end of FY15. It is anticipated that these projects will provide an additional 307 equivalent impervious acres of treatment as well as 5043 lbs. per year of total nitrogen, 681 lbs. per year of total phosphorus, and 111 tons of suspended solids to be reported in the upcoming

year. The inventory of these project and their locations are also submitted in Table D of **Appendix A**.

The County will continue to develop its inventory of proposed, under construction, and completed restoration projects as watershed restoration implementation continues.

D. Management Programs

The following management programs shall be implemented in areas served by Anne Arundel County's MS4. These management programs are designed to control stormwater discharges to the maximum extent practicable (MEP) and shall be maintained for the term of this permit. Additionally, these programs shall be integrated with other permit requirements to promote a comprehensive adaptive approach toward solving water quality problems. The County shall modify these programs according to needed program improvements identified as a result of periodic evaluations by MDE.

1. Stormwater Management

An acceptable stormwater management program shall continue to be maintained in accordance with the Environment Article, Title 4, Subtitle 2, Annotated Code of Maryland. Activities to be undertaken by the County shall include, but not be limited to:

a. Implementing the stormwater management design policies, principles, methods, and practices found in the latest version of the 2000 Maryland Stormwater Design Manual. This includes:

- ***i. Complying with the Stormwater Management Act of 2007 (Act) by implementing environmental site design (ESD) to the MEP for new and redevelopment projects;***
- ***ii. Tracking the progress toward satisfying the requirements of the Act and identifying and reporting annually the problems and modifications necessary to implement ESD to the MEP; and***
- ***iii. Reporting annually the modifications that have been or need to be made to all ordinances, regulations, and new development plan review and approval processes to comply with the requirements of the Act.***

Status:

The 2000 Maryland Stormwater Design Manual was fully implemented by the County. However, this condition was superseded by the Maryland Stormwater Management Act of 2007. During FY15 the Office of Planning and Zoning (OPZ) continued the requirement for all proposed new stormwater management plans to comply with the new Environmental Site Design (ESD) standards in accordance with the County Code, State Code and the current edition Maryland Stormwater

Management Design Manual. Two amendments to the County's Stormwater Management Practices and Procedures Manual were implemented in FY15, as more fully discussed in **Part IV.B**.

During this reporting period, efforts to update Chapter VI (Stormwater Management) of the Department of Public Works Design Manual were placed on a temporary hold. This is a collaborative work effort between DPW, OPZ, I&P, and the Soil Conservation District (SCD). As reported in prior years, the purpose of this effort is to:

- incorporate the new Maryland stormwater management requirements into the Department's guidance document for capital projects;
- add guidance for stormwater management associated with retrofit projects; and
- ensure that the procedures, standards and criteria within the manual are consistent with those prescribed by the State and County stormwater ordinance and with the County's Stormwater Practices and Procedures Manual.

Work will be re-initiated in FY16 and continue into the FY17 reporting cycle. The County will provide a copy of the final update for MDE review and approval prior to incorporating it into the County's Department of Public Works Design Manual.

As of September 2011 the County has an MDE-approved Stormwater Management Code, which incorporates the current edition of the Maryland Stormwater Management Design Manual. Copies of the County legislation (Bill 74-11) and the MDE approval letter were provided in the 2011 Annual Report. During the reporting period, no modifications to the Code were required to address programmatic problems.

MDE conducted the triennial inspection of the County's stormwater management program during FY15 finding, overall, that the program is acceptable. Recommendations for improving the program were identified and the County has begun, and will continue, to take appropriate action. The next triennial inspection is scheduled for September 2016 (FY17).

b. Maintaining programmatic and implementation information including, but not limited to:

i. Number of Concept, Site Development, and Final plans received. Plans that are re-submitted as a result of a revision or in response to comments should not be considered as a separate project;
ii. Number of redevelopment projects received;
iii. Number of stormwater exemptions issued; and
iv. Number and type of waivers received and issued, including those for quantity control, quality control, or both. Multiple requests for

waivers may be received for a single project and each should be counted separately, whether part of the same project or plan. The total number of waivers requested and granted for qualitative and quantitative control shall be documented.

Stormwater program data shall be recorded on MDE's annual report database and submitted as required in PART V of this permit.

Status:

During FY15, County records indicate the following information regarding stormwater management program data (Table 2).

Table 2. Concept, Site Development, Final Development, and Redevelopment Plans Received during FY15.

Type	Number of Projects Received
Concept Plan[1]	112
Site Development Plan[1]	168
Final Development Plan[2]	104
Final Redevelopment Plan[3]	17
Stormwater Exemptions	0
Waiver Requests Received	0
Waiver Requests Approved	0

Notes:
1 Concept Plan and Site Development Plan based on submittal date for each unique Project Number
2. Final Plan based on unique Grading Permit No.
3. Redevelopment data only available for Final Redevelopment Plan

c. Maintaining construction inspection information according to COMAR 26.17.02 for all ESD treatment practices and structural stormwater management facilities including the number of inspections conducted and violation notices issued by Anne Arundel County.

Status:

Stormwater construction inspections are conducted by the Erosion Control Inspectors in conjunction with the required erosion and sediment control plan inspections. All stormwater construction violations must be resolved and abated

prior to the completion of the associated grading permit. For the reporting period the following inspections were performed:

- 791 Stormwater Construction Inspections
- 33 Stormwater Correction Notices

d. Conducting 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. Documentation identifying the ESD systems and structural stormwater management facilities inspected, the number of maintenance inspections, follow-up inspections, the enforcement actions used to ensure compliance, the maintenance inspection schedules, and any other relevant information shall be submitted in the County's annual reports.

Status:

The State and County Stormwater Management Codes require preventive maintenance inspections once during the first year of operation and every three years thereafter for all stormwater management facilities. For the reporting period the following maintenance inspections were performed:

- 1,128 First Year of Operation Maintenance Inspections
- 2,560 Three Year Maintenance Inspections
- 967 Three Year Maintenance Correction Notices

The required first year inspections are performed by Erosion Control Inspectors as part of the process for completing issued grading permits. Grading permit Certificates of Completion are not issued until all construction is complete and a passing first year maintenance inspection result is obtained. The 1,128 inspections represent inspections of 638 BMP records containing approximately 915 BMP practices (includes ESD development for which individual practices may not have been given a distinct record in the database).

Three-year maintenance inspections are carried out by the Department of Inspections & Permits (I&P) and the Department of Public Works, Bureau of Highways, Infrastructure Management Division (IMD). In FY15, I&P had 7 inspector positions and 1 supervisor position dedicated to the 3-year stormwater facility maintenance inspections (aka triennial inspections) for private and certain public stormwater facilities, and for enforcement of illicit discharges to the closed storm drain system. Of the 7 dedicated inspector positions, 1 position was vacant during the reporting period. In FY15, IMD had 3 inspector positions dedicated to the triennial inspection and oversight of maintenance for approximately 855 publicly owned stormwater facilities. Per Table B of **Attachment A**, the referenced number of triennial inspections resulted in recorded inspection of 1,493 stormwater BMP facility records during FY15.

During the reporting period, the County began migration to a centralized asset management system and database for stormwater BMP inspections and maintenance (i.e., CSDS). The CSDS is structured such that multiple County Departments may have access to this centralized data, thus eliminating the multiple databases previously created for similar purposes. During FY15, the prior Urban BMP database (as implemented during first, second, and third generation permits) was retired. Legacy data from that database continues to be transferred to the CSDS. During the migration to the CSDS, County stormwater inspectors have maintained separate records and spreadsheets documenting inspection results. The County is in the process of consolidating these data sets and ensuring that all the inspection records are correctly recorded in the CSDS. Currently, a review of these internal records (e.g., interim spreadsheets, retired Urban BMP database) indicates at least 1,067 additional BMP records that should be listed as having had a triennial inspection during FY2015. However, the data to support those inspections has not transitioned to the CSDS. The County will address this issue in the near future and update the database to reflect all of the FY2015 triennial inspections.

Maintenance and repair of publicly owned stormwater BMP facilities is performed by County staff; therefore, no enforcement procedures or correction notices are issued for these facilities. The repair and maintenance records for public facilities are maintained by IMD. To enforce the outcome of the County's 3-year maintenance inspections for privately owned stormwater facilities, a 3 Phase Enforcement Procedure is utilized.

When a privately owned SWM facility receives an initial 3-year maintenance inspection and maintenance is required, Phase I is initiated. Using the proper Maintenance Inspection Checklists the stormwater inspectors perform the required 3-year maintenance inspection indicating on the Checklist if maintenance is required, not required, or the item is not-applicable to the facility being inspected. The information on the completed Checklist serves to comply with the inspection requirements of COMAR 26.17.02.11 and is used to complete the Phase 1 Correction Notice, as appropriate. The Correction Notice is issued to the property owner or responsible party.

- The Phase 1 Correction Notice is prepared using inspection report software. Each notice contains a detailed description of the maintenance required and the compliance date by which the required maintenance is to be completed. The CSDS Database is updated to show a 3-year Maintenance Inspection was performed and subsequently updated when compliance is obtained or Phase 2 enforcement is necessary.
    - For the reporting period all correction notices are being successfully enforced at the Phase 1 level.

- Phase 2 of the Enforcement Procedures reflects situations where Phase 1 Enforcement was not successful in obtaining compliance. Phase 2 Enforcement consists of a formal Phase 2 Violation Notice in the form of a certified letter to the property owner or responsible party. The Phase 2 Notice establishes the final compliance dates for the completion of the required maintenance. The final compliance dates may reflect agreed upon Compliance Schedules as authorized by the Inspection Supervisor. The CSDS Database is updated when compliance is obtained or Phase 3 enforcement is necessary.

    - For the reporting period no Phase 2 Violation Notices were required.

- Phase 3 reflects situations where Phase 2 Enforcement was not successful in obtaining compliance. Phase 3 enforcement consists of a legal referral to the Office of Law for the enforcement of the Private Inspection and Maintenance Agreement recorded against the deed for the property in question.

    - For the reporting period no Phase 3 enforcement was required but 1 aging Phase 3 violation was abated.

The triennial stormwater BMP facility maintenance inspection schedule is now a coordinated effort between County agencies such that focus is placed on inspecting all facilities within the required 3-year time frame. During FY15, inspection efforts for privately owned BMPs (inspected by I&P) were geared toward BMPs with drainage areas greater than 5 acres. For FY16 the schedule of privately owned BMPs also includes over 800 facilities with drainage areas greater than 2 acres and over 1,500 facilities with drainage areas less than 2 acres. IMD will continue inspection of the 855 facilities under their purview, conducting inspection on at least a triennial basis. A similar inspection schedule will be implemented in FY17 and FY18, resulting in all BMPs being inspected within the required time frame and another round of triennial inspections beginning in FY18.

2. Erosion and Sediment Control

An acceptable erosion and sediment control program shall continue to be maintained and implemented in accordance with the Environment Article, Title 4, Subtitle 1, Annotated Code of Maryland. Activities to be undertaken by the County shall include, but not be limited to:

a. Implementing program improvements identified in any MDE evaluation of the County's erosion and sediment control enforcement authority;

Status:

The Maryland Department of the Environment conducted their review of the County's erosion and sediment control program, as delegated by the State to the County, in 2014. During the reporting permit, and subsequent to the State's review, County Code relevant to Erosion and Sediment Control was updated to comply with the most recent changes to the State Erosion and Sediment Control Code. A copy of County Council Bill 83-15 reflecting the required code updates is enclosed with this report (**Appendix B**). Upon receipt of the signed and approved legislation, MDE continued the County's delegation of authority through June 30, 2017.

b. At least three times per year, conducting responsible personnel certification classes to educate construction site operators regarding erosion and sediment control compliance;

Status:

Anne Arundel County continues to require a valid Responsible Personnel Certification be held by construction site operators and includes a place on approved construction plans for the card-holders' name and certification number. Moreover, the County checks for a designated card-holder at the project pre-construction meeting.

Responsible Personnel Certification classes are no longer conducted by County staff. Beginning in FY15, MDE assumed responsibility for this training which is offered on-line via the MDE web site.

c. Program activity shall be recorded on MDE's annual report database and submitted as required in PART V of this permit; and

Status:

Based on guidance received from MDE, Anne Arundel County is no longer responsible for providing Green Card Training as it is available on-line on the MDE web site. Therefore, no Green Card certification information (Table J of Attachment A) is submitted.

d. Reporting quarterly, information regarding earth disturbances exceeding one acre or more. Quarters shall be based on calendar year and submittals shall be made within 30 days following each quarter. The information submitted shall cover permitting activity for the preceding three months.

Status:

Based on previous guidance from MDE, quarterly reports were not required providing the Construction General Permit Activity Database continues to be submitted with the annual report. Information regarding grading permits from the County's Construction General Permit Activity Database is provided in **Appendix A**.

3. Illicit Discharge Detection and Elimination (IDDE)

Anne Arundel County shall continue to implement an inspection and enforcement program to ensure that all discharges to and from the MS4 that are not composed entirely of stormwater are either permitted by MDE or eliminated. Procedures shall include, but not be limited to, the following activities.

a. The County shall conduct field screening for at least 150 outfalls annually. A sample from each outfall having a discharge at the time of the inspection shall be tested using a chemical test kit. Within one year of permit issuance, an alternative program may be submitted for MDE approval that methodically identifies, investigates, and eliminates illegal connections to the County's storm drain system.

Status:

Anne Arundel County has developed and continues to maintain an extensive program designed to detect and eliminate illicit discharges into the municipal storm drain system and upland pollutant sources resulting from dumping, poor housekeeping, and other non-permitted activities. The program includes the dry-weather inspection of a minimum of 150 storm drain outfalls annually. This outfall inspection records the presence of dry-weather flow, the structural integrity of the outfall, and relevant maintenance issues. During the 2015 reporting period, illicit discharge screening targeted Hanover, Linthicum Heights, and Glen Burnie; field crews evaluated 153 outfalls. No complaint-driven outfall inspections were performed during this reporting period.

Anne Arundel County's GIS coverage of storm drains and closed storm drain utility grids provided the base data for maps to guide field activities. These maps assisted field crews in identifying the extent of the storm drain systems, the locations of outfalls, and any contributing businesses or facilities. The maps included parcels for commercial and industrial facilities and their storm drain systems for screening efforts, as per the guidance provided by MDE (MDE 1997). Screening efforts did not generally include outfalls that primarily drain residential areas.

Field crews recorded the physical condition of each outfall structure and conditions surrounding the outfall on field datasheets for each site visit. When crews found a dry-weather discharge, they tested the discharge using a Chemetrics color comparator test kit (tested parameters included detergents, phenols, copper, chlorine, and ammonia), an Extech single analyte tester (for fluoride), and a YSI sonde (for water temperature and pH). Physical parameters noted at each outfall included structural condition, vegetative condition, erosion, floatables, algae growth, discharge odor, and discharge clarity.

If field tests determined that an outfall's discharge had a concentration above the action criteria for any of the analytes during the first visit, the protocol stipulated that crews revisit the outfall within 24 hours, but at least four hours after the first test. The second visit helps determine if the initial result was an anomaly, or, if the outfall continues to exhibit flowing discharge, confirm the results of the chemical tests conducted on the first visit.

If both inspections revealed dry-weather flows and concentrations above the action criteria, the outfall qualified as having a possible illicit connection. Another site condition that implied possible illicit connections included any situation where an observable pollutant had been discharged through a storm drain system, but, at the time of inspection, the system was not flowing, or the discharge test did not reveal detectable levels of the pollutant.

To identify the source of any possible illicit discharge, the field crews followed the storm drain system upstream, testing flows through manholes and inlets as necessary and practical, until either the source was identified or the discharge could not reasonably be tracked further. Field crews photo-documented evidence of illicit discharges, including the probable cause(s). Staff prepared site-specific reports for each identified illicit discharge and structural issue found in the field; staff submitted the reports to the Anne Arundel County MS4 Program Manager. The potential illicit discharge reports were then forwarded to the County Department of Inspections and Permits (I&P) for further investigation and enforcement.

Of the screened outfalls containing dry-weather flow during the 2015 reporting period, 11 yielded a result above the action-criteria limit for one or more of the tested contaminants. Field crews re-screened ten of these outfalls, and, of those, eight had concentrations that were above at least one action level when re-tested. The County inspectors performed follow-up site visits and inspections for the outfalls with reported potential illicit discharges. Further details, including site-specific reports, are included in the Illicit Discharge Detection and Elimination – 2015 Annual Report (**Appendix F**).

The County consultant's field teams identified two locations where physical issues significantly affected stormwater infrastructure within the targeted areas of Anne Arundel County during the 2015 reporting period. Staff reported these conditions

to the County MS4 Program Manager. These site specific reports were then forwarded to the County's Infrastructure Management Division (IMD) for distribution to the appropriate agency's personnel. Further details, including site-specific reports, are included in the Illicit Discharge Detection and Elimination – 2015 Annual Report (**Appendix F**).

b. The County shall conduct annual visual surveys of commercial and industrial facilities, as identified in PART IV.C.2 of the current MS4 Permit, for discovering, documenting, and eliminating pollutant sources. The County shall submit reports for the inspected facilities annually.

Status:

During the permitting period, field personnel perform a visual inspection of all accessible commercial and industrial sites within the target areas that have the potential to contribute significant pollutants. The inspections are designed to identify poor housekeeping, dumping, and other non-permitted discharges (e.g., vehicle wash water) that may be intercepted by the County's storm drain system.

Field crews identified 24 upland pollutant sources within the target areas during the 2015 reporting period; these sources demonstrated the potential to discharge pollutants into County storm drains or Waters of the United States. Staff reported upland pollutant sources to the County MS4 Program Manager; the Program Manager typically sent copies of the reports to I&P or the Health Department, as appropriate, to initiate plans for correction. A full report of the procedures and data collected from the illicit detection and elimination field investigations can be found in the Illicit Discharge Detection and Elimination – 2015 Annual Report; relevant digital data are included in **Appendix A**. The report contains details of the findings from the 2015 reporting period, and the corrective actions associated with these sites; the report also includes details regarding the resolution of previously unresolved cases described in the 2013 and 2014 reporting years.

c. The County shall maintain a program to address, and, if necessary, respond to, illegal discharges, dumping, and spills.

Status:

There are two departments within the County government that address reports of illegal dumping and spills. I&P is the County agency primarily responsible for enforcing regulations regarding spills and illegal dumping into both publicly and privately owned storm drain systems. The County Department of Health addresses complaints specifically relating to food service facilities (e.g., overflowing dumpsters or waste grease containers) and documents violations during regular facility inspections.

The County I&P Department received seven illicit discharge, dumping, or storm drainage complaints during the 2015 reporting period. These may include referrals from the Department of Public Works as part of the department's IDDE Program and referrals from other sources. Illicit discharge complaints and referrals are logged into the I&P Compliance Case Database; this is used to track cases from the receipt of a complaint or referral to closure. The Compliance Database is available for public viewing on the I&P page of the Anne Arundel County Web site (via a Quick Link). Case numbers facilitate tracking the progress of any individual Illicit Discharge complaint or referral received by I&P.

Compliance case data pertinent to the complaints received during the 2015 reporting year are documented in **Appendix F** of the Illicit Discharge Detection and Elimination – 2015 Annual Report. All complaints and referrals were investigated and enforced as appropriate.

I&P utilizes a phased approach to eliminating and enforcing illicit storm drain discharges. Phase I Enforcement consists of a Violation Notice sent by first class and certified mail to the property owner. The Phase I Violation Notice includes an explanation of the violation, and requests a written commitment to immediately cease the illicit discharging activity. Upon written receipt of the commitment to comply, the Department monitors the site for up to 60 days; if compliance is maintained, the violation is considered abated. Should the Department fail to receive the written commitment to comply, or if further violations are observed, the Department proceeds to Phase II Enforcement.

At the Phase II level of enforcement, I&P posts a Stop Work Order on the property and issues a $1,000 civil citation to the property owners. If the civil citation is not paid and the violating activity is not abated, the civil citation will move to litigation processes in court. If a violation were to remain unabated by the court date, the Department requests the full payment of the fines and an abatement order from the District Court judge. The failure to comply with any Court-issued abatement order results in Contempt of Court charges being filed by the County Office of Law.

Significant violations are screened with the County Office of Law for possible criminal enforcement as authorized in the County Code, or for referral to MDE for enforcement under the State Code. During the 2015 reporting period, it was not necessary to issue any civil citations for failure to eliminate illicit storm drain discharges.

As part of its general activities associated with food service facilities, the Department of Health has protocols for abatement of leaking or overflowing dumpsters. Enforcement is conducted under State of Maryland Regulations dealing with Food Service Facilities (COMAR 10.15.03.19) which requires that each facility retain a sufficient number of durable refuse containers capable of holding the facility's garbage between periods of removal; the containers must be

adequately covered and not leaking. Violation of this regulation would be marked on the food facility inspection report and would require correction typically within 30 days of the investigation. Failure to comply by the second re-inspection would result in $175 re-inspection fees until compliance is achieved.

The Anne Arundel Health Department also inspects food service facilities to monitor the sanitary and physical conditions of each establishment; there are three inspections per 12-month period. The first inspection is comprehensive and considers the operations of the facility as a whole, including sanitation and food flow processes. The second and third inspections involve monitoring food handling processes. If the County receives a complaint about a specific issue relevant to a food service facility, the Health Department conducts an investigation applicable to the issue; these inspections fall outside of the routine schedule for facility assessments defined above. The Health Department also conducts re-inspections, as necessary, to supplement routine inspections or complaints; these ensure corrective actions and facility compliance.

For the 2015 reporting period, staff identified and reported four issues with dumpsters or waste grease bins, specifically related to food service establishments, to the Health Department for further inspection and enforcement. The Health Department also addressed thirteen other issues reported to the Department by County consultants during the reporting period, and two other relevant issues: one reported by I&P staff members, and one discovered by Health Department staff during a routine inspection and subsequently investigated. Please refer to the Illicit Discharge Detection and Elimination – 2015 Annual Report (**Appendix F**) for details.

d. The County shall report significant illicit discharges to MDE.

Status:

For the 2015 reporting period, all illicit discharge complaints and referrals received were successfully enforced by I&P without the need for any referrals to MDE.

e. The County shall report illicit discharge detection and elimination activities as specified in PART V of the current MS4 Permit.

Status:

The Illicit Discharge Detection and Elimination – 2015 Annual Report (**Appendix F** of this report) provides descriptions of all activities completed as part of the County's 2015 IDDE program. Additionally, the County follows the requirements in the Permit's Attachment A for reporting IDDE data; these are included in **Appendix A**. The County makes no request to modify its IDDE program at this time.

4. Litter and Floatables

This section of the permit requires Anne Arundel County to address problems associated with litter and floatables in waterways that adversely affect water quality. Increases in litter discharges to receiving waters have become a growing concern both nationally and within Maryland and cannot be ignored. Anne Arundel County needs to evaluate current litter control problems associated with discharges from its storm drain system and develop and implement a public outreach and education program as needed on a watershed by watershed basis.

a. As part of Anne Arundel County's watershed assessments under PART IV.E.1 of this permit, Anne Arundel County shall document all litter control programs and identify potential sources, ways of elimination, and opportunities for overall improvement.

Status:

As watershed assessments continue per the schedule found in Part IV.E.1, information on litter control programs in those watershed areas, potential litter sources, and opportunities for eliminating litter and floatables will be examined. During the reporting period, no watershed assessments were initiated. In FY16, a watershed assessment project will be initiated for the Herring Bay watershed. This assessment will include documentation of potential sources and opportunities for control and elimination of litter and floatables.

b. Within one year of permit issuance, as part of the public education program described in PART IV.D.6., Anne Arundel County shall develop and implement a public education and outreach program to reduce littering and increase recycling. This shall include:

- ***i. Educating the public on the importance of reducing, reusing, and recycling;***
- ***ii. Disseminating information by using signs, articles, and other media outlets; and***
- ***iii. Promoting educational programs in schools, businesses, community associations, etc.***

c. Evaluating annually the effectiveness of the education program.

d. Submit annually, a report which details progress toward implementing the public education and outreach program. The report shall describe the status of public outreach efforts including resources (e.g., personnel and financial) expended and the effectiveness of all program components.

Status:

Litter Cleanup, Waste Management, & Recycling

The County's Waste Management Services (WMS) developed and operates a robust public education and outreach program targeted to waste reduction and recycling, as well as household hazardous waste disposal.

WMS recognizes the importance of keeping citizens educated about its programs, particularly in regards to its changes and advancements, and to encourage residents to recycle more often. Program specialists attend fairs, festivals, HOA meetings, community outreach events, and more. WMS also provide technical assistance with recycling at larger-scale events such as the County Fair, Annapolis Greek Festival; staff were present at over 20 fairs and festivals this year, and WMS provided recycling assistance to 15 events.

Anne Arundel County promotes its recycling program to the public through a number of methods such as:

- increasing customer base by providing services to small business and multifamily units;
- improving communication with customers by maximizing the use of various media including direct mail, broadcast media, and newspaper advertisements;
- civic and community meetings, workshops, displays, and special promotions;
- a specially designed program for school aged children; and
- educating customers on new programs, schedule changes and holiday collections.

This extensive outreach effort has proven to be very successful. Since its inception in 2008, the Countywide recycling rate has increased from 31% to 44%.

Anne Arundel offers a Small Business Recycling Program with weekly pickups. During FY15, 200 customers were signed up for Small Business Recycling and more than 1,500 tons of single-stream recycling was collected.

The County's efforts to promote recycling begin with its own employees through the County Office Recycling Program (CORP). CORP was developed to assist in

providing County offices and facilities with the necessary tools behind an effective recycling program (*e.g.*, containers, signage, and pick-up service); all offices/facilities have a Recycling Coordinator that directly communicates with the recycling program office. There are about 250 sites (County offices, parks, pools, etc.) that collected about 1,250 tons of single-stream recycling in FY15.

The County also provides support to citizens working to better their own communities. Each year WMS, upon written request from a local community association, dispatches roll-off dumpsters to aid in community and watershed cleanup activities. In 2015, roll off bins were provided for approximately 230 communities and citizen groups to assist in trash removals.

Education programs are offered to students, faculty, parents, and more throughout Anne Arundel County's public and private schools, as well as day care and home schooling groups. Technical assistance with recycling is also provided upon request, as well as assistance with obtaining Green School Certification through the MAEOE program. In 2015, the County visited approximately 3000 elementary school students, 1500 middle school students, and 300 high school students, as well as provided 12 student tours of the County Landfill, which included visitors up to the collegiate level. Staff also administer three contests annually for County students including a poster contest for elementary schools, a sculpture contest for middle schools, and a fashion contest for high school students. This helps generate even more excitement about the importance of recycling.

Additional information on the County's recycling and household hazardous waste programs may be found at the following websites:

- http://www.recyclemoreoften.com/
- http://www.aacounty.org/services-and-programs/household-hazardous-waste-drop-off-days
- https://www.facebook.com/annearundelrecycling

The County Bureau of Highways (BOH) is responsible for all maintenance activities associated with County roads. Litter is collected from County roadways on a routine basis. Additionally, BOH conducts weekend roadside litter and trash removal throughout the year, using supervised inmate labor, in partnership with the Department of Detention Facilities. The program was first started in 2007 with a focus on high litter count road segments, dump sites, and illegal roadside signs that were proliferating across the County. The goal of the weekend program is to realize an improvement in the condition of roadsides in Anne Arundel County without a reduction to other Highways services. Weekend litter removal activities follow a programmed frequency throughout the year.

A total of 8,733 thirty-gallon bags of litter were removed from roadsides from July 1, 2014 to June 30, 2015, with 4,213 bags collected during our routine work week and 4,520 bags collected by our weekend litter removal program. This represents a 26% increase from the last reporting period, in which 6,910 bags of litter were removed.

Stream Cleanups

BOH has supported several stream cleanup initiatives during the reporting period. This includes Project Clean Stream 2015, sponsored by the Alliance for the Chesapeake Bay and held in April of each year. Significant support was also provided to The Friends of the Patapsco Valley & Heritage Greenway who sponsored several watershed clean-ups in Patapsco State Park off of Race Road in Hanover, Maryland. Additionally, the Bureau of Highways removed in excess of 8 loads of trash, tires, metal, and glass dumped illicitly along roadsides and reported by these and other volunteer organizations.

Specific events supported by the County are listed here.

Patapsco Non-Tidal

May 2, 2015 – Patapsco Heritage Greenway, 1025 West Nursery Rd., removed trash from unsightly area of parkland, no weight or amount provided for materials removed.

Herring Bay

April 11, 2015 - Project Clean Stream, Rockhold Creek, 485 Deale Rd., no weight or amount provided for materials removed.

Magothy River

April 11, 2015 - Project Clean Stream, Cat Branch Creek Site 1, removed 1420 lbs. of trash.

April 11, 2015 - Project Clean Stream, Cat Branch Creek Site 2, no weight or amount provided for materials removed.

April 11, 2015 - Project Clean Stream, Cat Branch Creek Site 3, no weight or amount provided for materials removed.

April 11, 2015 – Project Clean Stream, Sandy Point State Park, Beach and Jetty Cleanup, removed trash from beaches, no weight or amount provided for materials removed.

Middle Patuxent

April 4, 2015 - Patuxent River Clean-up by Canoe, removed trash along the shoreline in and around Jug Bay, removed 200 lbs. of trash.

April 11, 2015 - Project Clean Stream, Patuxent Wetland Park, no weight or amount provided for materials removed

Patapsco Tidal

April 11, 2015 - Project Clean Stream, Wetland and Shoreline Cleanup along Swan Creek, no weight or amount provided for materials removed.

April 11, 2015 - Project Clean Stream, Trash removal at Marley Middle School and Marley Beach Park, no weight or amount provided for materials removed.

April 11, 2015 - Project Clean Stream, Rock Creek spring cleanup, trash removal along the Tar Cove Tributaries, no weight or amount provided for materials removed.

Severn River

April 11, 2015 - Project Clean Stream, Severn Run Natural Environmental Area, Cleanup at old dumping ground, 8247 New Cut Rd, no weight or amount provided for materials removed.

April 11, 2015 - Project Clean Stream, David's Run Trash Removal, no weight or amount provided for materials removed.

April 11, 2015 - Project Clean Stream, Severn Heights Community Association, no weight or amount provided for materials removed.

April 18, 2015 - Severn Run Stream Clean-up, removed trash piled at roadside of Najoles Rd., no weight or amount provided for materials removed.

South River

April 11, 2015 - Project Clean Stream, South River Federation, Trash Cleanup behind Bywater Estates, no weight or amount provided for materials removed.

April 11, 2015 – Project Clean Stream, Woodhaven Community Clean-up, removed trash and debris from Bell Branch, no weight or amount provided for materials removed.

West River

April 18, 2015 – Galesville Baseball Field Clean-up, no weight or amount provided for materials removed.

In total, landfill manifests associated with these stream cleanup efforts indicate 7,700 pounds (3.85 tons) of material was removed from local waterways.

5. Property Management and Maintenance

a. Anne Arundel County shall ensure that a Notice of Intent (NOI) has been submitted to MDE and a pollution prevention plan developed for each County-owned municipal facility requiring NPDES stormwater general permit coverage. The status of pollution prevention plan development and implementation for each County-owned municipal facility shall be reviewed, documented, and submitted to MDE annually.

Status:

Anne Arundel County's Water Reclamation Facilities (WRFs) NPDES discharge permits are current or continue in force pending MDE issuance of a revised permit. The County-owned WRFs with NPDES discharge permits are:

Annapolis WRF, permit number 12-DP-0838, effective October 1, 2015 to September 31, 2020.

Broadneck WRF, permit number 06-DP-0677, effective June 1, 2010 to May 31, 2015. A renewal package was submitted as per the permit requirement.

Broadwater WRF, permit number 06-DP-0813, effective March 1, 2010 to February 28, 2015. A renewal package was submitted as per the permit requirement.

Cox Creek WRF, permit number 07-DP-0698, effective January 1, 2010 to December 31, 2014. A renewal package was submitted as per the permit requirement.

Maryland City WRF, permit number 11-DP-2393, effective April 1, 2015 to March 31, 2020.

Mayo Large Communal WRF, permit number 02-DP-2291, effective October 1, 2013 to September 30, 2018.

Patuxent WRF, permit number 11-DP-0132, effective April 1, 2015 to March 31, 2020.

The State's General Discharge Permit for Stormwater Associated with Industrial Activities, Permit 12-SW, became effective January 2014. County-owned facilities requiring general discharge permit coverage have submitted NOIs to MDE.

During this reporting period, Anne Arundel County's Bureau of Utilities developed and submitted the required compliance information for the WRFs and the Utility Operations Center facilities listed below. Training sessions held in FY15 are listed as follows: Initial training, Comprehensive Site Evaluation training (CSE), and training by the Maryland Center for Environmental Training (MCET) on the general permits and facility plans.

Annapolis WRF, permit number 12-SW-0756: Notice of Intent submitted on May 20, 2014, coverage effective June 16, 2014 to December 31, 2018.

Broadneck WRF, permit number 12-SW-0758: Notice of Intent submitted on June 27, 2014, coverage effective July 30, 2014 to December 31, 2018. Initial training 8/14. CSE 8/14.

Broadwater WRF, permit number 12-SW-0757: Notice of Intent submitted on June 18, 2014, coverage effective June 26, 2014 to December 31, 2018.

Cox Creek WRF, permit number 12-SW-0760: Notice of Intent submitted on June 30, 2014, coverage effective August 11, 2014 to December 31, 2018. Initial training 11/14. CSE 12/14.

Maryland City WRF, permit number 12-SW-0761: Notice of Intent submitted on June 11, 2014, coverage effective July 14, 2014 to December 31, 2018. Initial training 7/14. CSE 10/14.

Patuxent WRF, permit number 12-SW-2459: Notice of Intent submitted on June 27, 2014, coverage effective August 6, 2014 to December 31, 2018. Initial training 10/14. MCET 7/15. 6/15.

Anne Arundel County Utility Operations Center, permit number 12-SW-2345: Notice of Intent submitted on July 16, 2014, coverage effective September 8, 2014 to December 31, 2018. Initial training 8/14. MCET 7/15. CSE 11/14.

SWPPPs, developed for each of the above facilities, were updated as required by the new permit and submitted with the Notice of Intent. In support of the NOI and in compliance with the SWPPP, WRF staff performs monthly inspections, quarterly dry weather inspections, quarterly wet weather inspections, annual comprehensive site inspections, annual record review, and annual training. These records are maintained at each facility.

The State's General Discharge Permit 12-SW also applies to the three County-owned facilities managed by Waste Management Services (WMS) noted below. During this reporting period, facilities developed and submitted the required compliance documentation to MDE:

- Northern Recycling Center (formerly known as Glen Burnie Convenience Center) and closed Landfill, permit number 12-SW-0298: Notice of Intent submitted on June 17, 2014, coverage effective August 15, 2014 to December 31, 2018.

- Millersville Sanitary Landfill and Resource Recovery Center, permit number 12-SW-1304: Notice of Intent to renew submitted on June 17, 2014, coverage effective August 15, 2014 to December 31, 2018; and

- Southern Recycling Center (formerly known as Sudley Convenience Center) and closed Landfill, permit number 12-SW-0297: Notice of Intent submitted June 17, 2014, coverage effective August 18, 2014 to December 31, 2018.

Annual Comprehensive SWPPP Compliance Evaluation Inspection Reports were completed for these facilities in December 2014 and documentation is available upon request. At these facilities the stormwater management facilities (SWMFs)

are inspected routinely and all necessary repairs are undertaken immediately. WMS employs two technicians tasked with the responsibility of inspection and maintenance of the SWMFs. No pesticides are used at these facilities; encroaching vegetation is removed entirely by mechanical means.

County-owned facilities operated by DPW, Bureau of Highways, that require NPDES stormwater general discharge permit coverage are listed in Table 3. Each of these facilities maintains compliance documentation required by General Permit 12-SW, for submittal to MDE.

Table 3. Bureau of Highways Facilities

Facility	Permit Number	NOI and SWPPP Submission	Permit Coverage Period
Northern District Roads			
200 Dover Rd	12-SW-1176	June 30, 2014	Sept. 12, 2014 – Dec. 31, 2018
318 Mountain Rd	12-SW-1181	June 30, 2014	Aug. 21, 2014 – Dec. 31, 2018
Central District Roads			
1427 Duckens St	12-SW-1177	June 30, 2014	Aug. 21, 2014 – Dec. 31, 2018
1847 Crownsville Rd	12-SW-1179	June 30, 2014	Aug. 21, 2014 – Dec. 31, 2018
415 Broadneck Rd	12-SW-1182	June 30, 2014	Aug. 21, 2014 – Dec. 31, 2018
Southern District Roads			
350 West Central Ave	12-SW-2298	June 30, 2014	Aug. 21, 2014 – Dec. 31, 2018
6657 Old Solomons Island Rd	12-SW-1180	June 30, 2014	Aug. 21, 2014 – Dec. 31, 2018

Bureau of Highways Stormwater Pollution Prevention Plan Development and Implementation

During the period July 1, 2014, through June 30, 2015, the following items related to implementation of 12-SW were completed:

- Implemented each SWPPP, including:
  - Performed routine facility inspections of each facility, at least quarterly.
  - Completed quarterly outfall visual assessments of each facility.
  - Completed comprehensive annual inspections of each facility in June 2015.
  - Provided training to Road District personnel during the reporting period to support SWPPP implementation.
  - Completed an internal document review during comprehensive annual inspections of each facility.
  - Continuation of maintenance improvements to further prevent stormwater impacts, including:
    - Use of coir log wattles and/or straw bales to protect inlets.
    - Use of asphalt curbing to contain bulk road maintenance materials.

- Completed underground storage tank testing using Maryland Department of the Environment Certified UST Inspectors for:
    - Annual testing of spill buckets (catchment basins) at all facilities during 2015.
    - Third Party Inspections completed on a rolling basis upon MDE notification.
    - Five year tank tightness testing completed at all facilities during August 2013.
    - Five year containment sump testing completed at select facilities during August 2013.
- Completed capital improvements to Salt Barn storage infrastructure at the following District Yards:
    - Northern District, Mountain Road, salt barn repairs, October 2015
    - Central District, Crownsville Yard, salt barn repairs, September 2015
    - Central District, Odenton Yard, salt barn repairs, November 2015
    - Southern District, Friendship Yard, salt barn repairs, August 2015

b. The County shall continue to implement a program to reduce pollutants associated with maintenance activities at County-owned facilities including parks, roadways, and parking lots. The maintenance program shall include these or MDE-approved alternative activities:

i. Street sweeping;

Status:

Anne Arundel County's street sweeping program is intended to provide a continuous level of street cleanliness while keeping debris (including litter and floatables) and pollutants out of storm drains, our creeks, rivers and ultimately the Chesapeake Bay.

Anne Arundel County has historically operated a modest program that includes two (2) county-owned street sweepers. In June 2014, the County contracted for street sweeping services for which funding was appropriated via the Watershed Protection and Restoration Fund (WPRF). These services will initially augment and then replace the existing County street sweeping program. As the WPRF is phased in and increased funding is available, the program can be expanded to encompass additional curbed County roadways.

FY15 Sweeping Schedule

The County's neighborhood streets are relatively clean because of the work of conscientious residents who assist us by keeping the areas in front of their homes free of litter and debris. Residential streets were not included in our program for routine street sweeping during this reporting period. Main thoroughfares, business parks and industrial areas, NPDES priority areas, and facility parking lots subject to SWPPP implementation were scheduled for monthly street sweeping. We targeted curbed roads with high traffic volumes as this allows us to capture the greatest pollutant load for each available hour of street sweeping effort as well as an NPDES priority area within the Patapsco River Watershed given the Baltimore Harbor Trash TMDL.

The County swept 2,895 curb miles from July 1, 2014 to June 30, 2015, which equates to 241 curb miles/month - a 953% increase from the last reporting period. Contractual street sweeping services contributed to the increased sweeping effort during the reporting period.

ii. Inlet inspection and cleaning;

Status:

The County cleaned and removed debris from catch basins, inlets and outlets of pipes to maintain proper drainage for 17,167 structures during the July 1, 2014 to June 30, 2015 reporting period. This is a 9% increase from the last reporting period in which 15,804 structures were cleaned by hand.

In addition, the County inspects catch basins, manholes, and associated pipes to identify structures for cleaning with a sewer vacuum or power rodder. A total of 1,591 structures were cleaned with a sewer vacuum, an increase of 37% from the last reporting period in which 1,165 were cleaned with a sewer vacuum. A total of 30,220 feet of pipe were cleaned by a power rodder, an increase of 33% from the last reporting period in which 22,648 feet were cleaned.

Ditch & Curbline Cleaning

During the reporting period, the County cleaned and removed debris from roadside inlet and outlet ditches and concrete swales, removed leaves from ditch lines and curbs using a leaf vacuum, and cleaned and reshaped roadside ditches by machine for a total of 172,963 feet during the reporting period. This is a 37% increase from the last reporting period in which the County cleaned 126,350 feet.

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

Status:

Pesticides & Herbicides

Anne Arundel County makes a financial contribution annually to support Maryland Department of Agriculture (MDA) programs for Gypsy Moth control (http://mda.maryland.gov/plants-pests/Pages/gypsy_moth_policy.aspx) and Mosquito control (http://mda.maryland.gov/plants-pests/Pages/mosquito_control_policy.aspx). Some of this work occurs along county-maintained roadways. No data regarding the quantity of pesticides applied along roadways is recorded by the Bureau of Highways.

Herbicide use associated with road maintenance performed by the Bureau of Highways is limited to the activities included in the performance standard for H0040, which covers the application of Glyphosate (e.g., Roundup ™) on County rights-of-way to control vegetative growth around guardrails, concrete structures and prior to crack sealing operations in the traveled portion of the roadway. A total of 115 gallons of Glyphosate were used during the reporting period. This is a 16% decrease over the previous reporting period in which 137 gallons were applied. The reduction can be largely attributed to the total number of application cycles scheduled during the reporting period.

The Bureau of Highways employs a contractor who holds a Pest Control Applicator Certificate. The applicator categories are 3A - Ornamental, 3C - Turf, and 6 - Right-of-Way. The contractor is required to attend re-certification training per the guidelines of MDA to include Integrated Pest Management and pesticide safety. Each time there is chemical use, a pesticide report is completed and filed, which is available to be reviewed during MDA's biennial inspection.

Landfills and recycling centers managed by WMS do not use pesticides to control the unwanted woody vegetation and encroaching vegetation. Weeds and other problematic vegetation at these facilities are removed entirely by physical and mechanical means.

Integrated Pest Management (IPM)

The maintenance plan for all FMD properties and right-of ways include IPM. Key elements include:

- use of herbicides only when pulling or cutting weeds have not proven effective;

- use of insecticides only when natural methods have not proven effective;
- elimination of fertilizer use, proper use of hand weeding and mulching, and sparing use of herbicides in on roadway medians;
- limiting fertilizer use on FMD properties, and only using when grass needs nutrients to encourage proper growth that helps with the prevention of soil erosion and limits runoff;
- selecting disease- and insect-resistant plants for new plantings; and
- selecting the least toxic product available, using appropriate storage facilities and techniques, and compliance with all applicable laws and regulations.

During the reporting period, the Department of Recreation and Parks (R&P) began implementation an (IPM) program for County parks and athletic facilities. The IPM plan is required pursuant to County legislation that became effective July 1, 2013 and that modified Article 14 of the County Code by adding §14-1-105 (Integrated Pest Management Plan). The updated Article 14 of the County Code can be found online at: www.aacounty.org /CountyCode/index.cfm. Pursuant to this legislative requirement, the public is provided prior notification of pesticide application at R&P public facilities.

Documentation for the program is available in **Appendix J**. Program objectives are to:

- minimize the amount and toxicity of pesticides used in the park facilities;
- eliminate unnecessary pesticide applications;
- provide IPM education to the public, park users and park staff;
- improve landscape and grounds cleanliness;
- utilize only Licensed, Certified and Registered Technician pesticide applicators;
- reduce or eliminate exposure of children, vulnerable adults, nursing mothers with infants and pets to pesticide applications; and
- provide universal public and staff notification.

iv. Reducing the use of winter weather deicing materials through research, continual testing and improvement of materials, equipment calibration, employee training, and effective decision-making; and

Status:

Snow and Ice Control

The amounts of de-icing chemicals used by the County Bureau of Highways from July 1, 2014 to June 30, 2015 are found in Table 4. De-icing chemical data for the 2012-2013 and 2013-2014 reporting period are provided as a comparison. The quantity of deicing chemicals used each year is highly variable because it is based on actual winter weather conditions including precipitation type, and factors such as road surface temperature.

Table 4. Deicing Material Applied

Material	2012-2013	2013- 2014	2014 – 2015
Salt	6,378 tons	50,996 tons	32,250 tons
Sand/ Salt mix	0 tons	0 tons	0 tons
Liquid Calcium Chloride	355 gal.	13,355[a] gal.	11,925 gal.
NWS[a] Snow Totals (BWI)	8.0 inches	39 inches [b]	28.7 inches

[a] Average winter temperature at BWI Thurgood Marshall Airport is 35.1 degrees according to the National Weather Service (NWS). Winter 2013-2014 average temperature was 32.0. Calcium Chloride depresses the freezing-point and is used more extensively during colder periods to prevent ice formation and to deice road surfaces. Use is likely when average temperature is near or below freezing.

[b] Average annual snowfall total at BWI Thurgood Marshall Airport is 20.1 inches according to the National Weather Service (NWS). Winter 2014-2015 snowfall totals were 28.7 inches, 43% higher than average but below the 2013-2014 season, resulting in less overall salt use.

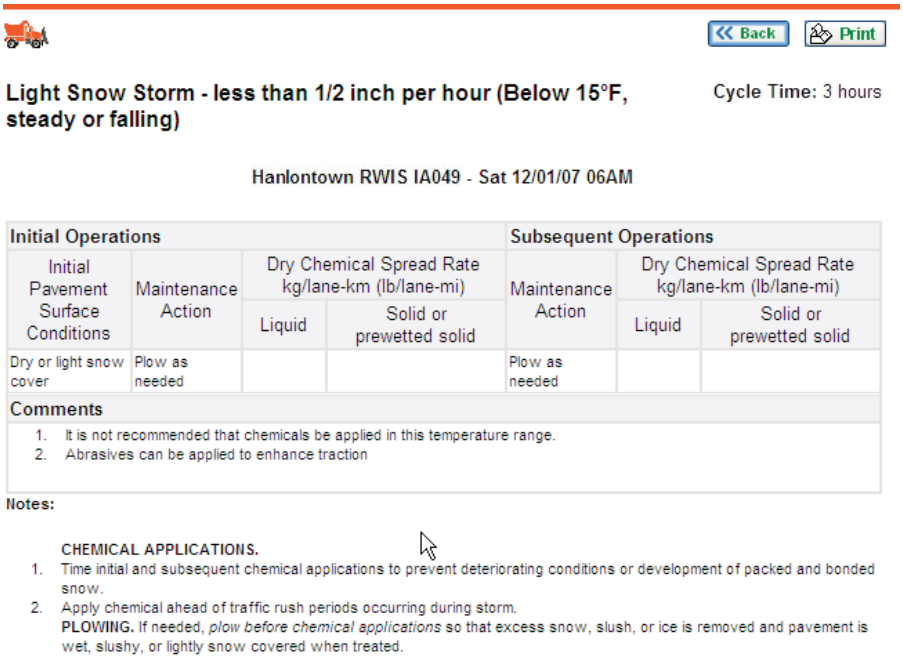
In 2014-2015, the Bureau continued its efforts to reduce the use of winter weather deicing through research, continual testing and improvement of materials, equipment calibration, employee training, and effective decision making. The County procured the infrastructure to support an anti-icing pilot project planned for the 2015-2016 season, procured light and medium duty dump trucks equipped with the latest spreader controller technology and on-board liquid application capability, and equipped its fleet with AVL tracking hardware to monitor and optimize snow removal operations.

The Bureau continued its use of a maintenance decision support system (MDSS) which uses real-time data from our Road Weather Information System (RWIS). The RWIS system is a series of pavement and bridge deck sensors and other instruments installed along certain County-owned bridges and roadways. The integration of RWIS data into a MDSS allows the management team to select the most appropriate winter treatment for actual weather conditions in each area of the County during a winter storm event. Studies have shown use of an MDSS can help reduce the use of deicing chemicals. Screen

shots from the MDSS are shown below (Figures 2 and 3) and are from our subscription weather service, MxVision WeatherSentry Online at http://weather.dtn.com /dtnweather/.



Figure 2. MDSS Hourly Weather Forecast With Treatment Recommendations



Back Print

Light Snow Storm - less than 1/2 inch per hour (Below 15°F, steady or falling)

Cycle Time: 3 hours

Hanlontown RWIS IA049 - Sat 12/01/07 06AM

Initial Operations				Subsequent Operations		
Initial Pavement Surface Conditions	Maintenance Action	Dry Chemical Spread Rate kg/lane-km (lb/lane-mi)		Maintenance Action	Dry Chemical Spread Rate kg/lane-km (lb/lane-mi)	
		Liquid	Solid or prewetted solid		Liquid	Solid or prewetted solid
Dry or light snow cover	Plow as needed			Plow as needed		

Comments

1. It is not recommended that chemicals be applied in this temperature range.
2. Abrasives can be applied to enhance traction

Notes:

CHEMICAL APPLICATIONS.

1. Time initial and subsequent chemical applications to prevent deteriorating conditions or development of packed and bonded snow.
2. Apply chemical ahead of traffic rush periods occurring during storm.

PLOWING. If needed, *plow before chemical applications* so that excess snow, slush, or ice is removed and pavement is wet, slushy, or lightly snow covered when treated.

Figure 3. MDSS Treatment Recommendation

Annual training on proper snow plowing techniques is also offered to both County and contractor personnel by BOH. The training includes information on the application of deicing products and proper application rates. Training sessions are held in October and November each year.

Activities at WMS facilities also require the use of salt de-icing. The salt usage at each facility, in FY15, is as follows:

- Millersville Landfill and Resource Recovery Facility – 12.5 tons
- Northern Recycling Center – 7.5 tons
- Central Recycling Center – 6.25 tons
- Southern Recycling Center – 5 tons

v. Ensuring that all County staff receive adequate training in pollution prevention and good housekeeping practices.

Status:

The three County-owned facilities managed by WMS that fall under the State's General Discharge Permit 12-SW (Northern Recycling Center, Millersville Sanitary Landfill and Resource Recovery Center, and Southern Recycling Center) have approved SWPPPs. WMS holds trainings at least annually at each of the facilities on the following topics: Hazardous Waste Operations (Response); Good Housekeeping and Spill Prevention; Preventative Maintenance for Sediment and Erosion Control; Runoff Control; and other SWPPP-related topics.

The Bureau of Utilities held staff training sessions at the WRFs and Utility Operations Center facilities, as listed in Section IV.D.5.a.

The Bureau of Highways held staff training sessions that have been administered to Road District personnel during the reporting period to support SWPPP implementation, as summarized in Table 5.

Table 5. SWPPP Training Summary for Bureau of Highways Facilities

Training Number	Training Location	Training Date	Training Session Topic
15139971	1311CC	05/28/2015	SESSION #1: WHEN IT RAINS, IT DRAINS
15148634	1311CO	05/22/2015	SESSION #3: CONTROL MEASURES/GOOD HOUSEKEEPING
15147199	1312SD	05/15/2015	SESSION # 3: CONTROL MEASURES/GOOD HOUSEKEEPING
15140818	1310ND	05/07/2015	SWPPP TOPIC: EROSION AND SEDIMENT: ITS NOT THE SAME THING (PPT & QUIZ)
15139974	1312SD	04/17/2015	MODULE #2: WHAT IS A SWPPP & WHAT DOES IT MEAN

Table 5. SWPPP Training Summary for Bureau of Highways Facilities

Training Number	Training Location	Training Date	Training Session Topic
14116175	1310NM	02/06/2015	SWPPP TOPIC: PROTECTING WATER QUAILITY FROM URBAN RUNOFF
15125608	1311CO	02/03/2015	SESSION #2: WHAT IS A SWPPP?
15125607	1311CC	01/29/2015	SESSION #1: WHEN IT RAINS, IT DRAINS
15125613	1312SD	01/25/2015	SESSION #1: WHEN IT RAINS IT DRAINS/WHERE WATER GOES WHEN IT RAINS AT FACILITY
14116178	1311CO	11/26/2014	SESSION #5: SECONDARY CONTAINMENT
14116180	1312SD	11/25/2014	SESSION #4: OUR SWPPP – PART II
14116179	1311CS	11/19/2014	SWPPP TOPIC: SPILLS & SPILL RESPONSE
14116177	1311CC	11/19/2014	SESSION #3: OUR SWPPP – PART II
14100863	1311CS	10/31/2014	SWPPP TOPIC: REVIEWED STABILIZATION/EROSION CONTROL
14106497	1311CC	09/03/2014	SWPPP TOPIC: REVIEWED THE IMPORTANCE OF THE SWPPP PROCESS WHILE CLEANING THE SEWER VACUUM DEWATERING PIT
14100864	1312SD	08/28/2014	SESSION #3: OUR SWPPP – PART I
14102312	1311CC	08/12/2014	SESSION # 1: WHEN IT RAINS, IT DRAINS
14100857	1310NM	08/08/2014	SWPPP TOPIC: REVIEWED GOOD HOUSEKEEPING, KEEPING DIRT OFF THE STREETS AND OUT OF STROMWATER RUNOFF. ONSITE AT FACILITY AND ON JOBSITES.

6. Public Education

Anne Arundel County shall continue to implement a public education and outreach program to reduce stormwater pollutants. Outreach efforts may be integrated with other aspects of the County's activities. These efforts are to be documented and summarized in each annual report. The County shall continue to implement a public outreach and education campaign with specific performance goals and deadlines to:

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

Status:

The Department of Inspections & Permits maintains a 24 Hour Environmental Hotline for citizens to report environmentally related complaints including spills and illegal dumping into the County storm drain system. The Hotline has been in existence since 1988 and has been advertised in numerous ways including the County webpage (www.aacounty.org/services-and-programs/building-grading-and-zoning-code-violations). The recently updated County webpage also provides a link for citizens to submit an on-line request for investigation.

For the reporting period a total of 632 environmentally related complaints were investigated by the Department requiring 936 inspections. The complaints received typically involve potential Critical Area violations, sediment control issues, tree removal without appropriate approvals, or illegal grading activities. All complaints including their compliance status, inspection results, enforcement and completion dates are viewable on the Department's Code Compliance Database which is available for viewing on the web site.

b. Provide information to inform the general public about the benefits of:

- ***i. Increasing water conservation;***
- ***ii. Residential and community stormwater management implementation and facility maintenance;***
- ***iii. Proper erosion and sediment control practices;***
- ***iv. Increasing proper disposal of household hazardous waste;***
- ***v. Improving lawn care and landscape management (e.g., the proper use of herbicides, pesticides, and fertilizers, ice control and snow removal, cash for clippers, etc.);***
- ***vi. Residential car care and washing; and***
- ***vii. Proper pet waste management.***

Status:

The County continues to provide residents with information necessary to make informed decisions regarding water quality issues and environmental stewardship. Several County departments have public outreach programs tailored to their specific discipline. Examples of some of the outreach activities are described below.

Anne Arundel County DPW webpage provides water quality-related information associated with County-provided services (http://www.aacounty.org/departments/public-works/). In FY15, information available through this website included the county's Annual Drinking Water Quality Report.

In addition, relevant information to help residents reduce stormwater pollution is provided on the County's Watershed Protection and Restoration website (www.aacounty.org/departments/public-works/wprp/) and its "Think Bay" webpage (http://www.aacounty.org/departments/public-works/wprp/think-bay/index.html). Topics include rainwater reuse, rain gardens, permeable paving materials, car maintenance, household hazardous waste, pesticide and fertilizer use, litter and recycling, pet waste cleanup, septic system maintenance, boating, and deicing.

During the reporting period the Bureau of Utilities attended numerous community events to promote water conservation and conducted tours of various County-operated water treatment plants and wastewater reclamation facilities (Table 6).

Table 6. Bureau of Utilities community events and tours

9/1/2014	AA County Fair-DPW/BUO	Outreach Event
9/20/2014	Chesterfield Community Fair	Outreach Event
9/27/2014	OEM's ER Preparedness	Outreach Event
10/11/2014	County Fire/Police Public Safety Expo.	Outreach Event
10/16/2014	CAT-N Open House	Outreach Event
10/18/2014	BWMC Community Event	Outreach Event
10/22/2014	Brooklyn Lions Club	Water Conservation Presentation
10/28/2014	Monarch Academy	Tour of Water Treatment Facility
10/29/2014	Old Mill Middle School	Water Conservation Presentation
11/5/2014	Old Mill Middle School	Tour of Water Treatment Facility
12/9/2014	Cub Scout Group	Water Conservation Presentation
3/11/2015	CAT-N	Tour of Water Reclamation Facility
3/23/2015	CAT-N	Tour of Water Treatment Facility
4/6/2015	Public Outreach Event	Outreach Event
4/11/2015	Girl/Boy Scout Troop	Tour of Water Treatment Facility
4/15/2015	Maryland City Elementary	Tour of Water Reclamation Facility
4/23/2015	Girl Scout Troop	Tour of Water Treatment Facility
4/27/2015	Hilltop Elementary	Water Conservation Presentation
5/4/2015	Older American Month	Outreach Event
5/21/2015	Public Works Week Event	Outreach Event
6/24/2015	Odenton Community Event	Outreach Event

The DPW Bureau of Highways developed information to act as a Resident's Guide to Rain Gardens in Anne Arundel County. The materials, available at www.aacounty.org/services-and-programs/rain-gardens, explain relevant County requirements and outline opportunities for homeowners to use rain gardens to provide flood control, groundwater recharge, and water-cooling benefits, while removing many types of pollutants and other contaminants from stormwater runoff.

Relating to sediment and erosion control practices, the I&P website contains general information available to the public regarding this topic including buffer management, grading and permits, the Chesapeake Bay Critical Area, invasive species, and sensitive areas. This information can be found at www.aacounty.org/departments/inspections-and-permits/environmental-programs/frequently-asked-questions/.

The Watershed Stewards Academy provides information about maintenance of residential septic systems (aawsa.org/new-page-1/), as does the County's Department of Health (http://aahealth.org).

Outreach pertinent to household hazardous waste disposal has been reported in prior annual reports. The DPW, Bureau of Waste Management Services (WMS) manages an extensive outreach campaign geared toward residential recycling. Additionally, Household Hazardous Waste drop-off events are vital in helping to keep harmful toxins out of the County landfill. In FY15, the County advertised and conducted six Household Hazardous Waste drop-off events, holding two events at each of the three Recycling Centers during this reporting period. These events attracted 2,716 customers and successfully kept 318,000 pounds (159 tons) of household hazardous waste out of the landfill. All hazardous waste collected at the facilities during these events is packaged, transported, and disposed of by a licensed hazardous waste.contractor. The County does not accept hazardous waste for disposal at its landfill. Additional information is available on the County's website at: http://www.aacounty.org/departments/public-works/waste-management/. WPRP has also developed a 'tip card' distributed to residents regarding proper household hazardous waste management.

Literature outlining alternatives to hazardous household chemicals, and safe disposal of such chemicals, is provided to the public through many different venues, including the Watershed Stewards Academy website (aawsa.org /choose-non-toxic-products/). DPW WMS also provides information such as what can be recycled; ways to get recycling and composting bins; dealing with yard waste and grass cycling; amounts recycled in different areas of the County; local events that promote recycling; and question-and-answer forums at outreach events, in County offices, through the County website, on the "Recycle. More. Often." website (www.recyclemoreoften.com), and on the Anne Arundel County Recycling Division Facebook page (https://www.facebook.com/annearundelrecycling/). Since the program's inception in 2008, the Countywide recycling rate has increased from 31% to 44%. See **Appendix G**.

Lawns make up a significant portion of individual properties and have been shown to produce more runoff than their forested counterparts. As such, in addition to the information provided on the WPRP website, the Watershed Stewards Academy promotes the use of "Bay Friendly" lawn care and landscaping practices both on their website (aawsa.org/new-page/) and through community outreach. WPRP has also developed a 'tip card' distributed to residents regrading proper lawn management.

The County's winter deicing strategy and resources are well explained on the County webpage at www.aacounty.org/departments/public-works/highways/snow-information/index.html. The County is dedicated to ensuring the safety of the traveling public while also providing timely service to County residents and businesses during inclement weather. This webpage succinctly explains the County's efforts toward winter preparations, what citizens and business should expect during snow storms, what County citizens can do to help during

inclement weather events, and general winter weather tips. Some excerpts from this webpage include:

> *"Winter operations activities related to snow and ice control include plowing snow from the roadway and shoulders, and responsibly applying deicing chemicals to arterial and collector roads and isolated icy spots to facilitate snow plowing.*
>
> *Anne Arundel County uses covered storage facilities for its road salt and stores a total of approximately 11,650 tons of salt at the following locations: Dover Road (Glen Burnie), Mountain Road (Pasadena), Crownsville Road (Annapolis), Broadneck Road (St. Margarets), Duckins Street (Odenton), West Central Avenue (Davidsonville), and at a storage yard in Friendship, MD. At the present time, a small portion of Anne Arundel County's fleet is equipped with liquid calcium chloride pre-wetting equipment. Pre-wetting dry salt during its application helps the salt to adhere to the roadway. In contrast, dry salt can "bounce" and blow off the roadway and be less effective.*
>
> *Deicing materials are an effective tool for maintaining safe winter road conditions. However, Anne Arundel County is aware that excessive use can have negative impacts on the environment. We strive to only apply as much salt as necessary to achieve safe driving conditions. So, what are some of the environmental concerns associated with road salts? Heavy use of road salts has been assessed to cause damage to vegetation, organisms in soil, birds and to other wildlife. Chloride ions from road salts find their way eventually into waterways, whether by direct runoff into surface water or by moving through the soil and groundwater. In surface water, road salts can harm freshwater plants, fish and other organisms that are not adapted to living in saline waters.*
>
> *In winter months, as soon as snow begins to accumulate, equipment is dispatched to service arterial and collector roadways. Our next priority will be insuring each community road is passable. Passable means that although the road may be snow-covered or snow-packed, at least one travel lane will be accessible with a front-wheel drive car. All-weather tires are a must. If our snowplow driver determines that your street meets our definition of passable, no further service will be provided."*

Residential car care and residential car washing can readily contribute pollutants to the storm drain system as can improper boat cleaning and maintenance actions. Information on proper maintenance and cleaning of these vehicles is provided on both the County WPRP web page (www.aarivers.org) and through the County's Watershed Stewards Academy (WSA). In addition to outreach by individual stewards, information on proper car and boat repair is found on the WSA webpage (aawsa.org/maintain-cars-and-boats/). This

webpage also include links to Maryland's Clean Marina Initiative and Eco-Friendly Car Washing, among others. The WPRP has developed a 'tip card' distributed to residents regarding proper car washing techniques.

The Public Safety article of the Anne Arundel County Code includes regulations governing animal control. Code section §12-4-909 is specific to the removal of animal excreta and requires that "A person shall remove excreta deposited by an animal owned by that person on public walks, recreation areas, or private property other than the owner's." DPW WMS advises residents on the proper disposal methods for a variety of problematic household waste products, including pet waste. Additionally, education regarding pet waste management is included on the "Think Bay" section of the WPRP webpage (www.aarivers.org) as well as the WSA webpage (http://aawsa.org/pick-up-pet-waste/). These webpages include links to information regarding pet waste removal stations as well as local services that will clean up pet waste. WPRP has also developed a 'tip card' distributed to residents regrading proper pet waste management.

During this reporting year Anne Arundel County DPW, the County Board of Education's Arlington Echo Outdoor Education Center, The Keith Campbell Foundation, the Chesapeake Bay Trust and National Fish and Wildlife Foundation continued to provide leadership and funding to the Watershed Stewards Academy (WSA), which was established in 2008 as an organized framework to educate community leaders to become "Master Watershed Stewards". During this reporting period, WSA completed certification of 26 Master Watershed Stewards, including the completion of capstone projects. Capstone projects include a comprehensive community assessment; outreach and education to the community on how to reduce pollution sources and employ rainscaping to reduce runoff; and either one in-the-ground rainscaping project per person or one behavior change program per group.

During the reporting period, WSA welcomed 45 new Master Watershed Steward Candidates into the 7th Certification Course. This year's certification course was divided into two tracks: Riverwise Congregations and RainScaping. The RiverWise Congregations Program, a partnership of WSA, the Alliance for the Chesapeake Bay and Interfaith Partners for the Chesapeake to engage faith communities in action for cleaner water. Also, 28 new Master Watershed Stewards were trained to coordinate and care for stormwater projects on congregation land and provide environmental education and outreach in faith congregations throughout Anne Arundel County. During their candidate year, it is estimated that faith based Stewards will reach over 12,000 people from faith congregations throughout Anne Arundel County.

Once certified, Master Watershed Stewards complete about 40 hours per year in volunteer community watershed restoration, and have networking

opportunities through five continuing education classes and three networking sessions annually. All certification and continuing education courses were instructed by stormwater professionals or Master Watershed Stewards and consisted of 50+ volunteer instructors logging over 120 hours of volunteer time spent on instruction.

The WSA continued to support and engage Certified Master Watershed Stewards through the following activities:

- Conducted three networking meetings designed to allow Stewards to share their successes and learn new techniques for engaging communities.
- Offered five continuing education classes for Certified Stewards.
- Held the fourth annual "Spring into Action" conference to a sellout crowd of 200 Stewards and Consortium members. This day-long conference offered additional training and networking opportunities to foster collaboration and action.
- Coordinated the use of training and outreach materials.
- Coordinated plant orders to give Stewards wholesale rates for additional rainscaping projects in their communities.
- Connected interested communities with their closest Master Watershed Steward for consultation and presentations.
- Coordinated the Backyard Buffer program, in collaboration with Maryland Department of Natural Resources (DNR), in which 2,400 tree seedlings were planted in areas adjacent to stormwater flow. An educational workshop for participants was held to instruct homeowners on how to plan, install and care for trees.
- Created several web-based tools to assist Stewards and communities in the installation of RainScaping projects including; Runoff Calculator, designed to simulate the runoff reduced of projects; Conservation Landscape Design Tool; and WSA Rainscaping Guidebook for residents and contractors.
- A Behavior Change Handbook was also completed during the reporting period. This handbook guides Stewards thought the community-based social marketing (CBSM) strategy which uses information about target audiences' barriers, perceived benefits and motivators to changing their behavior, to craft specifically focused marketing tools that will effect positive social change. CBSM tools may include informational brochures, reminder prompts, or pledges and are focused on targeting specific, identified barriers and benefits. Stewards have used the document to create a Pet Waste Management campaign to use in their local community.

As a group, Certified Steward and Steward Candidates gave over 3,500 volunteer hours toward engaging their communities in stormwater education and restoration. Stewards engaged over 800 community volunteers who gave almost 4,000 volunteer hours to install and maintain stormwater BMPs. They reached over 9,000 people in one-on-one outreach and education on stormwater topics. Stewards and their communities installed 123 rain barrels that captured over 6,765 gallons of water during each major rain event; planted over 9,400 native trees and plants; created 491,600 square feet of stormwater restoration; and removed almost 1,100 square feet of invasive plants. .Stewards recruited over $600,000 in grant matching funds and led their communities to donate almost $116,000 in private funds. Additionally, in-kind services valued at over $52,000 were donated to Steward projects.

The Watershed Stewards Academy continues with the piloting, development, and launch of the Clean Water Communities (CWC) Certification in the Linthicum area. This certification allows neighborhoods to utilize various stormwater practices and behavior change tools in order to reduce stormwater pollution and improve the health of local waterways in Anne Arundel County. One of the essential goals of Clean Water Communities is reduce runoff by 20% on residential properties. This is done through the installation of various best management practices which include but are not limited to conservation landscapes, rain gardens, rain barrels, cisterns, bioswales, and impervious surface removal. During the pilot, 10 residential properties were selected for implementation. As of June 30, 2015, Rainscaping Projects were installed on 6 of those properties with the final 4 properties scheduled for completion in the Fall of 2015. In total, the project will have installed:

- 1 rain garden
- 20 native trees
- 26 rain barrels
- 1 bioswale
- 2 grass infiltration swales
- 8 conservation landscapings
- 1 dry well
- 2 cisterns
- 1 permeable berm
- 1 french drain

As noted in prior Annual Reports, the WSA developed and refined training and resources for stewards to employ community-based social marketing to affect pollutant reducing behavior changes such as pet waste disposal, removal of leaves from impervious surfaces, and reduction in fertilizer use. Using face-to-face surveys, Stewards are taught to measure a baseline of behavior and measure a behavior change. They are also supported with

template tools and sample behavior change campaigns for use in their own community.

The WSA continued to facilitate the networking of Anne Arundel County restoration resources via involvement of watershed organizations, the WSA Consortium of Support Professionals, County restoration projects, and private communities to avoid duplication and further common goals.

From stormwater design and land-use planning, to public opinion research and engineering, the WSA Board members bring a diverse set of skills to lead the organization. The Board is united in their passion to support the mission of WSA; each member contributes in a unique and significant way. The Board roles include strategic planning, partnership building and fund-raising. In addition, board members led several Stormwater Tours designed to raise awareness of WSA and educate citizens of Anne Arundel County about the stormwater issues facing our county and successful solutions to those issues.

In an effort to increase stormwater pollution awareness throughout Anne Arundel County, the WPRP has developed a compressive web-based informational program. A major component of this initiative was the development of the WPRP's webpage (www.aarivers.org) to provide residents with an overview of the WPRP program and stormwater fee, environmental restoration plans, watershed assessments and information about stormwater pollution in general. The webpage also provides links to other County departments such as Utilities for water conservation tips and Inspections and Permits for stormwater management and Chesapeake Bay Critical Area information.

Since the development of the WPRP webpage, several enhancements have been integrated. Residents are provided with educational resources to reduce stormwater pollution from their property. Residents learn how their everyday actions can have an impact on our local waterways and provide recommendations on how they can minimize these impacts. The following topics are addressed:

- Rain barrel benefits and installation
- Rain garden benefits and installation
- Permeable pavement and paver benefits and installation
- Bay-friendly car maintenance tips
- Household Hazardous Waste disposal tips
- Fertilizer and pesticide application tips
- Recycling, litter reduction and source reduction tips
- Pet waste management tips
- Onsite septic tank maintenance tips
- Green boating tips

- Bay-friendly de-icing tips
- Effects of various types of pollutants on water quality

In the coming months, several additional enhancements are planned for the webpage. The goal is to provide residents with the most up to date information regarding the WPRP in the most convenient way.

In addition to the WPRP webpage, several social media outlets including Facebook (https://www.facebook.com/aawprp) and Twitter (https://twitter.com/AAWPRP), were also introduced to help educate residents about water quality issues and to provide an avenue for timely updates of restoration projects, educational materials, links to local watershed groups and newspaper articles. These social media sites are updated on a daily basis and provide residents with an outlet to discuss local stormwater issues and allow the WPRP to continually educate residents about the program.

The Arlington Echo Outdoor Education Center is operated by the Office of Environmental Literacy and Outdoor Education Program of Anne Arundel County Public Schools. Arlington Echo Outdoor Education Center offers Anne Arundel County students year-round opportunities to experience the natural environment. The Outdoor Education programs at Arlington Echo use environmental and outdoor learning to enhance, extend and enrich classroom curriculum. Arlington Echo mainly hosts fourth grade elementary students on day and overnight trips, but also hosts middle, and high school groups.

While developing a positive environmental ethic and sense of stewardship, students learn the meaning of respecting each other as well as respecting the environment. By the end of their residential experience, students are given the tools necessary to become Chesapeake Stewards, and have gained the knowledge to protect and preserve the Chesapeake Bay and its watershed at home, school, and on their own.

Chesapeake Connections is the Outdoor Education outreach program of Arlington Echo which connects classroom instruction with a series of relevant hands-on experiences that lead to environmental stewardship. The staff at Arlington Echo Outdoor Education Center provides support and expertise to complete yearlong environmental service-learning projects as part of Chesapeake Connections with many Anne Arundel middle and elementary schools. The service-learning projects are infused into each school's curricula and involve using community areas or school grounds for environmental restoration activities. The program works to restore and/or create bogs, gardens, and runoff areas on school grounds or in the community. These projects meet growing environmental needs in our area and help protect the Chesapeake Bay.

The WPRP has partnered with the Chesapeake Connections program to provide hands-on experiences for Anne Arundel County students through the planting of native trees and other vegetation at several restoration projects. Below is a listing of those opportunities that occurred during the reporting period:

- Ruppert's Ravine Restoration – 360 6th grade students from Old Mill Middle – South
- Gray's Luck Pond Retrofit – 200 6th grade students from Corkran Middle School
- Collington Court Pond Retofit – 40 AP Science students from Broadneck High School
- Haskell Drive Outfall Retrofit – 300 6th grade students from Marley Middle School
- Denington Lane Pond Retrofit – 120 6th grade students from Severna Park Middle School
- Olde Severna Park Outfall Repair – 300 6th grade students from Severna Park Middle School
- Buena Vista Phase 2 – 12 AP Environmental students from Broadneck High School
- Leeds Dr. – 300 6th grade students from Lindale Middle School
- Crofton Tributaries Phase 1 – 300 6th grade students from MacArthur Middle School

Successful conservation and preservation of Anne Arundel County's watersheds takes teamwork. To that end, in FY15 the Anne Arundel County Department of Public Works, in partnership with the Chesapeake Bay Trust, announced the Anne Arundel County Watershed Restoration Grant Program, a new community grant program to support watershed restoration activities throughout the County in order to improve water quality in local streams and rivers.

The grant program was created to engage local nonprofit organizations, landowners, and communities in efforts to restore the County's waterways; to provide resources to these groups to enable them to implement greening and water quality projects; and to assist Anne Arundel County's efforts to meet the requirements of its state and federal stormwater pollution permit and local waterway cleanup plan. This program encourages on-the-ground restoration activities that reduce stormwater flow and pollutants and engage Anne Arundel County residents in these activities. A total of $444,108 was awarded to our partner organization for completion of seven stormwater management projects. Below is a list of organizations that were awarded funding from Anne Arundel County for water quality restoration projects in FY15:

ORGANIZATION	PROJECT DESCRIPTION
Ben Oaks Civic Association	Ben Oaks Rain Garden
Herald Harbor Citizens Association	Bonaparte Road Bioswale and SPSC
Round Bay Community Association	Round Bay Community – Randall Road Rain Garden
South River Federation	Camp Woodlands Pre-Treatment Retrofit
South River Federation	Hillsmere Bioretention Expansion
South River Federation	Annapolis Harbour Center Stream and Wetland Restoration
West/Rhode Riverkeeper, Inc.	Avalon Shores Fire Department Stormwater Wetland

The WPRP strives to keep residents apprised of current accomplishments of the program. One of the most effective ways to communicate those milestones is through the local media. Below are select articles about the WPRP that were published during the reporting period:

- "*Stormwater projects rolling into summer*" – May 31, 2015-Capital Gazette, http://bit.ly/1M27htU.
- "*County to issue stormwater project grants*"- December 17, 2014-Capital Gazette, http://bit.ly/1M282mT.
- "*County wins first-place stormwater award*"-April 24, 2015-Capital Gazette, http://bit.ly/1M28oK6.
- "*Marley Middle digs into stormwater problems*"-November 6, 2014-Capital Gazette, http://bit.ly/1M28K3k
- Anne Arundel County students get dirty lesson: Broadneck HS students work at stormwater restoration site-March 25, 2015- WBAL-TV, http://bit.ly/1M2b4Y8

The following is a list of informational presentations and events in which the WPRP participated during the reporting period:

- 7/14/2014 - South River Federation
- 8/13/2014 - Shipleys Choice Dam Removal Public Mtg.
- 8/20/2014 - Gibson Island Garden Club
- 8/21/2014 - MD Homebuilder Association
- 8/27/2014 - Linthicum Shipley Improvement Association
- 9/4/2014 - Blue Water Baltimore
- 9/10/2014 - Anne Arundel County Fair (5 day event)
- 10/8/2014 - Bay Hills Community
- 10/9/2014 - AAC Environmental Summit
- 10/14/2014 - WSA
- 10/17/2014 - Greater Odenton Improvement Association
- 10/28/2014 - AAC Snow Expo
- 11/19/2014 - Lakeland Homeowners Association

- 1/5/2015 - Cypress Improvement Association
- 1/14/2015 - Linthicum Shipley Improvement Association
- 1/21/2015 - WSA
- 2/9/2015 - WSA Annual Meeting
- 2/18/2015 - Magothy River Association
- 3/9/2015 - Chartridge Community Association
- 3/14/2015 - Davidsonville Green Expo
- 3/19/2015 - Elephant Club
- 4/7/2015 - Stormwater Partners Meeting
- 4/15/2015 - Crofton Downs HOA
- 4/22/2015 - BWMC Earth Day Event
- 4/26/2015 - Earth Water Faith Festival
- 4/27/2015 - Annapolis Landing HOA
- 4/28/2015 - Restore Rock Creek
- 5/7/2015 - Severn River Commission
- 5/8/2015 - Eastport Democratic Club
- 5/12/2015 - Olde Brooklyn Park Improvement Association
- 5/14/2015 - Leadership Anne Arundel
- 5/15/2015 - Center for Watershed Protection
- 5/18/2015 - Roland Terrace Democratic Club
- 5/19/2015 - Severn River Association
- 5/20/2015 - Crofton Mews
- 6/17/2015 - Crofton Downs HOA
- 6/24/2015 - MACO Chesapeake Checkpoint Symposium

In addition to the above public outreach events and meetings, WPRP Project Managers provide continuous updates to members in the communities where our restoration projects occur. In some cases, feedback from the local community is taken into account from the design process through construction.

The Anne Arundel County Department of Health has published a fact sheet series entitled “Health Matters” (see examples in 2014 Annual Report). These fact sheets are distributed at events run by the Department of Health. Information can also be found on their website (www.aahealth.org). Some of the subjects covered include:

- Water quality and swimming or fishing in Anne Arundel County rivers and creeks;
- On-site sewage disposal systems and private water wells;
- Bay Restoration Fund (BRF) Program, for nitrogen-reducing pretreatment units for septic systems to be installed within the Chesapeake Bay Critical Area;
- Collapsed septic tanks, overflowing septic systems and failing septic systems interim health and safety requirements; and

- Application procedures for property improvements where well or on-site septic systems are utilized.

The Anne Arundel County Department of Health continues to publicize a seasonal water quality information line (410-222-7999) on the Department of Health's website (www.aahealth.org). The water quality information line alerts the public to current advisories and closures of recreational water as the result of sewage spills and bacterial exceedances from over 80 bathing beaches that the department monitors from Memorial Day through Labor Day. The Department also promotes an e-alert system so an individual can be notified by e-mail when the Department has an advisory or closure of recreational waters. Individuals can sign up for the e-alert system on the Department of Health's website. In addition, water quality advisories are communicated via the Department's Facebook and Twitter pages. The Department continued to recommend no direct water contact for 48 hours after a significant rain event due to predicted elevated bacteria levels.

The Department of Health, in conjunction with MDE and the Maryland Department of Health and Mental Hygiene, promotes the Maryland Healthy Beaches campaign (marylandhealthybeaches.com/). The campaign makes people aware of everyone's impact to the waterways in the State of Maryland. One of the campaigns major focus is the importance of picking up pet waste. In 2013, the Department of Health created a 'Beach Swimming Guide' on its website to keep the public abreast of recreational water quality in the County.

The Department of Health also publicizes information about on-site sewage disposal systems and private water wells. The Department also provides a DVD on the maintenance and care of an on-site sewage disposal system to each individual homeowner at the time of installation for each newly installed system. The DVD's are also available to view on the department's web-site.

The Department of Health promotes the Bay Restoration Program. This program is a grant that plans to use grant funds to help qualified applicants connect to existing public sewer and continues to pay for nitrogen reducing pretreatment units that must be installed in conjunction with an onsite sewage disposal system that is in the Chesapeake Bay Critical Area. The grant funds the entire cost off the treatment unit and a five-year service and maintenance program for repairs of failing systems in the Critical Area. The Department of Health administers this grant, awarded by MDE. In FY15, the Department of Health used the Fund to subsidize the installation of 241 pretreatment units. These treatment units reduce the nitrogen load from an on-site sewage disposal system by at least 50 percent. This is a direct reduction to the nitrogen load that is reaching the Chesapeake Bay. In addition, the Bay Restoration Fund Program has been expanded to include public sewer connections of existing dwellings currently served by a septic system where

public sewer is available and immediately abuts a property. During the reporting period 15 new connections were made to the public sewer system.

There are many other environmental health information topics located on the Department's website, under Environmental Health, including:

- The Bay Restoration Fund,
- Environmental Assistance Programs,
- Environmental Health Fees,
- Public Pool and Spa Discharge requirements,
- Recreational water quality, and
- Well and Septic Systems.

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.

Status:

The County provides training for staff working at County facilities having stormwater general discharge permits (Permit 12-SW) as discussed in **IV.D.5.v.** Managers at each of these County-owned facilities have updated their SWPPPs following the issuance of the new General Permit by MDE in January 2014 and perform pollution prevention training as set forth in their SWPPP. Training is performed yearly at a minimum, which is critical to ensure staff are fully knowledgeable of the potential pollutant sources at each facility, how to properly store and handle these sources, and the procedures for responding to a spill or emergency. Refresher trainings are provided when necessary.

By way of example, the County's BOH has developed a comprehensive in-house training document for the road operations yards. This training consists of a series of six modules intended to educate staff on pollutant sources, the importance of stormwater pollution prevention, what components constitute a stormwater pollution prevention plan, implementation of a stormwater pollution prevention plan, secondary containment concepts, and an effective pollution prevention team. These modules are presented on an annual, rotating basis.

In demonstration of compliance, SWPPP Evaluation Reports for the County's Waste Management Services facilities are completed on a regular basis, including training outlines for each. Pollution prevention plans and spill

prevention, control, and countermeasure plans are kept at these facilities and updated regularly.

E. Restoration Plans and Total Maximum Daily Loads

Anne Arundel County shall annually provide watershed assessments, restoration plans, opportunities for public participation, and TMDL compliance status to MDE. A systematic assessment shall be conducted and a detailed restoration plan developed for all watersheds within Anne Arundel County. As required below, watershed assessments and restoration plans shall include a thorough water quality analysis, identification of water quality improvement opportunities, and a schedule for BMP and programmatic implementation to meet stormwater WLAs included in EPA approved TMDLs.

1. Watershed Assessments

a. By the end of the permit term, Anne Arundel County shall complete detailed watershed assessments for the entire County. Watershed assessments conducted during previous permit cycles may be used to comply with this requirement provided the assessments include all of the items listed in PART IV.E.1.b below. Assessments shall be performed at an appropriate watershed scale (e.g., Maryland's hierarchical eight or twelve-digit sub-basins) and be based on MDE's TMDL analysis or an equivalent and comparable County water quality analysis;

b. Watershed assessments by the County shall;

- ***i. Determine current water quality conditions;***
- ***ii. Include the results of a visual watershed inspection;***
- ***iii. Identify and rank water quality problems;***
- ***iv. Prioritize all structural and nonstructural water quality improvement projects; and***
- ***v. Specify pollutant load reduction benchmarks and deadlines that demonstrate progress toward meeting all applicable stormwater WLAs.***

Status:

Anne Arundel County developed a TMDL Support group within the Watershed Protection and Restoration Program (WPRP) to comply with certain conditions outlined in the NPDES MS4 permit. One component of the program is to perform watershed assessments, as stipulated by the permit requirements (**Part E.1.b**), for each of the County's 12 watersheds. The watershed studies involve a partnership between the County, various consultants, and citizen stakeholders. The field data collection is performed primarily by consultants specifically for each watershed study effort. All modeling, analysis, and reporting are performed in-house by

County staff. Once the data are collected and analyzed for a watershed, the staff collaborates with the consultants and other citizen stakeholders in a series of professional management team meetings to thoroughly review the information and reach consensus pertaining to assumptions and data interpretations. Once consensus is reached, the County publishes the study, including recommended restoration/preservation actions and desired implementation strategies. Additionally, environmental concerns and recommendations are portrayed in GIS files published on the County website via the interactive WERS mapping application found at the following website address: http://gis-world2.aacounty.org/silverlightviewer/?Viewer=WERS.

Recommendations developed during watershed studies are used to advise and prioritize land use decisions and Capital Improvement Program expenditures relating to environmental restoration and preservation. To expedite implementation, preliminary restoration designs are developed as part of the watershed assessment and planning effort for some of the highest priority recommendations.

During the past permit cycle, the County completed watershed assessments for 7 of its 12 watersheds (Bodkin Creek, Magothy River, Patapsco Non-Tidal, Patapsco Tidal, Severn River, South River, and Upper Patuxent). During FY2015, two watershed assessments were underway (Little Patuxent, and West and Rhode Rivers). The remaining two watershed assessments (Herring Bay and Middle Patuxent) and are expected to be underway in FY2017.

Completed watershed assessments can be found on the County's website: www.aacounty.org/departments/public-works/wprp/watershed-assessment-and-planning/watershed-studies/. Table 7 shows the current schedule established to complete these studies.

During 2015, the County completed the Condition Assessment geomorphology analyses for the West and Rhode Rivers Study. Work remains to be completed for the prioritization analyses. All study related materials will be published on the County website: www.aacounty.org/departments/public-works/wprp/watershed-assessment-and-planning/watershed-studies/.

The draft report for Little Patuxent Watershed Assessment is expected to be finalized by the end of February 2016. At that time, the County will advertise the document for a 30-day public comment period. The draft report will be made available for review and/or download through the County webpage, and a minimum number of hard copy reports will be made available on request. Prior to final acceptance, a summary of the comments received and County response will be incorporated into the report. All study related materials will be published on the County website.

Watershed restoration efforts are monitored through the County's WPRP Ecological Assessment and Evaluation program. This program supports the

ongoing assessment of restoration project efficacy. At a minimum, restoration projects are monitored for stability and native vegetation survivability for up to five years following project completion. During this monitoring period, any identified issues that may lead to project failure are either addressed through immediate remediation via the Stream Monitoring project, or are put forward for re-design and construction through a stand-alone capital project.

Table 7. Watershed Assessment Schedule

Watershed	MDE 8-Digit Watershed Code	Timeline for Targeted Bioassessment Completion (Calendar Year)	Timeline for Habitat Assessment Completion (Calendar Year)	Timeline for Analysis Completion (Calendar Year)
Severn	02131002	Complete	Complete	Complete
South	02131003	Complete	Complete	Complete
Upper Patuxent	02131104	Complete	Complete	Complete
Magothy	02131001	Complete	Complete	Complete
Patapsco Non-Tidal	02130906	Complete	Complete	Complete
Patapsco Tidal	02130903	Complete	Complete	Complete
Bodkin	02130902	Complete	Complete	Complete
Little Patuxent	02131105	Complete	Complete	2016
Rhode	02131004	Complete	Complete	2016
West	02131004	Complete	Complete	2016
Herring Bay	02131005	Complete	2016	2017
Middle Patuxent	02131102	2016	2017	2017

2. <u>Restoration Plans</u>

a. Within one year of permit issuance, Anne Arundel County 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, June 2011 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, Anne Arundel County shall commence and complete the implementation of restoration efforts for twenty percent of the County'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 WQ_v 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.

Status:

The County's process for determining the restoration acreage goal was documented in its May 2015 impervious area assessment (Establishing Baseline - Impervious Area Assessment, Impervious Surfaces Treated to the MEP, submitted to MDE May 26, 2015). In July 2015, Maryland Department of the Environment (MDE) approved this impervious surface area assessment and the associated baseline for impervious area restoration. The impervious area assessment identified 1,639 acres as managed to the MEP (i.e., the baseline of managed impervious area) and 29,311 acres as either having no stormwater management or only partial management (i.e., the baseline of unmanaged impervious area). This resulted in an equivalent 20% restoration acreage goal of 5,862 acres (restoration goal), to be completed by the County on or before February 2019.

Included in **Appendix I** is the County's Impervious Area Restoration Plan for FY2015. This document provides a narrative description of the County's impervious area restoration progress to date, and projection of progress through the end of the permit term. Included in the County's Impervious Area Restoration Plan are County CIP restoration projects as well as alternative urban BMPs (i.e., street sweeping, septic system connections to WWTP, and septic systems upgraded to enhanced denitrification systems), County-funded restoration grant projects, and other NGO restoration projects.

To summarize this plan, the County completed restoration efforts equivalent to 48 impervious acres between February and July 2014, and 744 impervious acres during FY2015. The cumulative impervious area restored through the end of FY2015 is 792 acres.

b. Within one year of permit issuance, Anne Arundel County shall submit to MDE for approval a restoration plan for each stormwater WLA approved by EPA prior to the effective date of the permit. The County shall submit restoration plans for subsequent TMDL WLAs within one year of EPA approval. Upon approval by MDE, these restoration plans will be enforceable under this permit. As part of the restoration plans, Anne Arundel County shall:

i. Include the final date for meeting applicable WLAs and a detailed schedule for implementing all structural and nonstructural water quality 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 restoration plans through monitoring or modeling to document 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 County's watershed assessments.***

Status:

As of this reporting period TMDLs have been approved for 96 impairments within Anne Arundel County. These TMDLs have been developed and approved for waterbodies receiving stormwater runoff from Anne Arundel County MS4 permit-regulated land areas (see attached "Anne Arundel County TMDLs Summary by Impairment" EXCEL spreadsheet, **Appendix H**). Pursuant to its NPDES MS4 Permit requirements, Anne Arundel County is obligated to develop and submit to MDE restoration plans for every EPA approved TMDL having a stormwater wasteload allocation. These restoration plans identify a suite of structural and non-structural projects and programs necessary for meeting the WLAs identified in the Chesapeake Bay TMDL and the individual TMDLs and include cost estimates and a schedule for implementation. These restoration plans are being developed pursuant to the following MDE guidance documents:

- *"Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated – Guidance for National Pollutant Discharge Elimination System Stormwater Permits". August 2014*
- *"General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan". May 2014*
- *"Guidance for Developing a Stormwater Wasteload Allocation Implementation Plan for Bacteria Total Maximum Daily Loads". May 2014*
- *"Guidance for Developing a Stormwater Wasteload Allocation Implementation Plan for Nutrient and Sediment Total Maximum Daily Loads". November 2014*
- *"MDE Recommendations for Addressing the PCB SW-WLA". 2015*

Described below are EPA-approved TMDLs for Anne Arundel County that have a stormwater WLA, and the status of the restoration plans associated with them. **Appendix H** contains the completed draft individual TMDL Restoration Plans.

EPA has set 2025 as the final date for meeting the applicable WLA set forth in the Chesapeake Bay TMDL. For consistency purposes, Anne Arundel County has set

2025 as the final date for meeting the Stormwater WLAs for all other impairments with the exception of PCBs for which TMDLs were approved prior to the issuance of the County's current NPDES MS4 Permit (February 12, 2014). Further, Anne Arundel County has aligned its interim benchmarks with the Chesapeake Bay TMDL 2-Year Milestones.

Nitrogen, Phosphorus, and Sediment TMDLs

The Chesapeake Bay TMDL, as noted in Table 8, was approved on 29 December 2010 and applies to all of Anne Arundel County.

Table 8. Chesapeake Bay Nitrogen, Phosphorus, and Sediment TMDL

Location	Approval Date
Countywide	December 29, 2010

Sixty-six (66) of the ninety-six (96) individual impairments associated with nitrogen, phosphorus and total suspended solids are included in the *Chesapeake Bay TMDL for Nitrogen, Phosphorus and Sediment, December 29, 2010*. Anne Arundel County's Phase II Watershed Implementation Plan (WIP) serves as the restoration plan for the Stormwater WLAs for these impairments. Anne Arundel County's Phase II WIP can be found at: www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/WIPPhaseIICountyDocuments.aspx

On September 15, 2011 MDE finalized its Phase II Load Allocations. Anne Arundel County's Phase I MS4 load allocations are set forth in Table 9.

Table 9. Anne Arundel County (Non-Federal) Stormwater Wasteload Allocation

	Nitrogen (TN)	Phosphorus (TP)
2009 Baseline	657,383	56,531
2017 Interim Target	511,963	38,062
2025 Final Target	449,641	30,147

*Per Maryland's Phase II WIP, if TP is met, TSS target will be met.

Status of Restoration Plan:
In January 2015, Anne Arundel County submitted interim progress reports to MDE for its 2014-2015 Implementation and Programmatic 2-Year Milestones. These progress reports can be found at: www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/Programs/WaterPrograms/TMDL/implementation.aspx

Anne Arundel County submitted its FINAL 2014-2015 Implementation and Programmatic 2-Year Milestone Final Progress Reports to MDE on January 29, 2016. Along with the FINAL 2-Year Milestone reports, Anne Arundel County submitted its 2016-2017 Implementation and Programmatic 2-Year Milestones.

Individual Bacteria TMDLs

Table 10 characterizes the individual bacteria TMDLs in the County.

Table 10. Bacteria TMDLs

Location	Approval Date	% Reduction Required*
Magothy River Mainstem	February 20, 2006	12.8
Magothy River/Forked Creek	February 20, 2006	26.3
Magothy River/Tar Cove	February 20, 2006	0.0
Patapsco River/Furnace Creek	March 10, 2011	77.7
Patapsco River Lower North Branch, 8 Digit WS 02130906	December 3, 2009	20.7
Patapsco River/Marley Creek	March 10, 2011	75.7
Upper Patuxent River, Subsegment of 8 Digit WS 0213114	August 9, 2011	22.3
Rhode River/Bear Neck Creek	February 20, 2006	43.3
Rhode River/Cadle Creek	February 20, 2006	72.2
Severn River Mainstem, Subsegment of 8 Digit WS 02131002	April 10, 2008	19.0
Severn River/Mill Creek	April 10, 2008	86.0
Severn River/Whitehall & Meredith Creeks	April 10, 2008	90.0
South River/Duvall Creek	November 4, 2005	45.6
South River, Subsegment of 8 Digit WS 02131003	November 4, 2005	29.5
South River/Ramsey Lake	November 4, 2005	59.3
South River/Selby Bay	November 4, 2005	0.0
W.Chesapeake Bay/Tracy & Rockhold Creeks	February 20, 2006	81.6
West River, Subsegment of 8 Digit WS 02131004	February 20, 2006	35.3
West River/Parish Creek	February 20, 2006	53.1

*Based on the MDE published TMDL documents for bacteria impaired watersheds in Anne Arundel County and Anne Arundel County's *Draft Total Maximum Daily Load Restoration Plan for Bacteria, February 2015"*. Percent reductions required for the Patapsco and Upper Patuxent are for the Anne Arundel County portion only.

There are currently nineteen (19) approved bacteria TMDLs associated with Anne Arundel County watersheds. Fecal coliform is the impairing pollutant for fifteen (15) of the TMDLs, while E. coli and Enterococci are identified as the impairing pollutant for the remaining four (4). Each of the TMDLs set forth a Stormwater WLA which is noted as a percent reduction in the above table.

MDE identified four bacteria source categories in each of the 19 TMDLs: pet waste, wildlife, humans, and livestock. During the development of the TMDLs MDE quantified the contribution for each of these source categories to the impaired waterbody. Among all 19 TMDL watersheds, the average percent contribution for each category was determined (Table 11).

Table 11. Contributions to bacteria sources

Bacteria Source Category	Average % Contribution
Pet Waste	46.0
Wildlife	34.5
Human	6.9
Livestock	12.6
TOTAL	**100**

Due to the number of bacteria TMDLs and because all of the four source categories were representative of the impaired waterbodies, Anne Arundel County chose to develop a single consolidated implementation plan to address all 19 bacteria TMDLs.

Status of Restoration Plan:
During 2014-2015 a draft Restoration Plan was developed and distributed to other Anne Arundel County agencies for review and input prior to being submitted to MDE for review and comment as part of the 2014 NPDES MS4 Annual Report. This plan set forth proposed strategies for reducing bacteria loads that are broadly grouped into two tiers. Tier A strategies are proposed to reduce human bacteria sources and Tier B strategies are proposed to reduce non-human source (i.e., from wildlife, pet, and livestock waste). On May 19, 2015 MDE provided comments back to Anne Arundel County on the draft plan. Anne Arundel County addressed MDE's comments. The revised draft Restoration Plan is submitted as an appendix to this report (**Appendix H**). Once MDE concurs that their comments have been adequately addressed in the revised Restoration Plan the plan will be distributed to local watershed associations, posted on the County's web page, and notice of availability will be made in local newspapers to solicit public input. A public comment period will be held open for thirty (30) days after which the plan will be revised as appropriate based on comments received and a comment response document prepared. Both the revised plan incorporating public comments and the comment response document will be provided to MDE for final approval. Once MDE has approved the plan and the plan is considered final it will be posted on the County's website along with the comment response document.

Individual Nutrient TMDLs

The individual nutrient TMDL for Baltimore Harbor is characterized in Table 12.

Table 12. Nutrient TMDLs

Location	Approval Date
Baltimore Harbor	December 17, 2007 TMDL Revised August 31, 2015 (public comment period closed October 13, 2015)

Currently the "Total Maximum Daily Loads of Nitrogen and Phosphorus for the Baltimore Harbor in Anne Arundel, Baltimore, Carroll and Howard Counties and Baltimore City, Maryland" approved by EPA in 2007 and revised by MDE in August 2015 is the only individual nutrient TMDL in Anne Arundel County. All other waterbodies listed as impaired for nitrogen and phosphorus are included in the 2010 Chesapeake Bay TMDL. Reductions in nitrogen and phosphorus loads for those waterbodies are addressed by Anne Arundel County's Phase II WIP, July 2012.

The Baltimore Harbor TMDL covers 46,223 acres of the Patapsco tidal and Patapsco non-tidal watersheds within Anne Arundel County. To assure that critical conditions are addressed, the TMDL establishes a growing season allocation (May 1 through October 31) as well as an average annual allocation. The water quality goal of these TMDLs is to reduce excessive algal blooms that result in high chlorophyll *a* concentrations, and maintain the dissolved oxygen concentrations at levels above the water quality criteria for the specific designated uses of the Baltimore Harbor. The Baltimore Harbor TMDL sets forth Anne Arundel County's stormwater WLAs as listed in Table 13.

Table 13. Baseline loads and stormwater WLAs for the Baltimore Harbor TMDL

	Baseline Load	Load Allocation	Units	% Load Reduction
	Nitrogen			
Average Annual	187,433	159,318	lb/yr	15%
Growing Season	14,433	12,277	lb/ month	15%
	Phosphorus			
Average Annual	20,288	17,245	lb/yr	15%
Growing Season	1,434	1,219	lb/month	15%

Status of Restoration Plan:

Anne Arundel County initiated the development of a restoration plan to address the Baltimore Harbor Nutrient TMDL in response to comments received in MDE's letter dated May 19, 2015. The draft Restoration Plan is anticipated to be complete on February 19 and will be submitted to MDE under separate cover when received. Following MDE's initial review the County will revise the plan to respond to MDE's comments. The County will then advertise the availability of the plan for public comment in the local newspapers. The draft plan will also be

posted on the County's web page to solicit input from the public. Following a thirty (30) day public comment period the County will revise the plan to incorporate public comments as appropriate and develop a comment response document. The revised plan will be submitted to MDE for final approval. Once approved, the final approved plan will be posted on the County's web page.

Individual PCB TMDLs

There are currently four (4) EPA approved PCB TMDLs and one (1) draft PCB TMDLs in Anne Arundel County. The location of the TMDL and the approval dates are noted in Table 14.

Table 14. PCB TMDLs

Location	Approval Date
Subsegment of 8 Digit WS 0230903/Baltimore Harbor and Curtis Creek/Bay	October 1, 2012
Magothy River	March 16, 2015
Severn River	Draft submitted to EPA for Approval October 30, 2015
South River	April 27, 2015
West and Rhode Rivers	January 8, 2016

SubSegment of 8 Digit WS 0230903/Baltimore Harbor and Curtis Creek

The Maryland Department of Environment identified the Baltimore Harbor portion of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment which includes Curtis Creek/Bay as individually impaired by PCBs in fish tissue. In addition, the Curtis Creek/Bay portion of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment has been identified as individually impaired by PCBs in sediment as well as fish tissue. Both of these individual PCB impairments are addressed in the *"Total Maximum Daily Loads of Polychlorinated Biphenyls in Baltimore Harbor, Curtis Creek/Bay, and Bear Creek Portions of Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Maryland"* which was approved by EPA on October 1, 2012. The Baltimore Harbor portion of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment encompasses Curtis Creek/Bay. Because the Curtis Creek/Bay segment was individually identified as impaired for PCBs due to sediment data, in addition to the impairment listing for the entire Baltimore Harbor portion of the Bay Segment based on PCB fish tissue concentrations, there is spatial overlap between the PCB listings for this Bay Segment. As a result, the baseline and TMDL loads for the Baltimore Harbor portion of the Bay Segment include the baseline and TMDL loads for the Curtis Creek/Bay segment.

Both nonpoint sources and point sources of PCBs were identified throughout the Baltimore Harbor embayment's watershed. Nonpoint sources include loads from

direct atmospheric deposition to the embayment, identified contaminated sites, resuspension and diffusion from bottom sediments, tidal influence from the Chesapeake Bay mainstem, tributaries outside of the embayment's direct drainage, and runoff from non-regulated watershed areas within the embayment's direct drainage. Point sources include loads from municipal wastewater treatment plants, industrial process water facilities, dredge material containment facilities and National Pollutant Discharge Elimination System (NPDES) regulated stormwater runoff from watershed areas within the embayment's direct drainage.

Although the transport of PCBs to the embayment from bottom sediments via resuspension and diffusion is estimated to be a major source of PCBs to the embayment this load contribution results from other point and nonpoint source inputs within the embayment's watershed and is not considered for reduction in the TMDL. Further, transport of PCBs into the embayment due to tidal influxes from the Chesapeake Bay mainstem could be a major source to the system; however due to the high water column concentration of PCBs within the embayment, modeling results indicate a net transport of PCBs out of the embayment into the Bay's mainstem. The baseline loads and TMDL allocations only consider current sources of PCBs to the embayment and Curtis Creek/Bay that are considered to be directly controllable, and therefore do not include resuspension and diffusion from bottom sediments or tidal influence of the Chesapeake Bay mainstem.

The modelling scenario used to develop the load reductions, wasteload allocations and load allocations for the tributary, nonregulated watershed runoff, NPDES regulated stormwater, and atmospheric deposition results in a required reduction of 91.5% for all watershed sources (e.g. tributaries, non-regulated watershed runoff, and NPDES regulated stormwater), with slight variations in the regulated stormwater sector due to the locations of contaminated sites, and a 57.6% reduction for atmospheric deposition in order to achieve the sediment and water column TMDL endpoint tPCB concentrations " (*Total Maximum Daily Load of Polychlorinated Biphenyls in the BALTIMORE Harbor, Curtis Creek/Bay, and Bear Creek Portions of Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Maryland. MDE. Document version: September 28, 2011. EPA Approval Date: October 12, 2012. Pg. xv).* Further, based on the modeling used in this TMDL a 92.1% reduction in regulated stormwater PCB loads is required for Anne Arundel County's portion of the Baltimore Harbor embayment and a 93.5% reduction in regulated stormwater PCB loads is required for Curtis Creek/Bay. Therefore, a TMDL Restoration Plan must be developed for Anne Arundel County's portion of these waterbodies and associated watersheds.

A summary of the tPCB baseline loads, TMDL allocations, load reductions, and maximum daily loads for the Baltimore Harbor and Curtis Creek/Bay is presented in Tables 15 and 16.

Table 15. tPCB Baseline Loads and Load Reductions for the Baltimore Harbor Embayment

Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)	Maximum Daily Load (g/day)
Direct Atm. Deposition (to surface of embayment)	1,360.88	22.0	576.47	57.6	5.30
Tribtuaries[a]					
Jones Falls	299.34	4.8	25.59	91.5	0.24
Gwynns Falls	541.42	8.7	46.29	91.5	0.43
Patapsco LN Branch	688.85	11.1	58.90	91.5	0.54
Non-regulated Watershed Runoff[b]	362.49	5.9	30.99	91.5	0.29
Contaminated Sites	14.51	0.2	14.51	0.0	0.13
Nonpoint Sources	**3,267.49**	**52.7**	**752.75**	**77.0**	**6.93**
Industrial Process Water[c]	859.38	13.9	498.60	42.0	4.24
WWTPs (Patapsco and Cox Creek)	366.81	5.9	32.83	91.1	0.28
DMCFs (Dredge Material Sites)	77.6	1.3	77.60	0.0	0.66
NPDES Regulated Stormwater[b,d]					
Anne Arundel County	850.74	13.7	66.97	92.1	0.62
Baltimore County	338.50	5.5	28.94	91.5	0.27
Baltimore City	435.27	7.0	30.44	93.0	0.28
Point Sources/WLAs	**2,928.31**	**47.3**	**735.22**	**74.9**	**6.34**
MOS (5%)	**-**	**-**	**78.31**	**-**	**0.70**
Total	**6,195.79**	**100.0**	**1,566.29**	**74.7**	**13.96**

Notes:

[a] Although the tributary loads are reported here as a single nonpoint source value, they could include both point and nonpoint source loads.

[b] Load applies to the direct drainage portion of the applicable watershed only.

[c] 18.66 g/year of the 498.6 g/year allocated to industrial process water point sources is assigned to the Back River WWTP Outfall 002, since the effluent from the outfall is routed to RG Steel for use in their industrial processes. The allocation to the Back River WWTP Outfall 002 is calculated as the part of the WWTP design flow allocated to the outfall, which is 50 Million Gallons per Day (MGD), multiplied by the water column TMDL endpoint, which is 0.27 ng/L.

[d] Load per jurisdiction applies to all NPDES stormwater dischargers within the direct drainage area of the jurisdiction to the Baltimore Harbor embayment.

Table 16. tPCB Baseline Loads and Load Reductions for Curtis Creek/Bay

Source[a]	Baseline Load (g/year)	Baseline Load (%)	TMDL	Load Reduction (%)	Maximum Daily Load (g/day)
Direct Atm. Deposition (to surface of embayment)	121.26	20.5	51.37	57.6	0.47
Non-regulated Watershed Runoff[b]	771.19	13.1	6.60	91.5	0.06
Contaminated Sites	7.84	1.3	7.84	0.0	0.07
Nonpoint Sources	**206.29**	**35.0**	**65.81**	**68.1**	**0.61**
Industrial Process Water[c]	-	-	-	-	-
WWTPs[c]	-	-	-	-	-
DMCFs[c] (Dredge Material Sites)	-	-	-	-	-
NPDES Regulated Stormwater[b,d]					
Anne Arundel County	357.68	60.6	23.13	93.5	0.21
Baltimore City	26.22	4.4	2.91	88.9	0.03
Point Sources (WLAs	***383.89***	***65.0***	***26.05***	***93.2***	***0.24***
MOS (5%)	-	-	***4.83***	-	***0.04***
Total	**590.18**	**100.0**	**96.68**	**83.6**	**0.89**

Notes:

[a] None of the Baltimore Harbor upstream tributaries (i.e., Jones Falls, Gwynns Falls, and the Patapsco River Lower North Branch) drain directly into the Curtis Creek/Bay portion of the embayment.

[b] Load applies to the direct drainage portion of the applicable watershed only.

[c] No industrial process water facilities, WWTPs, or DMCFs have been identified in the applicable watershed.

[d] Load per jurisdiction applies to all NPDES stormwater dischargers within the direct drainage area of the jurisdiction to Curtis Creek/Bay.

Source: Total Maximum Daily Load of Polychlorinated Biphenyls in the Baltimore Harbor, Curtis Creek/Bay, and Bear Creek Portions of Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Maryland, Document Version: September 28, 2011, EPA Approval Date: October 1, 2012.

Status of Restoration Plan

Anne Arundel County initiated the development of a restoration plan to address the Baltimore Harbor and Curtis Creek/Bay PCB TMDL in response to comments received in MDE's letter dated May 19, 2015. A copy of the draft Restoration Plan is being submitted to MDE for review with this annual report. Following MDE's initial review the County will revise the plan to respond to MDE's comments. The County will advertise the availability of the plan for public comment in the local newspapers. The draft plan will also be posted on the County's web page to solicit input from the public. Following a thirty (30) day public comment period the County will revise the plan to incorporate public comments as appropriate and develop a comment response document. The revised plan will be submitted to MDE for final approval. Once approved, the final approved plan will be posted on the County's web page.

Magothy River

The *"Total Maximum Daily Load of Polychlorinated Biphenyls in the Magothy River Mesohaline Chesapeake Bay Tidal Segment, Anne Arundel County, Maryland"* was approved by EPA on March 16, 2105. Because the Magothy River is identified as impaired for PCBs in fish tissue, the overall objective of the PCB TMDL for the Magothy River is to ensure that the "fishing" designated use, which is protective of human health related to the consumption of fish in the river, is supported. This TMDL, however, also ensures the protection of all other applicable designated uses within the river. More specifically, the objective of this TMDL is to reduce the current total PCB (tPCB) loads to the Magothy River so that the water column and sediment TMDL endpoint tPCB concentrations are achieved.

Both nonpoint sources and point sources of PCBs were identified in the watershed. Nonpoint sources identified include direct atmospheric deposition to the river, contaminated sites, runoff from non-regulated watershed areas and tidal influence from the Chesapeake Bay main stem. Point sources identified include only NPDES regulated stormwater runoff in the watershed. Although transport of PCBs from bottom sediments to the water column can be a source, under the framework of the approved TMDL it is not considered a source. The water quality model developed for this TMDL simulates conditions within the water column and sediment as a single system therefore exchanges between the sediment and water column are considered an internal loading. Only external sources to the system were assigned a baseline load or allocation.

The water quality model developed for simulating the ambient sediment and water column tPCB concentrations within the Magothy River was used to determine the specific load reductions that would result in simulated tPCB concentrations in the sediment and water column that meet the TMDL endpoints. The model assumes that the tPCB concentrations in the Chesapeake Bay main stem are decreasing at a rate of 5% per year. Given this rate of decline, the tPCB TMDL endpoints in both the water column and sediments in the Magothy River embayment will be met in approximately 43.4 years with the natural attenuation of tPCB concentration in the Chesapeake Bay main stem. Loads from the watershed, including non-point and point sources, and atmospheric deposition only account for 1.3% of the total tPCB baseline load. If these loads were reduced by 100% it would only reduce the time necessary to achieve the water column and sediment tPCB TMDL endpoints by 579 days (1.6 years). Therefore, the TMDL states that "no reductions to these loads are necessary in order to achieve the TMDL" (*Total Maximum Daily Load of Polychlorinated Biphenyls in the Magothy River Mesohaline Chesapeake Bay Tidal Segment, Anne Arundel County, Maryland. MDE. Document version: February 12, 2015. EPA Approval Date: March 16, 2015. Pg. 28).* When the TMDL endpoints are met, the tPCB load from the Chesapeake Bay main stem will be reduced by about 92.3%

including an explicit 5% Margin of Safety. At that time, the total load to the waterbody will be reduced by 90.6% from its baseline.

A summary of the tPCB baseline loads, TMDL allocations, load reductions, and maximum daily loads for the Magothy is presented in Table 17.

Table 17. tPCB Baseline Loads and Load Reductions for Magothy River

Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)	Maximum Daily Load (g/day)
Ches. Bay Mainstem Tidal Influence	3,759.0	98.7	289.4	92.3	1.139
Direct Atmospheric Deposition	35.9	0.9	35.9	0.0	0.141
Maryland Non-regulated Watershed Runoff	3.3	0.1	3.3	0.0	0.013
Contaminated Sites	1.8	0.05	1.8	0.0	0.007
Nonpoint Sources	3,800.0	99.8	330.4	91.3	1.300
NPDES MS4 Regulated Stormwater	7.9	0.2	7.9	0.0	0.031
Point Sources	7.9	0.2	7.9	0.0	0.031
Margin of Safety	-	-	17.8	-	0.070
TOTAL	3,807.9	100.0	356.1	90.6	1.402

Source: Total Maximum Daily Load of Polychlorinated Biphenyls in the Magothy River Mesohaline Chesapeake Bay Tidal Segment, Anne Arundel County, Maryland, Document Version: February 12, 2015, EPA Approval Date: March 16, 2015

Status of Restoration Plan:

Per MDE, the PCB TMDL for the Magothy River is achieved through the decline in PCB concentrations in the Bay and natural attenuation in sediments. Therefore, no reduction in PCB loads is required to achieve the TMDL. The County understands the need to ensure that PCB loads from stormwater runoff will not increase over the baseline load. Although an increase in the baseline load is unlikely because the manufacture of PCBs has been banned since 1979, Anne Arundel County is prepared to investigate and identify remediation actions for any new sources of PCBs that may be identified in the future.

South River

The *"Total Maximum Daily Load of Polychlorinated Biphenyls in the South River Mesohaline Chesapeake Bay Tidal Segment, Anne Arundel County, Maryland"* was approved by EPA on April 27, 2015. Because the South River is identified as

impaired for PCBs in fish tissue, the overall objective of the PCB TMDL for the South River is to ensure that the "fishing" designated use, which is protective of human health related to the consumption of fish in the river, is supported. This TMDL, however, also ensures the protection of all other applicable designated uses within the river.

Both nonpoint sources and point sources of PCBs were identified in the watershed. Nonpoint sources identified include direct atmospheric deposition to the river, runoff from non-regulated watershed areas, re-suspension and diffusion from bottom sediments, and tidal influence from the Chesapeake Bay main stem. Point sources identified include National Pollutant Discharge Elimination System (NPDES) permitted wastewater treatment plants (WWTPs) and NPDES regulated stormwater runoff within the watershed. Model estimated tPCB loads from these point and nonpoint sources represent the baseline conditions for the South River. The transport of PCBs to the river from the Chesapeake Bay main stem and from bottom sediment via re-suspension and diffusion are not considered to be directly controllable sources. Within the modeling framework of the TMDL, these loads are considered as internal loads and not included in the tPCB baseline load and TMDL allocation.

The water quality model developed for simulating the ambient sediment and water column tPCB concentrations within the South River was used to determine the specific load reductions that would result in simulated tPCB concentrations in the sediment and water column that meet the TMDL endpoints. The model assumes that the tPCB concentrations in the Chesapeake Bay main stem are decreasing at a rate of 5% per year. Given this rate of decline, the tPCB TMDL endpoints in both the water column and sediments in the South River embayment will be met in approximately 12.3 years with the natural attenuation of tPCB concentration in the Chesapeake Bay main stem. Therefore, the TMDL states that "no reductions to these loads are necessary in order to achieve the TMDL" (*Total Maximum Daily Load of Polychlorinated Biphenyls in the South River Mesohaline Chesapeake Bay Tidal Segment, Anne Arundel County, Maryland. MDE. Document Version December, 2014. EPA Approval Date: April 27, 2015. Pg. 24)* When the targets are met, the PCB load from the Chesapeake Bay mainstem will be reduced by approximately 50% including an explicit 5% Margin of Safety. At that time, the total load to the waterbody will be reduced by 46% from its baseline.

A summary of the tPCB baseline loads, TMDL allocations, load reductions, and maximum daily loads for the South River is presented in Table 18.

Table 18. tPCB Baseline Loads and Load Reductions for South River

Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)	Maximum Daily Load (g/day)
Ches.Bay Mainstem Tidal Influence	2,227.0	98.7	1,124.0	49.5	4.62
Direct Atmospheric Deposition	38.4	1.7	38.4	0.0	0.16
Maryland Non-regulated Watershed Runoff	8.2	0.4	8.2	0.0	0.03
Nonpoint Sources	2,273.6	99.8	1,171	48.5	4.81
WWTP	0.024	0.001	0.024	0.0	0.0
NPDES MS4 Regulated Stormwater	3.9	0.2	3.9	0.0	0.02
Point Sources	3.92	0.2	3.92	0.0	0.02
Margin of Safety	-	-	62	-	0.25
TOTAL	2,278	100.0	1,237	45.7	5.08

Source: Total Maximum Daily Load of Polychlorinated Biphenyls in the South River Mesohaline Chesapeake Bay Tidal Segment, Anne Arundel County, Maryland, Document Version December, 2014, EPA Approval Date: April 27, 2015

Status of Restoration Plan:

Per MDE, the PCB TMDL for the South River is achieved through the decline in PCB concentrations in the Bay and natural attenuation in sediments. Therefore, no reduction in PCB loads is required to achieve the TMDL. The County understands the need to ensure that PCB loads from stormwater runoff will not increase over the baseline load. Although an increase in the baseline load is unlikely because the manufacture of PCBs has been banned since 1979, Anne Arundel County is prepared to investigate and identify remediation actions for any new sources of PCBs that may be identified in the future.

West and Rhode Rivers Status of Restoration Plan

The *Total Maximum Daily Load of Polychlorinated Biphenyls in the West and Rhode River, Mesohaline Segments, Anne Arundel County, Maryland* was approved by EPA on January 8, 2016. Anne Arundel County is currently reviewing the TMDL to determine whether a reduction in PCBs is required to meet the stormwater WLA. Should a reduction be required Anne Arundel County will develop a restoration plan structured to ensure that the WLA is met.

Sediment TMDLs

There are currently three (3) EPA approved sediment TMDLs in Anne Arundel County, as listed in Table 19.

Table 19. Sediment TMDLs

Location	Approval Date
Little Patuxent River, 8 Digit WS 02131105	September 30, 2011
Upper Patuxent River, 8 Digit WS 02131104	September 30, 2011
Patapsco River Lower North Branch, 8 Digit WS 02130906	September 30, 2011

Little Patuxent River

The *Total Maximum Daily Load of Sediment in the Little Patuxent River Watershed, Howard, and Anne Arundel Counties, Maryland, September 30, 2011* presents the TMDL for sediment in the Little Patuxent watershed as an average annual load to ensure the support of aquatic life. WLAs were calculated for NPDES regulated individual industrial, individual municipal, individual municipal separate storm sewer systems, general mineral mining, general industrial stormwater, and general MS4 permits in the Little Patuxent River watershed. In order to attain the TMDL loading cap, reductions were only applied to the urban sediment sources, since urban land was identified as the only predominant controllable sediment source in the watershed. The overall Little Patuxent WLA and the Anne Arundel County stormwater WLA, and the required percent reduction are presented in Table 20.

Table 20. Sediment Baseline Loads and Load Reductions, Little Patuxent River

NPDES MS4 Regulated SW Point Source	Baseline Load (tons/year)	SW WLA (tons/year)	% Reduction
Anne Arundel County	3,310.8	2,632.3	20.5
Total Little Patuxent	17,092.5	11,225.8	34.3

Status of Restoration Plan:

A draft Sediment TMDL restoration plan for the Little Patuxent River was submitted to MDE with Anne Arundel County's 2014 NPDES MS4 Permit Annual Report. On May 19, 2015 MDE provided comments to Anne Arundel County on the draft plan. During this reporting year Anne Arundel County worked to address MDE's comments. The revised restoration plan is submitted as an appendix to this report. Once MDE concurs that their comments have been adequately addressed in the revised restoration plan, the plan will be advertised in the local newspapers, distributed to local watershed associations, and posted on

the County's web page to solicit public input. A thirty (30) day public comment period will be held after which the plan will be revised as appropriate based on comments received and a comment response document prepared. Both the revised plan incorporating public comments and the comment response document will be provided to MDE for final approval. Once MDE has approved the plan and the plan is considered final it will be posted on the County's website along with the comment response document.

Upper Patuxent River

The *Total Maximum Daily Load of Sediment in the Upper Patuxent River Watershed, Anne Arundel, Howard and Prince George's Counties, Maryland, September 30, 2011* presents the TMDL for sediment in the Upper Patuxent watershed as an average annual load to ensure the support of aquatic life. In order to attain the TMDL loading cap calculated for the watershed, reductions were applied equally to the predominant controllable sediment sources, which were identified as urban land, high till crops, low till crops, and hay. Since all urban land use in the Upper Patuxent watershed is considered to be representative of all regulated stormwater sources, the NPDES stormwater WLA is equivalent to the urban land use loads resultant from applying reductions to all of the predominant land uses. The overall Upper Patuxent WLA and the Anne Arundel County stormwater WLA, and the required percent reduction are presented in Table 21.

Table 21. Sediment Baseline Loads and Load Reductions, Upper Patuxent River

NPDES MS4 Regulated SW Point Source	Baseline Load (tons/year)	SW WLA (tons/year)	% Reduction
Anne Arundel County	1,029.7	912.4	11.4
Total Upper Patuxent	9,102.0	8,064.6	11.4

Status of Restoration Plan:

A draft Sediment TMDL restoration plan for the Upper Patuxent River was submitted to MDE with Anne Arundel County's 2014 NPDES MS4 Permit Annual Report. On May 19, 2015 MDE provided comments to Anne Arundel County on the draft plan. During this reporting year Anne Arundel County worked to address MDE's comments. The revised restoration plan is submitted as an appendix to this report. Once MDE concurs that their comments have been adequately addressed in the revised restoration plan, the plan will be advertised in the local newspapers, distributed to local watershed associations, and posted on the County's web page to solicit public input. A thirty (30) day public comment period will be held after which the plan will be revised as appropriate based on comments received and a comment response document prepared. Both the revised plan incorporating public comments and the comment response document will be provided to MDE for final approval. Once MDE has approved the plan and the

plan is considered final it will be posted on the County's website along with the comment response document.

Patapsco River Lower North Branch

The *Total Maximum Daily Load of Sediment in the Patapsco River Lower North Branch Watershed, Baltimore City and Baltimore County, Howard, Carroll and Anne Arundel Counties,* Technical *Memorandum: Significant Sediment Point Sources in the Patapsco River Lower North Branch, September 30, 2011 p*resents the TMDL for the Lower North Branch as an average annual load to ensure that there will be no sediment impacts affecting aquatic health. The overall Patapsco Lower North Branch and the Anne Arundel County stormwater WLAs, and the required percent reduction are presented in Table 22.

Table 22. Sediment Baseline Loads and Load Reductions, Patapsco Lower North Branch

NPDES MS4 Regulated SW Point Source	Baseline Load (tons/year)	SW WLA (tons/year)	% Reduction
Anne Arundel County	1,915.1	1,490.0	22.2
Total LNB	15,536.8	13,052.9	16.0

Status of Restoration Plan:

A draft Sediment TMDL restoration plan for the Patapsco River Lower North Branch was submitted to MDE with Anne Arundel County's 2014 NPDES MS4 Permit Annual Report. On May 19, 2015 MDE provided comments to Anne Arundel County on the draft plan. During this reporting year Anne Arundel County worked to address MDE's comments. The revised restoration plan is submitted as an appendix to this report. Once MDE concurs that their comments have been adequately addressed in the revised restoration plan the plan will be advertised in the local newspapers, distributed to local watershed associations, and posted on the County's web page to solicit public input. A thirty (30) day public comment period will be held after which the plan will be revised as appropriate based on comments received and a comment response document prepared. Both the revised plan incorporating public comments and the comment response document will be provided to MDE for final approval. Once MDE has approved the plan and the plan is considered final it will be posted on the County's website along with the comment response document.

3. Public Participation

Anne Arundel County shall provide continual outreach to the public regarding the development of its watershed assessments and restoration plans. Additionally, the County shall allow for public participation in the TMDL process, solicit input, and incorporate any relevant ideas and

program improvements that can aid in achieving TMDLs and water quality standards. Anne Arundel County shall provide:

a. Notice in a local newspaper and the County's web site outlining how the public may obtain information on the development of watershed assessments and stormwater watershed restoration plans and opportunities for comment;

b. Procedures for providing copies of watershed assessments and stormwater watershed restoration plans to interested parties upon request;

c. A minimum 30 day comment period before finalizing watershed assessments and stormwater watershed restoration plans; and

d. A summary in each annual report of how the County addressed or will address any material comment received from the public.

Status:

The County provides information on watershed assessment and restoration via the County website (www.aarivers.org) as well as through our interactive online mapping application. As watershed assessments are completed, the associated study reports are published on the WPRP webpage as noted in **Part E.1**. Additionally, restoration projects are highlighted on the WPRP webpage. Watershed assessments to be initiated in FY2016 and FY2017 will include local news media notification regarding availability of information from these assessments.

As originally reported in the 2010 Annual Report, the County developed an interactive online mapping application to track restoration projects undertaken by non-County organizations such as the Watershed Stewards Academy, grassroots environmental preservation groups, and local Riverkeepers. The mapping application also allows these organizations, and anyone with internet access and interest, to open the mapping application and view the many data layers that have resulted from the County's watershed assessments. Since 2010, the County has provided additional functionality to this mapping application by making changes to the overall look and feel of the application. Most recently, the viewer was changed to a more robust Geocortex viewer. This required a change in the URL of the mapping application. The new address is http://gis-world2.aacounty.org/silverlightviewer/?Viewer=WERS.

The County recognizes the importance of public input into watershed assessments as well as TMDL restoration plans and will provide a minimum of 30 days for public comment on these draft plans/reports. The availability of draft reports and plans will be advertised through local print media as well as social media outlets.

Draft documents will be made available for review and/or download through the County webpage, and a minimum number of hard copy reports will also be made available on request. Prior to final acceptance, a summary of the comments received and County response will be incorporated into each document. The County will provide a summary of the comment/response documents in each subsequent NPDES MS4 Annual Report.

During FY2015, the County organized a stakeholder meeting with representatives from non-governmental organizations to provide status of the Little Patuxent Watershed Assessment project; seek input on the subwatershed prioritization, restoration, and preservation; and to update stakeholders on the next steps in the project. The draft project report will be finalized in February 2016 at which time the County will advertise its' availability for public review via local print media, webpage, Facebook, and Twitter. A 30-day public comment period will start on the date of advertisement. A summary comment-response document will be incorporated into the Watershed Assessment report and also referenced in the NPDES MS4 Annual Report for Fiscal Year 2016.

During FY2016 and as TMDL Implementation Plans are drafted and finalized, the County will provide notice of document availability in local newspapers and via the same social media outlets. During FY2016, if not earlier, the County anticipates issuing public comment notice for the individual TMDL restoration plans submitted with this FY2015 Annual Report.

4. TMDL Compliance

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

Status:

As noted earlier, Anne Arundel County continues working collaboratively with MDE and various stakeholders within the County to implement individual watershed restoration plans and the Chesapeake Bay TMDL Watershed Implementation Plan (WIP) to reduce the nutrient and sediment load within Anne Arundel County's portion of three major tributary basins (Lower Western Shore, Patuxent River, and Patapsco River).

Individual TMDL restoration plans were recently drafted and submitted, with this report, for MDE review and comment (see **Part IV.E.2.b**). These restoration plans provide information on load reductions and implementation costs associated with achieving the individual TMDL SW-WLAs. Implementation of activities associated with the Chesapeake Bay TMDL stormwater WLA for Anne Arundel County has been ongoing since FY2013. Detailed information pertaining to the County's progress toward achieving programmatic and implementation mile-stones associated with the County's Phase II WIP were reported to MDE on 29 January 2016 as previously documented in this section.

With respect to the net change in pollutant load reductions necessary to meet TMDL requirements, **Appendix A**, Table G of this report lists the load reduction summary for completed water quality improvement projects. For the FY2015 reporting year the County implemented twelve pond retrofits, six stream restoration projects, two outfall retrofits, six living shoreline restoration projects, and swept 2,895 miles of roadway. Pollutant load reductions realized through implementation of these projects is 3,253 lbs./year of Total Nitrogen, 461 lbs./year of Total Phosphorus, and 258 tons of Total Suspended Solid reductions at a cost of $4,083,695. Specific itemized costs for the projects completed in FY2015 are found below (Table 23). Costs associated with the individual shoreline restoration projects implemented by NGOs are not available.

The net pollutant load reductions associated with the County's cumulative stormwater management and restoration efforts, and the County's Chesapeake Bay TMDL stormwater WLA are shown below in Table 24. The remaining reductions required to meet the SW WLAs are to be achieved by 2025. The cumulative cost of these restoration efforts thus far has been $28,167,928. Project specific cost is documented in **Appendix K**.

Table 23. FY2015 Completed Restoration Projects with Costs

Structure ID or Outfall ID	Structure Name/Comments	Project Cost
AA000647	Berrywood West	$39,863
AA004310	B&A Trail Phase III	$101,465
AA000884	Weathersfield Pond	$287,567
AA002630	Severndale Ground Storage Tank	$25,496
AA004181	Grace Property Lots 1-5	$25,496
AA000839	Raintree Sec.1	$54,392
AA001526	Old Annapolis Neck Rd.	$86,392
AA004447	Western Dist. Police Station	$42,759
AA000662	Chelsea Beach Pond Retrofit	$22,702
AA004096	Coxby's Estates Section 3/Dillon Court	$107,885
AA000022	Brittingham I/Finnegan Dr.	$24,496
AA003631	Westridge Addition/244 Kennedy Dr.	$66,155
	Popham Creek Living Shoreline	n/a
	Camp Woodlands Living Shoreline	n/a
	YMCA Camp Letts Living Shoreline	n/a
	Arundel on the Bay Living Shoreline	n/a
	Bear Neck Creek Living Shoreline	n/a
	Pines on the Severn Living Shoreline	$318,000
S17H5O00001	Knollwood Road Outfall	$204,826
O12B5O00001	Dennington Land Outfall	$98,268
Q13A6O00002	Olde Severn Park Outfall Retrofit/Birch Ct.	$357,713
	Old Bay Ridge Rd/Abandoned RR Embank	$454,978
	Buena Vista Outfall Rest. Phase 2	$300,493
	South Down Shores Stream Rest.	$1,270,560
	Sands Road Bridge Stream Rest	$93,417
	Leeds Road Stream Rest.	$99,770
	Total Cost FY15	$4,083,695

Table 24. Pollutant Load Reductions and Waste Load Allocations (WLA)

	SW WLA Delivered	Required Reduction to Meet WLA	Load Reduction Achieved	Remaining Reduction Needed
Total Nitrogen (lbs/yr)	449,641	207,742	8,426	199,316
Total Phosphorus (lbs/yr)	30,147	26,385	3,477	22,908

The County continues to work toward meeting the targeted goals. Currently there are 13 projects under construction and 23 additional projects in the design phase. Thus, the County is moving toward implementation of up to 36 new water quality

improvement projects in the coming reporting cycle as previously mentioned in Part IV C.6 of this report.

Part IV. E.4.e. of Anne Arundel County's NPDES MS4 permit requires the development 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.

During the 2012 development of *Maryland's Phase II Watershed Implementation Plan (WIP) for the Chesapeake Bay*, Anne Arundel County with the concurrence of the State of Maryland and EPA recognized the need for adaptive management in the WIP development and implementation process. As discussed in *Maryland's Phase II Watershed Implementation Plan For The Chesapeake Bay, March 20, 2012,* as implementation moves forward achievement of stormwater waste load allocation goals needs to be evaluated and watershed restoration plans modified in response to the rate of progress, additional modeling results, and resource availability.

Anne Arundel County took a conservative approach when developing the urban stormwater component of its Phase II WIP. The County's strategy was structured to achieve the Edge of Stream (EOS) final target load derived from the County's Watershed Management Tool (WMT) baseline estimate which was higher than the MAST baseline estimates. In addition, the strategy included only restoration and preservation recommendations for the seven watersheds that were assessed at the time the County's Phase II WIP was developed in July 2012. Restoration opportunities for load reduction from the Little Patuxent, West and Rhode Rivers, Herring Bay and Middle Patuxent River watersheds were not identified nor taken into account.

Further, Anne Arundel County adopted legislation in June 2013 to create a Watershed Protection and Restoration Program (WPRP) including a Stormwater Remediation Fee (Fee). The Stormwater Remediation Fee is structured to provide sufficient funding for projects to meet the pollutant load reduction required by the Chesapeake Bay TMDL, EPA approved individual TMDLs with a stormwater WLA, and to meet the impervious surface management requirements as well as other stormwater obligations set forth in the County's NPDES MS4 Permit. Given the basis upon which the Fee was established, at this time, funding to achieve applicable stormwater WLAs is considered to be sufficient.

Adaptive management is a critical component of achieving the WLAs required by the County's NPDES MS4 Permit. The Chesapeake Bay TMDL and individual approved TMDLs have clearly established load reduction targets. Two-Year Implementation Milestones have been established by the County to provide interim planning targets and to serve as a vehicle for assessing progress toward the load reduction targets. Progress will be measured through three approaches: tracking implementation of management measures, estimating load reductions

through modeling, and tracking overall program success through long term monitoring. Planning targets will then be re-evaluated against progress and revised to ensure that Anne Arundel County is on track to meet its goals. Progress assessments are scheduled for 2017 and 2021, with 2025 set as the final date for achievement of loads reductions.

Following the adoption of its Stormwater Remediation Fee in 2013 Anne Arundel County developed a 6-year Capital Improvement Program (CIP) in FY14 that created a Watershed Protection and Restoration Program (WPRP) Class of projects to implement those restoration projects identified in the County's Phase II WIP for achieving stormwater WLAs. Funding for this class of projects averages $74 million annually. Projects in the WPRP Class were identified and prioritized through a planning level assessment and consist of restoration of ephemeral and perennial streams with a MBSS Maryland Physical Habitat Index (MPHI) score of severely degraded or degraded; implementation of stormwater/ water quality treatment at currently untreated stormwater pipe outfalls (greater than 24 inches), and retrofit of stormwater management ponds built prior to 2002, with drainage areas in excess of 10 acres, to optimize pollutant reduction and ecosystem functions for the facilities. As WPRP projects are funded, more detailed feasibility and constructability assessments are conducted. These assessments may result in identifying projects previously thought to be implementable but due to a variety of reasons are not; or identifying additional and new opportunities for load reduction. As these feasibility assessments are completed the County will incorporate these findings into its modeling, reassess anticipated load reductions and adapt its implementation program to delete or add projects.

At this time, multiple lines of evidence including results of several model runs, monitoring data, and the most recent science on BMP effectiveness and water quality response will be evaluated as part of TMDL compliance assessment. The milestones and progress assessments will contribute to continual reassessment of management plans, and adapting responses accordingly as technologies and efficiencies change, programs mature, credit trading is enacted, and regulations are put in place.

F. Assessment of Controls

Assessment of controls is critical for determining the effectiveness of the NPDES stormwater management program and progress toward improving water quality. The County 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, the County shall conduct physical stream monitoring to assess the implementation of the latest version of the 2000 Maryland Stormwater Design Manual. Specific monitoring requirements are described below.

1. Watershed Restoration Assessment

The County shall continue monitoring the Parole Plaza outfall and Church Creek in-stream station in the South River 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. Chemical Monitoring

i. Twelve storm events shall be monitored per year at each monitoring location with at least two 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 samples determined to be representative of each storm event shall be submitted to a laboratory for analysis according to methods listed in 40 CFR Part 136 and EMC shall be calculated for:

Biochemical Oxygen Demand (BOD_5)	*Total Lead*
Total Kjeldahl Nitrogen (TKN)	*Total Copper*
Nitrate plus Nitrite	*Total Zinc*
Total Suspended Solids	*Total Phosphorus*
Total Petroleum Hydrocarbons (TPH)	*Hardness*
E. coli or enterococcus	

iv. Continuous flow measurements shall be recorded at the in-stream monitoring station or other practical locations based on an 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 TMDL with a stormwater WLA.

Status:

Anne Arundel County continues to conduct a long-term monitoring program to satisfy the above permit conditions. This monitoring program includes chemical, biological, and physical monitoring in the Church Creek subwatershed located in the South River Watershed. Monitoring for this permit

reporting period extended from July 2014 through June 2015. The full Church Creek monitoring report can be found in **Appendix D** (*Chemical, Biological, and Physical Characterization of the Church Creek and Parole Plaza NPDES Monitoring Stations: 2014-2015*) and the data required to support this section are also provided in **Appendix A** in the prescribed format.

The chemical monitoring activities take place at two monitoring stations in the Church Creek subwatershed:

- Parole Plaza Station: Outfall representing a highly impervious (87 percent) commercial land use which was redeveloped in 2007 as the Annapolis Towne Centre; the construction incorporated stormwater management into the redevelopment (i.e., a restoration station); and
- Church Creek Station: An instream station approximately 2,000 feet downstream of the Parole Plaza monitoring station.

During the 2015 reporting period, eight storm events were sampled and four baseflow samples were collected and analyzed. Storm event samples were collected from both stations for the rising, peak, and falling limbs of the hydrograph. Samples were analyzed for the required parameters.

Continuous water level measurements were taken at the Church Creek instream station and within both the 60" corrugated metal pipe and the 54" reinforced concrete pipe at the Parole Monitoring Station. Event Mean Concentrations (EMCs) for each parameter were calculated for each storm and applied to total stormflow discharges to calculate stormflow pollutant loads for each site. An EMC is a statistical parameter used to represent the flow-weighted average concentration of a given parameter during a storm event (USEPA 2002). Total seasonal loads were calculated by multiplying the average seasonal EMC by the total volume for the season. Annual loads were calculated by summing all seasonal loads.

As in prior years, comparisons to water quality criteria continue to indicate elevated pollutant concentrations in the Church Creek watershed, primarily during wet weather conditions. In particular, copper, zinc, total phosphorous, BOD5, nitrate-nitrite, and *E. coli* frequently exceeded criteria at both sampling stations. Additionally, the Federal water quality criteria were exceeded for total phosphorous, and nitrate-nitrite during baseflow sampling at both the Church Creek and Parole Plaza Stations, with zinc and *E.coli* also being exceeded at the Parole Plaza station.

Water quality criteria for the pollutants listed above were more frequently exceeded at the Parole Plaza monitoring station than at the Church Creek station for all contaminants except for total phosphorus and nitrate-nitrite, which were exceeded 100 percent of the time at both stations. *E. coli* concentrations also remained high at both stations throughout the 2015

monitoring period, exceeding water quality criteria 71 percent of the time at Church Creek, and 95 percent of the time at Parole Plaza. Note that prior to site stabilization, total suspended solids concentrations had been particularly high due to construction activity at Annapolis Towne Centre. Following stabilization of the site in Fall 2008, the event mean concentrations for total suspended solids have dropped significantly. During the last three reporting years, no wet weather samples exceeded the water quality criterion for total suspended solids at either station.

When compared to the 2014 reporting year, 2015 loading rates decreased for all sampled parameters at the Parole Plaza Station with the exception of lead which slightly increased by 0.1 lbs. At the Church Creek Station, 2015 reporting year loading rates decreased for all sampled parameters when compared to the 2014 reporting year except for TSS, zinc, lead, and copper.

Hardness was much higher in the winter at both stations due to the large amount of road salt used to deice local roads during a winter that produced an abnormally large amount of snow and ice. In total, five of the parameters were highest in the winter, and four of the parameters were highest in the fall at the Church Creek station. All parameters, except TKN and *E. coli*, were highest in the winter at the Parole Plaza station. This may be due to a combination of some parameters having high natural background concentrations (e.g., nitrate-nitrite, which is often diluted during storm events) observed during the two winter baseflow sampling events, and other parameters having elevated concentrations during the sole storm event. Pollutant concentrations in 2015 decreased when compared to those from 2014, with the exception of a slight increase in lead.

Further discussion of the monitoring activities at these stations and the resulting data can be found in the included monitoring report in **Appendix D.**

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

Status:

A total of four 75-meter biological monitoring reaches are positioned along Church Creek between the Annapolis Towne Centre outfall and the Church Creek in-stream water quality monitoring station. Benthic macroinvertebrate samples were collected from these stations in March 2015, following the

MBSS spring index period protocols. One station is located on the Parole Plaza Tributary just below Forest Drive, two stations are located along the Church Creek mainstem, on either side of Solomons Island Road (Maryland State Highway 2), and a fourth site, located just upstream of the confluence with the Parole Plaza Tributary, was added in 2007 to monitor the effects of runoff from the adjacent Annapolis Harbour Center and Festival at Riva shopping centers.

The biological condition at each station was evaluated using the BIBI developed for use in Maryland's Coastal Plain streams. Results of the 2015 sampling period indicate that biological conditions within the Church Creek study area continue to be impaired by urbanization within the surrounding watershed. Since 2006, all stations have consistently been rated as either 'Poor' or 'Very Poor.' The number of EPT taxa, the number of Ephemeroptera and the percent Ephemeroptera were low for all stations.

The physical habitat quality was evaluated using the MBSS Physical Habitat Index (PHI) and EPA's Rapid Bioassessment Protocol (RBP). The stream physical habitat remains degraded throughout the entire study reach and appears to have changed very little from prior years. Overall, PHI and RBP scores indicate that habitat conditions limit the potential for healthy biological communities. The close proximity to roads and development, along with a lack of instream woody debris and stable epifaunal substrate, prohibits the stream from supporting a diverse and healthy macroinvertebrate community. Elevated levels of dissolved solids indicate the presence of water quality stressors. These appear to be a few of the factors limiting the biological conditions within Church Creek. The results of the biological monitoring work are included in **Appendix D.**

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.

Status:

Due to the highly altered conditions of the drainage area and stream channel in the study area, reliable bankfull indicators were often difficult to locate in the field, thus leading to a fair amount of professional judgment used to interpret the data and categorize the stream segments. This means that categorization of some of the stream segments may change dramatically from year to year. Table 25 is a summary of each reach and its classification.

Table 25. Physical Characterization Summary

Reach	2013 Classification	2014 Classification	2015 Classification	Notes
XS-1	F4	F5/4	F4	Channel degradation, loss of floodplain connectivity, and widening indicate this channel is not stable.
XS-2	G5c	G4c	G4	Actively degrading and widening with lack of sinuosity; shifting to a less-stable form.
XS-3	G4c	G4c	G4/3c	This section was recently stabilized with modification to the channel dimensions.
XS-4	C5	C5	C5	Low entrenchment, low width/depth ratio, low slope, and well-connected floodplain.
XS-5	F4/3	F3	F4/3	Slight entrenchment, moderate width/depth ratio, and low sinuosity.

While geomorphic data collected in the Church Creek study area were generally consistent with previous measurements, significant departure from expected values, as derived from Maryland Coastal Plain regional relationships of bankfull channel geometry, were observed for cross sectional area, bankfull width, and bankfull depth dimensions. All dimensions were generally larger in the Church Creek study area, and were more similar to relationships of bankfull channel geometry derived from urban watersheds. This reflects the higher level of imperviousness in the study area, as compared to those levels in the drainage areas used to develop the regional relationship data.

Additional information and data pertinent to the water quality, biological, physical and habitat assessments of Church Creek are included in the full report in **Appendix D**.

d. Annual Data Submittal

The County shall describe in detail its monitoring activities for the previous year and include the following:

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.

Status:

The required chemical monitoring results are found in **Appendix A**. Also included in **Appendix D** is the report entitled *Chemical, Biological, and Physical Characterization of the Church Creek and Parole Plaza NPDES Monitoring Stations: 2014-2015,* which provides greater detail on the work performed in this watershed.

During the 2016 reporting year, the County will continue the monitoring program at the Church Creek and Picture Spring Branch Stations. The County is working with the South River Federation to implement the Annapolis Harbor Center stream restoration project on Church Creek, upstream of the existing Church Creek water chemistry monitoring station. Therefore, the County's ongoing, long-term monitoring will continue at this same location and will be well-positioned to assess the effect of the stream restoration project. Biological and physical monitoring will also continue in the Church Creek watershed in 2016, with some adjustments due to the planned construction in spring 2016.

2. Stormwater Management Assessment

The County shall continue monitoring the Picture Spring Branch in the Severn River watershed, or select and submit for MDE's approval a new watershed restoration project for determining the effectiveness of stormwater management practices for stream channel protection. Physical stream monitoring protocols shall include:

i. An annual stream profile and survey of permanently monumented cross-sections in Picture Spring Branch to evaluate channel stability;
ii. 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
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.

Status:

Physical condition and habitat monitoring for Picture Spring Branch, in the vicinity of the West County Library site, began in 2003 and is conducted annually. Five permanent cross-sections were established throughout the study area to evaluate channel stability over time (see **Appendix E** for a location map). Three cross-sections are located on the North Tributary, including one downstream of Maryland State Highway 170, and one on the South Tributary. It should be noted that the South Tributary does not receive significant stormwater runoff from the West County Library site. The majority of the runoff from this site drains to the North Tributary.

In 2015, these cross sections were re-measured and longitudinal profile surveys were conducted along both the North Tributary (totaling 1,968 linear feet) and South Tributary (totaling 355 linear feet). Channel dimensions along the North Tributary have not changed substantially from baseline conditions, although some minor aggradation was noted. Channel dimensions appear moderately constant for three out of the five cross sections in 2015, compared to baseline conditions. Only very minor changes were observed from baseline conditions in cross section XS-2, showing signs of minor aggradation in this overwidened reach. On the other hand, cross sections XS-1 and XS-4 have experienced a 59.4 percent and 35.5 percent increase over baseline conditions, respectively. Not surprisingly, these are the only two sections not located in an engineered or partially-armored channel. Although cross section XS-4 has filled in slightly between 2013 and 2015, notable stream bed erosion is apparent. Cross sections XS-3 and XS-5 decreased in cross-section areas between the baseline assessment and the 2015 survey by 4.3 percent and 11 percent, respectively. These two stations also show a similar change between 2011 and 2015 surveys by a decrease of 1.2 percent and 9.2 percent, respectively.

Overall, it appears that the BMPs installed as part of the development of the West County Library site have been effective in reducing the geophysical impacts of stormwater runoff. As noted previously, the South Tributary does not receive significant amounts of drainage from the West County Library site.

In March 2015, a biological assessment was conducted at three previously established 75-meter reaches within the study area. From 2006 to 2008, biological condition in these reaches appeared to remain fairly steady with ratings of ‘Fair’ to ‘Poor’; however, during 2009 scores declined at all three sites with two of the sites rating ‘Poor’ and one rating ‘Very Poor’. Between 2009 and 2015, BIBI scores have been somewhat variable, fluctuating

between the 'Poor' and 'Fair' categories. In 2012 all sites received a rating of 'Fair', and in 2013 two of three sites received a rating of 'Fair' while one returned to the 'Poor' category. In 2015 the ratings for PSB-01 and PSB-02 remained in the 'Poor' category, while PSB-03 increased to the 'Fair' category. The full biological and geomorphological conditions report is included in **Appendix E** *(Biological and Geomorphological Conditions in the Picture Spring Branch Subwatershed: 2014-2015).*

G. Program Funding

1. Annually, a fiscal analysis of the capital, operation, and maintenance expenditures necessary to comply with all conditions of this permit shall be submitted as required in Part V below.

Status:

The 2015 Annual Report covers the reporting period of July 2014 to June 2015, and corresponds to the County's 2015 Fiscal Year (FY2015). The summary of funding is shown in this section (Table 26). The funding period reflects the second year of the revenue change from general obligation bonds and County pay-go funding to the dedicated special revenue from the WPRP. The WPRP Fund was implemented July 1, 2013 in response to State legislated requirements found in HB987. This Fund will provide the primary fiscal support for all eligible components of the NPDES MS4 Permit program. Those permit-requirement elements not eligible for WPRP funding will continue to be supported by the County's annual budget process (general revenue funds).

During the reporting period, funding for NPDES MS4 Permit compliance was addressed through the County CIP and operating budgets. CIP funding for the current County fiscal year and the next five fiscal years is allocated to the "Stormwater Runoff Controls," "Water Quality Improvements" and "Watershed Protection and Restoration" CIP project classes. Specific line items funded through the CIP include stormwater permit compliance program, storm drain rehabilitation, closed storm drain repairs and replacement, stormwater infrastructure inspection and maintenance, stormwater facility retrofits, outfall repairs, and stream and ecological restoration projects. The budgets for the "Stormwater Runoff Controls" and "Water Quality Improvements" have been incorporated into the Watershed Protection and Restoration CIP and operating budget items in future years. The Watershed Protection and Restoration CIP budgets for FY2016 through FY2021 total $459,600,000.

The Anne Arundel County operating budget for FY2015 also provides permit compliance support through funding of personnel associated with permit compliance. Such support is derived primarily from the County's OPZ, I&P,

SCD, DPW, Office of Law, and the County Health Department. Each of these agencies has responsibility or provides support for certain permit requirements and all must work collaboratively to achieve County compliance with permit terms. Additional funding for permit compliance has been included in the operating budgets for the WPRP Fund. Specific line items funded through the operating budget include chemical, biological, and physical assessments, public education, grants, and restoration projects.

With the implementation of the WPRP Fund, a dedicated revenue source has been created. These revenues for FY2015 totaled $16,925,000. A total of 171,046 properties in Anne Arundel County were assessed a fee equal to 80 percent of the full fee. Properties were assessed the full fee in FY2016. Estimated projections of revenue for FY2016 are $21,954,000. These revenues fund the operating budget directly, and the CIP budget indirectly through debt repayment.

The complete FY2015 approved County budget is available for review and download at www.aacounty.org/Budget/index.cfm.

2. ***Adequate program funding to comply with all conditions of this permit shall be maintained. Lack of funding does not constitute a justification for noncompliance with the terms of this permit.***

Status:

Table 26 denotes the distribution of funding from the County's FY2015 Capital and Operating Budgets. This table is provided below and also as an electronic file in the spreadsheet format as required for the 2015 NPDES MS4 Permit Annual Report.

With the increased funding provided by the WPRP, increased staffing began in FY14. Delays due to proposed legislation changes slowed the implementation of the program initially. Additional increases in staffing continued in FY2015 and FY2016. These staffing levels will improve the commitment of the County in achieving MS4 permit compliance and maintaining adequate funding to meet permit obligations.

Table 26. Fiscal Analysis

Permit Condition	Fiscal Year 2015
Legal Authority	$ 79,300
Source ID	$ 722,990
SW Management	$ 998,109
Erosion and Sediment Control	$ 51,300
Illicit Discharge Detection and Elimination	$ 89,812
Trash and Litter Control	$ 1,188,456
Property Management	$ 6,967,295
Inlet Cleaning	$ 537,571
Street Sweeping	$ 138,209
Other Road Maintenance	$ 0
Public Education	$ 588,040
Watershed Assessment	$ 511,935
Watershed Restoration	$76,706,581
Chemical Monitoring Assessment	$ 227,393
Biological Monitoring Assessment	$ 335,996
Physical Stream Assessment	$ 182,916
Stormwater Design Manual Monitoring	$ 53,968
TMDL Assessment	$ 434,907
Annual Report Preparation	$ 121,698
Total Annual Cost for NPDES MS4 Program	**$89,936,478**

H. References

Maryland Department of the Environment (MDE). 1997. Dry Weather Flow and Illicit Discharges in Maryland Storm Drain Systems.

Maryland Department of the Environment (MDE). 2000. 2000 Maryland Stormwater Design Manual, Volumes I & II. Revised May 2009. Prepared by the Center for Watershed Protection, Ellicott City, MD, for the Maryland Department of the Environment, Baltimore, MD.

Maryland Department of the Environment (MDE). 2014. Accounting For Stormwater Wasteload Allocations and Impervious Acres Treated: Guidance for National Pollutant Discharge Elimination System Stormwater Permits. Baltimore, MD.

USEPA. United States Environmental Protection Agency. 2002. *Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater BMP Database Requirements*. EPA-821-B-02-001.

Fwd: RSA Revision

David Braun <pzbrau93@aacounty.org> Sun, Jan 31, 2016 at 4:13 PM
To: Janis Markusic <pwmark02@aacounty.org>

---------- Forwarded message ----------
From: David Braun <pzbrau93@aacounty.org>
Date: Fri, Jul 10, 2015 at 11:38 AM
Subject: Fwd: RSA Revision
To: Stewart Comstock <stewart.comstock@maryland.gov>
Cc: Chris Soldano <pzsold00@aacounty.org>, Larry Tom <pztom264@aacounty.org>

Stewart:
Attached is a proposed revision to the County's SWM Manual that we are preparing to implement in the Overbank Flood Protection section. Essentially this is removing the requirement for a Rapid Stream Assessment that has been in place since the 2011 adoption of our updated manual.

Please let me know if you have any questions or need any additional information from us regarding this revision.
David

---------- Forwarded message ----------
From: David Braun <pzbrau93@aacounty.org>
Date: Thu, Jul 9, 2015 at 7:49 AM
Subject: RSA Revision
To: Larry Tom <pztom264@aacounty.org>, Chris Soldano <pzsold00@aacounty.org>

Attached is a draft for your review of the memo to MBIA for the RSA revision, and the final draft of the revised language.

Let me know if you would like any changes.
David

Rev SWM 722D 7-9-15.pdf
97K

ANNE ARUNDEL COUNTY
MARYLAND

County Executive Steven R. Schuh

Office of Planning and Zoning
Development Division

INTER-OFFICE CORRESPONDENCE

DATE: July 9, 2015

TO: MBIA and Review Agencies

FROM: Larry R. Tom, Planning & Zoning Officer

SUBJECT: **Rapid Stream Assessment Policy**

As outlined in the Transition Team Report for the Office of Planning & Zoning, the department has been working with the MBIA SWM Work Group to develop revisions to the County's Stormwater Management Practices and Procedures Manual (SWM Manual). The revisions are designed to eliminate the requirement for Rapid Stream Assessments as part of the determination of adequate outfall, while still requiring both the capacity and stability of the downstream conveyance system to be addressed.

Effective immediately, all new projects, any current projects that have not yet had APF Storm Drain approved, and any projects that have not completed a Rapid Stream Assessment as outlined in Section 7.2.2.D of the SWM Manual are able to operate under the revised Section 7.2.2.D attached.

The Office of Planning and Zoning would like to express their thanks to the MBIA Members that participated in these meetings. The SWM Work Group will continue to meet monthly to address other issues with the SWM Manual, and ultimately to address any issues raised by the MDE Triennial Review of the County's SWM program, which is in the process of being completed.

attachment

J:\Shared\subdiv\David Braun\SWM Workgroup\RSA Memo.docx

REVISED SECTION 7.2.2.D.
OF THE COUNTY STORMWATER PRACTICES AND PROCEDURES MANUAL
TO ELIMINATE REQUIREMENT FOR RAPID STREAM ASSESSMENT
Effective July 9, 2015

The existing Section 7.2.2.D. is hereby deleted, and the following is to be inserted in its place.

D. Downstream analysis and determination of adequate outfall

I. If the site discharges directly to an existing closed storm drain system, the following information is required:
   - **a.** Provide copies of as built maps of the system. If as-built maps are unavailable, then an as-built survey must be completed by the design consultant.
   - **b.** Determine, from the as-built information, the location of the most restricted segment of the system, e.g. the run of pipe with the lowest capacity or structure with the greatest hydraulic gradient.
   - **c.** Determine the runoff rate (cfs) that would make the system adequate (q adequate)
   - **d.** Compute the total runoff rate to that point, based on the total drainage area (q ultimate).
   - **e.** Adequacy of the system is established if q ultimate is less than or equal to q adequate.

II. If the site discharges to a clearly defined open channel or by sheet flow, both the Capacity and the Stability of the downstream system must be established to provide an adequate outfall. The following is required.
   - **a.** Capacity
     - **i)** Provide topographic maps of the channel to at least 100 feet beyond the top of bank.
     - **ii)** Determine the location of the most restrictive segment of the system, e.g. the channel section with the lowest capacity.
     - **iii)** Determine the runoff rate (cfs) that would make the system adequate (q adequate)
     - **iv)** Compute the total runoff rate to that point, based on the total drainage area (q ultimate).
     - **v)** Adequacy of the capacity of the system is established if q ultimate is less than or equal to q adequate.
   - **b.** Stability
     - **i)** Provide a photo walking tour in accordance with the requirements of Chapter III of "Stream Assessment Protocol" and the "Sketch Plan-Preliminary Plan Checklist". The photo walking tour must include a narrative description of the conditions from the site outfall to the POI. This document must include a plan of the system being evaluated with the location and direction of the photographs indicated on the plan.
     - **ii)** Based on analysis of the photo walking tour, determine any areas that indicate existing instability. Any areas that, in the County's opinion, indicate instability must be evaluated by a qualified professional (as outlined in Chapter III of the Stream Assessment Protocol) to determine if mitigation is necessary.
     - **iii)** Determine if the Department of Public Works, through a Capital Improvement Project, the Watershed Management Tool, or any other method, has identified any retrofit projects along the system being analyzed.
     - **iv)** Adequacy of the stability of the system is established if there is no existing downstream instability, or a mitigation agreement has been developed between the applicant and the County.

v) A mitigation agreement can include one or any combination of the following items, but should be addressed in the order of priorities indicated:
   1. Restoration work funded and performed by the applicant to address the instability within publicly owned land or in a public easement obtained by the applicant or the County.
   2. Provide private funding to a specific Capital Improvement Project (CIP) that has been identified by the Department of Public Works (DPW).
   3. Over-management of the site runoff, based on the percentage of flow from the site when compared to the total runoff to the area of instability.
   4. Provision of a hydrologic/hydraulic study that demonstrates that full compliance with the State SWM regulations and ESD to the MEP, shows the development will not have a negative impact on the existing conditions of the downstream facilities when considering flow rate and velocity, and that flows are being safely conveyed through the downstream system.

Janis Markusic <pwmark02@aacounty.org>

SWM Data Table Revision

David Braun <pzbrau93@aacounty.org> Mon, Feb 1, 2016 at 8:56 AM
To: Stewart Comstock <stewart.comstock@maryland.gov>
Cc: Janis Markusic <pwmark02@aacounty.org>, Ginger Ellis <pwelli16@aacounty.org>

Stewart:
Not sure I ever forwarded this before, but attached are a revised SWM Data Table and associated instructions that replaced the original form included in Appendix 11.7 of the County's SWM Practices and Procedures Manual.
Let me know if you have any questions on this revision.
David

2 attachments

StructuralDataSheet.xlsx
19K

StructuralSAMPLE.pdf
490K

STORMWATER MANAGEMENT DATA FORM GUIDANCE

A new "Stormwater Management Data" form was developed by DPW for compliance with the reporting requirements of the County's MS4 permit, effective December 1, 2014 for all new grading permit applications. The form is available in Excel format in "Online Forms" on the County Web Page for consultants to use, and replaces the "Stormwater Management Structure and Stream Restoration Summary Sheet" found in Appendix 11.7 of the County's "Stormwater Management Practices and Procedures Manual" that has been required on grading permit plans since the implementation of the 2010 SWM regulations.

The following pages are from Appendix B of the MS4 permit, which includes the necessary information to complete several of the required fields for each facility, specifically MDE BMP Class and MDE BMP TYPE (pg. 36-38), and MDP LAND USE CODE (pg. 38-40). Note that not all of the information in Appendix B is needed to complete the form. The fields on the spreadsheet for STORM_ID and USGS 12-Digit HUC will be completed by DPW.

Appendix B – BMP Data Reporting and Codes

Reporting Requirements: Prior to this guidance, permittees were required to submit databases to MDE that conformed to Attachment A (Annual Report Databases) of their NPDES MS4 permit. More recently, there have been significant changes to both Maryland's stormwater management program (e.g., ESD) and the CBP reporting requirements. Recognizing these changes, MDE is developing a geodatabase to more efficiently collect and organize the information submitted as part of the NPDES MS4 annual reporting. When this geodatabase is complete, MDE will provide a user guide with specific instruction on the reporting and use of the database. Until this geodatabase is implemented, Table B.1 below, *Urban Best Management Practices (BMPs) Associated with GIS Coverage*, should be used to submit this information to MDE.

The BMP database will tabulate a list of all BMPs within a jurisdiction. However, the ESD to the MEP mandate requires numerous ESD practices to be installed throughout a site in order to meet stormwater requirements. In these cases, local jurisdictions may enter the system of ESD practices by specifying the number and type of BMPs used to meet the target rainfall requirements (PE_REQ). This data may be entered in the NUM_BMPS and ESD_MEP fields shown below.

B.1. Urban Best Management Practices (BMPs) Associated with GIS Coverage

Column Name	Data Type	Size	Description
YEAR	NUMBER	4	Annual report year
MDE_STRU_ID	TEXT	8	Unique structure ID[1]
MD_NORTH	NUMBER	8	Maryland grid coordinate (NAD 83 meters) Northing
MD_EAST	NUMBER	8	Maryland grid coordinate (NAD 83 meters) Easting
WATERSHED8DGT	NUMBER	20	Maryland 8-digit hydrologic unit code
WATERSHED12DGT	NUMBER	20	USGS 12-digit hydrologic unit code
STRU_NAME	TEXT	60	Name of structure
BMP_CLASS	TEXT	1	BMP classification category (see list of BMPs: B, S, or A)
BMP_TYPE	TEXT	4	Type of BMP structure (see list of BMPs: enter code)[2]
NUM_BMPS	NUMBER	4	Number of all BMPs used to meet PE_REQ
ESD_MEP	TEXT	75	Type of all BMPs used to meet PE_REQ
LAND_USE	NUMBER	3	Predominant land use[3]
PERMIT_NO	TEXT	10	Unique permit number
ADDRESS	TEXT	50	Structure address
CITY	TEXT	15	Structure address
STATE	TEXT	2	Structure address
ZIP	NUMBER	10	Structure address
ON_OFF_SITE	TEXT	3	On or offsite structure
CON_PURPOSE	TEXT	4	New development (NEWD), Redevelopment (REDE), or Restoration (REST)
DRAIN_AREA	NUMBER	8	Structure drainage area (acres)[4]
IMP_ACRES	NUMBER	8	Structure impervious drainage area (acres)[4]
TOT_DRAIN	NUMBER	8	Total site area (acres)
PE_REQ	NUMBER	4	P_E required[5]
PE_ADR	NUMBER	4	P_E addressed[5]

IMP_ACRES_REST	NUMBER	4	Equals IMP_ACRES when PR_ADR = 1 inch (for restoration only)
RCN_PRE	NUMBER	2	Runoff curve number (weighted)[7]
RCN_POST	NUMBER	2	Runoff curve number (weighted)[7]
RCN_WOODS	NUMBER	2	Runoff curve number (weighted)[7]
APPR_DATE	DATE/TIME	8	Permit approval date
BUILT_DATE	DATE/TIME	8	As Built completion date
GEN_COMNT	TEXT	60	General comments
ADDITIONAL DATA REQUIREMENTS FOR ALL ALTERNATIVE BMPS			
TN_RED	NUMBER	12	Total load reduced after restoration (lbs)
TP_RED	NUMBER	12	Total load reduced after restoration (lbs)
TSS_RED	NUMBER	12	Total load reduced after restoration (lbs)
TN_LOAD	NUMBER	12	Load before restoration (lbs)
TP_LOAD	NUMBER	12	Load before restoration (lbs)
TSS_LOAD	NUMBER	12	Load before restoration (lbs)
PROJECT_LENGTH	NUMBER	6	For stream restoration, shoreline stabilization, or outfall stab in feet
ACRES_SWEPT	NUMBER	6	Acres swept for street sweeping
TIMES_SWEPT	NUMBER	6	Number of times per year area is swept
ACRES_PLANTED	NUMBER	6	Acres of trees planted on urban impervious (IMPI)
ACRES_PLANTED	NUMBER	6	Acres of trees planted on pervious (FPU)
IMPERV_ACR_REM	NUMBER	6	Impervious acres removed to pervious land (IMPP)
EQ_IMP_ACRES	NUMBER	6	Equivalent impervious acres treated by alternative BMP (see Table 7)
ADDITIONAL DATA REQUIREMENTS FOR STREAM RESTORATION			
NAME_OF_PROJECT	TEXT	25	Name of project
DESCR_OF_PROJECT	TEXT	75	Brief description of project
PERCENT_IMPERV	NUMBER	6	Watershed percent imperviousness
TSS_LOAD	NUMBER	12	Watershed TSS load before restoration (lbs/year)
TN_LOAD	NUMBER	12	Watershed TN load before restoration (lbs/year)
TP_LOAD	NUMBER	12	Watershed TP load before restoration (lbs/year)
PROTOCOL(S) OR INTERIM RATE	TEXT	8	Protocol 1 (P1), Protocol 2 (P2), Protocol 3 (P3); or interim rate (IR)
TSS_RED_P1	NUMBER	10	TSS load reduction (lbs/year) for P1
TN_RED_P1	NUMBER	10	TN load reduction (lbs/year) for P1
TP_RED_P1	NUMBER	10	TP load reduction (lbs/year) for P1
PRELENGTH_LT	NUMBER	10	Left side pre-restoration stream length connected to floodplain where bank height ratio is 1.0 or less
PRELENGTH_RT	NUMBER	10	Right side pre-restoration stream length connected to floodplain where bank height ratio is 1.0 or less
PREWIDTH_LT	NUMBER	10	The left side pre-restoration stream width taken from the thalweg to the edge of connected side of stream, as indicated by bank height ratio of 1.0 or less
PREWIDTH_RT	NUMBER	10	The right side pre-restoration stream width taken from the thalweg to the edge of connected side of stream, as indicated by bank height ratio of 1.0 or less
POSTLENGTH_LT	NUMBER	10	Left side post restoration stream length connected to floodplain where bank height ratio is 1.0 or less
POSTLENGTH_RT	NUMBER	10	Right side post restoration stream length connected to floodplain where bank height ratio is 1.0 or less
POSTWIDTH_LT	NUMBER	10	The left side post restoration stream width taken from the thalweg to the edge of connected side of stream, as indicated by bank height ratio

			of 1.0 or less
POSTWIDTH_RT	NUMBER	10	The right side post restoration stream width taken from the thalweg to the edge of connected side of stream, as indicated by bank height ratio of 1.0 or less
TSS_RED_P2	NUMBER	10	TSS load reduction (lbs/year) for P2
TN_RED_P2	NUMBER	10	TN load reduction (lbs/year) for P2
TP_RED_P2	NUMBER	10	TP load reduction (lbs/year) for P2
UP_DRAIN_AREA	NUMBER	6	Upstream area draining to stream restoration project
FP_WETLAND_AREA	NUMBER	6	Area (acres) of floodplain/wetland connected to stream
RATIO_FP_UPDA	NUMBER	3	Ratio of FP_WETLAND_AREA to UP_DRAIN_AREA
TSS_EFF_P3	NUMBER	10	TSS loading rate reduction efficiency (percent) for P3
TN_EFF_P3	NUMBER	10	TN loading rate reduction efficiency (percent) for P3
TP_EFF_P3	NUMBER	10	TP loading rate reduction efficiency (percent) for P3
TSS_RED_P3	NUMBER	10	TSS load reduction (lbs/year) for P3
TN_RED_P3	NUMBER	10	TN load reduction (lbs/year) for P3
TP_RED_P3	NUMBER	10	TP load reduction (lbs/year) for P3
TSS_RED_IR	NUMBER	10	TSS load reduction (lbs/year) for IR
TN_RED_IR	NUMBER	10	TN load reduction (lbs/year) for IR
TP_RED_IR	NUMBER	10	TP load reduction (lbs/year) for IR
REASON FOR USING INTERIM RATE	TEXT	75	Brief explanation of why interim rate was used in place of protocols
INSPECTION/MAINTENANCE DATA REQUIRED FOR ALL NEW REDEVELOPMENT, RETROFIT, AND ALTERNATIVE BMPS			
BMP_STATUS	TEXT	4	Pass/Fail
LAST_INSP_DATE	DATE/TIME	8	Last inspection date
MAIN_DATE	DATE	8	Last date maintenance was performed
REINSP_STATUS	DATE/TIME	4	Pass/Fail
REINSP_DATA	DATE/TIME	4	Reporting Year
REPORTING YEAR	TEXT	8	Date last change made to this record
GEN_COMNT	TEXT	60	General comments

MDE Approved BMP Classifications

LSD BMPs		
Category	Code	Code Description
Alternative Surfaces (AS)		
E	AGRE	Green Roof – Extensive
E	AGRI	Green Roof – Intensive
E	APRP	Permeable Pavements
E	ARTF	Reinforced Turf
Nonstructural Techniques (NS)		
E	NDRR	Disconnection of Rooftop Runoff
E	NDNR	Disconnection of Non-Rooftop Runoff
E	NSCA	Sheetflow to Conservation Areas
Micro-Scale Practices (MI)		
E	MRWH	Rainwater Harvesting
E	MSGW	Submerged Gravel Wetlands
E	MILS	Landscape Infiltration
E	MIBR	Infiltration Berms
E	MIDW	Dry Wells
E	MMBR	Micro-Bioretention

E	MRNG	Rain Gardens
E	MSWG	Grass Swale
E	MSWW	Wet Swale
E	MSWB	Bio-Swale
E	MENF	Enhanced Filters
Sedimentation (S)		
Ponds (P)		
S	PWED	Extended Detention Structure, Wet
S	PWET	Retention Pond (Wet Pond)
S	PMPS	Multiple Pond System
S	PPKT	Pocket Pond
S	PMED	Micropool Extended Detention Pond
Wetlands (W)		
S	WSHW	Shallow Marsh
S	WEDW	ED – Wetland
S	WPWS	Wet Pond – Wetland
S	WPKT	Pocket Wetland
Infiltration (I)		
S	IBAS	Infiltration Basin
S	ITRN	Infiltration Trench
Filtering Systems (F)		
S	FBIO	Bioretention
S	FSND	Sand Filter
S	FUND	Underground Filter
S	FPER	Perimeter (Sand) Filter
S	FORG	Organic Filter (Peat Filter)
S	FBIO	Bioretention
Open Channels (O)		
S	ODSW	Dry Swale
S	OWSW	Wet Swale
Other Practices (X)		
S	XDPD	Detention Structure (Dry Pond)
S	XDED	Extended Detention Structure, Dry
S	XFLD	Flood Management Area
S	XOGS	Oil Grit Separator
S	XOTH	Other

MDE Approved Alternative BMP Classifications

Alt. BMPs (A)	Code	Code Description
A	MSS	Mechanical Street Sweeping
A	VSS	Regenerative/Vacuum Street Sweeping
A	IMPP	Impervious Surface Elimination (to pervious)
A	IMPF	Impervious Surface Elimination (to forest)
A	FPU	Planting Trees or Forestation on Pervious Urban
A	CBC	Catch Basin Cleaning
A	SDV	Storm Drain Vacuuming
A	STRR	Stream Restoration
A	OUT	Outfall Stabilization
A	SPSC	Regenerative Step Pool Storm Conveyance
A	SHST	Shoreline Management
A	SEPP	Septic Pumping
A	SEPD	Septic Denitrification

A	SEPC	Septic Connections to WWTP

Notes:

1. Use unique structure identification codes listed below
2. For BSD to MEP, enter the most predominant BMP type
3. Use Maryland Office of Planning (MDP) land use codes listed below
4. GIS shapefile required
5. Rainfall target (from Table 5.3, Design Manual pp.5.21-22) used to determine BSD goals and size practices (for new development or redevelopment). If practice is for restoration, then PE_REQ is 1inch.
6. Rainfall addressed (using both BSD techniques and practices, and structural practices) by the BMPs within the drainage area
7. Optional - information should be submitted if available.

Unique Structure Identification Codes: Each stormwater best management structure or water quality improvement project will need a unique identification code. For management of these data statewide it is necessary that these codes also indicate the jurisdiction where they are implemented. Please use the County, City, or State abbreviations listed below as part of each structure's unique identification code.

Jurisdiction	Code
Anne Arundel County	AA
Baltimore City	BC
Baltimore County	BA
Carroll County	CA
Charles County	CH
Frederick County	FR
Harford County	HA
Howard County	HO
Prince George's County	PG
Montgomery County	MO
Maryland State Highway Administration	SHA

MDP Land Use/Land Cover

10 Urban Built-up

- **11 Low Density Residential** – Detached single family/duplex dwelling units, yards, and associated areas. Areas of more than 90 percent single family/duplex dwelling units, with lot sizes less than five acres but at least one-half acres (0.2 dwelling units/acre to 2 dwelling units/acre).
- **12 Medium Density Residential** – Detached single family/duplex, attached single unit row housing, yards, and associated areas. Areas of more than 90 percent single family/duplex units and attached single unit row housing, with lot sizes of less than one-half acre but at least one-eighth acre (2 dwelling units/acre to 8 dwelling units/acre).
- **13 High Density Residential** – Attached single unit row housing, garden apartments, high rise apartments/condominiums, mobile home and trailer parks. Areas of more than 90 percent high density residential units, with more than 8 dwelling units/acre.
- **14 Commercial** – Retail and wholesale services. Areas used primarily for the sale of products and services, including associated yards and parking areas.
- **15 Industrial** – Manufacturing and industrial parks, including associated warehouses, storage yards, research laboratories, and parking areas.

- **16 Institutional** – Elementary and secondary schools, middle schools, junior and senior high schools, public and private colleges and universities, military installations (built-up areas only, including buildings and storage, training, and similar areas) churches and health facilities, correctional facilities, and government offices and facilities that are clearly separable from the surrounding land cover.

- **17 Extractive** – Surface mining operations, including sand and gravel pits, quarries, coal surface mines, and deep coal mines. Status of activity (active vs. abandoned) is not distinguished.

- **18 Open Urban Land** – Urban areas whose use does not require structures, or urban areas where non-conforming uses characterized by open land have become isolated. Included are golf courses, parks, recreation areas (except associated with schools or other institutions), cemeteries, and entrapped agricultural and undeveloped land within urban areas.

- **191 Large Lot Subdivision (Agriculture)** – Residential subdivisions with lot sizes less than 20 acres but at least 5 acres, with a dominant land cover of open fields or pasture.

- **192 Large Lot Subdivision (Forest)** - Residential subdivisions with lot sizes less than 20 acres but at least 5 acres, with a dominant land cover of deciduous, evergreen or mixed forest.

20 Agriculture

- **21 Cropland** – Field and forage crops.

- **22 Pasture** – Land used for pasture, both permanent and rotated: grass.

- **23 Orchards/Vineyards/Horticulture** – Areas of intensively managed commercial bush and tree crops, including areas used for fruit production, vineyards, sod and seed farms, nurseries, and green houses.

- **24 Feeding Operations** – Cattle or hog feeding lots, poultry houses, and holding lots for animals, and commercial fishing areas (including oyster beds).

- **241 Feeding Operations** – Cattle or hog feeding lots, poultry houses, and holding lots for animals.

- **242 Agricultural Building** – Breeding and training facilities, storage facilities, built-up areas associated with a farmstead, small farm ponds, and commercial fishing areas.

- **25 Row and Garden Crops** – Intensively managed truck and vegetable farms and associated areas.

40 Forest

- **41 Deciduous Forest** – Forested areas in which the trees characteristically lose their leaves at the end of the growing season. Included are such species as oak, hickory, aspen, sycamore, birch, yellow poplar, elm, maple, and cypress.

- **42 Evergreen Forest** - Forested areas in which the trees are characterized by persistent foliage throughout the year. Included are such species as white pine, pond pine, hemlock, southern white cedar, and red pine.

- **43 Mixed Forest** – Forested areas in which neither deciduous or evergreen species dominate, but in which there is a combination of both types.

- **44 Brush** – Areas that do not produce timber or other wood products but may have cut-over timber stands, abandoned agriculture fields, or pasture. These areas are characterized by vegetation types such as sumac, vines, rose, brambles, and tree seedlings.

50 Water – Rivers, waterways, reservoirs, ponds, bays, estuaries, and ocean.

60 Wetlands – Forested and non-forested wetlands, including tidal flats, tidal and non-tidal marshes, and upland swamps and wet areas.

70 Barren Land

- 71 Beaches – Extensive shoreline areas of sand and gravel accumulation, with no vegetative cover or other land use.
- 72 Bare Exposed Rock – Areas of bedrock exposure, scarps, and other natural accumulations of rock without vegetative cover.
- 73 Bare Ground – Areas of exposed ground caused naturally, by construction, or other cultural processes.

80 Transportation - Transportation features include major highways, light rail or metro stations and large "Park N Ride" lots, generally over ten acres in size. Major highways were defined a those appearing on the State Highway maps as Controlled Access Highways or Primary Highways.

FINAL

COUNTY COUNCIL OF ANNE ARUNDEL COUNTY, MARYLAND

Legislative Session 2015, Legislative Day No. 3

Bill No. 9-15

Introduced by Mr. Walker, Chairman
(by request of the County Executive)

By the County Council, February 2, 2015

Introduced and first read on February 2, 2015
Public Hearing set for and held on February 17, 2015
Bill Expires May 8, 2015

By Order: Elizabeth E. Jones, Administrative Officer

A BILL ENTITLED

AN EMERGENCY ORDINANCE concerning: Floodplain Management, Erosion and Sediment Control, and Stormwater Management – Floodplain Management

FOR the purpose of amending certain definitions as required by the Federal Emergency Management Agency; incorporating the Flood Insurance Study for Anne Arundel County, Maryland and Incorporated Areas revised February 18, 2015; updating existing floodplain districts to remain in compliance with the National Flood Insurance Program; amending the process for floodplain district revisions in certain instances; modifying the notice requirements for development in floodplain districts; making this Ordinance an emergency measure; and generally relating to floodplain management.

BY repealing and reenacting, with amendments: §§ 16-1-101(22), (52), (56) and (60); 16-2-103(a) and (c); and 16-2-204(b)
Anne Arundel County Code (2005, as amended)

BY repealing: § 16-2-103(b)
Anne Arundel County Code (2005, as amended)

BY adding: § 16-2-103(b)
Anne Arundel County Code (2005, as amended)

EXPLANATION: CAPITALS indicate new matter added to existing law.
[Brackets] indicate matter stricken from existing law.

SECTION 1. *Be it enacted by the County Council of Anne Arundel County, Maryland,* That § 16-2-103(b) of the Anne Arundel County Code (2005, as amended) is hereby repealed.

SECTION 2. *And be it further enacted,* That Section(s) of the Anne Arundel County Code (2005, as amended) read as follows:

ARTICLE 16. FLOODPLAIN MANAGEMENT, EROSION AND SEDIMENT CONTROL, AND STORMWATER MANAGEMENT

TITLE 1. DEFINITIONS AND GENERAL PROVISIONS

16-1-101. Definitions.

In this article, the following words have the meanings indicated.

(22) "Development" has the meaning stated in Article 17 of this Code, EXCEPT THAT AS USED IN TITLE 1 AND TITLE 2 OF THIS ARTICLE, "DEVELOPMENT" ALSO INCLUDES FARMING, GARDENING, YARD MAINTENANCE, AND STORAGE OF EQUIPMENT OR MATERIALS.

(52) "Historic structure" means a structure that is listed on the Maryland Inventory of Historic Properties, the National Register of Historic Places, or the National Historic Landmarks, EXCEPT THAT AS USED IN TITLE 1 AND TITLE 2 OF THIS ARTICLE, "HISTORIC STRUCTURE" MEANS A STRUCTURE THAT IS LISTED ON THE MARYLAND REGISTER OF HISTORIC PROPERTIES, THE NATIONAL REGISTER OF HISTORIC PLACES, OR THE NATIONAL HISTORIC LANDMARKS.

(56) "Lowest floor" means the lowest floor of the lowest enclosed area including basements, except that an unfinished or flood-resistant enclosure used solely for parking, building access, or storage may not be considered the lowest floor, PROVIDED THAT SUCH ENCLOSURE IS NOT BUILT SO AS TO RENDER THE STRUCTURE IN VIOLATION OF THE APPLICABLE NON-ELEVATION DESIGN REQUIREMENTS.

(60) "New construction" means structures for which construction commenced on or after [July 25, 1988] MAY 2, 1983.

TITLE 2. FLOODPLAIN MANAGEMENT

16-2-103. Establishment of floodplain district and subdistricts.

(a) **Establishment of floodplain district.** A floodplain district is established. It includes the areas in the County subject to inundation by the waters of the 100-year flood as determined and delineated by:

(1) [the Flood Insurance Study and Wave Height Study for Anne Arundel County, Maryland (Unincorporated Areas), dated November 2, 1982, and the Flood Insurance Study and Wave Height Study for the Town of Highland Beach, Maryland (Incorporated Area), dated April 15, 1982,] THE FLOOD INSURANCE STUDY FOR ANNE ARUNDEL

COUNTY, MARYLAND AND INCORPORATED AREAS REVISED FEBRUARY 18, 2015, with accompanying flood insurance rate and floodway maps by FEMA and all subsequent revisions; or

(2) more restrictive floodplain studies or data approved in connection with application for a building or grading permit or for subdivision.

(B) **Subdistricts.** THE FLOODPLAIN DISTRICT CONSISTS OF THE FOLLOWING SUBDISTRICTS:

(1) ZONE A: SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1-PERCENT ANNUAL CHANCE (100-YEAR) FLOOD; BASE FLOOD ELEVATIONS ARE NOT DETERMINED.

(2) ZONE AE AND ZONE A1-30: SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1-PERCENT ANNUAL CHANCE (100-YEAR) FLOOD; BASE FLOOD ELEVATIONS ARE DETERMINED; FLOODWAYS MAY OR MAY NOT BE DETERMINED. IN AREAS SUBJECT TO TIDAL FLOODING, THE LIMIT OF MODERATE WAVE ACTION MAY OR MAY NOT BE DELINEATED.

(3) ZONE AH AND ZONE AO: AREAS OF SHALLOW FLOODING, WITH FLOOD DEPTHS OF 1 TO 3 FEET (USUALLY AREAS OF PONDING OR SHEET FLOW ON SLOPING TERRAIN), WITH OR WITHOUT BASE FLOOD ELEVATIONS OR DESIGNATED FLOOD DEPTHS.

(4) ZONE B AND ZONE X (SHADED): AREAS SUBJECT TO INUNDATION BY THE 0.2-PERCENT ANNUAL CHANCE (500-YEAR) FLOOD; AREAS SUBJECT TO THE 1-PERCENT ANNUAL CHANCE (100-YEAR) FLOOD WITH AVERAGE DEPTHS OF LESS THAN 1 FOOT OR WITH CONTRIBUTING DRAINAGE AREA LESS THAN 1 SQUARE MILE; AND AREAS PROTECTED FROM THE BASE FLOOD BY LEVEES.

(5) ZONE C AND ZONE X (UNSHADED): AREAS OUTSIDE OF ZONES DESIGNATED A, AE, A1-30, AO, VE, V1-30, B, AND X (SHADED).

(6) ZONE VE AND ZONE V1-30: SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1-PERCENT ANNUAL CHANCE (100-YEAR) FLOOD AND SUBJECT TO HIGH VELOCITY WAVE ACTION (ALSO SEE COASTAL HIGH HAZARD AREA).

(c) **Revisions to floodplain district.** The floodplain district boundaries may vary periodically as revisions to the flood insurance study and flood insurance rate maps are made and, upon receipt of changes by the Office of the County Executive, the changes automatically constitute changes to the boundaries of the floodplain district. The Office of Planning and Zoning may revise the delineation of the floodplain district only in compliance with the National Flood Insurance Program (NFIP) and the requirements of the State and only when there are changes through natural or other causes as indicated by ANALYSES OF detailed hydrologic and hydraulic studies. Changes to the delineation of the floodplain district SHALL BE SUBMITTED TO FEMA WITHIN SIX MONTHS AFTER SUCH DATA AND INFORMATION BECOMES AVAILABLE IF THE ANALYSES INDICATE CHANGES IN BASE FLOOD ELEVATIONS OR BOUNDARIES AND shall be subject to the review and approval of FEMA and the State, except that approval is not required and elevations shall be used if there is a conflict between map boundaries and elevations plotted on a topographic map.

16-2-204. Relocation, alteration, or modification of a watercourse or stream.

(b) **Notice**. If a modification granted under this title allows development that includes the relocation, alteration, restoration, or modification of a watercourse or stream, the developer shall maintain the flood carrying capacity of the altered, relocated, or restored watercourse. The developer shall provide notice of the relocation, alteration, restoration, or modification by certified mail to the Federal Emergency Management Agency, to the State, and to all [lot owners within 175 feet of the portion of] COMMUNITIES ADJACENT TO the watercourse or stream to be relocated or altered.

SECTION 3. *And be it further enacted*, That this Ordinance is hereby declared to be an emergency ordinance and necessary for the immediate preservation of the public peace, health, safety, welfare, and property and being passed by the affirmative vote of five members of the County Council, the same shall take effect from the date it becomes law.

READ AND PASSED this 17th day of February, 2015

By Order:

Elizabeth E. Jones
Administrative Officer

PRESENTED to the County Executive for his approval this 18th day of February, 2015

Elizabeth E. Jones
Administrative Officer

APPROVED AND ENACTED this 18 day of February, 2015

Steven R. Schuh
County Executive

EFFECTIVE DATE: February 18, 2015

I HEREBY CERTIFY THAT THIS IS A TRUE AND CORRECT COPY OF BILL NO. 9-15. THE ORIGINAL OF WHICH IS RETAINED IN THE FILES OF THE COUNTY COUNCIL.

Elizabeth E. Jones
Administrative Officer

FINAL

COUNTY COUNCIL OF ANNE ARUNDEL COUNTY, MARYLAND

Legislative Session 2015, Legislative Day No. 32

Bill No. 83-15

Introduced by Walker, Chairman
(by request of the County Executive)

By the County Council, July 20, 2015

Introduced and first read on July 20, 2015
Public Hearing set for and held on September 21, 2015
Bill Expires October 24, 2015

By Order: Elizabeth E. Jones, Administrative Officer

A BILL ENTITLED

AN ORDINANCE concerning: Erosion and Sediment Control – Plans and Permits

FOR the purpose of amending certain definitions; defining certain terms; adding new requirements for erosion and sediment control plans and the issuance of grading permits; adding requirements for site inspections and complaints; and generally relating to erosion and sediment control.

BY repealing and reenacting, with amendments: §§ 16-1-101(21) and (83); 16-3-201(b)(1); 16-3-204; 16-3-206(1); 16-3-209(c); and 16-3-306
Anne Arundel County Code (2005, as amended)

BY renumbering: §§ 16-1-101(52) through (95) to be 16-1-101(54) through (97), respectively; and 16-3-303 through 16-3-306 to be 16-3-304 through 16-3-307, respectively
Anne Arundel County Code (2005, as amended)

BY adding: §§ 16-1-101(52) and (53); 16-3-303; and 16-3-308
Anne Arundel County Code (2005, as amended)

SECTION 1. *Be it enacted by the County Council of Anne Arundel County, Maryland,* That Section(s) 16-1-101(52) through (95) and 16-3-303 through 16-3-306, respectively, of the Anne Arundel County Code (2005, as amended) are hereby

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EXPLANATION: CAPITALS indicate new matter added to existing law.
[Brackets] indicate matter stricken from existing law.

renumbered to be Sections(s) 16-1-101(54) through (97) and 16-3-304 through 16-3-307, respectively.

SECTION 2. *And be it further enacted,* That Section(s) of the Anne Arundel County Code (2005, as amended) read as follows:

ARTICLE 16. FLOODPLAIN MANAGEMENT, EROSION AND SEDIMENT CONTROL, AND STORMWATER MANAGEMENT

TITLE 1. DEFINITIONS AND GENERAL PROVISIONS

16-1-101. Definitions.

In this article, the following words have the meanings indicated.

(21) "Developer" has the meaning stated in [Article 17 of this Code]COMAR 26.04.03.01-1.

(52) "GRADING UNIT" MEANS THE MAXIMUM CONTIGUOUS AREA ALLOWED TO BE DISTURBED AT ANY ONE TIME AND MAY NOT EXCEED 20 ACRES.

(53) "HIGHLY ERODIBLE SOILS" HAS THE MEANING STATED IN ARTICLE 17 OF THIS CODE.

(83) "Standard grading plan" means a plan that may be used in lieu of a grading permit only for certain minor grading and earth disturbance associated with minor commercial and residential construction, AND, IF NECESSARY, MAY INCLUDE SOIL AND EROSION CONTROL PLANS.

TITLE 3. EROSION AND SEDIMENT CONTROL

16-3-201. Approval required; exceptions.

(b) **Exceptions.** Approval is not required for clearing or grading associated with:

(1) [accepted] agricultural land management practices;

16-3-204. Erosion and sediment control plans.

(A) **Application requirements.** An erosion and sediment control plan shall contain all information required by COMAR 26.17.01.07. In addition, an erosion and sediment control plan shall contain all information required by the Department AND THE ANNE ARUNDEL SOIL CONSERVATION DISTRICT. The information [required by the Department] ordinarily shall include:

(1) the signature and seal of a design professional ON ALL PLAN SHEETS;

(2) a boundary line survey tied to the County coordinate system;

(3) a detailed plan (plan sheet 24" x 36") at a scale that is no smaller than a 1" = 40';

(4) the elevations, dimensions, location, extent, and slope of proposed grading, including building and driveway grades, utilities, sewer, water, storm drains and, if applicable, the 100-year flood elevation clearly indicated with finished contours at the same interval as required or used for existing topography;

(5) the estimate of the quantity of excavation and fill involved;

(6) complete storm drainage studies and stormwater management analysis if not previously submitted in accordance with the provisions of Article 17 of this Code;

(7) an appropriate legend;

(8) a 100-foot adjacent peripheral strip, showing existing topography at a contour interval as specified by the Department;

(9) an acknowledgment that all clearing, grading, construction, and development will be done pursuant to the plan;

(10) an identification of responsible personnel;

(11) the use and extent of fills;

(12) a statement that inspections will be requested as required by § 16-3-302;

(13) any enclosure of sediment basins or traps required by § 16-3-104;

(14) the location of the erosion control monitoring device for any piped outfall, sediment trap outfall, sediment basin outfall, or open channel outfalls that serve as a sediment and erosion control feature during construction; and

(15) a statement in the construction sequence that the construction of the first floor walls of any building or structure may not proceed until the foundation has been backfilled, the disturbed areas have been stabilized and a certificate is provided to the inspector verifying the grades and drainage patterns shown on the approved erosion and sediment control plan have been obtained.

(B) **Sequence of construction required.** AN EROSION AND SEDIMENT CONTROL PLAN SHALL ALSO INCLUDE A SEQUENCE OF CONSTRUCTION THAT ACCURATELY DESCRIBES THE RELATIONSHIP BETWEEN THE IMPLEMENTATION AND MAINTENANCE OF CONTROLS, INCLUDING PERMANENT AND TEMPORARY STABILIZATION, GRADING UNITS AND THE VARIOUS STAGES OR PHASES OF EARTH DISTURBANCE AND CONSTRUCTION. PROJECTS SHALL BE SEQUENCED AND PHASED SO THAT NO MORE THAN ONE GRADING UNIT IS ALLOWED TO BE DISTURBED AT ANY GIVEN TIME. THE SEQUENCE OF CONSTRUCTION SHALL AT LEAST DESCRIBE:

(1) REQUESTS FOR A PRE-CONSTRUCTION MEETING WITH THE DEPARTMENT;

(2) CLEARING AND GRUBBING AS NECESSARY FOR THE INSTALLATION OF PERIMETER CONTROLS;

(3) CONSTRUCTION AND STABILIZATION OF PERIMETER CONTROLS;

(4) REMAINING CLEARING AND GRUBBING WITHIN INSTALLED PERIMETER CONTROLS;

(5) ROAD GRADING;

(6) GRADING FOR THE REMAINDER OF THE SITE;

(7) UTILITY INSTALLATION AND CONNECTIONS TO EXISTING STRUCTURES;

(8) CONSTRUCTION OF BUILDINGS, ROADS, AND OTHER CONSTRUCTION;

(9) FINAL GRADING, LANDSCAPING, AND STABILIZATION;

(10) INSTALLATION OF STORMWATER MANAGEMENT MEASURES;

(11) APPROVAL OF THE DEPARTMENT PRIOR TO REMOVAL OF SEDIMENT CONTROLS; AND

(12) REMOVAL OF CONTROLS AND STABILIZATION OF AREAS THAT ARE DISTURBED BY REMOVAL OF SEDIMENT CONTROLS.

(C) **Stabilization measures required.** EROSION AND SEDIMENT CONTROL PLANS SHALL ALSO INCLUDE SPECIFICATIONS FOR TEMPORARY AND PERMANENT STABILIZATION MEASURES. THE STANDARD STABILIZATION NOTE ON THE PLAN SHALL STATE:

(1) THAT FOLLOWING THE INITIAL SOIL DISTURBANCE OR RE-DISTURBANCE, PERMANENT OR TEMPORARY STABILIZATION MUST BE COMPLETED WITHIN (I) THREE CALENDAR DAYS FOR ALL PERIMETER DIKES, SWALES, DITCHES, PERIMETER SLOPES AND ALL SLOPES STEEPER THAN 3 HORIZONTAL TO 1 VERTICAL (3:1), AND (II) SEVEN CALENDAR DAYS FOR ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT NOT UNDER ACTIVE GRADING;

(2) ANY DETAILS FOR AREAS REQUIRING ADVANCED STABILIZATION; AND

(3) ANY MAINTENANCE REQUIREMENTS AS IDENTIFIED IN THE STANDARDS AND SPECIFICATIONS.

(D) **Additional requirements.** THE FOLLOWING ADDITIONAL REQUIREMENTS SHALL APPLY TO IMPLEMENTATION OF AN EROSION AND SEDIMENT CONTROL PLAN:

(1) A DEVELOPER SHALL OBTAIN ALL NECESSARY PERMITS AND REQUEST A PRE-CONSTRUCTION MEETING DESCRIBED IN § 16-3-301.

(2) THE PERMITTEE SHALL INSTALL SEDIMENT CONTROLS AND STABILIZE PERIMETER CONTROLS WITHIN THREE DAYS OF DISTURBANCE AND SHALL OBTAIN FIRST PHASE APPROVAL BY THE EROSION CONTROL INSPECTOR PRIOR TO COMMENCING WORK. THE INSPECTOR MAY REQUIRE THAT AN INSPECTION AND CERTIFICATION OF THE INSTALLATION OF SEDIMENT CONTROLS ALSO BE PERFORMED BY A DESIGN PROFESSIONAL PRIOR TO COMMENCING WORK.

(3) IF THERE IS TO BE DEMOLITION OF ANY EXISTING STRUCTURES, ALL DEBRIS SHALL BE HAULED TO AN APPROVED SITE.

(4) ACCESS, TRAVEL LANES, HEAVY USE, LAY DOWN, CONCRETE WASH DOWN, AND STAGING AREAS SHALL REQUIRE ACCELERATED MECHANICAL STABILIZATION.

(5) STABILIZATION SHALL BE COMPLETED IN SEVEN CALENDAR DAYS ON ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT NOT UNDER ACTIVE GRADING. IN THE EVENT OF WET WEATHER, THE SEDIMENT AND EROSION CONTROL INSPECTOR MAY REQUIRE ADDITIONAL SEDIMENT PROTECTION AND STABILIZATION.

(6) AFTER THE SITE IS STABILIZED AND WITH THE SEDIMENT AND EROSION CONTROL INSPECTOR'S APPROVAL, FRAMING MAY COMMENCE ON THE GROUND FLOOR. DURING BUILDING CONSTRUCTION BEYOND THE GROUND FLOOR, ALL DISTURBED AREAS MUST BE STABILIZED BY THE END OF EACH DAY.

(7) INSTALLATION OF STORM WATER MANAGEMENT SYSTEMS MAY NOT BE CONDUCTED UNTIL THE UPSTREAM AREAS ARE 95% STABILIZED.

16-3-206. Criteria for issuance.

The Department may not issue a grading permit unless:

(1) an erosion and sediment control plan is approved by the Anne Arundel Soil Conservation District IN ACCORDANCE WITH THE COMPREHENSIVE AND INTEGRATED PLAN APPROVAL PROCESS REQUIRED BY THE ENVIRONMENT ARTICLE, § 4-201.1 AND § 4-203, OF THE STATE CODE INCLUDING THE SUBMITTAL OF CONCEPT, SITE DEVELOPMENT AND FINAL PLANS;

16-3-209. Revisions.

(c) **Minor revisions.** The Department may approve minor revisions to the approved erosion and sediment control plan based on a list of minor revisions approved by the Anne Arundel Soil Conservation District AND THE MARYLAND DEPARTMENT OF THE ENVIRONMENT. To apply for a minor revision, the permittee shall have the design professional responsible for the grading permit plans prepare five sets of the permit plans showing the plan changes in red for review. These plans shall be transmitted to the Department. If approved, the plan sets will be stamped with the date approved and distributed.

16-3-303. Inspections.

(A) **Plan kept on site.** THE DEVELOPER SHALL MAINTAIN COPIES OF APPROVED EROSION AND SEDIMENT CONTROL PLANS ON SITE.

(B) **Routine inspection.** EVERY ACTIVE SITE HAVING AN APPROVED EROSION AND SEDIMENT CONTROL PLAN SHALL BE INSPECTED FOR COMPLIANCE WITH THE PLAN ON AVERAGE ONCE EVERY TWO WEEKS.

(C) **Reports.** A WRITTEN REPORT SHALL BE PREPARED BY THE INSPECTION AGENCY AFTER EVERY ROUTINE INSPECTION. THE REPORT SHALL DESCRIBE:

(1) THE DATE AND LOCATION OF THE SITE INSPECTION;

(2) WHETHER THE APPROVED EROSION AND SEDIMENT CONTROL PLAN HAS BEEN PROPERLY IMPLEMENTED AND MAINTAINED;

(3) PRACTICE DEFICIENCIES OR EROSION AND SEDIMENT CONTROL PLAN DEFICIENCIES;

(4) IF A VIOLATION EXISTS, THE TYPE OF ENFORCEMENT ACTION TAKEN; AND

(5) IF APPLICABLE, A DESCRIPTION OF ANY MODIFICATIONS TO THE EROSION AND SEDIMENT CONTROL PLAN.

(D) **Notice of violations.** IN ADDITION TO THE REQUIREMENTS OF § 16-5-104, THE INSPECTION AGENCY SHALL NOTIFY THE ON-SITE PERSONNEL OR THE DEVELOPER IN WRITING WHEN VIOLATIONS ARE OBSERVED, DESCRIBING:

(1) THE NATURE OF THE VIOLATION;

(2) THE REQUIRED CORRECTIVE ACTION; AND

(3) THE TIME PERIOD IN WHICH TO HAVE THE VIOLATION CORRECTED.

[16-3-306.] 16-3-307. Certificate of completion.

The Department shall issue a certificate of completion for a project for which a grading permit is required within 60 days after it receives a written notice of completion of the project if after an inspection the Department finds that the permittee has complied with the provisions of this [title] ARTICLE.

16-3-308. Complaints.

THE DEPARTMENT SHALL ACCEPT AND INVESTIGATE COMPLAINTS REGARDING EROSION AND SEDIMENT CONTROL CONCERNS FROM ANY INTERESTED PARTIES AND SHALL:

(1) CONDUCT AN INITIAL INVESTIGATION WITHIN THREE WORKING DAYS FROM RECEIPT OF THE COMPLAINT;

(2) NOTIFY THE COMPLAINANT OF THE INITIAL INVESTIGATION AND FINDINGS WITHIN SEVEN DAYS FROM RECEIPT OF THE COMPLAINT; AND

(3) TAKE APPROPRIATE ACTION PURSUANT TO TITLE 5 WHEN VIOLATIONS ARE DISCOVERED DURING THE COURSE OF THE COMPLAINT INVESTIGATION.

SECTION 3. *And be it further enacted,* That this Ordinance shall take effect 45 days from the date it becomes law.

READ AND PASSED this 21st day of September, 2015

By Order:

Elizabeth E. Jones
Administrative Officer

PRESENTED to the County Executive for his approval this 22nd day of September, 2015

Elizabeth E. Jones
Administrative Officer

APPROVED AND ENACTED this 29th day of September, 2015

Steven R. Schuh
County Executive

EFFECTIVE DATE: November 13, 2015

I HEREBY CERTIFY THAT THIS IS A TRUE AND CORRECT COPY OF BILL NO. 83-15. THE ORIGINAL OF WHICH IS RETAINED IN THE FILES OF THE COUNTY COUNCIL.

Elizabeth E. Jones
Administrative Officer

MARYLAND DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard • Baltimore MD 21230
410-537-3000 • 1-800-633-6101 • www.mde.maryland.gov

Larry Hogan
Governor

Boyd Rutherford
Lieutenant Governor

Ben Grumbles
Secretary

October 13, 2015

Ms. Eva M. Kerchner, Assistant Director
Inspections and Permits
Anne Arundel County
Heritage Office Complex
2664 Riva Road, MS6201
Annapolis MD 21401

Dear Ms. Kerchner:

The Maryland Department of the Environment, Water Management Administration (MDE/WMA) acknowledges the receipt of Anne Arundel County's (County) updated erosion and sediment control ordinance (Bill 83-15) on October 6, 2015. The County provided a signed copy of Bill 83-15 to MDE in accordance with State Law. Therefore, MDE is pleased to approve Anne Arundel County's continued delegation of erosion and sediment control enforcement authority. This delegation of authority to the County is effective through June 30, 2017.

If you have any questions or if I can be of any assistance, please call me at (410) 537-3543, or have a member of your staff contact Mr. Raymond Bahr, Sediment and Stormwater Program Review Division at (410) 537-3545 or raymond.bahr@maryland.gov.

Sincerely,

Brian S. Clevenger
Program Manager
Sediment, Stormwater, and Dam Safety Program

cc: John Peacock, Inspections and Permits, Anne Arundel County
John Czajkowski, District Manager, Anne Arundel Soil Conservation District
Ginger Ellis, Environmental Planning Administrator, Anne Arundel County

URBAN STORMWATER BMP DATABASE
HISTORIC BMP RECORD REVIEW AND UPDATE

SCOPE OF WORK

Background and Purpose

The Anne Arundel County National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, issued by the Maryland Department of Environment (MDE), requires that the County maintain an urban stormwater best management practices (BMP) database that identifies all existing stormwater facilities within the County along with specific design, construction, and inspection information, This information is to be documented in database format with accompanying GIS coverages.

The County has developed and maintains an urban stormwater (BMP) database that documents certain aspects of individual stormwater management facilities and practices. Over the years the required database structure, and data to be captured, have changed as changes in NPDES MS4 Permit reporting and tracking requirements have occurred. The two most recent changes occurred in August of 2014 and in March 2015.

In August 2014, MDE issued the guidance document: "Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated – Guidance for National Pollutant Discharge Elimination System Stormwater Permits." This document provided a roadmap for NPDES MS4 Phase I jurisdictions to determine their impervious acre baseline, the 20% impervious area management requirement, and to determine pollutant load credits for restoration project implementation. At the time of issuance, the stormwater facility database reporting requirements detailed in Appendix B of the August 2014 MDE guidance document took precedence over any prior issued guidance (e.g., Attachment A to the NPDES MS4 Phase I Permits).

In March 2015, MDE issued a geodatabase design and user's guide for the NPDES MS4 Phase I Permit program (MDE 2015). The geodatabase was designed for the purpose of NPDES MS4 Phase I permittee annual data reporting, and establishes a reporting structure for submittal of local jurisdictional program data and for showing compliance with permit requirements. The geodatabase design includes specific requirements for documentation of urban stormwater BMPs, some of which carry over from the August 2014 guidance requirements.

These most recent stormwater BMP reporting requirements include data fields not previously identified or captured for prior approved BMP records in the County database. Furthermore, some previously required data fields were not completed for some BMP records. To review the historic BMP records and to research, correct, and complete the required fields for each existing record, the County is soliciting contractual support. This work effort applies to all BMPs included in the County's existing Urban Stormwater BMP database as of June 30, 2015. There are approximately 14,000 records. Given the volume of data to be reviewed the County will pursue this effort in a phased manner.

In summary, the major components of this work effort are to

- review the existing stormwater BMP database records;
- research, correct, and populate the required database fields for existing records;
- as necessary, create new records for existing legacy BMPs (e.g., stacked ESD records) that do not have a separate record; and
- develop GIS coverages associated with this database.

The ultimate objective of this work effort is to produce a complete and accurate geodatabase of the existing urban stormwater BMPs. The resulting geodatabase will be used for multiple purposes. Such purposes include modeling nutrient and sediment load reductions associated with stormwater management measures throughout the County; determining the acres of impervious area managed by stormwater facilities and practices; and to serve as the platform from which stormwater facility inspections and maintenance efforts are scheduled and recorded, and from which stormwater facilities are identified for potential retrofit. Thus, the accuracy of the data must be sufficient for these purposes.

To assist in developing a technical and cost proposal, the County will provide the consultant with a copy of the master Urban Stormwater BMP Database. This database includes the entirety of the County's Urban Stormwater BMP records through June 30, 2015.

Timeline

This work effort will be accomplished as a progressive award. The County anticipates the completion of the first phase of the project within 12 months of Notice to Proceed. The work phases are described below:

Phase 1: This phase of the work effort will focus on stormwater management facility records associated with BMPs constructed starting in 2002. There are approximately 8,900 BMP records for this time period.

1) BMPs constructed from 2002 onward are most likely to be designed for water quality treatment. From this grouping of records, the priority for research is:
   a) BMPs with inspection dates between June 30, 2012 and June 30, 2015 (1286 records).
   b) BMPs with inspection dates unknown or prior to July 1, 2012 (7260 records).
   c) BMPs with inspection dates since July 1, 2015 (352 records).
2) BMPs constructed after 2010 will most likely include facilities, or groups of facilities, that meet the criteria of ESD to the MEP (~ 5000 records).

Phase 2: This phase of the work effort will focus on those stormwater facility records associated with BMPs constructed prior to 2002. There are approximately 5,100 BMP records for this time period.

1) BMPs constructed between 1985 and 2002 may or may not include water quality management measures. From this grouping of records, the priority for research is:
   a) BMPs with inspection dates between June 30, 2012 and June 30, 2015 (733 records).
   b) BMPs with inspection dates since July 1, 2015 (195 records).
   c) BMPs with inspection dates unknown or prior to June 30, 2012 (2900 records).
2) BMPs constructed prior to 1985 or with unknown built dates (1261 records).

When preparing the technical and cost proposal, please address each phase as a separate cost item.

Fee

The cost of the proposed work will be based upon actual cost plus a fixed fee.

Project Tasks

Task 1 Project Initiation, Coordination, and Quality Assurance Project Plan

Subtask 1.1 Project Initiation

Within two weeks of receiving the Notice to Proceed, the consultant will meet with the County Project Manager and designated staff to discuss project coordination efforts, the proposed work plan, and the schedule of activities. The meeting is anticipated to last no longer than two hours.

At the project initiation meeting, the County will provide the consultant with the most current Urban Stormwater BMP Database, with data records compiled through the end of County Fiscal Year 2015 (end date June 30, 2015). Additionally, the County will provide the consultant with information regarding the pertinent data sources for the required fields.

Results of the project initiation meeting will include a documented meeting summary and a project work plan and schedule.

Subtask 1.2 Project Coordination

Project coordination with County staff will be important throughout the course of the project. The consultant will attend and will, with assistance from the County Project Manager, lead in planning and organizing up to four (4) two (2) hour project coordination sessions for each phase of the project. These sessions will bring together the management team of County staff from within the Department of Public Works, and will ensure that the end products are usable and meet the permit requirements.

The consultant shall prepare an agenda for these meetings and email it to the County Project Manager for input two working days prior to the meeting date. Additionally, the consultant shall prepare meeting minutes describing work accomplished as well as action to be achieved in in the next quarter of work. The meeting minutes will be reviewed first by the Project Manager and then distributed by the consultant to the members of the management team. The meeting minutes shall be provided to the Project Manager within 5 working days of the meeting.

Subtask 1.3 Quality Assurance Project Plan and Standard Operating Procedures

A Quality Assurance Project Plan (QAPP) will be developed to document the standard procedures to be undertaken during this project, as well as the quality assurance and quality controls measures that will be employed. This document will serve as the Standard Operating Procedures and QAPP for the entirety of this project. The QAPP will include but not be limited to documentation of methods, data sources, meta data requirements, reporting and deliverable formats, quality assurance and quality control procedures, and schedule for task completion.

Task 1 Deliverables

The consultant will provide a draft and final memorandum documenting the project initiation meeting.

The consultant will develop and deliver the draft and final project work plan and schedule.

The consultant, with assistance from the County Project Manager, shall be the lead in the preparation of schedules, agendas, and meeting minute summaries of up to 4 coordination meetings per each phase of the project.

The consultant shall develop and finalize the detailed QAPP based on the comments from the initiation meeting. This deliverable shall be provided as an electronic copy in Word and PDF format.

Task 2 Urban Stormwater BMP Data Review and Update

Given the volume of data to be reviewed, the County will pursue this effort in the phased manner described above. When preparing the technical and cost proposal, please address each of these phases as separate cost items.

Subtask 2.1 Assemble Data

Stormwater BMP Facility Data
The consultant shall use all available data sources to research, correct, and populate the required database fields and develop a complete georeferenced inventory of all constructed and in-place publicly and privately owned and maintained stormwater BMPs located within the County. To assist with this effort, the County will provide electronic copies of the following databases and information. All databases will be current through June 30, 2015.

- County-wide Urban Stormwater BMP geodatabase
- County-wide BMP drainage area shapefiles
- Countywide impervious surfaces geodatabase
- LIDAR
- DEM
- County-wide Capital Improvement Program Restoration Project Dataset
- NPDES MS4 Geodatabase Design and User's Guide (MDE 2015 or most recent version)
- "Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated – Guidance for National Pollutant Discharge Elimination System Stormwater Permits (MDE 2014 or most recent version)

In some, but not all County watershed areas, the Urban Stormwater BMP data were reviewed to identify necessary information for purposes of nutrient load modeling for certain watershed studies. As part of this effort, some but not all stormwater BMP information has been researched and certain corresponding fields updated (i.e., missing data for BMP type, location, and drainage area). To provide information associated with that effort, Anne Arundel County will provide electronic copies of the following technical memoranda associated with these watershed studies:

- Technical memoranda for Urban Stormwater BMP data review and updates associated with the following County watershed studies:
    - West and Rhode River Watersheds,
    - Little Patuxent River Watershed

- Patapsco Tidal River and Bodkin Creek Watersheds.

Data Sources for Records Review

The consultant should note that certain components of data review and research will require the consultant to be physically located at the County offices to access and assemble County-held data. Such work components include researching County grading and building permits and associated approved grading plans and/or as-built plans for each stormwater BMP record. The County will coordinate with the consultant to plan and make provisions to accommodate this review and research, including but not limited to providing office space and limited computer network access.

The County will provide the consultant with files or sharing access (from the County office premises) to various data sources for purposes of records research and review. These data sources will aid the consultants in identifying accurate and correct data for BMP records. The following is a list and brief description of the primary data sources:

Scanned Grading and Building Permits: The Office of Inspection and Permits has scanned a number of grading and building permits to backup and replace the paper copies. This source of information shall be utilized to fill data gaps and/or resolve contradictions and duplications that may be discovered. The plans, plats, computations, and other permit related documentation is stored in a directory, and is identified by the grading permit, subdivision or project name. This data resource is a valuable search tool for obtaining additional information for records within the Urban Stormwater BMP Database. It should be noted that projects that were not issued grading and building permits through the Office of Inspection and Permits will not be found in this directory. The search keywords to use for retrieving permit related documentation are the grading permit number or the subdivision name listed in the Urban Stormwater BMP Database. This document search can only be done at the WPRP premises at the County office.

Department of Public Works As-Built Drawings: As-Built plans are generally available for all subdivisions and developments containing public infrastructure and requiring an As-Built plan completion for bond release purposes. This source of information shall be utilized to fill data gaps and/or resolve contradictions and duplications that may be discovered. DPW maintains a desktop enterprise tool used internally within the County office to view pertinent GIS layers and As-Built plans. The County can provide the consultant with an OIT GIS "As-Built Viewer Help" document to assist in this research. DPW also hosts a publically available website for querying and viewing as-built drawings.

File Room Plans: Hardcopy SWM plans and computations are housed at three locations within the County. These are the file room at Inspection and Permits (e.g., hard copy grading and building permits, approved stormwater plans), As-Built plans awaiting scanning at the DPW/MGI records desk, and the Soil Conservation District office (e.g., MD-378 ponds). Additionally, hard copy grading and/or building permit files associated with a limited number of public stormwater BMP facilities may be housed in the DPW Bureau of Highways Infrastructure Management Division. All locations are within the Heritage Office Complex and access to these records will be arranged through the WPRP project manager.

Iron Mountain: Older hard copy records of grading or building permits, stormwater management plans and computations, and other information pertinent to this work effort may not be housed within County offices. These documents and information may have been archived off-site. Should this information be needed to complete the research, record review, and data field updates the retrieval of these data will be arranged through the WPRP project manager.

Various supporting GIS layers: The County maintains various GIS layers that can support the search for a BMP location. Layers denoted with © are only available through a shared access computer at the County offices. Examples of the available support layers are:

- County Street Centerline File
- Parcel map and GIS property query ©
- Consolidated property file table
- Aerial photographs
- Microsoft Live Local Pictometry ©
- Digital storm and sewer 40 scale operating maps ©
- LIDAR DEM and drain line at 1000 pixel resolution or finer if needed for drainage area delineation purposes.

Additional GIS layers (e.g., address points, streams, closed storm drain system) can also be made available as needed.

Subtask 2.2 Data Review for Accuracy and Completeness

Existing stormwater BMP data and GIS coverage will be reviewed for purposes of pollutant load reduction calculation, impervious area management credit, and potential for retrofit. The consultant will be required to review and identify inaccurate or missing information for each of the fields identified in Appendix B of the of the August 2014 MDE guidance (MDE 2014). Additionally, the consultant should be aware that in certain instances multiple stormwater BMP facilities were entered into the existing database as a single record. Therefore, these records should be designated for further research to identify the individual facilities and to create complete records for each. This work to be completed under Task 2.3

As examples for this task, for those database fields listed below the following minimum data are required. Please note that the information below is not an exhaustive list of the data fields to be researched for each BMP record.

Location: Because MDE requires all BMPs to be spatially located in a GIS point shapefile and associated table, Maryland grid coordinates (Northing and Easting in NAD 83 feet) shall be reported for each facility. Please note that although MDE requires data submittal in NAD 83 meters, the County standard is NAD 83 feet and the location coordinates should adhere to County standards.

The spatial accuracy may vary based on available information with a preferred hierarchy as specified below:

- Riser structure as applicable and identifiable, confirmed using County 2014 aerial photography and/or field verification as needed.
- Actual centroid of the facility based on record drawings and confirmed using County 2014 aerial photography.
- Centroid of the property
- Geocoded by a street address, the entire address including street number must be available.
-

Many records contained in the stormwater BMP database may have inaccurate or unknown spatial locations, or have multiple facilities “stacked” in one location. These records should be tagged such that spatial locations and disaggregation, as appropriate, can be addressed in Task 2.3.

Watershed: All BMP records shall be attributed with the Maryland 8-digit hydrologic unit code. The USGS 12-digit hydrologic unit code will be automatically assigned in the geodatabase.

BMP Class: All BMP records must be classified as either E, S, or A. The definition of these classifications is found in Appendix B of the August 2014 MDE guidance document (MDE 2014).

Structure Type: All BMP records must by assigned a 4-letter structure type code as identified in Appendix B of the August 2014 MDE guidance (MDE 2014) The County requests that two fields be developed to address this MDE database requirement. The first field will identify the structure type using the codes or descriptors found on the as-built plants or other verifiable record. The second field will translate that structure type into the required 4-letter structure type code from Appendix B (MDE 2014). A translation table will be provided by the County.

WQv and/or PE: All BMP records must have documentation of the required and achieved WQv or, if the BMP is part of an Environmental Site Design (ESD) development, the BMP must have documentation of the required and achieved PE for the site.

Drainage Area: All BMPs shall be attributed with a drainage area. The drainage area for many of the records can be found in the existing BMP database. For records with null or zero values, the consultant must research all available sources to identify the drainage area. Sources in preferred priority order include As-Built plans found on CountyView, the scanned grading and building permits on the County server, hard copy grading and building permit files held by the County (either in County offices or stored in archives), and DPW file room plans. Should these sources not provide a drainage area associated with the original BMP design, the consultant will tag the record for drainage area delineation as per Task 2.4.

(Permit) Approval Date (Permit Issuance Date): All BMPs shall have an approval date that represents the date of the corresponding grading or building permit approval. For existing records without approval dates or with incorrect approval dates (e.g., 1/1/1900), the consultant will research available sources including the scanned grading and building permits on the County server, the file room plans, archived records, and As-built plans on CountyView to identify the correct dates.

Completion Date (aka Built Date per MDE): All BMPs shall have a completion date that represents the date of As-Built completion. For existing records without completion dates, the consultant will research available sources including the scanned grading and building permits on the County server, the file room plans, archived records, and As-built plans on CountyView to identify the correct dates.

Note that the existing County database already includes a field for “Built Date” which represents the date the stormwater facility was put into the ground; it does not reflect the date of As–built plan completion. MDE requires a field to document the date of As-built plan completion.

***Storm ID*:** As noted earlier in this task description, each existing stormwater BMP record will ultimately have a corresponding STORM ID in the database. Should the consultant identify multiple BMPs represented by a single BMP entry (i.e., multiple BMPs associated with a single STORM ID), the records should be flagged for correction as part of Task 2.3.

Subtask 2.3 Research, Update, and Complete Data Fields

Following review of existing stormwater BMP facility records and identification of incorrect and/or missing data, the consultant will research, compile, and confirm/update all fields for each stormwater BMP facility record and confirm or identify the correct spatial locations of each facility. The consultant is reminded that certain components of data research will require the consultant to be physically located at the County offices to access County-held data. With respect to the stormwater BMP facility spatial location, the consultant is referred to the MDE geodatabase structure guidance (MDE 2015) for information on point and polygon coverage attributes.

During the course of BMP research, multiple BMPs may be found to be represented by a single entry in the database. These records should have been flagged in Task 2.2 and are to be corrected in this task. Correction is made by creating a new BMP point for each of the BMPs, and placing it appropriately within a GIS context. A new Storm ID is to be created by adding a sequential letter to the end of the original point's Storm ID. These data can then be captured in a new field (i.e., *NewSTORMID)* that is included in the draft revised database.

The consultant may identify duplicate records within the stormwater BMP facility database and should make every effort to identify and tag potential duplicate records. Duplicate records may be identified through examining attributes and spatial locations. Duplicate records should not be removed from the draft revised database, but should be reviewed with the County project team to determine if they are indeed duplicates or representative of the evolution of a facility (i.e., original facility and retrofit of original facility). Notation of potential duplicate records shall be made in a new, appropriately named field in the geodatabase.

All hard copy source data utilized to review, verify, and update facility records should be set aside for future scanning purposes. Scanning will be accomplished by the County. The consultant is responsible only for aggregating these hard copy sources by Permit or project number.

Subtask 2.4 Verify or Correct BMP Location

The stormwater BMP facility dataset contains records with unknown or inaccurate spatial location (e.g., spatial location is the centroid of the County). For each record researched, the location (coordinates) in the current Urban BMP database shall be visually checked using the GIS and verified or corrected based on the retrieved research documents and/or a site visit as necessary. The geodatabase should then be updated to reflect that the location of the BMP has been verified or corrected.

With respect to spatial verification of each BMP, the consultant should include a "note" to specifically identify how the BMP was spatially verified and include general information about that BMP as appropriate. The consultant will make specific notation regarding what and how those data were modified by adding a new field labeled "Location Source" to the BMP feature class with domain values of:

- UBMP Database – verified
- Georeferenced plan
- Plan Coordinates
- Orthophoto
- GPS

Subtask 2.5. Delineate BMP Drainage Areas

To properly account for impervious area management and nutrient/sediment load reductions associated with stormwater BMP facilities, and to comply with NPDES MS4 Permit requirements, drainage areas must be delineated for all stormwater BMP facilities. In this task, the consultant will capture (digitize polygon) the drainage area(s) shown on the plans in a polygon feature class related to the BMP point feature class. The resulting drainage area value should match the value for the drainage area on the plans (i.e., a QC check) or the difference in values should be less than 1%. If there is a difference between the drainage area value on the plans and the drainage area shown on the plans, and that difference is greater than 1%, the consultant should also delineate the drainage area using ArcHydro or another County pre-approved method.

Drainage areas that are also delineated using ArcHydro or other County pre-approved method, should be saved in a separate feature class. Thus, it should be recognized that some stormwater BMP facilities will have two (2) drainage area polygons, one (1) that matches the original plans and stormwater reports for the facility, and one (1) that is derived from ArcHydro or other pre-approved method.

Drainage area delineations are addressed differently depending on the BMP structure type, the original data source, and the accuracy of the BMP's spatial location. In addition to delineating the drainage area and completing the required database field, the consultant will provide documentation of the method used to create and populate the drainage area field in the BMP Feature class attributes.

For BMPs with no measurable water quality benefit (e.g., pre-treatment BMPs), drainage areas are not to be created. The Delineate field for these BMPs will be marked as "No WQ – No DA."

Drainage area polygons for stormwater BMPs facilities and restoration projects associated with the **Capital Improvement Program** were previously developed and provided to the consultant in Task 2.1 These drainage area polygons should require no modifications.

It is anticipated that there will be overlapping/nested drainage areas where multiple BMPs have been established through the land development process. The County desires that the drainage areas be topologically correct; thus, once the drainage areas are created or compiled for each BMP in the final dataset a topology will be established to identify overlapping drainage areas. The consultant and County will work together to define the rules governing treatment of overlapping/nested drainage areas, but some basic assumptions are provided here. For example, each BMP facility should have a discreet drainage area for which it is assumed to provide exclusive treatment. It is also assumed that overlapping drainage area polygons will be assigned to the BMP point that topographically best reflects the likely flow path to that point or matches best with the existing closed storm drain coverage. In most cases, the County believes that the BMP point closest to an individual drainage area polygon will be attributed to that polygon, but the consultant will verify that relationship.

Following completion of this step, the consultant will attribute the drainage area to each BMP by current County impervious and pervious areas. The resulting acreage of impervious area within the stormwater BMP facility drainage area can then be identified.

Subtask 2.6 Determine BMP WQv

Within the County's urban stormwater BMP facility database, WQv is reported to be the most common field with missing data. Historically, this field was not required to be submitted in design plans during the County plan review process; however, the County is now required to report these data for each BMP facility record. Moreover, stormwater BMP facilities with missing WQv data cannot be utilized for impervious area management credit or nutrient/sediment load reduction calculations; in essence, these BMPs are not being used for addressing NPDES MS4 Permit or Bay TMDL Stormwater WLA compliance. Because these data are not always available for historic BMPs, yet the information is critical to the County's impervious area accounting as well as TMDL Stormwater WLA compliance, a new method for populating the missing records must be developed.

The Maryland Department of the Environment outlines the method for calculating WQv in the Unified Stormwater Sizing Criteria found in Chapter 2 of the Maryland Stormwater Design Manual, Volume 1 (MDE 2000, MDE 2009). WQv represents the storage needed to capture and treat the runoff from 90% of the average annual rainfall measured in acre-feet. The equation is as follows:

$$WQv = [(P)\ (Rv)\ (A)\ ]/12$$

P = rainfall depth in inches and is equal to 1.0" in the Eastern Rainfall Zone Rv = 0.05 + 0.009(I)
I= percent impervious cover A = area in acres

The only unknown variables required to calculate the required WQv are percent impervious cover and the drainage area. Through the delineation process outlined in Task 2.5, a drainage area for each BMP is developed and the associated impervious area within that drainage area is documented. The consultant will utilize this information to determine an estimate of required WQv for each stormwater BMP facility.

It is recognized that some facilities may not be designed to manage 100% of the required WQv. To determine the percentage of WQv managed by a facility, the designed storage capacity of the facility must be determined. If this information is not readily available from the previously reviewed plans and/or stormwater report, the consultant should estimate the capacity based on the facility dimensions.

In determining WQv for each record using the drainage area delineation data from Task 2.4, the County acknowledges that potential for error exists. This drainage area may not be an exact match of the drainage area as per the original facility design. For example, the current elevation model being used for delineation may not reflect conditions as present during the design and construction of a BMP. This could cause a slight mismatch in drainage area boundaries. The impervious surface layer utilized in the facility design analysis may not represent the current conditions within the drainage area. It is possible the percent imperviousness within the drainage area has changed since the design of the BMP. To gain a better understanding of the accuracy of this method a subset of BMPs with recorded WQv will be used to test the calculation methodology prior to completing this task. Comparing the recorded WQv to the calculated WQv will provide the County with a level of confidence in the proposed methodology and allow the County, in consultation with the consultant, to identify any needed adjustments to the methodology.

Task 2 Deliverables

Phase 1:

- Final QAPP with all SOPs utilized in Phase 1 of this work effort.
- Proposed Geodatabase design

Interim Deliverables:

- Technical Memorandum and geodatabase submission at 10% completion
- Technical Memorandum and geodatabase submission at 60% completion

Final Deliverables:

- Updated/Verified/Completed Master Urban Stormwater BMP database
- Final Urban Stormwater BMP shapefiles with features and metadata
- Technical report documenting research procedures taken and methodology used for data field review/update.
- Hard copy data sources (e.g., as-built plans, stormwater reports, drawings) used for database review and update, compiled by Permit or Project Number and delivered to County for scanning purposes.

Phase 2:

- Final QAPP with all SOPs utilized in Phase 2 of this work effort.

Interim Deliverables:

- Technical Memorandum and geodatabase submission at 10% completion
- Technical Memorandum and geodatabase submission at 60% completion

Final Deliverables:

- Updated/Verified/Completed Master Urban Stormwater BMP database
- Final Urban Stormwater BMP shapefiles with features and metadata
- Technical report documenting research procedures taken and methodology used for data field review/update.
- Hard copy data sources (e.g., as-built plans, stormwater reports, drawings) used for database review and update, compiled by Permit or Project Number and delivered to County for scanning purposes.

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ANNE ARUNDEL COUNTY
URBAN STORMWATER BMP DATABASE – HISTORIC BMP RECORD REVIEW AND UPDATE
CLARIFICATION TO SUBTASK 2.5 DELINEATE BMP DRAINAGE AREA

The goal of this scope of work task is to develop a polygon feature class containing drainage areas for each BMP in the data inventory. The information provided below serves as guidance and clarification for Subtask 2.5 of the Urban Stormwater BMP Database Historic BMP Record Review and Update Scope of Work. Consultants should note that the complete drainage area delineation methodology including QA/QC procedures for this subtask will be developed, in concert with County staff, and documented in the QAPP (See Subtask 1.3 of the full Scope of Work).

Subtask 2.5 Delineate BMP Drainage Area

It is suggested that the following three steps be taken ahead of the drainage area delineation step:

1. Assemble all source data
2. Verify the BMP point locations and annotate the source of that verification data (e.g., grading permit, as-built, aerial photo, field visit)
3. Capture all the tabular data for the database fields from their source documents (e.g., plans, reports)

To delineate the BMP drainage areas the following actions are recommended.

- If the drainage area is delineated on the as-built plans, then the scanned image should be georeferenced and the drainage area polygon boundary digitized from the plans.

- If the drainage area is not available from the historical records, whether because it is not shown on the plans or because the plan records are unavailable, the Consultant should create the drainage area polygon using the ESRI ArcHydro model. The County will provide the consultant with the current models and the associated MXD for this purpose.

    - When using the ArcHydro method, the Consultant may encounter instances where the BMP point location does not fall on the flow accumulation grid. In these cases, the Consultant should **NOT** move the BMP in the point feature class but should **create new fields called X_Hydro and Y_Hydro** and use the location defined in these new fields for modeling only. The consultants should note that these new fields should contain at least 5 decimal places.

- In instances where the drainage area is not on the as-built plans nor can it be created accurately in ArcHydro because the flow accumulation grid is incorrect, the consultant should flag these instances for joint review with the County.

- The consultant will attribute the resulting polygon layer with the source of that polygon (e.g., ArcHydro, as-built plan). The polygon feature class must contain a Primary Key (in addition to FID) and must contain a Foreign Key to link back to the Primary Key in the BMP point feature class.

- The consultant should perform internal QA/QC checks on these data. For instance, the digitized drainage area (from the plans) should "match" the tabular data for that facility within a certain

tolerance value. If it does not, the County anticipates that the consultant will investigate the reasons why and make the appropriate corrections or consult with the County on how to address the discrepancy. Further recommended QC procedures include performing logical checks, for example, a rain barrel should not have a drainage area of 100 acres, and a wet pond should not have a drainage area of several hundred square feet.

- The final resulting drainage area GIS layer must be topologically correct. The consultant will apply appropriate topology rules, developed in consultation with County staff and documented in the QAPP, to identify and address overlapping/nested drainage areas (e.g., within ArcGIS: Must Not Overlap and Must Not Have Gaps).

- Once the final drainage area GIS layer is completed, the Consultant will attribute each BMP drainage area by current County impervious and pervious areas. The County will provide the most recent (e.g., 2014) impervious area coverage for this purpose. The Consultant will join the layers to attribute pervious versus impervious area.

The resulting Countywide Urban BMP drainage area polygon will be a combination of digitized and modeled polygons. Consultants should provide the County with interim deliverables (e.g., a 10% pilot delivery, 60% interim delivery) so the County has an opportunity to review the resulting layer and provide QC and comments.

Additional information regarding the topology rules previously noted, and for purposes of addressing slivers and/or overlapping or nested drainage areas:

Using ArcHydro, a Batch Watershed Delineation generates the full drainage area polygons for each BMP regardless of overlaps in their drainage areas. Batch Subwatershed Delineation generates the nested drainage area polygons for each BMP and will eliminate overlaps. Consultants should be aware that to delineate these subwatershed drainage areas using the ArcHydro model, a BMP point in the X_Hydro and Y_Hydro fields must be created for all the BMPs and that point must fall on the flow accumulation grid.

After preparation of all the data for ArcHydro input, the estimated time necessary to complete the initial and subsequent ArcHydro runs is about 1 week for an area the size of the Severn River watershed. This work effort would include potentially having to run several hundred/thousand drainage areas (depending on the number that are manually digitized versus modeled), QC initial results, correct identified errors, rerun that subset of corrected drainage areas, then compile into a complete GIS drainage area polygon layer.

CHEMICAL, BIOLOGICAL, AND PHYSICAL CHARACTERIZATION OF THE CHURCH CREEK AND PAROLE PLAZA NPDES MONITORING STATIONS: 2014 - 2015

Prepared for

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February 2016

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1 INTRODUCTION

In 1998, Anne Arundel County began implementing a long-term monitoring program that satisfies requirements for its Countywide National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Discharge Permit. Monitoring has continued to be required as part of the terms of each renewed permit. Currently, monitoring is required to satisfy conditions outlined in Section F: Assessment of Controls of the County's new permit issued in February 2014. The monitoring program includes chemical, biological, and physical monitoring in the Church Creek subwatershed located within the larger South River watershed. This document describes the monitoring effort undertaken from July 2014 through June 2015.

Biological and physical monitoring take place at monumented locations along the study reach, as described in more detail below. The chemical monitoring activities take place at two stations in the Church Creek subwatershed:

- Downstream of two high-imperviousness, commercial land use outfalls, called the Parole Plaza monitoring station
- An instream station downstream of the Route 2 culvert, called the Church Creek monitoring station

The basic permit requirements for storm event monitoring include sampling a target of 12 storms per year (three in each quarter) that are characterized by three representative (rising, peak, and falling limbs of the hydrograph) discrete samples per storm event, the collection of baseflow samples during extended dry periods, laboratory analysis of water quality parameters specified in the permit, biological and physical characterizations of the study reach, and continuous flow monitoring.

The County is interested in determining the extent to which the redevelopment of the Parole Plaza site (now known as the Annapolis Towne Centre at Parole) has affected the quality of the stormwater effluent from the site. Construction began in 2004, and the bulk of the site work was completed by late 2008.

2 METHODS

2.1 CHEMICAL MONITORING

During the 2015 sampling period, July 2014 through June 2015, eight storm events were sampled and four baseflow samples were collected and analyzed. This section describes the equipment and techniques used in this sampling program. It includes discussions of sample collection, sample analysis, flow data collection, and basin rainfall characterization. A summary of maintenance activities is also included. Data and quarterly data reports (Versar, Inc., 2015a, 2015b, and 2015c) were used to prepare this annual summary report.

2.1.1 Monitoring Sites

The long-term chemical monitoring program is performed at one outfall station, Parole Plaza, and one instream station, Church Creek. The two stations are described below:

Parole Monitoring Station. This station is a restoration station located at the head of the Parole Tributary to Church Creek. There are two outfalls draining to the sampling station. The first is a 60" corrugated metal pipe (CMP) that has been the historical sampling location for the monitoring of this station. The second is a 54" reinforced concrete pipe (RCP) that was connected to the drainage network during the summer of 2007.

Church Creek Monitoring Station. This station is an instream station on the mainstem of Church Creek. It is located approximately 500 feet downstream of the confluence of the tributary that carries the runoff from the Parole Plaza monitoring station. The samples are collected in the 96" CMP culvert that carries Church Creek underneath Maryland State Highway 2 (Solomons Island Road). Currently, the bottom of this culvert is lined with concrete that extends 1.8 feet in height up the sides of the corrugated metal culvert.

Location information and land use data were taken from the *Annapolis Towne Centre @ Parole Stormwater Management Report* (Greenhorne & O'Mara 2005), and summarized for each site in Tables 2-1 and 2-2.

Table 2-1. Drainage areas and site locations of monitoring stations in Church Creek watershed

Monitoring Station	Station Type	Location	Area (acres)
Parole Plaza	Restoration/Outfall	Southwest corner of Forest Drive and MD State Highway 2	60.41
Church Creek	Instream	Downstream (east) of MD State Highway 2	279.09

Table 2-2. Land use summary for the monitoring stations in the Church Creek subwatershed				
Land Use	**Land Use Area (acres)**		**Percent of Total Acreage**	
	Parole Plaza	**Church Creek**	**Parole Plaza**	**Church Creek**
Impervious	52.81	191.37	87.4	68.6
Open Space	7.60	87.72	12.6	31.4
TOTAL	**60.41**	**279.09**	**100**	**100**

2.1.2 Water Sample Collection and Data Analysis

The sample period for this reporting cycle extended from July 2014 through June 2015. Samples are analyzed for the presence of the pollutants listed in Table 2-3.

Table 2-3. Analytes, detection limits, and analytical methods for the Church Creek and Parole Plaza Monitoring stations		
Parameter	**Detection Limit (mg/L)**	**Analytical Method**
Biochemical Oxygen Demand (5 Day)	2.0	SM 5210 B-01
Total Kjeldahl Nitrogen	0.5	SM 4500-NH3 C97
Nitrate + Nitrite	0.05	SM 4500-NO3 H00
Total Phosphorus	0.01	SM 4500-P E99
Total Suspended Sediments	1.0	SM 2540 D-97
Total Copper (µg/L)	2.0	EPA 200.8
Total Lead (µg/L)	2.0	EPA 200.8
Total Zinc (µg/L)	20.0	EPA 200.8
Total Petroleum Hydrocarbons	5.0	EPA 1664
E. coli (MPN/100 ml)	10.0	SM 9223B
Hardness	1.0	SM 2340 C

During the sampling period, eight storm samples and four baseflow samples were collected. Baseflow samples were taken in lieu of storm samples for the following reasons:

- September 16, 2014 - Baseflow samples were collected on September 16 at both sites due to the approaching end of the quarter and inability to monitor the September 6 storm event. At time of arrival (early afternoon), both Church Creek and Parole Plaza were exhibiting baseflow conditions. For this event, samples were collected 70 hours after the most recent rainfall.

- September 30, 2014 - Total rainfall for the month of September was 1.69", which was below average. Rainfall in September primarily occurred on weekends when no staff from Versar and the lab were available to capture the event. On the last day of September, field staff obtained a baseflow sample to represent the September event.

- February 25, 2015 - The total rainfall amount for January and February, which included rain, snow, and wintry mix was 4.53". Beginning January 12 and continuing until the end of February, a runoff event (either rain, snow, or snow melt) took place every other day, which limited sampling opportunities. Monitoring attempts on February 9 and February 22, which were predicted to be rain, were not successful due to snowfall instead. Because of storm sampling false starts and persistence of runoff events inside the 72-hour window, baseflow samples were collected on February 25.

- March 26, 2015 - The start of rainfall on March 26 was predicted for three different times, all with uncertain probability. A Versar field crew prepared to sample the event, but the storm surprisingly arrived before the predicted time in the afternoon and the field team could not sample. Since the end of the month was near, Versar waited 72 hours for the dry weather criterion to be satisfied and then collected a baseflow sample.

Below is a discussion of the storm events that were sampled during the monitoring period. Additional discussion of each event can be found in Appendix A.

- August 12, 2014 - The total rainfall for this event was 3.32" and lasted approximately 12 hours, based on data from the Church Creek rain gauge.

- October 15, 2014 - The total rainfall for this event was 0.84" and lasted approximately 6 hours, based on data from the Church Creek rain gauge.

- November 6, 2014 - The total rainfall for this event was 0.30" and lasted approximately 12 hours, based on data from the Church Creek rain gauge.

- December 22, 2014 - The total rainfall for this event was 0.12" and lasted approximately 8 hours, based on data from the Church Creek rain gauge.

- March 4, 2015 - The total rainfall for this event was 0.23" and lasted approximately 8.5 hours, based on data from the Church Creek rain gauge.

- April 14, 2015 - The total rainfall for this event was 0.53" and lasted approximately 13.5 hours, based on data from the Church Creek rain gauge.

- June 8, 2015 - The total rainfall for this event was 0.23" and lasted approximately 8.5 hours, based on data from the Church Creek rain gauge.

- June 27, 2015 - The total rainfall for this event was 1.24" and lasted approximately 21 hours, based on data from the Church Creek rain gauge.

A total of 40.52 inches of precipitation was recorded at the Church Creek station during the 2015 reporting period. Rainfall was measured using a tipping bucket rain gage located at the Church Creek station.

Table 2-4 lists the total rainfall for each sampled event. Hydrographs are provided in Appendix A. These data, along with stream level readings collected at 5 minute intervals from a permanently mounted pressure transducer, were logged into an ISCO 6712FR automated sampler.

Table 2-4. Rainfall data for sampled storm and baseflow events

Date	Rainfall (inches)
8 August 2014	3.32
18 September 2014	0.00 (Baseflow)
30 September 2014	0.00 (Baseflow)
15 October 2014	0.84
6 November 2014	0.30
22 December 2014	0.12
25 February 2015	0.00 (Baseflow)
4 March 2015	0.23
31 March 2015	0.00 (Baseflow)
14 April 2015	0.53
8 June 2015	0.23
27 June 2015	1.24

The ISCO sampler located at the Church Creek station is configured to hold 24 one-liter polyethylene bottles, and can be used to collect samples directly from the 96" CMP. However, this station is generally manned for the entire duration of each event. Therefore, samples are typically taken as grabs from the culvert outfall. Total petroleum hydrocarbon and *E. coli* samples are always collected as manual grab samples. The grab sample location is approximately six feet downstream of the intake for the automated sampler and samples should be equivalent in concentrations. When personnel leave the site during an event, the sampler is programmed to collect discrete, four-bottle (four-liter) samples at fixed time intervals. These intervals are based upon observations of the unique storm response characteristics of each watershed and the anticipated event duration to ensure that samples are distributed to characterize the typical storm as accurately as possible. The only 2015 event that the ISCO was programmed to collect samples was on June 27, 2015. The ISCO sampler collected samples at 45 minute intervals for 18 hours during this event. For this event, TPH and *E. coli* samples were not submitted to the labs since

field personnel were not available to collect manual samples for TPH, and submit the samples to the lab within the 6 hour holding time for *E. coli*.

When the 54" RCP came online at Parole Plaza in the summer of 2007, portions of the drainage that had historically been passing through the 60" CMP began flowing through the new pipe. In order to maintain consistency in the characterization of the watershed, it was determined that samples were required from both pipes. Pressure transducers were permanently mounted in the 60" CMP and 54" RCP. These measured flow depth at 5-minute intervals, and stored data for up to three months. Data were downloaded bi-weekly. Stage/discharge relationships were prepared for each pipe, to determine the discharge from the pipes based on field-measured depths. The relationships were based on a combination of field measurements and modeled values. The model was necessary in order to characterize major storm events where measured values were not currently available. The rating tables are included in Appendix A.

A spreadsheet was developed to allow the field sampling crews to input field-measured level data. The spreadsheet interpolated the corresponding flow from the rating curves developed as described above. The flows from the 60" CMP and the 54" RCP were totaled and the resulting combined hydrograph for each event was plotted real-time. This method allowed the field crews to determine when the rising, peak, and falling limbs for the combined hydrograph occurred. The spreadsheet also calculated the percentage of the combined flow that each pipe was contributing. Using volumetric containers, the sampling team prepared composite samples using these percentages, and distributed them to the sample containers. A Technical Memorandum describing the sampling procedures in detail was submitted to the Maryland Department of the Environment in May 2008, and is included in Appendix A.

Water quality instruments for measuring pH, temperature, and conductivity were used at both stations. At Parole, an In-Situ Troll 9500 unit mounted within each pipe was used to obtain measurements during storm events; providing measurements every 5 minutes. Measurements for these parameters were not available when personnel were not present due to the low flow conditions at this station. Permanently installed probes would likely dry out and need to be replaced often, thus these units are engaged only during storm events. At the Church Creek station, a YSI 600 XL multiparameter sonde was permanently mounted within the culvert and was connected directly to the ISCO automated sampler; providing measurements every 5 minutes. This unit operates continuously.

Samples were distributed into bottles provided by Martel Laboratories JDS, Inc., and Chesapeake Environmental Lab, Inc. All *E. coli* samples were delivered to the Chesapeake Environmental Lab for processing within six hours of being collected, and all other samples were delivered to Martel Laboratories JDS within 48 hours. As was the case at the Church Creek station, the only 2015 event that ISCO samplers were programmed to collect samples was on June 27, 2015. Field personnel temporarily installed an ISCO sampler at each pipe to collect samples at 45 minute intervals for 18 hours. For this event, TPH and *E. coli* samples were not submitted to the labs since field personnel were not available to collect manual samples for TPH, and submit the samples to the lab within the 6 hour holding time for *E. coli*.

Event Mean Concentrations (EMCs) for each parameter were calculated for each storm and applied to total stormflow discharges to calculate stormflow pollutant loads for each site. An EMC is a statistical parameter used to represent the flow-weighted average concentration of a given parameter during a storm event (USEPA 2002). The EMC for a storm event where discrete samples have been collected (i.e., samples collected during the rise, peak, and falling limb of a storm event), was calculated using the following formula:

$$EMC = \frac{\sum_{i=1}^{n} V_i C_i}{\sum_{i=1}^{n} V_i}$$

where,

V: volume of flow during period *i*, which is determined from the interval associated with the samples collected during each limb
C: analytical result associated with period *i*
n: total number of limbs taken during event

The stormflow pollutant load for each parameter was calculated as:

$$Load = EMC_j V_j$$

where,

V: total volume of flow during period *j* (entire storm event).

Average annual EMCs were calculated by taking the arithmetic average of separate EMCs calculated when non-detects were set to zero and when non-detects were set to the detection limit. Since the true concentration of non-detect samples falls somewhere between the detection limit and the null value, this calculation represents a more accurate estimate than using EMCs with non-detects set to either zero or the detection limit. Seasonal loads (also referred to as quarterly loads) for monitored events were calculated by summing all monitored event loads for a specific season. Total seasonal loads were calculated by multiplying the average seasonal EMC by the total volume for the season. Annual loads were calculated by summing all seasonal loads.

2.1.3 Monitoring Station Maintenance

Maintenance was conducted at each sampling station on a biweekly basis. Maintenance included calibration of all probes, inspection of the sampling equipment, intake lines, and programming, and an overall cleaning and organization of the stations. A few issues concerning the replacement of monitoring equipment and the loss of data occurred during the monitoring period; below is a summary of these issues:

- On August 5 at 12:20, staff unscrewed the cap on the Global Water logger for the RCP at Parole Plaza to download data. While unscrewing the cap, the wire attached to the battery assembly disconnected. Staff sent the Global Water logger to the

manufacturer for repairs. The logger was reinstalled on August 27; however, the unit had been reset to write data at the factory default rate of once every 15 days. Since there were almost no data recorded until September 24, data were estimated by applying a correction curve. The correction curve was prepared by plotting CMP level versus RCP level from storm events where both data sets were known to be correct. The corrected RCP data were obtained by using the correction curve equation, which was determined using a SAS curve-fitting program. Resulting RCP levels that were 0 or less were replaced with an assumed baseflow value of 0.02 ft.

- During the early October storm event, continuous level data were accidently erased from the logger for the CMP at Parole Plaza; therefore, data are missing from September 30 until October 14 at 8:52. The inverse of the correction curve equation used to estimate missing RCP levels was used to estimate CMP levels for the missing data. Corrected CMP data values were set to 0 when RCP levels fell below 0.02 ft. since the CMP typically does not exhibit baseflow when RCP levels are below 0.02 ft. During the 10/24/14 maintenance visit, the field team noticed the mounting plate for the RCP logger had become distorted in shape due to sand, gravel, and debris buildup under the plate. The field team was able to straighten the plate at the time but eventually a screw is needed in the plate to keep it from happening again. Fixing the plate caused an inaccurate reading at 15:00.

- During routine maintenance on February 6, the Versar field crew discovered the battery had died for the RCP logger at Parole Plaza; therefore, continuous level data are missing from January 30 until February 6 at 13:20. Missing data was estimated using the RCP correction curve that was prepared for the missing September 2014 data.

- During the February 25 maintenance visit, the field team noticed the mounting plate for the RCP logger had become distorted in shape due to sand, gravel, and debris buildup under the plate. The field team was able to straighten the plate at the time and is looking into the type of screws needed in the plate to keep it from happening again.

- During routine maintenance on March 18, 2015, the Versar field crew accidently deleted the data (March 4 – March 18) while collecting the data from the CMP logger. During a subsequent visit, while checking on the batteries in the CMP logger, Versar noticed that the wire leading from the power supply was stripped. Since the logger had no power, data are missing from March 31 until the logger was replaced in April. Missing data were estimated using the CMP correction curve that was prepared for the missing October 2014 data.

2.2 BIOLOGICAL MONITORING

All biological assessment data were collected in accordance with the Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan (Anne

Arundel County 2010), which incorporates many elements of Maryland Department of Natural Resources' Maryland Biological Stream Survey (MBSS). Geomorphic assessment data were collected in accordance with the standard operating procedures (SOPs) approved for the County's NPDES Program. All methods are consistent with previous years' methods (with applicable updates) to ensure data comparability between years. Collection methods are summarized below. Field data were collected in 2015 by Versar, Inc., a consultant to Anne Arundel County.

2.2.1 Sampling Locations

The study area is located in the northern portion of the Church Creek subwatershed, within the larger South River watershed in Anne Arundel County, Maryland (Figure 2-1). A total of four 75-meter biological monitoring sites are positioned along the study reach and are monitored annually. Three sites were established and first monitored in 2006; one site is located on the Parole Plaza Tributary just below Forest Drive, and two sites are located along the Church Creek mainstem, on either side of Solomons Island Road (Maryland State Highway 2). A fourth site, located just upstream of the confluence with the Parole Plaza Tributary, was added in 2007 to monitor the effects of runoff from the Festival at Riva shopping center.

2.2.2 Stream Habitat Evaluation

To support the biological monitoring, a visual assessment of physical habitat was completed at each monitoring site to evaluate the reach's ability to support aquatic life. Both the MBSS Physical Habitat Index (PHI; Paul et al. 2003) and the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocol (RBP) habitat assessment for low gradient streams (Barbour et al. 1999) were used to visually assess the physical habitat at each site in conjunction with the spring benthic monitoring. Both habitat assessments consist of a review of biologically significant habitat parameters that evaluate a stream's ability to support an acceptable level of biological health.

To calculate PHI at each site, six parameters were given a numerical score and a categorical rating: instream habitat, epibenthic substrate, remoteness, instream woody debris and rootwads, shading, and bank stability. The raw scores are then transformed into a scaled score (0-100 scale) as described in Paul et al. (2003), and the six scaled scores are averaged into an aggregate final PHI score. Narrative condition descriptions and scoring ranges for the PHI are displayed in Table 2-5.

Table 2-5. Maryland Biological Stream Survey PHI scoring

Score	Narrative
81-100	Minimally Degraded
66-80.9	Partially Degraded
51-65.9	Degraded
0-50.9	Severely Degraded

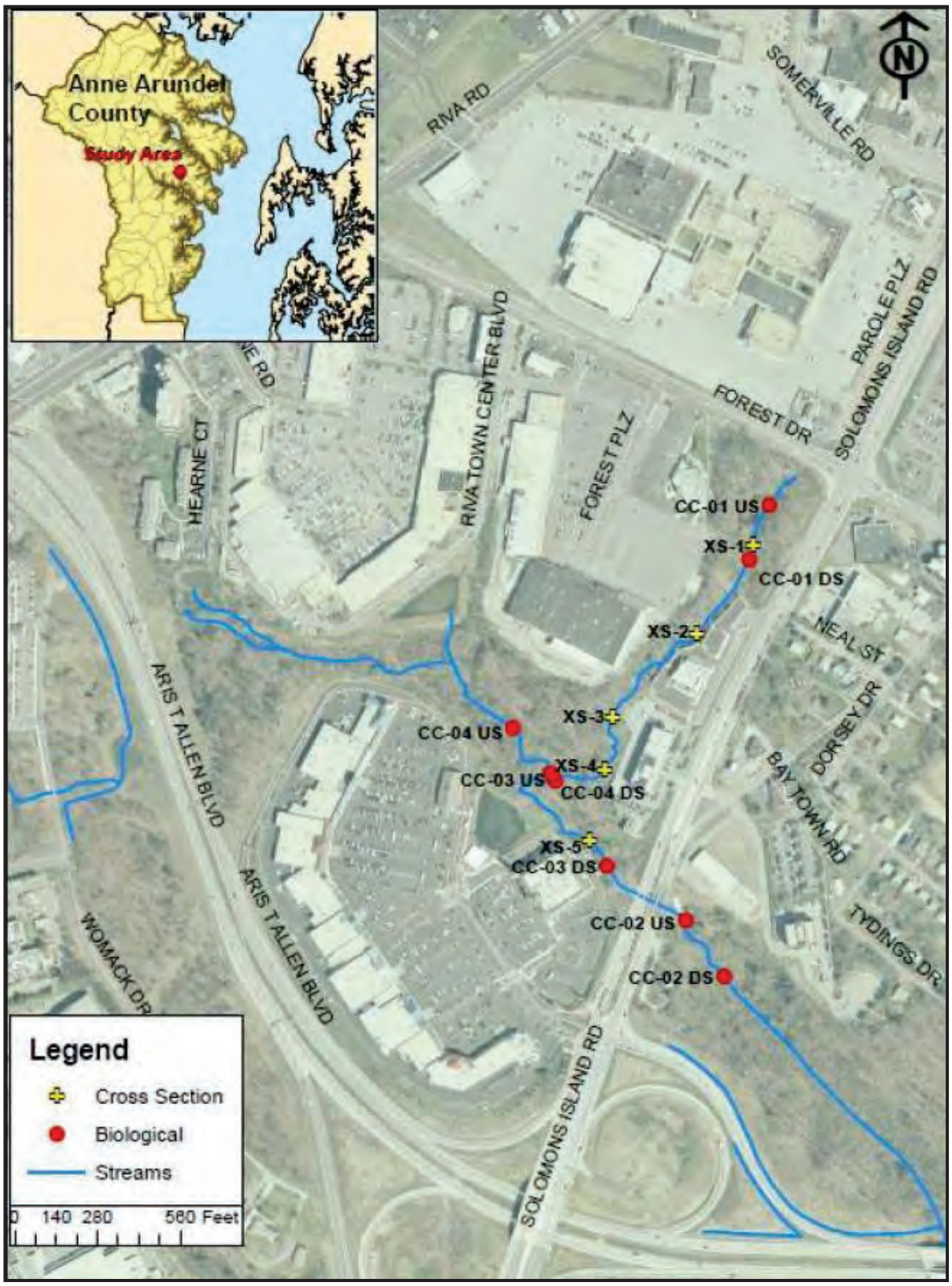


Figure 2-1. Church Creek study area and stream monitoring locations

The Rapid Bioassessment Protocol (RBP) habitat assessment consists of a review of ten biologically significant habitat parameters that assess a stream's ability to support an acceptable level of biological health: Epifaunal substrate/available cover, Embeddedness, Velocity/depth regime, Sediment deposition, Channel flow status, Channel alteration, Frequency of riffles/ bends, Bank stability, Vegetative protection, and Riparian vegetative zone width. In the field, each parameter was given a numerical score from 0-20 (20=best, 0=worst), or 0-10 (10=best, 0=worst) for individual bank parameters, and a categorical rating of optimal, suboptimal, marginal or poor (Barbour et al. 1999). Overall habitat quality typically increases as the total score for each site increases. The individual RBP habitat parameters for each reach were summed to obtain an overall RBP assessment score. Because adequate reference conditions currently do not exist for Anne Arundel County, the percent comparability was calculated based on western coastal plain reference site conditions obtained from work done in Prince George's County streams (Stribling et al. 1999). The percent of reference score, or percent comparability score, was then used to place each site into corresponding narrative rating categories. The ranges are shown in Table 2-6.

Table 2-6. EPA Rapid Bioassessment Protocol (RBP) scoring

Percent of Reference Score	Narrative
90 - 100	Comparable to Reference
75.1 - 89.9	Supporting
60.1 - 75	Partially Supporting
0 - 60	Non-Supporting

2.2.3 Water Quality Measurement

In situ water quality was measured at each site with a YSI 6820 multiparameter water quality sonde. Turbidity was measured once at the upstream end of the site, all other parameters were measured from three locations within each sampling reach (upstream end, mid-point, and downstream end) and results were averaged to minimize variability and better represent water quality conditions throughout the entire sampling reach. Data were compared to the standards listed in the Code of Maryland Regulations (COMAR) 26.08.02.03-3 – Water Quality (MDE, 2010) and shown in Table 2-7.

Table 2-7. Maryland COMAR Water Quality Standards for Use I Streams

Parameter	Standard
pH	6.5 to 8.5
Dissolved Oxygen (mg/L)	Minimum of 5 mg/L
Conductivity (µS/cm)	No existing standard
Turbidity (NTU)	Maximum of 150 NTU and maximum monthly average of 50 NTU
Temperature (°C)	Maximum of 32 °C (90 °F) or ambient temperature, whichever is greater

Source: Code of Maryland Regulations (COMAR) 26.08.02.03-3-Water Quality

2.2.4 Biological Sample Collection

Benthic macroinvertebrate samples were collected in March 2015 following the MBSS Spring index period protocols (DNR, 2010) and as specified in *Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan* (QAPP; Anne Arundel County 2010). This methodology emphasizes the community composition and relative abundance of benthic macroinvertebrates inhabiting the most taxonomically diverse, or productive, instream habitats. In this sampling approach, a total of twenty jabs are distributed among the most productive habitats present within the 75-meter reach and sampled in proportion to their occurrence within the segment. The most productive stream habitats are riffles followed by rootwads, rootmats and woody debris and associated snag habitat; leaf packs; submerged macrophytes and associated substrate; and undercut banks. Other less preferred habitats include gravel, broken peat, clay lumps and detrital or sand areas in runs; however, of the aforementioned habitat types, those that are located within moving water are preferred over those in still water.

2.2.5 Biological Sample Processing and Identification

Benthic macroinvertebrate samples were processed and subsampled according to Maryland Biological Stream Survey methods described in the MBSS laboratory methods manual (Boward and Freidman, 2000) and as briefly summarized in the Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan (Anne Arundel County 2010). Subsampling is conducted to standardize the sample size and reduce variation caused by field collection methods. In brief, the sample was washed of preservative in a 0.595 mm screen and spread evenly across a tray comprised of 100 numbered 5cm x 5cm grids. A random number between one and 100 was selected and the selected gird was picked entirely of macroinvertebrates under a bright light source. This process was repeated until a count of 120 was reached. The 120 organism target was used following MBSS methods to allow for specimens that are missing parts or are early instars, which cannot be properly identified.

The samples were taxonomically identified by Versar taxonomists certified by the Society for Freshwater Science (SFS) (formerly known as the North American Benthological Society, NABS). The taxonomic hierarchical level for most organisms was genus level when possible with the exception of Oligochaeta, which were identified to the family level. Early instars or damaged specimens were identified to the lowest possible level. Oligochaeta and Chironomidae specimens were permanently slide mounted for identification. Counts and identifications were recorded on a laboratory bench sheet and entered into a master database for analysis. A list of all taxa identified is provided in Appendix B: Master Taxa List.

2.2.6 Biological Data Analysis

Benthic macroinvertebrate data were analyzed using methods developed by MBSS as outlined in the *New Biological Indicators to Better Assess the Condition of Maryland Streams* (Southerland et al. 2005). The Benthic Index of Biotic Integrity (BIBI) approach involves statistical analysis using metrics that have a predictable response to water quality and/or habitat impairment. The metrics selected fall into five major groups including taxa richness, composition

measures, tolerance to perturbation, trophic classification, and habit measures. Tolerance values were obtained from Bressler et al. (2005).

Raw values from each metric are given a score of 1, 3 or 5 based on ranges of values developed for each metric. The results are combined into a scaled BIBI score ranging from 1.0 to 5.0 and a corresponding narrative rating is assigned. Table 2-8 shows the thresholds for the determination of the metric scoring. Three sets of metric calculations have been developed for Maryland streams based on broad physiographic regions: Coastal Plain, Piedmont and Combined Highlands. The Coastal Plain and Piedmont regions are divided by the Fall Line. The current study area is located within the Coastal Plain region. The metrics calculated for Coastal Plain streams are as follows:

Total Number of Taxa – Equals the richness of the community in terms of the total number of genera at the genus level or higher. A large variety of genera typically indicate better overall water quality, habitat diversity and/or suitability, and community health.

Number of EPT Taxa – Equals the richness of genera within the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). EPT taxa are generally considered pollution sensitive, thus higher levels of EPT taxa would be indicative of higher water quality.

Number of Ephemeroptera Taxa – Equals the total number Ephemeroptera Taxa in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.

Percent Intolerant Urban – Percentage of sample considered intolerant to urbanization. Equals the percentage of individuals in the sample with a tolerance value of 0-3 out of 10. As impairment increases the percent of intolerant taxa decreases.

Percent Ephemeroptera – Equals the percent of Ephemeroptera individuals in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.

Number Scraper Taxa – Equals the number of scraper taxa in the sample, those taxa that scrape food from the substrate. As the levels of stressors or pollution rise there is an expected decrease in the numbers of Scraper taxa.

Percent Climbers – Equals the percentage of the total number of individuals who are adapted to living on stem type surfaces. Higher percentages of climbers typically represent a decrease in stressors and overall better water quality.

All of the metric scores are summed and then averaged to obtain the final BIBI score. Table 2-9 shows the scores and narrative rankings of the MBSS BIBI. The biological assessment results are included in Appendix C. The QA/QC information is included in Appendix D.

Table 2-8. Biological condition scoring for the coastal plains metrics			
Metric	**Score**		
	5	**3**	**1**
Total Number of Taxa	≥ 22	14-21	< 14
Number of EPT Taxa	≥ 5	2-4	< 2
Number of Ephemeroptera Taxa	≥ 2	1.9-1.0	< 1.0
Percent Intolerant Urban	≥ 28	10-27	< 10
Percent Ephemeroptera	≥ 11	0.8-10.9	< 0.8
Number of Scraper Taxa	≥ 2	1.9-1.0	< 1.0
Percent Climbers	≥ 8.0	0.9-7.9	< 0.9

Table 2-9. Maryland Biological Stream Survey BIBI scoring		
BIBI Score	**Narrative Ranking**	**Characteristics**
4.0-5.0	Good	Comparable to reference conditions, stream considered to be minimally impacted, biological metrics fall within upper 50th percentile of reference site conditions.
3.0-3.9	Fair	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of minimally impacted streams.
2.0-2.9	Poor	Significant deviation from reference conditions, indicating some degradation. On average, biological metrics fall below the 10th percentile of reference site values.
1.0-1.9	Very Poor	Strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of minimally impacted streams, indicating severe degradation. On average, most or all metrics fall below the 10th percentile of reference site values.

2.3 PHYSICAL MONITORING

2.3.1 Monitoring Sites

Five cross sections (XS), four of which were established in 2003 and one which was established in 2007, have been measured annually through 2015. Four of these cross sections are located along the Parole Plaza Tributary, and one cross section is located on the Church Creek mainstem, just upstream of Solomon's Island Road (Maryland State Highway 2; Figure 2-1). Cross section monuments, placed on each bank, consist of capped steel reinforcement bars set within six inches of the ground surface. Field data collected by Versar, Inc. during 2015 were used to prepare this annual summary report.

2.3.2 Physical Data Collection and Analysis

Geomorphic assessments include a longitudinal profile survey, cross section surveys, and representative pebble counts. A spreadsheet tool called *The Reference Reach Spreadsheet* version 4.3L (Mecklenburg 2006) was used to facilitate data entry and analyses. This spreadsheet was used to compile, manipulate, and plot field data and to analyze dimension, profile, and channel material characteristics of the Church Creek study area.

Data from geomorphic assessments were used to determine the stream type of each reach as categorized by the Rosgen Stream Classification methodology (Rosgen 1996). In this classification methodology, streams are categorized based on their measured field values of entrenchment ratio, width/depth ratio, sinuosity, water surface slope, and channel materials according to the table in Appendix E**.** As illustrated in Appendix E, the Rosgen Stream Classification categorizes streams into broad stream types, which are identified by the letters Aa, A, B, C, D, DA, E, F, and G. Table 2-10 includes general descriptions of each Rosgen stream type. A summary of the stream types identified within this study is included in Appendix F.

Table 2-10. Rosgen stream classification types

Channel Type	General Description
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.
A	Steep, entrenched, confined, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.
B	Moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools. Moderate width/depth ratio. Narrow, gently sloping valleys. Very stable plan and profile. Stable banks.
C	Low gradient, meandering, slightly entrenched, point-bar, riffle/pool, alluvial channels with broad, well-defined floodplains.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks. Active lateral adjustment, high bedload and bank erosion.
DA	Anastomosing (multiple channels) narrow and deep with extensive, well-vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and width/depth ratios. Very stable streambanks.
E	Low gradient, Highly sinuous, riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander/width ratio.
F	Entrenched, meandering riffle/pool channel on low gradients with high width/depth ratio and high bank erosion rates.
G	Entrenched “gully” step/pool and low width/depth ratio on moderate gradients. Narrow valleys. Unstable, with grade control problems and high bank erosion rates.

Source: Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, Colorado

The cross section surveys were performed at the five permanent cross section locations, and photos were taken of upstream, downstream, left bank, and right bank views at each cross

section location. Cross section surveys consisted of measuring the topographic variability of the associated stream bed, floodplains, and terraces, including:

- Monument elevations
- Changes in topography
- Top of each channel bank
- Elevations of bankfull indicators
- Edge of water during the time of survey
- Thalweg or deepest elevation along active channel
- Depositional and erosional features within the channel

During the cross sectional survey, the following measurements and calculations of the bankfull channel, which are critical for determining the Rosgen stream type of each reach, also were collected:

- Bankfull Width (Wbkf): the width of the channel at the elevation of bankfull discharge or at the stage that defines the bankfull channel.
- Mean Depth (dbkf): the mean depth of the bankfull channel.
- Bankfull Cross Sectional Area (Abkf): the area of the bankfull channel, estimated as the product of bankfull width and mean depth.
- Width Depth Ratio (Wbkf/dbkf): the ratio of the bankfull width versus mean depth.
- Maximum Depth (dmbkf): the maximum depth of the bankfull channel, or the difference between the thalweg elevation and the bankfull discharge elevation.
- Width of Floodprone Area (Wfpa): the width of the channel at a stage of twice the maximum depth. If the width of the floodprone area was far outside of the channel, its value was visually estimated or paced off.
- Entrenchment Ratio (ER): the ratio of the width of the floodprone area versus bankfull width.
- Sinuosity (K): ratio of the stream length versus the valley length or the valley slope divided by the channel slope. Sinuosity was visually estimated or the valley length was paced off so that an estimate could be calculated.

To quantify the distribution of channel substrate particles sizes within the study area, a modified Wolman pebble count (Rosgen 1996) was performed at each cross section location. Reach-wide proportional counts were used. Each pebble count consists of stratifying the reach based on the frequency of channel features in that reach (e.g., riffle, run, pool, glide) and measuring 100 particles across ten transects (i.e., 10 particles in each of 10 transects). The transects are allocated across all feature types in the proportion at which they occur within the reach. The intermediate axis of each measured pebble is recorded. The goal of the pebble count is to measure 100 particles across the bankfull width of the channel and calculate the median substrate particle size (i.e., D50) of the reach. This value is used for categorizing the sites into the Rosgen Stream Classification (Rosgen 1996). If a channel was clearly a sand or silt bed channel with no distinct variation in material size, the pebble count was not performed, and the

D50 was visually estimated. However, if the channel did have variation in bed material size from feature to feature, a full pebble count was performed.

2.4 LAND USE AND STORMWATER MANAGEMENT ASSESSMENT

2.4.1 Church Creek Watershed Land Use

A previous report (Versar 2013) provided information on land use, based on field reconnaissance conducted during 2013. As seen in an aerial photograph and stormwater best management practice (BMP) facilities map (Figure 2-2), the watershed is predominantly commercial with open space area adjacent to the stream channels. There is little available area for further development in the watershed except for areas that are being redeveloped. Anecdotal information indicates there has been no change in land use in this watershed since the 2013 land use evaluation. Changes in land use characteristics were not field evaluated during the 2014 or 2015 reporting period.

2.4.2 Church Creek Watershed Stormwater BMPs

Based on record review and field reconnaissance conducted during December 2015 - January 2016, the Church Creek watershed contains 29 BMPs, as shown in Figure 2-2. BMP details are provided in Table 2-11. Starting in the summer of 2014 and continuing through the 2015, inspections were performed at BMPs under the County's jurisdiction. Inspection and maintenance information is currently being updated in the County's BMP database. Inspection reports are maintained at the County's offices.



Figure 2-2. Church Creek BMPs

Table 2-11. Church Creek BMP overview

AA County Urban BMP Database ID	BMP Type[a]	Drainage Area (acres)	Location	Address	Last Inspection[b]	Rank[c]
AA001128	PWED	22.94	Festival at Riva	Riva Rd. & Forest Dr.	8/18/2014	1
AA001042	PWED	18.79	Annapolis Harbour Center	Old Solomons Island Rd.	10/30/2014	2
AA000335	ITRN	9.16	Sovran Building	-	5/6/2003	3
AA005932	ITRN	6.73	South Annapolis Forest Drive Home Depot	Forest Dr.	8/25/2014	4
AA008474	XOGS	5.63	Annapolis Town Center at Parole Infrastructure	Forest Dr.	8/13/2014	5
AA008470	FSND	4.78	Annapolis Town Center at Parole Infrastructure	Forest Dr.	8/13/2014	6
AA000074	XDPD	4.47	Forest Garden Apartments	130 Hearne Ct.	2/11/2015	7
AA000071	XDED	3.71	Nationwide Insurance	2500 Riva Rd.	11/13/2001	8
AA002384	ITRN	2.23	Hampton Inn & Suites	124 Womack Dr.	11/18/2014	9
AA000058	XDPD	2.07	Parole Professional Building	132 Holiday Ct.	1/7/2004	10
AA012015	MSGW	1.94	AAA Mid Atlantic Car Care	2054 Summerfield Rd.	-	11
AA008473	XOGS	1.88	Annapolis Town Center at Parole Infrastructure	Forest Dr.	8/13/2014	12
AA001962	XDPD	1.15	Hemlsman Property/ Womack Ave.	-	-	13
AA001446	PWED	1.13	Second National Federal Savings Bank	2045 West St.	11/15/2001	14
AA006493	ITRN	1.00	Annapolis Harbour Center	2431 Solomons Island Rd.	8/8/2014	15
AA001180	ITRN	0.53	Two Restaurant Sites	2436 Solomons Island Rd.	12/3/2014	16
AA008472	XOGS	0.53	Annapolis Town Center at Parole Infrastructure	Forest Dr.	8/13/2014	17
AA002634	ITRN	0.50	Festival at Riva	Riva Rd. & Forest Dr.	8/24/1995	18
AA003322	ITRN	0.50	Festival at Riva	Riva Rd. & Forest Dr.	8/24/1995	18
AA003350	ITRN	0.50	Festival at Riva	Riva Rd. & Forest Dr.	8/24/1995	18
AA003388	ITRN	0.50	Festival at Riva	Riva Rd. & Forest Dr.	8/24/1995	18
AA008475	FBIO	0.40	Annapolis Town Center at Parole Infrastructure	Forest Dr.	8/13/2014	22
AA008471	FSND	0.30	Annapolis Town Center at Parole Infrastructure	Forest Dr.	8/13/2014	23
AA013422	SPSC	0.30	ARINC	2551 Riva Rd.	2/18/2014	23
AA012013	SPSC	0.26	AAA Mid Atlantic Car Care	2054 Summerfield Rd.	-	25
AA012012	SPSC	0.21	AAA Mid Atlantic Car Care	2054 Summerfield Rd.	-	26
AA006819	NDRR	0.20	Days Inn/ Riva Road	2451 Riva Rd.	-	27
AA010516	ODSW	0.14	2525 Riva Road	2525 Riva Rd.	7/16/2014	28
AA012014	APRP	0.03	AAA Mid Atlantic Car Care	2054 Summerfield Rd.	-	29

(a) MDE BMP codes, see Appendix H
(b) Dates as recorded in the County's Urban BMP database (Attachment A, Table B of Anne Arundel County MS4 Report for FY2015, February 2016)
(c) Ranked in order by drainage area

3 RESULTS

3.1 POLLUTANT CONCENTRATIONS

During this sampling period, 56 water chemistry samples were analyzed. In a few instances, analyte concentrations fell below the specified detection limits. Table 3-1 shows the percentage of samples that were below the detection limit.

Table 3-1. The percentage of non-detects by parameter

Parameter	Detection Limit	Dry Weather	Wet Weather
BOD_5 (mg/L)	4.0	88	31
TKN (mg/L)	0.5	25	21
Nitrate + Nitrite (mg/L)	0.05	0	0
Total Phosphorus (mg/L)	0.01	0	0
TSS (mg/L)	1.0	0	0
Total Copper (µg/L)	2.0	38	2
Total Lead (µg/L)	2.0	100	40
Total Zinc (µg/L)	20	0	0
TPH (mg/L)	5.0	100	77
E. coli (MPN/100 ml)	10.0	13	10
Hardness (mg/L)	1.0	0	0

Tables 3-2 and 3-3 show the maximum values observed for dry and wet weather samples for both stations. Table 3-4 shows the maximum value for each parameter during wet weather monitoring, the station of occurrence, and the storm date of the observation. Parole Plaza had the highest wet-weather value for ten of the thirteen parameters measured during wet weather sampling in 2015. A nitrate-nitrite concentration of 170 mg/L was observed at Parole Plaza during the August 2014 storm event. This concentration is more than 100 times higher than all of the other storm event nitrate-nitrite concentrations observed at this station during the 2015 monitoring period, and thus was flagged as an outlier and was not included in the EMC and loading calculations. During the same event, *E. coli* concentrations of 4,500 MPN/100 mL, 54,750 MPN/100 mL, and 241,960 MPN/100 mL were observed at the Parole Plaza station, while all *E. coli* concentrations fell below the detection limit at the Church Creek station. Consistently high *E. coli* concentrations at the upstream station paired with non-detectable *E. coli* concentrations at the downstream station is illogical and is likely the result of a lab or sampling anomaly; therefore, the *E. coli* data for the August 2014 storm event were not included in EMC and loading calculations. Chemical monitoring summaries can be found in Appendix G.

Table 3-2. Maximum dry weather values observed during sampling period		
Parameter	**Church Creek**	**Parole Plaza**
Water Temperature (°F)	65.48	65.84
pH	6.9	7.1
BOD_5 (mg/L)	BDL	5
TKN (mg/L)	0.80	0.70
Nitrate + Nitrite (mg/L)	1.60	6.00
Total Phosphorus (mg/L)	0.08	0.09
TSS (mg/L)	22	18
Total Copper (µg/L)	2.80	8.60
Total Lead (µg/L)	BDL	BDL
Total Zinc (µg/L)	98	130
TPH (mg/L)	BDL	BDL
E. coli (MPN/100 ml)	171	246
Hardness (mg/L)	480	890
BDL: Below Detection Limit		

Table 3-3. Maximum wet weather values observed during sampling period		
Parameter	**Church Creek**	**Parole Plaza**
Water Temperature (°F)	75.56	77.20
pH	7.20	8.38
BOD_5 (mg/L)	20	39
TKN (mg/L)	1.60	1.80
Nitrate + Nitrite (mg/L)	1.70	170*
Total Phosphorus (mg/L)	0.56	0.26
TSS (mg/L)	180	230
Total Copper (µg/L)	30	38
Total Lead (µg/L)	14	13
Total Zinc (µg/L)	190	280
TPH (mg/L)	8	6
E. coli (MPN/100 ml)	24,196	241,960**
Hardness (mg/L)	180	410
BDL: Below Detection Limit * Flagged as an outlier. Was not included in EMC and Loading calculations **Was not included in EMC and Loading calculations due to large discrepancy between Church Creek and Parole Plaza *E. coli* values during August 12, 2014 storm event		

Table 3-4. Storm dates for wet weather maximum values

Parameter	Date of Storm	Site	Maximum Value
Water Temperature (°F)	8/12/14	Parole Plaza	77.20
pH	4/14/15	Parole Plaza	8.38
BOD_5 (mg/L)	12/22/14	Parole Plaza	39
TKN (mg/L)	12/22/14	Parole Plaza	1.80
Nitrate + Nitrite (mg/L)	8/12/14	Parole Plaza	170*
Total Phosphorus (mg/L)	11/6/14	Church Creek	0.56
TSS (mg/L)	6/8/15	Parole Plaza	230
Total Copper (µg/L)	3/4/15	Parole Plaza	38
Total Lead (µg/L)	8/12/14 and 10/15/14	Church Creek	14
Total Zinc (µg/L)	3/4/15	Parole Plaza	280
TPH (mg/L)	6/8/15	Church Creek	8
E. coli (MPN/100 ml)	8/12/14	Parole Plaza	241,960**
Hardness (mg/L)	3/4/15	Parole Plaza	410

* Flagged as an outlier. Was not included in EMC and Loading calculations
**Was not included in EMC and Loading calculations due to large discrepancy between Church Creek and Parole Plaza *E. coli* values during August 12, 2014 storm event

3.2 EVENT MEAN CONCENTRATIONS AND POLLUTANT LOADINGS

Flow-weighted stormflow event mean concentrations (EMCs) values are presented in Table 3-5. EMCs for every parameter except TKN, total lead, TPH and hardness were higher at Parole Plaza than EMCs at Church Creek.

Summed loads for the sampled events monitored during the July 2014 to June 2015 sampling period are shown in Table 3-6. Church Creek per-acre loading rates for monitored events were higher than Parole Plaza for all parameters.

Table 3-5. Average EMCs observed during July 2014 to June 2015		
Parameter	**Church Creek**	**Parole Plaza**
Water Temperature (°F)	70.31	71.42
pH	6.87	7.66
BOD_5 (mg/L)	1.83	1.96
TKN (mg/L)	0.613	0.566
Nitrate + Nitrite (mg/L)	0.278	0.361
Total Phosphorus (mg/L)	0.126	0.128
TSS (mg/L)	42.06	42.95
Total Copper (µg/L)	10.96	12.63
Total Lead (µg/L)	4.44	3.36
Total Zinc (µg/L)	72.16	80.97
TPH (mg/L)	2.1	1.7
E. coli (MPN/100 ml)	2,100.13	3,332.62
Hardness (mg/L)	34.62	33.28

Table 3-6. Estimated pollutant loadings for observed events, in pounds, for the July 2014 to June 2015 sampling period				
Parameter	**Church Creek**		**Parole Plaza**	
	Total	**Per Acre**	**Total**	**Per Acre**
BOD_5	1,363.08	4.88	82.00	1.36
TKN	456.45	1.64	23.65	0.39
Nitrate + Nitrite	207.04	0.74	15.08	0.25
Total Phosphorus	93.43	0.33	5.34	0.09
TSS	31,302.12	112.16	1,795.00	29.71
Total Copper	8.16	0.03	0.53	0.01
Total Lead	3.307	0.01	0.140	<0.01
Total Zinc	53.695	0.19	3.384	0.06
TPH	1548.277	5.55	71.737	1.19
Hardness	25,762.729	92.31	1,390.646	23.02

3.3 BIOLOGICAL ASSESSMENT

Biological and physical habitat assessments were completed on March 12, 2015. Presented below are the summary results for each assessment site. For full bioassessment data and results, refer to Appendix C. A complete taxonomic list can be found in Appendix B. QA/QC information is in Appendix D.

Physical habitat quality was evaluated using the MBSS PHI, and rated "Degraded" for two sites and "Partially Degraded" for two site (Table 3-7). Index scores varied somewhat and ranged from a low of 52.9 at CC-02 to a high of 66.7 at CC-03. All sites received very low scores for remoteness due to the proximity of the stream channel to roads and development. Generally, instream woody debris scored high for all the sites. Individual parameter results are listed in Appendix C. Overall, PHI scores throughout the study area indicate habitat conditions that are limiting the potential for healthy biological communities.

The RBP was also used to evaluate the physical habitat quality and rated "Partially Supporting" for three sites and "Non-supporting" for one site (Table 3-7). The scores ranged from a low of 59 at CC-02 to a high of 67 at CC-01. Generally, epifaunal substrate/cover, embeddedness, velocity/depth regime, and vegetative protection scored low for all the sites. Overall, RBP scores throughout the study area indicate habitat conditions that are limiting the potential for healthy biological communities, similar to what was found using the PHI.

Table 3-7. PHI and RBP physical habitat assessment results - 2015

Site	PHI Score	PHI Narrative Rating	RBP Score	RBP Narrative Rating
CC-01	66.4	Partially Degraded	67	Partially Supporting
CC-02	52.9	Degraded	59	Non- supporting
CC-03	66.7	Partially Degraded	66	Partially Supporting
CC-04	62.7	Degraded	66	Partially Supporting

For biological conditions, three stations received a rating of "Very Poor" and one station rated "Poor", indicating a highly impaired benthic macroinvertebrate community. Only six total taxa were observed at station CC-01, which is extremely low. Number of EPT taxa, Number of Ephemeroptera and Percent Ephemeroptera metrics scored low for all sites. The Percent Climbers metric received high scores for all sites while the Percent Intolerant to Urban received median scores at stations CC-03 and CC-04. The lower than average temperature during March 2015 combined with the high conductivity values from salt treatment of roads found at the sites likely contributed to the metrics being scored lower this year than in the past. BIBI scores and ratings are summarized in Table 3-8.

Table 3-8. Benthic macroinvertebrate assessment results - 2015

Site	BIBI Score	Narrative Rating
CC-01	1.57	Very Poor
CC-02	1.57	Very Poor
CC-03	2.14	Poor
CC-04	1.86	Very Poor

To supplement the biological assessment data, *in situ* water quality parameters were measured at each biological monitoring site prior to sample collection. Table 3-9 shows the water quality data for each site. All parameters measured were within Maryland's water quality standards for Use I streams. Conductivity values were very elevated compared to most coastal plain streams, and far exceeded the 75th percentile of values (i.e., 307 µS/cm) measured during Round One (2004-2008) of the Countywide Biological Monitoring and Assessment Program (Hill and Pieper, 2011). Conductivity values were relatively high compared to most coastal plain streams, as well as higher than the range of those found in other urban, or highly impervious, drainage areas in Maryland (DNR, 2001, 2003, 2005; KCI, 2009a; Hill and Crunkleton, 2009). Stream conductivity is affected by inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions or sodium, magnesium, calcium, iron, and aluminum cations, many of which are generally found at elevated concentrations in urban streams (Paul and Meyer, 2001). Increased stream ion concentrations (measured as conductivity) in urban systems typically results from runoff over impervious surfaces, passage through pipes, and exposure to other infrastructure (Cushman, 2006). In 2014, a greater than average snow amount caused the roads to be treated with salt more frequently than during an average year. Although 2015 conductivity values, at three of the four stations, were reduced by approximately half as compared to 2014 values, levels were still twice the amount found in previous years. Seasonal use of road salt has most likely caused conductivity values to be high.

Table 3-9. *In situ* water quality results - 2015

Site	pH	Temperature	Dissolved Oxygen	Turbidity	Conductivity
	SU	°C	mg/L	NTU	µS/cm
CC-01	7.07	8.62	10.50	25.6	3015
CC-02	7.07	5.90	12.00	29.9	1464
CC-03	7.05	6.21	10.82	28.0	1746
CC-04	6.97	7.75	11.07	30.8	1816

3.4 GEOMORPHIC ASSESSMENT

Due to the highly altered conditions of the drainage area (i.e., high imperviousness, altered flow regime, numerous stormwater outfalls) and stream channel (i.e., channelization, stabilization) in the study area, reliable bankfull indicators were often difficult to locate in the field. In the absence of reliable bankfull indicators, bankfull elevations were adjusted to match the predicted values for bankfull area provided by the bankfull channel geometry relationship for urban streams developed specifically for Anne Arundel County (AADPW 2002). Furthermore, categorization of segments into the Rosgen Classification scheme for natural rivers required a fair amount of professional judgment to interpret the data. When assigning the stream classification types, values for some parameters would often fit into the prescribed ranges according to the Rosgen Classification while others would not. Many of the features at the existing cross

section locations have shifted from riffle features to pool features, which can skew the channel dimensions since classifications are based on riffle dimensions. Consequently, it was often necessary to apply best professional judgment and incorporate supplemental information (e.g., presence of depositional features) in order to assign the most appropriate stream classifications. The Rosgen classification system is summarized in Appendix E and 2015 data for Church Creek sites are in Appendix F.

The most upstream reach on the Parole Plaza Tributary, XS-1, has been undergoing a transition from a Rosgen C4/5 channel to a F4 channel, as evidenced by changes in the width/ depth and entrenchment ratios. Previous monitoring in 2010 suggested that this reach was shifting from an E to a C channel as evidenced by channel degradation along the right bank and a notable increase in sediment deposition and point bar formation along the right bank just downstream. Additional degradation between 2010 and 2012 suggest that the channel had lost connectivity to the floodplain and had likely shifted to an F stream type. Mid-channel degradation continued between 2014 and 2015 showing approximately a 0.3 feet difference. In 2015, geomorphic assessment parameters continue to support the classification of this reach as an F channel. The channel evolution is supported by a 36.3% increase in channel cross-sectional area since 2003 and considerable widening and mid-channel bar formation immediately downstream, which is indicative of a channel that it not stable and is undergoing a widening and degradation phase. Left bank widening was also apparent between 2013 and 2014 monitoring years and remained consistent during 2015. However, it is also important to acknowledge that this cross section is no longer located in a riffle feature and is now in a pool feature, which affects the channel dimensions and complicates classification using the Rosgen system.

The next site downstream on the Parole Plaza Tributary, XS-2, was classified as a Rosgen G4 channel based on its low width/depth ratio, relatively low slope, and sandy substrate. Between 2014 and 2015 monitoring the substrate became slightly less coarse. Since 2012 its entrenchment ratio was slightly higher than those typical of G streams, but to retain consistency with the 2011 classification, the G rating was retained. This reach was previously classified as an E type channel; however, it was noted that the reach was actively degrading and widening. While E streams are typically more sinuous, this segment has been noticeably straightened and stabilized by a retaining wall and rubble/fill along the left bank (facing downstream). The lack of sinuosity in the channel has likely resulted in instability, and consequently resulted in a shift to a less-stable form.

Site XS-3, located along the restored segment of Parole Plaza Tributary, was not classified until 2013, after allowing 3 years of stabilization after restoration. In 2013 and 2014 it was classified as a Rosgen G4c channel based on its low entrenchment ratio, low width/depth ratio, and low slope. In 2015 XS-3 remained a G type channel; however, the substrate has become coarser resulting in a G4/3c classification. Before restoration, this cross section was classified as a Rosgen G5c channel; however, since the Rosgen scheme was developed to classify natural channels, or those that are shaped naturally by fluvial processes, it was deemed inappropriate to classify immediately after construction. This section is still heavily armored and reliable bankfull indicators are not easily identified.

The most downstream site on the Parole Plaza Tributary, XS-4, has transitioned from a Rosgen E5 channel to a C5 channel due to an increase in width/depth ratio. It should also be noted that a large woody debris jam located just downstream of the cross section location has resulted in a considerable accumulation of fine sediment and debris across the channel and, consequently, is leading to aggradation and a reduction in the cross sectional area. Since 2003 cross-sectional area has decreased by 35.7%.

Located on the mainstem of Church Creek, upstream of the MD Rt. 2 culvert, XS-5 has transformed from a Rosgen C3/5 channel into an F4/3 channel due to a significantly decreased entrenchment ratio from 4.0 to 1.7 between 2012 and 2015. Although still categorized as moderate, the width/depth ratio has also decreased slightly. Between 2014 and 2015 this portion of the reach has become slightly coarser from a D50 of 34 mm to 61 mm. This segment shows evidence of previous alteration in the form of cobble-sized riprap armoring along the bed and lower banks to protect a sewer line crossing and obvious channel straightening, which explains the lack of sinuosity typical of F type streams. The substantial amount of cobble-sized rip-rap in the stream channel has resulted in a bi-modal distribution of substrate particles within this reach, with a predominance of gravel in the pools and artificial cobbles in the riffles.

4 DISCUSSION

Results from the July 2014-June 2015 study period are discussed in the following section. Water quality, biological, and geomorphological data are interpreted, presented and compared to previous data. A discussion of the characteristics of the watershed is also included.

4.1 WATER CHEMISTRY

Water quality criteria are presented in Table 4-1. The measured data are compared, where possible, to these criteria to assess the extent of the pollution concerns in this tributary.

Table 4-1. State and Federal water quality criteria available for parameters sampled at Church Creek

Parameter (mg/L, except as noted)	Chronic	Acute	Reference
Lead (µg/L)	2.5	65	COMAR 26.08.02.03-2
Copper (µg/L)	9	13	COMAR 26.08.02.03-2
Zinc (µg/L)	120	120	COMAR 26.08.02.03-2
Total P	0.0225		USEPA 2000
BOD_5	7		USEPA 1986
Nitrate + Nitrite	0.095		USEPA 2000
TSS	500		USEPA 1974
TKN	None		
TPH	None		
*E. coli** (MPN/100ml)	235		COMAR 26.08.02.03-3.
Hardness	None		

* Used most restrictive standard for *E. coli* as a conservative approach: frequent full body contact recreation criterion.

Criteria are used to protect against both short-term and long-term effects. Numeric criteria are important where the cause of toxicity is known or for protection against pollutants with potential human health impacts or bioaccumulation potential. Narrative criteria can be the basis for limiting toxicity in discharges where a specific pollutant can be identified as contributing to the toxicity. Biological criteria can be used to complement traditional, chemical-specific criteria as indicators of aquatic health and impacts to the aquatic ecosystem.

Tables 4-2 and 4-3 compare baseflow and storm event results to the Federal and State acute and chronic criteria. Comparison and interpretation of Church Creek pollutant concentrations to Federal and State water quality criteria, and relating these conditions to ultimate ecological outcomes in the system, however, are difficult. Criteria do not exist for all

Table 4-2. Maximum concentrations observed for baseflow samples compared to appropriate criteria

Parameter (mg/L, except as noted)	Chronic	Acute	Church Creek	Parole Plaza
Lead (µg/L)	2.5	65	BDL	BDL
Copper (µg/L)	9	13	2.80	8.60
Zinc (µg/L)	120	120	98	130*
Total P	0.0225		0.08*	0.09*
BOD_5	7		0	5
Nitrate + Nitrite	0.095		1.60*	6.00*
TSS	500		22	18
TKN	None		0.80	0.70
TPH	None		BDL	BDL
*E. coli*** (MPN/100ml)	235		171	246*
Hardness	None		480	890

* Criterion exceeded
** Used most restrictive standard for *E. coli* as a conservative approach: frequent full body contact recreation criterion.
BDL: Below Detection Limit

Table 4-3. Maximum concentrations observed for wet weather samples compared to appropriate criteria

Parameter (mg/L, except as noted)	Acute	Church Creek	Parole Plaza
Lead (µg/L)	65	14	13
Copper (µg/L)	13	30*	38*
Zinc (µg/L)	120	190*	280*
Total P	0.0225	0.56*	0.26*
BOD_5	7	20*	39*
Nitrate + Nitrite	0.095	1.70*	170*[(a)]
TSS	500	180	230
TKN	None	1.60	1.80
TPH	None	8	6
*E. coli*** (MPN/100ml)	235	24,196*	241,960*[(b)]
Hardness	None	180	410

* Criterion exceeded
** Used most restrictive standard for *E. coli* as a conservative approach: frequent full body contact recreation criterion.
[(a)] Flagged as an outlier. Was not included in EMC and Loading calculations
[(b)] Was not included in EMC and Loading calculations due to large discrepancy between Church Creek and Parole Plaza *E. coli* values during August 12, 2014 storm event

parameters measured at the monitoring stations. In addition, a clear cause and effect relationship between water quality and ecological condition is difficult to determine. However, these comparisons can be used as general indicators of water quality impairment. Both State and Federal criteria are based on ambient stream conditions. Chronic criteria consider the maximum levels at which aquatic life can survive if continuously subjected to a pollutant concentration. Acute criteria reflect the maximum level at which an aquatic organism can survive if periodically subjected to a pollutant concentration. Since storm events represent a periodic condition, wet-weather samples are compared only to acute criteria.

As in prior years, comparisons to water quality criteria continue to indicate elevated pollutant concentrations in the Church Creek watershed, primarily during wet weather conditions. In particular, copper, zinc, total phosphorous, BOD_5, nitrate-nitrite, and *E. coli* frequently exceeded criteria at both sampling stations. Table 4-3 (above) shows the maximum concentrations for each sampling site, and compares these to the criteria. Additionally, as shown in Table 4-2, the Federal water quality criteria were exceeded for total phosphorous and nitrate-nitrite during baseflow sampling at both the Church Creek and Parole Plaza stations, with zinc and *E. coli* also being exceeded at the Parole Plaza station.

Table 4-4 shows the percentage of wet weather samples for which criteria were exceeded. Water quality criteria for the pollutants listed above were more frequently exceeded at the Parole Plaza monitoring station than at the Church Creek station for all contaminants except for total phosphorus and nitrate-nitrite, which were exceeded 100% of the time at both stations. *E. coli* concentrations also remained high at both stations throughout the 2015 monitoring period, exceeding water quality criteria 71% of the time at Church Creek, and 95% of the time at Parole Plaza. Note that prior to site stabilization, total suspended solids concentrations had been particularly high due to construction activity at Annapolis Towne Centre. Following stabilization of the site in Fall 2008, the event mean concentrations for total suspended solids have dropped significantly. During the last four reporting years, no wet weather samples exceeded the water quality criterion for total suspended solids at either station.

Table 4-5 shows the annual average event mean concentrations that exceeded water quality criteria. As can be seen from the table, some criteria were consistently exceeded at both stations.

The high levels of pollutants observed in the watershed are typical for commercial and retail land uses that are coupled with high levels of automobile traffic and impervious surface area (USEPA, 1983). As shown in Table 2-2, 87% of the watershed to the Parole monitoring station and 69% of the watershed to the Church Creek station is impervious.

In 2007, loading rates (Table 4-6 and 4-7) increased sharply at both stations. For 2008, loading rates were still high, when compared to historical values, but dropped dramatically from the 2007 levels. During the 2009 reporting year, loading rates dropped further, and aligned more closely with historical values. The high levels in 2007 likely resulted from the construction activity that was underway immediately upstream of the Parole Plaza station. Since the majority of the site was stabilized by the end of 2008, this likely caused the pollutant loads to decrease.

Table 4-4. Percentage of all wet weather samples that exceed appropriate criteria

Parameter	Criteria (mg/L, except as noted)	Church Creek (%)	Parole Plaza (%)
Lead (µg/L)	65	0	0
Copper (µg/L)	13	29	71
Zinc (µg/L)	120	25	50
Total P	0.0225	100	100
BOD_5	7	12.5	21
Nitrate + Nitrite	0.095	100	100
TSS	500	0	0
TKN	None	NA	NA
TPH	None	NA	NA
*E. coli** (MPN/100ml)	235	71	95
Hardness	None	NA	NA

* Used most restrictive standard for *E. coli* as a conservative approach: frequent full body contact recreation criterion.

Table 4-5. Annual average event mean concentrations and criteria (parameters that exceeded appropriate criteria are indicated)

Parameter (mg/L, except as noted)	Chronic Criteria	Acute Criteria	Church Creek	Parole Plaza
Lead (µg/L)	2.5	65	4[(a)]	3[(a)]
Copper (µg/L)	9	13	11[(a)]	13[(a)]
Zinc (µg/L)	120	120	72	81
Total P	0.0225		0.126[(a)]	0.128[(a)]
BOD_5	7		1.83	1.96
Nitrate + Nitrite	0.095		0.278[(a)]	0.361[(a)]
TSS	500		42.06	42.95
TKN	None		0.61	0.57
TPH	None		2.1	1.7
*E. coli** (MPN/100ml)	235		2,100.13[(a)]	3,332.62[(a)]
Hardness	None		34.62	33.28

[(a)] Chronic or general criterion exceeded
[(b)] Acute criterion exceeded
* Used most restrictive standard for *E. coli* as a conservative approach: frequent full body contact recreation criterion.

Table 4-6. Total annual loading rates, in pounds, observed at the Parole Plaza Sampling Station from 2002 to 2015

Year	BOD	TSS	TP	TKN	NO_3+NO_2	Zinc	Lead	Copper	Hardness	Fecal Coliform[a]
2002	2,912	26,585	1,178	388	323	58	14	1	NA	1,152,001
2003	21,665	86,385	372	1,477	714	176	69	15	NA	5,350,164
2004	8.025	57,447	293	655	391	57	7	8	NA	402,127
2005	4,573	33,015	184	483	350	50	12	8	NA	665,232
2006	13,562	94,306	650	1,867	410	177	13	25	NA	3,360,952
										E. coli[a]
2007	40,009	848,116	1,649	2,328	1,401	349	26	162	NA	11,017
2008[b]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2009	2,175	11,787	59	490	117	56	0.8	6.5	NA	2,115
2010	2,209	17,609	89	309	120	40	1.2	4.1	NA	1,740
2011	2,114	13,894	42	371	131	58	1.1	6.3	6,987	2,682
2012	3,660	15,335	62	284	214	57	1.0	6.6	14,578	10,209
2013	1,481	6,079	34	155	108	34	0.5	4.9	8,586	16,041
2014	2,040	18,953	54	536	497	50	1.0	8.1	36,945	12,716
2015	940	14,606	45	232	162	38	1.1	5.3	29,023	3,333
2002-2006 Mean	8,544	59,548	535	974	438	104	23	11	NA	2,186,095
2009-2015 Mean	2,088	14,038	55	340	193	48	1	6	19,224	6,977
2002-2015 Mean	**7,488**	**95,701**	**362**	**737**	**380**	**92**	**11**	**20**	**19,224**	**7,482**

[a] Units of Fecal Coliform and *E. coli* are MPN/100 mL.
[b] In 2008, monitoring was conducted for both outfalls at Parole Plaza, but continuous level monitoring was not available for the 54" RCP; therefore, loads could not be calculated.
[c] Mean *E. coli* value, does not include pre-2007 Fecal Coliform data.

Table 4-7. Loading rates, in pounds, observed at the Church Creek Sampling Station from 2002 to 2015

Year	BOD	TSS	TP	TKN	NO_3+NO_2	Zinc	Lead	Copper	Hardness	Fecal Coliform*
2002	6,408	58,501	2,593	854	711	127	32	3	NA	2,534,970
2003	47,673	190,090	818	3,250	1,571	387	151	32	NA	11,773,001
2004	17,660	126,411	645	1,441	860	126	19	18	NA	884,887
2005	10,062	72,648	405	1,062	771	109	27	16	NA	1,463,839
2006	29,844	207,520	1,431	4,109	902	390	29	54	NA	7,395,753
										E. coli*
2007	265,499	3,312,794	8,381	20,330	436,206	3,663	277	652	NA	1,755
2008	60,843	458,185	3,037	12,468	4,444	693	37	36	NA	3,857
2009	35,521	206,184	1,296	9,377	2,505	531	30	57	NA	3,912
2010	49,256	341,877	2,066	9,561	2,912	739	39	77	NA	3,358
2011	42,883	214,820	1,340	7,410	3,606	704	30	41	259,076	3,995
2012	40,145	150,490	1,103	3,714	3,018	551	20	31	250,747	5,549
2013	43,980	180,946	899	3,326	2,782	558	27	57	314,179	2,399
2014	31,969	299,830	1,065	12,177	6,019	551	27	78	646,801	8,638
2015	19,643	344,419	1,057	5,743	3,148	665	35	99	455,627	2,100
2002-2006 Mean	22,329	131,034	1,178	2,143	963	228	52	25	NA	4,810,490
2009-2015 Mean	37,628	248,367	1,261	7,330	3,427	614	30	63	385,286	4,279
2002-2015 Mean	**50,099**	**440,337**	**1,867**	**6,773**	**33,532**	**700**	**56**	**89**	**385,286**	**3,951****

* Units of Fecal Coliform and *E. coli* are MPN/100 mL.
** Mean *E. coli* value, does not include pre-2007 Fecal Coliform data.

During the 2015 reporting year, loading rates decreased for all sampled parameters at the Parole Plaza station when compared to the 2014 reporting year. At the Church Creek station, 2015 reporting year loading rates decreased for all sampled parameters when compared to the 2014 reporting year except for TSS, zinc, lead, and copper. None of the parameters at the Church Creek station had a loading rate increase of more than 30% when compared to 2014. The 2015 *E. coli* concentrations at the Church Creek station were the lowest observed since 2007. The low *E. coli* concentrations observed at both stations is partly due to there being no *E. coli* storm event data from the summer quarter (which is typically the quarter with the highest *E. coli* concentrations) that was used to calculate the annual EMCs.

During the post-construction period (2009 to 2015), the loading rates at Parole Plaza have tended to be below the levels existing prior to the redevelopment of the Towne Centre. However, at the Church Creek station, most of the sampled parameters have exceeded average pre-construction (2002-2006) monitoring levels, and continued doing so in 2015.

Seasonal pollutant loads in 2015 are provided in Table 4-8. Hardness was much higher in the winter at both stations due to the large amount of road salt used to deice local roads during a winter that produced an abnormally large amount of snow and ice. In total, five of the parameters were highest in the winter, and four of the parameters were highest in the fall at the Church Creek station. All parameters, except TKN and *E. coli*, were highest in the winter at the Parole Plaza station. This may be due to a combination of some parameters having high natural background concentrations (e.g. nitrate-nitrite, which is often diluted during storm events) observed during the two winter baseflow sampling events, and other parameters having elevated concentrations during the sole storm event after consistent freeze/thaw cycles occurring during the first couple months of winter may have caused an increase in weathering of infrastructure, allowing more pollutants (e.g. dissolved metals and sediments) to be available for entrainment and transport during the late winter rain event. It should be noted, however, that the limited number of samples collected for each season ultimately makes it difficult to draw strong conclusions about seasonal pollutant loading rates. These interpretations should be viewed cautiously.

Annual average event mean concentrations were plotted for each monitoring year. Plots were constructed to illustrate the impact that construction activity and redevelopment of the Annapolis Towne Centre site has had on water quality within the study reach. Figures 4-1 through 4-5 show how the event mean concentrations have changed from 2004 to 2015 at the Parole Monitoring Station. As can be seen from the graphs, nearly every concentration rose substantially between 2006 and 2007 when the majority of the site work was being conducted at the Towne Centre. These concentrations fell significantly in 2008, as the site was stabilized, and continued the downward trend in 2009. The reduction in pollutant concentrations stabilized in 2010 and 2011 possibly indicating that the stream has reached a post-construction baseline. Pollutant concentrations in 2015 decreased when compared to those from 2014, with the exception of a slight increase in lead. The 2013 rise in TPH was due to an increase in the detection limit, and may not be associated with an actual increase in concentration as greater than 95% of TPH concentrations fell below the detection limit. It is important to note that the 2013 data included in these plots do not include summer season data, which is often the season that

produces the highest event mean concentrations for many of the parameters, although this was not the case in 2015.

Table 4-8. Seasonal loading rates, in pounds, observed at the Church Creek and Parole Plaza sampling stations in 2015

Season	BOD	TSS	TP	TKN	NO_3+NO_2	Zinc	Lead	Copper	Hardness	*E. coli**
Church Creek										
Summer	1,823	88,805	239	916	314	120	9.0	11.9	44,711	100
Fall	5,153	112,526	331	1,355	758	167	10.5	19.7	77,710	12,602
Winter	7,797	96,267	305	2,105	1,403	240	9.3	32.9	257,709	722
Spring	4,870	46,822	182	1,367	673	139	6.4	34.3	75,497	594
Parole Plaza										
Summer	59	3,310	10	30	24	3.8	0.3	0.6	1,336	11
Fall	233	3,373	11	74	37	9.5	0.2	1.2	2,977	15,045
Winter	347	4,573	15	67	71	15.0	0.4	2.0	21,367	2,009
Spring	301	3,351	10	61	31	9.7	0.2	1.6	3,343	3,264

* Units of *E. coli* are MPN/100 mL.

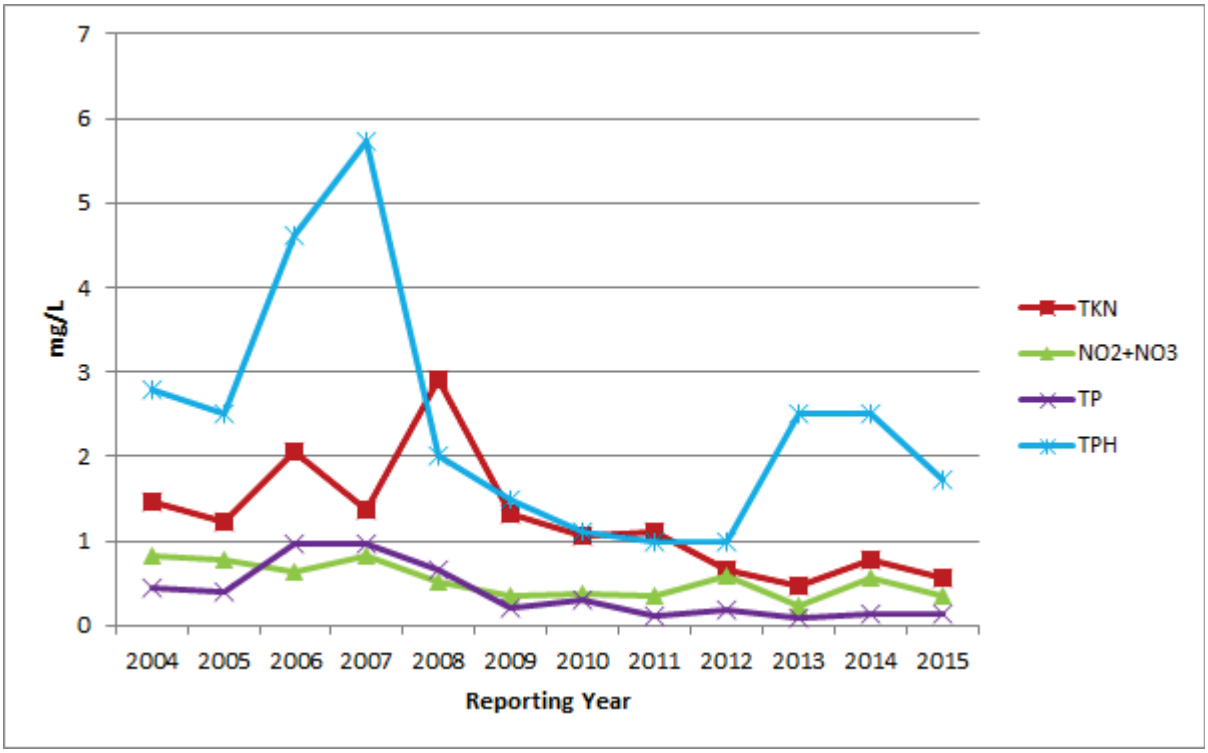


Figure 4-1. Parole station long-term monitoring: annual EMCs (TKN, NO_2+NO_3, TP, TPH; mg/L)

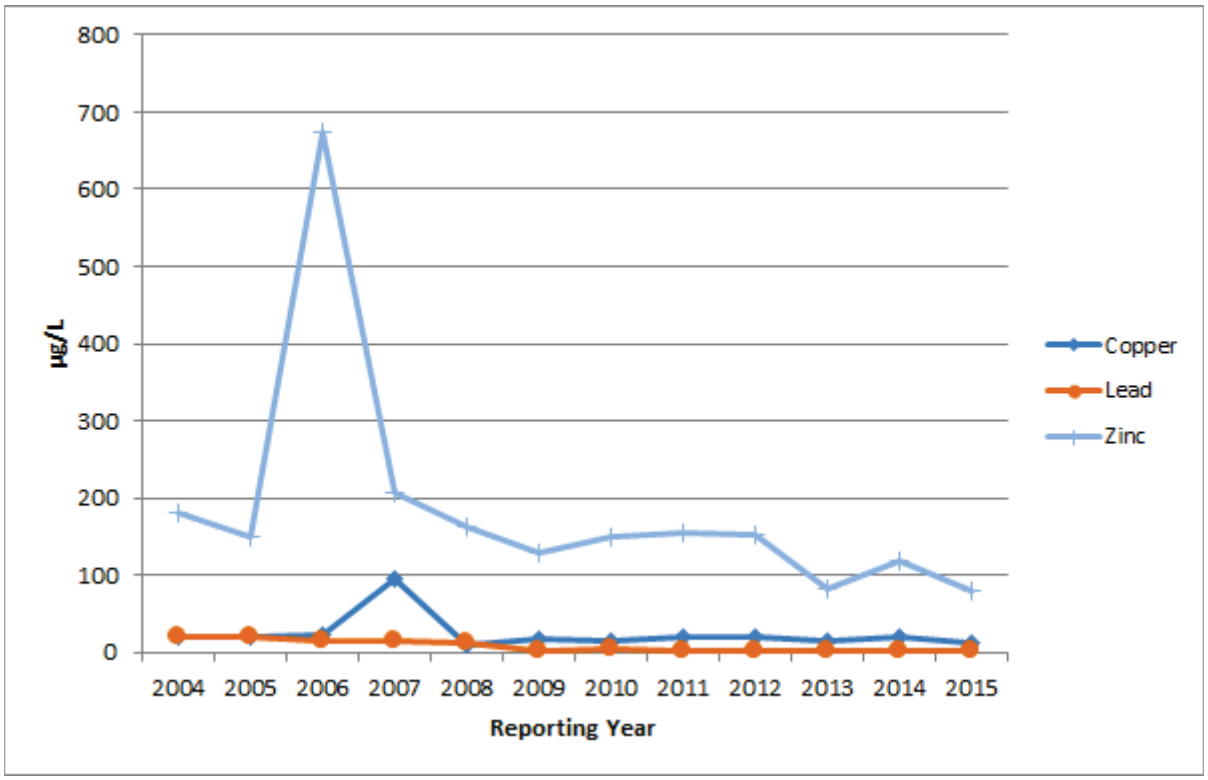


Figure 4-2. Parole station long-term monitoring: annual EMCs (Cu, Pb, Zn; mg/L)

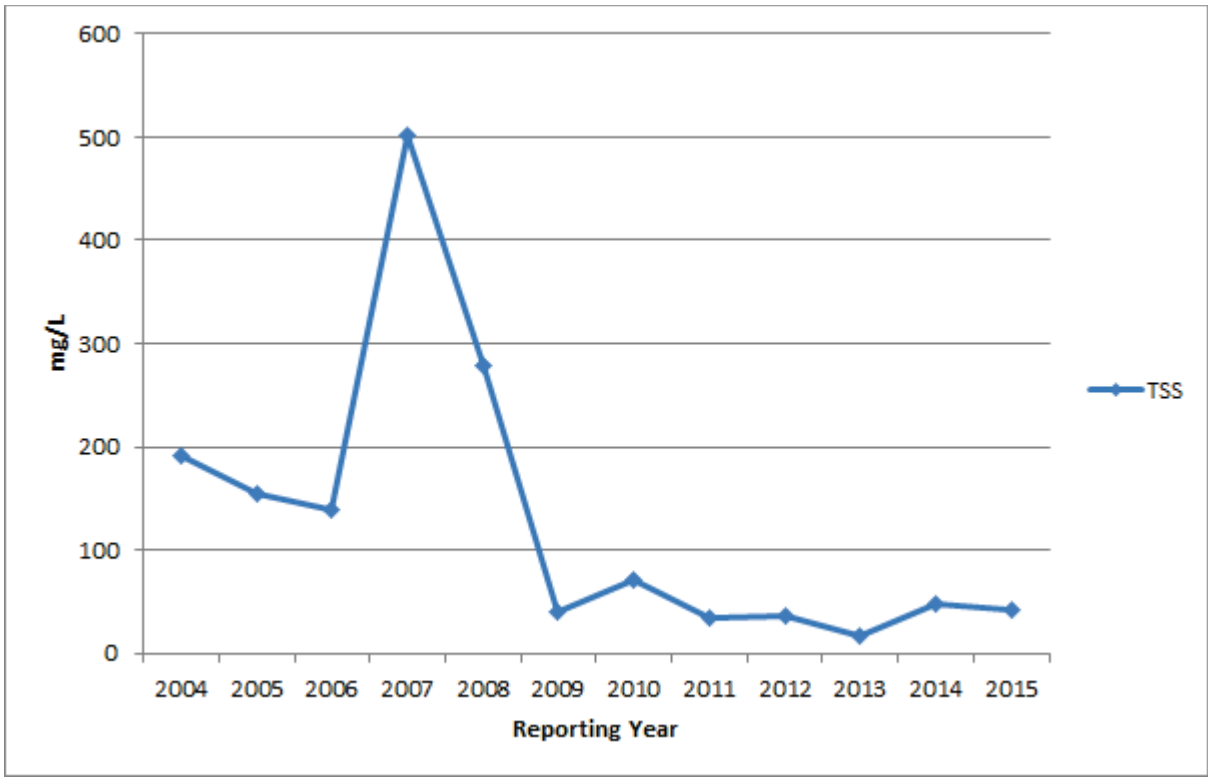


Figure 4-3. Parole station long-term monitoring: annual EMCs (TSS; mg/L)

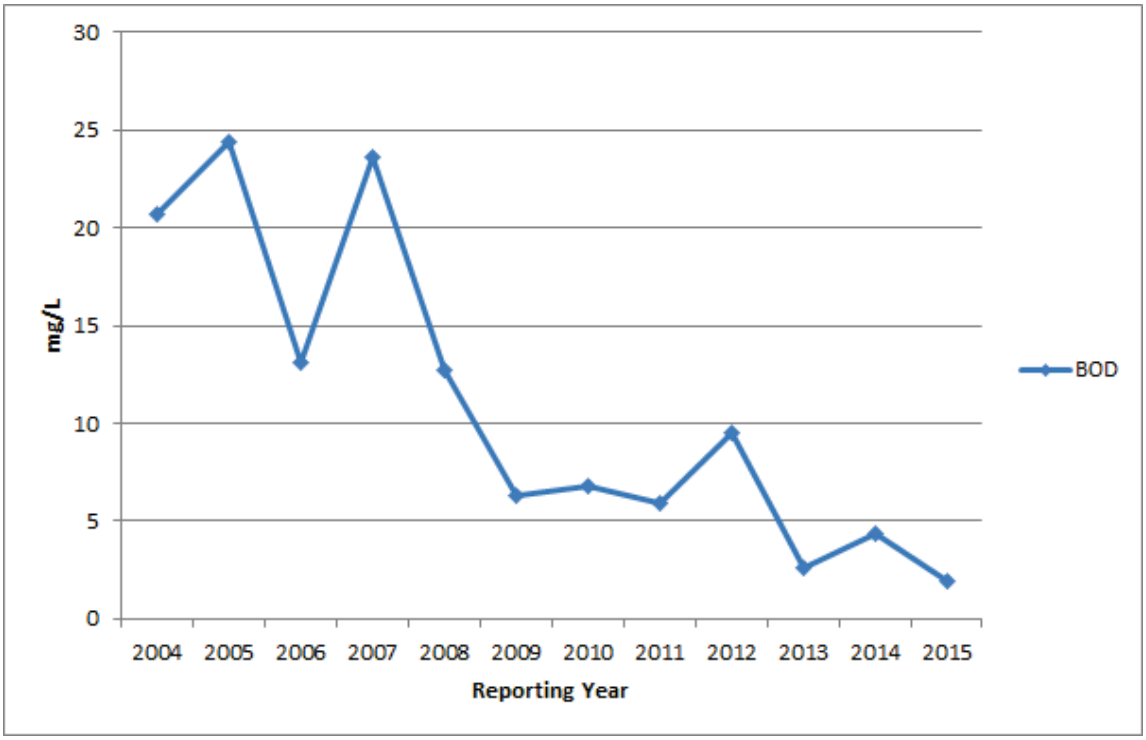


Figure 4-4. Parole station long-term monitoring: annual EMCs (BOD_5; mg/L)

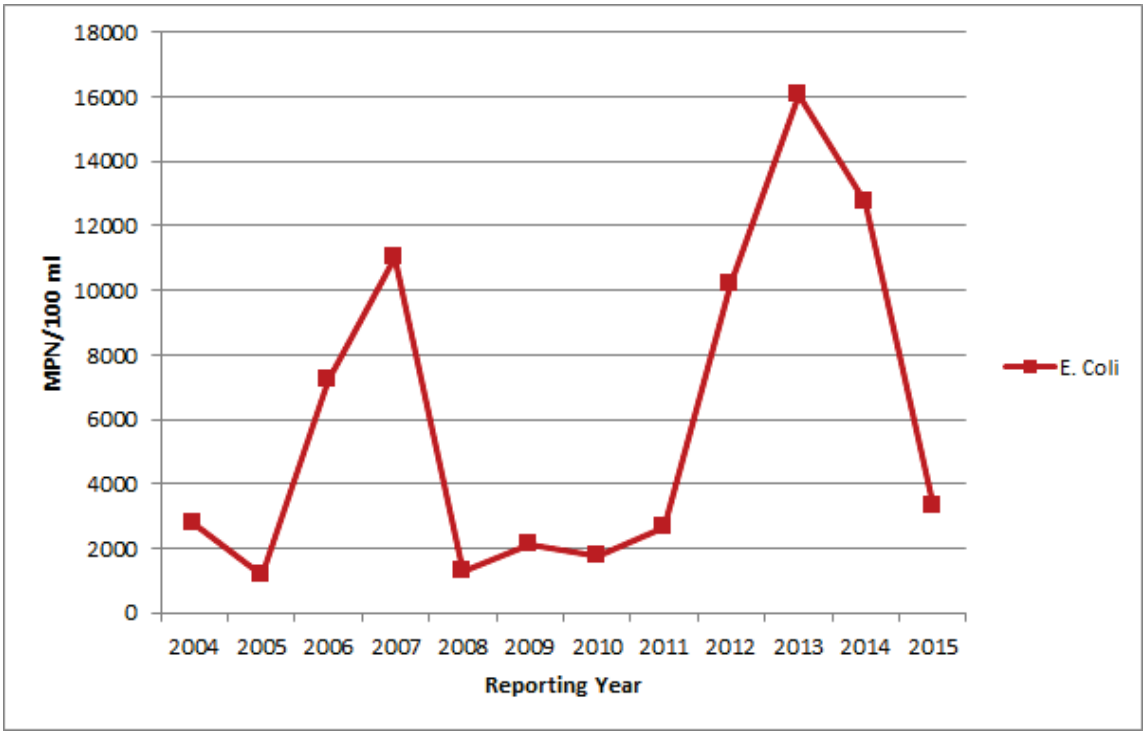


Figure 4-5. Parole station long-term monitoring: annual EMCs (*E. coli*; MPN/100 mL)

Figures 4-6 through 4-10 show a slightly different trend in EMCs for the Church Creek Monitoring Station. A slight rise in pollutant concentrations at Church Creek was observed in 2015 for TKN, nitrate-nitrite, TSS, zinc, and lead when compared to 2014 EMCs. Note that the apparent rise in TPH at Church Creek in 2013, like Parole Plaza, was due to an increase in the detection limit. Also like Parole Plaza, summer season concentrations were not included with the 2013 EMC data.

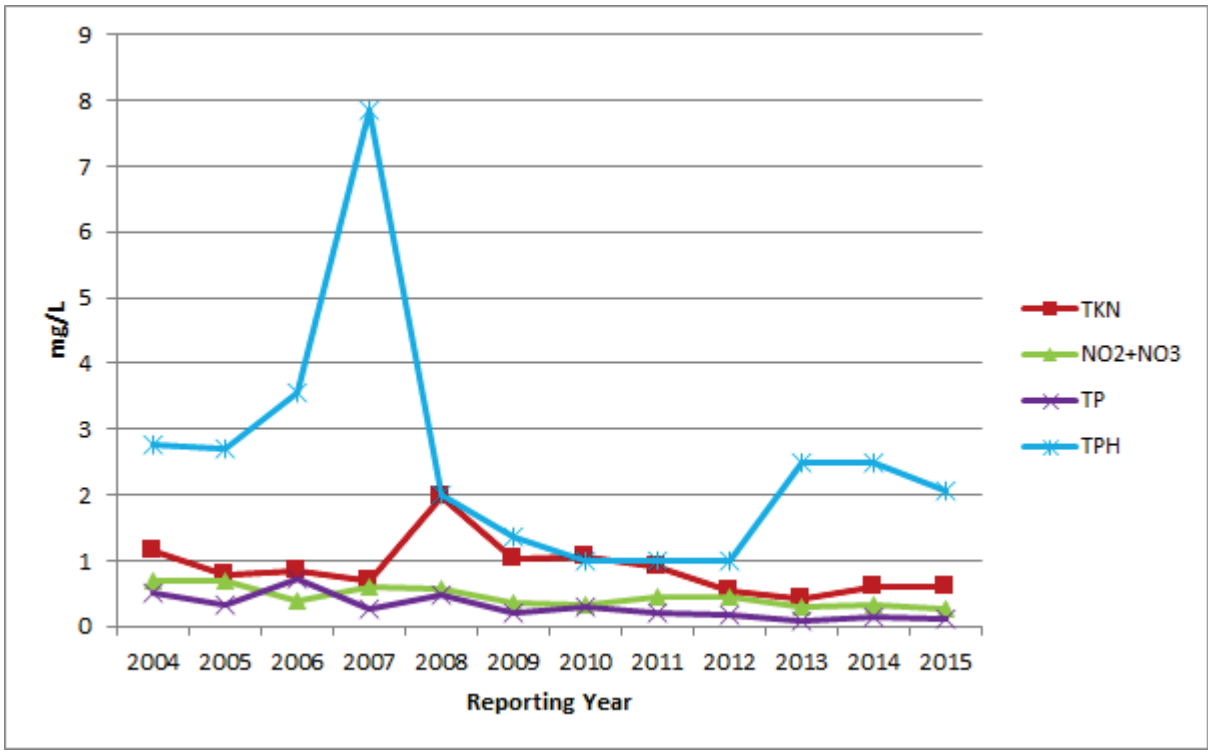


Figure 4-6. Church Creek station long-term monitoring: annual EMCs (TKN, NO_2+NO_3, TP, TPH; mg/L)

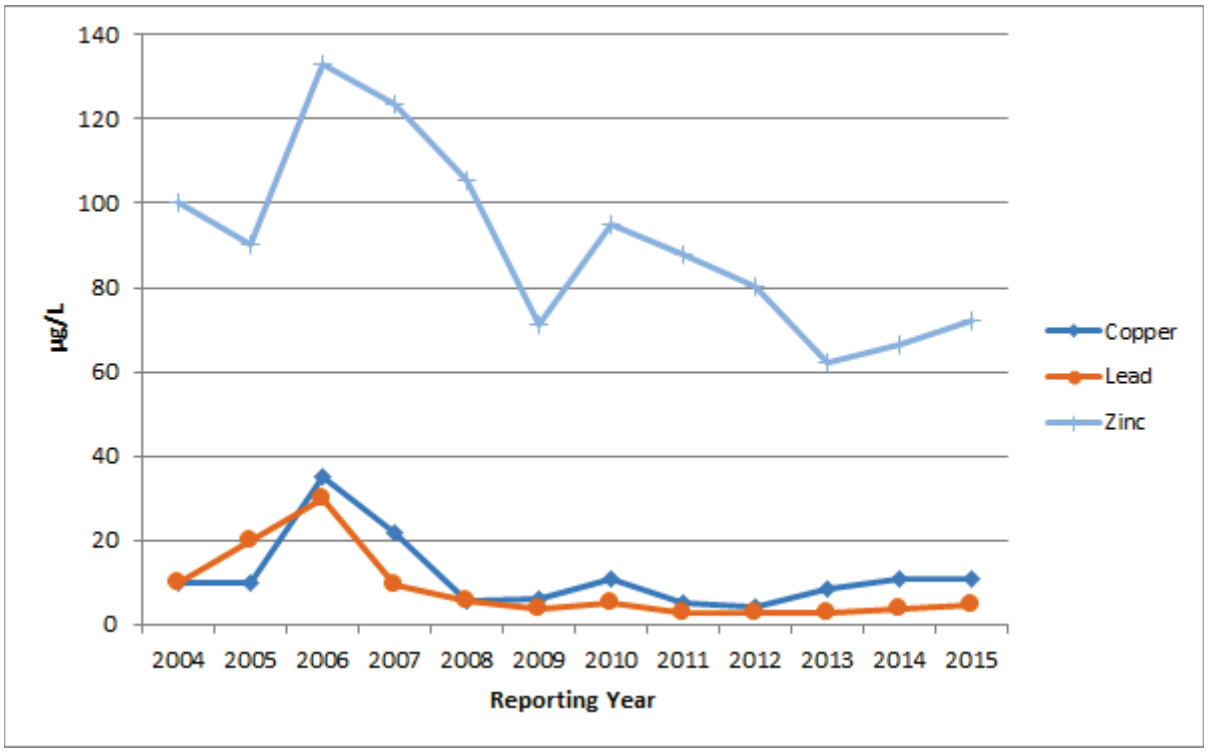


Figure 4-7. Church Creek station long-term monitoring: annual EMCs (Cu, Pb, Zn; mg/L)

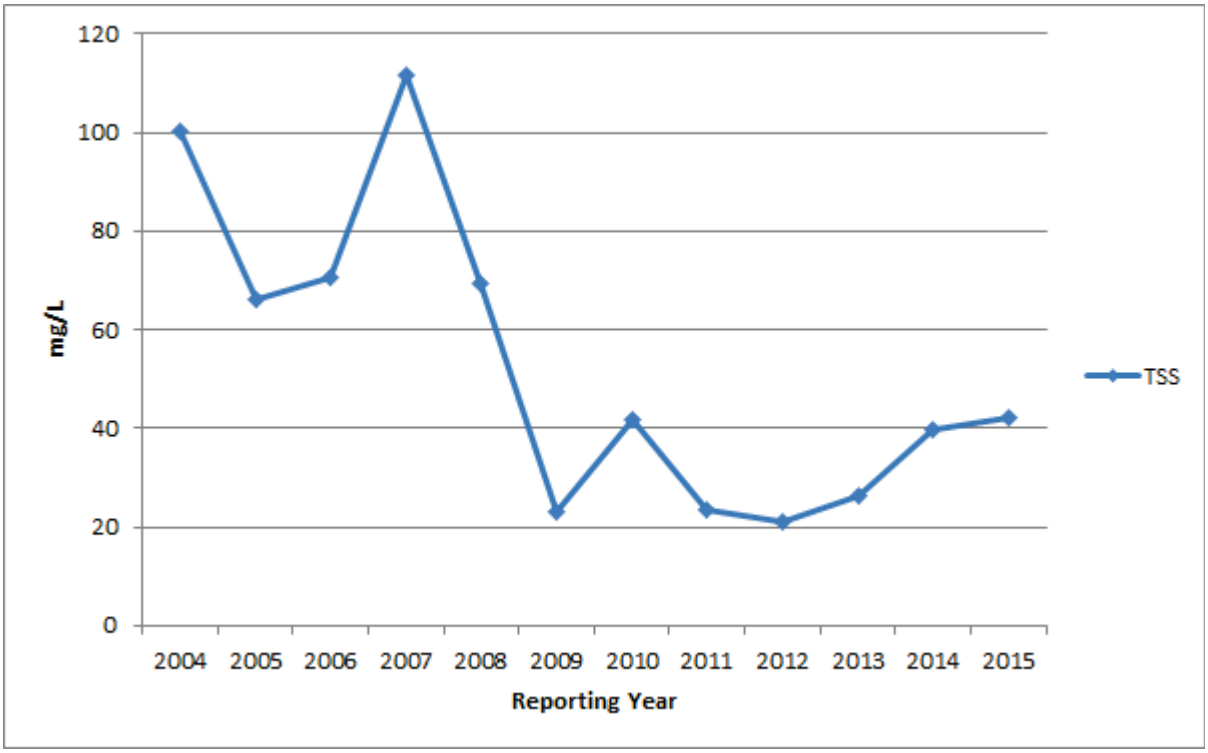


Figure 4-8. Church Creek station long-term monitoring: annual EMCs (TSS; mg/L)

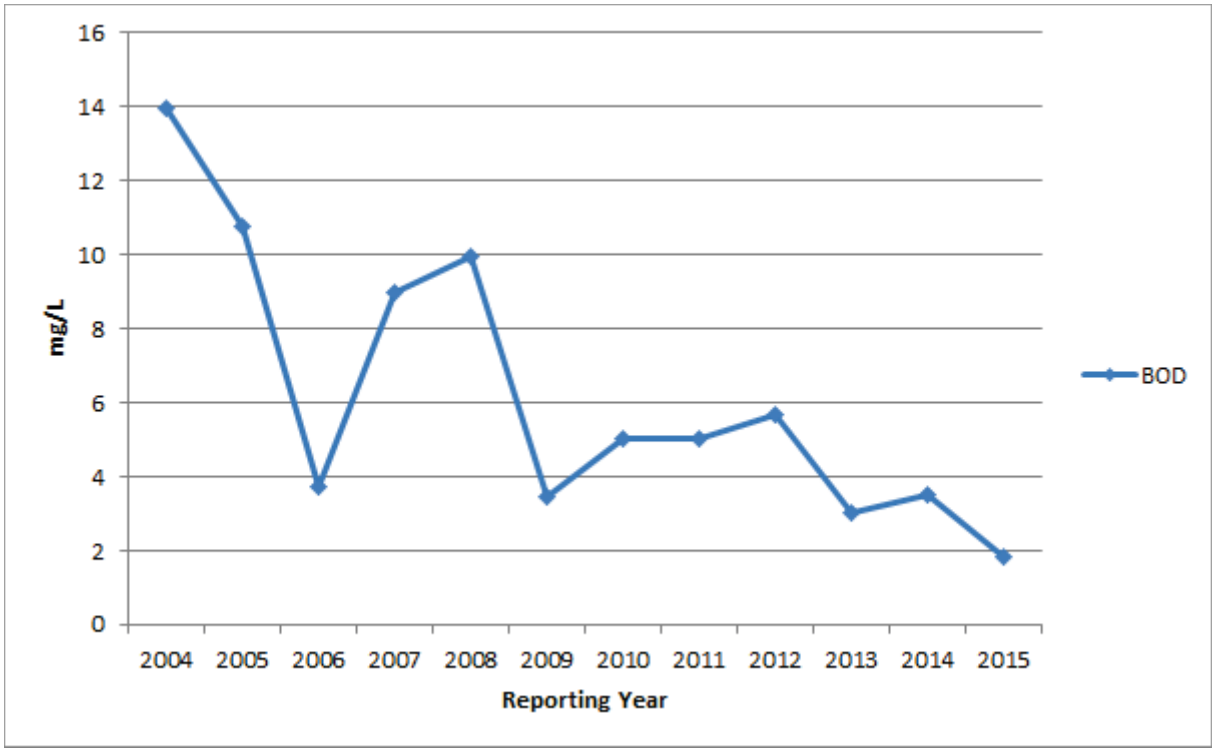


Figure 4-9. Church Creek station long-term monitoring: annual EMCs (BOD_5; mg/L)

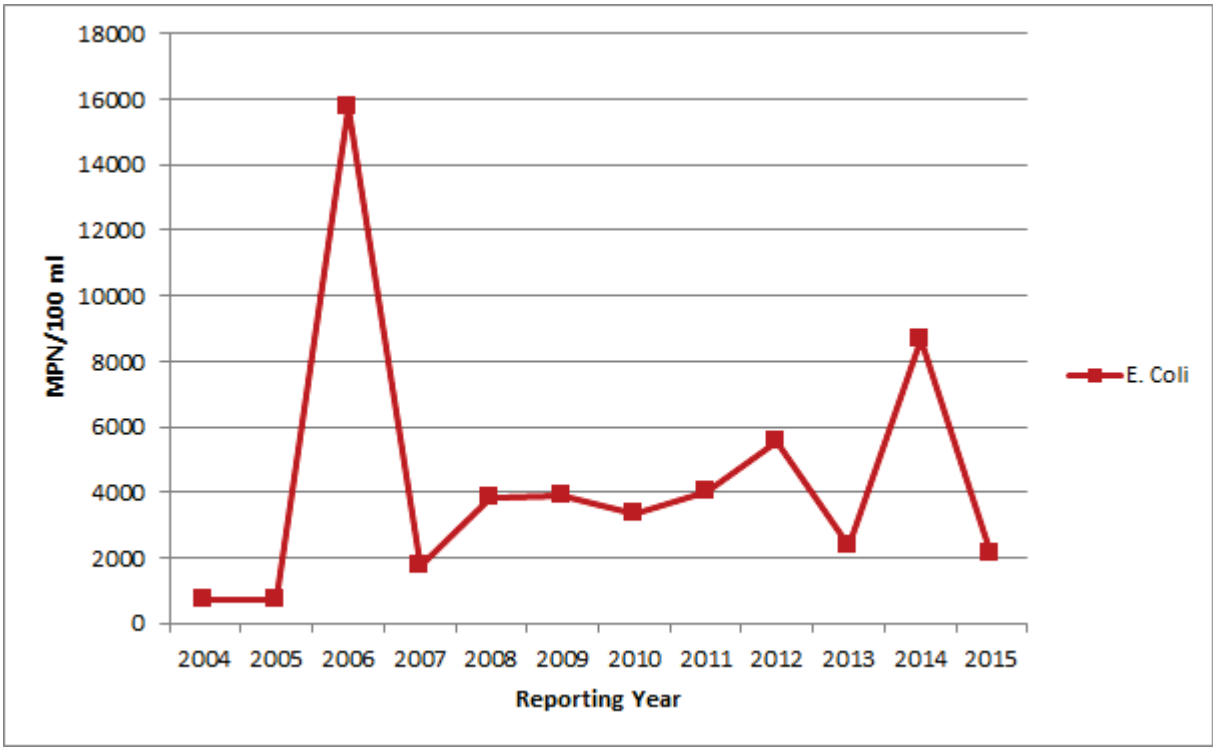


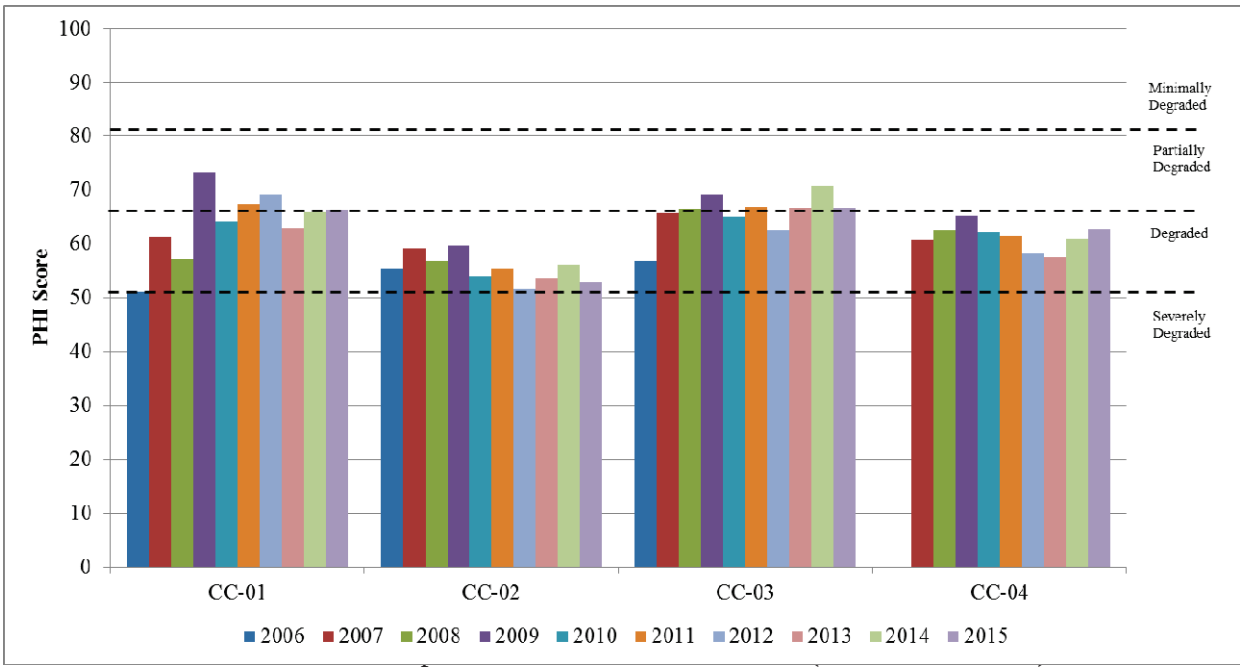
Figure 4-10. Church Creek station long-term monitoring: annual EMCs (*E. coli*; MPN/ 100 mL)

4.2 PHYSICAL HABITAT AND BIOLOGICAL CONDITIONS

Physical habitat and biological conditions within the Church Creek study area continue to be impaired by urbanization within the surrounding watershed. Stream physical habitat remains degraded throughout the entire study reach and appears to have changed very little from the previous year (Table 4-9, Figure 4-11). Three of the four sites were rated the same in 2015 as in 2014 indicating no change in habitat condition. One site (CC-01) was slightly upgraded from a rating of Degraded in 2014 to a rating of Partially Degraded in 2015. Urban stressors such as hydrologic alteration (i.e., increased runoff, increased frequency of peak flows, reduced infiltration) within the watershed have resulted in a reduction of stable instream habitat as well as increased channel erosion and sedimentation. A general lack of a stable epifaunal substrate further limits the capacity of the stream to support a diverse and healthy macroinvertebrate community. In addition, elevated conductivity levels reflect high levels of dissolved solids during baseflow conditions, which typically indicate the presence of water quality stressors.

Table 4-9. PHI scores from 2006 to 2015

Site		CC-01	CC-02	CC-03	CC-04
2006	PHI Score	51.1	55.4	56.8	No Data
	Rating	Degraded	Degraded	Degraded	Collected
2007	PHI Score	61.2	59.1	65.7	60.8
	Rating	Degraded	Degraded	Degraded	Degraded
2008	PHI Score	57.1	56.8	66.6	62.6
	Rating	Degraded	Degraded	Partially Degraded	Degraded
2009	PHI Score	73.2	59.6	69.2	65.2
	Rating	Partially Degraded	Degraded	Partially Degraded	Degraded
2010	PHI Score	64.3	53.9	65.0	62.3
	Rating	Degraded	Degraded	Degraded	Degraded
2011	PHI Score	67.4	55.3	66.9	61.5
	Rating	Partially Degraded	Degraded	Partially Degraded	Degraded
2012	PHI Score	69.2	51.5	62.5	58.3
	Rating	Partially Degraded	Degraded	Degraded	Degraded
2013	PHI Score	63.0	53.5	66.6	57.5
	Rating	Degraded	Degraded	Partially Degraded	Degraded
2014	PHI Score	65.85	56.16	70.79	61.01
	Rating	Degraded	Degraded	Partially Degraded	Degraded
2015	PHI Score	66.35	52.93	66.68	62.70
	Rating	Partially Degraded	Degraded	Partially Degraded	Degraded



calculate PHI instead of the original MBSS methods (Hall et al. 2002) which had been used in the Church Creek watershed reports from prior years. Scores for 2006-2012 shown in Table 4-9 and Figure 4-11 were calculated using the original method, while scores for 2013, 2014, and 2015 were calculated using the updated method.

Biological impairment is evident within this watershed as reflected by the macroinvertebrate communities found throughout the study reach. A comparison of BIBI scores from 2006 through 2015 (Table 4-10) shows no substantial change in biological conditions throughout the study reach. While BIBI scores tend to fluctuate from year to year, overall classifications have changed very little with sites consistently rating either “Poor” or “Very Poor”, no clear trends have been established (Figure 4-12). It appears that the biological community continues to be limited by the presence of urban stressors and the degraded physical condition of the stream, and annual shifts in BIBI scores are likely related to random and systematic variability inherent in the assessment process.

Table 4-10. BIBI scores from 2006 to 2015

Site		CC-01	CC-02	CC-03	CC-04
2006	BIBI Score	1.86	2.43	1.86	No Data
	Rating	Very Poor	Poor	Very Poor	Collected
2007	BIBI Score	1.00	1.86	2.71	2.71
	Rating	Very Poor	Very Poor	Poor	Poor
2008	BIBI Score	2.43	2.43	2.43	2.14
	Rating	Poor	Poor	Poor	Poor
2009	BIBI Score	1.86	1.86	2.14	2.43
	Rating	Very Poor	Very Poor	Poor	Poor
2010	BIBI Score	1.29	1.86	1.57	2.14
	Rating	Very Poor	Very Poor	Very Poor	Poor
2011	BIBI Score	1.57	1.86	1.57	2.14
	Rating	Very Poor	Very Poor	Very Poor	Poor
2012	BIBI Score	1.86	2.43	1.57	2.43
	Rating	Very Poor	Poor	Very Poor	Poor
2013	BIBI Score	1.57	2.43	1.86	1.29
	Rating	Very Poor	Poor	Very Poor	Very Poor
2014	BIBI Score	1.57	1.86	1.29	1.57
	Rating	Very Poor	Very Poor	Very Poor	Very Poor
2015	BIBI Score	1.57	1.57	2.14	1.86
	Rating	Very Poor	Very Poor	Poor	Very Poor

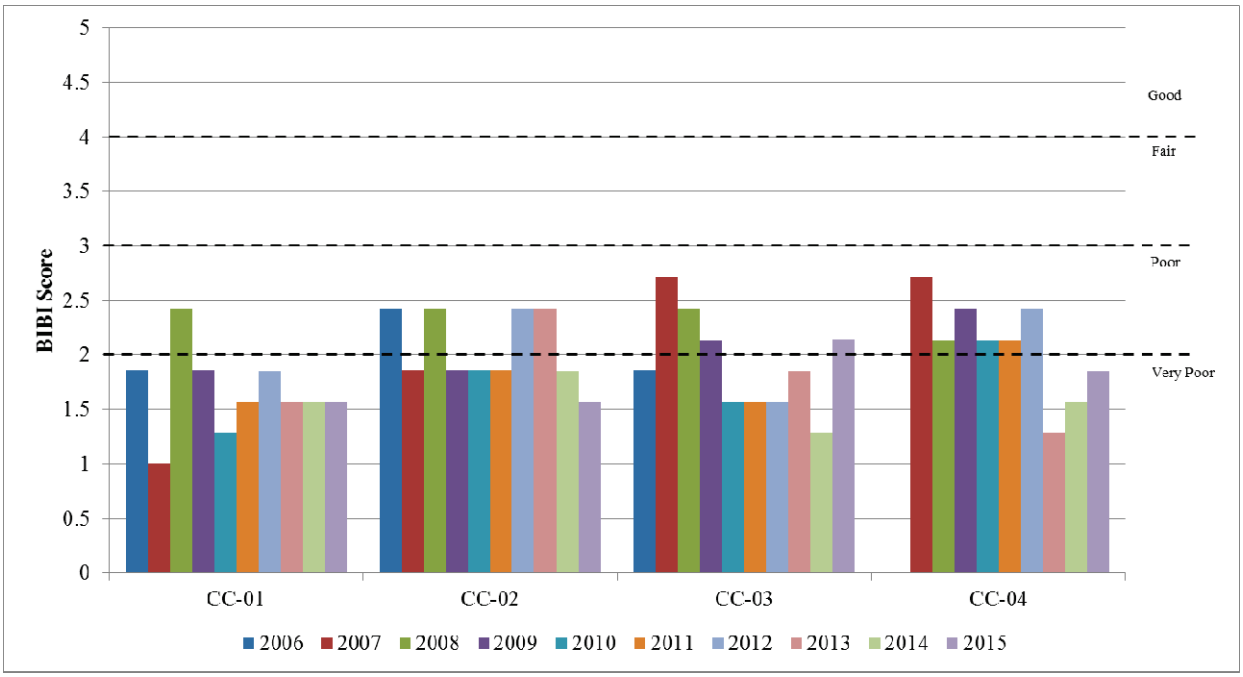


Figure 4-12. Comparison of BIBI scores from 2006 to 2015

4.3 GEOMORPHIC CONDITIONS

The Church Creek study area has a very high percentage of impervious surface cover (approximately 64 percent), and only one reach was classified as a C channel, which are generally considered stable stream types due to adequate floodplain connectivity. In contrast, the other four reaches were classified as either F or G channels, which are more entrenched and less stable. The Parole Plaza Tributary maintains some limited connectivity to its floodplain even though there are significant stormwater inputs feeding into the stream, which typically results in accelerated channel erosion and degradation. Evolution of channel type over the course of the study at each cross section is presented in Table 4-11. It is likely that current stormwater management and wetland storage on the Church Creek mainstem, as well as the presence of an intact riparian vegetative buffer along much of the stream corridor, contributes to minimizing some of the adverse effects of the high imperviousness in the watershed. Additionally, grade controls such as the culvert at Solomon's Island Road and cobble rip-rap armoring at XS-5 likely prevent some degradation from occurring in the channel upstream. Nonetheless, there are clear indications of channel instability (i.e., degradation, aggradation, widening) in the upper reaches of the Parole Plaza Tributary, and thus, a need for additional stormwater management to prevent further channel erosion.

Table 4-11. Past Rosgen classifications

Cross Section	2006	2007	2008	2009	2010	2011	2012	2013b	2014	2015
XS-1	E5	C5	E4	E5 → C5	E5 → C4/5	C4/5 → F4/5	F5	F4	F5/4	F4
XS-2	E5	E5	E5	E5	E5	G5c	G5c	G5c	G4c	G4
XS-3	G5c	G5c	G5c	G5c	G5c	No Data	No Data	G4c	G4c	G4/3c
XS-4	E5	E5	E5	E5	E5	E5	E5	C5	C5	C5
XS-5	E5b	C5	C5	C5	C3/5	C3/5	C3/5	F4/3	F3	F3/4

Bankfull channel dimensions (cross sectional area, width, depth) in the Church Creek study area showed significant departure from expected values, as derived from Maryland Coastal Plain regional relationships of bankfull channel geometry (McCandless, 2003). Almost all dimensions were generally larger in the Church Creek study area (see Figures 4-13, 4-14, and 4-15), and were often more similar to relationships of bankfull channel geometry derived from gaged urban watersheds located in the Coastal Plain. These relationships were developed for an urban stream restoration project in Anne Arundel County (AADPW 2002). Values measured in 2015 were roughly consistent with prior assessment results. This reflects the higher level of imperviousness in the study area, as compared to the lower impervious levels in the drainage areas used to develop the regional relationship data. The results suggest that this stream has become enlarged as a result of the high imperviousness, and is both wider and deeper than stable C and E type channels located in rural/suburban watersheds of the coastal plain. It should be noted, however, that locating bankfull elevations in the field on actively eroding, previously stabilized, or incising channels is difficult and not recommended due to unreliable and/or

misleading indicators, and instead bankfull elevations should be estimated using the aforementioned regional curves (Rosgen, personal communication, May 2011). Where bankfull indicators were suspect or questionable, the indicator approximating the rural/ suburban regional curve for bankfull area was used to estimate bankfull elevations. Additionally, the Rosgen method is best used on streams that are free to adjust their lateral boundaries under the current discharge regime experienced by the system (Rosgen 1996). Given the high levels of rip rap and/or concrete rubble armoring found in the reaches containing cross sections 2, 3 and 5, the accurate determination of the bankfull indicators in the field at these locations is problematic.

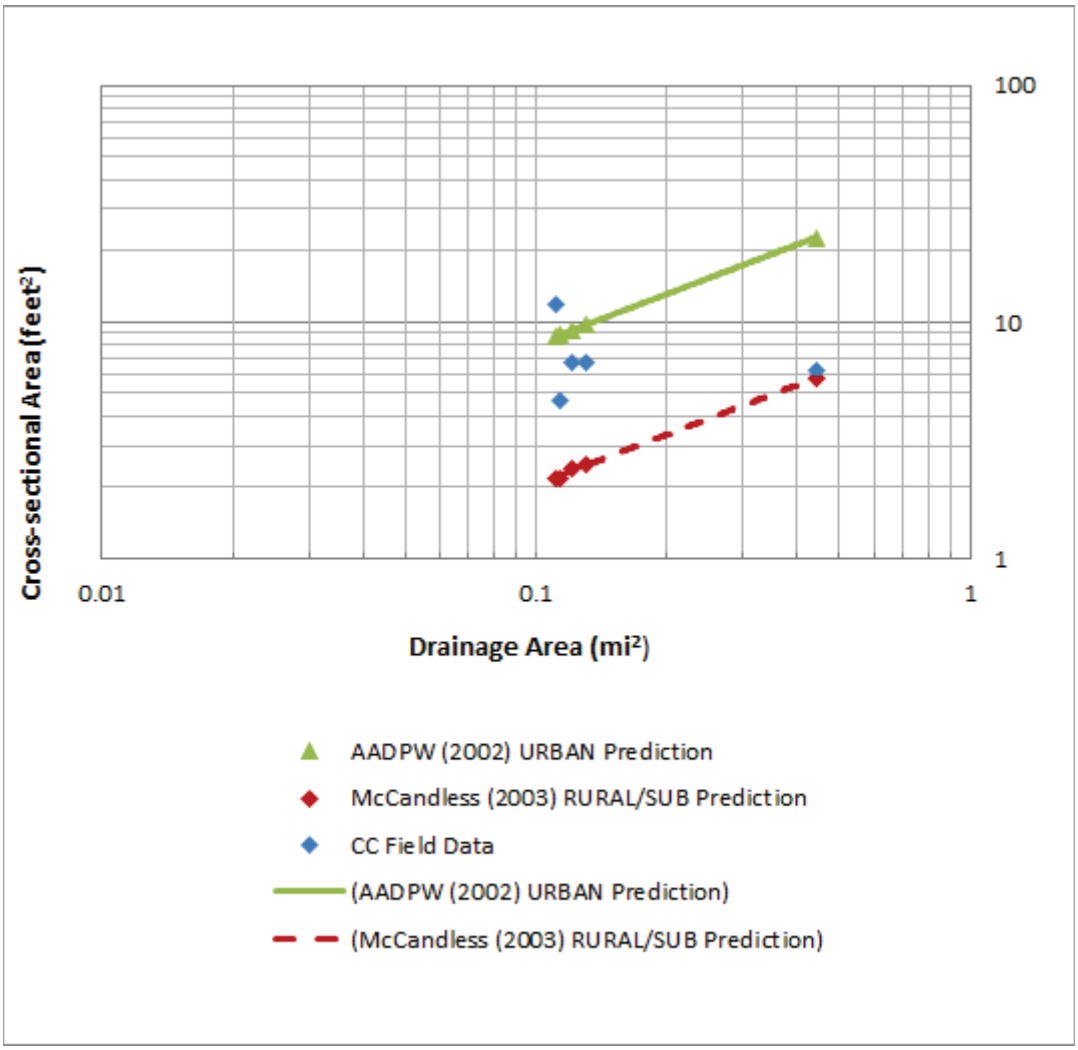


Figure 4-13. Comparison of bankfull channel cross sectional area to drainage area (CC = Church Creek, 2015 data)

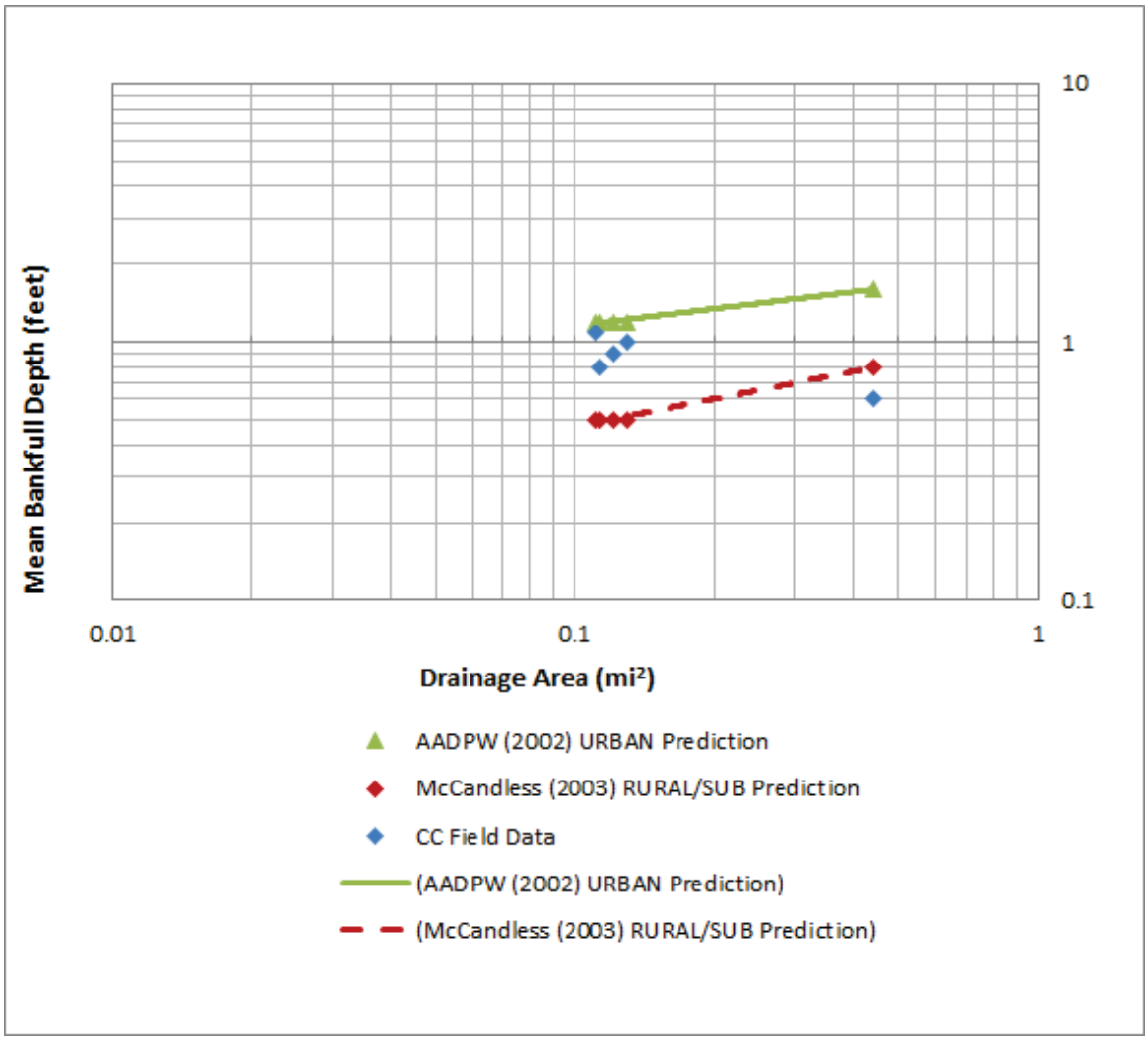


Figure 4-14. Comparison of mean bankfull depth to drainage area (CC = Church Creek, 2015 data)

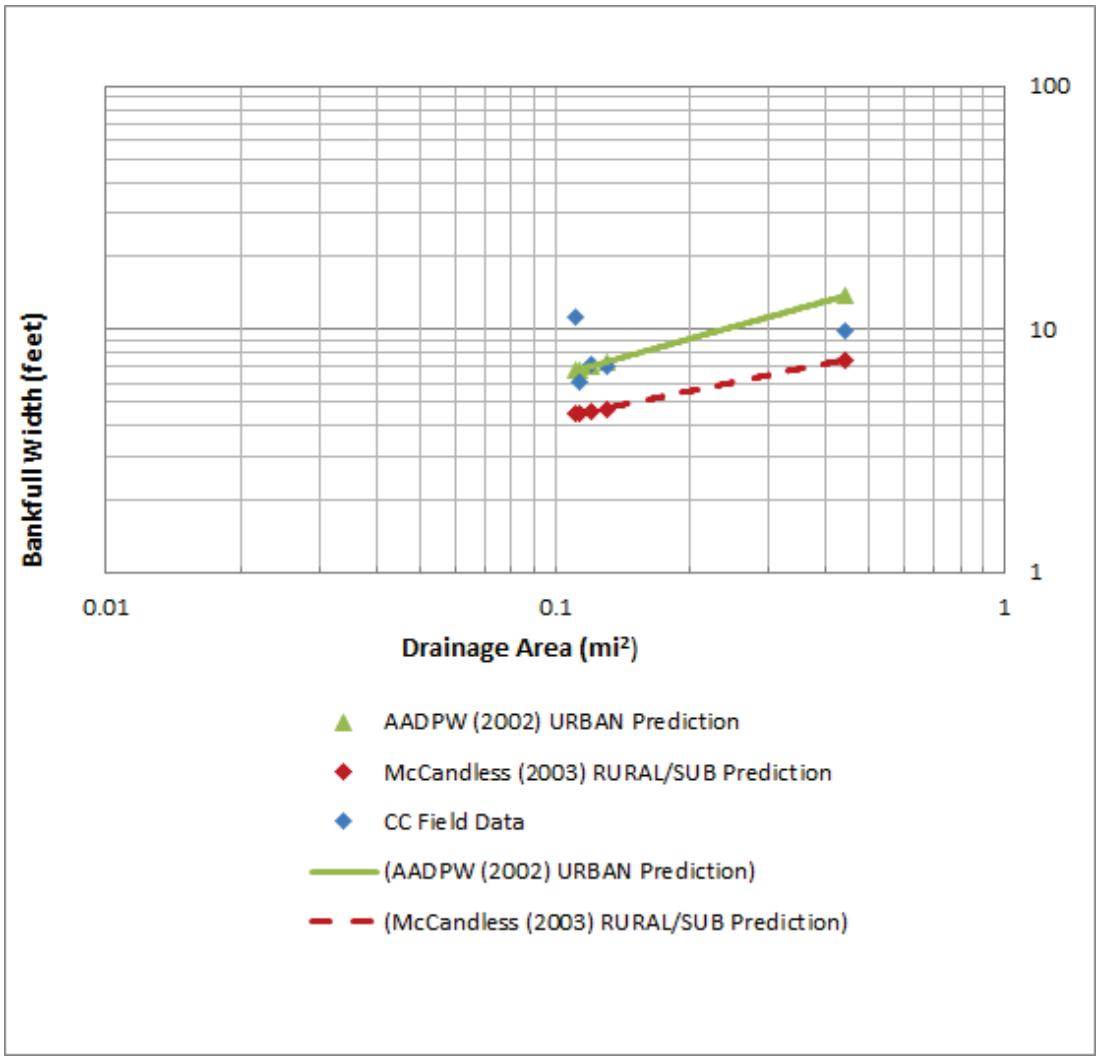


Figure 4-15. Comparison of bankfull width to drainage area (CC = Church Creek, 2015 data)

Three of the five cross sections showed enlargement from channel erosion while the other two showed aggradation as compared to baseline measurements (Table 4-12). Due to the replacement of XS-3 following channel restoration, data were compared to 2007 at this location only, whereas all other comparisons were made to 2003 data. Cross sectional area from 2011 through 2015 was calculated using the top of bank elevation from the baseline survey in order to standardize comparisons and reduce variability among more subjective bankfull elevation reference points, or even changes that can occur to top of bank elevation from year to year. It is important to note that calculations prior to 2011 did not use the baseline reference elevation, instead they used the corresponding year's top of bank elevation for calculating cross sectional area, and consequently these values are not directly comparable to the cross sectional areas reported in 2011 through 2015. Comparison of baseline cross sectional area is however comparable to 2011 through 2015 since all calculations are made using the same top of bank elevation.

Table 4-12. Summary of cross sectional area changes over time.

Cross Section[a]	XS-1	XS-2	XS-3	XS-4	XS-5
July 2003	16.8	8.9	ND	14.3	9.7
Jan 2005	20.7	10.0	ND	14.4	9.9
March 2006	19.4	8.0	ND	18.4	9.5
March 2007	19.4	8.9	19.8	17.4	9.0
May 2008	20.1	10.1	16.7	18.0	8.9
July 2009	19.6	9.8	21.0	15.4	8.3
May 2010	19.8	10.3	20.4	16.4	8.5
July 2011[b]	21.3	15.9	20.6	7.8	10.5
April 2012[b]	21.6	15.4	19.2	11.7	5.9
July 2013[b]	21.0	15.5	20.2	11.7	6.9
June 2014 [b]	22.4	16.2	20.6	6.8	6.7
May 2015 [b]	22.6	16.4	18.6	9.2	6.7
% Change 2003-2014	36.3	84.3	-6.1[c]	-35.7	-30.9
% Change 2011-2014	7.5	3.1	-9.7	17.9	-36.2

[a] All values listed here are for top of bank area and are listed in square feet
[b] Values obtained using reference elevations (top of bank) from baseline measurements
[c] % change from 2007
ND = No Data

Using the current reference elevation comparison method, the upstream cross sections (XS-1 and XS-2) showed fairly substantial enlargement, with increases of approximately 36.3%, and 84.3% respectively, since baseline measurements began in 2003. The bed elevation at XS-1 appears to have dropped more than half a foot since 2003, remaining relatively stable since last year, but with a noticeable amount of bed scour occurring between 2008 and 2009 (Appendix F). With the exception of minor scouring near the left bank, there has been very little overall change in bed elevation during 2013 to 2014. Over the last year however, there has been slightly more scour occurring mid channel which has resulted in a mean depth increase from 0.7 ft. in 2014 to 1.1 ft. in 2015. The channel at XS-2 has widened notably since 2003, with considerable erosion along the right bank and toe of slope on the right bank, although the left bank has not experienced further erosion during the last five years (Appendix F). Although cross section area comparisons between baseline and 2015 show a substantial increase, percent change occurring over the last four years only has been fairly minimal with 7.5% increase at XS-1 and 3.1% increase at XS-2.

Cross section XS-3 has had very minimal changes in cross-sectional area with just a 6% decrease since 2003 baseline measurements and -9.7% change between 2011 and 2015. Between 2009 and 2011, the XS-3 channel appeared to be enlarging, as the right bank and bottom of the right bank experienced some erosion and the cross-sectional area increased (Appendix F). However, during the past four years, the right bank has experienced some aggradation (Appendix F). Between 2012 and 2015 monitoring, there has been little change with the

exception of slight aggradation across the stream bed. Cross section XS-3 continues to have yard waste (i.e., grass clippings, leaves, and branches) dumped along the left bank floodplain.

Conversely, the two most downstream cross sections (XS-4, and XS-5) showed varying degrees of aggradation, decreasing from baseline measurements in cross-sectional area 35.7%, and 30.9%, respectively. Between 2010 and 2011 cross section XS-4 had shown moderate signs of aggradation. Within the next year, the channel experienced erosion of the bed particularly along the right hand side of the stream. In the 2013 survey, signs of aggradation were again present and the stream bed characteristics resemble those of the 2011 survey. In 2014 the stream bed remained elevated as in 2011 and 2013 however there was slight widening along the right bank. In 2015, widening continued along the right bank as well as significant degradation of the stream bed by almost one foot. Another significant change at XS-4 first occurred between 2003 and 2006, where the average bed elevation dropped by more than one-half foot (Appendix F). The woody debris jam just downstream of XS-4 which formed between 2011 and 2012 is still present and contributing to debris and sediment accumulation in the channel and on the banks. Between 2011 and 2015 the cross-sectional area has increased by 17.9% but continues overall trend in aggradation at this location since 2003 (a net 35.7% decrease in cross-sectional area compared to the baseline study). Cross section XS-5 has been armored with cobble-sized rip rap in its bed to protect the sewer line. Between 2012 and 2013, XS-5 appears to have eroded by several inches of sediment most notably near the left bank. During the past two years, however, there has been little change in both stream bed elevation and bank stability (Appendix F).

4.4 GENERAL CONCLUSIONS

Based upon the data collected in 2015, stream water quality has improved when compared to pre-construction and earlier post-construction monitoring years, but biological and physical conditions within the Church Creek study area have not improved and remain in a degraded and impaired condition. Although the stream channel has been stabilized along several reaches, the effects on biota are yet to be seen from such efforts.

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APPENDIX A

STORM EVENT HYDROGRAPHS, NARRATIVES AND COMPOSITE SAMPLING METHOD TECHNICAL MEMORANDUM

KCI TECHNOLOGIES

TECHNICAL MEMORANDUM

TO:	Janis Markusic, AACO DPW
FROM:	James Tomlinson
DATE:	5/12/08
SUBJECT:	Proposed Modifications to Sampling Procedures Church Creek/Parole Plaza NPDES Monitoring 2008 KCI Job Order No. 01-032333.38

Dear Ms. Markusic,

Monitoring at the Parole Plaza station has historically entailed collecting storm water samples from a 60" corrugated metal pipe (CMP) outfall draining the Parole Plaza site. The rising, peak, and falling limb of each storm event was sampled and analyzed in the lab. In the summer of 2007, a newly-installed 54" reinforced concrete pipe (RCP) was connected to the Church Creek drainage network (refer to Figure 1). The new 54" RCP drains the *Annapolis Towne Center at Parole* construction site and contains portions of the drainage that had historically been passing through the 60" CMP. Based on plan reviews, on-site discussions with County staff /inspectors, and discussions with Mr. Matthew Kelly of Greenhorne & O'Mara Inc. (Head Engineer) it was determined that runoff from the *Annapolis Towne Centre at Parole* site would be discharging from both the 60" CMP and 54" RCP outfalls under post-construction conditions.

In order to maintain consistency in the characterization of the watershed, samples are being collected from both pipes. As in the 2006-2007 reporting year, the 2007-2008 reporting year has also encountered the challenge of determining the active drainage configuration during each sampled event. To address this problem, samples were collected for each limb of an event and taken to the laboratory for each pipe separately. In 2007, storm samples were collected and analyzed for both outfall pipes for three storm events (9/11/07, 10/9/07, and 10/19/07) at the Parole Plaza station. In 2008, storm samples were collected and analyzed for both outfall pipes for two storm events (1/10/08 and 1/17/08) at the Parole Plaza station.

Stage/discharge relationships were developed for both pipes, to determine the discharge from each pipe based on field-measured depths. The rating tables were used to determine discharges and total flow volumes for each limb of the storm. The reported concentrations for each limb were then weighted by the flow for that limb of the storm to determine the event mean concentration for each pipe. The event mean concentrations for each pipe were then flow weighted again for the total discharge through each pipe to determine the total event mean concentration for the *Annapolis Towne Center at* Parole site.

In March 2008, the sampling methodology was modified such that only one flow-weighted composite sample per event limb is collected and analyzed at the lab. The goal of compositing the discharge from both pipes is to ensure a comprehensive analysis of the storm water leaving the *Annapolis Towne Center at Parole* site during and after construction. The flow-weighted composite sample for each limb of an event is determined by the combined discharge of the 60" CMP and 54"RCP outfalls. Stage/discharge relationships were developed for both pipes, to determine the discharge from each pipe based on field-measured depths. The relationships are based on modeled values and are currently being validated by field-measured data. A sample

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is collected for each limb of a storm by proportioning the appropriate volume of RCP/CMP sample into a sample container, based on each pipes contribution to the total runoff. To determine the appropriate amount of sample to collect from each pipe for each limb, the discharge from the CMP and RCP is computed and totaled. The CMP and RCP discharge is then divided by the total discharge to determine the percent contribution to the total discharge. Once the percent contribution is determined, then volumetric containers are utilized to proportion each pipe sample to create one composite sample. The composite sample is then distributed into the laboratory bottles.

At this time, three storm events (3/19/08, 4/20/08, and 4/26/08) have been sampled utilizing the flow-weighted composite method. Currently, no automated equipment is available for the RCP. Level, pH, and temperature are taken manually during sampled events. All of the flow data and discharge characteristics for each outfall pipe are recorded during the storm event into a laptop spreadsheet that automatically calculates the correct sample proportions. General notes, field-measured velocity data, and a hydrograph are also recorded on the laptop spreadsheet during the storm event (see Figure 2).

As discussed in the field on April 10, 2008, KCI feels that this is an appropriate method for maintaining consistency with the historical data, while reducing the costs of sampling and testing both outfalls individually.

If you have any questions or comments, please feel free to contact me at the number below.

Sincerely,

James A. Tomlinson, PE
Project Manager
(410) 316-7864

ND/jt

cc: Christopher Victoria, AACo DPW
Nathan Drescher/KCI

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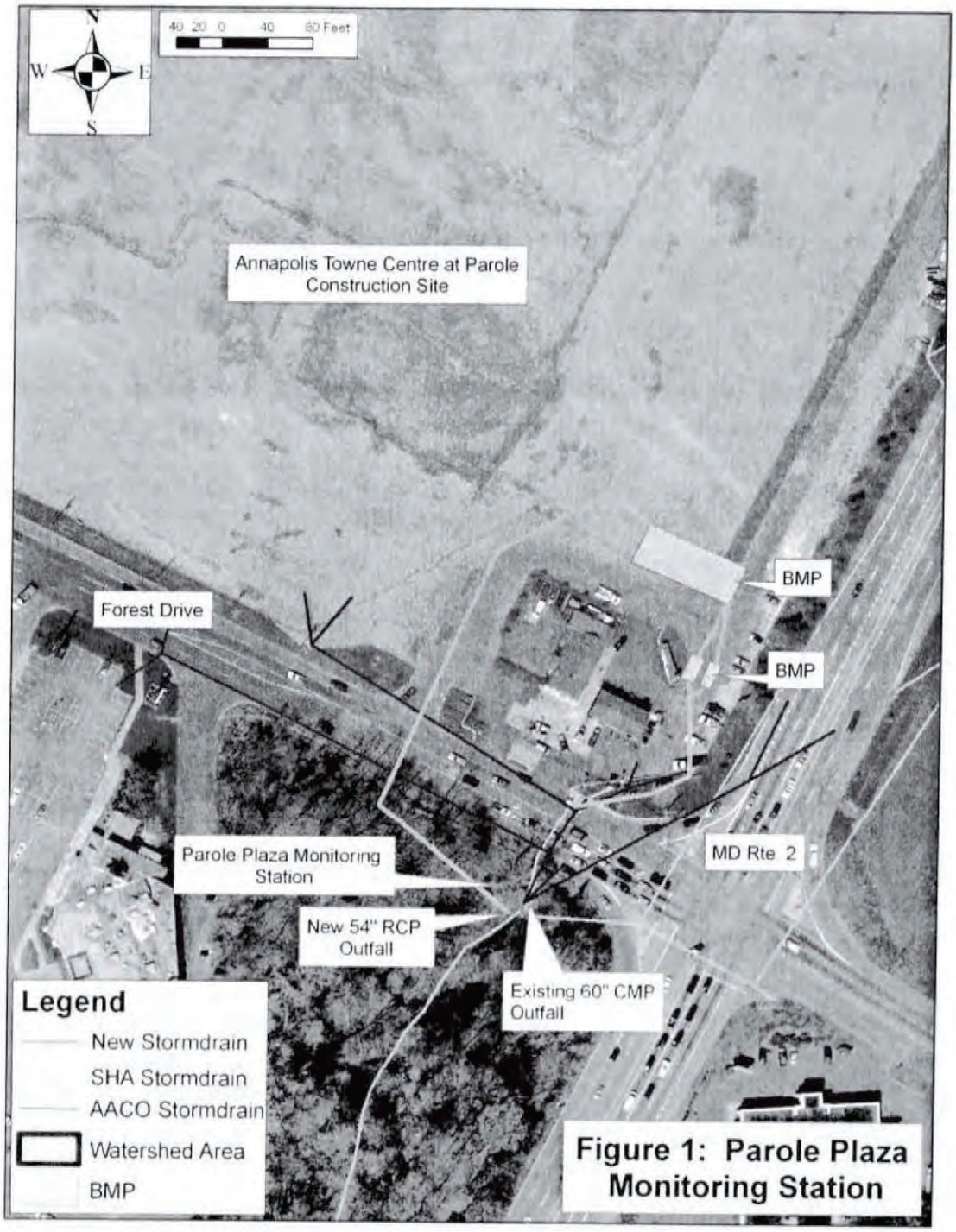
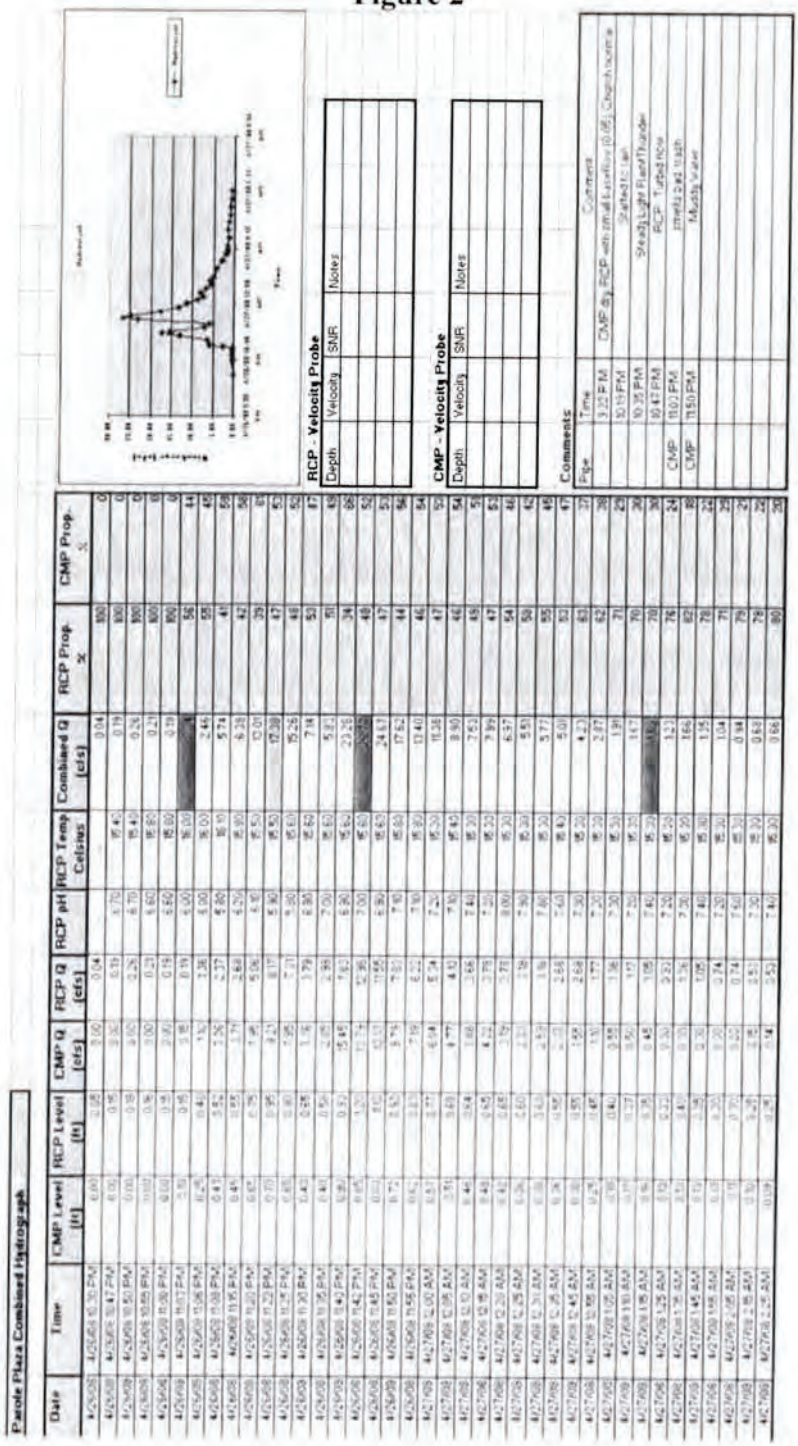


Figure 1: Parole Plaza Monitoring Station

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Figure 2



Storm Event Narratives

- August 12, 2014 – At Church Creek, the EMCs of most parameters during the August 12, 2014 storm were greater than the two baseflow values from the last month of the summer quarter, except for TKN, nitrate-nitrite, *E. coli*, and hardness. TPH and *E. coli* were not detected in any samples at Church Creek during the event. The anomalous results were investigated by project staff, including possibilities of sampling error and laboratory error, but no cause for the non-detectible results was found. At Parole Plaza, the EMCs of most parameters during the August 12, 2014 storm were greater than the two baseflow values from the last month of the summer quarter except nitrate-nitrite, zinc, and hardness. At Parole Plaza, TPH was the only parameter not detected in any samples. Unlike at Church Creek, *E. coli* was detected at high concentrations in samples during the event. During the August 12 storm event, level measurements were measured manually for the RCP pipe at Parole Plaza due to the unavailability of the Global Water logger. These records are highlighted in blue in the spreadsheet.

- October 15, 2014 - At Church Creek, the EMCs of most parameters during the October 15, 2014 storm were greater than the other two storm EMCs from the fall quarter, except for BOD, TKN, nitrate-nitrite, and total phosphorus. TPH was not detected in any samples at Church Creek during the event; therefore, the EMC is presented as 0. At Parole Plaza, the EMCs of total phosphorus, TSS, lead, and *E. coli* during the October 15, 2014 storm were greater than the two storm EMCs from the fall quarter. As was the case at Church Creek, TPH at Parole Plaza was not detectible in any samples.

- November 6, 2014 - At Church Creek, during the November 6, 2014 storm, the total phosphorus EMC was greater than the other two storm EMCs from the fall quarter. TPH was not detected in any samples at Church Creek during the event; therefore, the EMC is presented as 0. At Parole Plaza, the EMCs of most parameters during the November 6, 2014 storm were less than the other two storm EMCs s from the fall quarter except BOD, nitrate-nitrite, and zinc. As was the case at Church Creek, TPH at Parole Plaza was not detectible in any samples.

- December 22, 2014 – At Church Creek, during the December 22, 2014 storm, BOD, TKN, nitrate-nitrite, and total phosphorus EMCs were greater than the other two storm EMCs from the fall quarter. TPH was not detected in any samples at Church Creek during the event; therefore, the EMC is presented as 0. At Parole Plaza, the *E. coli* EMC during the December 22, 2014 storm was less than the other two storm EMCs from the fall quarter. The greatest EMCs for the quarter occurred during this storm for most parameters. TPH was not detectible in any samples during this event.

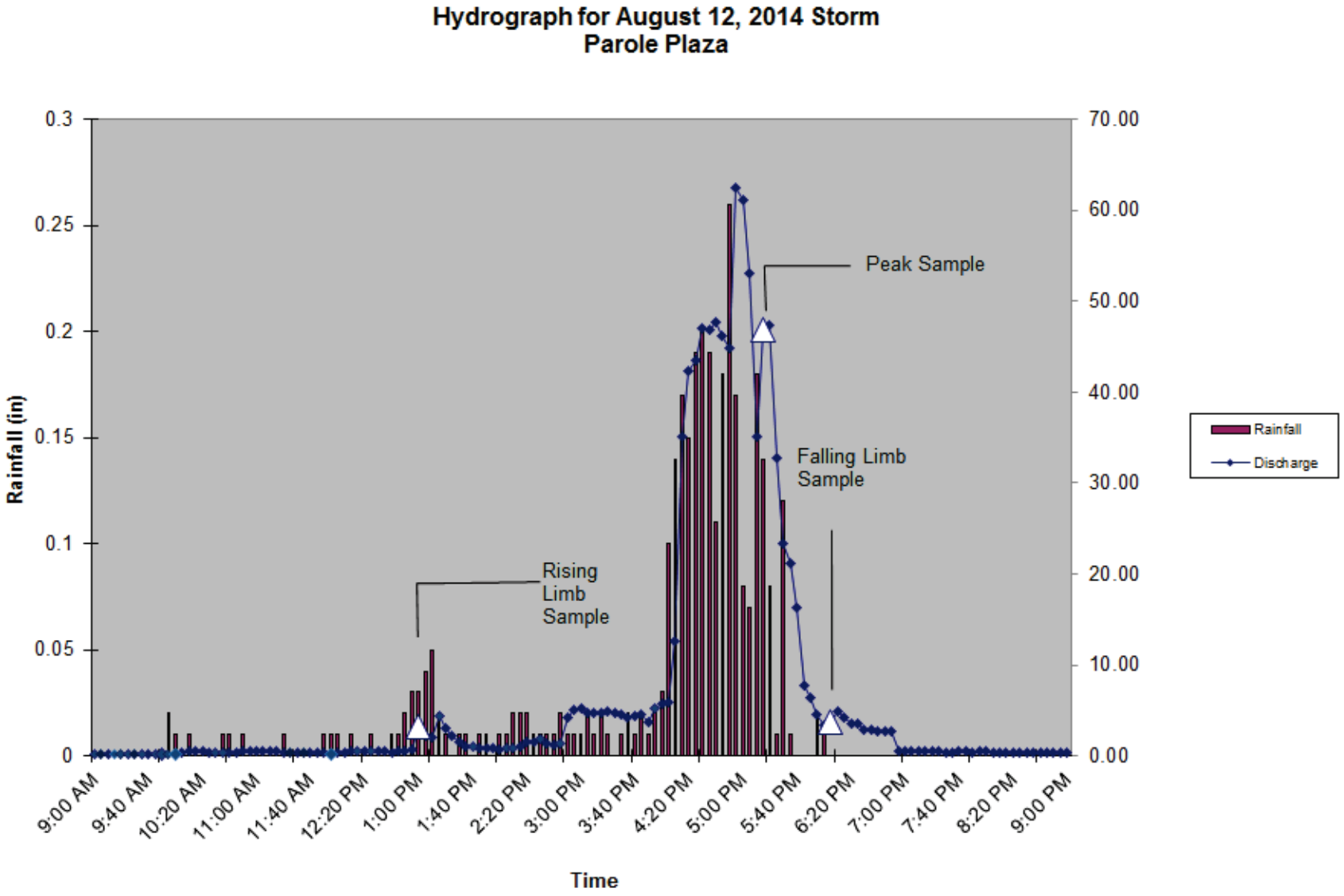
- March 4, 2015 - At Church Creek, the EMCs of all parameters during the storm were greater than the average concentrations of the storms captured since December 12, 2012, except for BOD and *E. coli*. EMCs for BOD and total phosphorus were generally comparable to historical average values for storm runoff. The EMCs for the remaining parameters exceeded

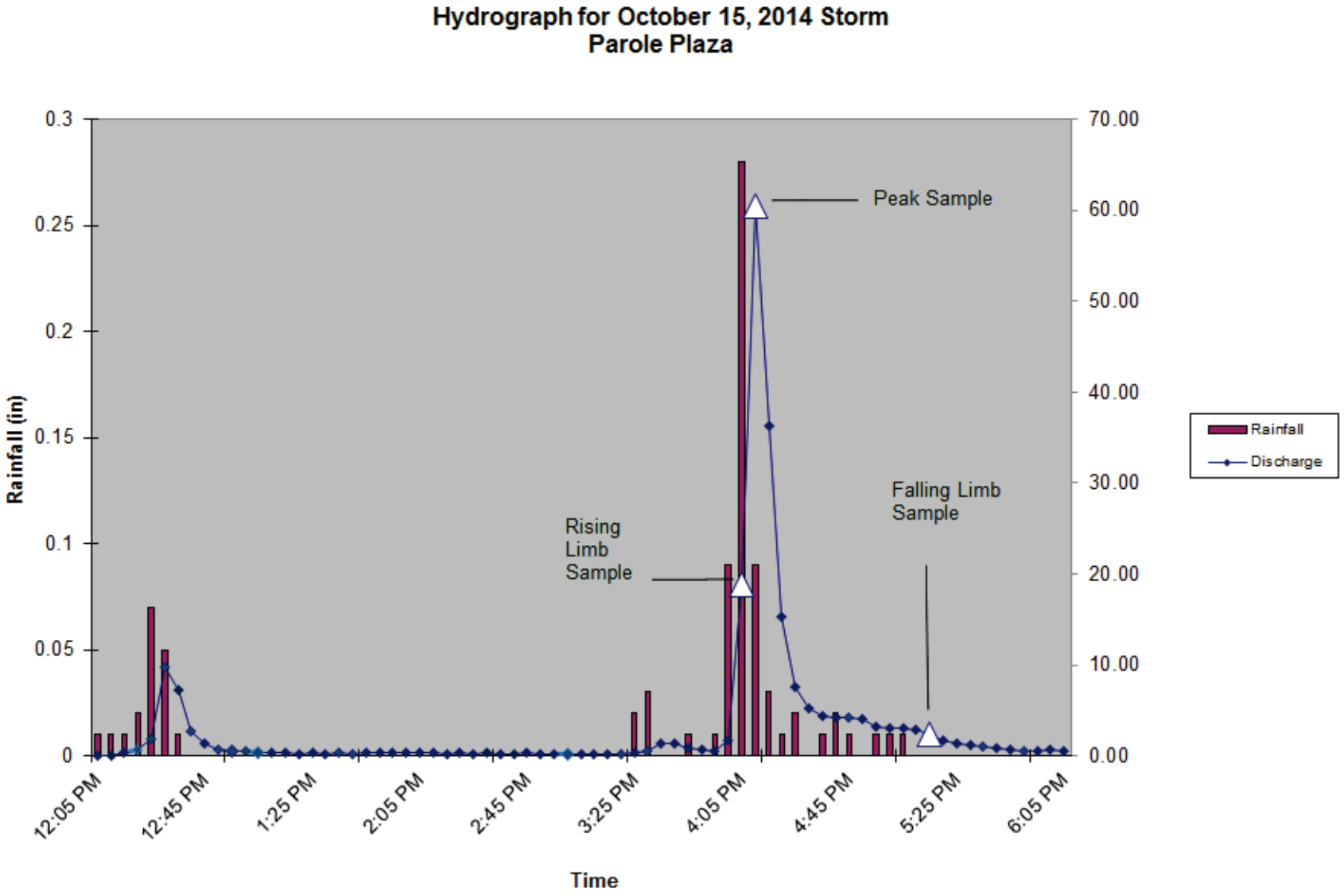
their historical averages by between 34% (TSS) and 151% (hardness). During this event, TPH was detected for the first time since Versar began monitoring in December 2012, at 5.0 and 7.0 mg/L. At Parole Plaza, the EMCs of all parameters during the March 4, 2015 storm were greater than the average concentrations of the storms captured since December 12, 2012, except for BOD, nitrate-nitrite, and *E. coli*. The EMC for TKN was comparable to the historical average for storm events; other parameters were greater than the historical average by between 16% (TSS) and 98% (lead). The EMC for hardness was five times the historical average, which may have been caused by input of deicing compounds during the quarter. At Parole Plaza, TPH was detected for the first time since Versar began monitoring in December 2012, at 6.0 mg/L (during the rising limb only).

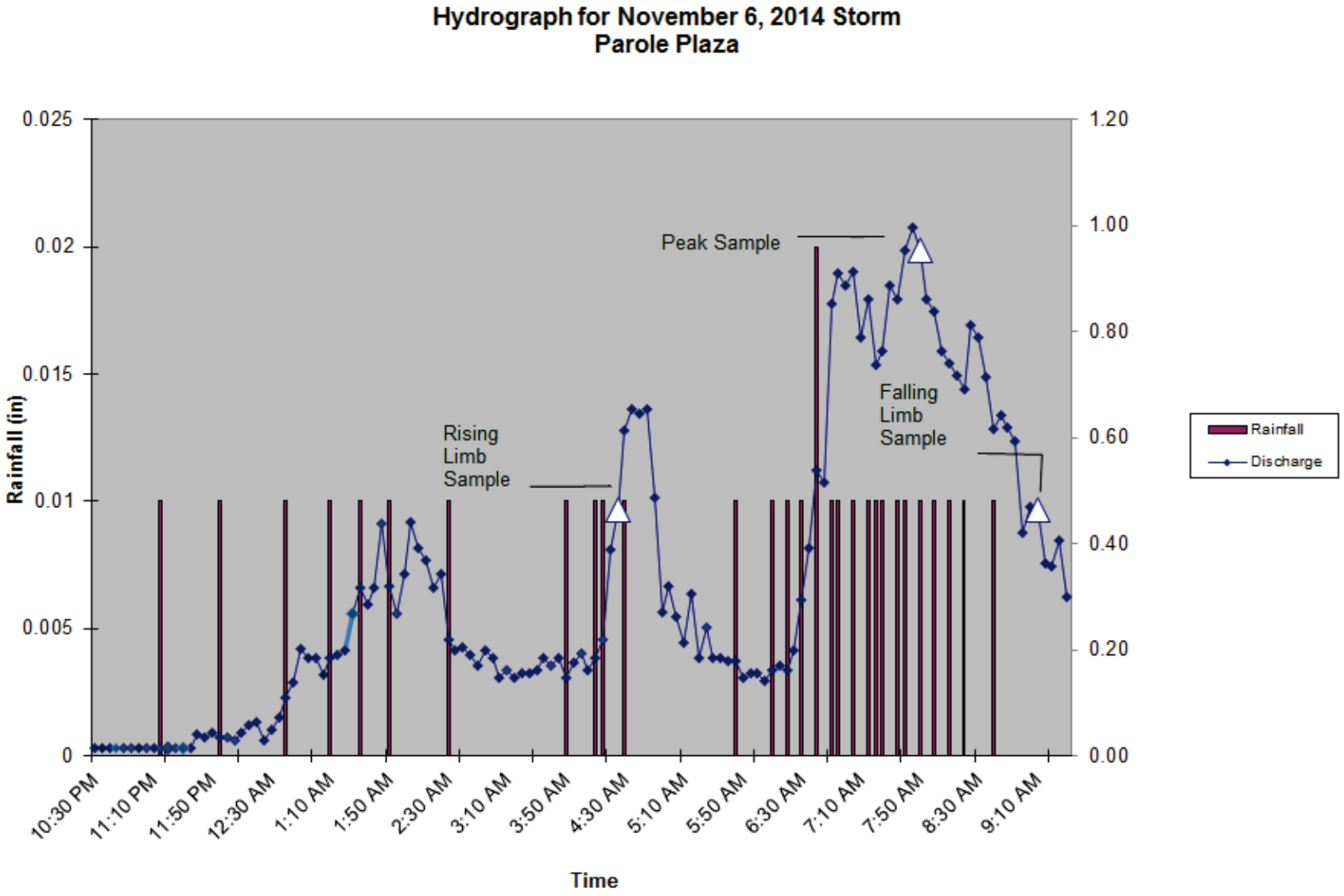
- April 14, 2015 - At the Church Creek station, the EMCs of all parameters during the April 14, 2015 storm were normal when compared to their historical concentrations. TPH and Lead were not detected in any samples at Church Creek during the event. At the Parole Plaza station, the EMCs of most parameters during the April 14, 2015 storm were comparable to EMC values for the other storms monitored during the quarter, except for BOD, which was more than twice the concentration of the other Spring storm events. As was the case at Church Creek, TPH was not detected in any samples.

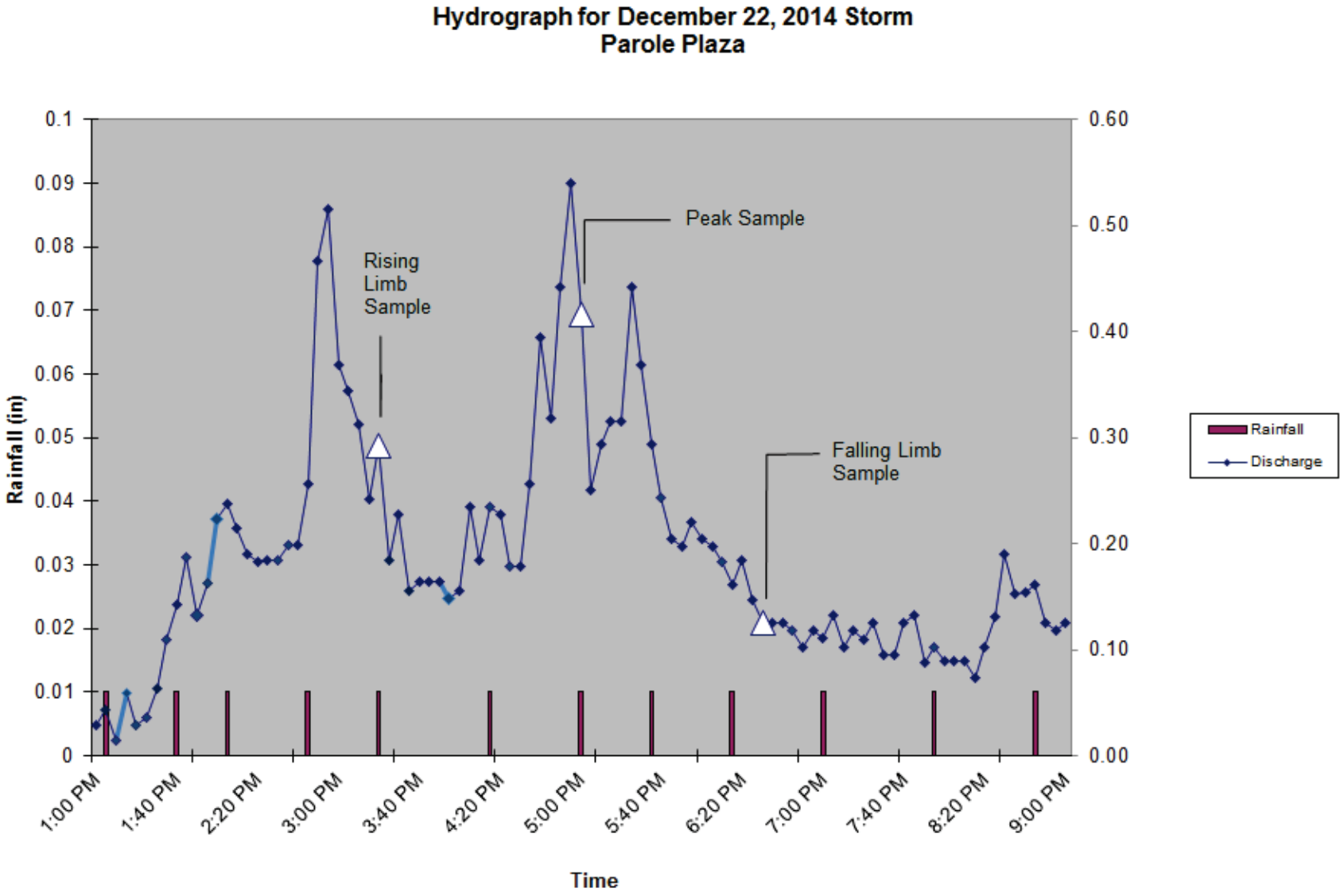
- June 8, 2015 - At the Church Creek station, EMCs for BOD, TKN, nitrate-nitrite, Total Phosphorus, TSS, Lead, Zinc, TPH, and *E. coli* during the June 8, 2015 storm were higher than the EMC values for the other storms monitored during the quarter. At the Parole Plaza station, the EMCs of nitrate-nitrite and *E. coli* were higher than EMCs for other storms monitored during the quarter. TPH was the only parameter not detected in any of the Parole Plaza samples.

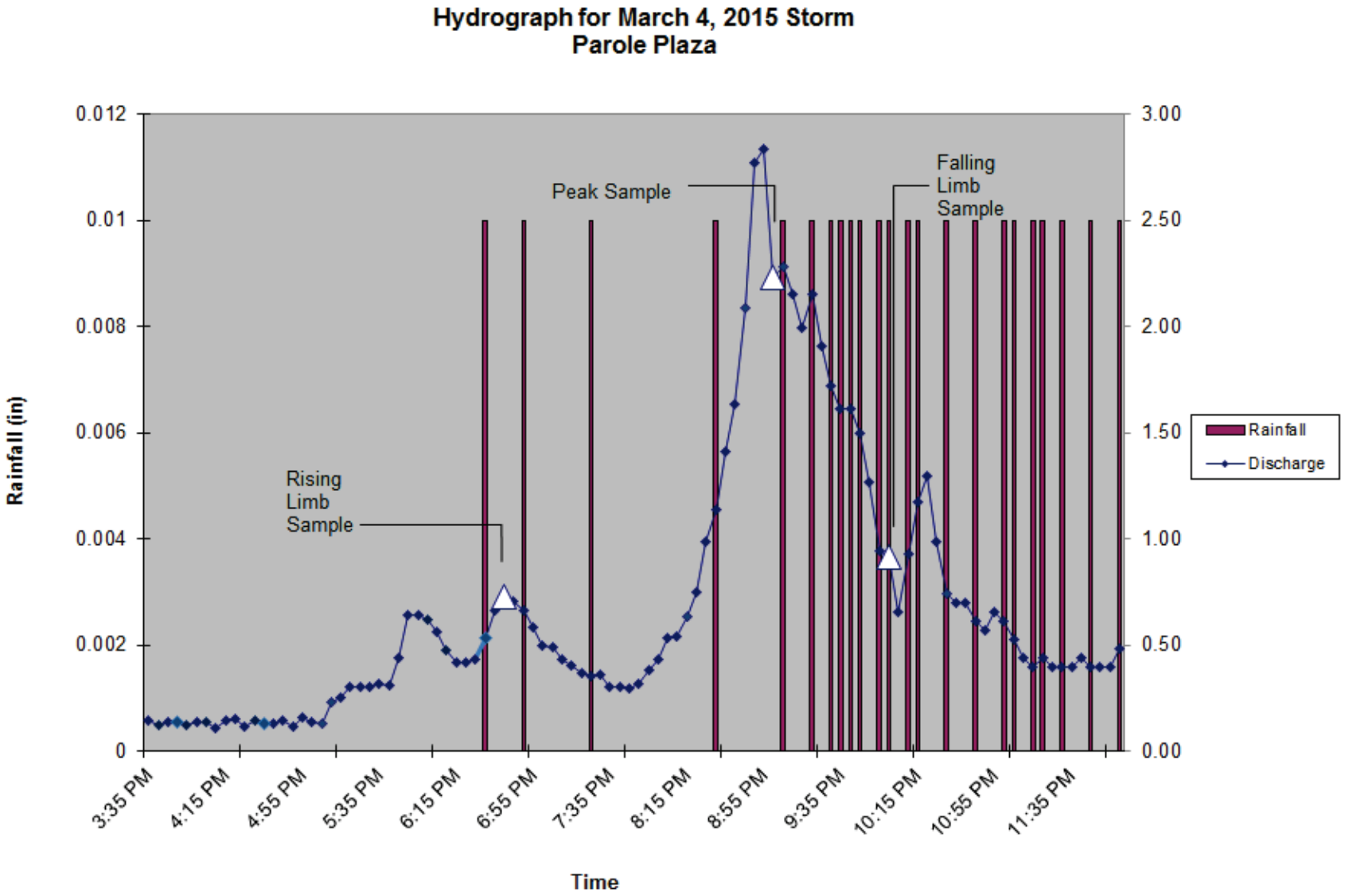
- June 27, 2015 - At the Church Creek station, the EMCs of many parameters, including BOD, nitrate-nitrite, total phosphorus, TSS, zinc, and hardness, were lower during the June 27, 2015 storm than the EMC values for the other storms monitored during the quarter. TPH and *E. coli* samples were not analyzed for this event. Samples were collected with ISCO samplers due to a lack of available staff that were needed at the stations during this event in order to collect manual TPH samples and transport *E. coli* samples to the lab within the hold time. At the Parole Plaza station, the EMCs of all parameters during the June 27, 2015 storm were lower than the EMC values for other storms monitored during the quarter, except for temperature and pH. Lead was the only parameter not detected in any Parole Plaza samples. As was the case with Church Creek, TPH and *E. coli* samples were not analyzed for this event.

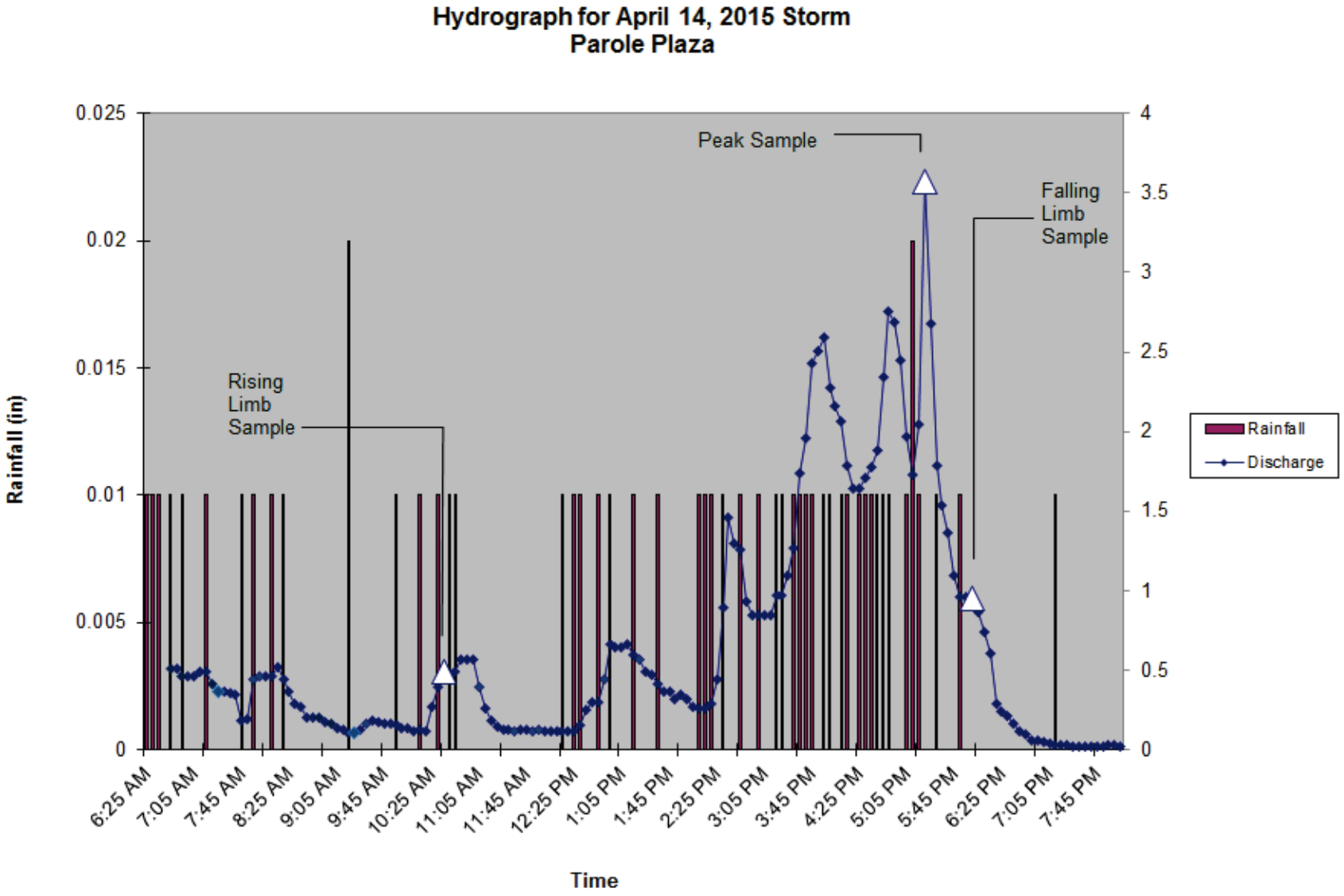

Hydrograph for August 12, 2014 Storm
Parole Plaza
Rainfall (in)
0.3
0.25
0.2
0.15
0.1
0.05
0
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Peak Sample
Falling Limb Sample
Rising Limb Sample
Rainfall
Discharge
9:00 AM
9:40 AM
10:20 AM
11:00 AM
11:40 AM
12:20 PM
1:00 PM
1:40 PM
2:20 PM
3:00 PM
3:40 PM
4:20 PM
5:00 PM
5:40 PM
6:20 PM
7:00 PM
7:40 PM
8:20 PM
9:00 PM
Time

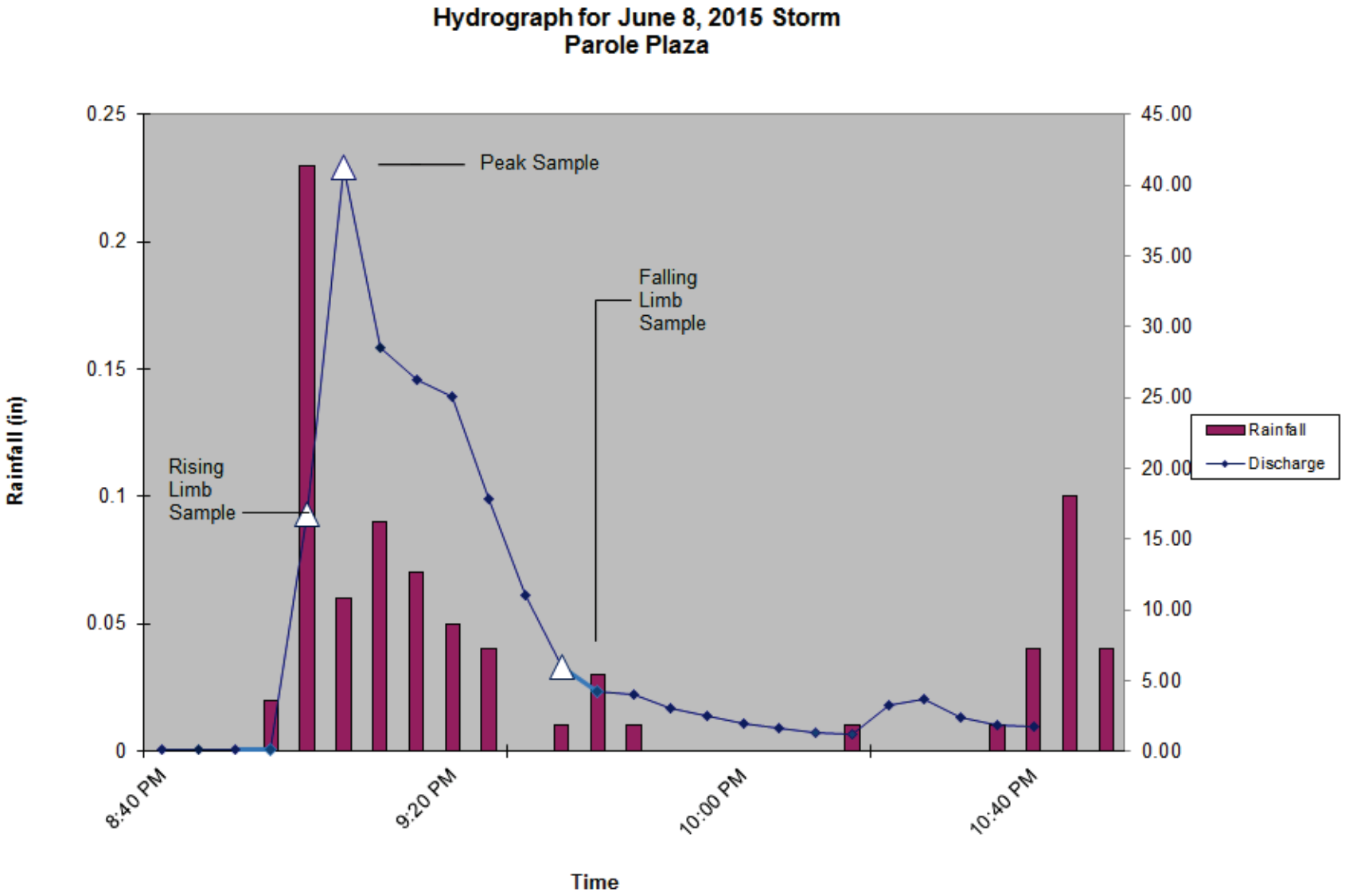

Hydrograph for October 15, 2014 Storm
Parole Plaza
Rainfall (in)
0.3
0.25
0.2
0.15
0.1
0.05
0
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Peak Sample
Rising Limb Sample
Falling Limb Sample
12:05 PM
12:45 PM
1:25 PM
2:05 PM
2:45 PM
3:25 PM
4:05 PM
4:45 PM
5:25 PM
6:05 PM
Time
Rainfall
Discharge

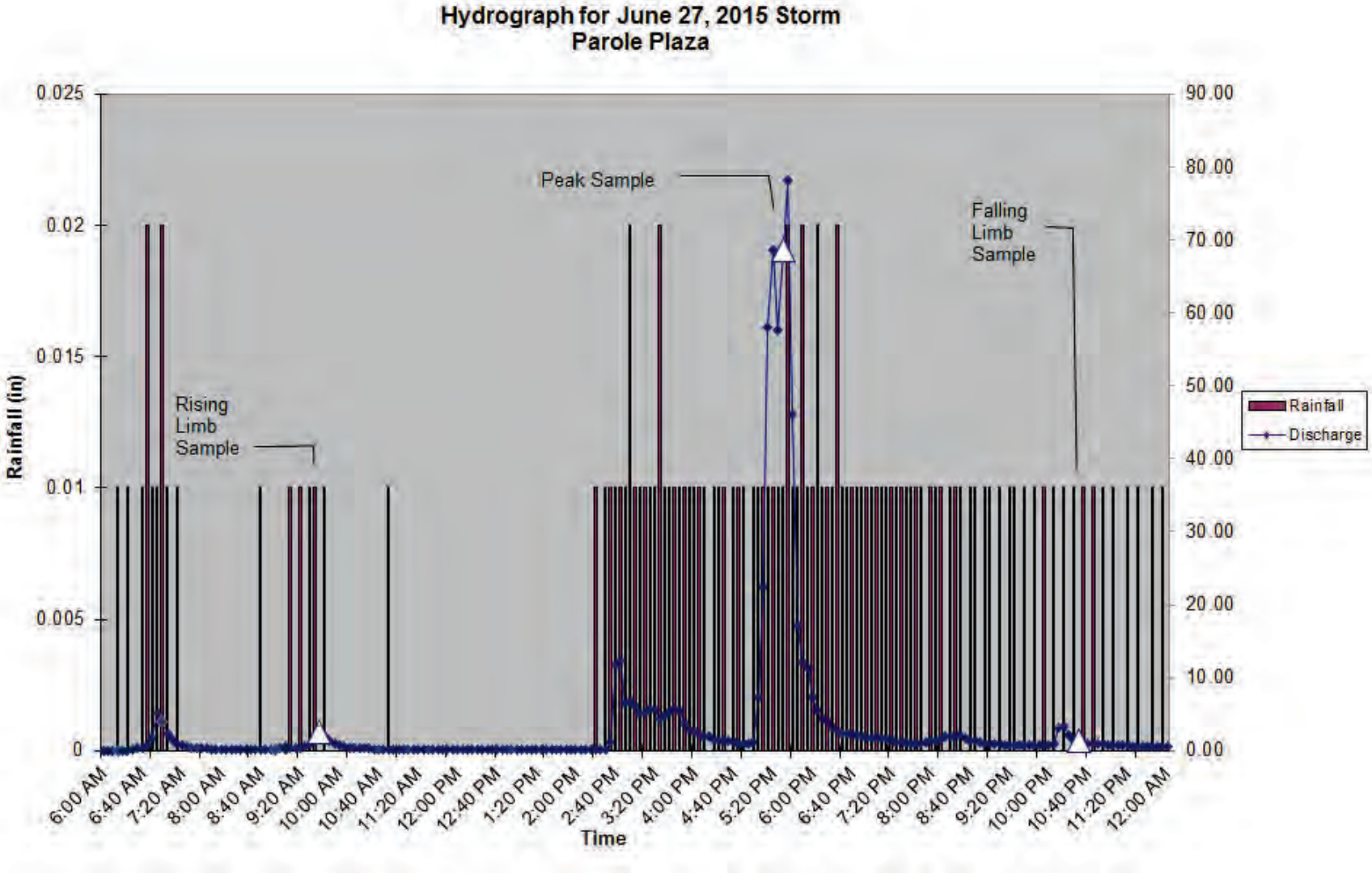

Hydrograph for November 6, 2014 Storm
Parole Plaza
Rainfall (in)
0.025
0.02
0.015
0.01
0.005
0
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Peak Sample
Rising Limb Sample
Falling Limb Sample
10:30 PM
11:10 PM
11:50 PM
12:30 AM
1:10 AM
1:50 AM
2:30 AM
3:10 AM
3:50 AM
4:30 AM
5:10 AM
5:50 AM
6:30 AM
7:10 AM
7:50 AM
8:30 AM
9:10 AM
Time
Rainfall
Discharge


Hydrograph for December 22, 2014 Storm
Parole Plaza
Rainfall (in)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Rising Limb Sample
Peak Sample
Falling Limb Sample
1:00 PM
1:40 PM
2:20 PM
3:00 PM
3:40 PM
4:20 PM
5:00 PM
5:40 PM
6:20 PM
7:00 PM
7:40 PM
8:20 PM
9:00 PM
Time
Rainfall
Discharge


Hydrograph for March 4, 2015 Storm
Parole Plaza
Rainfall (in)
0.012
0.01
0.008
0.006
0.004
0.002
0
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Peak Sample
Falling Limb Sample
Rising Limb Sample
Rainfall
Discharge
3:35 PM
4:15 PM
4:55 PM
5:35 PM
6:15 PM
6:55 PM
7:35 PM
8:15 PM
8:55 PM
9:35 PM
10:15 PM
10:55 PM
11:35 PM
Time

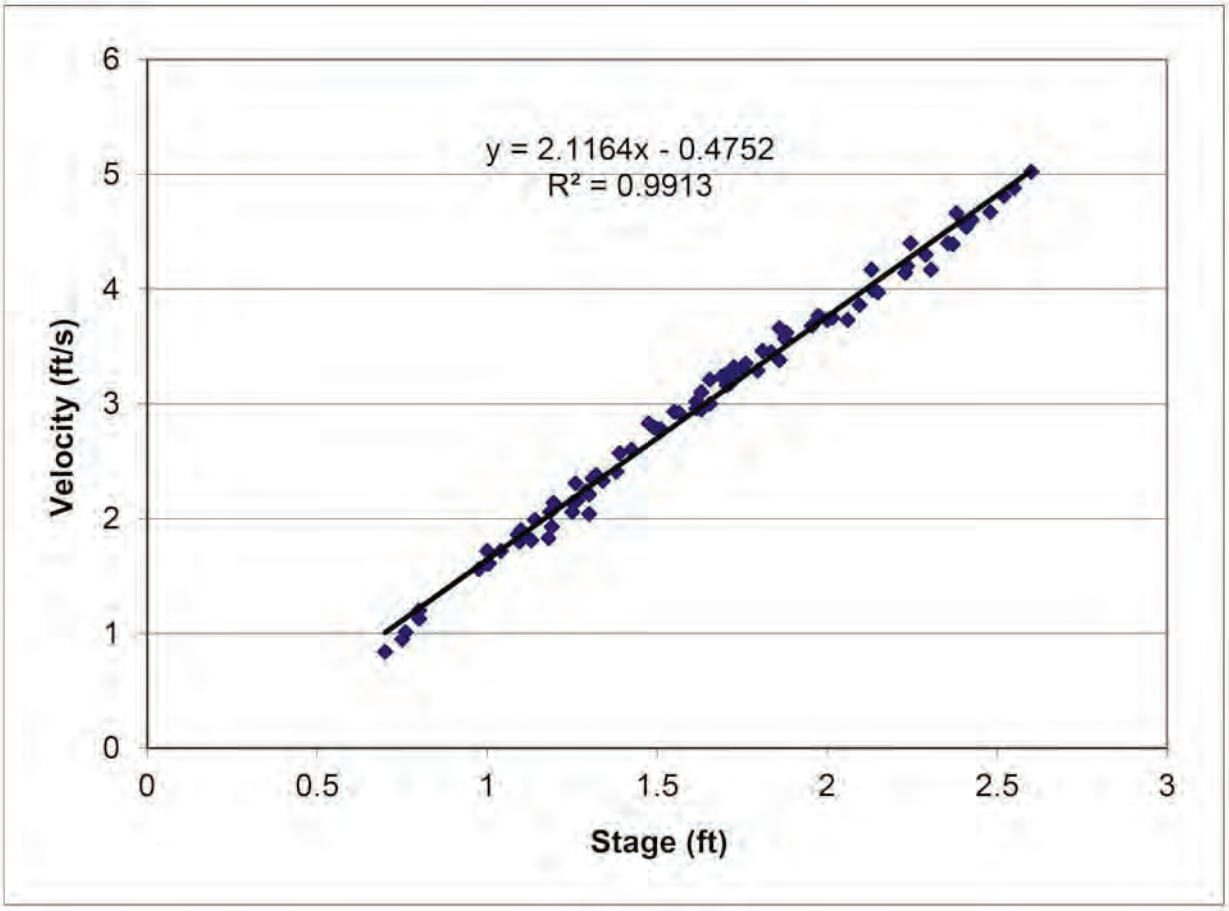

Hydrograph for April 14, 2015 Storm
Parole Plaza
Peak Sample
Falling Limb Sample
Rising Limb Sample
Rainfall
Discharge
Rainfall (in)
Time
0.025
0.02
0.015
0.01
0.005
0
4
3.5
3
2.5
2
1.5
1
0.5
0
6:25 AM
7:05 AM
7:45 AM
8:25 AM
9:05 AM
9:45 AM
10:25 AM
11:05 AM
11:45 AM
12:25 PM
1:05 PM
1:45 PM
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5:45 PM
6:25 PM
7:05 PM
7:45 PM

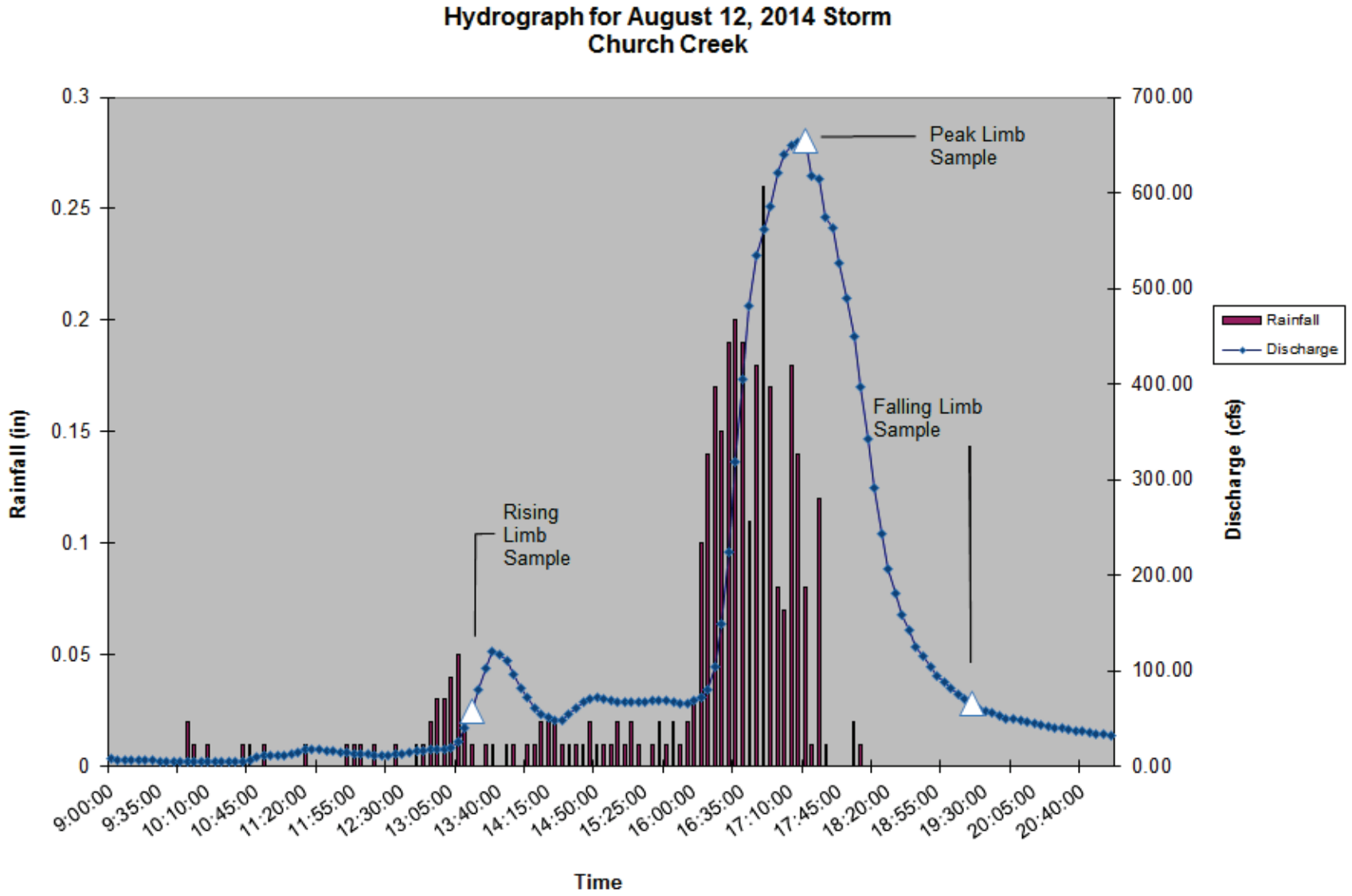

Hydrograph for June 8, 2015 Storm
Parole Plaza
Peak Sample
Falling
Limb
Sample
Rising
Limb
Sample
Rainfall (in)
0.25
0.2
0.15
0.1
0.05
0
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Rainfall
Discharge
8:40 PM
9:20 PM
10:00 PM
10:40 PM
Time

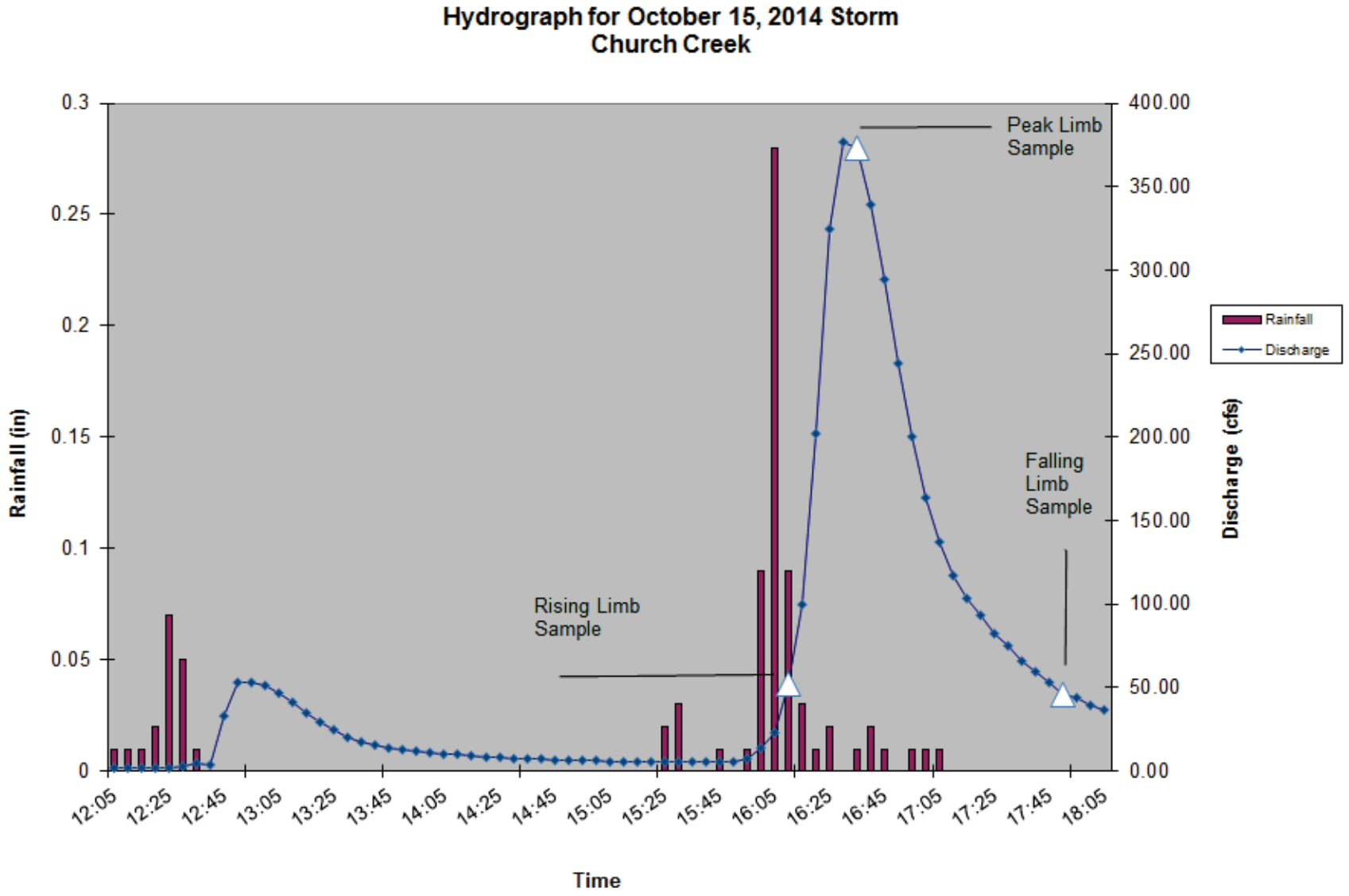

Hydrograph for June 27, 2015 Storm
Parole Plaza
Rainfall (in)
0.025
0.02
0.015
0.01
0.005
0
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Peak Sample
Falling Limb Sample
Rising Limb Sample
Rainfall
Discharge
6:00 AM
6:40 AM
7:20 AM
8:00 AM
8:40 AM
9:20 AM
10:00 AM
10:40 AM
11:20 AM
12:00 PM
12:40 PM
1:20 PM
2:00 PM
2:40 PM
3:20 PM
4:00 PM
4:40 PM
5:20 PM
6:00 PM
6:40 PM
7:20 PM
8:00 PM
8:40 PM
9:20 PM
10:00 PM
10:40 PM
11:20 PM
12:00 AM
Time

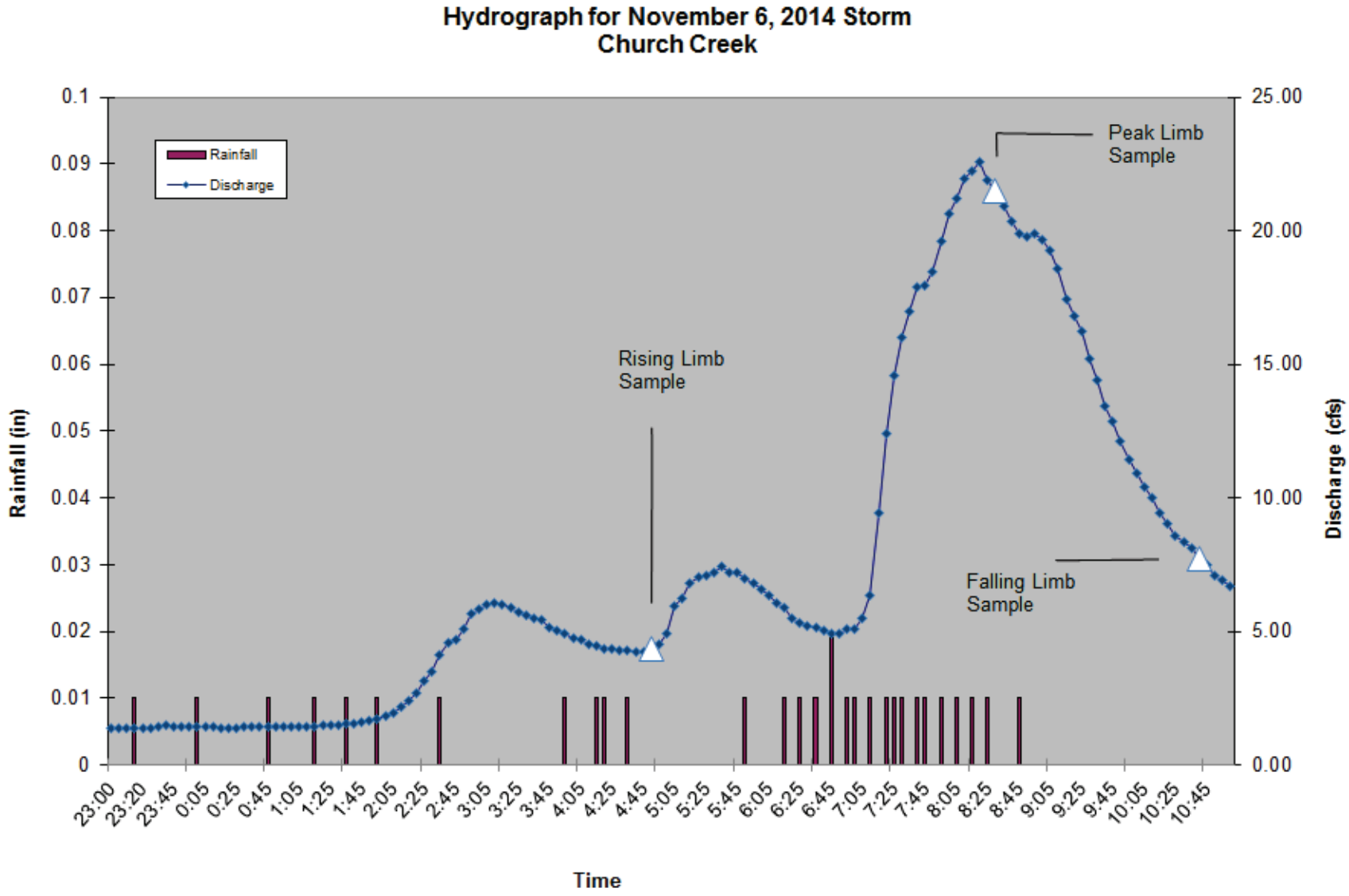
Church Creek Discharge Rating Table

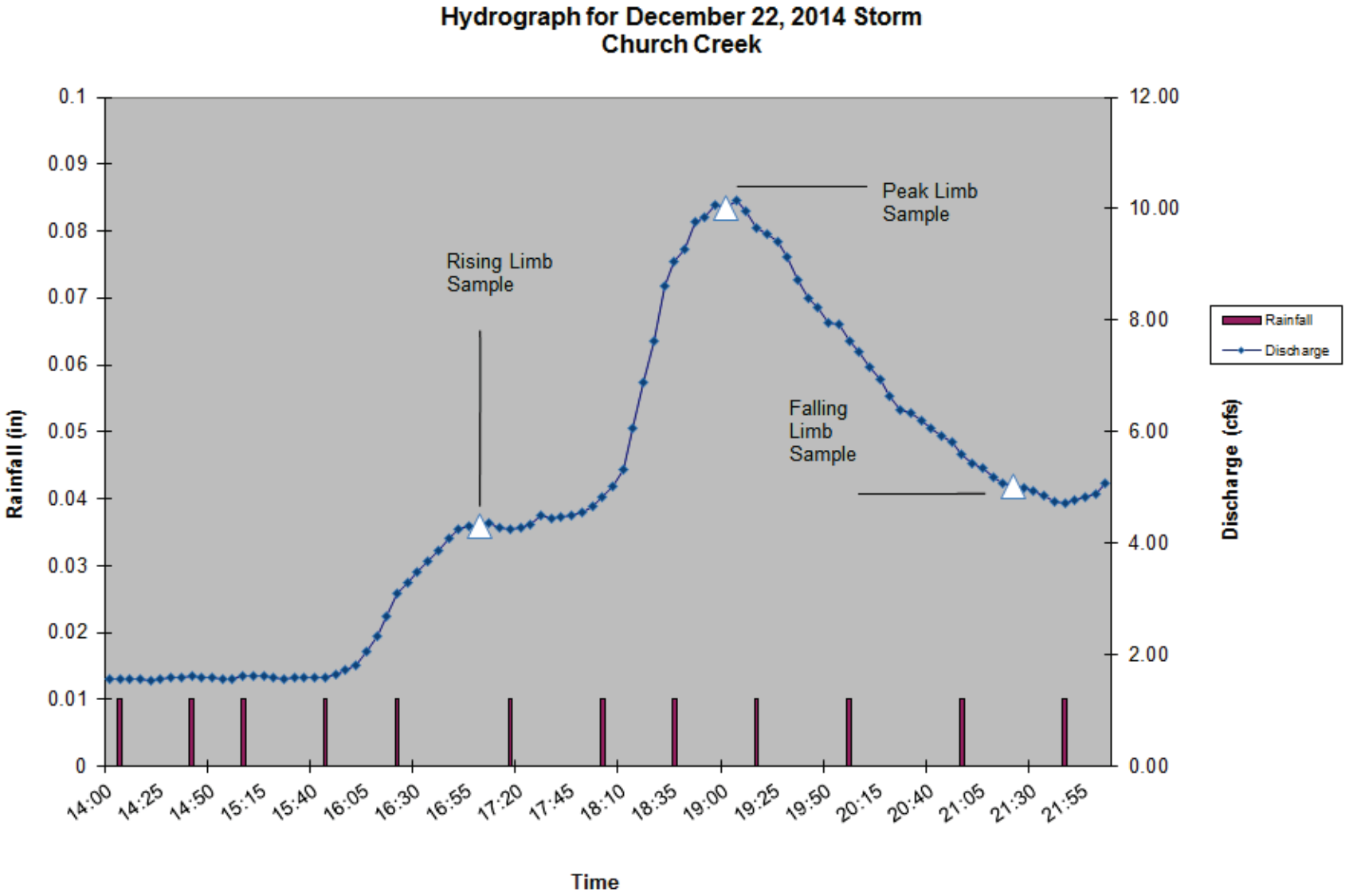
Stage (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)	Velocity, (ft/s)	Discharge (cfs)
0.0	0	0	0	0.00	0.00
0.1	0.21	2.77	2.75	0.00	0.00
0.2	0.53	3.62	3.57	0.00	0.00
0.3	0.91	4.03	3.93	0.16	0.15
0.4	1.31	4.36	4.19	0.37	0.49
0.5	1.75	4.83	4.58	0.58	1.02
0.6	2.22	5.09	4.73	0.79	1.76
0.7	2.70	5.34	4.88	1.01	2.72
0.8	3.20	5.73	5.20	1.22	3.90
0.9	3.74	6.14	5.54	1.43	5.35
1.0	4.31	6.48	5.81	1.64	7.07
1.1	4.90	6.75	5.98	1.85	9.08
1.2	5.50	7.01	6.16	2.06	11.35
1.3	6.13	7.28	6.33	2.28	13.95
1.4	6.77	7.53	6.49	2.49	16.84
1.5	7.43	7.80	6.66	2.70	20.06
1.6	8.10	8.08	6.86	2.91	23.58
1.7	8.80	8.37	7.06	3.12	27.48
1.8	9.51	8.65	7.26	3.33	31.71
1.9	10.25	8.93	7.44	3.55	36.35
2.0	11.00	9.15	7.52	3.76	41.33
2.1	11.75	9.35	7.54	3.97	46.64
2.2	12.51	9.55	7.57	4.18	52.30
2.3	13.26	9.75	7.60	4.39	58.24
2.4	14.03	9.96	7.63	4.60	64.60
2.5	14.79	10.16	7.65	4.82	71.23
2.6	15.56	10.36	7.68	5.03	78.23
2.7	16.33	10.56	7.71	5.24	85.55
2.8	17.10	10.76	7.73	5.45	93.21
2.9	17.87	10.96	7.76	5.66	101.19
3.0	18.65	11.17	7.79	5.87	109.55
3.1	19.43	11.37	7.81	6.09	118.24
3.2	20.21	11.57	7.84	6.30	127.27
3.3	21.00	11.77	7.87	6.51	136.69
3.4	21.79	11.97	7.89	6.72	146.44
3.5	22.58	12.18	7.92	6.93	156.53
3.6	23.37	12.38	7.95	7.14	166.95
3.7	24.17	12.58	7.98	7.36	177.78

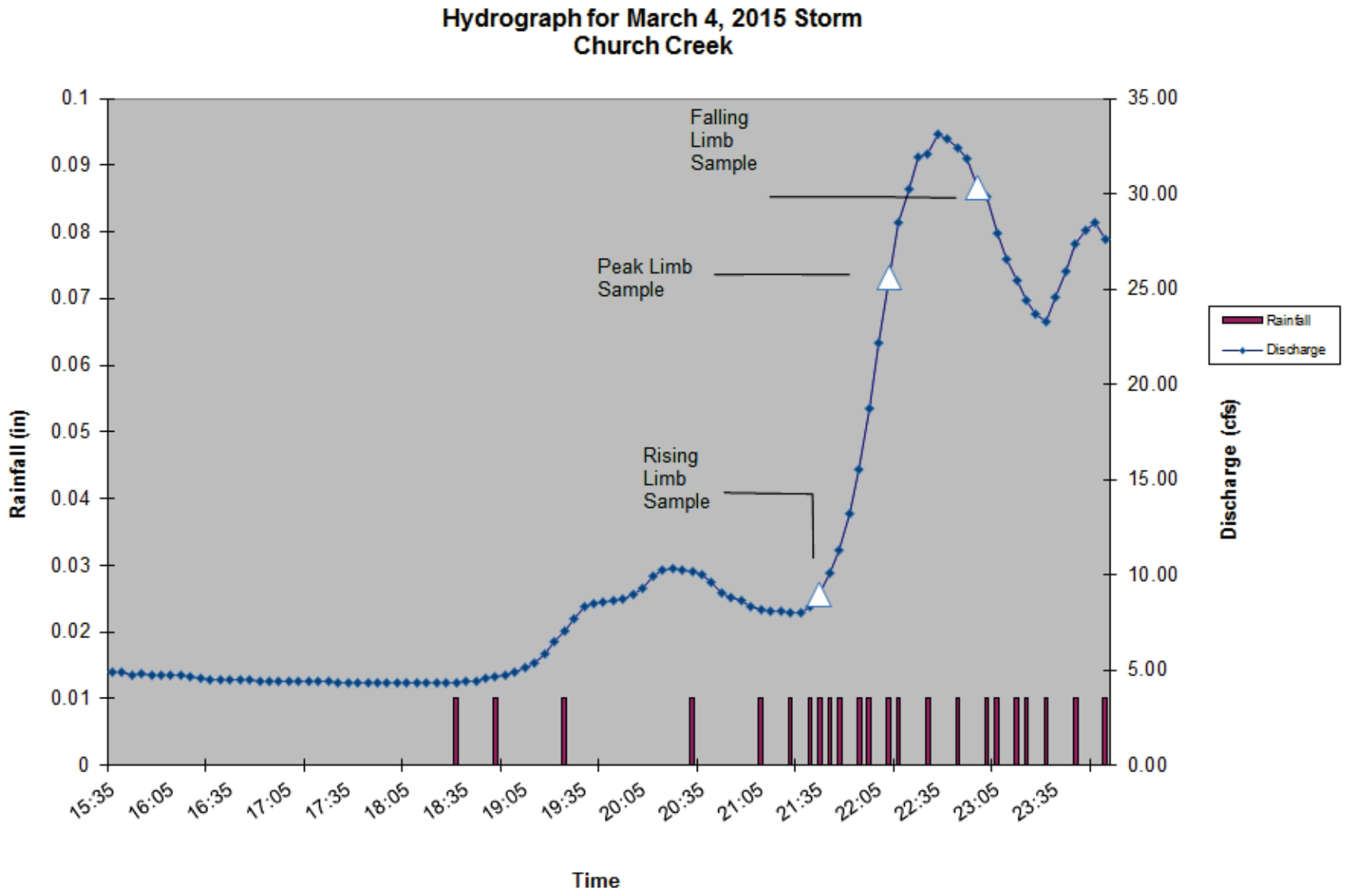

y = 2.1164x - 0.4752
R² = 0.9913
Velocity (ft/s)
Stage (ft)
0
1
2
3
4
5
6
0
0.5
1
1.5
2
2.5
3

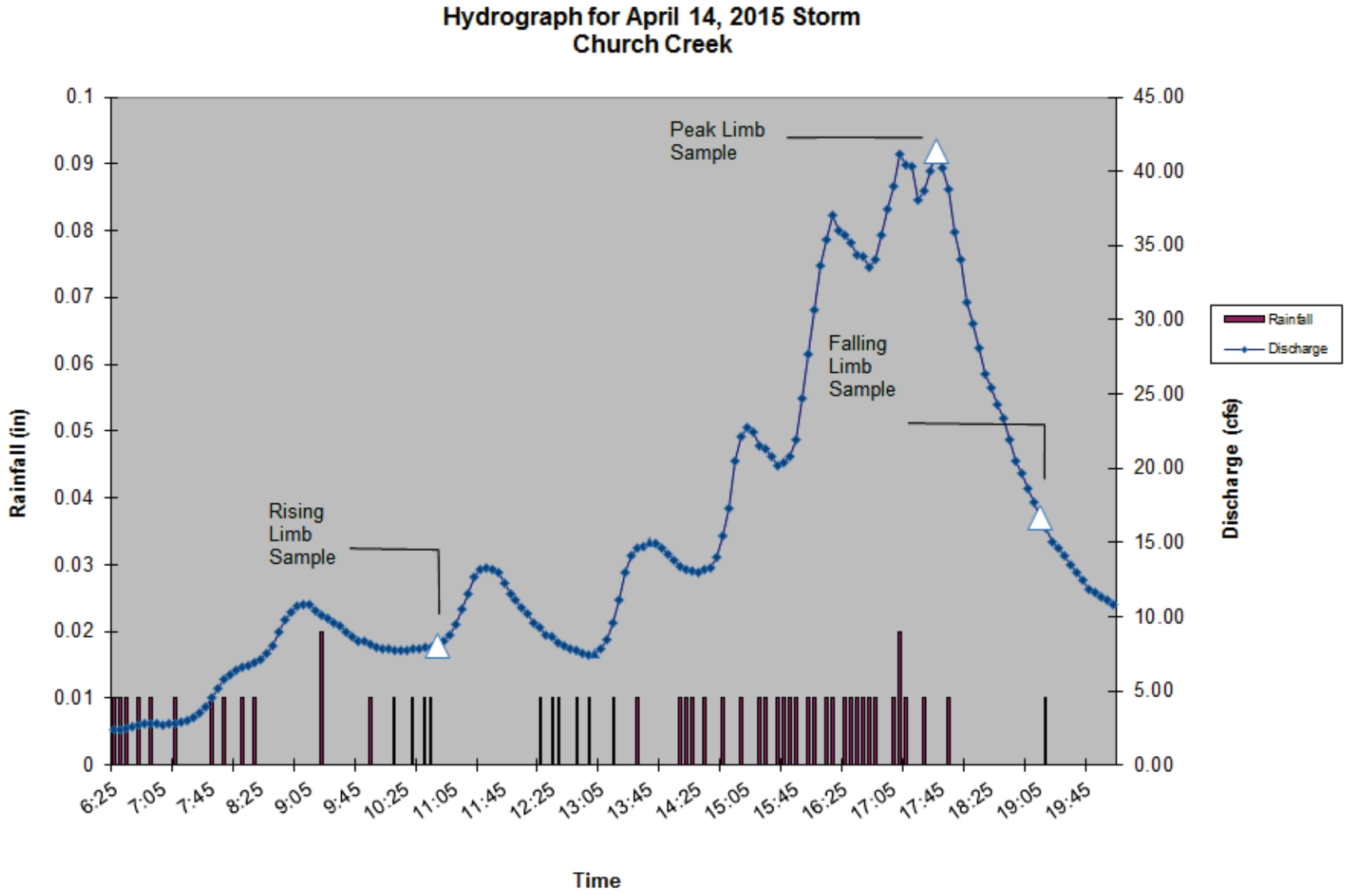

Hydrograph for August 12, 2014 Storm
Church Creek
Rainfall (in)
Discharge (cfs)
Time
Peak Limb Sample
Falling Limb Sample
Rising Limb Sample
Rainfall
Discharge
0.3
0.25
0.2
0.15
0.1
0.05
0
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
9:00:00
9:35:00
10:10:00
10:45:00
11:20:00
11:55:00
12:30:00
13:05:00
13:40:00
14:15:00
14:50:00
15:25:00
16:00:00
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20:05:00
20:40:00

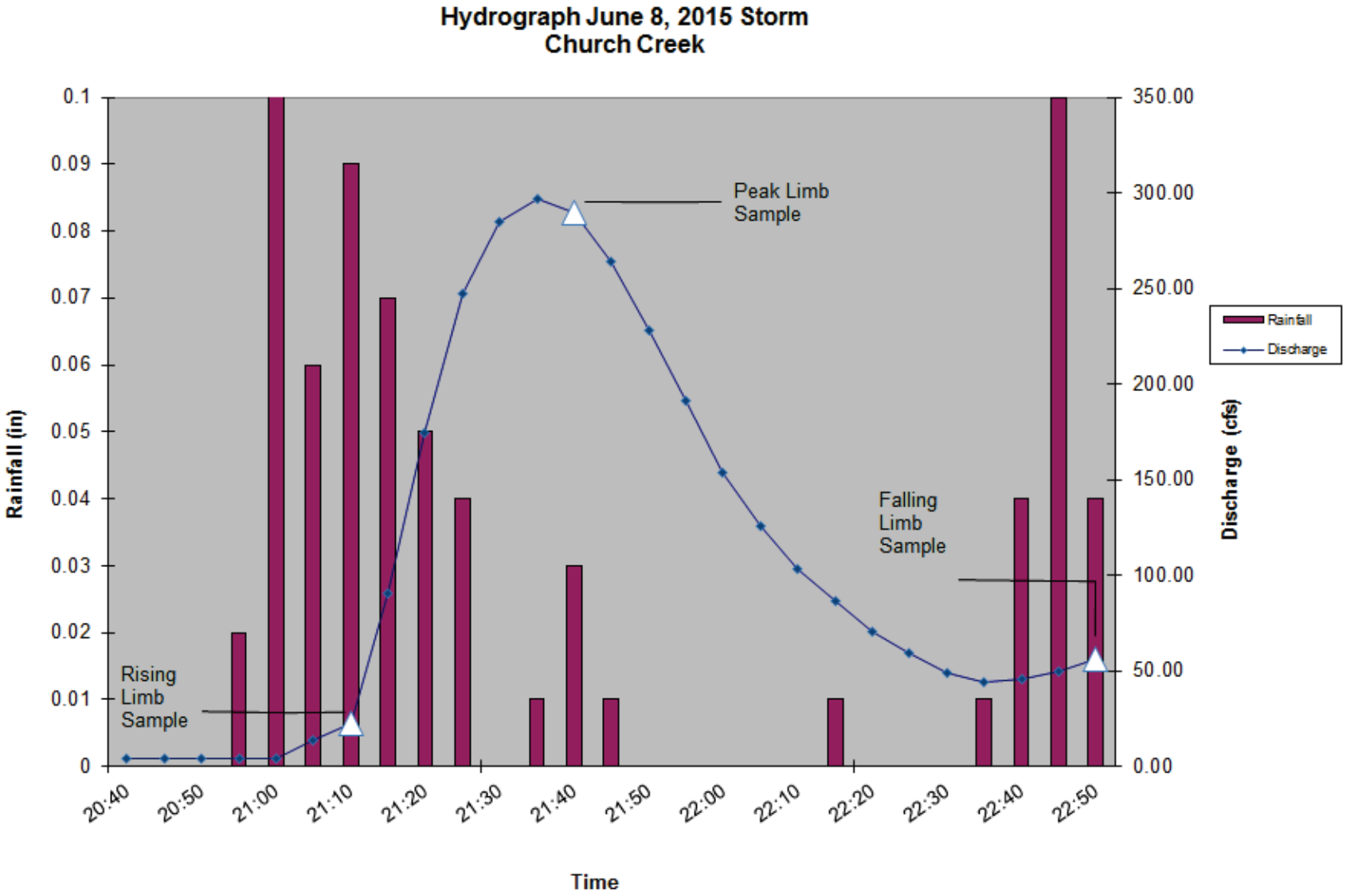

Hydrograph for October 15, 2014 Storm
Church Creek
Rainfall (in)
Discharge (cfs)
Time
Peak Limb Sample
Rising Limb Sample
Falling Limb Sample
Rainfall
Discharge
0.3
0.25
0.2
0.15
0.1
0.05
0
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
12:05
12:25
12:45
13:05
13:25
13:45
14:05
14:25
14:45
15:05
15:25
15:45
16:05
16:25
16:45
17:05
17:25
17:45
18:05

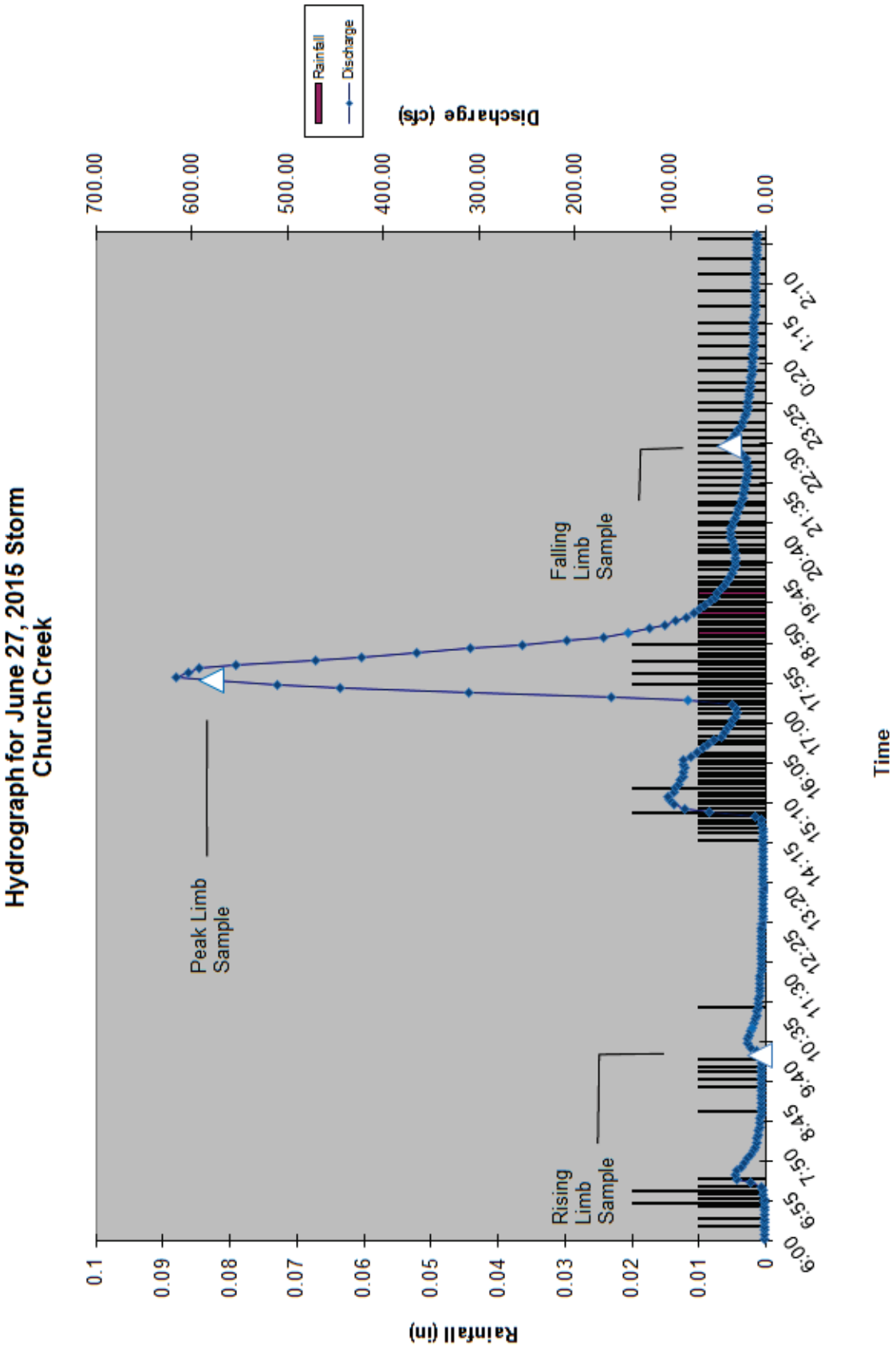

Hydrograph for November 6, 2014 Storm
Church Creek
Rainfall
Discharge
Peak Limb Sample
Rising Limb Sample
Falling Limb Sample
Rainfall (in)
Discharge (cfs)
Time
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
25.00
20.00
15.00
10.00
5.00
0.00
23:00
23:20
23:45
0:05
0:25
0:45
1:05
1:25
1:45
2:05
2:25
2:45
3:05
3:25
3:45
4:05
4:25
4:45
5:05
5:25
5:45
6:05
6:25
6:45
7:05
7:25
7:45
8:05
8:25
8:45
9:05
9:25
9:45
10:05
10:25
10:45


Hydrograph for December 22, 2014 Storm
Church Creek
Rainfall (in)
Discharge (cfs)
Time
Rising Limb Sample
Peak Limb Sample
Falling Limb Sample
Rainfall
Discharge
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
12.00
10.00
8.00
6.00
4.00
2.00
0.00
14:00
14:25
14:50
15:15
15:40
16:05
16:30
16:55
17:20
17:45
18:10
18:35
19:00
19:25
19:50
20:15
20:40
21:05
21:30
21:55


Hydrograph for March 4, 2015 Storm
Church Creek
Falling Limb Sample
Peak Limb Sample
Rising Limb Sample
Rainfall
Discharge
Rainfall (in)
Discharge (cfs)
Time
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
15:35
16:05
16:35
17:05
17:35
18:05
18:35
19:05
19:35
20:05
20:35
21:05
21:35
22:05
22:35
23:05
23:35


Hydrograph for April 14, 2015 Storm
Church Creek
Peak Limb Sample
Falling Limb Sample
Rising Limb Sample
Rainfall (in)
Discharge (cfs)
Time
Rainfall
Discharge
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
6:25
7:05
7:45
8:25
9:05
9:45
10:25
11:05
11:45
12:25
13:05
13:45
14:25
15:05
15:45
16:25
17:05
17:45
18:25
19:05
19:45


Hydrograph June 8, 2015 Storm
Church Creek
Rainfall (in)
Discharge (cfs)
Time
Rainfall
Discharge
Peak Limb Sample
Rising Limb Sample
Falling Limb Sample
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
20:40
20:50
21:00
21:10
21:20
21:30
21:40
21:50
22:00
22:10
22:20
22:30
22:40
22:50


Hydrograph for June 27, 2015 Storm
Church Creek
Rainfall
Discharge
Discharge (cfs)
Rainfall (in)
Time
Peak Limb Sample
Falling Limb Sample
Rising Limb Sample
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
6:00
6:55
7:50
8:45
9:40
10:35
11:30
12:25
13:20
14:15
15:10
16:05
17:00
17:55
18:50
19:45
20:40
21:35
22:30
23:25
0:20
1:15
2:10

APPENDIX B

MASTER TAXA LIST

Order	Family	Genus	Final ID	FFG[1]	Habit[2]	Tolerance Value[3]
Amphipoda	Gammaridae	Gammarus	Gammarus	Shredder	sp	6.7
Arhynchobdellida	Erpobdellidae		Erpobdellidae	Predator	sp	10
Basommatophora	Physidae	Physa	Physa	Scraper	cb	7
Coleoptera	Dytiscidae	Neoporus	Neoporus	Predator		
Diptera			Diptera			6
Diptera	Chironomidae	Conchapelopia	Conchapelopia	Predator	sp	6.1
Diptera	Chironomidae	Cryptochironomus	Cryptochironomus	Predator	sp, bu	7.6
Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	Collector	bu	9
Diptera	Chironomidae	Orthocladius	Orthocladius	Collector	sp, bu	9.2
Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	Collector	cn	8.7
Diptera	Chironomidae	Polypedilum	Polypedilum	Shredder	cb, cn	6.3
Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	Filterer	cn	7.2
Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	Predator	sp	5.3
Diptera	Empididae	Hemerodromia	Hemerodromia	Predator	sp, bu	7.9
Diptera	Ptychopteridae	Bittacomorpha	Bittacomorpha	Collector	bu	4
Diptera	Tipulidae	Limonia	Limonia	Shredder	bu, sp	4.8
Diptera	Tipulidae	Tipula	Tipula	Shredder	bu	6.7
Isopoda	Asellidae	Caecidotea	Caecidotea	Collector	sp	2.6
Lumbriculida	Lumbriculidae		Lumbriculidae	Collector	bu	6.6
Odonata	Aeshnidae	Boyeria	Boyeria	Predator	cb, sp	6.3
Odonata	Calopterygidae	Calopteryx	Calopteryx	Predator	cb	8.3
Odonata	Coenagrionidae		Coenagrionidae	Predator	cb	9
Odonata	Coenagrionidae	Argia	Argia	Predator	cn, cb, sp	9.3
Odonata	Libellulidae	Pachydiplax	Pachydiplax	Predator		8
Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	Filterer	cn	6.5
Tubificida	Tubificidae		Tubificidae	Collector	cn	8.4
Veneroida	Pisidiidae	Pisidium	Pisidium	Filterer	bu	5.7

1 Functional Feeding Group
2 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer information for the particular taxa was not available.
3 Tolerance Values, based on Hilsenhoff, modified for Maryland; na indicates information for the particular taxa was not available.

APPENDIX C

BIOLOGICAL ASSESSMENT RESULTS

Church Creek Site CC-01

Sampled: 3/12/2015

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Very Poor
BIBI Score	1.57

Metric	Value	Score
Total Taxa	6	1
EPT Taxa	0	1
Number Ephemeroptera	0	1
% Intolerant to Urban	0	1
% Ephemeroptera	0	1
Scraper Taxa	0	1
% Climbers	29.79	5

Benthic Macroinvertebrate Taxa List

Taxa	Count
Argia	12
Calopteryx	2
Erpobdellidae	2
Pisidium	6
Tipula	1
Tubificidae	24

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Partially Degraded
PHI Score	66.35

Metric	Score
Drainage area (acres)	70.40
Remoteness	24.93
Percent Shading	63.55
Epifaunal Substrate	57.54
Instream Habitat	92.64
Instream Wood Debris	94.26
Bank Stability	65.20

Rapid Bioassessment Protocal

Narrative Rating	Partially Supporting
RBP Score	67

Metric	Score
Epifaunal Substrate / Cover	6
Embeddedness	10
Velocity / Depth Regime	8
Sediment Deposition	12
Channel Flow Status	15
Channel Alteration	18
Frequency of Riffles	8
Bank Stability	6(Left)/6(Right)
Vegetative Protection	6(Left)/5(Right)
Riparian Veg Zone Width	8(Left)/4(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	10.5
pH	7.07
Specific Conductance (µS/cm)	3015
Temperature (°C)	8.62
Turbidity (NTUs)	25.6

Church Creek Site CC-02

Sampled: 3/12/2015

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Very Poor
BIBI Score	1.57

Metric	Value	Score
Total Taxa	14	3
EPT Taxa	0	1
Number Ephemeroptera	0	1
% Intolerant to Urban	3.70	1
% Ephemeroptera	0	1
Scraper Taxa	0	1
% Climbers	7.34	3

Benthic Macroinvertebrate Taxa List

Taxa	Count
Boyeria	2
Caecidotea	4
Coenagrionidae	5
Conchapelopia	3
Dicrotendipes	1
Gammarus	59
Neoporus	1
Orthocladius	1
Pachydiplax	1
Phaenopsectra	2
Pisidium	10
Polypedilum	1
Tubificidae	18
Zavrelimyia	1

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Degraded
PHI Score	52.93

Metric	Score
Drainage area (acres)	282.24
Remoteness	31.22
Percent Shading	54.42
Epifaunal Substrate	48.50
Instream Habitat	72.88
Instream Wood Debris	69.66
Bank Stability	40.89

Rapid Bioassessment Protocal

Narrative Rating	Non-supporting
RBP Score	59

Metric	Score
Epifaunal Substrate / Cover	7
Embeddedness	8
Velocity / Depth Regime	9
Sediment Deposition	10
Channel Flow Status	15
Channel Alteration	15
Frequency of Riffles	7
Bank Stability	3(Left)/4(Right)
Vegetative Protection	6(Left)/7(Right)
Riparian Veg Zone Width	4(Left)/4(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	12
pH	7.07
Specific Conductance (µS/cm)	1464
Temperature (°C)	5.9
Turbidity (NTUs)	29.9

Church Creek Site CC-03

Sampled: 3/12/2015

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Poor
BIBI Score	2.14

Metric	Value	Score
Total Taxa	14	3
EPT Taxa	1	1
Number Ephemeroptera	0	1
% Intolerant to Urban	13.68	3
% Ephemeroptera	0	1
Scraper Taxa	0	1
% Climbers	9.47	5

Benthic Macroinvertebrate Taxa List

Taxa	Count
Argia	6
Caecidotea	13
Calopteryx	2
Cheumatopsyche	17
Conchapelopia	1
Cryptochironomus	2
Erpobdellidae	1
Gammarus	7
Limonia	1
Orthocladius	33
Pisidium	9
Polypedilum	1
Rheotanytarsus	1
Zavrelimyia	1

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Partially Degraded
PHI Score	66.68

Metric	Score
Drainage area (acres)	282.24
Remoteness	31.22
Percent Shading	40.96
Epifaunal Substrate	94.97
Instream Habitat	100.00
Instream Wood Debris	72.62
Bank Stability	60.31

Rapid Bioassessment Protocal

Narrative Rating	Partially Supporting
RBP Score	66

Metric	Score
Epifaunal Substrate / Cover	12
Embeddedness	11
Velocity / Depth Regime	9
Sediment Deposition	12
Channel Flow Status	16
Channel Alteration	16
Frequency of Riffles	7
Bank Stability	6(Left)/6(Right)
Vegetative Protection	5(Left)/5(Right)
Riparian Veg Zone Width	3(Left)/3(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	10.82
pH	7.05
Specific Conductance (µS/cm)	1746
Temperature (°C)	6.21
Turbidity (NTUs)	28

Church Creek Site CC-04

Sampled: 3/12/2015

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Very Poor
BIBI Score	1.86

Metric	Value	Score
Total Taxa	13	1
EPT Taxa	1	1
Number Ephemeroptera	0	1
% Intolerant to Urban	21.19	3
% Ephemeroptera	0	1
Scraper Taxa	1	3
% Climbers	3.39	3

Benthic Macroinvertebrate Taxa List

Taxa	Count
Bittacomorpha	1
Caecidotea	25
Calopteryx	1
Cheumatopsyche	28
Conchapelopia	6
Diptera	3
Gammarus	14
Hemerodromia	1
Lumbriculidae	1
Phaenopsectra	1
Physa	2
Pisidium	12
Polypedilum	1
Tubificidae	22

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Degraded
PHI Score	62.70

Metric	Score
Drainage area (acres)	110.53
Remoteness	31.22
Percent Shading	40.96
Epifaunal Substrate	54.61
Instream Habitat	76.92
Instream Wood Debris	100.00
Bank Stability	72.51

Rapid Bioassessment Protocal

Narrative Rating	Partially Supporting
RBP Score	66

Metric	Score
Epifaunal Substrate / Cover	5
Embeddedness	8
Velocity / Depth Regime	7
Sediment Deposition	6
Channel Flow Status	15
Channel Alteration	18
Frequency of Riffles	13
Bank Stability	8(Left)/8(Right)
Vegetative Protection	6(Left)/3(Right)
Riparian Veg Zone Width	9(Left)/5(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	11.07
pH	6.97
Specific Conductance (µS/cm)	1816
Temperature (°C)	7.75
Turbidity (NTUs)	30.8

APPENDIX D

QA/QC INFORMATION

Quality Assurance/Quality Control Summary for NPDES Monitoring Activities

This section describes all Quality Assurance/Quality Control (QA/QC) procedures implemented for this project including field sampling, laboratory sorting and subsampling, data entry, metric calculation, final IBI calculation, geomorphic field sampling, and classification of stream types.

Field Sampling

Initial QA/QC procedures for benthic macroinvertebrate field sampling included formal training for field crew leaders in MBSS Sampling Protocols. All field crew members have attended at least one MBSS Spring Index Period Training. At least one crew member extensively trained and certified in MBSS sampling protocols was present for each field sampling day. Also during field sampling, each data sheet was double checked for completeness and sample bottle labels were double checked for accuracy. Geomorphic assessment field crews have more than one year of experience conducting similar assessment using the Rosgen Stream Classification Methodology.

Geomorphic assessment survey equipment is calibrated annually and regularly inspected to ensure proper functioning. Cross section and profile data were digitally plotted and analyzed in Ohio Department of Natural Resources (ODNR) Reference Reach Spreadsheet Version 4.3L for accuracy.

Water quality QA/QC procedures included calibration of the YSI multiprobe meter daily during the sampling season. Dissolved oxygen probe membranes were inspected regularly and replaced when dirty or damaged.

Laboratory Sorting and Subsampling

Sorting QA/QC was conducted on one sample since only seven samples were collected for this survey. This check consisted of entirely resorting one randomly selected sample to a sorting consistency above ninety percent efficiency. This QC resulted in a sorting efficiency above 95%, so no further action was required. As a taxonomic QC, one sample was re-identified completely by another Versar SFS-certified taxonomist following the same identification methods stated above. The Percent Difference in Enumeration (PDE) and the Percent Taxonomic Disagreement (PTD) were calculated and no further action was required since both the PDE and PTD met MBSS requirements.

Data Entry

All data entered were double checked by someone other than the person who performed the initial data entry. Any errors found during QA/QC were corrected to ensure 100% accuracy of the data.

Metric and IBI Calculations

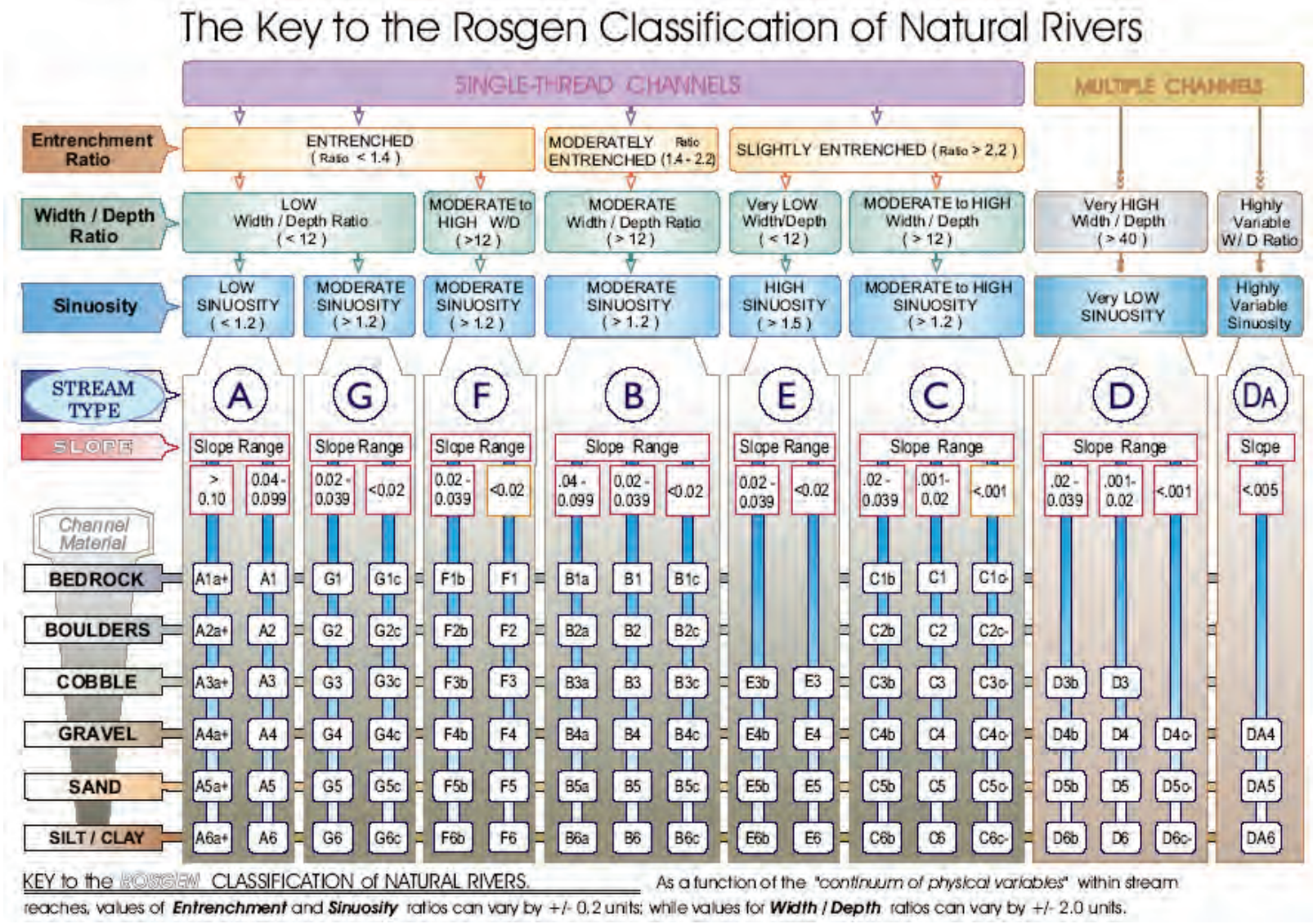
Ten percent of metric and IBI calculations were checked by hand using a calculator to ensure correct calculation by the Access database. Any discrepancies were addressed at that time.

Identification of Stream Types

All stream types were determined by hand based on the methods of the Rosgen Stream Classification (Rosgen, 1996). Due to the natural variability, or continuum, of streams, adjustments in the values of Width Depth Ratio (+/- 2.0) and Entrenchment Ratio (+/-0.2) are allowed, which may result in assigning a different stream type. Therefore, all stream types assigned were checked and any necessary adjustments were made.

APPENDIX E

ROSGEN CLASSIFICATION SCHEME



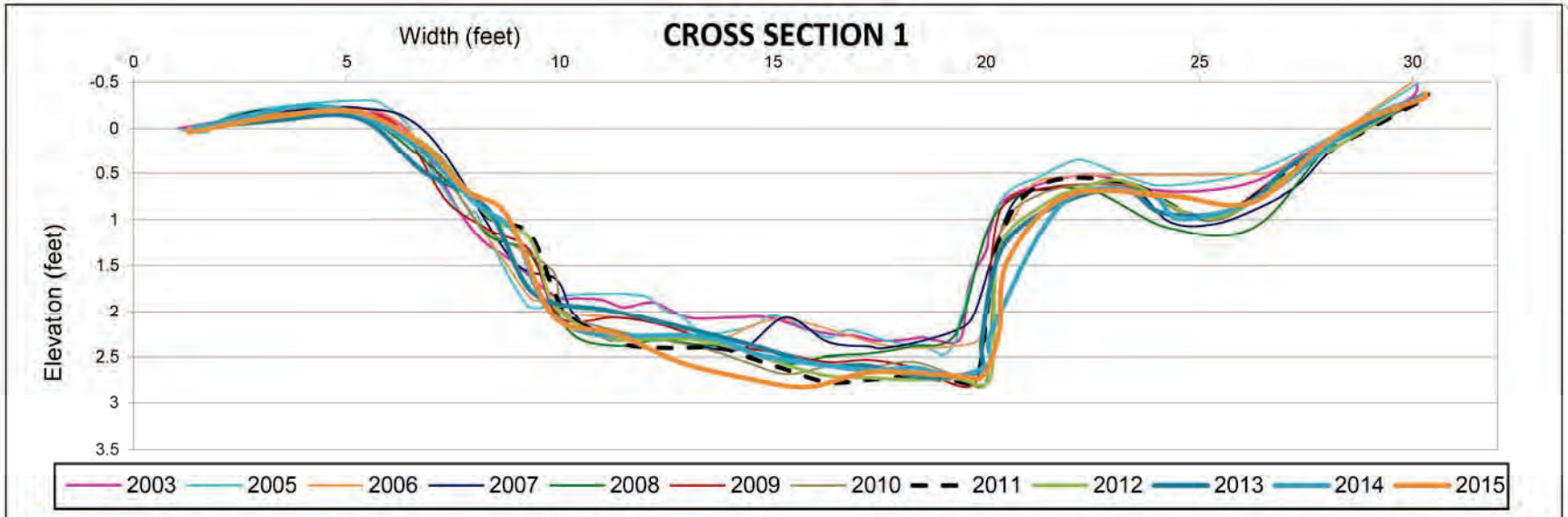
Source: Rosgen, D.L. 1996. *Applied River Morphology*. Wildland Hydrology, Pagosa Springs, CO.

APPENDIX F

GEOMORPHOLOGICAL DATA

Church Creek
2015 Geomorphic Assessment Results Summary

Assessment Parameter	Cross Section				
	XS-1 Pool @ sta 3+70.5	XS-2 Pool @ sta 6+82	XS-3 Pool @ sta 11+00	XS-4 Pool @ sta 13+53	XS-5 Riffle @ sta 17+36
Classification	F4	G4	G4/3c	C5	F3/4
Bankfull Width (ft)	11.2	6.1	7.2	7.0	9.9
Mean Depth (ft)	1.1	0.8	0.9	1.0	0.6
Bankfull X-Sec Area (sq ft)	12.0	4.7	6.7	6.8	6.2
Width:Depth Ratio	10.5	7.9	7.7	7.1	15.6
Flood-Prone Width (ft)	21.9	10.5	9.1	15.6	16.7
Entrenchment Ratio	1.9	1.7	1.3	2.2	1.7
D50(mm)	15	10	16	1.3	61
Water Surface Slope (ft/ft)	0.003	0.022	0.005	0.002	0.014
Sinuosity	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
Drainage Area (mi2)	0.111	0.113	0.121	0.130	0.441
Adjustments?	Sin ↑, ER ↓, W/D ↑	Sin ↑, ER ↓	Sin ↑	Sin ↑, W/D ↑	Sin ↑, ER ↓





Upstream View



Downstream View

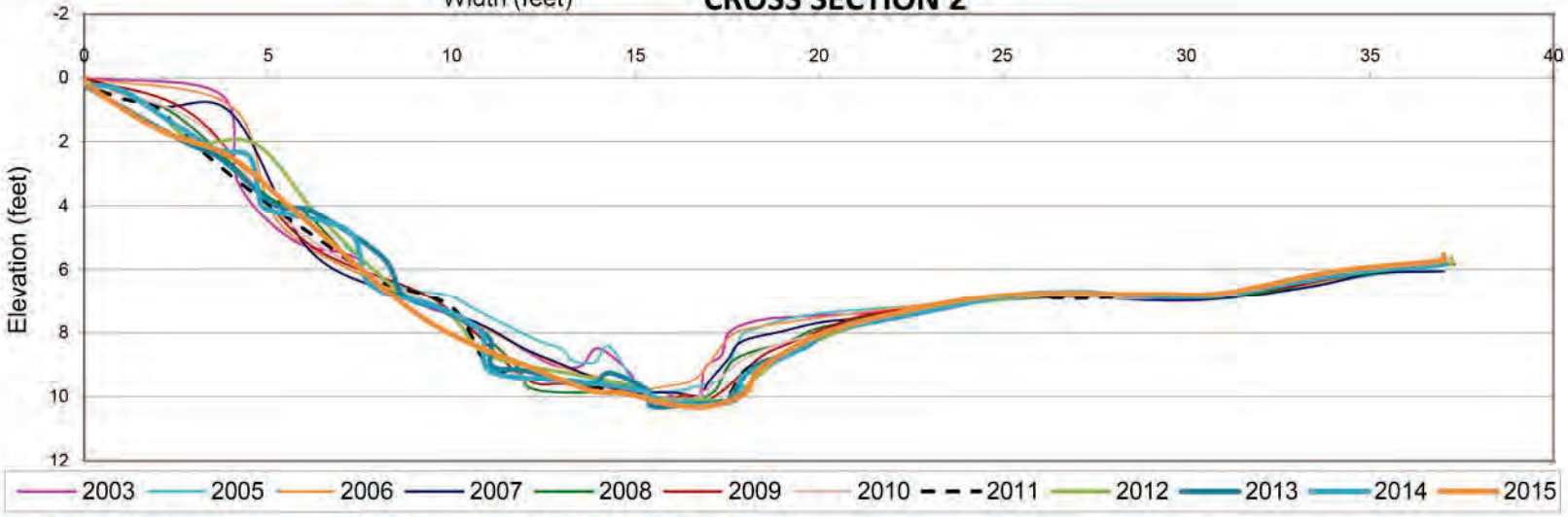


Left Bank View



Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	11.2
Mean Depth (d_{bkf}) (feet)	1.1
Bankfull Cross-sectional Area (A_{bkf}) ($feet^2$)	12.0
Width/Depth Ratio (W_{bkf}/d_{bkf})	10.5
Width of Flood-prone Area (W_{fpa}) (feet)	21.9
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	1.9
Channel Materials D_{50} (millimeters)	15
Water Surface Slope (S)	0.003
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑, ER ↓, W/D ↑
STREAM TYPE	**F4**





Upstream View



Downstream View

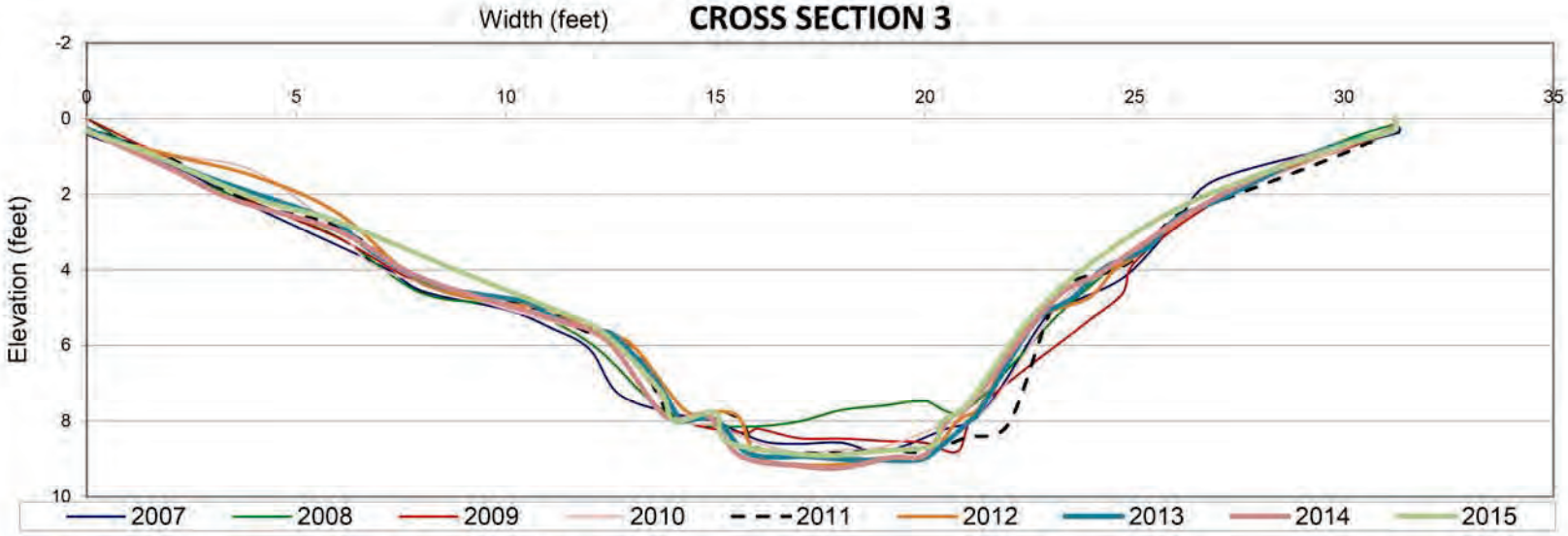


Left Bank View



Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	6.1
Mean Depth (d_{bkf}) (feet)	0.8
Bankfull Cross-sectional Area (A_{bkf}) ($feet_2$)	4.7
Width/Depth Ratio (W_{bkf}/d_{bkf})	7.9
Width of Flood-prone Area (W_{fpa}) (feet)	10.5
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	1.7
Channel Materials D_{50} (millimeters)	10
Water Surface Slope (S)	0.022
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑ ER ↓
STREAM TYPE	**G4**





Upstream View



Downstream View

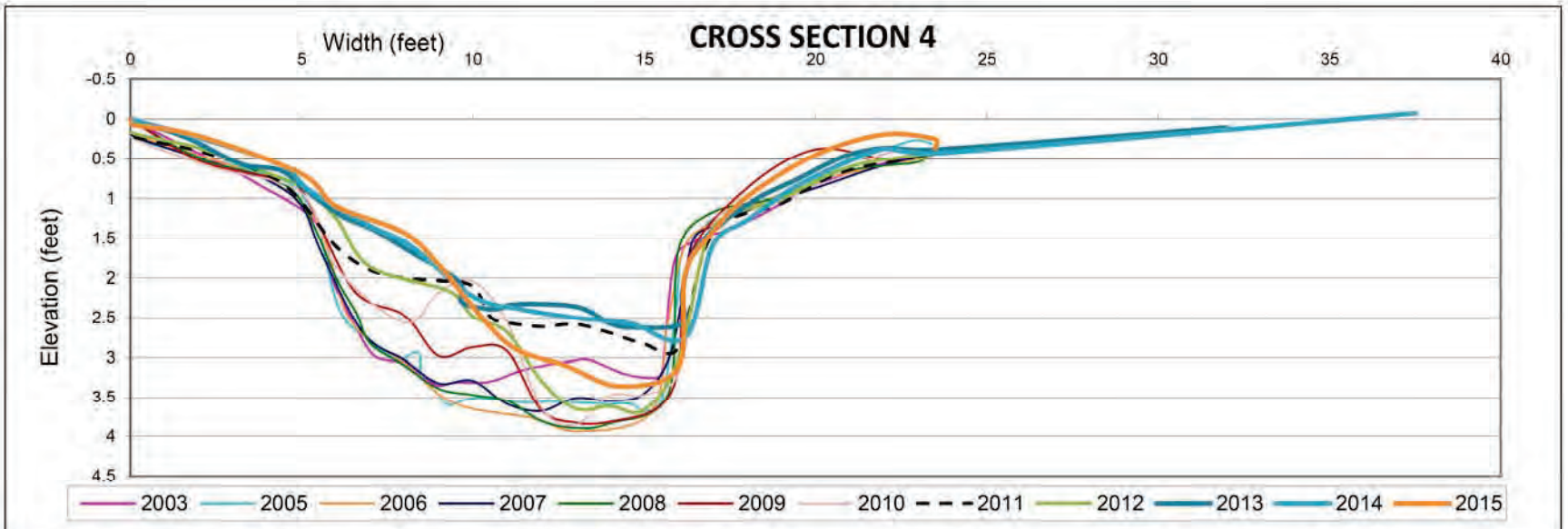


Left Bank View



Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	7.2
Mean Depth (d_{bkf}) (feet)	0.9
Bankfull Cross-sectional Area (A_{bkf}) ($feet_2$)	6.7
Width/Depth Ratio (W_{bkf}/d_{bkf})	7.7
Width of Flood-prone Area (W_{fpa}) (feet)	9.1
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	1.3
Channel Materials D_{50} (millimeters)	16
Water Surface Slope (S)	0.005
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑
STREAM TYPE	**G4/3c**





Upstream View



Downstream View

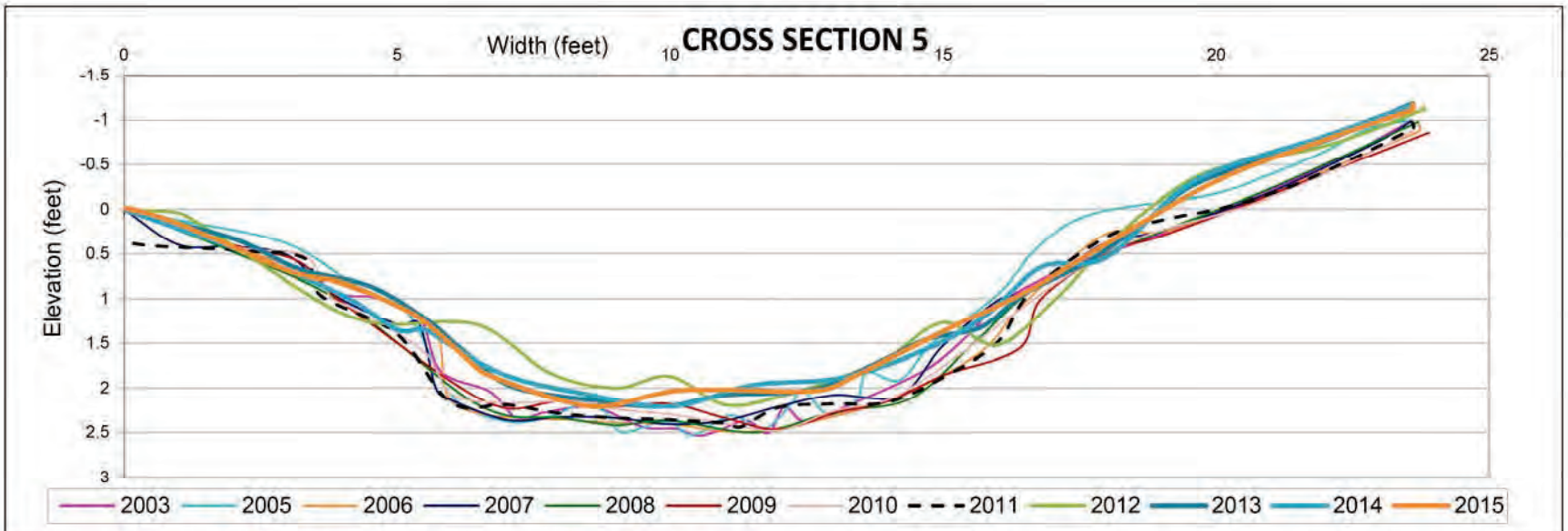


Left Bank View



Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	7.0
Mean Depth (d_{bkf}) (feet)	1.0
Bankfull Cross-sectional Area (A_{bkf}) (feet$_2$)	6.8
Width/Depth Ratio (W_{bkf}/d_{bkf})	7.1
Width of Flood-prone Area (W_{fpa}) (feet)	15.6
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	2.2
Channel Materials D_{50} (millimeters)	1.3
Water Surface Slope (S)	0.002
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑, W/D ↑
STREAM TYPE	**C5**





Upstream View



Downstream View



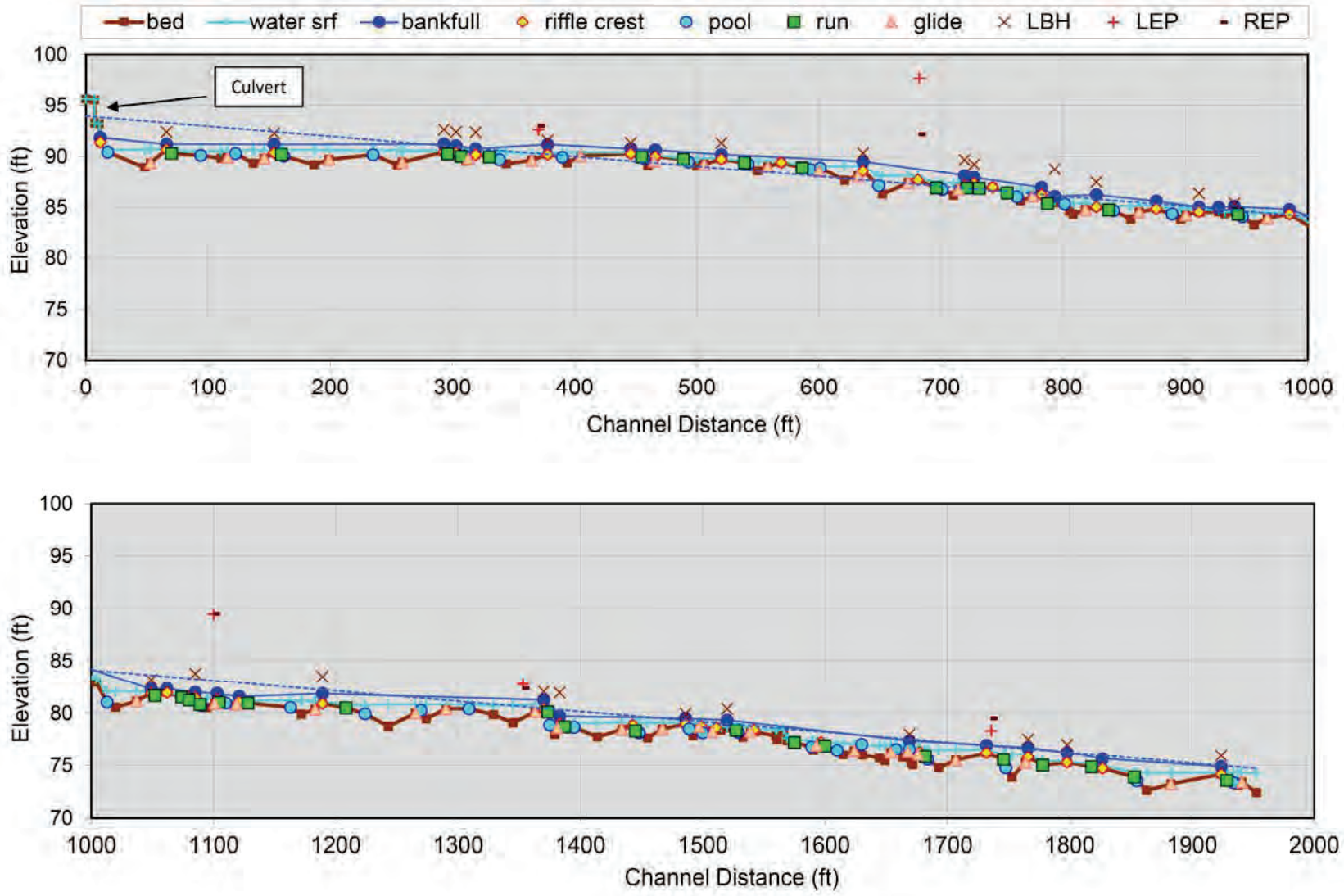
Left Bank View

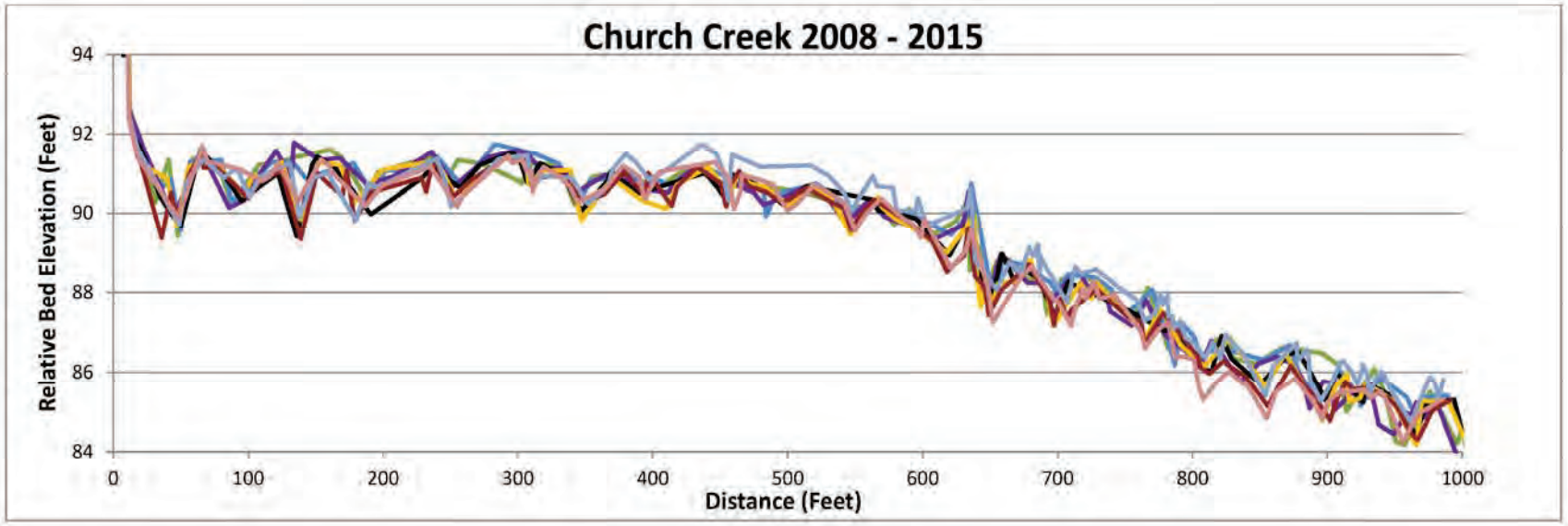


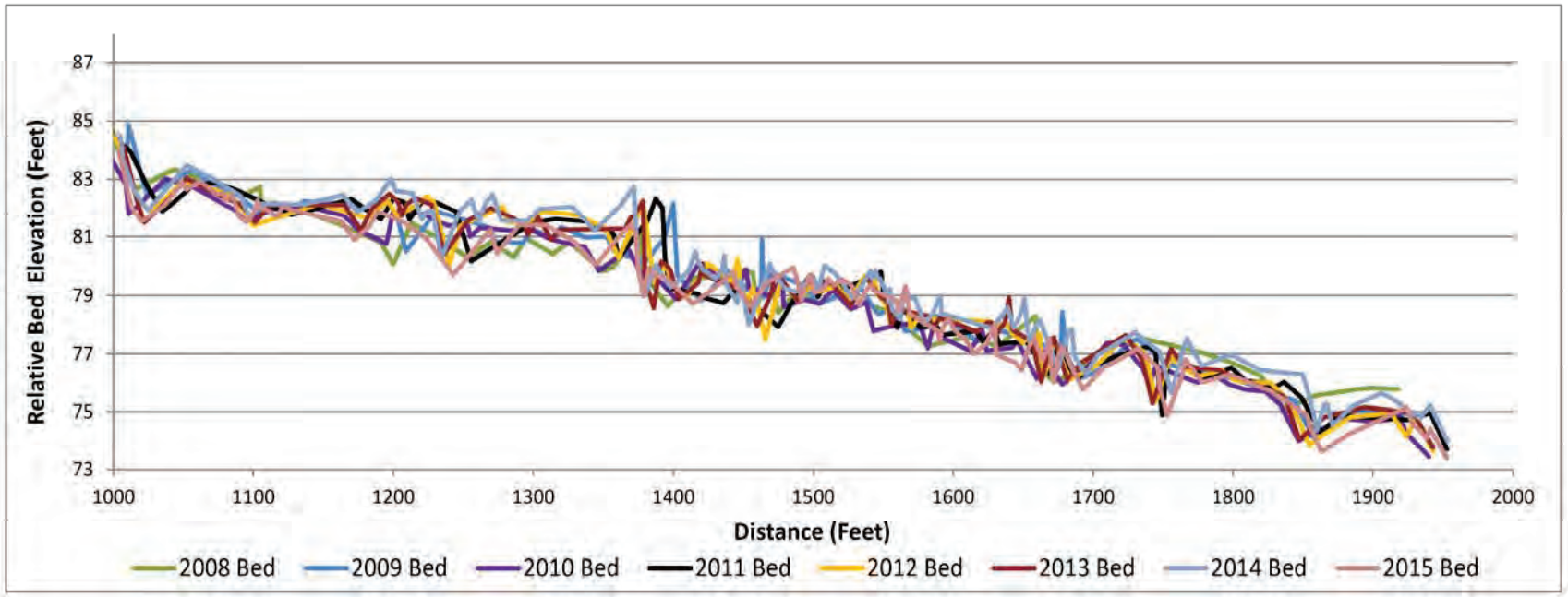
Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	9.9
Mean Depth (d_{bkf}) (feet)	0.6
Bankfull Cross-sectional Area (A_{bkf}) ($feet_2$)	6.2
Width/Depth Ratio (W_{bkf}/d_{bkf})	15.6
Width of Flood-prone Area (W_{fpa}) (feet)	16.7
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	1.7
Channel Materials D_{50} (millimeters)	61
Water Surface Slope (S)	0.003
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑, ER ↓
STREAM TYPE	**F4/3**

Church Creek Longitudinal Profile




Church Creek 2008 - 2015
Relative Bed Elevation (Feet)
94
92
90
88
86
84
0
100
200
300
400
500
600
700
800
900
1000
Distance (Feet)


Relative Bed Elevation (Feet)
87
85
83
81
79
77
75
73
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Distance (Feet)
2008 Bed
2009 Bed
2010 Bed
2011 Bed
2012 Bed
2013 Bed
2014 Bed
2015 Bed

APPENDIX G

CHEMICAL MONITORING RESULTS

Anne Arundel County NPDES
Sampling and EMC Data – 2015 Reporting Year
Parole Plaza Station

Sampler	ID	Jurisdiction	Date	Time	Site	Outfall or Instream	Storm or Baseflow	Inches	Hours	In/Hr	oF	cf	pH	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) MPN	MPN	(0) MPN	(dt) mg/L	(0) mg/L	(0) mg/L
											Temperature - field	Flow	pH - field	dt for BOD	BOD	BOD	dt for Total Kjeldahl Nitrogen	Total Kjeldahl Nitrogen	Total Kjeldahl Nitrogen	dt for Nitrate+ Nitrite - N	Nitrate+ Nitrite - N	Nitrate+ Nitrite - N	dt for Total Phosphorus	Total Phosphorus	Total Phosphorus	dt for TSS	TSS	TSS	dt for Copper	Copper	Copper	dt for Lead	Lead	Lead	dt for Zinc	Zinc	Zinc	dt for TPH	TPH	TPH	dt for E-COLI	E-COLI	E-COLI	dt for HARDNESS	HARDNESS	HARDNESS
Versar	1	AP	8/12/2014	1300	101	O	S	3.32	12.0	0.28	77.20	5669	7.53	2.00	4.00	4.00	0.50	1.60	1.60	0.05	170.0	170.0	0.01	0.13	0.13	1.0	98.0	98.0	2.00	29.00	29.00	2.00	5.50	5.50	20.00	240.00	240.00	5.0	0.0	5.0	100.0	4500.0	4500.0	1.0	52.0	52.0
Versar	2	AP	8/12/2014	1715	101	O	S				74.14	213561	7.14	2.00	0.00	2.00	0.50	0.00	0.50	0.05	0.140	0.140	0.01	0.17	0.17	1.0	63.0	63.0	2.00	11.00	11.00	2.00	5.70	5.70	20.00	64.00	64.00	5.0	0.0	5.0	100.0	54750.0	54750.0	1.0	21.0	21.0
Versar	3	AP	8/12/2014	1800	101	O	S				74.97	56436	7.07	2.00	0.00	2.00	0.50	1.50	1.50	0.05	1.500	1.500	0.01	0.20	0.20	1.0	44.0	44.0	2.00	11.00	11.00	2.00	4.00	4.00	20.00	65.00	65.00	5.0	0.0	5.0	100.0	241960.0	241960.0	1.0	33.0	33.0
COMBINED 8/12/2014										**Event Mean Concentration:**	**74.37**		**7.14**	**2.00**	**0.08**	**2.04**	**0.50**	**0.340**	**0.73**	**0.05**	**0.424**	**0.424**	**0.01**	**0.175**	**0.175**	**1.0**	**59.8**	**59.8**	**2.00**	**11.37**	**11.37**	**2.00**	**5.348**	**5.348**	**20.00**	**67.824**	**67.824**	**5.0**	**0.0**	**5.0**	**100.0**	**92043.5**	**92043.5**	**1.0**	**24.1**	**24.1**
Versar	1	AP	9/16/2014	1320	101	O	B				65.34	80	6.09	2.00	0.00	2.00	0.50	0.00	0.50	0.05	6.00	6.00	0.01	0.02	0.02	1.0	6.0	6.0	2.00	4.10	4.10	2.00	0.00	2.00	20.00	81.00	81.00	5.0	0.0	5.0	10.0	10.0	10.0	1.0	200.0	200.0
										Event Mean Concentration:	**65.34**		**6.09**	**2.00**	**0.00**	**2.00**	**0.50**	**0.00**	**0.50**	**0.05**	**6.00**	**6.00**	**0.01**	**0.02**	**0.02**	**1.0**	**6.0**	**6.0**	**2.00**	**4.10**	**4.10**	**2.00**	**0.00**	**2.00**	**20.00**	**81.00**	**81.00**	**5.0**	**0.0**	**5.0**	**10.0**	**10.0**	**10.0**	**1.0**	**200.0**	**200.0**
Versar	1	AP	9/30/2014	1130	101	O	B				65.84	2	7.06	2.00	0.00	2.00	0.50	0.70	0.70	0.05	4.80	4.80	0.01	0.02	0.02	1.0	1.0	1.0	2.00	0.00	2.00	2.00	0.00	2.00	20.00	57.00	57.00	5.0	0.0	5.0	10.0	41.0	41.0	1.0	190.0	190.0
										Event Mean Concentration:	**65.84**		**7.06**	**2.00**	**0.00**	**2.00**	**0.50**	**0.70**	**0.70**	**0.05**	**4.80**	**4.80**	**0.01**	**0.02**	**0.02**	**1.0**	**1.0**	**1.0**	**2.00**	**0.00**	**2.00**	**2.00**	**0.00**	**2.00**	**20.00**	**57.00**	**57.00**	**5.0**	**0.0**	**5.0**	**10.0**	**41.0**	**41.0**	**1.0**	**190.0**	**190.0**
Versar	1	AP	10/15/2014	1605	101	O	S	0.84	6.0	0.14	71.55	15385	7.99	2.00	2.00	2.00	0.50	0.90	0.90	0.05	0.24	0.24	0.01	0.08	0.08	1.0	40.0	40.0	2.00	12.00	12.00	2.00	3.40	3.40	20.00	110.000	110.000	5.0	0.0	5.0	10.0	0.0	10.0	1.0	28.0	28.0
Versar	2	AP	10/15/2014	1610	101	O	S				71.44	11899	7.74	2.00	0.00	2.00	0.50	0.00	0.50	0.05	0.17	0.17	0.01	0.15	0.15	1.0	95.0	95.0	2.00	19.00	19.00	2.00	5.90	5.90	20.0	120.000	120.000	5.0	0.0	5.0	10.0	24196.0	24196.0	1.0	34.0	34.0
Versar	3	AP	10/15/2014	1715	101	O	S				70.20	37477	8.04	2.00	0.00	2.00	0.50	1.00	1.00	0.05	0.34	0.34	0.01	0.16	0.16	1.0	33.0	33.0	2.00	12.00	12.00	2.00	0.00	2.00	20.0	84.000	84.000	5.0	0.0	5.0	10.0	24196.0	24196.0	1.0	37.0	37.0
COMBINED 10/15/2014										**Event Mean Concentration:**	**70.74**		**7.98**	**2.00**	**0.48**	**2.00**	**0.50**	**0.793**	**0.88**	**0.05**	**0.285**	**0.285**	**0.01**	**0.139**	**0.139**	**1.0**	**46.1**	**46.1**	**2.00**	**13.29**	**13.29**	**2.00**	**1.892**	**3.049**	**20.0**	**96.791**	**96.791**	**5.0**	**0.0**	**5.0**	**10.0**	**18447.9**	**18450.3**	**1.0**	**34.3**	**34.3**
Versar	1	AP	11/6/2014	325	101	O	S	0.30	12.0	0.03	59.31	3367	7.14	2.00	3.00	3.00	0.50	1.30	1.30	0.05	1.40	1.40	0.01	0.07	0.07	1.0	16.0	16.0	2.00	15.00	15.00	2.00	0.00	2.00	20.0	200.0	200.0	5.0	0.0	5.0	10.0	780.0	780.0	1.0	44.0	44.0
Versar	2	AP	11/6/2014	650	101	O	S				54.88	5917	7.13	2.00	3.00	3.00	0.50	0.80	0.80	0.05	0.65	0.65	0.01	0.06	0.06	1.0	11.0	11.0	2.00	8.20	8.20	2.00	0.00	2.00	20.0	130.0	130.0	5.0	0.0	5.0	10.0	1333.0	1333.0	1.0	25.0	25.0
Versar	3	AP	11/6/2014	810	101	O	S				56.95	3298	7.63	2.00	5.00	5.00	0.50	0.00	0.50	0.05	1.10	1.10	0.01	0.07	0.07	1.0	7.0	7.0	2.00	12.00	12.00	2.00	0.00	2.00	20.0	120.0	120.0	5.0	0.0	5.0	10.0	7270.0	7270.0	1.0	36.0	36.0
COMBINED 11/06/2014										**Event Mean Concentration:**	**56.61**		**7.27**	**2.00**	**3.52**	**3.52**	**0.50**	**0.724**	**0.86**	**0.05**	**0.969**	**0.969**	**0.01**	**0.065**	**0.065**	**1.0**	**11.3**	**11.3**	**2.00**	**11.02**	**11.02**	**2.00**	**0.00**	**2.00**	**20.0**	**146.11**	**146.11**	**5.0**	**0.0**	**5.0**	**10.0**	**2741.3**	**2741.3**	**1.0**	**33.0**	**33.0**
Versar	1	AP	12/22/2014	1520	101	O	S	0.12	8.0	0.02	44.96	1638	7.70	2.00	39.00	39.00	0.50	1.80	1.80	0.05	1.20	1.20	0.01	0.18	0.18	1.0	32.0	32.0	2.00	36.00	36.00	2.00	2.50	2.50	20.0	250.0	250.0	5.0	0.0	5.0	10.0	309.0	309.0	1.0	55.0	55.0
Versar	2	AP	12/22/2014	1700	101	O	S				42.31	1473	8.28	2.00	11.00	11.00	0.50	1.70	1.70	0.05	0.78	0.78	0.01	0.12	0.12	1.0	27.0	27.0	2.00	25.00	25.00	2.00	2.60	2.60	20.0	230.0	230.0	5.0	0.0	5.0	10.0	384.0	384.0	1.0	43.0	43.0
Versar	3	AP	12/22/2014	1830	101	O	S				44.53	1349	8.20	2.00	14.00	14.00	0.50	1.30	1.30	0.05	1.10	1.10	0.01	0.09	0.09	1.0	14.0	14.0	2.00	18.00	18.00	2.00	0.00	2.00	20.0	170.0	170.0	5.0	0.0	5.0	10.0	272.0	272.0	1.0	49.0	49.0
COMBINED 12/22/2014										**Event Mean Concentration:**	**43.96**		**8.04**	**2.00**	**22.19**	**22.19**	**0.50**	**1.616**	**1.62**	**0.05**	**1.031**	**1.031**	**0.01**	**0.133**	**0.133**	**1.0**	**24.9**	**24.9**	**2.00**	**26.92**	**26.92**	**2.00**	**1.777**	**2.382**	**20.0**	**219.20**	**219.20**	**5.0**	**0.0**	**5.0**	**10.0**	**322.6**	**322.6**	**1.0**	**49.2**	**49.2**
Versar	1	AP	2/25/2015	1050	101	O	B				40.07	10	6.26	2.00	5.00	5.00	0.50	0.60	0.60	0.05	3.50	3.50	0.01	0.06	0.06	1.0	18.0	18.0	2.00	8.60	8.60	2.00	0.00	2.00	20.0	130.0	130.0	5.0	0.0	5.0	10.0	246.0	246.0	1.0	890.0	890.0
										Event Mean Concentration:	**40.07**		**6.26**	**2.00**	**5.00**	**5.00**	**0.50**	**0.60**	**0.60**	**0.05**	**3.50**	**3.50**	**0.01**	**0.06**	**0.06**	**1.0**	**18.0**	**18.0**	**2.00**	**8.60**	**8.60**	**2.00**	**0.00**	**2.00**	**20.0**	**130.0**	**130.0**	**5.0**	**0.0**	**5.0**	**10.0**	**246.0**	**246.0**	**1.0**	**890.0**	**890.0**
Versar	1	AP	3/4/2015	1840	101	O	S	0.23	8.5	0.03	42.69	3221	8.20	4.00	7.00	7.00	0.50	1.30	1.30	0.05	1.30	1.30	0.01	0.26	0.26	1.0	81.0	81.0	2.00	38.0	38.0	2.00	5.20	5.20	20.0	280.0	280.0	5.0	6.0	6.0	10.0	2046.0	2046.0	1.0	410.0	410.0
Versar	2	AP	3/4/2015	2100	101	O	S				42.39	7107	8.26	4.00	6.00	6.00	0.50	0.90	0.90	0.05	0.79	0.79	0.01	0.24	0.24	1.0	87.0	87.0	2.00	31.0	31.0	2.00	6.70	6.70	20.0	240.0	240.0	5.0	0.0	5.0	10.0	2014.0	2014.0	1.0	240.0	240.0
Versar	3	AP	3/4/2015	22:00	101	O	S				41.82	6218	8.12	4.00	0.00	4.00	0.50	0.70	0.70	0.05	0.98	0.98	0.01	0.12	0.12	1.0	23.0	23.0	2.00	15.0	15.0	2.00	2.40	2.40	20.0	120.0	120.0	5.0	0.0	5.0	10.0	1989.0	1989.0	1.0	280.0	280.0
										Event Mean Concentration:	**42.23**		**8.20**	**4.00**	**3.94**	**5.44**	**0.50**	**0.90**	**0.90**	**0.05**	**0.961**	**0.96**	**0.01**	**0.199**	**0.20**	**1.0**	**61.8**	**61.78**	**2.00**	**26.35**	**26.35**	**2.00**	**4.79**	**4.79**	**20.0**	**202.69**	**202.69**	**5.0**	**1.2**	**5.2**	**10.0**	**2010.8**	**2010.8**	**1.0**	**288.1**	**288.1**
Versar	1	AP	3/31/2015	1230	101	O	B				52.34	6	6.96	2.00	0.00	2.00	0.50	0.70	0.70	0.05	3.20	3.20	0.01	0.09	0.09	1.0	7.00	7.0	2.00	7.20	7.20	2.00	0.00	2.00	20.0	75.0	75.0	5.0	0.0	5.0	10.0	20.0	20.0	1.0	250.0	250.0
										Event Mean Concentration:	**52.34**		**6.96**	**2.00**	**0.00**	**2.00**	**0.50**	**0.70**	**0.70**	**0.05**	**3.20**	**3.20**	**0.01**	**0.09**	**0.09**	**1.0**	**7.00**	**7.0**	**2.00**	**7.20**	**7.20**	**2.00**	**0.00**	**2.00**	**20.0**	**75.0**	**75.0**	**5.0**	**0.0**	**5.0**	**10.0**	**20.0**	**20.0**	**1.0**	**250.0**	**250.0**
Versar	1	AP	4/14/2015	1035	101	O	S	0.53	13.5	0.04	59.33	3962	7.81	4.00	16.00	16.00	0.50	1.50	1.50	0.05	0.45	0.45	0.01	0.18	0.18	1.0	52.0	52.0	2.00	29.0	29.0	2.00	3.20	3.20	20.0	220.0	220.0	5.0	0.0	5.0	10.0	414.0	414.0	1.0	58.0	58.0
Versar	2	AP	4/14/2015	1720	101	O	S				56.74	22420	8.37	4.00	9.00	9.00	0.50	0.70	0.70	0.05	0.20	0.20	0.01	0.14	0.14	1.0	80.0	80.0	2.00	25.0	25.0	2.00	4.40	4.40	20.0	170.0	170.0	5.0	0.0	5.0	10.0	5794.0	5794.0	1.0	52.0	52.0
Versar	3	AP	4/14/2015	1800	101	O	S				55.15	3794	8.27	4.00	6.00	6.00	0.50	0.90	0.90	0.05	0.28	0.28	0.01	0.17	0.17	1.0	19.0	19.0	2.00	14.0	14.0	2.00	0.00	2.00	20.0	95.0	95.0	5.0	0.0	5.0	10.0	4884.0	4884.0	1.0	44.0	44.0
										Event Mean Concentration:	**56.88**		**8.29**	**4.00**	**9.54**	**9.54**	**0.50**	**0.83**	**0.83**	**0.05**	**0.243**	**0.24**	**0.01**	**0.149**	**0.15**	**1.0**	**68.7**	**68.65**	**2.00**	**24.14**	**24.14**	**2.00**	**3.69**	**3.94**	**20.0**	**167.13**	**167.13**	**5.0**	**0.0**	**5.0**	**10.0**	**4973.3**	**4973.3**	**1.0**	**51.8**	**51.8**
Versar	1	AP	6/8/2015	2100	101	O	S	0.23	8.5	0.03	69.73	2582	7.14	2.00	6.00	6.00	0.50	1.00	1.00	0.05	0.30	0.30	0.01	0.11	0.11	1.0	230.0	230.0	2.00	31.4	31.4	2.00	13.00	13.00	20.0	239.0	239.0	5.0	0.0	5.0	10.0	388.0	388.0	1.0	70.0	70.0
Versar	2	AP	6/8/2015	2105	101	O	S				73.58	8698	8.06	2.00	5.00	5.00	0.50	1.30	1.30	0.05	0.25	0.25	0.01	0.19	0.19	1.0	160.0	160.0	2.00	37.0	37.0	2.00	8.30	8.30	20.0	230.0	230.0	5.0	0.0	5.0	10.0	2014.0	3873.0	1.0	62.0	62.0
Versar	3	AP	6/8/2015	2135	101	O	S				73.71	39659	7.72	2.00	4.00	4.00	0.50	0.70	0.70	0.05	0.44	0.44	0.01	0.10	0.10	1.0	29.0	29.0	2.00	15.0	15.0	2.00	2.00	2.00	20.0	100.0	100.0	5.0	0.0	5.0	10.0	19863.0	19863.0	1.0	25.0	25.0
										Event Mean Concentration:	**73.48**		**7.75**	**2.00**	**4.27**	**4.27**	**0.50**	**0.82**	**0.82**	**0.05**	**0.400**	**0.40**	**0.01**	**0.116**	**0.12**	**1.0**	**61.6**	**61.56**	**2.00**	**19.59**	**19.59**	**2.00**	**3.63**	**3.63**	**20.0**	**129.24**	**129.24**	**5.0**	**0.0**	**5.0**	**10.0**	**15828.0**	**16145.5**	**1.0**	**33.6**	**33.6**
Versar	1	AP	6/27/2015	945	101	O	S	1.24	21.0	0.06	71.66	11072	7.85	2.00	0.00	2.00	0.50	0.70	0.70	0.05	0.43	0.43	0.01	0.04	0.04	1.0	7.0	7.0	2.00	15.0	15.0	2.00	0.00	2.00	20.0	110.0	110.0	N/A	N/A	N/A	N/A	N/A	N/A	1.0	34.0	34.0
Versar	2	AP	6/27/2015	1715	101	O	S				73.28	172393	8.14	2.00	0.00	2.00	0.50	0.00	0.50	0.05	0.19	0.19	0.01	0.05	0.05	1.0	14.0	14.0	2.00	8.2	8.2	2.00	0.00	2.00	20.0	45.0	45.0	N/A	N/A	N/A	N/A	N/A	N/A	1.0	18.0	18.0
Versar	3	AP	6/27/2015	2230	101	O	S				72.42	30863	7.95	2.00	0.00	2.00	0.50	0.90	0.90	0.05	0.25	0.25	0.01	0.13	0.13	1.0	10.0	10.0	2.00	15.0	15.0	2.00	0.00	2.00	20.0	80.0	80.0	N/A	N/A	N/A	N/A	N/A	N/A	1.0	40.0	40.0
										Event Mean Concentration:	**73.07**		**8.10**	**2.00**	**0.00**	**2.00**	**0.50**	**0.17**	**0.57**	**0.05**	**0.211**	**0.21**	**0.01**	**0.061**	**0.06**	**1.0**	**13.1**	**13.06**	**2.00**	**9.53**	**9.53**	**2.00**	**0.00**	**2.00**	**20.0**	**53.40**	**53.40**							**1.0**	**22.0**	**22.0**

Anne Arundel County NPDES
Sampling and EMC Data – 2015 Reporting Year
Parole Plaza Station

Sampler	ID	Jurisdiction	Date	Time	Site	Outfall or Instream	Storm or Baseflow	Depth	Duration	Intensity	Temperature - field	Flow	pH - field	(dt) mg/L	BOD	(0) mg/L	(dt) mg/L	Total Kjeldahl Nitrogen	(0) mg/L	(dt) mg/L	Nitrate+ Nitrite - N	(0) mg/L	(dt) mg/L	Total Phosphorus	(0) mg/L	(dt) mg/L	TSS	(0) mg/L	(dt) µg/L	Copper	(0) µg/L	(dt) µg/L	Lead	(0) µg/L	(dt) µg/L	Zinc	(0) µg/L	(dt) mg/L	TPH	(0) mg/L	(dt) MPN	E-COLI	(0) MPN	(dt) mg/L	HARDNESS	(0) mg/L
								Inches	Hours	In/Hr	oF	cf	pH	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) MPN	MPN	(0) MPN	(dt) mg/L	mg/L	(0) mg/L
SUMMER QUARTER (JULY, AUGUST, SEPTEMBER)																																													
Summer Quarter Flow-Weighted EMC (8/12/14, 9/16/14, 9/30/14):											74.37		7.14		0.08	2.04		0.34	0.73		0.43	0.43		0.18	0.18		59.81	59.81		11.37	11.37		5.35	5.35		67.83	67.83		0.00	5.00		10.76	10.76		24.15	24.15
Average:															1.06	mg/l		0.53	mg/l		0.43	mg/l		0.18	mg/l		59.81	mg/l		11.368	µg/l		5.347	µg/l		67.828	µg/l		2.50	mg/l		10.76	MPN/100mL		24.15	mg/l
															0.0000663	lb/cf		0.0000333	lb/cf		0.0000266	lb/cf		0.0000109	lb/cf		0.0037333	lb/cf		0.0000007	lb/cf		0.0000003	lb/cf		0.0000042	lb/cf		0.0001560	lb/cf					0.0015071	lb/cf
Total Volume (Quarter Events):															275,748	cf																														
Pollutant Load (Quarter Events):															18.3	lbs		9.18	lbs		7.33	lbs		3.02	lbs		1,029.46	lbs		0.20	lbs		0.09	lbs		1.17	lbs		43.03	lbs					415.59	
Total Volume (Quarter):															886,593	cf																														
Pollutant Load (Quarter):															59	lbs		30	lbs		24	lbs		10	lbs		3,310	lbs		0.6	lbs		0.3	lbs		4	lbs		138	lbs					1,336	
FALL QUARTER (OCTOBER, NOVEMBER, DECEMBER)																																													
Fall Quarter Flow-Weighted EMC(10/15/14, 11/6/14, 12/22/14):											67.11		7.87		2.13	3.34		0.83	0.92		0.431	0.431		0.127	0.127		39.55	39.55		13.680	13.680		1.595	2.851		111.050	111.050		0.0	5.0		15043.95	15045.83		34.92	34.92
Average:															2.73	mg/l		0.87	mg/l		0.43	mg/l		0.13	mg/l		39.55	mg/l		13.680	µg/l		2.223	µg/l		111.050	µg/l		2.50	mg/l		15044.89	MPN/100mL		34.92	mg/l
															0.0001705	lb/cf		0.0000545	lb/cf		0.0000269	lb/cf		0.0000080	lb/cf		0.0024688	lb/cf		0.0000009	lb/cf		0.0000001	lb/cf		0.0000069	lb/cf		0.0001560	lb/cf					0.0021794	lb/cf
Total Volume (Quarter Events):															81,802	cf																														
Pollutant Load (Quarter Events):															13.9	lbs		4.46	lbs		2.20	lbs		0.65	lbs		201.96	lbs		0.07	lbs		0.01	lbs		0.57	lbs		12.76	lbs					178.28	
Total Volume (Quarter):															1,366,102	cf																														
Pollutant Load (Quarter):															233	lbs		74.46	lbs		36.735	lbs		10.9	lbs		3372.7	lbs		1.166	lbs		0.190	lbs		9.469	lbs		213.2	lbs					2977.25	
WINTER QUARTER (JANUARY, FEBRUARY, MARCH)																																													
Fall Quarter Flow-Weighted EMC (2/25/15, 3/4/15, 3/31/15):											42.23		8.2		3.9	5.4		0.90	0.90		0.963	0.963		0.20	0.20		61.7	61.7		26.332	26.332		4.787	4.789		202.599	202.599		1	5.19		2009.0	2009.0		288.47	288.47
Average:															4.69	mg/l		0.90	mg/l		0.96	mg/l		0.20	mg/l		61.73	mg/l		26.33	µg/l		4.79	µg/l		202.60	µg/l		3.18	mg/l		2009.05	MPN/100mL		288.47	mg/l
															0.00	lb/cf		0.00	lb/cf		0.00	lb/cf		0.00	lb/cf		0.00	lb/cf		0.000	lb/cf		0.000	lb/cf		0.000	lb/cf		0.00	lb/cf					0.02	lb/cf
Total Volume (Quarter Events):															16561.71	cf																														
Pollutant Load (Quarter Events):															5	lbs		1	lbs		1	lbs		0	lbs		64	lbs		0	lbs		0	lbs		0	lbs		3	lbs					298.20	
Total Volume (Quarter):															1,186,701.000	cf																														
Pollutant Load (Quarter):															347	lbs		66.84	lbs		71.330	lbs		14.7	lbs		4572.6	lbs		1.950	lbs		0.355	lbs		15.006	lbs		235.6	lbs					21366.93	
SPRING QUARTER (APRIL, MAY, JUNE)																																													
Fall Quarter Flow-Weighted EMC (4/14/15), (6/8/15), (6/27/15):											71.5		8.1		1.7	3.2		0.35	0.64		0.25	0.25		0.08	0.08		27.1	27.1		12.757	12.757		1.003	2.480		78.092	78.092		0.0	1.4		3237	3292		27.04	27.04
Average:															2.4	mg/l		0.49	mg/l		0.247	mg/l		0.08	mg/l		27.1	mg/l		12.757	µg/l		1.742	µg/l		78.092	µg/l		1	mg/l		3264.3	MPN/100mL		27.04	mg/l
															0.00	lb/cf		0.000	lb/cf		0.000	lb/cf		0.000	lb/cf		0.00	lb/cf		0.00	lb/cf		0.000	lb/cf		0.000	lb/cf		0.00	lb/cf					0.00	lb/cf
Total Volume (Quarter Events):															295442.70	cf																														
Pollutant Load (Quarter Events):															44.9317016	lbs		9.0707229	lbs		4.5538323	lbs		1.4651592	lbs		499.7645975	lbs		0.2352417	lbs		0.0321146	lbs		1.4400340	lbs		12.6571187	lbs					498.5837437	
Total Volume (Quarter):															1,980,895	cf																														
Pollutant Load (Quarter):															301.3	lbs		60.82	lbs		30.53	lbs		9.82	lbs		3,350.84	lbs		1.58	lbs		0.22	lbs		9.66	lbs		84.86	lbs					3,342.92	
AVERAGE ANNUAL EMCs:											71.4		7.7		2.0	mg/l		0.57	mg/l		0.36	mg/l		0.13	mg/l		43.0	mg/l		12.634	µg/l		3.360	µg/l		80.971	µg/l		1.7	mg/l		3333	mg/l		33.28	mg/l
TOTAL ANNUAL POLLUTANT LOAD (EVENTS):															82.00	lbs		23.646	lbs		15.080	lbs		5.338	lbs		1795.00	lbs		0.528	lbs		0.140	lbs		3.384	lbs		71.74	lbs					1390.65	lbs
Per Acre:															1.36			0.39			0.25			0.09			29.7			0.009			0.002			0.06			1.2						23.0	
TOTAL 2015 POLLUTANT LOAD:															940.33	lbs		231.65	lbs		162.17	lbs		45.11	lbs		14,606.04	lbs		5.32	lbs		1.06	lbs		37.88	lbs		671.96	lbs					29,023.31	lbs
TOTAL 2014 POLLUTANT LOAD:															2,039.81	lbs		536.08	lbs		497.02	lbs		53.58	lbs		18,953.49	lbs		8.12	lbs		0.95	lbs		50.40	lbs		1,155.52	lbs					36,945.03	lbs

Anne Arundel County NPDES
Sampling and EMC Data – 2015 Reporting Year
Church Creek Station

Sampler	ID	Jurisdiction	Date	Time	Site	Outfall or Instream	Storm or Baseflow	Depth	Duration	Intensity	Temperature - field	Flow	pH - field	dt for BOD	BOD	BOD	dt for Total Kjeldahl Nitrogen	Total Kjeldahl Nitrogen	dt for Total Kjeldahl Nitrogen	Total Kjeldahl Nitrogen	dt for Nitrate+ Nitrite - N	Nitrate+ Nitrite - N	dt for Total Phosphorus	Total Phosphorus	dt for Total Phosphorus	Total Phosphorus	dt for TSS	TSS	TSS	dt for Copper	Copper	Copper	dt for Lead	Lead	Lead	dt for Zinc	Zinc	Zinc	dt for TPH	TPH	TPH	dt for E-COLI	E-COLI	E-COLI	dt for HARDNESS	HARDNESS	HARDNESS
								Inches	Hours	In/Hr	oF	cf	pH	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) MPN	MPN	(0) MPN	(dt) mg/L	(0) mg/L	(0) mg/L
Versar	1	AC	8/12/2014	1320	102	I	S	3.32	12.0	0.28	75.56	188549	7.1	2.00	6.00	6.00	0.50	1.60	1.60	0.05	0.66	0.660	0.01	0.40	0.40	1.0	180.0	180.0	2.00	23.00	23.00	2.00	14.00	14.00	20.00	160.0	160.0	5.0	0.0	5.0	100.0	0.0	100.0	1.0	120.0	120.0
Versar	2	AC	8/12/2014	1720	102	I	S				73.58	2627549	6.9	2.00	0.00	2.00	0.50	0.80	0.80	0.05	0.17	0.170	0.01	0.16	0.16	1.0	62.0	62.0	2.00	8.20	8.20	2.00	6.50	6.50	20.00	73.0	73.0	5.0	0.0	5.0	100.0	0.0	100.0	1.0	23.0	23.0
Versar	3	AC	8/12/2014	1910	102	I	S				74.66	2031467	6.9	2.00	0.00	2.00	0.50	0.00	0.50	0.02	0.21	0.210	0.01	0.13	0.13	1.0	42.0	42.0	2.00	5.80	5.80	2.00	4.30	4.30	20.00	78.0	78.0	5.0	0.0	5.0	100.0	0.0	100.0	1.0	29.0	29.0
										Event Mean Concentration:	**74.11**		**6.9**	**2.00**	**0.23**	**2.16**	**0.50**	**0.50**	**0.71**	**0.04**	**0.206**	**0.206**	**0.01**	**0.157**	**0.157**	**1.0**	**58.2**	**58.2**	**2.00**	**7.770**	**7.770**	**2.000**	**5.87**	**5.87**	**20.00**	**78.48**	**78.48**	**5.0**	**0.0**	**5.0**	**100.0**	**0.0**	**100.0**	**1.0**	**29.3**	**29.3**
Versar	1	AC	9/18/2014	1330	102	I	B				65.48	591	6.9	2.00	0.00	2.00	0.50	0.00	0.50	0.05	0.80	0.800	0.01	0.08	0.080	1.0	22.00	22.0	2.00	2.00	2.00	2.00	0.000	2.00	20.00	38.0	38.0	5.0	0.0	5.0	10.0	171.0	171.0	1.0	100.0	100.0
										Event Mean Concentration:	**65.48**		**6.9**	**2.00**	**0.00**	**2.00**	**0.50**	**0.00**	**0.50**	**0.05**	**0.80**	**0.800**	**0.01**	**0.08**	**0.080**	**1.0**	**22.00**	**22.0**	**2.00**	**2.00**	**2.00**	**2.00**	**0.000**	**2.00**	**20.00**	**38.0**	**38.0**	**5.0**	**0.0**	**5.0**	**10.0**	**171.0**	**171.0**	**1.0**	**100.0**	**100.0**
Versar	1	AC	9/30/2014	1055	102	I	B				65.30	440	6.5	2.00	0.00	2.00	0.50	0.70	0.70	0.05	0.55	0.550	0.01	0.03	0.03	1.0	4.00	4.0	2.00	0.000	2.00	2.00	0.000	2.00	20.00	24.0	24.0	5.0	0.0	5.0	10.0	0.0	10.0	1.0	94.0	94.0
										Event Mean Concentration:	**65.30**		**6.5**	**2.00**	**0.00**	**2.00**	**0.50**	**0.70**	**0.70**	**0.05**	**0.55**	**0.550**	**0.01**	**0.030**	**0.030**	**1.0**	**4.00**	**4.0**	**2.00**	**0.000**	**2.00**	**2.00**	**0.000**	**2.00**	**20.00**	**24.0**	**24.0**	**5.0**	**0.0**	**5.0**	**10.0**	**0.0**	**10.0**	**1.0**	**94.0**	**94.0**
Versar	1	AC	10/15/2014	1610	102	I	S	0.84	6.0	0.14	70.16	214278	7	2.00	3.00	3.00	0.50	0.70	0.70	0.05	0.26	0.26	0.01	0.21	0.21	1.0	100.0	100.0	2.00	19.00	19.00	2.00	9.50	9.50	20.00	150.0	150.0	5.0	0.0	5.0	10.0	7701.0	7701.00	1.0	64.0	64.0
Versar	2	AC	10/15/2014	1635	102	I	S				70.70	364468	7.2	2.00	3.00	3.00	0.50	1.20	1.20	0.05	0.22	0.22	0.01	0.28	0.28	1.0	130.0	130.0	2.00	20.00	20.00	2.00	14.00	14.00	20.00	170.0	170.0	5.0	0.0	5.0	10.0	24196.0	24196.00	1.0	33.0	33.0
Versar	3	AC	10/15/2014	1750	102	I	S				69.62	671522	7	2.00	0.00	2.00	0.50	0.60	0.60	0.05	0.24	0.24	0.01	0.11	0.11	1.0	50.0	50.0	2.00	7.80	7.80	2.00	3.50	3.50	20.00	60.0	60.0	5.0	0.0	5.0	10.0	15531.0	15531.00	1.0	33.0	33.0
										Event Mean Concentration:	**70.03**		**7.1**	**2.00**	**1.39**	**2.46**	**0.50**	**0.79**	**0.79**	**0.05**	**0.238**	**0.238**	**0.01**	**0.177**	**0.177**	**1.0**	**81.9**	**81.9**	**2.00**	**13.276**	**13.276**	**2.00**	**7.589**	**7.589**	**20.00**	**107.49**	**107.49**	**5.0**	**0.0**	**5.0**	**10.0**	**16715.0**	**16715.0**	**1.0**	**38.3**	**38.3**
Versar	1	AC	11/6/2014	350	102	I	S	0.30	12.0	0.03	55.94	61762	6.6	2.00	3.00	3.00	0.50	0.80	0.80	0.05	1.50	1.50	0.01	0.11	0.11	1.0	13.0	13.0	2.00	4.80	4.80	2.00	0.000	2.00	20.00	59.0	59.0	5.0	0.0	5.0	10.0	420.0	420.00	1.0	90.0	90.0
Versar	2	AC	11/6/2014	730	102	I	S				55.40	136524	6.8	2.00	3.00	3.00	0.50	0.00	0.50	0.05	0.94	0.94	0.01	0.14	0.14	1.0	29.0	29.0	2.00	7.40	7.40	2.00	3.00	3.00	20.00	66.0	66.0	5.0	0.0	5.0	10.0	1670.0	1670.00	1.0	50.0	50.0
Versar	3	AC	11/6/2014	940	102	I	S				54.86	113283	6.7	2.00	2.00	2.00	0.50	0.90	0.90	0.05	0.56	0.56	0.01	0.56	0.56	1.0	6.0	6.0	2.00	4.80	4.80	2.00	0.000	2.00	20.00	48.0	48.0	5.0	0.0	5.0	10.0	1198.0	1198.00	1.0	43.0	43.0
										Event Mean Concentration:	**55.31**		**6.7**	**2.00**	**2.64**	**2.64**	**0.50**	**0.49**	**0.70**	**0.05**	**0.913**	**0.913**	**0.01**	**0.287**	**0.287**	**1.0**	**17.5**	**17.5**	**2.00**	**5.939**	**5.939**	**2.00**	**1.315**	**2.438**	**20.00**	**58.07**	**58.07**	**5.0**	**0.0**	**5.0**	**10.0**	**1250.6**	**1250.6**	**1.0**	**55.4**	**55.4**
Versar	1	AC	12/22/2014	1600	102	I	S	0.12	8.0	0.02	40.82	23588	6.6	2.00	4.00	4.00	0.50	0.00	0.50	0.05	1.50	1.50	0.01	0.04	0.04	1.0	11.0	11.0	2.00	0.00	2.00	2.00	0.000	2.00	20.00	73.0	73.0	5.0	0.0	5.0	10.0	63.0	63.00	1.0	120.0	120.0
Versar	2	AC	12/22/2014	1800	102	I	S				41.90	44458	6.6	2.00	20.00	20.00	0.50	1.00	1.00	0.05	1.70	1.70	0.01	0.16	0.16	1.0	17.0	17.0	2.00	6.60	6.60	2.00	0.000	2.00	20.00	100.0	100.0	5.0	0.0	5.0	10.0	262.0	262.00	1.0	97.0	97.0
Versar	3	AC	12/22/2014	2020	102	I	S				42.08	61746	6.7	2.00	13.00	13.00	0.50	1.50	1.50	0.05	0.73	0.73	0.01	0.06	0.06	1.0	11.0	11.0	2.00	6.20	6.20	2.00	0.000	2.00	20.00	67.0	67.0	5.0	0.0	5.0	10.0	279.0	279.00	1.0	54.0	54.0
										Event Mean Concentration:	**41.79**		**6.6**	**2.00**	**13.76**	**13.76**	**0.50**	**1.06**	**1.15**	**0.05**	**1.202**	**1.202**	**0.01**	**0.091**	**0.091**	**1.0**	**13.1**	**13.1**	**2.00**	**5.210**	**5.574**	**2.00**	**0.000**	**2.000**	**20.00**	**79.39**	**79.39**	**5.0**	**0.0**	**5.0**	**10.0**	**233.9**	**233.9**	**1.0**	**80.7**	**80.7**
Versar	1	AC	2/25/2015	930	102	I	B				32.1	245	6.9	2.00	0.00	2.00	0.50	0.80	0.80	0.05	1.60	1.60	0.01	0.04	0.04	1.0	9.0	9.0	2.00	2.80	2.80	2.00	0.000	2.00	20.00	98.0	98.0	5.0	0.0	5.0	10.0	41.0	41.0	1.0	480.0	480.0
										Event Mean Concentration:	**32.10**		**6.9**	**2.00**	**0.00**	**2.00**	**0.50**	**0.80**	**0.80**	**0.05**	**1.60**	**1.60**	**0.01**	**0.04**	**0.04**	**1.0**	**9.0**	**9.0**	**2.00**	**2.80**	**2.80**	**2.00**	**0.000**	**2.00**	**20.00**	**98.0**	**98.0**	**5.0**	**0.0**	**5.0**	**10.0**	**41.0**	**41.0**	**1.0**	**480.0**	**480.0**
Versar	1	AC	3/4/2015	2100	102	I	S	0.23	8.5	0.03	39.92	152328	6.9	4.00	6.00	6.00	0.50	1.50	1.50	0.05	1.00	1.00	0.01	0.18	0.18	1.0	55.0	55.0	2.00	21.00	21.00	2.00	5.20	5.20	20.00	150.0	150.0	5.0	5.0	5.00	10.0	327.0	327.0	1.0	180.0	180.0
Versar	2	AC	3/4/2015	2135	102	I	S				39.56	58952	6.9	4.00	5.00	5.00	0.50	1.30	1.30	0.05	0.79	0.79	0.01	0.24	0.24	1.0	85.0	85.0	2.00	26.00	26.00	2.00	8.70	8.70	20.00	190.0	190.0	5.0	7.0	7.00	10.0	1058.0	1058.0	1.0	150.0	150.0
Versar	3	AC	3/4/2015	2220	102	I	S				39.20	79804	6.9	4.00	0.00	4.00	0.50	0.80	0.80	0.05	0.58	0.58	0.01	0.15	0.15	1.0	44.0	44.0	2.00	13.00	13.00	2.00	4.00	4.00	20.00	100.0	100.0	5.0	7.0	7.00	10.0	1236.0	1236.0	1.0	110.0	110.0
										Event Mean Concentration:	**39.65**		**6.9**	**4.00**	**4.15**	**5.25**	**0.50**	**1.27**	**1.27**	**0.05**	**0.842**	**0.84**	**0.01**	**0.184**	**0.18**	**1.0**	**58.1**	**58.1**	**2.00**	**19.82**	**19.82**	**2.00**	**5.58**	**5.58**	**20.00**	**144.39**	**144.39**	**5.0**	**6.0**	**5.95**	**10.0**	**724.3**	**724.3**	**1.0**	**154.7**	**154.73**
Versar	1	AC	3/31/2015	1135	102	I	B				46.4	794	6.3	2.00	0.00	2.00	0.50	0.60	0.60	0.05	1.00	1.00	0.01	0.06	0.06	1.0	6.0	6.0	2.00	0.000	2.00	2.00	0.000	2.00	20.00	49.0	49.0	5.0	0.0	5.00	10.0	41.0	41.0	1.0	130.0	130.0
										Event Mean Concentration:	**46.40**		**6.3**	**2.00**	**0.00**	**2.00**	**0.50**	**0.60**	**0.60**	**0.05**	**1.00**	**1.00**	**0.01**	**0.06**	**0.06**	**1.0**	**6.0**	**6.0**	**2.00**	**0.000**	**2.00**	**2.00**	**0.000**	**2.00**	**20.00**	**49.0**	**49.0**	**5.0**	**0.0**	**5.00**	**10.0**	**41.0**	**41.0**	**1.0**	**130.0**	**130.0**
Versar	1	AP	4/14/2015	1045	102	I	S	0.53	13.5	0.04	57.20	102835	6.4	4.00	9.00	9.00	0.50	0.90	0.90	0.05	0.76	0.76	0.01	0.09	0.09	1.0	11.0	11.0	2.00	12.0	12.0	2.00	0.00	2.00	20.0	62.0	62.0	5.0	0.0	5.0	10.0	1354.0	1354.0	1.0	83.0	83.0
Versar	2	AP	4/14/2015	1740	102	I	S				57.38	480582	6.5	4.00	0.00	4.00	0.50	0.00	0.50	0.05	0.31	0.31	0.01	0.08	0.08	1.0	19.0	19.0	2.00	8.0	8.0	2.00	0.00	2.00	20.0	53.0	53.0	5.0	0.0	5.0	10.0	1043.0	1043.0	1.0	37.0	37.0
Versar	3	AP	4/14/2015	1905	102	I	S				56.84	139436	6.5	4.00	7.00	7.00	0.50	0.60	0.60	0.05	0.33	0.33	0.01	0.07	0.07	1.0	14.0	14.0	2.00	7.0	7.0	2.00	0.00	2.00	20.0	49.0	49.0	5.0	0.0	5.0	10.0	1126.0	1126.0	1.0	43.0	43.0
										Event Mean Concentration:	**57.25**		**6.49**	**4.00**	**2.63**	**5.29**	**0.50**	**0.24**	**0.58**	**0.05**	**0.378**	**0.38**	**0.01**	**0.079**	**0.08**	**1.0**	**16.9**	**16.90**	**2.00**	**8.38**	**8.38**	**2.00**	**0.00**	**2.00**	**20.0**	**53.51**	**53.51**	**5.0**	**0.0**	**5.0**	**10.0**	**1103.3**	**1103.3**	**1.0**	**44.7**	**44.7**
Versar	1	AP	6/8/2015	2110	102	I	S	0.23	8.5	0.03	73.4	13178	6.8	2.00	5.00	5.00	0.50	1.10	1.10	0.05	0.46	0.46	0.01	0.09	0.09	1.0	57.0	57.0	2.00	19.0	19.0	2.00	4.90	4.90	20.0	130.0	130.0	5.0	0.0	5.0	10.0	0.0	10.0	1.0	54.0	54.0
Versar	2	AP	6/8/2015	2140	102	I	S				73.4	375092	6.8	2.00	3.00	3.00	0.50	1.00	1.00	0.05	0.31	0.31	0.01	0.19	0.19	1.0	59.0	59.0	2.00	9.6	9.6	2.00	7.20	7.20	20.0	76.0	76.0	5.0	0.0	5.0	10.0	2014.0	9804.0	1.0	19.0	19.0
Versar	3	AP	6/8/2015	2250	102	I	S				72.86	492739	6.9	2.00	4.00	4.00	0.50	0.60	0.60	0.05	0.46	0.46	0.01	0.08	0.08	1.0	38.0	38.0	2.00	8.4	8.4	2.00	4.40	4.40	20.0	63.0	63.0	5.0	8.0	8.0	10.0	20.0	20.0	1.0	35.0	35.0
										Event Mean Concentration:	**73.10**		**6.86**	**2.00**	**3.59**	**3.59**	**0.50**	**0.78**	**0.78**	**0.05**	**0.396**	**0.40**	**0.01**	**0.127**	**0.13**	**1.0**	**47.2**	**47.22**	**2.00**	**9.07**	**9.07**	**2.00**	**5.60**	**5.60**	**20.0**	**69.54**	**69.54**	**5.0**	**4.5**	**6.7**	**10.0**	**868.7**	**4185.4**	**1.0**	**28.5**	**28.5**
Versar	1	AP	6/27/2015	945	102	I	S	1.24	21.0	0.06	70.61	151618	6.75	2.00	2.00	2.00	0.50	0.00	0.50	0.05	0.43	0.43	0.01	0.04	0.04	1.0	3.0	3.0	2.00	4.1	4.1	2.00	0.00	2.00	20.0	40.0	40.0	N/A	N/A	N/A	N/A	N/A	N/A	1.0	38.0	38.0
Versar	2	AP	6/27/2015	1715	102	I	S				72.50	1910098	6.85	2.00	0.00	2.00	0.50	0.70	0.70	0.05	0.16	0.16	0.01	0.06	0.06	1.0	15.0	15.0	2.00	5.6	5.6	2.00	0.00	2.00	20.0	34.0	34.0	N/A	N/A	N/A	N/A	N/A	N/A	1.0	20.0	20.0
Versar	3	AP	6/27/2015	2230	102	I	S				71.69	1424433	6.85	2.00	0.00	2.00	0.50	0.00	0.50	0.05	0.24	0.24	0.01	0.05	0.05	1.0	7.0	7.0	2.00	30.0	30.0	2.00	3.50	3.50	20.0	73.0	73.0	N/A	N/A	N/A	N/A	N/A	N/A	1.0	34.0	34.0
										Event Mean Concentration:	**72.09**		**6.85**	**2.00**	**0.09**	**2.00**	**0.50**	**0.38**	**0.61**	**0.05**	**0.204**	**0.20**	**0.01**	**0.055**	**0.06**	**1.0**	**11.2**	**11.21**	**2.00**	**15.50**	**15.50**	**2.00**	**1.43**	**2.61**	**20.0**	**50.20**	**50.20**							**1.0**	**26.5**	**26.5**

Anne Arundel County NPDES
Sampling and EMC Data – 2015 Reporting Year
Church Creek Station

Sampler	ID	Jurisdiction	Date	Time	Site	Outfall or Instream	Storm or Baseflow	Depth	Duration	Intensity	Temperature - field	Flow	pH - field	dt for BOD	BOD	BOD	dt for Total Kjeldahl Nitrogen	Total Kjeldahl Nitrogen	Total Kjeldahl Nitrogen	dt for Nitrate+ Nitrite - N	Nitrate+ Nitrite - N	Nitrate+ Nitrite - N	dt for Total Phosphorus	Total Phosphorus	Total Phosphorus	dt for TSS	TSS	TSS	dt for Copper	Copper	Copper	dt for Lead	Lead	Lead	dt for Zinc	Zinc	Zinc	dt for TPH	TPH	TPH	dt for E-COLI	E-COLI	E-COLI	dt for HARDNESS	HARDNESS	HARDNESS
								Inches	Hours	In/Hr	oF	cf	pH	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) mg/L	mg/L	(0) mg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) µg/L	µg/L	(0) µg/L	(dt) mg/L	(0) mg/L	(0) mg/L	(dt) MPN	MPN	(0) MPN	(dt) mg/L	(0) mg/L	(0) mg/L
SUMMER QUARTER (JULY, AUGUST, SEPTEMBER)																																														
Summer Quarter Flow-Weighted EMC (9/12/13):											74.11		6.91		0.23	2.16		0.50	0.71		0.21	0.21		0.16	0.16		58.20	58.20		7.77	7.77		5.87	5.87		78.47	78.47		0.00	5.00		98.00	102.27		29.30	29.30
Average:															1.19	mg/l		0.60	mg/l		0.21	mg/l		0.16	mg/l		58.20	mg/l		7.769	µg/l		5.869	µg/l		78.469	µg/l		2.50	mg/l		100.14	MPN/100mL		29.30	mg/l
														0.0000746	lb/cf		0.0000375	lb/cf		0.0000129	lb/cf		0.0000098	lb/cf		0.0036325	lb/cf		0.0000005	lb/cf		0.0000004	lb/cf		0.0000049	lb/cf		0.0001560	lb/cf					0.0018289	lb/cf
Total Volume (Quarter Events):															4,848,595	cf																														
Pollutant Load (Quarter Events):															361.47	lbs		181.76	lbs		62.32	lbs		47.43	lbs		17,612.71	lbs		2.35	lbs		1.78	lbs		23.75	lbs		756.57	lbs					8,867.58	
Total Volume (Quarter):															24,447,042	cf																														
Pollutant Load (Quarter):															1,823	lbs		916	lbs		314	lbs		239	lbs		88,805	lbs		11.9	lbs		9.0	lbs		120	lbs		3,815	lbs					44,711	
FALL QUARTER (OCTOBER, NOVEMBER, DECEMBER)																																													
Fall Quarter Flow-Weighted EMC (10/7/13), (12/6/13), (12/23/13):											65.15		6.97		2.57	3.36		0.76	0.80		0.436	0.436		0.190	0.190		64.74	64.74		11.306	11.334		5.851	6.212		96.232	96.232		0.0	5.0		12602.20	12602.20		44.71	44.71
Average:															2.96	mg/l		0.78	mg/l		0.44	mg/l		0.19	mg/l		64.74	mg/l		11.320	µg/l		6.031	µg/l		96.232	µg/l		2.50	mg/l		12602.20	MPN/100mL		44.71	mg/l
														0.0001851	lb/cf		0.0000487	lb/cf		0.0000272	lb/cf		0.0000119	lb/cf		0.0040410	lb/cf		0.0000007	lb/cf		0.0000004	lb/cf		0.0000060	lb/cf		0.0001560	lb/cf					0.0027907	lb/cf
Total Volume (Quarter Events):															1,691,628	cf																														
Pollutant Load (Quarter Events):															313.04	lbs		82.31	lbs		46.03	lbs		20.10	lbs		6,835.85	lbs		1.20	lbs		0.64	lbs		10.16	lbs		263.96	lbs					4,720.80	
Total Volume (Quarter):															27,846,027	cf																														
Pollutant Load (Quarter):															5,153	lbs		1,355	lbs		758	lbs		331	lbs		112,526	lbs		19.7	lbs		10.5	lbs		167	lbs		4,345	lbs					77,710	
WINTER QUARTER (JANUARY, FEBRUARY, MARCH)																																													
Fall Quarter Flow-Weighted EMC:											39.66		6.90		4.14	5.24		1.27	1.27		0.84	0.84		0.18	0.18		57.88	57.88		19.75	19.76		5.56	5.57		144.09	144.09		5.93	5.95		721.83	721.83		154.94	154.94
Average:															4.69	mg/l		1.27	mg/l		0.84	mg/l		0.18	mg/l		57.88	mg/l		19.754	µg/l		5.564	µg/l		144.095	µg/l		5.94	mg/l		721.83	MPN/100mL		154.94	mg/l
														0.0002926	lb/cf		0.0000790	lb/cf		0.0000526	lb/cf		0.0000115	lb/cf		0.0036125	lb/cf		0.0000012	lb/cf		0.0000003	lb/cf		0.0000090	lb/cf		0.0003708	lb/cf					0.0096706	lb/cf
Total Volume (Quarter Events):															292,123	cf																														
Pollutant Load (Quarter Events):															85.47	lbs		23.07	lbs		15.38	lbs		3.35	lbs		1,055.29	lbs		0.36	lbs		0.10	lbs		2.63	lbs		108.32	lbs					2,825.02	
Total Volume (Quarter):															26,648,542	cf																														
Pollutant Load (Quarter):															7,797	lbs		2,105	lbs		1,403	lbs		305	lbs		96,267	lbs		32.9	lbs		9.3	lbs		240	lbs		9,882	lbs					257,709	
SPRING QUARTER (APRIL, MAY, JUNE)																																													
Fall Quarter Flow-Weighted EMC (4/7/14, 5/27/14, 6/19/14):											70.15		6.80		1.05	2.74		0.43	0.63		0.26	0.26		0.07	0.07		18.25	18.25		13.38	13.38		1.95	3.04		54.01	54.01		0.77	1.87		307.03	881.11		29.43	29.43
Average:															1.90	mg/l		0.53	mg/l		0.26	mg/l		0.07	mg/l		18.25	mg/l		13.378	µg/l		2.496	µg/l		54.014	µg/l		1.32	mg/l		594.07	MPN/100mL		29.43	mg/l
														0.0001185	lb/cf		0.0000333	lb/cf		0.0000164	lb/cf		0.0000044	lb/cf		0.0011391	lb/cf		0.0000008	lb/cf		0.0000002	lb/cf		0.0000034	lb/cf		0.0000824	lb/cf					0.0018368	lb/cf
Total Volume (Quarter Events):															5,090,010	cf																														
Pollutant Load (Quarter Events):															603.10	lbs		169.31	lbs		83.31	lbs		22.55	lbs		5,798.27	lbs		4.25	lbs		0.79	lbs		17.16	lbs		419.42	lbs					9,349.34	
Total Volume (Quarter):															41,102,669	cf																														
Pollutant Load (Quarter):															4,870	lbs		1367.24	lbs		672.776	lbs		182.1	lbs		46822.0	lbs		34.322	lbs		6.403	lbs		138.571	lbs		3386.9	lbs					75497.42	
AVERAGE ANNUAL EMCs:											70.3		6.9		1.83	mg/l		0.61	mg/l		0.28	mg/l		0.13	mg/l		42.1	mg/l		10.961	µg/l		4.444	µg/l		72.16	µg/l		2.1	mg/l		2100.1	mg/l		34.6	mg/l
TOTAL ANNUAL POLLUTANT LOAD (EVENTS):															1363.08	lbs		456.45	lbs		207.04	lbs		93.43	lbs		31302.1	lbs		8.157	lbs		3.307	lbs		53.70	lbs		1548.3	lbs					25762.7	lbs
Per Acre:															4.88			1.64			0.74			0.33			112.16			0.03			0.012			0.192			5.548						92.310	
TOTAL 2015 POLLUTANT LOAD:															19642.7	lbs		5743.28	lbs		3147.533	lbs		1057.26	lbs		344419.4	lbs		98.706	lbs		35.094	lbs		665.234	lbs		21428	lbs					455626.57	lbs

APPENDIX H

BMP CODES

MDE Approved BMP Classifications

ESD BMPs		
Category	Code	Code Description
Alternative Surfaces (A)		
E	AGRE	Green Roof - Extensive
E	AGRI	Green Roof - Intensive
E	APRP	Permeable Pavements
E	ARTF	Reinforced Turf
Nonstructural Techniques (N)		
E	NDRR	Disconnection of Rooftop Runoff
E	NDNR	Disconnection of Non-Rooftop Runoff
E	NSCA	Sheetflow to Conservation Areas
Micro-Scale Practices (M)		
E	MRWH	Rainwater Harvesting
E	MSGW	Submerged Gravel Wetlands
E	MILS	Lanscape Infiltration
E	MIBR	Infiltration Berms
E	MIDW	Dry Wells
E	MMBR	Micro-Bioretention
E	MRNG	Rain Gardens
E	MSWG	Grass Swale
E	MSWW	Wet Swale
E	MSWB	Bio-Swale
E	MENF	Enhanced Filters
Structural BMPs		
Ponds (P)		
S	PWED	Extended Detention Structure, Wet
S	PWET	Retention Pond (Wet Pond)
S	PMPS	Mutliple Pond System
S	PPKT	Pocket Pond
S	PMED	Micropool Extended Detention Pond
Wetlands (W)		
S	WSHW	Shallow Marsh
S	WEDW	ED - Wetland
S	WPWS	Wet Pond - Wetland
S	WPKT	Pocket Wetland
Infiltration (I)		
S	IBAS	Infiltration Basin
S	ITRN	Infiltration Trench

Filtering Systems (F)		
S	FBIO	Bioretention
S	FSND	Sand Filter
S	FUND	Underground Filter
S	FPER	Perimeter (Sand) Filter
S	FORG	Organic Filter (Peat Filter)
S	FBIO	Bioretention
Open Channels (O)		
S	ODSW	Dry Swale
S	OWSW	Wet Swale
Other Practices (X)		
S	XDPD	Detention Structure (Dry Pond)
S	XDED	Extended Detention Structure, Dry
S	XFLD	Flood Management Area
S	XOGS	Oil Grit Separator
S	XOTH	Other

MDE Approved Alternative BMP Classifications

Alt. BMPs (A)	Code	Code Description
A	MSS	Mechanical Street Sweeping
A	VSS	Regenerative/Vacuum Street Sweeping
A	IMPP	Impervious Surface Elimination (to pervious)
A	IMPF	Impervious Surface Elimination (to forest)
A	FPU	Planting Trees or Forestation on Pervious Urban
A	CBC	Catch Basin Cleaning
A	SDV	Storm Drain Vacuuming
A	STRE	Stream Restoration
A	OUT	Outfall Stabilization
A	SPSC	Regenerative Step Pool Storm Conveyance
A	SHST	Shoreline Management
A	SEPP	Septic Pumping
A	SEPD	Septic Denitrification
A	SEPC	Septic Connections to WWTP

BIOLOGICAL AND GEOMORPHOLOGICAL CONDITION IN THE PICTURE SPRING BRANCH SUBWATERSHED, SEVERN RIVER WATERSHED, ANNE ARUNDEL COUNTY, MARYLAND: 2015

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1.0 INTRODUCTION

Anne Arundel County is required to perform physical stream monitoring in the Picture Spring Branch Subwatershed in accordance with their National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Discharge Permit (NPDES permit number MD0068306). The goal of this monitoring effort is to assess the implementation of best management practice (BMP) design criteria from the *2000 Maryland Stormwater Design Manual* approved by Maryland Department of the Environment (MDE). The BMP design criteria were applied to the stormwater management system constructed at the West County Library site, located in Odenton, Maryland, just west of the intersection of State Highways 170 (Telegraph Road) and 175 (Annapolis Road). Specifically, bioretention areas and dry swale structural BMPs, and the nonstructural credit "sheetflow to buffer" were incorporated into the library site development in order to mitigate the effects of stormwater runoff on Picture Spring Branch.

In addition, there are four other BMPs within the watershed that are providing detention for stormwater that are impacting the flows through the study reach. These include a dry detention pond, a retention pond, and two other detention ponds with shallow wetlands. Baseline conditions within the watershed, for both land use and BMP functionality, were developed as part of this long-term study. These conditions are monitored periodically to determine if changes within the watershed affect the conditions found in the stream channel. Stormwater facility locations within the watershed were verified for this 2015 report.

To monitor the effectiveness of these BMPs on stream channel protection, the County has implemented a NPDES Monitoring Program to characterize the biological and geomorphological conditions of the Picture Spring Branch Subwatershed, located within the Severn River Watershed, in the vicinity of the Odenton / West County Library. Physical condition and habitat monitoring for Picture Spring Branch began in 2003 and is conducted on an annual basis. Biological monitoring to measure overall stream health is also performed.

This report summarizes the results of biological, geomorphological, and physical habitat assessments performed in 2015 with comparisons to previous years' conditions, and discusses the current watershed conditions.

2.0 METHODS

2.1 SAMPLING LOCATIONS

The study area is located in the southwestern portion of the Picture Spring Branch Subwatershed, within the Severn River Watershed in Anne Arundel County, Maryland (Figure 2-1). The study area consists of the North Tributary and South Tributary and encompasses approximately 155 acres of drainage. The land use within the Picture Spring Branch study area is dominated by developed land, with over 56% residential, commercial, and industrial uses (Table 2-1). Less than one-third of the subwatershed (31.6%) is open space or wooded land cover, most of which surrounds the stream valley.

Three biological monitoring locations are located within the study area, which were selected by County staff in 2006 (see Figure 2-1). Two sites were placed on the North Tributary and one site was placed downstream of the confluence with the South Tributary and below Piney Orchard Parkway (MD State Highway 170). Sites were marked in the field using silver tree tags labeled with the site name located at the upstream and downstream ends of each 75-meter sampling segment.

Table 2-1. Summary of land use in the Picture Spring Branch Subwatershed, Anne Arundel County

Land Use	Acres	% of Watershed Area
Commercial	15.6	10.0%
Industrial	16.3	10.5%
Open Space	6.0	3.9%
Residential	56.0	36.1%
Transportation	16.8	10.8%
Utility	1.6	1.1%
Forest	43.0	27.7%
Total	**155.3**	

Source: Anne Arundel County Department of Public Works

Five permanent cross sections were previously established for the County's NPDES Program and were measured again in 2015 as part of the annual geomorphological assessment. Three cross sections are located along the North Tributary, one is located on the South Tributary, and another is located downstream of Piney Orchard Parkway (see Figure 2-1). Permanent cross section monuments were placed on each bank and consist of iron bolts set in concrete flush to the ground surface.

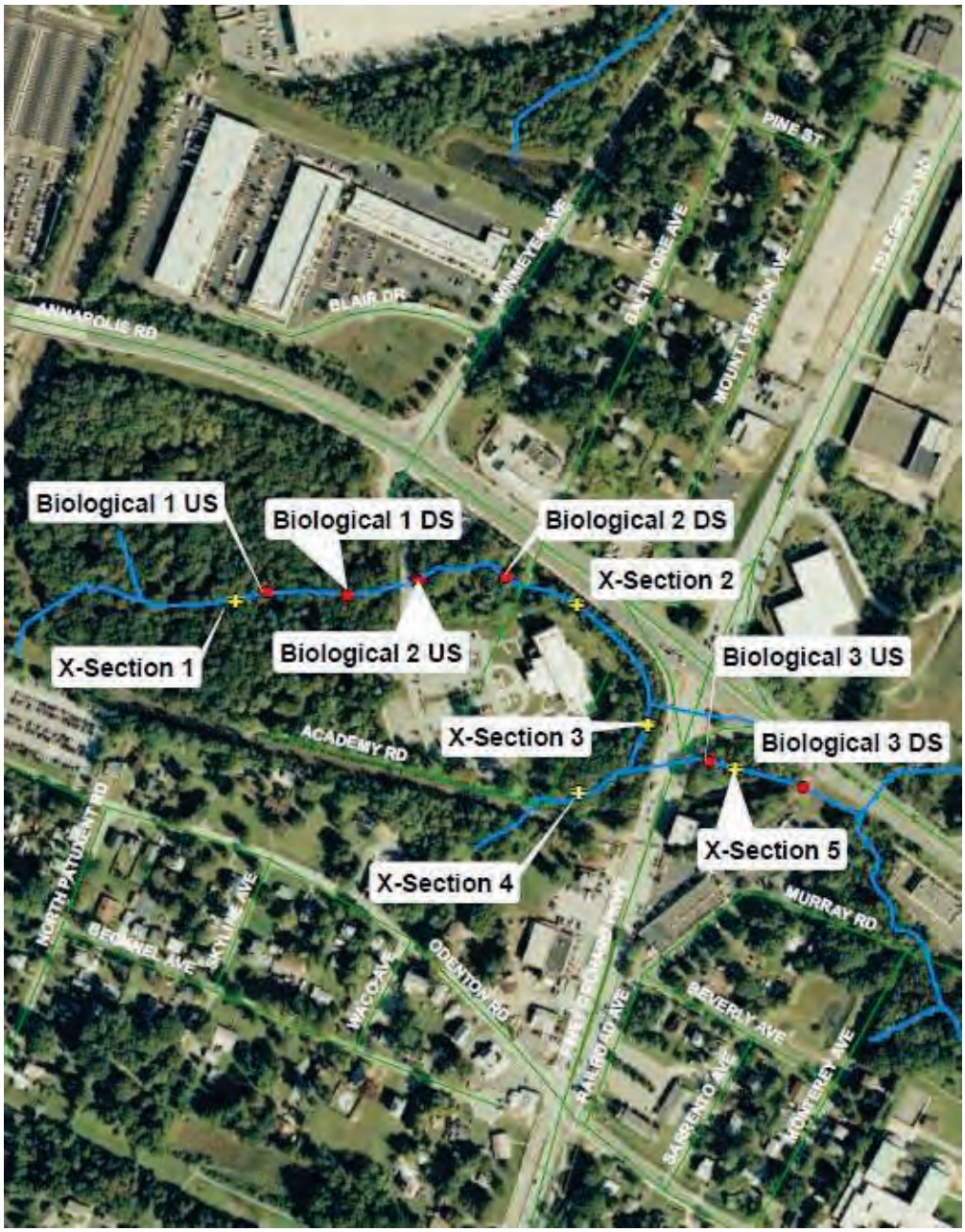


Figure 2-1. Picture Spring Branch study area stream monitoring locations

2.2 FIELD METHODS

All biological assessment data were collected in accordance with the *Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan* (Anne Arundel County 2010), which incorporates many elements of Maryland Department of Natural Resources' Maryland Biological Stream Survey (MBSS). Geomorphic assessment data were

collected in accordance with the standard operating procedures (SOPs) approved for the County's NPDES Program. All methods are consistent with previous years' methods (with applicable updates) to ensure data comparability between years. Collection methods are summarized below. Field data were collected in 2015 by Versar, Inc., a consultant to Anne Arundel County.

2.2.1 Stream Habitat

To support the biological monitoring, a visual assessment of physical habitat was completed at each monitoring site to evaluate the reach's ability to support aquatic life. Both the MBSS Physical Habitat Index (PHI; Paul et al. 2003) and the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocol (RBP) habitat assessment for low gradient streams (Barbour et al. 1999) were used to visually assess the physical habitat at each site in conjunction with the spring benthic monitoring. Both habitat assessments consist of a review of biologically significant habitat parameters that assess a stream's ability to support an acceptable level of biological health.

2.2.2 Benthic Macroinvertebrates

Benthic macroinvertebrate samples were collected in March 2015 following the MBSS Spring index period protocols (MD DNR 2010) and consistent with the methods specified in *Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan* (QAPP; Anne Arundel County 2010). This methodology emphasizes the community composition and relative abundance of benthic macroinvertebrates inhabiting the most taxonomically diverse, or productive, instream habitats. In this sampling approach, a total of twenty jabs are distributed among the most productive habitats present within the 75-meter reach and sampled in proportion to their dominance within the segment. The most productive stream habitats are riffles followed by rootwads, rootmats and woody debris, and associated snag habitat; leaf packs; submerged macrophytes and associated substrate; and undercut banks. Other less preferred habitats include gravel, broken peat, clay lumps and detrital or sand areas in runs; however, of the aforementioned habitat types, those that are located within moving water are preferred over those in still water.

2.2.3 Water Quality

To supplement the biological and physical sampling, *in situ* water quality was measured at each site. Field tested parameters include pH, specific conductivity, dissolved oxygen, temperature, and turbidity. With the exception of turbidity, which was measured once at the upstream end of the site, all measurements were collected from three locations within each sampling reach (upstream end, midpoint, and downstream end) and results were averaged to minimize variability and better represent water quality conditions throughout the entire sampling reach. All *in situ* parameters were measured with a YSI 6820 multiparameter water quality sonde.

2.2.4 Geomorphic Assessment

Geomorphic assessments included a survey of the longitudinal profile, measurement of permanent cross sections, and representative pebble counts. Data from these measurements were used to determine the stream type of each reach as categorized by the Rosgen Stream Classification (Rosgen 1996), which can be found in Appendix A.

The longitudinal profile was performed throughout the entire study area, totaling 1968 linear feet along the North Tributary and continuing below Telegraph Road (Maryland Route 170 and 355 linear feet along the South Tributary. The goal of the longitudinal profile was to identify indicators and elevations of the bankfull discharge (i.e., bankfull indicators) and to determine the bankfull water surface slope throughout the study reach. Once the bankfull indicators were identified, elevation data on the channel thalweg, water surface, and bankfull indicators were also collected.

The cross section surveys were performed at the five permanent cross section locations (Figure 2-1). Photos were taken of upstream, downstream, left bank, and right bank views at each cross section location. Photographs are included in Appendix B. Cross section surveys consisted of measuring the topographic variability of the associated stream bed, floodplains, and terraces, including:

- Monument elevations
- Changes in topography
- Top of each channel bank
- Elevations of bankfull indicators
- Edge of water during the time of survey
- Thalweg or deepest elevation along active channel
- Depositional and erosional features within the channel

During the cross sectional survey, the following measurements and calculations of the bankfull channel, which are critical for determining the Rosgen stream type of each reach, were also collected:

- Bankfull Width (Wbkf): the width of the channel at the elevation of bankfull discharge or at the stage that defines the bankfull channel.
- Mean Depth (dbkf): the mean depth of the bankfull channel.
- Bankfull Cross Sectional Area (Abkf): the area of the bankfull channel, estimated as the product of bankfull width and mean depth.
- Width Depth Ratio (Wbkf/dbkf): the ratio of the bankfull width to mean depth.
- Maximum Depth (dmbkf): the maximum depth of the bankfull channel, or the difference between the thalweg elevation and the bankfull discharge elevation.

- Width of Floodprone Area (Wfpa): the width of the channel at a stage of twice the maximum depth. If the width of the floodprone area was far outside of the channel, its value was visually estimated or paced off.
- Entrenchment Ratio (ER): the ratio of the width of the floodprone area versus bankfull width.
- Sinuosity (K): ratio of the stream length versus the valley length or the valley slope divided by the channel slope. Sinuosity was visually estimated or the valley length was paced off so that an estimate could be calculated.

To quantify the distribution of channel substrate particle sizes within the study area, a modified Wolman pebble count (Rosgen 1996) was performed at each cross section location. Reach-wide proportional counts were used. Each pebble count consists of stratifying the reach based on the frequency of channel features in that reach (e.g., riffle, run, pool, glide) and measuring 100 particles across ten transects (i.e., 10 particles in each of 10 transects). The transects are allocated across all feature types in the proportion at which they occur within the reach. The intermediate axis of each measured pebble is recorded. The goal of the pebble count is to measure 100 particles across the bankfull width of the channel and calculate the median substrate particle size (i.e., D50) of the reach. This value is used for categorizing the sites into the Rosgen Stream Classification (Rosgen 1996). If a channel was clearly a sand or silt bed channel with no distinct variation in material size, the pebble count was not performed, and the D50 was visually estimated. However, if the channel did have variation in bed material size from feature to feature, a full pebble count was performed.

2.3 DATA ANALYSIS

2.3.1 Aquatic Habitat

At each monitoring site, stream physical habitat was visually assessed utilizing the Maryland Biological Stream Survey (MBSS) Physical Habitat Index (PHI; Paul et al. 2003). The PHI was developed in part based on the EPA's Rapid Bioassessment Protocol (RBP; Barbour et al. 1999), and has been specifically calibrated to each of Maryland's physiographic regions. The habitat metrics for coastal plain streams include epifaunal substrate, percent shading, remoteness (i.e., distance to the nearest road), instream habitat, bank stability, and instream woody debris and rootwads. The metrics selected represent a mixture of physical habitat characteristics including geomorphology, habitat complexity for aquatic biota, riparian condition, and surrounding land use.

To calculate PHI at each site, six parameters were given a numerical score and a categorical rating. The raw scores are then transformed into a scaled score (0-100 scale) as described in Paul et al. (2003), and the six scaled scores are averaged into an aggregate final PHI score. Narrative condition descriptions and scoring ranges for the PHI are displayed in Table 2-2.

The RBP habitat assessment consists of a review of ten biologically significant habitat parameters that assess a stream's ability to support an acceptable level of biological health: Epifaunal substrate/available cover, Embeddedness, Velocity/depth regime, Sediment deposition, Channel flow status, Channel alteration, Frequency of riffles/bends, Bank stability, Vegetative protection, and Riparian vegetative zone width (Barbour et al. 1999). In the field, each parameter was given a numerical score from 0-20 (20=best, 0=worst), or 0-10 (10=best, 0=worst) for individual bank parameters, and a categorical rating of optimal, suboptimal, marginal or poor. Overall habitat quality typically increases as the total score for each site increases. The individual RBP habitat parameters for each reach were summed to obtain an overall RBP assessment score. Because adequate reference conditions currently do not exist for Anne Arundel County, the percent comparability was calculated based on western coastal plain reference site conditions obtained from work done in Prince George's County streams (Stribling et al. 1999). The percent of reference score, or percent comparability score, was then used to place each site into corresponding narrative rating categories. The ranges are shown in Table 2-3.

Table 2-2. Maryland Biological Stream Survey PHI scoring

Score	Narrative
81-100	Minimally Degraded
66-80.9	Partially Degraded
51-65.9	Degraded
0-50.9	Severely Degraded

Table 2-3. EPA Rapid Bioassessment Protocol (RBP) scoring

Percent of Reference Score	Narrative
90-100	Comparable to Reference
75.1-89.9	Supporting
60.1-75	Partially Supporting
0-60	Non-Supporting

2.3.2 Benthic Macroinvertebrates

Benthic macroinvertebrate samples were processed and subsampled according to MBSS methods described in the MBSS laboratory methods manual (Boward and Freidman, 2000) and as briefly summarized in the *Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan* (Anne Arundel County 2010). Subsampling is conducted to standardize the sample size and reduce variation caused by field collection methods. In brief, the sample was washed of preservative in a 0.595mm screen and spread evenly across a tray comprised of 100 numbered 5cm x 5cm grids. A random number between one and 100 was selected and the selected gird was picked entirely of macroinvertebrates under a bright light source. This process was repeated until a count of 120 was reached. The 120 organism target was used following MBSS methods to allow for specimens that are missing parts or are early instars, which cannot be properly identified.

The samples were taxonomically identified by Versar taxonomists certified by the Society for Freshwater Science (SFS) (formerly known as the North American Benthological Society, NABS). The taxonomic level for most organisms was genus level when possible, with the exception of Oligochaeta which were identified to the family level. Early instars or damaged specimens were identified to the lowest possible level. Oligochaeta and Chironomidae specimens were permanently slide mounted for identification. Counts and identifications were recorded on a laboratory bench sheet and entered into a master database for analysis. A list of all taxa identified is provided in Appendix C: Master Taxa List.

Benthic macroinvertebrate data were analyzed using methods developed by MBSS as outlined in the *New Biological Indicators to Better Assess the Condition of Maryland Streams* (Southerland et al. 2005). The Benthic Index of Biotic Integrity (BIBI) approach involves statistical analysis using metrics that have a predictable response to water quality and/or habitat impairment. The metrics selected fall into five major groups including taxa richness, composition measures, tolerance to perturbation, trophic classification, and habit measures. Tolerance values were obtained from Bressler et al. (2005).

Raw values from each metric are given a score of 1, 3, or 5 based on ranges of values developed for each metric. The results are combined into a scaled BIBI score ranging from 1.0 to 5.0 and a corresponding narrative rating is assigned. Three sets of metric calculations have been developed for Maryland streams based on broad physiographic regions: Coastal Plain, Piedmont and Combined Highlands. The Coastal Plain, and Piedmont regions are divided by the Fall Line. The current study area is located within the Coastal Plain region. Table 2-4 shows the thresholds for the determination of the metric scoring. The metrics calculated for Coastal Plain streams are as follows:

Total Number of Taxa – Equals the richness of the community in terms of the total number of genera at the genus level or higher. A large variety of genera typically indicate better overall water quality, habitat diversity and/or suitability, and community health.

Number of EPT Taxa – Equals the richness of genera within the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). EPT taxa are generally considered pollution sensitive, thus higher levels of EPT taxa would be indicative of higher water quality.

Number of Ephemeroptera Taxa – Equals the total number of Ephemeroptera Taxa in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.

Percent Intolerant Urban – Percentage of sample considered intolerant to urbanization. Equals the percentage of individuals in the sample with a tolerance value of 0-3 out of 10. As impairment increases the percent of intolerant taxa decreases.

Percent Ephemeroptera – Equals the percent of Ephemeroptera individuals in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.

Number Scraper Taxa – Equals the number of taxa in the sample that have evolved to scrape their food from the substrate in their environment. As the levels of stressors or pollution rise, there is an expected decrease in the numbers of Scraper taxa.

Percent Climbers – Equals the percentage of the total number of individuals who are adapted to living on stem type surfaces. Higher percentages of climbers typically represent a decrease in stressors and overall better water quality.

Table 2-4. Biological condition scoring for the coastal plains metrics

Metric	Score		
	5	**3**	**1**
Total Number of Taxa	≥ 22	14-21	< 14
Number of EPT Taxa	≥ 5	2-4	< 2
Number of Ephemeroptera Taxa	≥ 2	1.9-1.0	< 1.0
Percent Intolerant Urban	≥ 28	10-27	< 10
Percent Ephemeroptera	≥ 11	0.8-10.9	< 0.8
Number Scraper Taxa	≥ 2	1.9-1.0	< 1.0
Percent Climbers	≥ 8.0	0.9-7.9	< 0.9

All of the metric scores are summed and then averaged to obtain the final BIBI score. Table 2-5 shows the scores and narrative rankings of the MBSS BIBI. The QA/QC information for these calculations is included in Appendix D.

Table 2-5. Maryland Biological Stream Survey BIBI scoring

BIBI Score	Narrative Ranking	Characteristics
4.0-5.0	Good	Comparable to reference conditions, stream considered to be minimally impacted, biological metrics fall within upper 50th percentile of reference site conditions.
3.0-3.9	Fair	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of minimally impacted streams.
2.0-2.9	Poor	Significant deviation from reference conditions, indicating some degradation. On average, biological metrics fall below the 10th percentile of reference site values.
1.0-1.9	Very Poor	Strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of minimally impacted streams, indicating severe degradation. On average, most or all metrics fall below the 10th percentile of reference site values.

2.3.3 Water Quality

Data were compared to the standards for Use I streams listed in the *Code of Maryland Regulations (COMAR) 26.08.02.03-3 Water Quality* and shown in Table 2-6.

Table 2-6. Maryland COMAR water quality standards for Use I streams

Parameter	Standard
pH	6.5 to 8.5
Dissolved Oxygen (mg/L)	Minimum of 5 mg/L
Conductivity (µS/cm)	No existing standard
Turbidity (NTU)	Maximum of 150 NTU and maximum monthly average of 50 NTU
Total Dissolved Solids (mg/L)	No existing standard
Temperature (C)	Maximum of 32 °C (90 °F) or ambient temperature, whichever is greater

Source: Code of Maryland Regulations (COMAR) 26.08.02.03-3 Water Quality

2.3.4 Geomorphic Assessment

Geomorphic field data were compared to regional relationships of bankfull channel geometry developed by the USFWS for streams in the Maryland Coastal Plain (McCandless 2003) and by Anne Arundel County Department of Public Works (AADPW 2002) for urban streams within the County. Estimates of the bankfull channel parameters, the longitudinal profile survey, the cross section survey, and the pebble count data were entered into *The Reference Reach Spreadsheet* (Mecklenburg 2004) and analyzed for each assessment site. These data were used to identify each stream reach as one of the stream types categorized by the Rosgen Stream Classification (Rosgen 1996). In the Rosgen Classification methodology, streams are categorized based on their measured field values of entrenchment ratio, width/depth ratio, sinuosity, water surface slope, and channel materials according to the table in Appendix A: Rosgen Stream Classification. As illustrated in Appendix A, the Rosgen Stream Classification categorizes streams into broad stream types, which are identified by the letters Aa, A, B, C, D, DA, E, F, and G. Table 2-7 includes general descriptions of each Rosgen stream type. A summary of the stream types identified for the streams in this study is included in Appendix B: Geomorphic Assessment Results.

Table 2-7. Rosgen Stream Classification types

Channel Type	General Description
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.
A	Steep, entrenched, confined, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.
B	Moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools. Moderate width/depth ratio. Narrow, gently sloping valleys. Very stable plan and profile. Stable banks.
C	Low gradient, meandering, slightly entrenched, point-bar, riffle/pool, alluvial channels with broad, well-defined floodplains.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks. Active lateral adjustment, high bedload and bank erosion.
DA	Anastomosing (multiple channels) narrow and deep with extensive, well-vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and width/depth ratios. Very stable streambanks.
E	Low gradient, Highly sinuous, riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander/width ratio.
F	Entrenched, meandering riffle/pool channel on low gradients with high width/depth ratio and high bank erosion rates.
G	Entrenched "gully" step/pool and low width/depth ratio on moderate gradients. Narrow valleys. Unstable, with grade control problems and high bank erosion rates.

Source: Rosgen (1996).

2.4 LAND USE AND STORMWATER MANAGEMENT ASSESSMENT

2.4.1 Picture Spring Branch Watershed BMP Inspection

Based on record review and field reconnaissance conducted during December 2015 - January 2016, Picture Spring Branch watershed contains 17 BMPs, as shown in Figure 2-2. BMP details are provided in Table 2-8. Inspections at BMPs under the County's jurisdiction are carried out regularly. Inspection and maintenance information is currently being updated in the County's BMP database. Inspection reports are maintained at the County's offices.



Figure 2-2. Picture Spring Branch BMPs

Table 2-8. Picture Spring Branch BMP overview

AA County Urban BMP Database ID	BMP Type[a]	Drainage Area (acres)	Location	Address	Last Inspection[b]	Rank[c]
AA002445	PWED	36.86	Peach Tree East	1300 Treasure Dr.	7/25/2012	1
AA004443	IBAS	10.60	Odenton Commuter Rail Station	End of Odenton Rd.	6/25/2013	2
AA009976	ITRN	3.00	The Village at Odenton Station - WQ Sediment Chambers (6)	360 Morgan Rd.	8/12/2014	3
AA009977	ITRN	3.00	The Village at Odenton Station - Water Quality Trenches (6)	360 Morgan Rd.	8/12/2014	3
AA004926	ITRN	2.97	Epiphany Episcopal Church	1419 Odenton Rd.	8/5/2002	5
AA004558	XDPD	1.73	Donaldson Funeral Home	Annapolis Rd. 1411	-	6
AA012418	FBIO	1.57	West County Regional Library	1325 Annapolis Rd.	5/8/2012	7
AA012422	WSHW	1.07	West County Regional Library	1325 Annapolis Rd.	5/8/2012	8
AA012419	FBIO	0.83	West County Regional Library	1325 Annapolis Rd.	5/8/2012	9
AA012421	ODSW	0.70	West County Regional Library	1325 Annapolis Rd.	5/8/2012	10
AA009979	ITRN	0.70	The Village at Odenton Station - Peak Sed Chambers (4)	360 Morgan Rd.	8/12/2014	11
AA012190	XDPD	0.68	Walgreens Store 12559	8374 Piney Orchard Pkwy.	12/20/2012	12
AA009980	ITRN	0.67	The Village at Odenton Station - Bioretention (2)	360 Morgan Rd.	8/12/2014	13
AA012189	FSND	0.57	Walgreens Store 12559	8374 Piney Orchard Pkwy.	12/20/2012	14
AA009978	ITRN	0.51	The Village at Odenton Station - Peak Mgmt Trenches (6)	360 Morgan Rd.	8/12/2014	15
AA012420	FBIO	0.35	West County Regional Library	1325 Annapolis Rd.	5/8/2012	16
AA000692	ITRN	-	Goodman Office Building	Second Ave.	6/20/2002	17

(a) MDE BMP codes, see Appendix E
(b) Dates as recorded in the County's Urban BMP database (Attachment A, Table B of Anne Arundel County MS4 Report for FY2015, February 2016)
(c) Ranked in order by drainage area

3.0 RESULTS

3.1 AQUATIC HABITAT

Physical habitat quality within the Picture Spring Branch study area was primarily rated as "Degraded" by the Maryland PHI. However, the most upstream reach, PSB-01, received the highest score (72.1), and was rated as "Partially Degraded." Remoteness was rated very low at PSB-01; however, there was substantial riparian buffer throughout this reach providing adequate shading, banks exhibited only minor erosion and were well-vegetated, and woody debris and rootwads were present in sufficient amounts for colonization of benthic macroinvertebrates. Site PSB-02, located between the Winmeyer Avenue and Baltimore Avenue culverts, received a score of 64.4 and a narrative rating of "Degraded." Remoteness was rated very low due to the immediate proximity to the parking lot and roads surrounding the stream reach. The site downstream of Maryland Route 170 (PSB-03) also received a "Degraded" habitat rating (PHI score of 60.5), primarily due to a very low remoteness score, a low score for shading and epifaunal substrate, and a marginal score for instream habitat. Table 3-1 shows the PHI scores for the sampling sites within the Picture Spring Branch study area. Data for individual parameters are listed in Appendix F.

Physical habitat quality was also evaluated with the RBP and rated "Partially Supporting" for two sites and "Supporting" for one site (Table 3-1). Index scores varied somewhat and ranged from a low of 62 at PSB-03 to a high of 79 at PSB-01. All sites scored low for velocity/depth regime metric. PSB-02 scored especially low in sediment deposition, while all sites scored low in epifaunal substrate/cover and embeddedness.

Table 3-1. PHI and RBP physical habitat assessment results - 2015

Site	PHI Score	PHI Narrative Rating	RBP Score	RBP Narrative Rating
PSB-01	72.1	Partially Degraded	79	Supporting
PSB-02	64.4	Degraded	63	Partially Supporting
PSB-03	60.5	Degraded	62	Partially Supporting

3.2 BENTHIC MACROINVERTEBRATES

The biological condition rated "Poor" at sites PSB-01 and PSB-02, and "Fair" at PSB-03. Table 3-2 contains the BIBI scores and corresponding narrative condition ratings for each sampling location. Detailed data on each site can be found in Appendix F: Biological Assessment Results.

The most upstream site within the North Tributary (PSB-01) had a BIBI score of 2.43, which is identical to its 2014 BIBI score. This site is buffered by a young deciduous forest. The macroinvertebrate community was represented by 20 taxa, four of which were sensitive EPT taxa. The sample was dominated by individuals of the family Pisidium, a small to minute freshwater bivalve mollusk. Overall, 9.4% of the individuals present were intolerant to urban stressors. However, the complete lack of Ephemeroptera taxa in the subsample indicates that stressors such as sedimentation may be affecting the biological community. Climbers made up 8.4% of the sample.

Table 3-2. Benthic macroinvertebrate assessment results - 2015

Site	BIBI Score	Narrative Rating
PSB-01	2.43	Poor
PSB-02	2.71	Poor
PSB-03	3.00	Fair

Site PSB-02, also located on the North Tributary, received a BIBI score of 2.71 in 2015, identical to its score in 2014. Of the 17 taxa present in the subsample, 7.7% were intolerant to urban stressors, and three taxa were the sensitive EPT taxa. The dominant taxa at this site was the chironomid Parametriocnemus, followed by Pisidium and Polypedilum. Like PSB-01, this site also lacked Ephemeroptera taxa. PSB-02, however, did have a higher percentage of climbers as compared to PSB-01 in 2015, 16.2% and 8.4% respectively.

Downstream of State Highway 170, site PSB-03 received a BIBI score of 3.00, an increase from its 2014 score of 2.43 (Versar 2014). Overall, this site had a total of 24 taxa identified, including three sensitive EPT taxa. The sample had a low abundance of 85 individual organisms. This could be due to the cold water temperatures present at the time of sampling or due to lack of substrate and habitat desirable for colonization at the site. However, none of the individuals present in the subsample were intolerant to urban stressors, suggesting an increase in urban stressors at this sampling location. As with the other two sites, Ephemeroptera taxa were again absent from the subsample. The benthic community was dominated by the taxa Conchapelopia and Parametriocnemus, both generally tolerant midges of the Chironomidae family.

3.3 WATER QUALITY

All water quality measurements met Maryland's water quality standards for Use I streams (Table 3-3). Conductivity values were relatively high compared to most coastal plain streams, but are within the range of those found in other urban, or highly impervious, drainage areas in Maryland (DNR, 2001, 2003, 2005; KCI, 2009a; Hill and Crunkleton, 2009). Stream conductivity is affected by inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions or sodium, magnesium, calcium, iron, and aluminum cations, many of which are generally found at elevated concentrations in urban streams (Paul and Meyer 2001).

Increased stream ion concentrations (measured as conductivity) in urban systems typically result from runoff over impervious surfaces, passage through pipes, and exposure to other infra-structure (Cushman 2006).

Table 3-3. Water Quality Measurement Results - 2015

Site	pH unit	Temperature °C	Dissolved Oxygen mg/L	Conductivity µS/cm	Turbidity NTU
PSB-01	6.55	8.86	10.92	1139	19.6
PSB-02	6.84	8.49	11.75	1011	19.7
PSB-03	7.12	8.61	12.39	909	22.3

3.4 GEOMORPHIC ASSESSMENT

The geomorphic assessment field data were compared to both the Maryland Coastal Plain (MCP) regional relationships of bankfull channel geometry (McCandless 2003) and relationships for gaged urban Coastal Plain streams developed specifically for Anne Arundel County (AADPW 2002) to determine how bankfull characteristics observed in the field compared to those predicted by the MCP and urban relationships. Comparisons of bankfull width, bankfull cross-sectional area, and mean bankfull depth are shown in Figures 3-1, 3-2, and 3-3, respectively. Bankfull width values tended to loosely fit the predictions of the urban curve, with some points wider than predicted due to the engineered channel design. All bankfull cross-section area field data values fell between the MCP curve and urban curve predictions. Field data for mean bankfull depth mainly fell between the MCP curve and urban curve predictions, with one site falling just below the MCP curve. Overall, it appears that some of the field data were not consistent with the MCP relationships; however, it should be noted that the regional curves were developed using streams with drainage areas ranging from 0.3 to 89.7 square miles, with the majority of the data collected in watersheds greater than one square-mile with low (zero to three percent) imperviousness. Thus, it is possible that stream channels with smaller drainage areas, such as those studied in this assessment (ranging from 0.07 to 0.23 square miles), exhibit greater variability in channel dimensions when compared to the MCP relationships. Additionally, the Rosgen method is best used on streams that are free to adjust their lateral boundaries under the current discharge regime experienced by the system (Rosgen 1996), conditions which do not necessarily exist in the study area. For example, cross sections 2, 3, and 5 are underlain by concrete trapezoidal channels, possibly making the accurate determination of the bankfull indicators in the field at these locations problematic. Regardless, given the high imperviousness of the study drainage area and the modified nature of the channel, it is not surprising that the field data deviated in many cases from the MCP curve and were more closely matched to urban curve predictions for bankfull width.

Based on the Rosgen Classification scheme, two sites were classified as C channels, two sites as F channels, and one site was classified as an E channel (Table 3-4). Water surface slopes along the study area ranged from 0.002 ft/ft to 0.016 ft/ft. D50's ranged from 0.18 mm to

1.3 mm, meaning all five sites had channel substrates dominated by sand. Detailed summaries of the geomorphic data and stream types are included in Appendix B: Geomorphic Assessment Results.

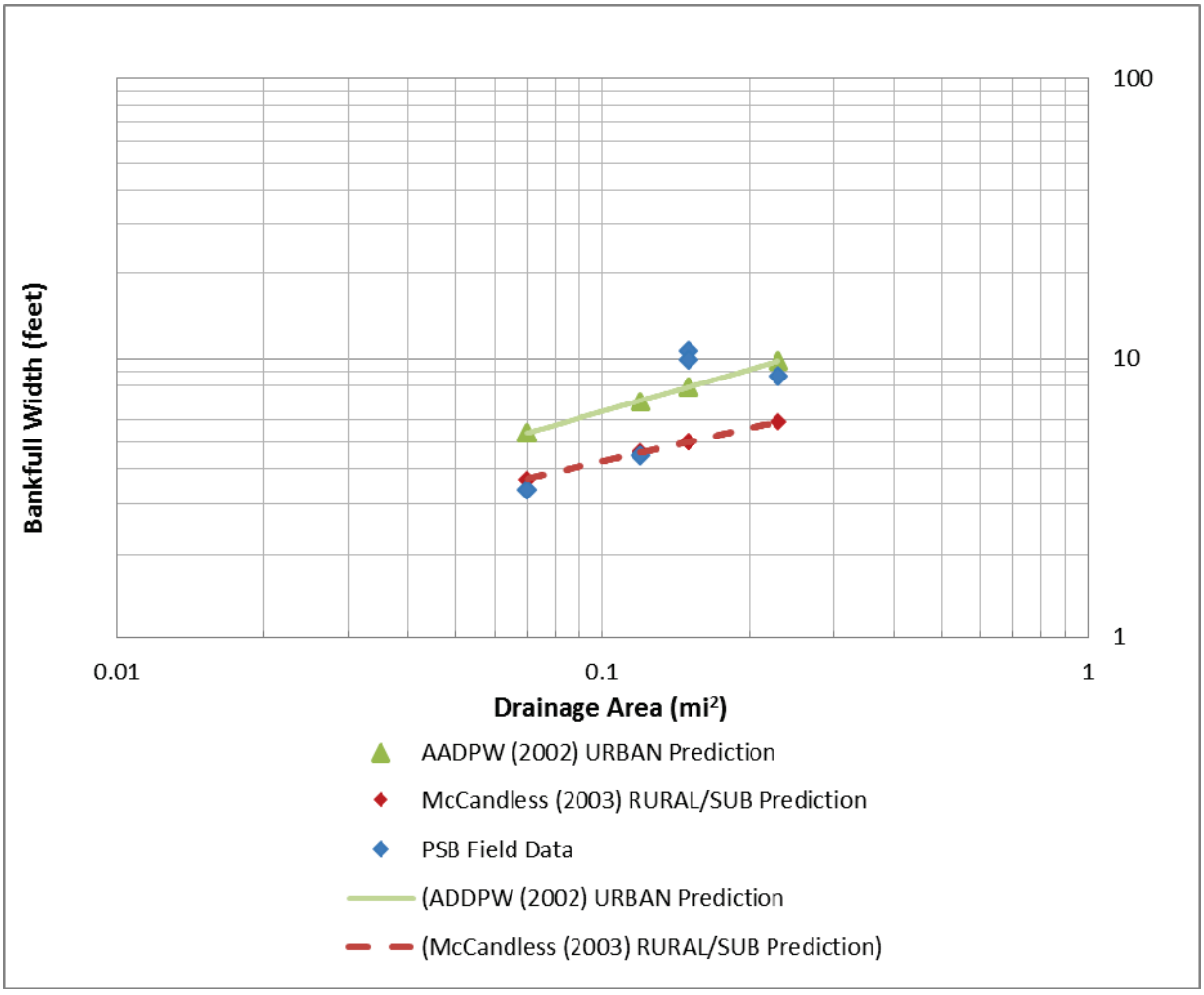


Figure 3-1. Comparison of the bankfull width drainage area relationship between Picture Spring Branch (PSB) 2015 field data and regional relationship curve data

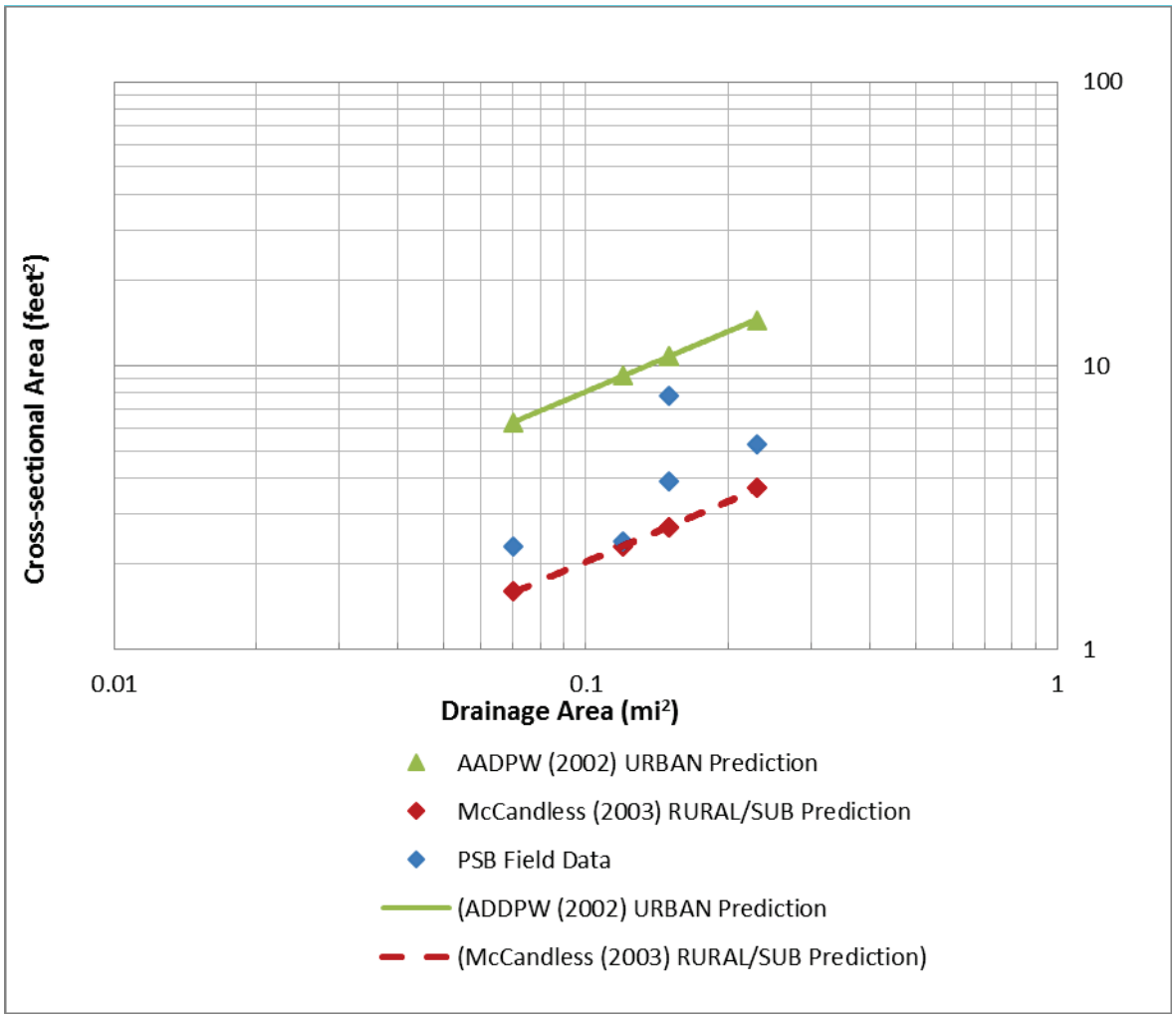


Figure 3-2. Comparison of the bankfull cross-sectional area drainage area relationship between Picture Spring Branch 2015 field data and regional relationship curve data

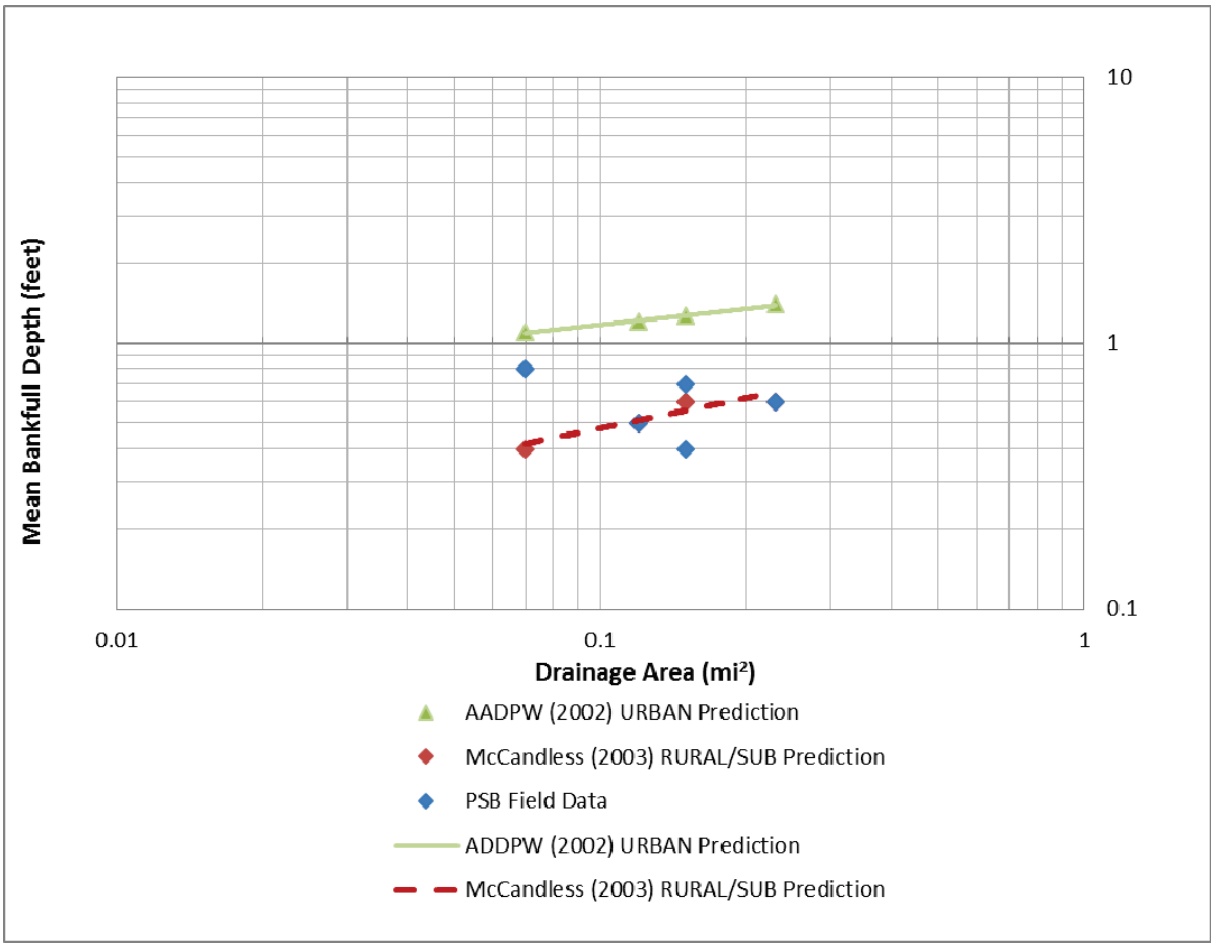


Figure 3-3. Comparison of the mean bankfull depth drainage area relationship between Picture Spring Branch 2015 field data and regional relationship curve data

Table 3-4. Rosgen Classification Results - 2015

Cross Section	Classification	D50 (mm)	Water Surface Slope (ft/ft)
XS-1	C5	0.18	0.009
XS-2	F5	0.23	0.002
XS-3	F5	1.3	0.011
XS-4	E5	0.23	0.016
XS-5	C5	0.55	0.002

The channel located in the well-forested, upper portion of the North Tributary at cross section 1 exhibited characteristics typical of both C and E type channels, as well as some characteristics that fit neither. For example, E channels are typically very sinuous; however, this reach had very little sinuosity. Likewise, C channels often have numerous point bars, which were not common along this reach. As a result, best professional judgment was applied and the final decision was to assign a C5 classification in order to be consistent with the prior classifications, since there is little evidence to indicate that the channel has evolved from a C to E type channel.

F channels were identified at cross sections 2 and 3, which had been altered in the past with concrete trapezoidal channels. The channel along this segment of the North Tributary and downstream of Maryland State Highway 170 was overwidened as a result of the channelization. However, it continues to adjust by filling with sediment and woody debris, thus establishing a more "natural" stream channel within the man-made, engineered channel. Increase in width/depth ratio and decrease in entrenchment ratio reflect the changes occurring at cross section 5 as a result of continued sediment deposition. Consequently, the Rosgen classification at this cross section has changed from an F5 in 2014, to a C5 in 2015.

An E channel was identified at cross section 4 on the South Tributary, which appeared to have been channelized in the past and is piped underground for a significant distance upstream, further modifying its hydrology. However, the South Tributary is not overwidened and is significantly steeper than the North Tributary. Indicators were observed that show some limited floodplain connectivity along the upstream portion of the tributary where the cross section is located. However, just downstream of the cross section location, the channel became noticeably entrenched and showed signs of active downcutting. While it is possible that this reach may exhibit both B and E characteristics along different portions of the reach, it was assigned an E5 classification primarily based on the entrenchment and width/depth ratios measured at the cross section location. Evidence of recent downcutting (e.g., nick points) suggests that the reach is unstable and is likely shifting from an E channel to a B channel. Significant changes in the shape of this cross section were observed during the 2013 survey, as the channel had noticeably deepened and widened since the 2012 survey (Appendix B). Over the next year, as seen in the 2014 survey, aggradation occurred affecting the bed level by raising it approximately 0.5 feet. From 2014 to 2015, the channel has shifted slightly, but has remained stable in terms of aggradation or deepening. Analysis of the longitudinal profile overlay from 2007 through 2015 shows considerable downcutting between stations 1+00 and 2+20 (Appendix B). However, during 2014 the pool near station 2+00 has mostly filled in. This trend has continued in 2015, with the pool working its way up the reach to station 1+80. The headcut and large scour pool between stations 2+68 and 2+90 just downstream from this eroded section have not worsened. It is recommended that this area continue to be monitored, since further erosion could eventually lead to undermining of the concrete-lined channel just downstream.

An overlay of North Tributary longitudinal profiles shows little change occurring to this reach from 2007 through 2015 (Appendix B). Numerous man-made structures (i.e., culverts, concrete-lined channel) throughout this reach appear to be providing adequate grade control, preventing substantial channel degradation.

4.0 SUMMARY AND CONCLUSIONS

4.1 BIOLOGICAL ASSESSMENT SUMMARY

Water quality measurements showed all parameters within COMAR standards. Conductivity levels at all of the sampling sites continue to be elevated, which is likely due to the high percent of impervious surfaces within the drainage area and the resulting stormwater runoff. In urban systems, high conductivity may be an indicator of road salt usage (Morgan et al. 2012, Southerland et al. 2007, Kaushal et al. 2005); however, chloride concentrations are often necessary to confirm whether road salts are a primary source. Given the presence in the watershed of the large MARC train station Park & Ride lots, which likely receive large quantities of de-icing salts, and two adjacent detention/shallow wetland ponds, which may accumulate the salts and slowly release them through the groundwater, it is plausible that road salt application is responsible, at least in part, for the observed elevated conductivity.

Physical habitat was rated "Partially Degraded" to "Degraded" throughout the study area, which is exactly the same as the ratings from 2014 (Table 4-1). The "Partially Degraded" site was located along the wooded upper reach of the North Tributary, which had a substantial riparian buffer, adequate shading, minor bank erosion, and sufficient instream woody debris and rootwads. These factors increase the potential of the stream to support a diverse macroinvertebrate community. Sites PSB-02 and PSB-03 had marginal riparian buffers and scored very low for remoteness due to their proximities to Routes 170 and 175. While the scores for epifaunal substrate at PSB-02 and PSB-03 were lower than PSB-01, the reduced PHI scores at these two lower sites are primarily due to the remoteness measure, which cannot improve over time.

During the past five years of monitoring, PHI scores have fluctuated slightly from year to year (Figure 4-1). Fluctuations in annual physical habitat scores may be attributed to two primary factors: 1) changes in habitat suitable for colonization (i.e., changes in substrate/embeddedness and changes in the quantity of woody debris) affects direct scoring of this parameter, and also indirectly influences scoring for epifaunal substrate and instream habitat; and 2) variability in qualitative visual assessment scoring between field crews.

In 2013, the updated MBSS PHI methods (Paul et al. 2003) were used to calculate PHI instead of the original MBSS methods (Hall et al. 2002) which had been used in the Picture Spring Branch watershed reports from prior years. Scores for 2006-2012 shown in Table 4-1 and Figure 4-1 were calculated using the original method, while the scores for 2013-2015 were calculated using the updated method.

In 2015, the benthic macroinvertebrate community at two sites within the Picture Spring Branch study area were rated as "Poor", which is considered to be a degraded biological condition where overall taxa is depressed. One site in 2015 was rated "Fair." While the BIBI scores are higher than those in 2014, they are worse than those in 2013. Overall, taxa diversity was increased in 2015 in all three sites as compared to 2014, but remains fairly low. Individuals intolerant to urban stressors at sites ranged from 0% (PSB-03) to 9.4% (PSB-01) of the total

specimens. The numbers of sensitive EPT taxa were lower at PSB-02 and PSB-03 (3 taxa) than at PSB-01 (4 taxa). However, no Ephemeroptera taxa were found at any of the sites during this sampling period.

Table 4-1. PHI scores from 2006 to 2015

Site		PSB-01	PSB-02	PSB-03
2006	PHI Score	66.0	60.1	50.9
	Rating	Degraded	Degraded	Severely Degraded
2007	PHI Score	79.6	69.5	69.5
	Rating	Partially Degraded	Partially Degraded	Partially Degraded
2008	PHI Score	84.5	73.0	73.3
	Rating	Minimally Degraded	Partially Degraded	Partially Degraded
2009	PHI Score	76.4	65.9	58.6
	Rating	Partially Degraded	Degraded	Degraded
2010	PHI Score	84.3	72.4	73.8
	Rating	Minimally Degraded	Partially Degraded	Partially Degraded
2011	PHI Score	83.3	73.4	71.9
	Rating	Minimally Degraded	Partially Degraded	Partially Degraded
2012	PHI Score	83.9	74.8	73.2
	Rating	Minimally Degraded	Partially Degraded	Partially Degraded
2013	PHI Score	77.2	62.6	57.2
	Rating	Partially Degraded	Degraded	Degraded
2014	PHI Score	77.7	64.7	65.7
	Rating	Partially Degraded	Degraded	Degraded
2015	PHI Score	72.1	64.4	60.5
	Rating	Partially Degraded	Degraded	Degraded

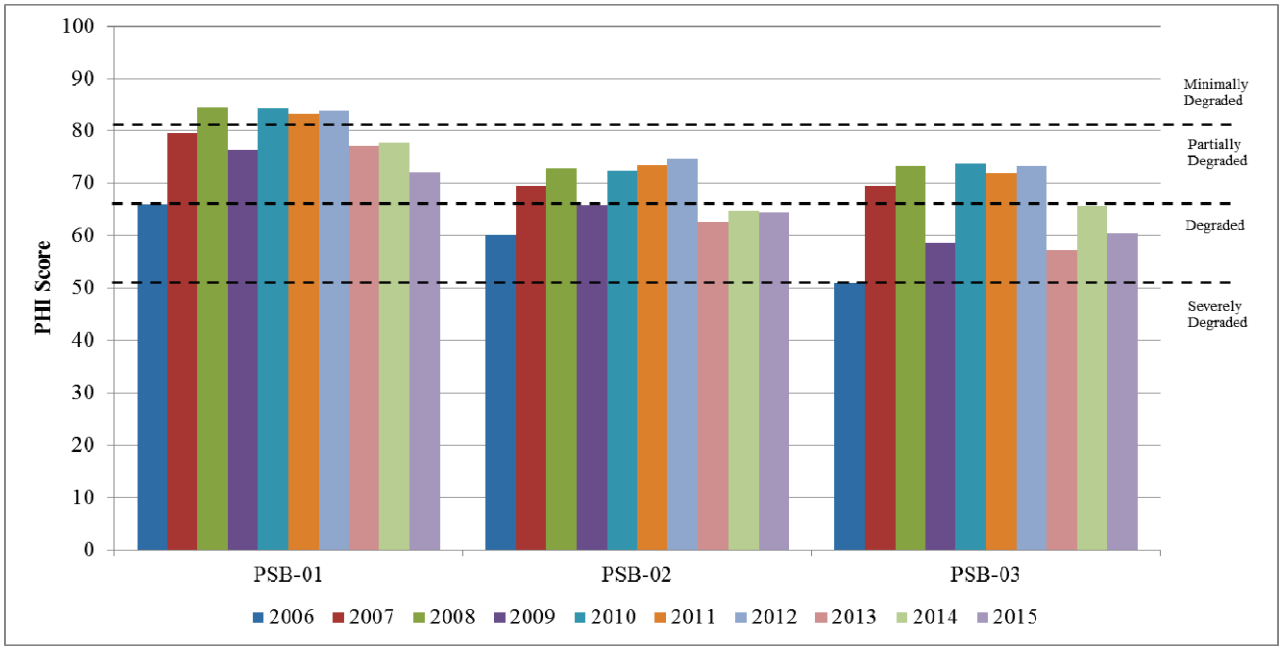


Figure 4-1. Comparison of PHI Habitat Scores from 2006 through 2015

BIBI scores increased at PSB-03, and stayed constant at the other two sites from 2014 to 2015 (Table 4-2). The narrative ratings, like the BIBI scores, stayed the same at two sites, while improving from "Poor" to "Fair" at PSB-03. Figure 4-2 provides a visual comparison of BIBI scores over time and shows scores fluctuating from year to year.

Table 4-2. BIBI scores from 2006 to 2015

Site		PSB-01	PSB-02	PSB-03
2006	BIBI Score	3.00	2.71	2.43
	Rating	Fair	Poor	Poor
2007	BIBI Score	3.29	3.00	3.57
	Rating	Fair	Fair	Fair
2008	BIBI Score	3.86	3.00	2.71
	Rating	Fair	Fair	Poor
2009	BIBI Score	2.43	2.71	1.86
	Rating	Poor	Poor	Very Poor
2010	BIBI Score	2.71	3.00	2.43
	Rating	Poor	Fair	Poor
2011	BIBI Score	3.29	3.29	2.71
	Rating	Fair	Fair	Poor
2012	BIBI Score	3.29	3.00	3.00
	Rating	Fair	Fair	Fair
2013	BIBI Score	2.71	3.29	3.00
	Rating	Poor	Fair	Fair
2014	BIBI Score	2.43	2.71	2.43
	Rating	Poor	Poor	Poor
2015	BIBI Score	2.43	2.71	3.00
	Rating	Poor	Poor	Fair

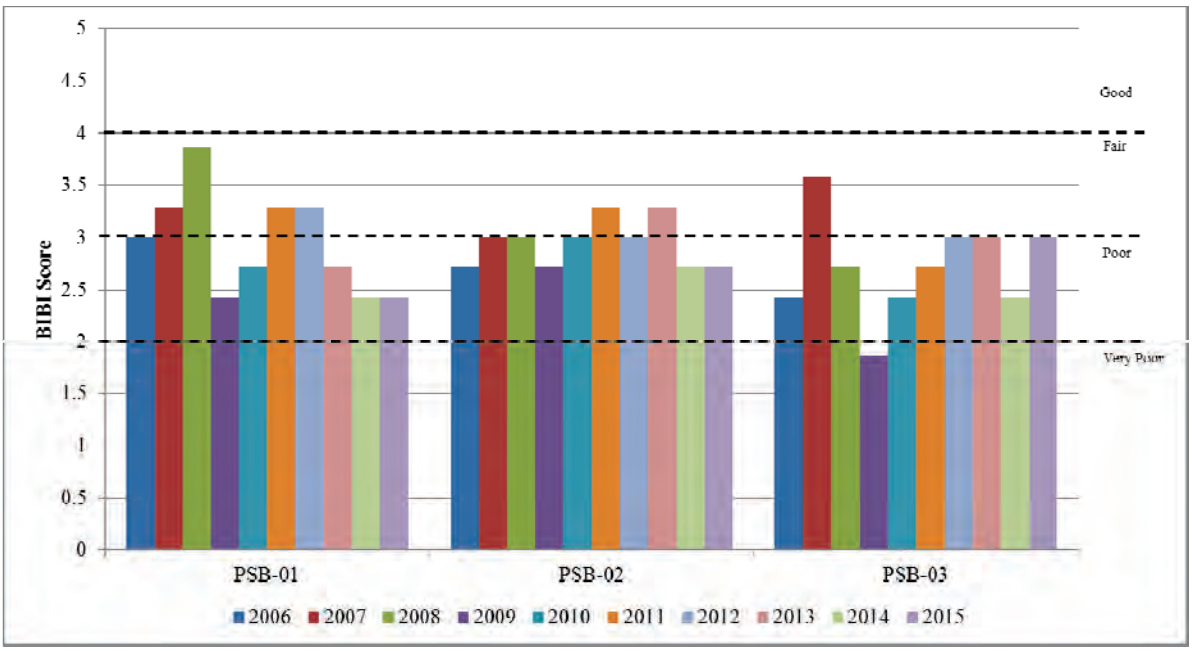


Figure 4-2. Comparison of BIBI Scores from 2006 through 2015

4.2 GEOMORPHIC ASSESSMENT SURVEY

The majority of the streams within the Picture Spring Branch study area have been altered by past channelization and the installation of concrete-lined channels, resulting from modifications made to accommodate runoff from Maryland State Highways 170 and 175, running both parallel and adjacent to the stream channel. Consequently, stream reaches in the vicinity of cross sections XS-2, XS-3, and XS-5, on the North Tributary and mainstem were overwidened resulting in F channels at these locations. A notable amount of sediment has deposited in these concrete channels in the past, and it appears as though these channels have become naturalized, especially below Route 170 where a more natural stream pattern is emerging, resulting in a C channel forming within the larger channel at XS-5. These cross sections also appeared quite stable during recent years, having shown very little change from previous surveys, with the exception of XS-5 which experienced notable aggradation across its total width between 2011 and 2012. Between 2012 and 2013 the right side stream bed at XS-5 eroded slightly while the left side had no change. From 2014 to 2015, surveys continued to show minor erosion at the bottom of the left bank. Past channelization also appears to have occurred on the South Tributary in the vicinity of cross section XS-4. The slope of the South Tributary is much greater than that of the North Tributary, and the channel is showing signs of active downcutting. Historically, the reach of stream in the Picture Spring Branch study area which appeared to be least disturbed was in the vicinity of XS-1. This previously stable section of stream is in a forested upper portion of the North Tributary and is classified as a C5 channel. Although still a C5 channel, the channel is now deepening.

To compare changes in cross sectional area over time, cross sectional area from 2011 through 2015 was calculated using the top of bank elevation from the baseline survey in order to standardize comparisons and reduce variability among more subjective bankfull elevation reference points, or even changes that can occur to top of bank elevations from year to year. It is important to note that calculations prior to 2011 did not use the baseline reference elevation, instead they used the corresponding years top of bank elevation for calculating cross sectional area, and consequently these values are not directly comparable to the cross sectional areas reported in 2011 through 2015. Comparison of baseline cross sectional area is however comparable to 2011 through 2015 since all calculations are made using the same top of bank elevation. Channel dimensions appear moderately constant for two out of the five cross sections,compared to baseline conditions (Table 4-3). The stream channel at XS-2 and XS-3 has remained relatively stable, with cross sectional area decreasing only 2.1% and 4.3% respectively since 2003. In contrast, significant increases in cross sectional areas have occurred at XS-1 and XS-4. Due to channel deepening in the past year, cross-sectional area at XS-1 has increased 59.4% from baseline conditions, and another 21.9% from 2014. XS-4, although relatively stable in the past three years, has had cross sectional area increase 35.5% from baseline conditions. XS-5 has continued to aggrade, resulting in a 2.8% decrease in cross sectional area from 2014, and 11% overall from baseline conditions in 2003. This continued deposition of fine sediments at XS-5 has defined the channel, resulting in a C5 stream classification. Unsurprisingly, XS-1 and XS-4 are located in portions of stream where there has been no engineering or armoring of the stream channel, while the other three cross sections have been channelized.

Table 4-3. Summary of cross sectional area (square feet) at the five cross-sections and changes over time.

Cross Section[a]	XS-1	XS-2	XS-3	XS-4	XS-5
July 2003	ND	146.0	84.5	7.6	35.5
Jan 2005	6.4	164.4	83.2	5.5	35.2
March 2006	7.6	143.9	81.0	7.6	34.0
March 2007	6.8	142.6	81.1	7.6	32.9
May 2008	6.3	141.5	81.5	7.4	34.9
July 2009	6.8	142.8	80.8	8.4	33.4
May 2010	6.0	145.2	80.5	9.7	34.5
July 2011[b]	9.7	143.0	81.9	9.3	34.8
April 2012[b]	8.0	143.1	81.8	9.2	28.4
July 2013[b]	8.6	142.8	80.4	10.5	30.9
June 2014 [b]	8.8	141.9	77.4	10.0	32.6
June 2015 [b]	10.2	143.0	80.9	10.3	31.6
% Change 2003-2015	59.4[c]	-2.1	-4.3	35.5	-11.0
% Change 2011-2015	5.2	0	-1.2	10.8	-9.2

[a] All values listed here are for top of bank area
[b] Values obtained using reference elevations (top of bank) from baseline measurements
[c] % change from 2005
ND = No Data

4.3 GENERAL CONCLUSIONS

Based upon the data collected over the course of this study, it appears that the development of the West County Library site has not accelerated the degradation of this system. While physical habitat and biological conditions have fluctuated slightly from year to year, the overall conditions have changed minimally when compared to baseline data. It is likely that the best management practices installed within the watershed have reduced the impact of some stressors affecting the stream (i.e., hydrologic alteration) such that the system has begun to stabilize from past alteration and land use modifications (i.e., extensive channelization).

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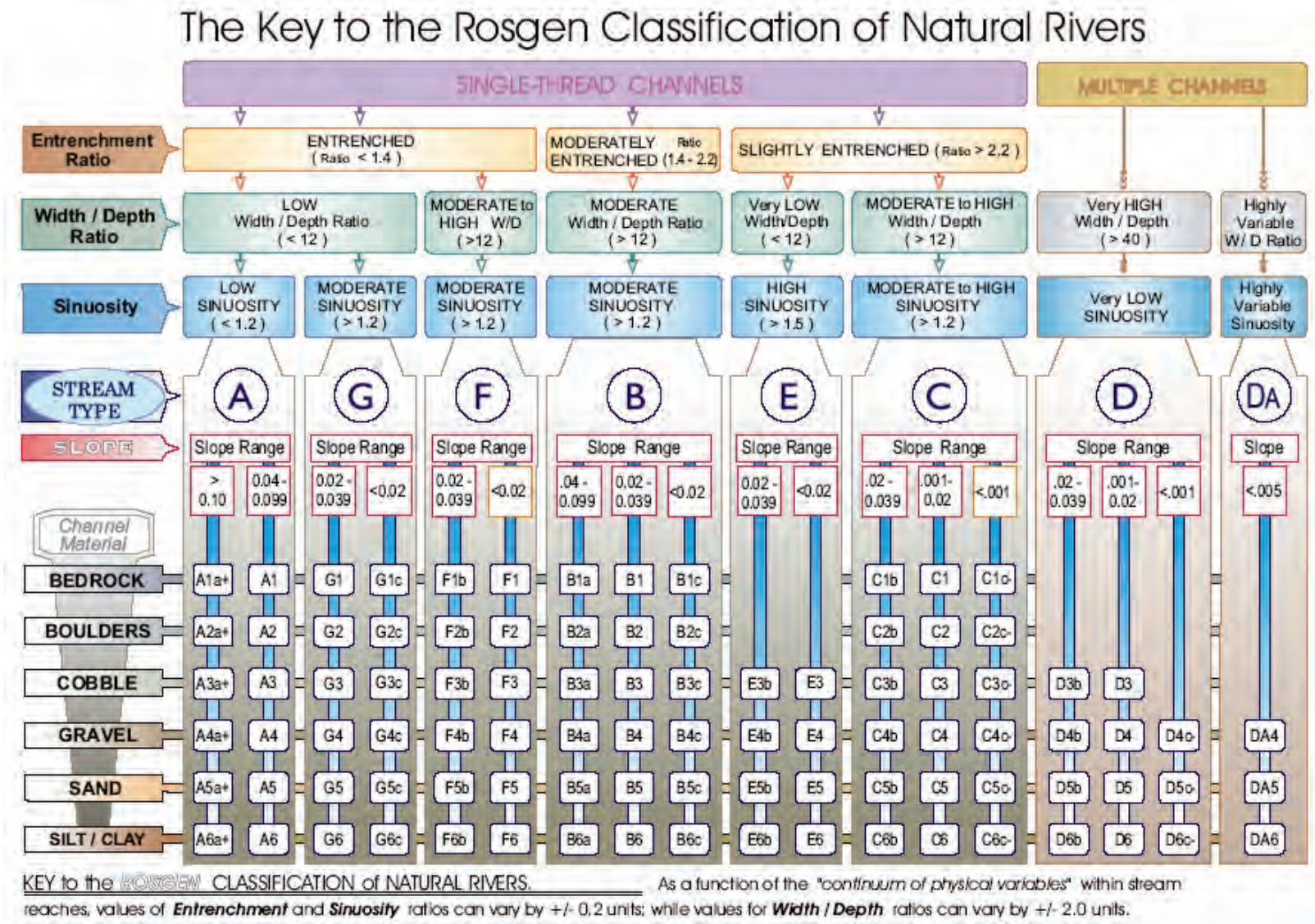
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Versar, Inc. 2014. Biological and Geomorphological Condition in the Picture Spring Branch Subwatershed, Severn River Watershed, Anne Arundel County, Maryland: 2014. Prepared for Anne Arundel County Department of Public Works. September 2014.

APPENDIX A

ROSGEN STREAM CLASSIFICATION



KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

Source: Rosgen, D.L. 1996. *Applied River Morphology*. Wildland Hydrology, Pagosa Springs, CO.

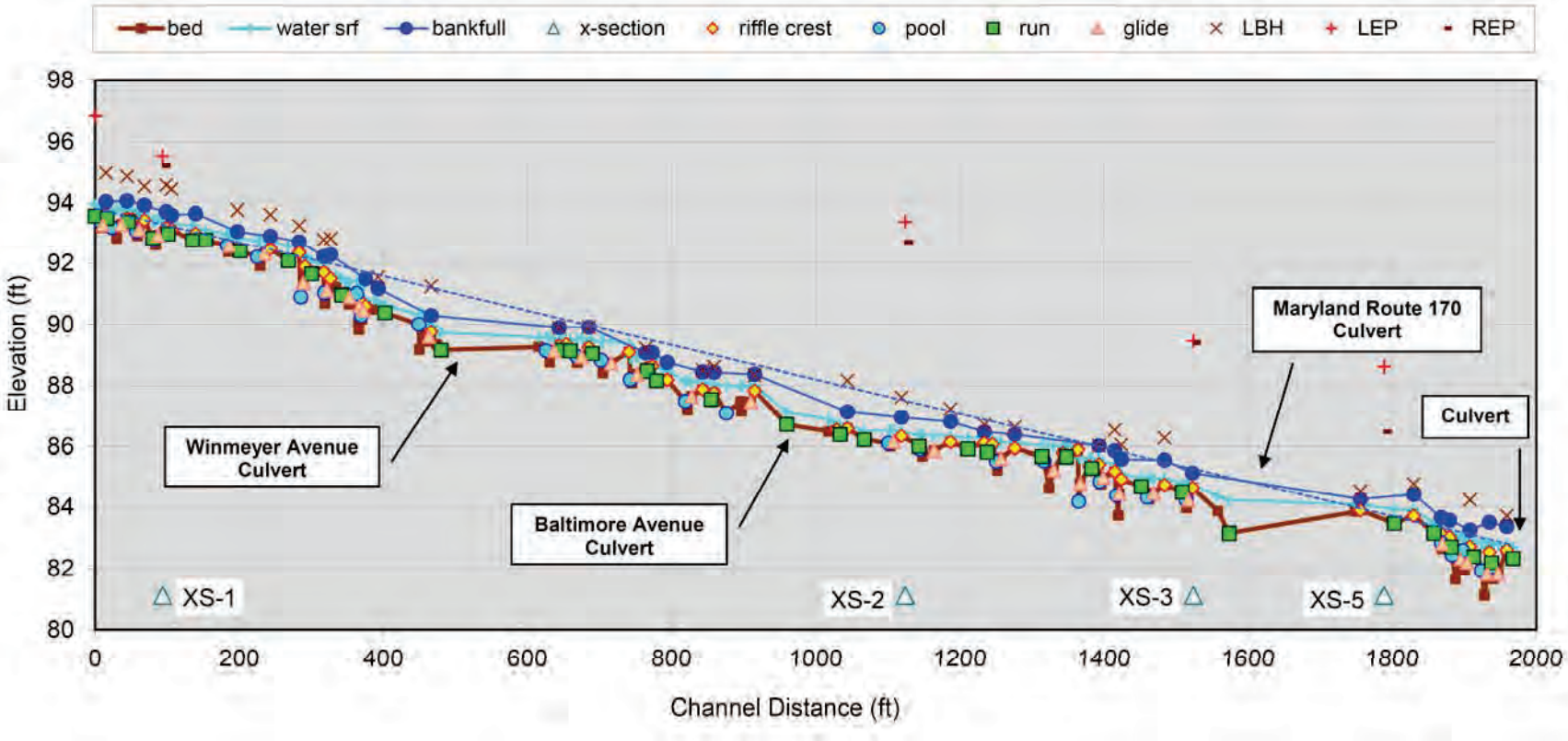
APPENDIX B

GEOMORPHIC ASSESSMENT RESULTS

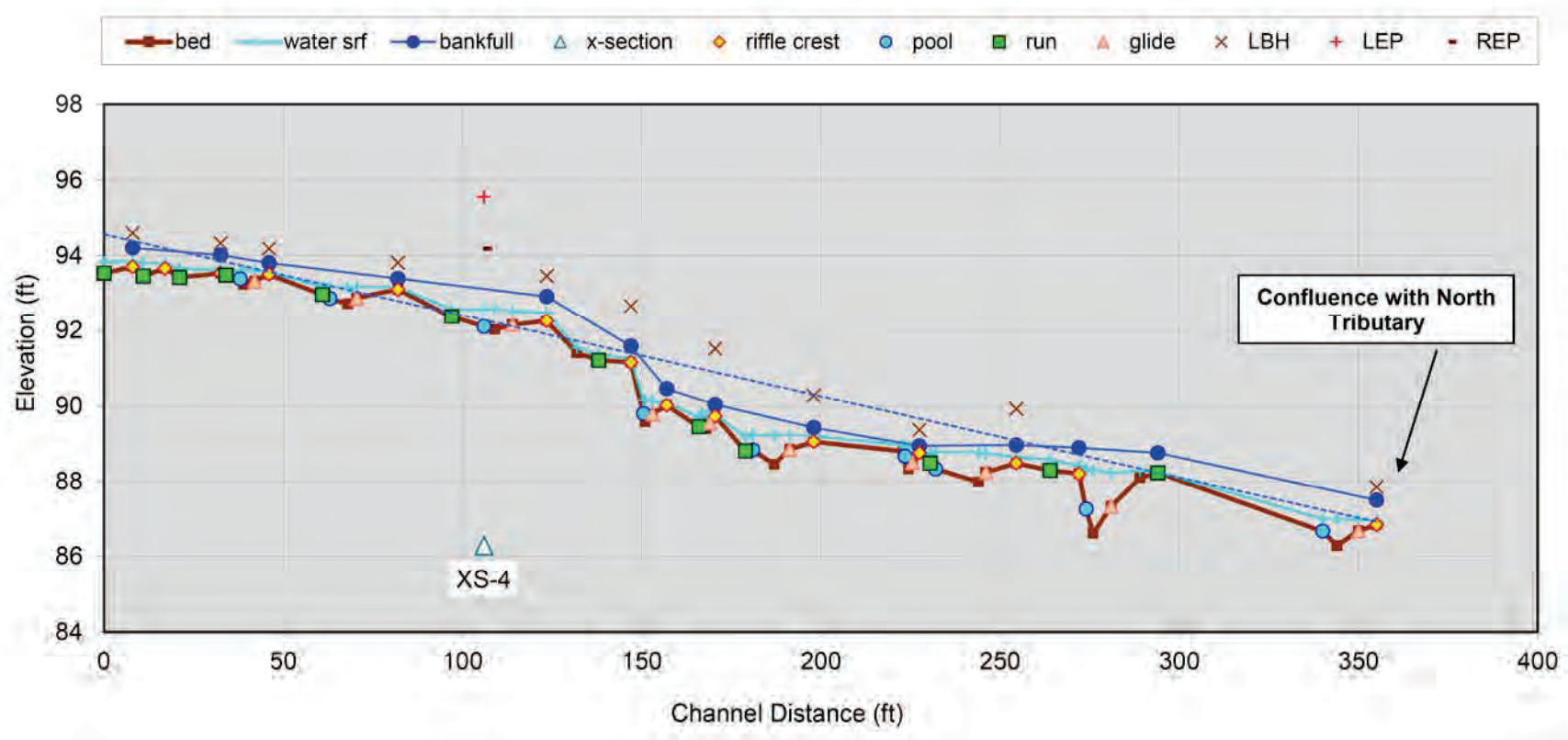
Picture Spring Branch
2015 Geomorphic Assessment Results Summary

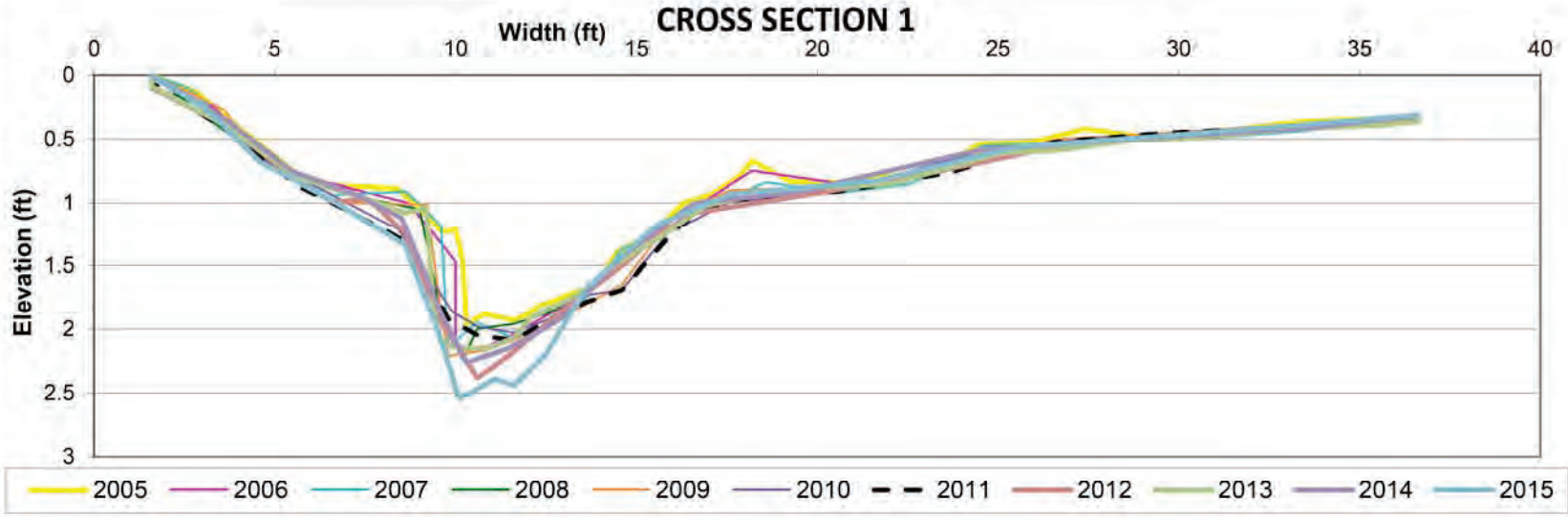
Assessment Parameter	Cross Section				
	XS-1 Run @ Sta. 0+93.5	XS-2 Run @ Sta. 11+24	XS-3 Run @ Sta. 15+24	XS-4 Run @ Sta. 1+06 on South Tributary	XS-5 Run @ Sta. 17+89
Classification	C5	F5	F5	E5	C5
Bankfull Width (ft)	4.5	10.7	9.9	3.1	8.7
Mean Depth (ft)	0.5	0.7	0.4	0.8	0.6
Bankfull X-Sec Area (sq ft)	2.4	7.8	3.9	2.3	5.3
Width:Depth Ratio	8.4	14.6	25.0	4.1	14.2
Flood-Prone Width (ft)	16.4	14.2	13.1	8.4	21.0
Entrenchment Ratio	3.6	1.3	1.3	2.7	2.4
D50(mm)	0.18	0.23	1.3	0.23	0.55
Water Surface Slope (ft/ft)	0.0092	0.0021	0.011	0.016	0.0023
Sinuosity	<1.2	<1.2	<1.2	<1.2	<1.2
Drainage Area (mi^2)	0.12	0.15	0.15	0.07	0.23
Adjustments?	Sin ↑, ER ↑, WD ↑	Sin ↑, ER ↑, WD ↓	Sin ↑, ER ↓, WD ↓	Sin ↑, ER ↑, WD ↑	Sin ↑, ER ↓,WD ↑

Picture Spring Branch
North Tributary Longitudinal Profile



Picture Spring Branch
South Tributary Longitudinal Profile







Upstream View



Downstream View

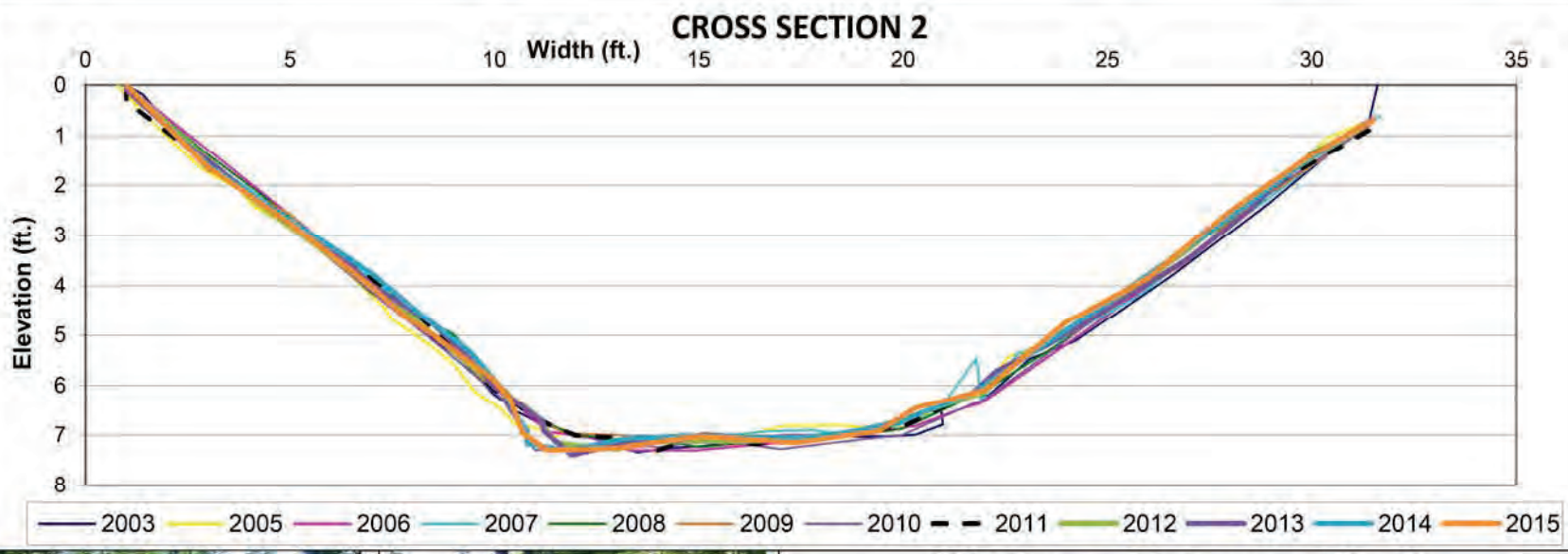


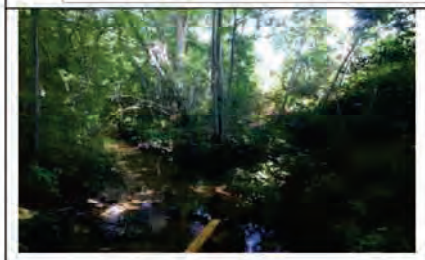
Left Bank View



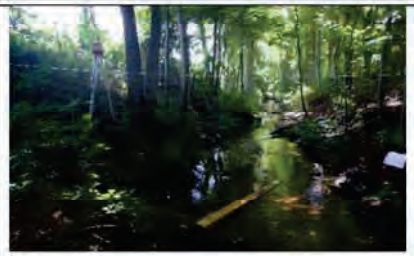
Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	4.5
Mean Depth (d_{bkf}) (feet)	0.5
Bankfull Cross-sectional Area (A_{bkf}) ($feet_2$)	2.4
Width/Depth Ratio (W_{bkf}/d_{bkf})	8.4
Width of Flood-prone Area (W_{fpa}) (feet)	16.4
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	3.6
Channel Materials D_{50} (millimeters)	0.18
Water Surface Slope (S)	0.0092
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑, WD ↑
STREAM TYPE	**C5**





Upstream View



Downstream View

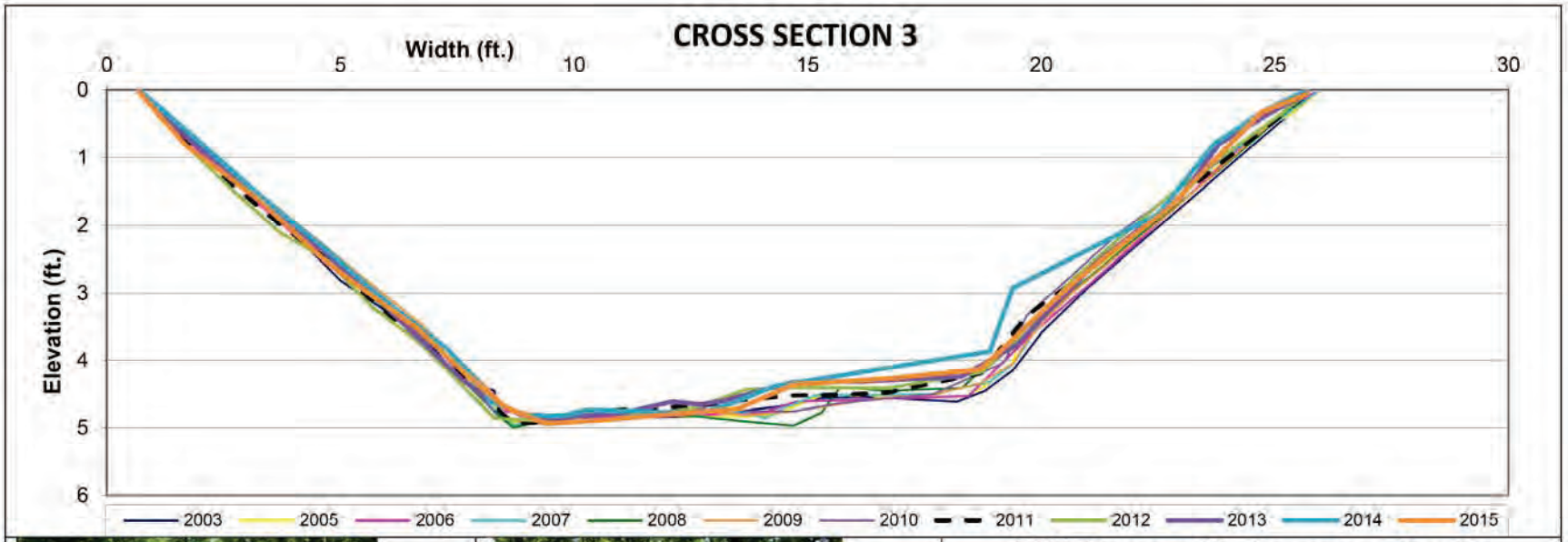


Left Bank View



Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	10.7
Mean Depth (d_{bkf}) (feet)	0.7
Bankfull Cross-sectional Area (A_{bkf}) (feet$_2$)	7.8
Width/Depth Ratio (W_{bkf}/d_{bkf})	14.6
Width of Flood-prone Area (W_{fpa}) (feet)	14.2
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	1.3
Channel Materials D_{50} (millimeters)	0.23
Water Surface Slope (S)	0.0021
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑
STREAM TYPE	**F5**





Upstream View



Downstream View

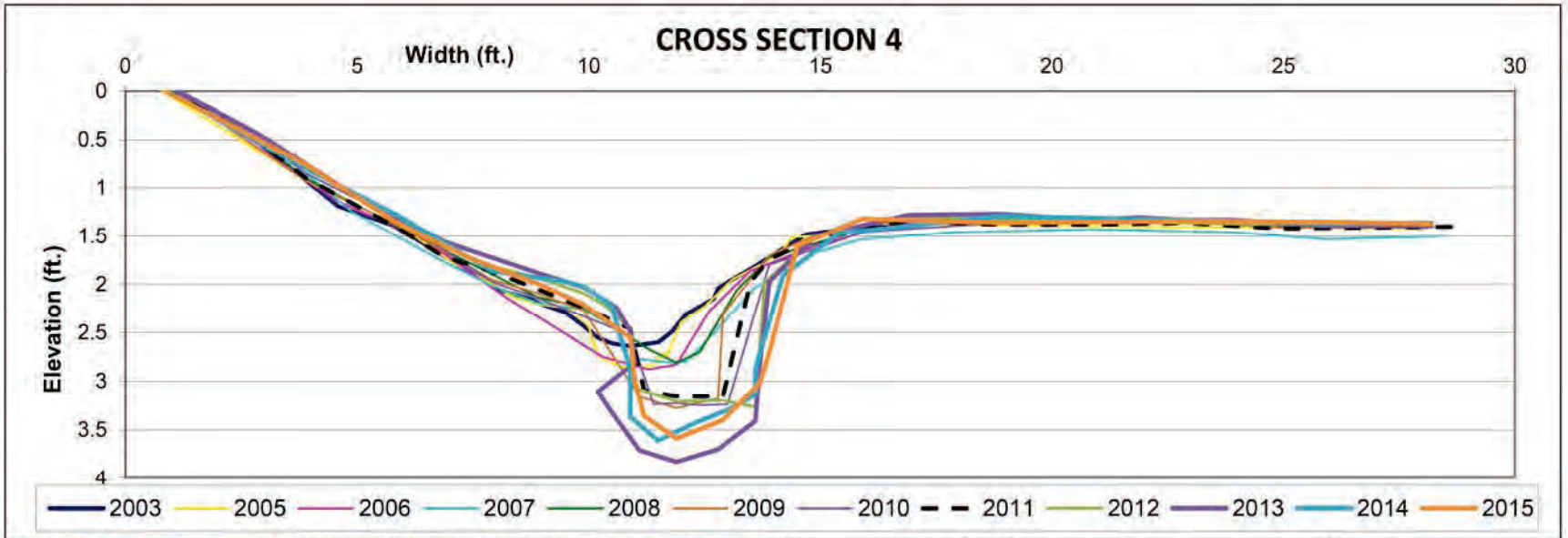


Left Bank View



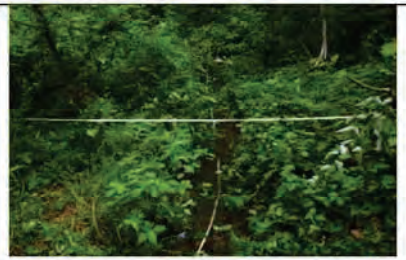
Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	9.9
Mean Depth (d_{bkf}) (feet)	0.4
Bankfull Cross-sectional Area (A_{bkf}) (feet^2)	3.9
Width/Depth Ratio (W_{bkf}/d_{bkf})	25.0
Width of Flood-prone Area (W_{fpa}) (feet)	13.1
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	1.3
Channel Materials D_{50} (millimeters)	1.3
Water Surface Slope (S)	0.011
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑
STREAM TYPE	**F5**





Upstream View



Downstream View

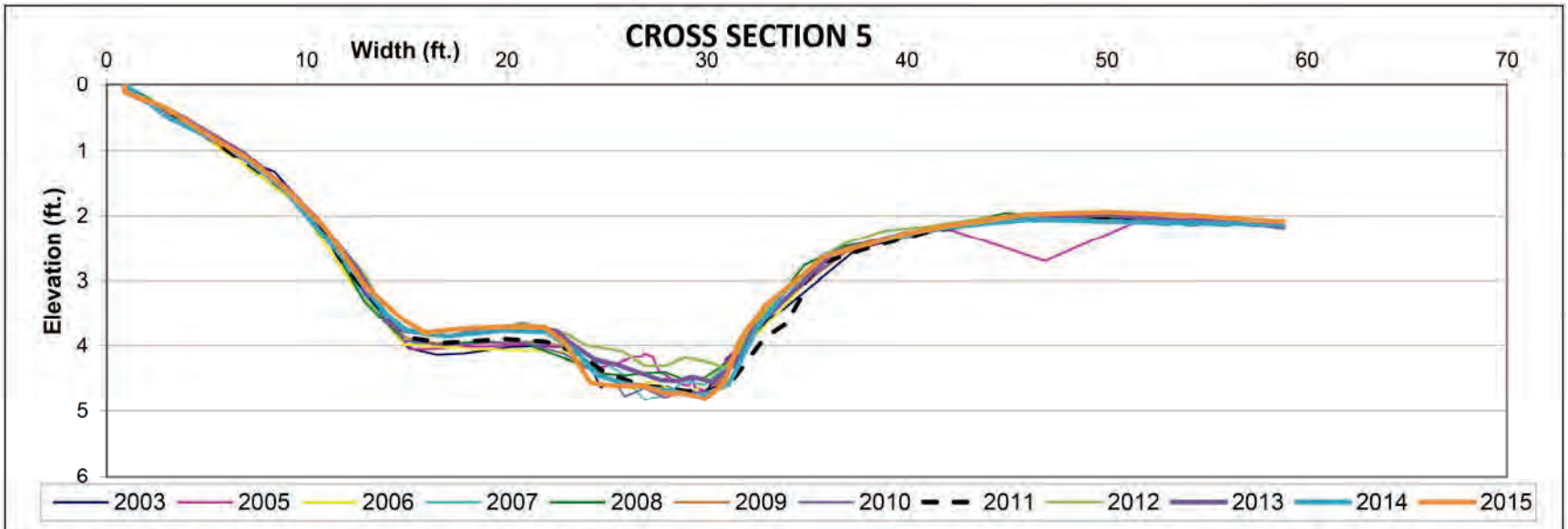


Left Bank View



Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	3.1
Mean Depth (d_{bkf}) (feet)	0.8
Bankfull Cross-sectional Area (A_{bkf}) ($feet_2$)	2.3
Width/Depth Ratio (W_{bkf}/d_{bkf})	4.1
Width of Flood-prone Area (W_{fpa}) (feet)	8.4
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	2.7
Channel Materials D_{50} (millimeters)	0.23
Water Surface Slope (S)	0.016
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑
STREAM TYPE	**E5**





Upstream View



Downstream View

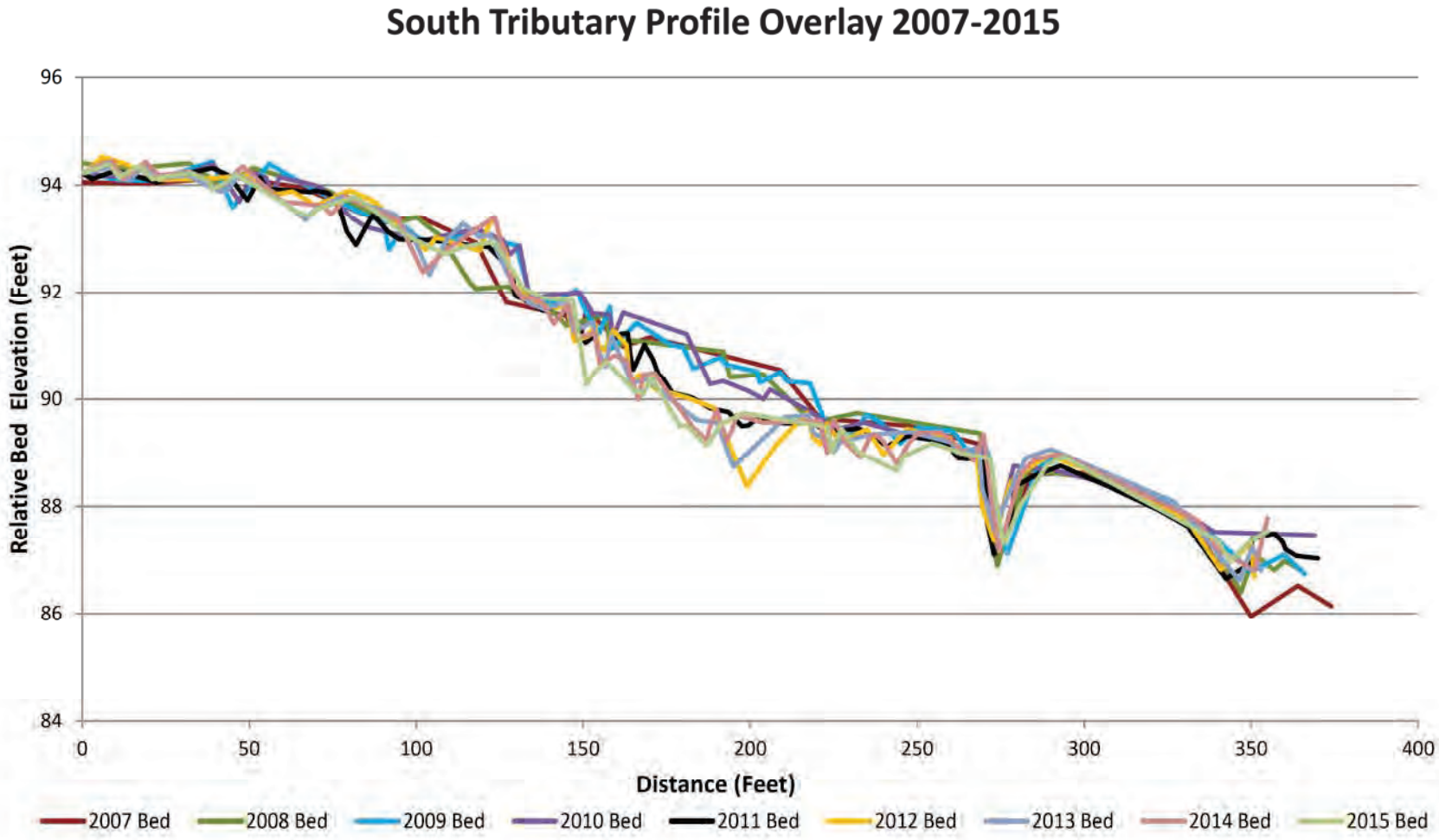


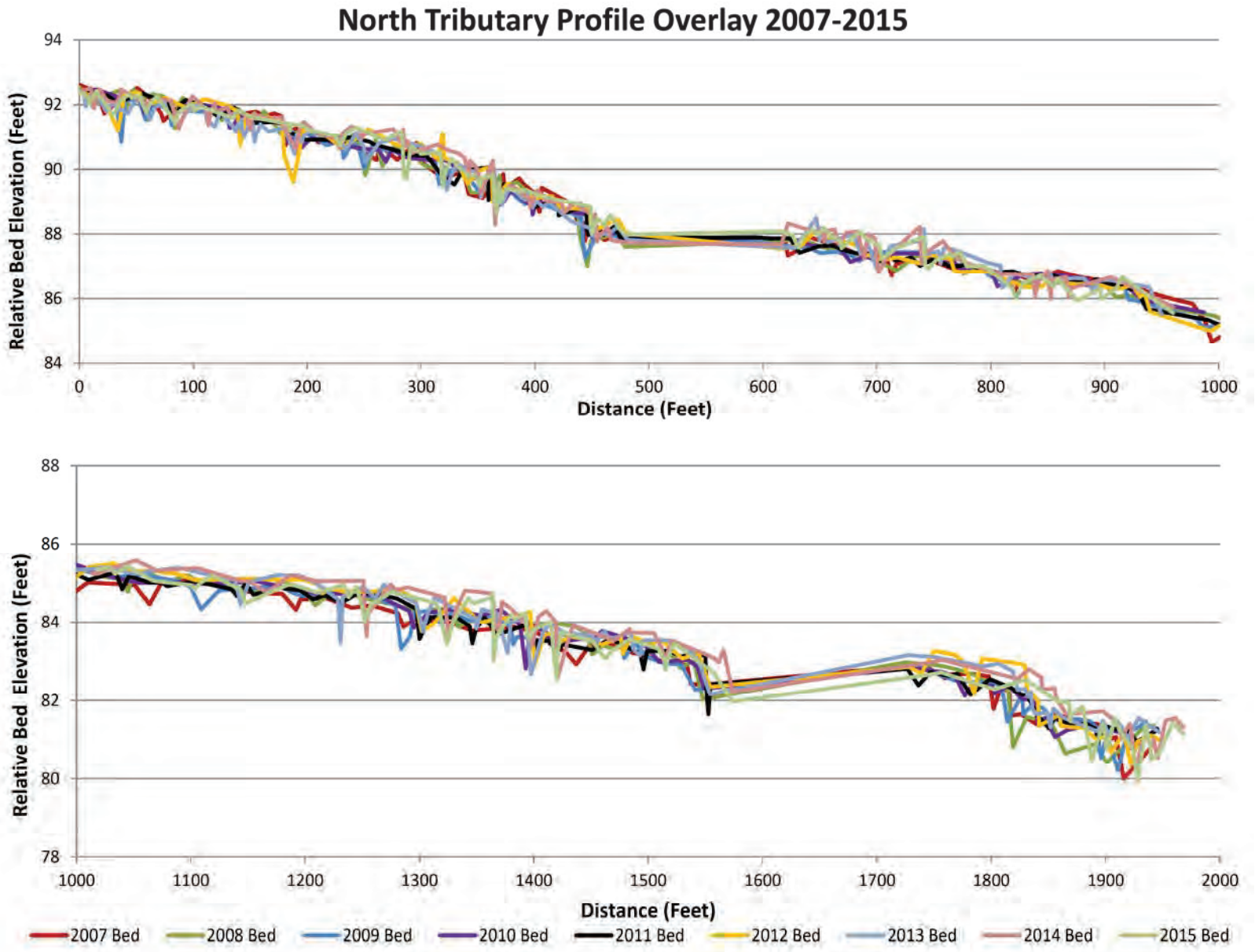
Left Bank View



Right Bank View

2015 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	8.7
Mean Depth (d_{bkf}) (feet)	0.6
Bankfull Cross-sectional Area (A_{bkf}) ($feet_2$)	5.3
Width/Depth Ratio (W_{bkf}/d_{bkf})	14.2
Width of Flood-prone Area (W_{fpa}) (feet)	21.0
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	2.4
Channel Materials D_{50} (millimeters)	0.55
Water Surface Slope (S)	0.0023
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑
STREAM TYPE	**C5**


South Tributary Profile Overlay 2007-2015
Relative Bed Elevation (Feet)
96
94
92
90
88
86
84
0
50
100
150
200
250
300
350
400
Distance (Feet)
2007 Bed
2008 Bed
2009 Bed
2010 Bed
2011 Bed
2012 Bed
2013 Bed
2014 Bed
2015 Bed


North Tributary Profile Overlay 2007-2015
Relative Bed Elevation (Feet)
94
92
90
88
86
84
0
100
200
300
400
500
600
700
800
900
1000
Distance (Feet)
Relative Bed Elevation (Feet)
88
86
84
82
80
78
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Distance (Feet)
2007 Bed
2008 Bed
2009 Bed
2010 Bed
2011 Bed
2012 Bed
2013 Bed
2014 Bed
2015 Bed

APPENDIX C

MASTER BENTHIC MACROINVERTEBRATE TAXA LIST

Order	Family	Genus	Final ID	FFG[1]	Habit[2]	Tolerance Value[3]
Amphipoda	Crangonyctidae	Stygonectes	Stygonectes	Collector		8
Basommatophora	Lymnaeidae		Lymnaeidae	Scraper	cb	6.9
Basommatophora	Physidae	Physa	Physa	Scraper	cb	7
Coleoptera	Dryopidae	Helichus	Helichus	Scraper	cn	6.4
Coleoptera	Elmidae	Stenelmis	Stenelmis	Scraper	cn	7.1
Coleoptera	Hydrophilidae	Hydrobius	Hydrobius	Collector	cb, cn, sp	4.1
Diptera			Diptera			6
Diptera	Chironomidae	Chaetocladius	Chaetocladius	Collector	sp	7
Diptera	Chironomidae	Conchapelopia	Conchapelopia	Predator	sp	6.1
Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	Scraper	sp	7.2
Diptera	Chironomidae	Orthocladius	Orthocladius	Collector	sp, bu	9.2
Diptera	Chironomidae	Paracladopelma	Paracladopelma	Collector	sp	6.6
Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	Collector	sp	4.6
Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	Collector	sp	7.7
Diptera	Chironomidae	Paratendipes	Paratendipes	Collector	bu	6.6
Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	Collector	cn	8.7
Diptera	Chironomidae	Polypedilum	Polypedilum	Shredder	cb, cn	6.3
Diptera	Chironomidae	Prodiamesa	Prodiamesa	Collector	bu, sp	6.6
Diptera	Chironomidae	Stictochironomus	Stictochironomus	Collector	bu	9.2
Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	Predator	sp	8.2
Diptera	Chironomidae	Tvetenia	Tvetenia	Collector	sp	5.1
Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	Predator	sp	5.3
Diptera	Empididae		Odontomyia/ hedriodiscus	Collector		7
Diptera	Ptychopteridae	Bittacomorpha	Bittacomorpha	Collector	bu	4
Diptera	Tipulidae	Tipula	Tipula	Shredder	bu	6.7
Haplotaxida	Enchytraeidae		Enchytraeidae	Collector	bu	9.1
Isopoda	Asellidae	Caecidotea	Caecidotea	Collector	sp	2.6
Megaloptera	Sialidae	Sialis	Sialis	Predator	bu, cb, cn	1.9
Odonata	Aeshnidae	Boyeria	Boyeria	Predator	cb, sp	6.3
Odonata	Calopterygidae	Calopteryx	Calopteryx	Predator	cb	8.3
Odonata	Coenagrionidae		Coenagrionidae	Predator	cb	9
Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	Filterer	cn	6.5
Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	Filterer	cn	2.7
Trichoptera	Limnephilidae		Limnephilidae	Shredder	cb, sp, cn	3.4
Trichoptera	Philopotamidae	Chimarra	Chimarra	Filterer	cn	4.4
Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	Filterer	cn	1.1
Tubificida	Tubificidae		Tubificidae	Collector	cn	8.4
Veneroida	Pisidiidae	Pisidium	Pisidium	Filterer	bu	5.7

1 Functional Feeding Group

2 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer
Some information for the particular taxa was not available.

3 Tolerance Values, based on Hilsenhoff, modified for Maryland

APPENDIX D

QUALITY ASSURANCE / QUALITY CONTROL

This section describes all Quality Assurance/Quality Control (QA/QC) procedures implemented for this project including field sampling, laboratory sorting and subsampling, data entry, metric calculation, final IBI calculation, geomorphic field sampling, and classification of stream types.

Field Sampling
Initial QA/QC procedures for benthic macroinvertebrate field sampling included formal training for field crew leaders in MBSS Sampling Protocols. All field crew members have attended at least one MBSS Spring Index Period Training. At least one crew member extensively trained and certified in MBSS sampling protocols was present for each field sampling day. Also during field sampling, each data sheet was double checked for completeness and sample bottle labels were double checked for accuracy. Geomorphic assessment field crews have more than one year of experience conducting similar assessment using the Rosgen Stream Classification Methodology.

Geomorphic assessment survey equipment is calibrated annually and regularly inspected to ensure proper functioning. Cross section and profile data were digitally plotted and analyzed in Ohio Department of Natural Resources (ODNR) Reference Reach Spreadsheet Version 4.3L for accuracy.

Water quality QA/QC procedures included calibration of the YSI multiprobe meter daily during the sampling season. Dissolved oxygen probe membranes were inspected regularly and replaced when dirty or damaged.

Laboratory Sorting and Subsampling
Sorting QA/QC was conducted on one sample since only seven samples were collected for this survey. This check consisted of entirely resorting one randomly selected sample to a sorting consistency above ninety percent efficiency. This QC resulted in a sorting efficiency above 95%, so no further action was required. As a taxonomic QC, one sample was re-identified completely by another Versar SFS-certified taxonomist following the same identification methods stated above. The Percent Difference in Enumeration (PDE) and the Percent Taxonomic Disagreement (PTD) were calculated and no further action was required since both the PDE and PTD met MBSS requirements.

Data Entry
All data entered were double checked by someone other than the person who performed the initial data entry. Any errors found during QA/QC were corrected to ensure 100% accuracy of the data.

Metric and IBI Calculations
Ten percent of metric and IBI calculations were checked by hand using a calculator to ensure correct calculation by the Access database. Any discrepancies were addressed at that time.

Identification of Stream Types
All stream types were determined by hand based on the methods of the Rosgen Stream Classification (Rosgen, 1996). Due to the natural variability, or continuum, of streams, adjustments in the values of Width Depth Ratio (+/- 2.0) and Entrenchment Ratio (+/- 0.2) are allowed,

which may result in assigning a different stream type. Therefore, all stream types assigned were checked by a second person and any necessary adjustments were made.

APPENDIX E

BMP CODES

MDE Approved BMP Classifications

ESD BMPs		
Category	Code	Code Description
Alternative Surfaces (A)		
E	AGRE	Green Roof - Extensive
E	AGRI	Green Roof - Intensive
E	APRP	Permeable Pavements
E	ARTF	Reinforced Turf
Nonstructural Techniques (N)		
E	NDRR	Disconnection of Rooftop Runoff
E	NDNR	Disconnection of Non-Rooftop Runoff
E	NSCA	Sheetflow to Conservation Areas
Micro-Scale Practices (M)		
E	MRWH	Rainwater Harvesting
E	MSGW	Submerged Gravel Wetlands
E	MILS	Lanscape Infiltration
E	MIBR	Infiltration Berms
E	MIDW	Dry Wells
E	MMBR	Micro-Bioretention
E	MRNG	Rain Gardens
E	MSWG	Grass Swale
E	MSWW	Wet Swale
E	MSWB	Bio-Swale
E	MENF	Enhanced Filters
Structural BMPs		
Ponds (P)		
S	PWED	Extended Detention Structure, Wet
S	PWET	Retention Pond (Wet Pond)
S	PMPS	Mutliple Pond System
S	PPKT	Pocket Pond
S	PMED	Micropool Extended Detention Pond
Wetlands (W)		
S	WSHW	Shallow Marsh
S	WEDW	ED - Wetland
S	WPWS	Wet Pond - Wetland
S	WPKT	Pocket Wetland
Infiltration (I)		
S	IBAS	Infiltration Basin
S	ITRN	Infiltration Trench
Filtering Systems (F)		
S	FBIO	Bioretention
S	FSND	Sand Filter
S	FUND	Underground Filter

S	FPER	Perimeter (Sand) Filter
S	FORG	Organic Filter (Peat Filter)
S	FBIO	Bioretention
Open Channels (O)		
S	ODSW	Dry Swale
S	OWSW	Wet Swale
Other Practices (X)		
S	XDPD	Detention Structure (Dry Pond)
S	XDED	Extended Detention Structure, Dry
S	XFLD	Flood Management Area
S	XOGS	Oil Grit Separator
S	XOTH	Other

MDE Approved Alternative BMP Classifications

Alt. BMPs (A)	Code	Code Description
A	MSS	Mechanical Street Sweeping
A	VSS	Regenerative/Vacuum Street Sweeping
A	IMPP	Impervious Surface Elimination (to pervious)
A	IMPF	Impervious Surface Elimination (to forest)
A	FPU	Planting Trees or Forestation on Pervious Urban
A	CBC	Catch Basin Cleaning
A	SDV	Storm Drain Vacuuming
A	STRE	Stream Restoration
A	OUT	Outfall Stabilization
A	SPSC	Regenerative Step Pool Storm Conveyance
A	SHST	Shoreline Management
A	SEPP	Septic Pumping
A	SEPD	Septic Denitrification
A	SEPC	Septic Connections to WWTP

APPENDIX F

BIOLOGICAL ASSESSMENT RESULTS

Picture Spring Branch Site PSB-01

Sampled: 3/17/2015

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Poor
BIBI Score	2.43

Metric	Value	Score
Total Taxa	20	3
EPT Taxa	4	3
Number Ephemeroptera	0	1
% Intolerant to Urban	9.35	1
% Ephemeroptera	0	1
Scraper Taxa	1	3
% Climbers	8.41	5

Benthic Macroinvertebrate Taxa List

Taxa	Count
Bittacomorpha	1
Caecidotea	3
Calopteryx	2
Cheumatopsyche	1
Chimarra	1
Coenagrionidae	1
Conchapelopia	19
Diplectrona	6
Helichus	1
Limnephilidae	5
Odontomyia/hedriodiscus	1
Parametriocnemus	13
Phaenopsectra	1
Pisidium	24
Prodiamesa	16
Sialis	1
Stictochironomus	2
Tipula	1
Tubificidae	3
Zavrelimyia	5

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Partially Degraded
PHI Score	72.11

Metric	Score
Drainage area (acres)	76.80
Remoteness	42.78
Percent Shading	78.67
Epifaunal Substrate	68.60
Instream Habitat	75.10
Instream Wood Debris	93.27
Bank Stability	74.25

Rapid Bioassessment Protocal

Narrative Rating	Supporting
RBP Score	79

Metric	Score
Epifaunal Substrate / Cover	8
Embeddedness	8
Velocity / Depth Regime	7
Sediment Deposition	7
Channel Flow Status	16
Channel Alteration	18
Frequency of Riffles	15
Bank Stability	9(Left)/9(Right)
Vegetative Protection	9(Left)/9(Right)
Riparian Veg Zone Width	9(Left)/9(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	10.92
pH	6.55
Specific Conductance (µS/cm)	1139
Temperature (°C)	8.86
Turbidity (NTUs)	19.6

Picture Spring Branch Site PSB-02

Sampled: 3/17/2015

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Poor
BIBI Score	2.71

Metric	Value	Score
Total Taxa	17	3
EPT Taxa	3	3
Number Ephemeroptera	0	1
% Intolerant to Urban	7.69	1
% Ephemeroptera	0	1
Scraper Taxa	3	5
% Climbers	16.24	5

Benthic Macroinvertebrate Taxa List

Taxa	Count
Caecidotea	3
Conchapelopia	10
Diplectrona	3
Diptera	1
Limnephilidae	2
Lymnaeidae	1
Parametriocnemus	29
Paratendipes	4
Physa	3
Pisidium	24
Polycentropus	3
Polypedilum	13
Prodiamesa	2
Stenelmis	2
Stictochironomus	4
Thienemannimyia group	5
Tubificidae	2
Zavrelimyia	6

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Degraded
PHI Score	64.38

Metric	Score
Drainage area (acres)	96.00
Remoteness	18.60
Percent Shading	63.55
Epifaunal Substrate	49.71
Instream Habitat	83.91
Instream Wood Debris	93.71
Bank Stability	76.80

Rapid Bioassessment Protocal

Narrative Rating	Partially Supporting
RBP Score	63

Metric	Score
Epifaunal Substrate / Cover	8
Embeddedness	7
Velocity / Depth Regime	8
Sediment Deposition	4
Channel Flow Status	16
Channel Alteration	18
Frequency of Riffles	10
Bank Stability	9(Left)/9(Right)
Vegetative Protection	4(Left)/5(Right)
Riparian Veg Zone Width	4(Left)/4(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	11.75
pH	6.84
Specific Conductance (µS/cm)	1011
Temperature (°C)	8.49
Turbidity (NTUs)	19.7

Picture Spring Branch Site PSB-03

Sampled: 3/17/2015

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Fair
BIBI Score	3.00

Metric	Value	Score
Total Taxa	24	5
EPT Taxa	3	3
Number Ephemeroptera	0	1
% Intolerant to Urban	0.00	1
% Ephemeroptera	0	1
Scraper Taxa	3	5
% Climbers	22.67	5

Benthic Macroinvertebrate Taxa List

Taxa	Count
Boyeria	1
Calopteryx	7
Chaetocladius	1
Cheumatopsyche	2
Chimarra	3
Conchapelopia	9
Enchytraeidae	1
Hydrobaenus	1
Hydrobius	1
Limnephilidae	1
Orthocladius	1
Paracladopelma	1
Parametriocnemus	8
Paratanytarsus	1
Phaenopsectra	3
Physa	3
Pisidium	4
Polypedilum	4
Stenelmis	4
Stictochironomus	2
Stygonectes	1
Thienemannimyia group	4
Tipula	1
Tubificidae	9
Tvetenia	2

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Degraded
PHI Score	60.45

Metric	Score
Drainage area (acres)	147.20
Remoteness	20.96
Percent Shading	68.32
Epifaunal Substrate	52.74
Instream Habitat	79.54
Instream Wood Debris	74.07
Bank Stability	67.08

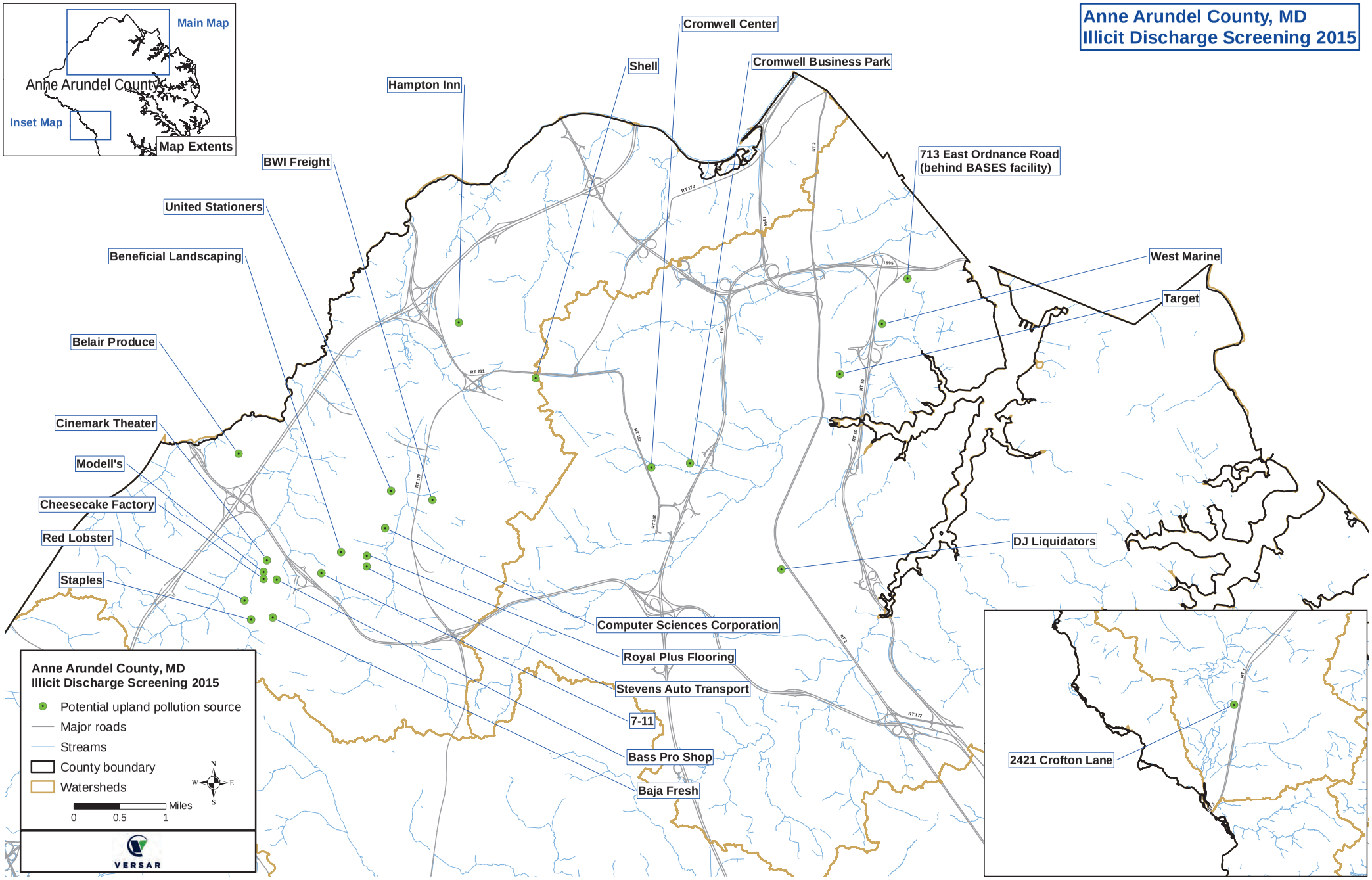
Rapid Bioassessment Protocal

Narrative Rating	Partially Supporting
RBP Score	62

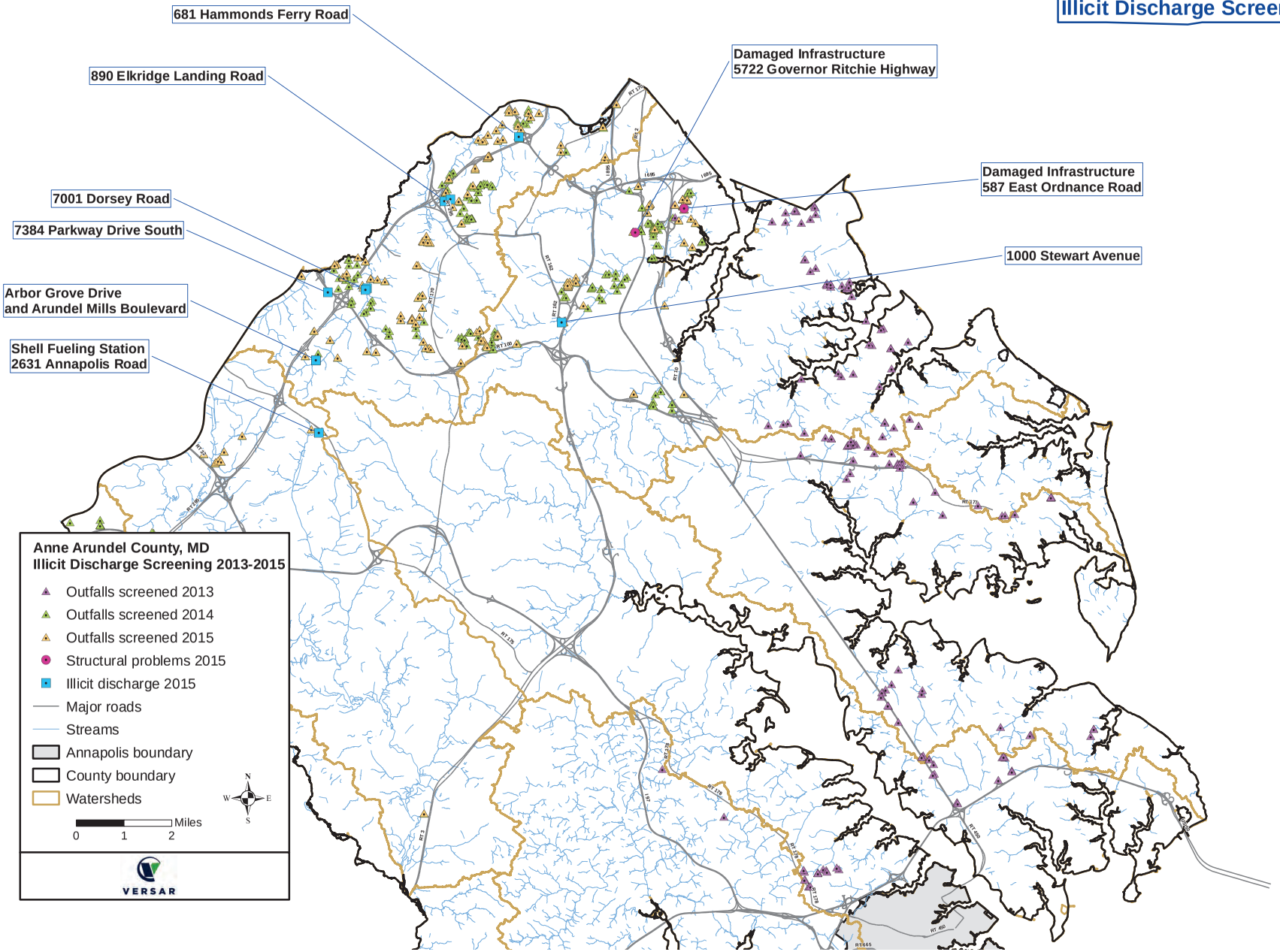
Metric	Score
Epifaunal Substrate / Cover	7
Embeddedness	8
Velocity / Depth Regime	7
Sediment Deposition	8
Channel Flow Status	16
Channel Alteration	14
Frequency of Riffles	6
Bank Stability	7(Left)/7(Right)
Vegetative Protection	7(Left)/7(Right)
Riparian Veg Zone Width	3(Left)/7(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	12.39
pH	7.12
Specific Conductance (µS/cm)	909
Temperature (°C)	8.61
Turbidity (NTUs)	22.3


Anne Arundel County, MD
Illicit Discharge Screening 2015
Main Map
Anne Arundel County
Inset Map
Map Extents
Cromwell Center
Shell
Cromwell Business Park
Hampton Inn
713 East Ordnance Road
(behind BASES facility)
BWI Freight
United Stationers
Beneficial Landscaping
West Marine
Target
Belair Produce
Cinemark Theater
Modell's
Cheesecake Factory
Red Lobster
Staples
DJ Liquidators
Computer Sciences Corporation
Royal Plus Flooring
Stevens Auto Transport
7-11
Bass Pro Shop
Baja Fresh
2421 Crofton Lane
Anne Arundel County, MD
Illicit Discharge Screening 2015
Potential upland pollution source
Major roads
Streams
County boundary
Watersheds
N
W
E
S
Miles
0
0.5
1
VERSAR

Anne Arundel County, MD
Illicit Discharge Screening 2013 - 2015



ANNE ARUNDEL COUNTY
ILLICIT DISCHARGE DETECTION AND ELIMINATION

2015 ANNUAL REPORT

PERMIT NUMBER MD0068306

Submitted to

Anne Arundel County
Department of Public Works
2662 Riva Road
Annapolis, MD 21401

Submitted by

Versar, Inc.
9200 Rumsey Road
Columbia, MD 21045

January 12, 2016

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1 INTRODUCTION

Under its National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit #MD0068306, Part III.E.3., Anne Arundel County is required to implement an inspection and enforcement program to ensure that all discharges to and from the municipal separate storm sewer system that are not composed entirely of storm-water are either permitted by the Maryland Department of the Environment (MDE) or eliminated. The requirements for the permit encompass five main components: field screening of a minimum of 150 storm drain outfalls annually, conducting routine surveys of commercial and industrial drainage catchments to find and eliminate pollutant sources, maintaining a program to address illegal dumping and spills, maintaining appropriate enforcement procedures for investigating and eliminating non-permitted discharges, and reporting of all discharge detection and elimination activities.

The County's program uses outfall field screening to locate illegal storm drain connections or other non-permitted dry-weather discharges through the municipal storm sewer systems. Versar, Inc. (Versar; with LimnoTech as subcontractor) has a contract with the County to perform the field screening. Where dry-weather effluent from municipal storm sewers is found, it is tested for contaminants. If contamination is found, the program requires that it be eliminated or permitted.

Within each area where field crews conduct dry-weather screening of outfalls, Versar and LimnoTech teams also perform routine visual surveys of commercial and industrial drainage areas. Inspectors drive through each commercial and industrial area, looking for signs of pollution. If pollutant sources are present, the field team notifies the County of the possible infraction at the site; the County then reviews the conditions and considers possible enforcement actions.

The Anne Arundel County Department of Inspections and Permits (I&P) maintains an inspection and enforcement program for identifying, reporting, and eliminating non-stormwater discharges into the County storm drain system, which includes illicit dumping and spills. This program is complaint-based with complaints filed by the public, other County inspectors or departments, and the Versar/LimnoTech team. The County agencies did not request any outfall inspections by the field teams that were initiated by complaints during the 2015 reporting period.

In the event of dumping, a spill, or an illegal connection, I&P corrects the situation or refers the matter to MDE for correction. If inspections identify food-waste-related concerns (e.g., overflowing or leaking dumpsters or grease collection facilities), the Anne Arundel County Department of Health corrects the situation. Both County agencies and MDE maintain appropriate enforcement procedures to ensure correction of these activities.

This report summarizes the outfall and commercial and industrial drainage catchment screening activities conducted by Versar and LimnoTech field teams during the 2015 reporting period. The 2015 reporting period extended from July 2014 through June 2015. The report also includes descriptions of screening activities led by Anne Arundel County, and compliance or enforcement updates from illicit discharges, upland pollutant sources, or structural issues

reported during the 2015 reporting period. Additionally, a summary of the final resolution of complaints reported on as unresolved during the 2013 and 2014 reporting periods is presented in this year's report.

2 METHODOLOGY

2.1 FIELD INVESTIGATION – OUTFALL INSPECTIONS

Dry-weather discharges from illegal sources have a higher likelihood of originating from commercial and industrial land uses (MDE, 1997). The areas targeted for the 2015 field effort included –Hanover, Linthicum Heights, and Glen Burnie. Target outfalls draining portions of commercial and industrial land uses were identified using a Geographic Information Systems (GIS) desktop analysis. To prepare for the field inspections, technicians used the Anne Arundel County's GIS coverage of storm drains and closed storm drain utility grids to create base maps for the targeted areas. Field crews used these maps in a differential Global Positioning System (GPS) unit to identify the extents of the local networks, the locations of outfalls, and the businesses or facilities within the drainage areas.

Field crews inspected 153 outfalls during the reporting period. The crews recorded water chemistry and physical condition of each outfall and its surrounding area in electronic field sheets. Crews documented additional details pertaining to each outfall in the "notes" section of the field sheets. Physical parameters recorded at each outfall included structural condition, deposits, vegetative condition, erosion, floatables, odor, color, and clarity. Crews took photographs of each outfall to document conditions. The inspection methodologies for these physical parameters are presented below.

The field teams' assessments of the structural condition of each outfall involved inspecting the outfall pipe and outfall structure for cracking, spalling, stability, and pipe separations. Often, outfall pipes or structures can be damaged or impaired by large scour holes at the outfall or severe downstream channel erosion that undermines the storm drain outfall. Other conditions such as excessive debris or pipe corrosion can affect the structural integrity of an outfall. When field teams identified damaged outfalls or situations that could threaten the stability of the storm drain system, they documented the significant factors at the outfall that were affecting the structural integrity of the storm drain pipe or outfall structure on the field data sheets and reported the structural issues to the Anne Arundel County Program Manager; the manager then notified the Infrastructure Management Division (IMD).

Deposits and stains present in an outfall can indicate the past discharge of a contaminant. If field crews observed significant deposits or staining at an outfall, they then investigated areas upstream in the network to determine the source.

Vegetative condition is a physical parameter that can be used to indicate the possibility of excessive nutrients, or chemicals and compounds in a discharge that harm or inhibit growth. If field crews found unusual vegetative conditions at a site, they attempted to determine the cause.

At each outfall, field crews inspected the banks of the channel leading away from the outfall for signs of erosion. Crews documented any significant erosion within 25 feet of an outfall.

If the field crews observed flowing water during a dry-weather screening, they inspected the discharge to determine the presence of floatables. The presence of floatables such as trash, sewage, or oil sheen can be evidence of an ongoing illicit connection, poor housekeeping, or a recent spill. If the crews found significant floatables in the discharge, they attempted to identify the source.

The field crews also recorded whether they detected any odor at each site where they found dry-weather flow. If the crews perceived a rancid-sour, sewage, gas, or other strong odor at a site, they recorded its qualities on the field sheets. These odors can indicate an illegal connection or spill. If the crews detected these odors, they attempted to locate the source.

Field crews documented whether algae growth was present at each outfall. The presence of algae growth may indicate nutrients or sewage contained within the discharge. If the crews found significant algae growth within the storm drain pipe or in the receiving channel, they attempted to identify the source.

Similarly, the color and clarity of the discharge can indicate contaminants in the discharge. A cloudy or opaque discharge typically means that solids are suspended in the effluent. The color of a discharge can be a clue to help assess the composition of the discharge, including chemicals or sewage contained within. If the field team found abnormal color or clarity, field teams attempted to identify the source of the potential contaminant.

In some cases, outfalls were either completely or partially submerged as a result of changing deposition patterns at the outfall or in the downstream channel, or its position in a tidal area. In these cases, field crews attempted to collect flowing discharge samples from the upstream storm drain structures. Submerged conditions do not necessarily indicate a storm drain structural problem.

Field crews chemically tested dry-weather discharge from outfalls using Chemetrics color comparator test kits (for detergents, phenols, copper, chlorine, and ammonia), an Extech single analyte tester (for fluoride), and a YSI or *In-situ* multi-parameter sonde (for water temperature and pH). All field screening took place following a minimum of 72 hours (i.e., less than 0.10 inches of rainfall) of dry-weather. Crews compared the results of the screening tests to "action" criteria, presented in Table 2-1, to determine which results should be considered abnormal and warrant further investigation (action) for possible illicit connections.

If the field teams determined that chemical conditions at an outfall resulted in any tested concentrations above the action criteria, they revisited the site within 24 hours, but at least four hours after the first test. This protocol was followed to account for any discharge anomalies, and to confirm the results of the chemical test conducted on the first visit.

Field crews indicated a possible illicit connection for any outfall with dry-weather flow that was found to have a concentration above any of the action criteria (Table 2-1) during both inspections. Possible illicit connections also included situations where an observable pollutant had been discharged through a storm drain system, but at the time of inspection the system did not exhibit flowing effluent or the discharge did not contain the pollutant. To identify the source

of any illicit discharge, the field crews followed the storm drain systems upstream, testing flows through manholes and inlets as necessary and practical, until the source was identified or the discharge could not reasonably be tracked further. Field teams documented evidence of illicit discharges, including the probable cause(s) with photographs.

Table 2-1. Analytes, testing ranges, and action criteria for dry-weather discharge screening in Anne Arundel County

Analyte	Effluent Type Indicated	Action Criterion	Minimum Detection Limit	Instrument Range	Kit or Probe
Chlorine (Cl)	industrial, tap water, sewage	≥ 0.40 mg/l[(a)]	0.05 mg/l	0 to 5 mg/l	Chemetrics color comparator
Copper (Cu)	industrial	≥ 0.21 mg/l[(a)]	0.05 mg/l	0 to 10 mg/l	Chemetrics color comparator
Phenols	dry cleaning	≥ 0.17 mg/l[(a)]	0.05 mg/l	0 to 12 mg/l	Chemetrics color comparator
Detergents*	sewage, washwater	≥ 0.5 mg/l (residential)[(a)]	0.15 mg/l	0.15 to 3 mg/l	Chemetrics color comparator
Ammonia	sewage	≥ 1.0 mg/l[(b)]	N/A	0 to 300 mg/l	Chemetrics color comparator
Fluoride	Sewage, tap water	≥ 0.75 mg/l[(c)]	N/A	0 to 10 mg/l	Extech fluoride meter
pH	Industrial washwater	≤ 6.5 or ≥ 8.5	N/A	0 to 14	YSI sonde
Water Temperature	Sewage	N/A	N/A	N/A	YSI sonde

[(a)] MDE 1997
[(b)] CWP 2004a, CWP 2004b, and Pitt 2004
[(c)] Anne Arundel County (2011)
* Field test results may fall below instrument range when using color comparators

Versar staff prepared site-specific reports for each identified storm drain structural issue found in the field and submitted them to the Anne Arundel County MS4 Program Manager. The Program Manager typically then shared the reports with the IMD to facilitate corrections for the infractions. In some instances, the identified structural issues is associated with non-County-owned infrastructure. In these cases, the Program Manager typically sent copies of the reports to I&P for follow-up site visits, inspections, and appropriate enforcement. Appendix A includes copies of the site-specific reports detailing structural issues identified in the field during the 2015 reporting period.

Versar staff prepared and submitted reports of field-identified possible illicit connections to the Anne Arundel County MS4 Program Manager. The Program Manager then sent copies of the reports to I&P to initiate plans for follow-up site visits and inspections for these reported problems, and enforcement action as appropriate. Appendix B includes copies of the reports of possible illicit connections, with details of the findings by Versar and LimnoTech field teams.

During the illicit discharge outfall investigations, many storm drain outfalls were found that were not on the County's digital version of its infrastructure network. In such cases, field teams recorded each new outfall's location with the GPS unit. Versar staff will send the locations of all previously unmapped outfalls found during the field investigations to the County to augment the County's GIS coverage.

2.2 FIELD INVESTIGATION – ROUTINE SURVEY OF COMMERCIAL AND INDUSTRIAL DRAINAGE CATCHMENTS

Within the three areas where field crews performed dry-weather screening of outfalls in the 2015 reporting period (Hanover, Linthicum Heights, and Glen Burnie), field teams also conducted routine visual surveys of the drainage areas of commercial and industrial facilities to search for signs of polluting activities. These efforts are intended to help the County discover and eliminate any upland pollutant sources. Versar staff used GIS tools to identify areas depicting commercial and industrial land uses, as defined by the Maryland Department of Planning's 2010 land cover data set (Maryland Department of Planning 2010), to facilitate the surveys of these properties. Field crews visited each commercial or industrial property in the designated areas to confirm storm drain system components and to document upland pollutant sources if the teams found evidence of polluting activities during the surveys. Upland pollutant source identification includes evidence of spills or dumping, poor housekeeping, poor maintenance of drainage systems, or other polluting activity not approved by a valid MDE permit. If field teams identified any upland pollutant source, they recorded the evidence on electronic field data sheets and documented the conditions with photographs.

Versar and LimnoTech teams reported evidence of upland pollutant sources to the Anne Arundel County MS4 Program Manager. The Program Manager then typically sent copies of the reports to I&P or the Health Department, as appropriate, to initiate plans for correction. Versar prepared and submitted site-specific reports for any site that the field teams determined required further investigation or correction. Appendix C includes copies of these reports.

As part of the County's program to address spills and illegal dumping, the County provides a means to receive complaints from residents to assist in identifying possible problems during regular field activities. The County requested one site investigation based on a complaint during the 2015 reporting period. On March 10, 2015, the Anne Arundel County Department of Public Works (DPW) received a citizen complaint via the Water Protection Division of the U.S. Environmental Protection Agency, Region III, regarding washdown activity in the rear of Clothes Call (2421 Crofton Lane) in Crofton, MD. Anne Arundel County assigned the investigation task to Versar; company staff conducted a site visit on April 16, 2015, consisting of both a hotspot investigation and dry-weather screening of the storm sewer network associated with the facility's property.

2.3 DATA ENTRY

All of the information entered into the outfall inspection field sheets was transferred to a Microsoft Access database. The database conforms to the format required by MDE, and is included in Appendix E of this report. The database contains a record for each visit to an outfall site. If field inspections indicated that an outfall had dry-weather flow containing a high concentration of a contaminant, project protocol required that field crews screen the outfall again to verify the results of the initial test. The Access database includes the data gathered during the second visit as a separate entry from data recorded on the first site visit. The database format

specified by the County's permit provides several options for each of the following parameters: structural condition, deposits, vegetative condition, erosion, floatables, odor, color, and clarity. The "notes" field contains any specific details or findings from the field assessment that did not match one of these options; this information can be used as a guide for future maintenance activities.

Appendix D contains two maps that show the locations of outfalls screened in the 2015 reporting period. One of the maps shows potential upland pollutant sources identified during the period. The other map shows all outfalls screened in the period, and structural or erosion issues identified by field teams.

3 RESULTS

3.1 PHYSICAL FINDINGS

Versar and LimnoTech field teams identified two locations where physical issues significantly affected stormwater infrastructure within the targeted areas of Anne Arundel County during the 2015 reporting period (Table 3-1). Appendix A contains site-specific reports on these findings.

Table 3-1. Structural issues identified in field inspections during the 2015 reporting period

Location	Town	Outfall ID	Inspection Date	Issue
587 East Ordnance Rd.	Glen Burnie	N/A	5/3/2015	Missing manhole cover
6722 Ritchie Highway	Glen Burnie	N/A	5/3/2015	Stormwater management riser damaged and missing manhole cover

3.2 CHEMICAL FINDINGS

Of the 153 outfalls screened by Versar and LimnoTech, 56 had dry-weather flow. Where possible at each of these outfalls, field crews collected a sample of the effluent and conducted tests on portions of the sample for phenols, chlorine, copper, detergents, ammonia, and fluoride. Field crews also documented air and water temperature and pH during the site visit. Of the screened outfalls containing dry-weather flow, 11 yielded a result above the action criteria limit for one or more of the tested contaminants. Field crews re-screened ten of these outfalls, and of those, eight had concentrations that were above at least one action level when re-tested (Table 3-2). Appendix B contains site-specific reports for the re-tested outfalls that staff identified as confirmed illicit discharges.

Appendix E contains the Microsoft Access database of all of the 163 inspection results (153 initial tests and 10 re-tests) from the 2015 reporting period. The database structure includes a separate record for each site visit to these outfalls.

Table 3-2. Potential illicit discharges identified in field inspections during the 2015 reporting period, based on results from re-tests

Outfall	Date of Test	Test Description	Chlorine (mg/l)	Copper (mg/l)	Phenols (mg/l)	Detergents (mg/l)	Ammonia (mg/l)	Fluoride (mg/l)	pH
L07A1O004	3/19/15	Initial	**3**	**0.4**	0	**0.75**	0	0.6	7.65
	3/19/15	Re-test	**0.6**	0.1	0.1	0.1	0	0.6	7.75
F06H4O016	4/13/15	Initial	**1**	0.1	0	**0.5**	0	0.3	7.28
	4/13/15	Re-test	0.1	0	0	**0.5**	0	0.2	N.T.
F07F8O003	4/29/15	Initial	0.1	0	0	**0.9**	**10**	0.4	7.41
	4/30/15	Re-test	0.05	0	0	**5**	**10**	0.5	7.34
F07F8O003new	4/29/15	Initial	0	0	0	0.15	**2.5**	0.5	7.8
	4/30/15	Re-test	0	0	0	0.25	**2.5**	0	7.76
F09F5O001	5/5/15	Initial	0	0	0	**0.9**	0	0	N.T.
	5/6/15	Re-test	N.T.	N.T.	N.T.	**3**	N.T.	N.T.	N.T.
I04E4O006	5/5/15	Initial	0	0	0	**0.5**	0	0.1	6.97
	5/6/15	Re-test	N.T.	N.T.	N.T.	**0.65**	N.T.	N.T.	N.T.
I04F3O014	5/5/15	Initial	0	0	0	**1**	0	0	7.16
	5/6/15	Re-test	N.T.	N.T.	N.T.	**1**	N.T.	N.T.	N.T.
K02B8O002	5/27/15	Initial	0	0	0	**0.75**	0	0	7.06
	5/28/15	Re-test	0	0	0	**2**	0	0	7.43

Bold = Exceeds action criteria threshold
N.T. = not tested

3.3 UPLAND POLLUTANT SOURCE FINDINGS

Versar and LimnoTech field crews identified 24 upland pollutant sources during the routine survey of the commercial and industrial sites within the targeted areas of Anne Arundel County. Table 3-3 provides a summary of the results of the upland pollutant source investigations. Appendix C contains site-specific reports on these sites.

Table 3-3. Summary of upland pollutant source findings identified during the 2015 reporting period

Address	Town	Business Name	Inspection Date	Wash-down Activity	Poor House-keeping (solid waste)	Poor House-keeping (liquid waste)
1334 Ashton Rd.	Hanover	Beneficial Landscaping	3/11/2015		X	
1327 Ashton Rd.	Hanover	Royal Plus Flooring	3/11/2015		X	
7484 Candlewood Rd.	Hanover	Stevens Auto Transport	3/11/2015		X	
1401 Dorsey Road	Hanover	Dorsey Road 7-11	3/11/2015		X	
Mathison Way & Aviation Blvd.	Hanover	BWI Freight	3/12/2015		X	
6938 Aviation Blvd.	Ferndale	Cromwell Center	3/12/2015		X	X
1001 Aviation Blvd.	Ferndale	Shell	3/12/2015		X	X
829 Elkridge Landing Rd.	Linthicum Heights	Hampton Inn	3/12/2015		X	
7000 Arundel Mills Circle	Hanover	Cinemark Theater	3/13/2015		X	
7000 Arundel Mills Circle	Hanover	Modell's	3/13/2015		X	
7002 Arundel Mills Circle	Hanover	Cheesecake Factory	3/13/2015		X	X
7063 Arundel Mills Circle	Hanover	Red Lobster	3/13/2015			X
7000 Arundel Mills Circle	Hanover	Bass Pro	3/13/2015	X		

Table 3-4. (Continued)

Address	Town	Business Name	Inspection Date	Wash-down Activity	Poor House-keeping (solid waste)	Poor House-keeping (liquid waste)
7661 Arundel Mills Blvd.	Hanover	Staples	3/13/2015		X	
7645 Arundel Mills Blvd.	Hanover	Baja Fresh	3/13/2015			X
7459 Candlewood Rd.	Hanover	Computer Sciences Corporation	3/13/2015		X	
7441 Candlewood Rd.	Hanover	United Stationers	3/13/2015		X	
7572 Ritchie Highway	Glen Burnie	DJ Liquidators	4/13/2015			X
2421 Crofton Ln.	Crofton	2421 Crofton Lane	4/16/2015		X	
595 East Ordnance Rd.	Glen Burnie	West Marine	4/24/2015		X	
713 East Ordnance Rd.	Glen Burnie	behind BASES	4/24/2015		X	
6717 Ritchie Highway	Glen Burnie	Target	4/24/2015		X	
801 Cromwell Park Dr.	Glen Burnie	Cromwell Business Park	4/24/2015		X	
7226 Parkway Drive	Hanover	Belair Produce	6/25/2015			X

4 SUMMARY AND CONCLUSIONS

In support of Anne Arundel County's NPDES permit requirements (Condition III.E.3.a, Illicit Discharge Detection and Elimination, NPDES municipal stormwater permit #MD0068306), Versar and LimnoTech field crews visited 153 outfalls for the 2015 reporting period. Appendix E contains the Microsoft Access database of the results of these visits. Table 4-1 contains a summary of the physical and chemical parameters evaluated in the outfall screening for the period. The table includes only the results from the first visit of re-screened outfalls.

Table 4-1. Summary of conditions evaluated during outfall inspections performed during the 2015 reporting period

Condition	Number of Outfalls
Observable Flow	56
Chlorine present	22
Detergents present	44
Ammonia present	3
Fluoride present	29
Excessive vegetation	8
Algae growth	27
Cloudy water	3
Opaque water	2
Outfall damage	18
Concrete cracking	3
Concrete spalling	9
Sediment deposits	55
Submerged outfall	4
Moderate erosion	14
Severe erosion	6
Oil sheen	5
Trash present	13
Oil/Gas/Sulfur/Sewage odor	10
Rancid/sour odor	0
Other than clear color	9

*Note: Several sites had multiple findings, resulting in an overall total greater than 153.

Versar and LimnoTech field crews identified two stormwater structures exhibiting structural or erosion problems within the targeted areas of Anne Arundel County during the 2015 reporting period. Table 5-1 and Appendix A contain details of these findings, and the corrective actions associated with these sites.

Of the outfalls screened by Versar and LimnoTech containing dry-weather flow, eight yielded results above the action criteria for tested contaminants within the targeted areas of Anne Arundel County for the 2015 reporting period. Table 5-1 and Appendix B contain details of these findings, and the corrective actions associated with these sites.

As required in Condition III.E.3.b, the field program included investigations of commercial and industrial sites in the target areas to determine if any upland pollutant sources were present. Field teams identified 24 upland pollutant during these surveys for the 2015 reporting period. Table 5-1 and Appendix C contain details of these findings, and the corrective actions associated with these sites.

To comply with Condition III.E.3.c, Anne Arundel County maintained an environmental hotline to provide the residents of the County a means for reporting environmental-related complaints, including illegal dumping and spills. Environmental hotline complaints typically involve sediment control issues, illegal grading activities, or potential violations of Critical Area regulations. In the 2015 reporting period, I&P received 7 complaints that were applicable to the NPDES MS4 requirements for Illicit Discharge Detection and Elimination (IDDE), including those forwarded to the County by Versar. Appendix F, which is a summary of the compliance cases that fall under the IDDE program, contains records of these complaints. In the event that illegal dumping or a spill is reported, County personnel immediately mobilize to correct the problem, or refer it to MDE.

As required by Condition III.E.3.c and d, Anne Arundel County used appropriate enforcement procedures to correct any illicit discharge, upland pollutant source, spill, or illegal dumping activities identified within the County. The Corrections and Enforcement Actions section of this report below describes follow-up actions in further detail for the problems identified during the illicit discharge inspections and routine survey of commercial and industrial drainage catchments (see Table 5-1 and Appendix F).

Condition III.E.3.e of the County's NDPES municipal stormwater permit requires that all efforts to comply with the illicit discharge detection and elimination requirements are documented and submitted with the County's Annual Report. Versar staff prepared the Illicit Discharge Detection and Elimination 2015 Annual Report to comply with this permit requirement. As required, the Recommendations section included below provides documentation of the proposed changes to the program for subsequent efforts, if applicable.

5 CORRECTIONS AND ENFORCEMENT ACTIONS

As presented in Table 5-1, the Anne Arundel County Program Manager sent copies of reports for significant findings from field investigations to the responsible authorities for action. Reports of illicit connections and upland pollutant sources (e.g., leaking dumpsters) identified during the investigations for the 2015 reporting period went to either I&P or to the County Health Department. The Program Manager reported structural issues to IMD to determine ownership of the infrastructure (and whether a stormwater agreement existed with the owner); then, either IMD or I&P would respond, depending on their areas of responsibility. The IMD or I&P Departments then addressed the problems based on whether the infrastructure was publicly or privately owned, respectively. Occasionally, complex cases are not resolved in time for a particular year's report; such cases are typically reported as unresolved. This year, Table 5-2 was created to provide details regarding the ultimate resolution of unresolved cases described in the 2013 and 2014 reporting years.

The Anne Arundel County Department of Inspections and Permits applies a phased approach to eliminating and enforcing illicit storm drain discharges. Phase 1 Enforcement consists of a Violation Notice sent by first class and certified mail to the property owner. The Phase 1 Violation Notice includes an explanation of the violation and requests a written commitment to immediately cease the illicit discharge. Upon written receipt of the commitment to comply, the Department monitors the site for up to 60 days. If compliance is maintained, the violation is considered abated. Should the Department fail to receive written commitment to comply, or if further violations are observed, the Department proceeds to Phase 2 Enforcement. At the Phase 2 Enforcement level, the Department posts a Stop Work Order on the property and issues a $1000 civil citation to the property owners. The civil citation must be paid and the violation abated or the civil citations are litigated in court. For the 2015 reporting period, the Inspection and Permits Department successfully enforced all illicit discharge complaints and referrals without the need for any referrals to MDE.

Appendix F contains inspection compliance database reports from the I&P Complaint Tracking System for each identified illicit connection, upland pollutant source, or environmental hotline complaint that is relevant to this report. These reports detail County efforts in determining if remediation is necessary and if action was taken.

Table 5-1. 2015 Illicit Discharge Detection and Elimination Program: Investigative activities and follow-up actions

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
March 13, 2015	N/A	7000 Arundel Mills Circle (Egyptian 24)	A Versar field team found two dumpsters that had been placed over a storm drain curb inlet alongside the Cinemark Egyptian 24 and XD (movie theater) at the listed address. The field team noted that there were stains leading to the curb inlet, suggesting that materials other than water have been entering the storm system at this location. Although the field crew found the dumpsters appropriately closed, any trash alongside the containers, or exposed when the lids are open may blow off-site or into the adjacent opening to the storm drain system. Any debris deposited on the ground may also leak potentially contaminating contents onto surfaces that could enter the storm drain inlet easily. Inspection by the Health Department found no violation at the time of inspection and the case was considered resolved.	April 20, 2015: Received from Versar April 21, 2015: Sent to HD. May 6, 2015: Inspection by HD showed no violation. **CASE CLOSED.**	RESOLVED
March 11, 2015	N/A	1401 Dorsey Road	A Versar field team discovered an open dumpster and scattered debris associated with a 7-11 store at the listed address. The field crew found one of the dumpsters open and filled with trash. Behind the store, the field crew found a large amount of debris (filled bags, cardboard, and food containers) among the bushes. Debris deposited on the ground may allow trash to blow off-site or leak potentially contaminating contents onto surfaces that could lead to adjacent storm drain inlets or open water. An inspection in May by the Health Department confirmed observed conditions. Site manager counseled on maintaining dumpster area.	April 9, 2015: Received from Versar. April 21, 2015: Sent to HD. May 8, 2015: Inspected and manager counseled on maintaining dumpster area. June 22, 2015: At HD request, part of reported unresolved cases. Confirmed inspection made in May, as referenced above. **CASE CLOSED.**	RESOLVED
March 11, 2015	N/A	1327 Ashton Road	A Versar field team discovered an open dumpster behind the Royal Plus building at the listed address. The field crew was unable to determine whether the dumpster was being shared by several businesses. The dumpster had been placed in a corner of the parking lot immediately adjacent to a storm drain inlet. The photographs taken on the day of the visit reveal some debris in the area surrounding the dumpster, which could also enter the storm drain system. During the inspection, the Health Department spoke with property manager about dumpster and the issue was corrected.	April 9, 2015: Received from Versar. April 21, 2015: Sent to HD. May 8, 2015: Inspection by HD. Inspector spoke with property manager about dumpster. Property manager agreed to monitor situation. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
March 12, 2015	N/A	829 Elkridge Landing Road	A Versar field team discovered a large amount of debris surrounding an open dumpster associated with the Hampton Inn hotel at the listed address. The open dumpster was not full; this suggests that the debris may have been deposited on the ground at an earlier time, perhaps when the unit was full, or that the dumpster is not being used routinely for trash disposal. The field team documented debris on all sides of the unit, including a mattress along with bagged and loose trash, including food containers. Alongside the dumpster enclosure, the field crew observed several discarded ventilation units. The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site and into the storm drain system. Debris deposited on the ground may leak potentially contaminating contents onto surfaces that could also lead to adjacent storm drain inlets or open water. Some debris may also attract pests to the site. An inspection by the HD confirmed the violation, which was corrected by the property owner.	April 9, 2015: Received from Versar. April 21, 2015: Sent to HD. April 28, 2015: Inspected by HD. Confirmed site not in compliance. Asked to perform cleanup. Will re-inspect on May 12. May 12, 2015: HD performed re-inspection and all issues are resolved. **CASE CLOSED.**	RESOLVED
March 13, 2015	N/A	7000 Arundel Mills Circle (Modell's)	A Versar field team found an overfilled roll-off dumpster in the parking lot near the Modells Sporting Goods store at the listed address. The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site and into the storm drain system. Debris that falls to the ground may leak potentially contaminating contents onto surfaces that could also lead to adjacent storm drain inlets or open water. Some debris may also attract pests to the site. An inspection by the Health Department found no violations.	April 20, 2015: Received from Versar. April 21, 2015: Sent to HD. May 11, 2015: Inspection by HD found no violations. **CASE CLOSED.**	RESOLVED
March 13, 2015	N/A	7661 Arundel Mills Blvd	A Versar field team found an open dumpster with debris scattered around it behind the Staples store at the listed address. The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site and into the storm drain system. Debris on the ground may be carried by wind or water to nearby storm drain inlets; it may also leak potentially contaminating contents onto surfaces that could also lead to nearby storm drain inlets or open water. Some debris may also attract pests to the site. After two Health Department inspections, the property owner brought the site into compliance and the case was closed.	April 20, 2015: Received from Versar. April 21, 2015: Sent to HD. April 24, 2015: Inspected by HD (before receiving WRPR report). April 28, 2015: Re-inspected by HD. Site not in compliance. Property owner told to clean up area. Will re-inspect in 15 days. May 6, 2015: Re-inspection by HD finds site in compliance. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
March 11, 2015	E-2015-143	1334 Ashton Road, Hanover	A Versar field team discovered a condition of improper bulk solid storage, in the form of snow removal and road de-icing supplies and tools, in the parking lot adjacent to (immediately to the west of) the building located at 1334 Ashton Road, in Hanover, MD. The field crew documented bags of salt, loose salt, and an open storage trailer at this location. The field crew found a skid steer loader in the same area with residual de-icing salt in its bucket. The truck parked between the storage trailer and the skid loader, with a snow plow attachment displayed a company logo for Beneficial Landscaping, LLC. This small company is located in Sykesville, MD, so the Hanover storage site may be established under an agreement with the landowner of the Ashton Road building, or the building at 7467 Ridge Road, Hanover, which lies adjacent to the parking lot on the southwest side. The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could drift into adjacent storm drain inlets or open water. An inspection by Inspections and Permits found all salt piles properly managed and the snow removal equipment removed.	April 20, 2015: Received from Versar. April 21, 2015: Sent to I&P. June 22, 2015: Status update request sent to I&P May 20, 2015: I&P inspection finds all salt piles covered. Snow removal equipment removed from site. **CASE CLOSED.**	RESOLVED
March 12, 2015	E-2015-146	BWI Freight parking lot, Mathison Way at Aviation Blvd	A Versar field team discovered large chunks of road salt at a curb inlet in the parking lot associated with BWI Freight. The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could easily enter the adjacent storm drain inlet. The professional opinion of the inspector was that the placement of the salt relative to the storm drain system coupled with the small amount of material left made this situation not a significant concern.	April 9, 2015: Received from Versar. April 21, 2015: Sent to I&P May 11, 2015: Inspected by I&P. The small amount of salt and its placement with respect to the stormdrain was judged to not be a concern by the inspector. **CASE CLOSED.**	RESOLVED
March 11, 2015	E-2015-144	7484 Candlewood Road	A Versar field team discovered very large, uncovered piles of road salt in the parking lot associated with Stevens Auto Transport. Near the salt piles, the field crew photo-documented a company truck with a snow plow installed on the front. The salt may have been intended, then, for surface treatment as part of snow removal services. The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could wash into adjacent storm drain inlets or open water. An inspection by Inspections and Permits found the salt piles properly managed and the snow plow removed.	April 9, 2015: Received from Versar. April 21, 2015: Sent to I&P. June 22, 2015: Status update request sent to I&P. May 20, 2015: Site inspected. Tarps placed over salt piles. Snow plow not present. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
March 13, 2015	E-2015-145	7441 Candlewood Road	A Versar field team discovered a large amount of debris on a slope leading to a stream alongside a parking lot associated with United Stationers at the listed address. The material deposited on the slope included bottles, cans, and plastic containers. In one area, there were also larger pieces: plastic bags, a box, and strips of foam. The trash was found strewn along a wide stretch of the woods along the stream. The sloped land would contribute to a significant pollution source from this site, as materials could enter the stream easily, carried by wind or rain. Debris deposited on the ground may also leak potentially contaminating contents onto surfaces that could lead to the open water. Some debris may also attract pests to the site. After contact by Inspection and Permits, the property owner cleaned up the area in question and is now in compliance.	April 20, 2015: Received from Versar April 21, 2015: Sent to I&P. June 22, 2015: Status update request sent to I&P. June 24, 2015: A letter has been sent to property owner instructing owner to clean up debris. Additional actions will be triggered if contact is not made with I&P in 30 days. July 30, 2015: I&P inspection has found the debris removed. This site is no longer a significant source of pollution to the stream. **CASE CLOSED.**	RESOLVED
March 13, 2015	E-2015-333	7000 Arundel Mills Circle (Bass Pro Shops)	A Versar field team discovered a man washing a boat with water from a hose at the service entrance of Bass Pro Shops at the listed address. This activity, conducted on impervious surface, may allow tap water to enter the storm drain system; the activity would constitute an illicit discharge. The field crew photo-documented the wastewater entering the roadway via paved surfaces. The current storm drain network is not available in digital format for this location to assess the relative location of the wastewater to an inlet.	April 22, 2015: Received from Versar. April 27, 2015: Sent to HD. May 1, 2015: HD claims not an issue for them. May 1, 2015: Sent to I&P. June 22, 2015: Status update request sent to I&P. June 26, 2015: Inspector informed property owner that boat washing into storm drains is not permitted. The manager stated he would comply. **CASE CLOSED.**	RESOLVED
March 13, 2015	N/A	7002 Arundel Mills Circle (Cheesecake Factory)	A Versar field team discovered two issues of concern in the parking lot near the restaurant The Cheesecake Factory at the listed address. The field crew documented an improper cooking oil storage situation and a dumpster with debris around it on March 13. The field team found a kitchen oil collection container with an open lid in the parking lot associated with the restaurant when they visited the site at 2:45 p.m. The team noted that the open container was located uphill of a curb inlet for the parking area. Cooking oil on an impervious surface poses a hazard to pedestrians; in a rain event, the oil may also distribute contaminants to adjacent impervious surfaces and eventually to storm drain inlets or open water. There is also a concern for attracting pests to the site. Inspections by the Health Department and discussions with the mall manager and the business owners led to correction of the issues.	April 22 , 2015: Received from Versar April 27, 2015: Sent to HD. May 11, 2015: Inspection by HD. Issues were being corrected at time of inspection. Inspector counseled Mall management, business owner about issues to prevent future problems. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
March 12, 2015	N/A	6938 Aviation Blvd.	A Versar field team discovered two issues of concern in the parking lot near the three restaurants at Cromwell Center at the listed address. The field crew documented an improper cooking oil storage situation and a dumpster with debris around it on March 12. The field team discovered a soiled biofuels collection container, intended for the disposal of waste kitchen oil, alongside the parking lot at Cromwell Center. The field crew photo-documented fresh oil on and around the container, and extensive stains on the pavement; this suggests that oil may be coming from a leak in the container and spills during attempts to empty materials into the container. Cooking oil on an impervious surface poses a hazard to pedestrians; in a rain event, the oil may also distribute contaminants to adjacent impervious surfaces and eventually to storm drain inlets or open water. There is also a concern for attracting pests to the site. The Health Department inspected the site, counseled property owner to do better housekeeping.	April 22, 2015: Received from Versar. April 27, 2015: Sent to HD. May 5, 2015: HD inspected site. Consulted with property owner to do better housekeeping. **CASE CLOSED.**	RESOLVED
March 13, 2015	N/A	7063 Arundel Mills Circle	A Versar field team discovered a grease collection container, intended for the disposal of waste kitchen grease, in the parking lot associated with the Red Lobster restaurant at the listed address. The field crew members found the container lid open when they visited the site at 2:55 p.m. Cooking oil on an impervious surface poses a hazard to pedestrians; in a rain event, the oil may also distribute contaminants to adjacent impervious surfaces and eventually to storm drain inlets or open water. There is also a concern for attracting pests to the site. Health Department inspection resulted in site manager agreeing to correct dumpster and to better manage housekeeping of grease trap.	April 22, 2015: Received from Versar. April 27, 2015: Sent to HD. May 14, 2015: Inspection by HD. Inspector spoke with manager who agreed to fix the dumpster or get a new one and take better care of the grease trap. **CASE CLOSED.**	RESOLVED
March 13, 2015	N/A	7459 Candlewood Road	A Versar field team found an open, overfilled dumpster near a yard grate in the parking lot associated with the Computer Sciences Corporation at the listed address. The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site or into the nearby storm drain system. Debris that falls on the ground may also leak potentially contaminating contents onto surfaces that could lead to nearby storm drain inlets or open water. Some debris may also attract pests to the site. An inspection by the Health Department found no violations and the case was considered resolved.	April 22, 2015: Received from Versar. April 27, 2015: Sent to HD. June 22, 2015: At HD request, part of reported unresolved cases. May 8, 2015: HD inspection found no violations. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
March 12, 2015	N/A	1001 Aviation Blvd.	A Versar field team discovered two issues of concern at the Shell fuel station at the listed address. The field crew documented an inadequate drum storage situation and an overloaded dumpster with debris around it on March 12. In an enclosure on the edge of the parking lot, the field team observed unmarked storage drums among other stored items. The field crew counted six 55-gallon drums in this storage area. Liquid materials in barrels should have secondary containment if placed on an impervious surface. Drums for liquids should also be labeled appropriately with content descriptions and hazard notices. As the contents of these containers were not specified, it is possible that the storage arrangements need to be modified to accommodate these guidelines. The Versar field team also documented an overflowing dumpster on the property at the same Shell fuel station. On closer inspection, the field team noted debris scattered on the pavement around the dumpster. The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site and into the storm drain system. Debris deposited on the ground may leak potentially contaminating contents onto surfaces that could also lead to adjacent storm drain inlets or open water. Some debris may also attract pests to the site. Inspection by the Health Department led to correction of issues with overflowing dumpsters. The barrel labeling issue is not a health code violation.	April 22, 2015: Received from Versar. April 27, 2015: Sent to HD. (may need sending to I&P) Will wait for HD response. June 22, 2015: At HD request, part of reported unresolved cases. May 8, 2015: Site inspected and manager instructed to clean dumpster area. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
March 19, 2015	E-2015-110	1000 Stewart Ave	At 11:30 a.m. on March 19, a LimnoTech field team inspected the outfall designated as L07A1O004, located at 1000 Stewart Ave., which is the address of a SunTrust Bank branch. The discharge was noted to be sporadic and began shortly after the arrival of the field team. A gasoline odor was also apparent. The flowing water tested above action levels for copper, chlorine, and detergents. Fluoride was also elevated but was below the action level. At 4:05 p.m., the team returned to the site and performed a 2nd test of the flowing water. At this time, only chlorine was above the corresponding action level. Fluoride was again elevated at this time, but below the action level. The flow rate was lower during the return visit and was continuous. The discharge was also not as cloudy and had a less significant gas odor than our first visit. The team documented a noticeable white powdery residue in the concrete channel that received the discharge. Results are summarized in Table 1 below. After the retest, the field team tracked flow from three directions in the network. Two of the branches originated in parking lot catch basins. The center branch originated from the south, from the direction of the building. The field crew was not able to open the manhole near the building which would confirm that the illicit discharge was originating from the building. Multiple inspections to observe this discharge and assistance from the cooperative property owner in attempting to recreate the issue yielded no results.	March 23, 2015: Received from Versar. March 23, 2015: Sent to I&P March 23, 2015: Inspected by I&P. Possible cross connection suspected. May 12, 2015: HD inspector reports that multiple visits since the initial inspection have resulted in not finding the issue again. Consequently, this case is closed and there is no issue. **CASE CLOSED.**	RESOLVED
April 13, 2015	N/A	7304 Parkway Drive South	Versar field staff conducted site visits to two outfalls (one, a target) associated with a stormwater pond along Parkway Drive South, near the Raspberry Deli at the listed address, on April 13. On the first visit to the outfall F06H4O016, at 11:32 a.m., the field crew documented flow from the 18-inch pipe discharging to the pond. The field team tracked the pipe back to the inlet on the southwest edge of Parkway Drive South (the only source of water for the outfall) and found the inlet dry. The screening results at the outfall on the first visit were above action levels for chlorine (1.0 mg/l) and detergents (0.5 mg/l). The field crew returned to the site several hours later (3:15 p.m.) to retest the discharge from the pipe. The retest yielded the same above-action detergent levels (0.5 mg/l) and a reduced level of chlorine (0.1 mg/l) to a concentration below the action threshold. The field team did not observe any other factors of concern in the discharge water (e.g., color, odor, or floatables). Staff reported the illicit discharge to the Environmental Hotline on 4.14.15. An inspection was conducted by Inspections and Permits on May 1.	April 16, 2015: Received from Versar April 27, 2015: Sent to I&P. May 1, 2015: Inspected by I&P. As this is an SHA pond and outfall, the County has no jurisdiction regarding enforcement. August 17, 2015: SHA informed of possible IDDE issue. September 16, 2015: Follow up with SHA to determine resolution. **CASE OPEN.**	UNRESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
March 13, 2015	N/A	7645 Arundel Mills Blvd	A Versar field team discovered two cooking oil collection containers, intended for the disposal of waste kitchen oil, in the parking lot associated with the Baja Fresh restaurant at the listed address. The field crew documented significant oil stains around the containers; the oil may be coming from leaks in the containers and spills during attempts to empty materials into the containers. Cooking oil on an impervious surface poses a hazard to pedestrians; in a rain event, the oil may also distribute contaminants to adjacent impervious surfaces and eventually to storm drain inlets or open water. There is also a concern for attracting pests to the site.	April 22, 2015: Received from Versar April 28, 2015: Sent to HD. May 6, 2015: Inspection by HD shows no violations. **CASE CLOSED.**	RESOLVED
April 16, 2015	N/A	2421 Crofton Lane	A Versar field team identified several issues of concern related to waste management in an area of the parking lot associated with 2421 Crofton Lane (multiple businesses). The field team discovered an open dumpster. The dumpsters were located next to an enclosed outdoor storage area. The field crew documented that some large pieces of debris have been placed both inside and outside of this enclosure. In a nearby corner of the parking lot, the field crew found more debris blocking a corner drain opening for the lot. The nearest stormwater system inlet is some distance away from the dumpsters and debris; the field team photo-documented its position relative to the storage area. The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site or into the nearby storm drain system. Debris that falls on the ground may also leak potentially contaminating contents onto surfaces that could lead to nearby storm drain inlets or open water. Large debris may pose a hazard to drivers in the parking lot, or block efficient drainage of rainwater across the impervious surface to the stormwater inlets.	May 3, 2015: Received from Versar. May 4, 2015: Sent to HD. May 7, 2015: Inspection by HD confirms violation. May 15, 2015: Re-inspected by HD, no action. June 19, 2015: Re-inspected by HD. Clean up confirmed. CASE CLOSED.	RESOLVED
April 13, 2015	E-2015-182	6722 Ritchie Highway	A LimnoTech field team discovered unsafe conditions with a stormwater detention basin riser structure behind the Best Buy store at the listed address. The field crew inspected the device and photo-documented the extent of the destruction of the facility. The top of the riser was dislocated and the manhole cover was lying on the ground at the base. The embankment behind the riser shows signs of extensive erosion, which suggests that the facility may no longer be properly functioning. The eroded area has been accumulating debris, also. The device in this condition presents a significant safety hazard for the public, although the fence may deter many trespassers. Most work has been completed, but property owner is waiting on design plans to make repairs to pipe and riser structures.	May 3, 2015: Received from Versar. May 4, 2015: Sent to I&P. May 20, 2015: I&P staff met with property owner. Necessary work discussed and discussion continues on necessary repairs. June 22, 2015: Status update request sent to I&P. June 29, 2015: Some repairs and clean up made, but other issues remain unrepaired. August 14, 2015: Status update request sent to I&P. August 14, 2015: I&P reports that property owner is currently developing plans to make repairs. September 8, 2014: Property owner still working on making needed repairs. **CASE OPEN.**	UNRESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
April 13, 2015	N/A	7572 Ritchie Highway	A LimnoTech field team discovered several open buckets of blacktop sealer on a sidewalk behind the D J Liquidators store (approximately) at the listed address. The field crew noted that there was extensive staining on the sidewalk suggesting that sealer has been transferred or spilled in this location in other recent incidents. Residue washed from the buckets or the sidewalk could easily enter the nearby curb inlet and introduce petroleum-based contaminants to the storm sewer system and receiving waters. A Health Department inspection found that all the buckets had been removed and that all observed sealer was dry.	May 3, 2015: Received from Versar. May 4, 2015: Sent to HD. May 8, 2015: Inspection by HD. Buckets had been removed and all sealer was dry. **CASE CLOSED.**	RESOLVED
April 13, 2015	E-2015-183	587 East Ordnance Road	A LimnoTech field team discovered an open stormwater manhole behind the building (unoccupied) at the listed address. An open hole in the ground presents a significant safety hazard for the public, although someone has attempted to create a make-shift marker to alert people of the opening.	May 3, 2015: Received from Versar. May 4, 2015: Sent to I&P. May 6, 2015: Inspection by I&P. Property owner instructed to properly install manhole cover. May 29, 2015: Follow up inspection shows location in compliance. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
April 29, 2015	E-2015-185 E-2015-186	Arbor Grove Drive and Arundel Mills Boulevard	On April 29, 2015 at 1:45 p.m., a Versar field team conducted an inspection of a target outfall that discharges to a wet pond located at the above intersection. Upon arrival, the field team identified two outfalls opening into the same headwall. The larger of the two, the target outfall, was 42" in diameter and was situated on the left (facing up-network) and an unmapped outfall (designated as F07F8O003NEW1) was 36" in diameter and oriented to the right. Both outfalls at the time had dry weather flow discharging to the stormwater pond. Outfall F07F8O003 (42", on the left) had sewage smell, was slightly brownish in color, and had a faint sheen on the water surface. The sound of water entering upstream suddenly increased during inspection. The discharge failed chemical tests for detergents (0.9 mg/l) and ammonia (10 mg/l). Outfall F07F8O003NEW1 (36", on the right) had no color or sheen, but had noticeable toilet paper residue at the outfall opening. It, too, had a sewage smell and the ammonia concentration was above the action level at 2.5 mg/l. Given the seriousness of the illicit discharge, Versar contacted I&P to inquire whether they would like to participate in tracking the source. On April 30, 2015 at 12:30 p.m., the field team returned to conduct the retest of both outfalls. Effluent from the 42" outfall was above the corresponding action levels for ammonia, chlorine, and detergents. The 36" outfall failed the ammonia test. With staff from I&P, flow to outfall F07F8O003 was tracked to an inlet just inside the entrance gate to Arbor Grove Drive, off Arundel Mill Blvd. An approximately 9" diameter PVC pipe entering the side of the inlet was dripping grayish water. The pipe was coming from the direction of a building 10 meters away. The detergent concentration in this effluent was off-scale; the ammonia concentration was also higher. A cross connection was found in the upstream network, which was corrected. The source of flow to F07F8O003NEW1 appeared to originate between two manholes and the effluent tested negative for illicit discharge indicators at that point. I&P inspectors and Versar staff continued their upstream investigation and could find no evidence of additional cross connections or other illegal discharge into this network, resolving this case.	April 29, 2015: Issue discovered by Versar. I&P consulted to assist. May 7, 2015: WPRP staff informed of progress via email. May 10, 2015: Report received from Versar. May 11, 2015: I&P inspector met with Versar crew to begin work in determining source of supposed cross connection. Also met with property owner/manager to discuss situation and plot out next steps. Note that there appear to be two cases, one for the 36 inch and one for the 42 inch outfall. May 19, 2015: Copy forwarded on to I&P. June 22, 2015: Status update request sent to I&P. July 7, 2015: Notice received from I&P that the suspected cross connections have been corrected on at least one site (186); E-2015-185 continues as a separate case concerning the Shops at Arundel Preserve to correct/confirm remaining high detergent readings. July 17, 2015: Inspection and investigation of outfall for E-2015-185. Extensive testing of the upstream network by I&P and Versar found no evidence of cross connection or other inputs. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
May 5, 2015	E-2015-229	890 Elkridge Road	Versar inspected the above outfalls on May 5, 2015 at 3:11 p.m. The screening results for I04E4O006 included an above-action level result for detergents (0.5 mg/l). The inspectors also screened outfall I04F3O014, which was a part of the drainage to outfall I04E4O006. Outfall I04F3O014 failed the screening test for detergents (1 mg/l) and the team suspected that the discharge from this outfall was a possible source of the detergent concentration at outfall I04E4O006. The field team returned to the site on May 6, 2015 at 3:00 p.m. The dry-weather discharges from both outfalls were tested and similar results for detergents were obtained: 0.65 mg/l at outfall I04E4O006 and 1 mg/l at outfall I04F3O014. At outfall I04F3O014, the field team tracked the effluent up the network, but could not ascertain the source of the high detergent concentrations since the source was behind the perimeter fence of a National Security Agency property. Staff also conducted a lengthy trackdown of the other sources of flow to outfall I04E4O006, but no other sources of detergents in the system were apparent. The trackdown procedure was hampered by the location of the trunk line which ran along the center of Elkridge Landing Road and the presence of traffic precluded opening of manhole covers. Small flows were found in several of the branch lines to the trunk, leading field staff to conclude that lower detergent concentrations found at outfall I04E4O006 were the result of dilution of detergent levels found in outfall I04F3O014. Versar notified I&P via the pollution hotline on May 7, 2015. Two site visits were made to perform inspections. On the second visit, water testing revealed no issues so the case was closed.	May 7, 2015: Versar called environmental hotline to report this violation. May 11, 2015: Report received from Versar. May 19, 2015: Copy of report sent to I&P to confirm follow up. June 22, 2015: Status update request sent to I&P. June 15, 2015: Inspection by I&P. Soapy water observed, but unclear about source as there are three inlets. Coordinating with Versar and property owners for additional testing. Follow up scheduled for June 30. July 1, 2015: Additional inspections occurred, but failed to find evidence of illicit discharge. Additional inspection/testing scheduled. July 30, 2015: Additional testing at outfall found detergent below action levels. No evidence of illicit discharge observed. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
May 5, 2015	E-2015-228	2631 Annapolis Road (Hanover Shell)	A Versar field team inspected the above outfall (actually the downstream end of a crossing) at 3:05 p.m. on May 5, 2015. The field team immediately noted that the water below the outfall had a greenish color, and there were suds where the dripping water was pooling. The field team collected a water sample, which had an oily odor and contained above action concentration of detergents (0.9 mg/l). The area around the outfall was severely eroded. At 1:12 p.m. on May 6, 2015, the team retested the outfall and obtained a result of 3 mg/l for detergents. Versar tracked the flow through the crossing and overland to another outfall (F09G5O001). The orifice of the outfall was found to be blocked by tree branches that appeared to have been deliberately placed. The team tested the flowing water from this outfall and obtained a detergents result that was off-scale. Source tracking of the discharge led the team to a car wash at a Shell fueling station. Two trench drains (at the entrance and exit) appeared to be connected to the storm drain system. Considering the persistence of flow through the network and through a downstream crossing, it is probable that much excess wash water is entering the system via the trench drains or possibly the main car wash effluent drainage is directly connected to the stormwater network. On May 7, Versar contacted I&P via the pollution hotline to report the matter. After an investigation by I&P, it was determined that an oil-grit separator servicing an on-site carwash was clogged and overflowing into the stormdrain. The BMP was rehabilitated and made functional again. The property owner was advised on the need to perform routine maintenance.	May 5, 2015: Issue discovered by Versar. May 7, 2015: I&P contacted via environmental hotline. May 10, 2015: Report received from Versar. May 19, 2015: Report forwarded to I&P. June 22, 2015: Status update request sent to I&P. June 24, 2015: Meeting between I&P, property owner led to discovery of overflowing oil-grit separator, which is likely source of problem. Property owner will do maintenance on facility. I&P will re-inspect once work is completed. July 30, 2015: I&P inspection found site in compliance. Oil-grit separator has been repaired and the property owner counseled to perform regular maintenance in the future. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
May 27, 2015	E-2015-292	601 and 611 Hammonds Ferry Road	A Versar field team inspected outfall K02B8O002, located in the stormwater management facility behind the business park located at 601 and 611 Hammonds Ferry Rd. During the initial visit on May 27 at 2:50 p.m., the test of the water flowing in the outfall resulted in 0.75 mg/l concentration of detergents. The outfall was re-screened the following day at 2:00 p.m. At the time of the follow up visit, the outfall contained obvious suds and tested above the action criterion for detergents again at 2.00 mg/l. The field team initiated procedures to track down the source of the illicit discharge. At the 2nd yard grate up the system where the network split, detergents were found at a concentration of 0.25 mg/l in the steadily flowing water in the network from between the buildings. The next storm drain inlet up in the line between the buildings was damp but not flowing. The branch line from the north side of the building tested at 0.75 mg/l but was puddled up and barely flowing at the junction. The next test point on the line that wraps around the north side of the building was dry. While tracking down and testing, staff observed several instances of vehicles being washed down, but no obvious signs of detergent in use, at two businesses. A chance conversation with an employee revealed that vehicle washing in the complex was common practice. Washing was observed at two businesses during trackdown activities: Valley Lighting and Iron Shore contracting. At Valley Lighting an employee started hosing off a personal truck but quickly stopped. At Iron Shore, employees were observed washing several trucks off. Versar notified I&P via the pollution hotline on May 28, 2015. During multiple inspections, I&P did not observe any vehicle washing. Business owners were advised that vehicle washing into stormdrain system was illegal and the property owner was contacted and asked to reach out to all businesses in the complex and ask them not to wash vehicles into the stormdrain system. A leaking dumpster was observed during the first visit, but was replaced. I&P inspector speculates that flow could be from ground water inflow.	May 28, 2015: Versar alerts I&P to issues. June 15, 2015: Report received from Versar. June 16, 2015: Reported again by WPRP to I&P for follow up. June 17, 2014: Case opened by I&P. June 22, 2015: Status update request sent to I&P. July 1, 2015: Inspection by I&P observed flow in storm drain, but no vehicle washing was observed during this inspection. A leaking dumpster was observed and reported to the Health Department. July 7, 2015: Re-inspection by I&P found flow at site, but no vehicle washing was observed. Businesses in counseled about vehicle washing on-site. Property owner contacted and asked to remind all business on property about prohibition on car washing. Dumpster had been replaced. Flow attributed to groundwater infiltration. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
April 24, 29, 2015	N/A	595 E. Ordnance Road	A LimnoTech field team discovered an overfilled roll-off dumpster in the parking lot behind the West Marine store at the listed address. Debris evident at the top of the pile included several open, used containers; the field crew was unable to determine the contents of these visible containers. The field crew also found large pieces of debris scattered around the dumpster. The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site or into the nearby storm drain system. Large pieces of debris, already on the ground or blown to the ground with a strong wind, may create hazards for drivers in the parking lot. Debris that falls onto the ground may also leak potentially contaminating contents onto surfaces that could lead to nearby storm drain inlets or open water; open containers in the dumpster may also release contaminants into the dumpster during rain events. Some debris may also attract pests to the site.	May 17, 2015: Report received from Versar. May 19, 2015: Report forwarded to HD. June 22, 2015: At HD request, part of reported unresolved cases. May 15, 2015: Site inspected. West Marine claims dumpster is not theirs. As of this report, on business is claiming ownership of issue. Citation sent to property owner. . June 17, 2015: Site re-inspected. July 2 is deadline for correction. August 14, 2015: Status update request sent to HD. August 17, 2015: Re-inspection by HD finds the dumpster gone. **CASE CLOSED**	RESOLVED
April 24, 2015	N/A	801 Cromwell Park Drive	A LimnoTech field team discovered a pair of open dumpsters in an enclosure alongside the parking lot behind the Cromwell Business Park building (multiple businesses) at the listed address. One dumpster, intended for the disposal of recyclable material, was overfilled. The other dumpster, intended for trash, had many bags of garbage strewn around it and some loose debris; food containers were apparent in some of the bags. The dumpsters were situated on a concrete pad above the curb. There were curb inlets near the dumpsters, one approximately 65 feet north and the other approximately 117 feet south of the enclosure. The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site or into the nearby storm drain system. Debris on the ground may leak potentially contaminating contents onto surfaces that could lead to nearby storm drain inlets or open water. Some debris may also attract pests to the site.	May 17, 2015: Received from Versar. May 19, 2015: Forwarded to HD. June 22, 2015: Follow up by HD. Re-inspection shows no violation. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
April 24, 2015	E-2015-227	6717 Governor Ritchie Highway	A LimnoTech field team discovered what appeared to be a large pile of road de-icing salt in the parking lot behind the Target store at the listed address. The large pile of road salt was found uncovered on the pavement. Small piles of salt were found scattered on the ground above the curb. In the same area, the field crew also found several bags of salt crystals; this material is intended for use in water softening systems. The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could drift into adjacent storm drain inlets or open water. The salt piles already on the ground pose a hazard to animals passing through the area; with rain events, the salt could infiltrate the soil, lead to elevated sodium and chloride levels in the soil, and damage nearby plants. With repeated rains, the salt and its derivatives could enter the nearby stream headwaters behind the parking lot; elevated chloride levels can be toxic to aquatic life.	May 17, 2015: Received from Versar. May 19, 2015: Sent to I&P. June 22, 2015: Status update request sent to I&P. May 20, 2015: Inspection finds not road salt stored in parking lot. Letter sent to property owner on proper storage of road salt. **CASE CLOSED.**	RESOLVED
April 24, 2015	E-2015-226	713 E. Ordnance Road	A LimnoTech field team discovered what appeared to be a large pile of road de-icing salt in the parking lot at the corner of the building (multiple businesses) at the listed address. At the time of the site visit, the pile was partially uncovered. The field crew noted that a line of residue could be traced from the area of the pile along part of the parking lot. Investigations conducted for this report included confirmation with imagery from Google Maps (https://www.google.com/maps/); the image available at the time of the report draft (May 11, 2015) showed a significant line of residue from the same corner where the road salt was being stored on April 24 to an area of distinct but indeterminate use along the parking lot. The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could drift into adjacent storm drain inlets or open water.	May 17, 2015: Report received from Versar. May 19, 2015: Report sent to I&P. June 22, 2015: Status update requested from I&P. May 21, 2015: Site inspection found no exposed salt. Letter sent to property owner about proper salt storage. **CASE CLOSED.**	RESOLVED

Table 5-1. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
June 12, 2015	E-2015-332	7001 Dorsey Road	A Versar field team inspected outfall G06G3O001 which drains a stormwater management (SWM) facility north of 7001 Dorsey Road. The initial visit took place at 12:00 p.m. on June 12. At that time, field testing results included a pH level of 9.18 and chlorine concentration of 0.6 mg/l. The outfall was re-screened on June 15 (due to interposing rainfall); however concentrations of all parameters were in the acceptable range. While at the same facility, staff screened an outfall (G06G3O004) that had dry weather flow into the facility. The contributing outfall had a detergents concentration of 0.75 mg/l. Since the high detergent concentration at outfall G06GEO004 occurred during a follow-up to a downstream outfall that earlier had an above-action level concentration of chlorine, field staff implemented trackdown procedures on June 15 and June 16 to identify the source. Staff tracked the flow to a junction manhole upslope of the SWM. The western branch (originating from Dorsey Road) could not be sampled from the manhole due to extreme depth; staff tested flow at an upstream manhole instead and found a detergent concentration of 0.1 mg/l. Along the southern branch, the flow from the parking lot of 7001 Dorsey tested at 0.5 mg/l for detergents. Farther up-network, at the only flowing and sampleable conduit, the detergent concentration was 0.3 mg/l. Staff noted that within a gated area behind 7001, absorbent berms had been placed around a yard inlet. All other conduits contributing to the outfall were dry or had very low and unsampleable flow. Staff communicated their findings to the pollution hotline on June 16, 2015.	June 24, 2015: Report received from Versar. June 24, 2015: Report sent to I&P. August 14, 2015: Follow up sent to I&P. October 7, 2015: I&P reports that all issues have been remediated and the property owner has been counseled. **CASE CLOSED.**	RESOLVED
June 25, 2015	N/A	7226 Parkway Drive	While in the area to screen an outfall, a Versar field team discovered an actively polluting condition at a roll-away dumpster found behind a Belair Produce building at the above address (Figure 1). The team observed the dumpster leaking a red liquid of sufficient quantity (Figure 2) to span the rear of the parking area (Figure 3) and enter the adjacent wooded land (Figure 4). In light of the nature of the business, one could surmise that the leachate may contain material from fruits and vegetables that have been discarded to the trash compactor; as such, the fluid may contain nutrients, bacteria, waxes, pesticides, and fungicides, among other constituents. In 2014, field crews documented a dumpster in the same location leaching sour-smelling liquid which followed a similar path to the woods. The trail of liquids, apparently emanating from the dumpster, is evident in aerial photographs, since at least 2007 (the date for the photograph used in Figure 5 in this report). An area map, indicating the location of the dumpster, is provided in Figure 5.	June 30, 2015: Report received from Versar. June 30, 2015: Report sent to HD. Also sent to I&P due to likely long term nature of impact. No action requested of I&P at this time. August 14, 2015: Follow up request sent to HD. August 17, 2015: HD met with property managers. Several changes to the site were requested. A follow up inspection was scheduled for later in August. October 19, 2015: HD inspectors have met with property owner, who has repaired the dumpster. Leaking still persists and the HD continues to work to correct issue. **CASE OPEN.**	UNRESOLVED

Table 5-2. Follow up and resolution of past cases from reporting years 2014 and 2013					
Survey Date	**I&P Compliance Database ID**	**Outfall/Site Address**	**Issue**	**Response**	**Status**
May 6, 2014	E-2014-229	510 McCormick Drive	While conducting outfall screening in the target area, the IDDE field team noted a hole in the asphalt near a storm drain inlet in the south parking area at the property of interest's address. Upon closer inspection, the interior of the catch basin could be clearly seen through the open hole. While no vehicles were parked in this area, the weakened asphalt could create a falling hazard for passers-by or cause damage to vehicles. If there is an erosion problem, the condition could worsen. I&P staff determined that there is a stormwater maintenance agreement with the County for this facility requiring the property owner to perform regular maintenance in accord with that agreement. A meeting on-site was held with the property manager, who assured the inspector that this matter would be quickly corrected.	May 8, 2014: Received from Versar. May 12, 2014: Sent to I&P. Complaint opened. May 29, 2014: Inspection by I&P confirming issue. August 5, 2014: I&P follow up meeting with property manager to discuss issue. August 19, 2014: WPRP sent follow up sent to I&P. August 22, 2014: Investigation and follow up on-going. September 3, 2014: Case pending. October 2, 2014: Owner obtaining bids to make repairs. November 7, 2014: Re-inspection finds repairs have been satisfactorily completed. **CASE CLOSED.**	RESOLVED

Table 5-2. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
May 14, 2014	E-2014-252	1300 Concourse Drive (IDDE)	The IDDE field team conducted site visits to several targeted outfalls in the vicinity of Concourse Drive on May 14th. At 1:45 p.m., the field team screened outfall I03E8O003, which discharges to a wet pond and was partially submerged. A visual inspection of the 1st manhole up from the outfall in the middle of Concourse Dr. showed flowing water. A faint rancid odor was noted when the water sample was collected at the outfall, with the results above action the action level for fluoride and elevated for detergents and ammonia. On the following day, the field team retested water obtained from the flowing pipe, rather than the stagnant water at the outfall. The retest yielded results that caused the field staff traced the source of the flow. During trackdown, the field team tested flowing water in a manhole located in the southeast entrance driveway of 1302 Concourse Drive. Again, testing results were high parameters of interest. Field staff also noted white residue on the interior surface of the storm drain pipe and a stronger odor. The field team followed the odor, whitish residue, and flowing water through the curb inlets on the northern edge of 1300 Concourse Dr. (Embassy Suites) to the end of the system, which terminated in a curb inlet located down-gradient from the hotel loading dock. Within this curb inlet, the field team found some standing gray water with a strong foul odor. Testing of the water again yielded elevated detergents and ammonia concentrations. A general inspection of the area around the curb inlet and of the loading dock area showed no signs of active illicit discharge activities. The field crew noted and photo-documented conditions of the dock area as the curb inlet grate was generally untidy, with some staining of the pavement from the direction of the loading dock towards the curb inlets readily apparent. Some residual puddled grey water was also found in the area, but staff couldn't discern the source. Field crew noted the condition of the loading dock to be messy, with clear signs of regular discharge (i.e., a stain line to the drain and apparent residual discharge) from a large rollaway dumpster. Two standard-sized dumpsters were also placed beside the dock; they were over-flowing with cardboard and some trash was noted around them. A waste cooking oil vat was also noted beside the dock but appeared to be in good condition. A mop pail was also present on the loading dock, suggesting that hotel staff may be disposing of wash water onto the parking lot. An inspection by I&P found that the source of the discharges characterized above came from used mop water being regularly disposed of on the loading dock and from a leaking dumpster. Hotel staff were counseled to dispose of all mop water into floor drains connected to the sanitary sewer. The dumpster for the hotel is slated for replacement.	May 16, 2014: Received from Versar May 30, 2014: Site visit by I&P staff and Versar staff. Identified as a cross connection between sanitary sewer and stormdrain. August 19, 2014: Follow up sent to I&P. August 23, 2014: No cross connection here, just a leaking dumpster and improper disposal of mop water. August 29, 2014: Follow up with Hotel by I&P inspector. Status of dumpster replacement questioned. Trash around existing dumpster observed; hotel instructed to perform cleanup. September 3, 2014: Status inquiry sent to I&P regarding dumpster replacement. September 5, 2014: Update from I&P states that dumpster not replaced at this time. September 15, 2014: I&P reports that property owner will have new dumpster in place by end of September. October 22, 2015: Inspection shows new dumpster installed, loading area cleaned. **CASE CLOSED**.	RESOLVED

Table 5-2. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
July 7, 2014	N/A	832 Oregon Avenue, Linthicum Heights, MD	The IDDE field team investigating the stormwater infrastructure along Oregon Avenue noted damage to the asphalt and gutter which has caused partial collapse of these surfaces bordering an inlet down the street from a warehouse at the above address (Lighting Maintenance, Inc. occupies Suite A of 832 Oregon Avenue). The field crew also observed that sediment had accumulated in the inlet box; water flow to the connected pipe did not appear to be blocked, yet. The cause of the damage could not be ascertained on the day of the site visit. The field crew did note that trucks - displaying logos that were not obviously associated with the Lighting Maintenance company - were parked alongside the curb (i.e., spanning several parking spaces) on the same side of the street as the inlet. One could surmise that the parking area and gutter damage around the inlet grate may have been caused by bearing the excessive weight of a parked truck for extended periods of time. If the inlet box structure has been compromised, or the sub-surface of the parking asphalt is being saturated due to leaks in the infrastructure, there is increased potential for damage or collapse in the future.	July 18, 2014: Received from Versar August 1, 2014: Reported to Andy Watcher (Infrastructure) August 4, 2014: Assigned to Ron Rose for follow up August 19, 2014: Follow up sent to AW. September 4, 2014: Follow up sent to AW. September 16, 2014: Follow up sent to AW. Inspector requested to investigate issue. August 20, 2015: IMD has confirmed County ownership and repairs are funded and planned for FY 2016. **CASE CLOSED.**	RESOLVED
July 7, 2014	E-2014-468	1591 West Nursery Road, Linthicum Heights, MD (housekeeping)	While the IDDE field team was investigating a structural problem at a curb inlet in the parking lot behind the Hoyt's Cinema 14 at the subject address, team members detected a foul smell. The crew removed the manhole cover and inspected the contents of the catch basin. The field crew determined that the debris found in the bottom of the catch basin is the likely cause of the disagreeable odor, as the trapped material was rotting in place. The field team noted that the dumpsters are slightly uphill from the inlet; it is possible that the debris in the inlet has accumulated from loose debris associated with the dumpster (an open cover which allows loose debris to be carried out with strong winds or debris that is not properly inserted into the dumpster). I&P inspected the facility and confirmed the field team's findings. Research is underway to determine if a SWMA exists and I&P has made contact with the property owner and has asked for these issues to be corrected.	July 18, 2014: Received from Versar. August 1, 2014: Sent to I&P August 19, 2014: Follow up sent to I&P. August 22, 2014: Re-sent the original report and the tax ID number. I&P inspection performed. August 25, 2014: I&P opened complaint case and is researching if a stormwater management agreement exists for this facility. September 4, 2014: Follow up sent to I&P. September 15, 2014: I&P sent an email to the business owner requesting that the issues be resolved as soon as possible. October 22, 2014: Inspection finds debris removed. Facility in compliance. **CASE CLOSED.**	RESOLVED
July 7, 2014	E-2014-468	1591 West Nursery Road, Linthicum Heights, MD (infrastructure)	A Versar field team discovered a hole in the ground under the corner of a curb inlet in the parking lot behind the Hoyt's Cinema 14 at the subject property. The loss of ground support under the bricks may contribute to a weakened state in the future and present a hazard. In another photograph taken by the field crew, there is evidence of possible structural compromises in the curb inlet support: the corner block does not show supporting mortar and there is an uneven crack through the gutter suggesting a shift in underlying support associated with the same corner. The field team investigated the condition but did not find evidence of an obvious cause for the missing dirt. If there is an erosion problem, the condition could worsen. I&P contacted property owner and asked for this issue to be corrected.	July 18, 2014: Received from Versar August 1, 2014: Sent to Infrastructure (AW). August 4, 2014: Reply from AW—private facility. August 19, 2014: Follow up sent to AW. September 4, 2014: Follow up sent to AW. September 15, 2014: Sent to I&P for consultation and possible action. September 16, 2014: I&P contacted property owner for correction. October 22, 2014: I&P inspection finds sinkhole repaired. **CASE CLOSED.**	RESOLVED

Table 5-2. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
July 7, 2014	E-2014-511	5179 Raynor Ave.	The IDDE field team investigating the stormwater infrastructure between the Motel 6 and the McDonald's restaurant at the subject address discovered a partially clogged outlet for a pipe that drains the Motel 6 parking lot. The outlet is occluded with hard sediment. One crew member inspected the interior of the pipe and reported that he was not able to see an opening for water passage. The presence of similar sedimentation around the opening suggests that the discharged fine silt has been accumulating over time, and a thin top layer of algae on the sediment suggests that water may be still trickling through the pipe, although the drainage is no longer fully effective. Sluggish drainage of the parking lot in this corner may pose a hazard for motorists and pedestrians with accumulating debris, leaves, standing water, and ice.	July 18, 2014: Received from Versar August 1, 2014: Sent to infrastructure (AW). August 4, 2014: Reply from AW—private facility. August 19, 2014: Follow up sent to AW. September 4, 2014: Follow up sent to AW. September 15, 2014: Sent to I&P for consultation and possible action. October 16, 2014: Inspection finds BMP in compliance. **CASE CLOSED.**	RESOLVED
May 15, 2014	E-2014-469	705 East Ordnance Road	While conducting outfall screening in the target area, the IDDE field team discovered an outfall (N04H2O015) almost completely blocked by hard sediment. The outfall drains a parking lot to a stormwater pond behind the building at the above location. The photograph, taken by the field crew on May 15, shows some standing water near the outlet. A thin, top layer of algae downstream of the pipe opening suggests that water may continue to trickle through the pipe; the field crew reported that the outlet was not draining on the day of the field visit. Sluggish drainage of the parking lot in this corner may pose a hazard for motorists and pedestrians with accumulating debris, leaves, standing water, and ice. An inspection by the HD found a number of serious deficiencies that are now slated for correction. A re-inspection is scheduled for September 29, 2014.	August 22, 2014: Received from Versar. August 22, 2014: Sent to I&P. August 29, 2014: Site inspection of stormwater pond noted a number of issues that require correction, including sediment removal, grass cutting, securing access, and other items. Property owner informed. Inspection planned for 9/29/14. October 8, 2014: Pond still not in compliance. Re-inspection to occur in early November. October 22, 2014: Inspection shows pond in compliance. **CASE CLOSED.**	RESOLVED
June 16, 2014	N/A	7201 Standard Drive, Hanover	While conducting outfall screening in the target area, a Versar field team discovered a section of parking lot pavement that had collapsed along with the adjoining curb in the parking lot behind the building at the above location. The field team documented the condition with photographs. No vehicles were parked in this area; however, the weakened asphalt could create a falling hazard for passers-by or cause damage to vehicles. Interpretation of the photographs suggests that there may be an erosion problem, and the condition could worsen. The site may have been repaired previously. County GIS coverage indicates that a storm drain inlet is in the near vicinity and may be part of the problem area.	July 2, 2014: Received from Versar. September 29, 2014: Sent to IMD for review and guidance. September 16, 2015: Follow up with IMD shows this is a private stormdrain system, so no action by IMD is required. **CASE CLOSED.**	RESOLVED

Table 5-2. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
June 2, 2014	E-2014-538	1745 W. Nursery Road	While conducting outfall screening in the target area, a Versar field team discovered two large, uncovered piles - one salt and one sand - at the above location, which is the parking area across the street from the Hilton BWI Airport Hotel. The field team documented the condition with photographs. The sand pile was uncontained and uncovered. Sand was evident in the parking area between the sand pile and the storm drain inlet at the corner of the parking lot. The field crew documented that there was sand in the storm drain, itself. The salt pile was partly contained with a section of concrete barrier (Jersey wall) and some tires, and partially covered. The placement of sand and salt on an impervious surface introduces the risk of distribution, by wind or rain, of particles and associated contaminants which could be transported into adjacent storm drain inlets or open water. An inspection was performed by I&P. One of the two piles was no longer present. However, the remaining pile was not being covered properly and salt was observed in the parking lot and in the stormdrain system. The property owner was instructed to secure the pile and remove the salt from the parking lot and the stormdrain system.	July 2, 2014: Received from Versar. September 29, 2014: Sent to I&P for review. Site inspected same day. October 1, 2014: Property owner notified and asked to correct issue. CASE OPEN October 10, 2014: Inspection by I&P shows site is partially in compliance. Additional housekeeping requested to contain salt spills and grit in parking lot and grass island areas. October 24, 2014: Additional housekeeping requested. Reminder to property owner about proper stockpiling procedures. November 24, 2014: Inspection finds site in compliance. **CASE CLOSED.**	RESOLVED
April 4, 2013	E-2013-0219	101 Stockton Lane	Versar and LimnoTech Field staff visited a dry pond located adjacent to 101 Stockton Lane. The riser of the dry pond was found to be filled with riprap, probably from stone placed over the low-flow dewatering pipe connecting to the riser. The presence of the stone in the riser possibly restricts flow during high flow events. The location of the problem and the photo-documentation was sent to Infrastructure Maintenance group in DPW.	4/19/2013: Received by WERS. 4/22/2013: Forwarded to Infrastructure 4/30/2013: Inspections & Permits (I&P) Database ID assigned. Will forward to Infrastructure Maintenance Group (IMG) as I&P says this is a public pond. 5/1/2013: Forwarded to IMG 5/2/2013: This site was added to the list of upcoming BMP maintenance activities for FY 2014. 8/19/2015: Confirmed with IMD that necessary maintenance performed. **CASE CLOSED.**	RESOLVED
April 11, 2013	N/A	R07H5O007/ Montrose Road & Byrd Lane	While conducting dry weather screening on April 11, 2013, a Versar field team identified a blocked outfall. Field staff were in the area attempting to locate the outfall of a network draining a commercial area. The outfall, identified as R07H5O007, is located at the intersection of Montrose Road and Byrd Lane directly behind a sewage pumping station. The field staff noted that the outfall appeared to be entirely blocked with sediment. At the time of the field visit, water was flowing out of the ground approximately four feet away. The water was clear and colorless but had some algal growth. No suspicious odors or floatables were detected at the time of the inspection so it was suspected the discharge was most likely due to water backed up within the storm sewer system.	5/8/2013: Received by WERS 5/8/2013: Reported to Infrastructure Maintenance Division (IMD). 9/13/2013: An inspection IMD confirmed the existence of the blockage and identified possible other damage to the storm drainage infrastructure at this facility. IMD will complete all necessary repairs in FY 2014. 8/19/2015: Report from IMD confirms repairs completed in January 2014. **CASE CLOSED.**	RESOLVED

Table 5-2. (Continued)

Survey Date	I&P Compliance Database ID	Outfall/Site Address	Issue	Response	Status
April 18, 2013	N/A	W10A8O001/ Mountain Road near Milburne Ct. and Ventnor Rd.	While conducting outfall screening in the target area, a Versar field team noticed a problem storm drain inlet, in passing, while traveling along Mountain Road. The field team documented the problem inlet and also inspected the outfall. The outfall, identified as W10A8O001 and located on the south side of Mountain Road, was found to be partially buried. Field staff noted that the outfall discharges into Cooks Pond and is about 80% blocked with sediment. The headwall, which is composed of field stone and concrete, is moderately deteriorating. The inlet, located on the north side of Mountain Road in a bamboo stand, is missing a grate and creating a falling hazard for the public.	5/8/2013: Received by WERS 5/8/2013: Reported to IMD. 9/13/2013: Upon inspection by IMD, it was determined that this part of the stormdrain system entering Mountain Road is the responsibility of the SHA. SHA has been informed of the issues. 9/16/ 2015: Email sent to SHA to obtain status of this site. 9/17/2015: Discussion with SHA IDDE coordinator will result in SHA inspection and maintenance at this location. **CASE CLOSED.**	RESOLVED
April 4, 2013	N/A	Old Magothy Bridge Road near Country Life Road	While conducting outfall screening on April 4, 2013, a Versar field team identified an erosion problem at an open concrete ditch near Magothy Bridge Road. The ditch is located on the north side of Old Magothy Bridge Road west of the intersection with Country Life Road. Field staff noted moderate erosion next to and under the concrete ditch, which was causing it to collapse.	5/8/2013: Received by WERS 5/8/2013: Reported to IMD. 9/13/2013: An inspection by IMD confirmed the observed damage. IMD will schedule and complete necessary repairs using FY 2014 funding. 8/19/2015: Report from IMD confirms repairs were completed in May 2015. **CASE CLOSED.**	RESOLVED
April 18, 2013	N/A	Lake Shore Plaza near Giant Foods	While conducting outfall screening in the vicinity of Lake Shore Plaza on April 18, 2013, a Versar field team identified a storm drain inlet that had become blocked and non-functional. The inlet is located along a ditch between a Giant parking lot and a medical services building and south of a free standing, walkup Bank of America ATM machine. Field staff noted that the inlet was completely filled with compressed leaves and trash. After probing they were unable to determine the depth of the catch basin, only that it was greater than 24 inches. Field staff were unable to identify an outfall that services the network that includes the blocked inlet.	5/8/2013: Received by WERS 5/8/2013: Reported to IMD. 9/13/2013: IMD has determined that this site is under private ownership and not the responsibility of the County. The property owner will be counseled to perform necessary maintenance. Re-inspection will occur during next IDDE assessment to ensure compliance. **CASE CLOSED .**	RESOLVED

6 RECOMMENDATIONS

The County's illicit discharge detection and elimination program has been successful in the identification and removal of a wide variety of sources of pollutants, including illicit connections, upland pollutant sources, dumping and spills. At this time, no recommendations are being made for improvements to the program.

7 REFERENCES

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APPENDIX A
EROSION AND STRUCTURAL ISSUES
SITE-SPECIFIC REPORTS

Anne Arundel County Infrastructure Site Visit Report

Location: 587 East Ordnance Road, Glen Burnie
Date: April 13, 2015
Investigators: G. Zuknick and B. Crary
Concern: Infrastructure, manhole cover missing

A LimnoTech field team discovered an open stormwater manhole behind the building (unoccupied) at the above address (Figure 1). An open hole in the ground presents a significant safety hazard for the public, although someone has attempted to create a make-shift marker to alert people of the opening. An area map, indicating the location of the missing manhole cover, is provided in Figure 2.



Figure 1. Stormwater system manhole found open

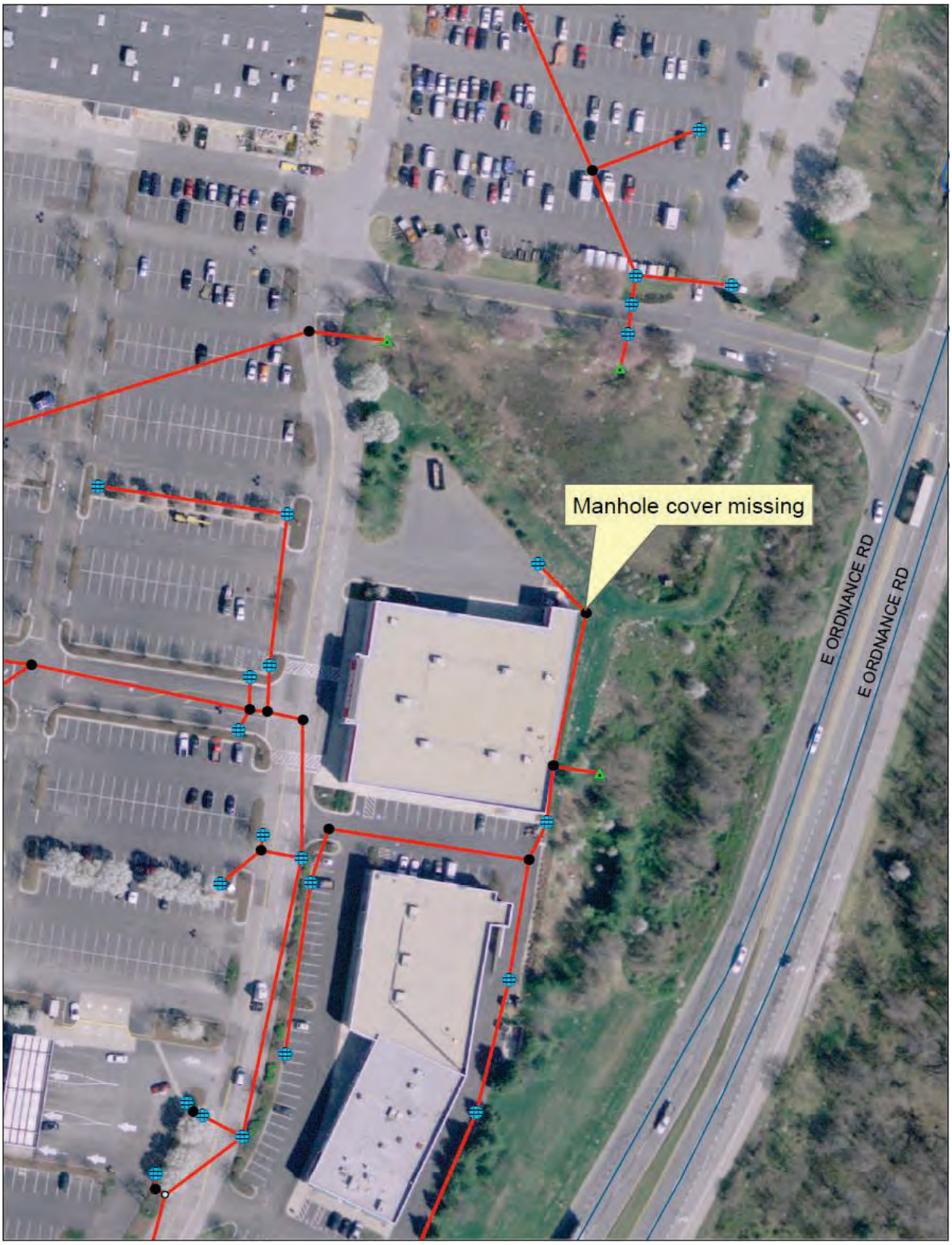


Figure 2. Area map

Anne Arundel County Infrastructure Site Visit Report

Location: Best Buy store, 6722 Ritchie Highway, Glen Burnie
Date: April 13, 2015
Investigators: G. Zuknick and B. Crary
Concern: Infrastructure, damaged

A LimnoTech field team discovered unsafe conditions with a stormwater detention basin riser structure behind the Best Buy store at the above address. The field crew inspected the device and photo-documented the extent of the destruction of the facility. The top of the riser was dislocated and the manhole cover was lying on the ground at the base (Figure 1). The embankment behind the riser shows signs of extensive erosion (Figure 2), which suggests that the facility may no longer be properly functioning. The eroded area has been accumulating debris, also. The device in this condition presents a significant safety hazard for the public, although the fence may deter many trespassers. An area map, indicating the location of the damaged riser, is provided in Figure 3.



Figure 1. Stormwater riser structure condition showing dismantled top



Figure 2. View from the detention basin showing the extent of erosion on the rear bank



Figure 3. Area map

APPENDIX B
ILLICIT CONNECTIONS SITE-SPECIFIC REPORTS

Anne Arundel County Illicit Discharge Site Visit Report

Outfall ID: L07A1O004
Location: 1000 Stewart Ave., Glen Burnie
Date: March 19, 2015
Investigators: G. Zuknick, B. Crary
Concern: Above action pH level.

At 11:30 a.m. on March 19, a LimnoTech field team inspected the outfall (Figure 1) designated as L07A1O004, located at 1000 Stewart Ave., which is the address of a SunTrust Bank branch. The discharge was noted to be sporadic and began shortly after the arrival of the field team. A gasoline odor was also apparent. The flowing water tested above action levels for copper, chlorine, and detergents. Fluoride was also elevated but was below the action level.

At 4:05 p.m., the team returned to the site and performed a 2nd test of the flowing water. At this time, only chlorine was above the corresponding action level. Fluoride was again elevated at this time, but below the action level. The flow rate was lower during the return visit and was continuous. The discharge was also not as cloudy and had a less significant gas odor than our first visit. The team documented a noticeable white powdery residue in the concrete channel that received the discharge. Results are summarized in Table 1 below. After the retest, the field team tracked flow from three directions in the network. Two of the branches originated in parking lot catch basins. The center branch originated from the south, from the direction of the building. The field crew was not able to open the manhole near the building which would confirm that the illicit discharge was originating from the building. An area map is provided in Figure 3.

Table 1. Chemical test results (red values indicate above action level concentration).

	Action Level	Test 1 Result	Test 2 Result
pH	≤ 6.5 or ≥ 8.5	7.65	7.75
Temperature (°F)		54.3	60.2
Ammonia (mg/l)	≥ 1	0.0	0.0
Total Chlorine (mg/l)	≥ 0.4	**3.0**	**0.6**
Detergents (mg/l)	≥ 0.5	**0.75**	0.1
Fluoride (mg/l)	≥ 0.75	0.6	0.6
Phenols (mg/l)	≥ 0.17	0.0	0.1
Copper (mg/l)	≥ 0.21	**0.4**	0.1



Figure 1. Outfall L07A1O004 at 1000 Stewart Ave.



Figure 2. Whitish residue on concrete channel downstream of outfall.



Figure 3. Area map.

Anne Arundel County Illicit Discharge Site Visit Report

Outfall ID: F06H4O016
Location: Stormwater pond adjacent to 7304 Parkway Drive South, Hanover
Date: April 13, 2015
Investigators: T. Jones, I. Turcsányi
Concern: Above-action detergents and chlorine

Versar field staff conducted site visits to two outfalls (one, a target) associated with a stormwater pond along Parkway Drive South, near the Raspberry Deli at the above address, on April 13. On the first visit to the outfall F06H4O016, at 11:32 a.m., the field crew documented flow from the 18-inch pipe discharging to the pond (Figure 1). The field team tracked the pipe back to the inlet on the southwest edge of Parkway Drive South (the only source of water for the outfall) and found the inlet dry. The screening results at the outfall on the first visit were above action levels for chlorine (1.0 mg/l) and detergents (0.5 mg/l); these results are tabulated in the Test 1 Result column of Table 1.

The field crew returned to the site several hours later (3:15 p.m.) to retest the discharge from the pipe. The retest yielded the same above-action detergent levels (0.5 mg/l) and a reduced level of chlorine (0.1 mg/l) to a concentration below the action threshold. The results for the retest are tabulated in the Test 2 Result column of Table 1.

The field team did not observe any other factors of concern in the discharge water (e.g., color, odor, or floatables). Staff reported the illicit discharge to the Environmental Hotline on 4.14.15. An area map indicating the outfall and its inlet is provided in Figure 2.

Table 1. Chemical test results (red values indicate above-action-level concentration)

	Action Level	**Test 1 Result (outfall)**	**Test 2 Result (outfall)**
pH	≤ 6.5 or ≥ 8.5	7.28	7.69
Temperature (°F)		56	60
Ammonia (mg/l)	≥ 1	0.00	0.00
Total Chlorine (mg/l)	≥ 0.4	**1.0**	0.1
Detergents (mg/l)	≥ 0.5	**0.5**	**0.5**
Fluoride (mg/l)	≥ 0.75	0.3	0.2
Phenols (mg/l)	≥ 0.17	0.00	0.00
Copper (mg/l)	≥ 0.21	0.1	0.00



Figure 1. Outfall F06H4O016 showing a small amount of flowing water on April 13

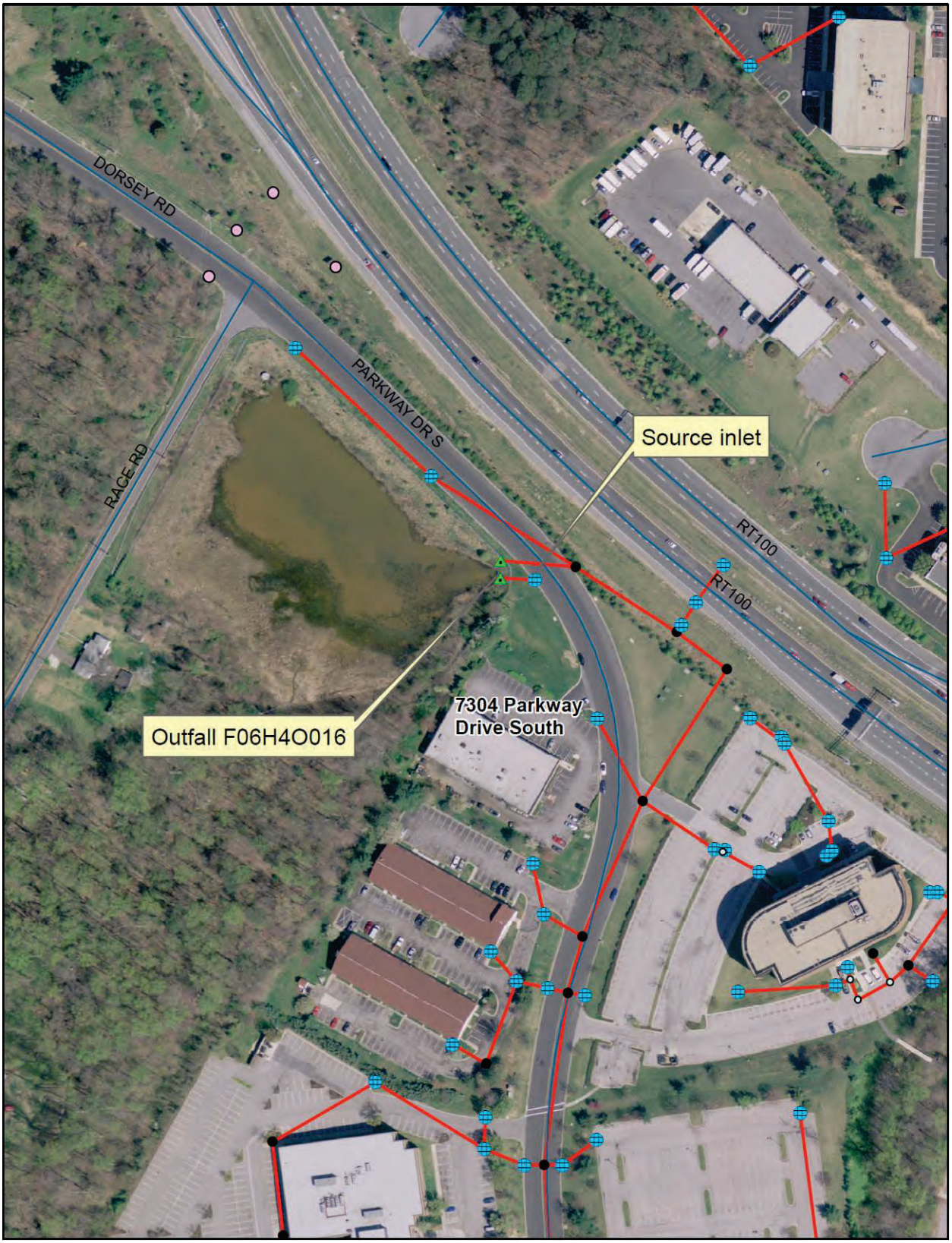


Figure 2. Area map Outfall F06H4O016

Anne Arundel County Illicit Discharge Site Visit Report

Outfall ID: F07F8O003 and F07F8O003NEW
Location: Stormwater Facility at Arbor Grove Drive and Arundel Mills Boulevard, Hanover
Date: April 29, 2015
Investigators: M. Berlett, I. Turcsányi, P. Potti
Concern: Possible multiple cross-connections

On April 29, 2015 at 1:45 p.m., a Versar field team conducted an inspection of a target outfall that discharges to a wet pond located at the above intersection. Upon arrival, the field team identified two outfalls opening into the same headwall (Figure 1). The larger of the two, the target outfall, was 42" in diameter and was situated on the left (facing up-network) and an unmapped outfall (designated as F07F8O003NEW) was 36" in diameter and oriented to the right. Both outfalls at the time had dry weather flow discharging to the stormwater pond.

Outfall F07F8O003 (42", on the left) had sewage smell, was slightly brownish in color, and had a faint sheen on the water surface. The sound of water entering upstream suddenly increased during inspection. The discharge failed chemical tests for detergents (0.9 mg/l) and ammonia (10 mg/l). Outfall F07F8O003NEW (36", on the right) had no color or sheen, but had noticeable toilet paper residue at the outfall opening (Figure 2). It, too, had a sewage smell and the ammonia concentration was above the action level at 2.5 mg/l (Table 1 and Table 2).

Given the seriousness of the illicit discharge, Versar contacted I&P to inquire whether they would like to participate in tracking the source. On April 30, 2015 at 12:30 p.m., the field team returned to conduct the retest of both outfalls. Effluent from the 42" outfall was above the corresponding action levels for ammonia, chlorine, and detergents. The 36" outfall failed the ammonia test. With staff from I&P, flow to outfall F07F8O003 was tracked to an inlet just inside the entrance gate to Arbor Grove Drive, off Arundel Mill Blvd. An approximately 9" diameter PVC pipe entering the side of the inlet was dripping grayish water. The pipe was coming from the direction of a building 10 meters away. The detergent concentration in this effluent was off-scale; the ammonia concentration was also higher. The source of flow to F07F8O003NEW appeared to originate from buildings to the northwest of Arbors at Arundel Preserve condominium complex (not shown on aerial map); I&P inspectors are continuing the investigation of both networks.

Table 1. Chemical test results (red values indicate above action level concentration) of outfall F07F8O003.

	Action Level	Test 1 Result	Test 2 Result
pH	≤ 6.5 or ≥ 8.5	7.41	7.34
Temperature (°F)		60.3	57.6
Ammonia (mg/l)	≥ 1	**10**	**10**
Total Chlorine (mg/l)	≥ 0.4	0.1	**0.5**
Detergents (mg/l)	≥ 0.5	**0.9**	**5.0**
Fluoride (mg/l)	≥ 0.75	0.4	0.5
Phenols (mg/l)	≥ 0.17	0.0	0.0
Copper (mg/l)	≥ 0.21	0.0	0.0

Table 2. Chemical test results (red values indicate above action level concentration) of outfall F07F8O003NEW.			
	Action Level	**Test 1 Result**	**Test 2 Result**
pH	≤ 6.5 or ≥ 8.5	7.80	7.76
Temperature (°F)		55.9	60.3
Ammonia (mg/l)	≥ 1	**2.5**	**2.5**
Total Chlorine (mg/l)	≥ 0.4	0.0	0.0
Detergents (mg/l)	≥ 0.5	0.15	0.25
Fluoride (mg/l)	≥ 0.75	0.5	0.0
Phenols (mg/l)	≥ 0.17	0.0	0.0
Copper (mg/l)	≥ 0.21	0.0	0.0



Figure 1. Outfalls F07F8O003 and F07F8O003NEW near Arbor Grove Drive



Figure 2. Noticeable toilet paper at the opening of outfall F07F8O003NEW



Figure 3. Area map.

Anne Arundel County Illicit Discharge Site Visit Report

Outfall ID: F09F5O001
Location: 2631 Annapolis Road, Hanover
Date: May 5, 2015
Investigators: M. Berlett, P. Potti
Concern: Above action detergents concentration

A Versar field team inspected the above outfall (actually the downstream end of a crossing) at 3:05 p.m. on May 5, 2015. The field team immediately noted that the water below the outfall had a greenish color, and there were suds where the dripping water was pooling (Figure 1 and Figure 2). The field team collected a water sample (Figure 3), which had an oily odor and contained above action concentration of detergents (0.9 mg/l; Table 1). The area around the outfall was severely eroded (Figure 4).

At 1:12 p.m. on May 6, 2015, the team retested the outfall and obtained a result of 3 mg/l for detergents. Versar tracked the flow through the crossing and overland to another outfall (F09G5O001). The orifice of the outfall was found to be blocked by tree branches that appeared to have been deliberately placed (Figure 5). The team tested the flowing water from this outfall and obtained a detergents result that was off-scale. Source tracking of the discharge led the team to a car wash at a Shell fueling station. Two trench drains (at the entrance and exit; Figure 6) appeared to be connected to the storm drain system. Considering the persistence of flow through the network and through a downstream crossing, it is probable that much excess wash water is entering the system via the trench drains or possibly the main car wash effluent drainage is directly connected to the stormwater network. On May 7, Versar contacted I&P via the pollution hotline to report the matter. An area map is provided in Figure 7.

Table 1. Chemical test results (red values indicate above action level concentration) for outfall F09F5O001.

	Action Level	Test 1 Result	Test 2 Result
pH	≤ 6.5 or ≥ 8.5	7.35	N.T.
Temperature (°F)		N.T.	N.T.
Ammonia (mg/l)	≥ 1	0.0	N.T.
Total Chlorine (mg/l)	≥ 0.4	0.0	N.T.
Detergents (mg/l)	≥ 0.5	**0.9**	**3**
Fluoride (mg/l)	≥ 0.75	0.6	N.T.
Phenols (mg/l)	≥ 0.17	0.0	N.T.
Copper (mg/l)	≥ 0.21	0.0	N.T.
N.T. = not tested			



Figure 1. Outfall F09F5O001



Figure 2. Discharge and suds below oufall F09F5O001



Figure 3. Outfall water sample showing color



Figure 4. Erosion at outfall F09F5O001



Figure 5. Outfall F09G5O001 with branches placed in front of orifice.



Figure 6. Trench drain at entry to Shell car wash



Figure 7. Area map.

Anne Arundel County Illicit Discharge Site Visit Report

Outfall ID: I04E4O006 and I04F3O014
Location: Stormwater Facility near 890 Elkridge Landing Road, Hanover
Date: May 5, 2015
Investigators: C. Tonkin, A. Vanko, M. Berlett, P. Potti
Concern: Above action level detergents

Versar inspected the above outfalls on May 5, 2015 at 3:11 p.m. The screening results for I04E4O006 (Figure 1) included an above-action level result for detergents (0.5 mg/l; Table 1). The inspectors also screened outfall I04F3O014 (Figure 2), which was a part of the drainage to outfall I04E4O006. Outfall I04F3O014 failed the screening test for detergents (1 mg/l; Table 2) and the team suspected that the discharge from this outfall was a possible source of the detergent concentration at outfall I04E4O006.

The field team returned to the site on May 6, 2015 at 3:00 p.m. The dry-weather discharges from both outfalls were tested and similar results for detergents were obtained: 0.65 mg/l at outfall I04E4O006 and 1 mg/l at outfall I04F3O014. At outfall I04F3O014, the field team tracked the effluent up the network, but could not ascertain the source of the high detergent concentrations since the source was behind the perimeter fence of a National Security Agency property. Staff also conducted a lengthy trackdown of the other sources of flow to outfall I04E4O006, but no other sources of detergents in the system were apparent. The trackdown procedure was hampered by the location of the trunk line which ran along the center of Elkridge Landing Road and the presence of traffic precluded opening of manhole covers. Small flows were found in several of the branch lines to the trunk, leading field staff to conclude that lower detergent concentrations found at outfall I04E4O006 were the result of dilution of detergent levels found in outfall I04F3O014. Versar notified I&P via the pollution hotline on May 7, 2015. An area map is provided in Figure 3.

Table 1. Chemical test results (red values indicate above action level concentration) of outfall I04E4O006.

	Action Level	Test 1 Result	Test 2 Result
pH	≤ 6.5 or ≥ 8.5	6.97	N.T.
Temperature (°F)		58.1	N.T.
Ammonia (mg/l)	≥ 1	0.0	N.T.
Total Chlorine (mg/l)	≥ 0.4	0.0	N.T.
Detergents (mg/l)	≥ 0.5	**0.5**	**0.65**
Fluoride (mg/l)	≥ 0.75	0.1	N.T.
Phenols (mg/l)	≥ 0.17	0.0	N.T.
Copper (mg/l)	≥ 0.21	0.0	N.T.
N.T. = Not Tested			

Table 2. Chemical test results (red values indicate above action level concentration) of outfall I04F3O014.			
	Action Level	**Test 1 Result**	**Test 2 Result**
pH	≤ 6.5 or ≥ 8.5	7.16	N.T.
Temperature (°F)		66.7	N.T.
Ammonia (mg/l)	≥ 1	0.0	N.T.
Total Chlorine (mg/l)	≥ 0.4	0.0	N.T.
Detergents (mg/l)	≥ 0.5	**1.0**	**1.0**
Fluoride (mg/l)	≥ 0.75	0.0	N.T.
Phenols (mg/l)	≥ 0.17	0.0	N.T.
Copper (mg/l)	≥ 0.21	0.0	N.T.
N.T. = Not Tested			



Figure 1. Outfall I04E4O006



Figure 2. Outfall I04F3O014 discharging to dry pond



Figure 3. Area map.

Anne Arundel County Illicit Discharge Site Visit Report

Outfall ID: K02B8O002
Location: Stormwater Facility at 601 Hammonds Ferry Road, Linthicum Heights
Date: May 27, 2015
Investigators: C. Tonkin, D. Spradlin
Concern: Above action level detergents

A Versar field team inspected outfall K02B8O002, located in the stormwater management facility behind the business park located at 601 and 611 Hammonds Ferry Rd. During the initial visit on May 27 at 2:50 p.m., the test of the water flowing in the outfall resulted in 0.75 mg/l concentration of detergents. The outfall was re-screened the following day at 2:00 p.m. At the time of the follow up visit, the outfall contained obvious suds and tested above the action criterion for detergents again at 2.00 mg/l (Figure 1).

The field team initiated procedures to track down the source of the illicit discharge. At the 2nd yard grate up the system where the network split, detergents were found at a concentration of 0.25 mg/l in the steadily flowing water in the network from between the buildings. The next storm drain inlet up in the line between the buildings was damp but not flowing. The branch line from the north side of the building tested at 0.75 mg/l but was puddled up and barely flowing at the junction. The next test point on the line that wraps around the north side of the building was dry.

While tracking down and testing, staff observed several instances of vehicles being washed down, but no obvious signs of detergent in use, at two business. A chance conversation with an employee revealed that vehicle washing in the complex was common practice. Washing was observed at two businesses during trackdown activities: Valley Lighting and Iron Shore contracting. At Valley Lighting an employee started hosing off a personal truck but quickly stopped (Figure 2). At Iron Shore, employees were observed washing several trucks off (Figure 3). Versar notified I&P via the pollution hotline on May 28, 2015. An area map is provided in Figure 4.

Table 1. Chemical test results (red values indicate above action level concentration) of outfall K02B8O002.

	Action Level	Test 1 Result	Test 2 Result
pH	≤ 6.5 or ≥ 8.5	7.06	7.43
Temperature (°F)		70.7	71.8
Ammonia (mg/l)	≥ 1	0.0	0.0
Total Chlorine (mg/l)	≥ 0.4	0.0	0.0
Detergents (mg/l)	≥ 0.5	**0.75**	**2.00**
Fluoride (mg/l)	≥ 0.75	0.0	0.0
Phenols (mg/l)	≥ 0.17	0.0	0.0
Copper (mg/l)	≥ 0.21	0.0	0.0



Figure 1. Outfall K02B8O002 with suds, May 28, 2015



Figure 2. Washdown activity observed at 601-611 Hammonds Ferry Rd. on May 28, 2015



Figure 3. Washdown activity observed at 601-611 Hammonds Ferry Rd. on May 28, 2015

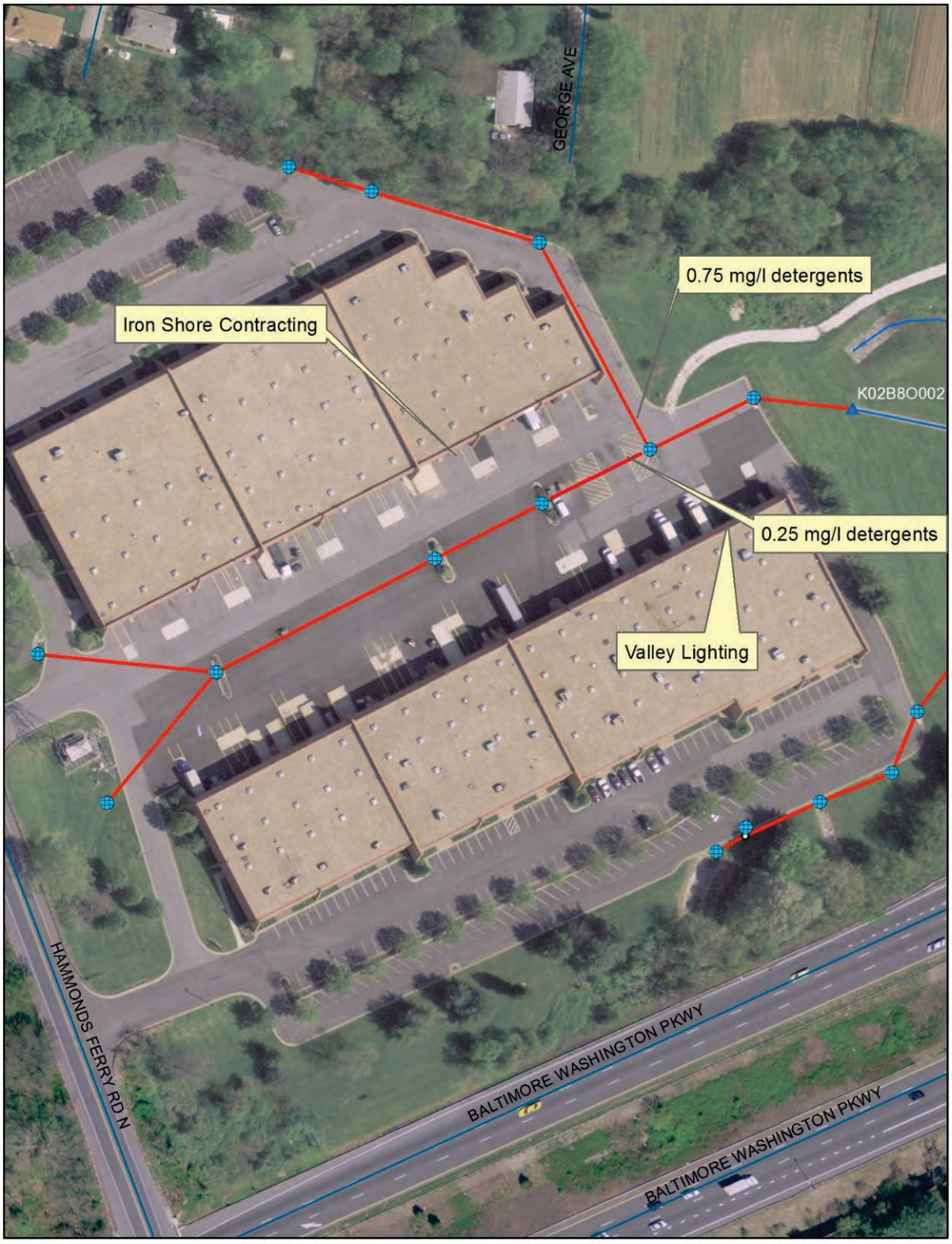


Figure 4. Area map.

Anne Arundel County Illicit Discharge Site Visit Report

Outfall ID: G06G3O001 and G06G3O004
Location: Stormwater Facility at 7001 Dorsey Road, Hanover
Date: June 12, 2015
Investigators: T. Jones, C. Tonkin, M. Berlett, & I. Turcsányi
Concern: Above action level detergents

A Versar field team inspected outfall G06G3O001 which drains a stormwater management (SWM) facility north of 7001 Dorsey Road. The initial visit took place at 12:00 p.m. on June 12. At that time, field testing results included a pH level of 9.18 and chlorine concentration of 0.6 mg/l (Table 1). The outfall was re-screened on June 15 (due to interposing rainfall), however concentrations of all parameters were in the acceptable range. While at the same facility, staff screened an outfall (G06G3O004) that had dry weather flow into the facility. The contributing outfall had a detergents concentration of 0.75 mg/l (Figure 1 and Table 2).

On the basis of identifying two potential illicit discharges in the same storm sewer catchment, onsite field staff performed a trackdown during the second visit even though the indicator pollutants at outfall G06G3O001 were within the acceptable range. Field staff implemented trackdown procedures on June 15 and June 16 to identify the source. Staff tracked the flow to a junction manhole upslope of the SWM. The western branch (originating from Dorsey Road) could not be sampled from the manhole due to extreme depth; staff tested flow at an upstream manhole instead and found a detergent concentration of 0.1 mg/l. Along the southern branch, the flow from the parking lot of 7001 Dorsey tested at 0.5 mg/l for detergents. Farther up-network, at the only flowing and sampleable conduit, the detergent concentration was 0.3 mg/l. Staff noted that within a gated area behind 7001, absorbent berms had been placed around a yard inlet (Figure 2). All other conduits contributing to the outfall were dry or had very low and unsampleable flow. Staff communicated their findings to the pollution hotline on June 16, 2015. An area map is provided in Figure 3.

Table 1. Chemical test results (red values indicate above action level concentration) of outfall G06G3O001.

	Action Level	Test 1 Result	Test 2 Result
pH	≤ 6.5 or ≥ 8.5	**9.18**	7.81
Temperature (°F)		88.3	92.8
Ammonia (mg/l)	≥ 1	0.1	0.0
Total Chlorine (mg/l)	≥ 0.4	**0.6**	0.25
Detergents (mg/l)	≥ 0.5	0.05	0.2
Fluoride (mg/l)	≥ 0.75	0.1	0.1
Phenols (mg/l)	≥ 0.17	0.0	0.0
Copper (mg/l)	≥ 0.21	0.0	0.0

Table 2. Chemical test results (red values indicate above action level concentration) of outfall G06G3O004.			
	Action Level	**Test 1 Result**	**Test 2 Result**
pH	≤ 6.5 or ≥ 8.5	7.1	N.A.
Temperature (°F)		66.2	N.A.
Ammonia (mg/l)	≥ 1	0.1	N.A.
Total Chlorine (mg/l)	≥ 0.4	0.2	N.A.
Detergents (mg/l)	≥ 0.5	**0.75**	N.A.
Fluoride (mg/l)	≥ 0.75	0.0	N.A.
Phenols (mg/l)	≥ 0.17	0.0	N.A.
Copper (mg/l)	≥ 0.21	0.0	N.A.



Figure 1. Outfall G06G3O004, June 15, 2015



Figure 2. Enclosed area behind 7001 Dorsey Rd. with absorbent berms around yard inlet



Figure 3. Area map.

APPENDIX C
UPLAND POLLUTANT SOURCES
SITE-SPECIFIC REPORTS

Anne Arundel County Hotspot Site Investigation Visit Report

Location: 1334 Ashton Road, Hanover
Date: March 11, 2015
Investigators: M. Berlett, I. Turcsányi
Concern: Bulk solid storage

A Versar field team discovered a condition of improper bulk solid storage, in the form of snow removal and road de-icing supplies and tools, in the parking lot adjacent to (immediately to the west of) the building located at 1334 Ashton Road, in Hanover, MD. The field crew documented bags of salt, loose salt, and an open storage trailer at this location (Figure 1). The field crew found a skid steer loader in the same area with residual de-icing salt in its bucket (Figure 2). The truck parked between the storage trailer and the skid loader, with a snow plow attachment, displayed a company logo for Beneficial Landscaping, LLC (Figure 3). This small company is located in Sykesville, MD, so the Hanover storage site may be established under an agreement with the landowner of the Ashton Road building, or the building at 7467 Ridge Road, Hanover, which lies adjacent to the parking lot on the southwest side. The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could drift into adjacent storm drain inlets or open water. An area map, indicating the location of the loose salt, is provided in Figure 4.



Figure 1. An open storage trailer and several small piles of de-icing salt found in the parking lot



Figure 2. Skid steer loader found with de-icing salt in the bucket



Figure 3. Truck found alongside the storage trailer, with company logo on the door



Figure 4. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Royal Plus, 1327 Ashton Road, Hanover
Date: March 11, 2015
Investigators: M. Berlett, I. Turcsányi
Concern: Waste management

A Versar field team discovered an open dumpster behind the Royal Plus building at the above address (Figure 1). The field crew was unable to determine whether the dumpster was being shared by several businesses. The dumpster had been placed in a corner of the parking lot immediately adjacent to a storm drain inlet. The photographs taken on the day of the visit reveal some debris in the area surrounding the dumpster, which could also enter the storm drain system. An area map, indicating the location of the dumpster, is provided in Figure 2.



Figure 1. Open dumpster placed by a storm drain inlet found behind the Royal Plus building

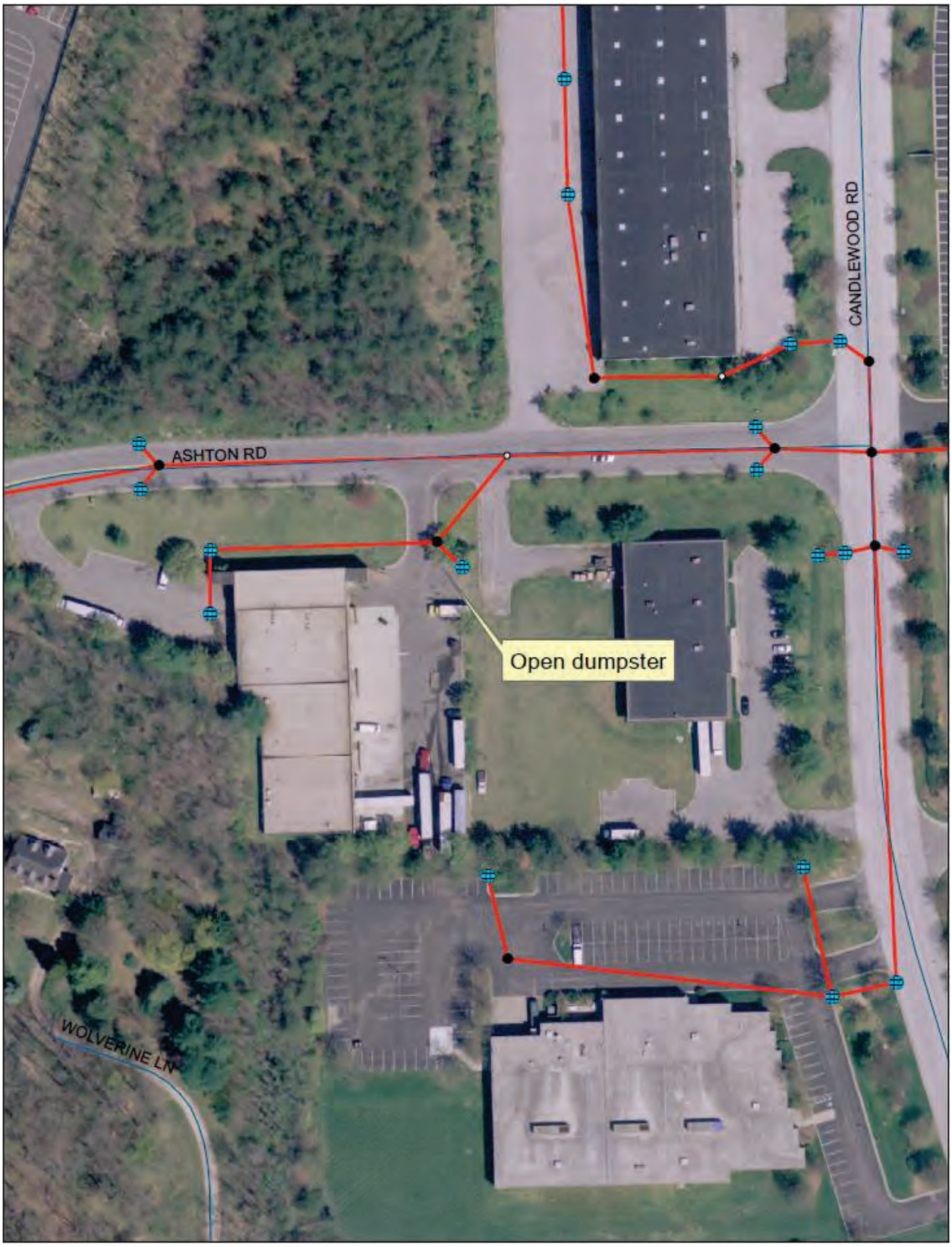


Figure 2. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Stevens Auto Transport, 7484 Candlewood Road, Hanover
Date: March 11, 2015
Investigators: M. Berlett, I. Turcsányi
Concern: Bulk solid storage

A Versar field team discovered very large, uncovered piles of road salt in the parking lot associated with Stevens Auto Transport (Figure 1). Near the salt piles, the field crew photo-documented a company truck with a snow plow installed on the front (Figure 2). The salt may have been intended, then, for surface treatment as part of snow removal services. The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could wash into adjacent storm drain inlets or open water. An area map, indicating the location of the salt piles, is provided in Figure 3.



Figure 1. Exposed piles of salt found in a parking area associated with Stevens Auto Transport



Figure 2. Truck with mounted snow plow, belonging to Stevens Auto Transport, found near the salt piles



Figure 3. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: 7-11 Store, 1401 Dorsey Road, Hanover
Date: March 11, 2015
Investigators: M. Berlett, I. Turcsányi
Concern: Waste management

A Versar field team discovered an open dumpster and scattered debris associated with a 7-11 store at the above address. The field crew found one of the dumpsters open and filled with trash (Figure 1). Behind the store, the field crew found a large amount of debris (filled bags, cardboard, and food containers) among the bushes (Figure 2). Debris deposited on the ground may allow trash to blow off-site or leak potentially contaminating contents onto surfaces that could lead to adjacent storm drain inlets or open water. An area map, indicating the location of the open dumpster, is provided in Figure 3.



Figure 1. Open dumpster (right) found in the parking area of the 7-11 store



Figure 2. Debris found strewn behind the 7-11 store



Figure 3. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: BWI Freight parking lot, Mathison Way at Aviation Blvd., Baltimore
Date: March 12, 2015
Investigators: B. Hood, M. Berlett
Concern: Bulk solid storage

A Versar field team discovered large chunks of road salt at a curb inlet in the parking lot associated with BWI Freight (Figure 1). The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could easily enter the adjacent storm drain inlet. An area map, indicating the location of the salt chunks, is provided in Figure 2.



Figure 1. Road salt found at a curb inlet in a parking area associated with BWI Freight

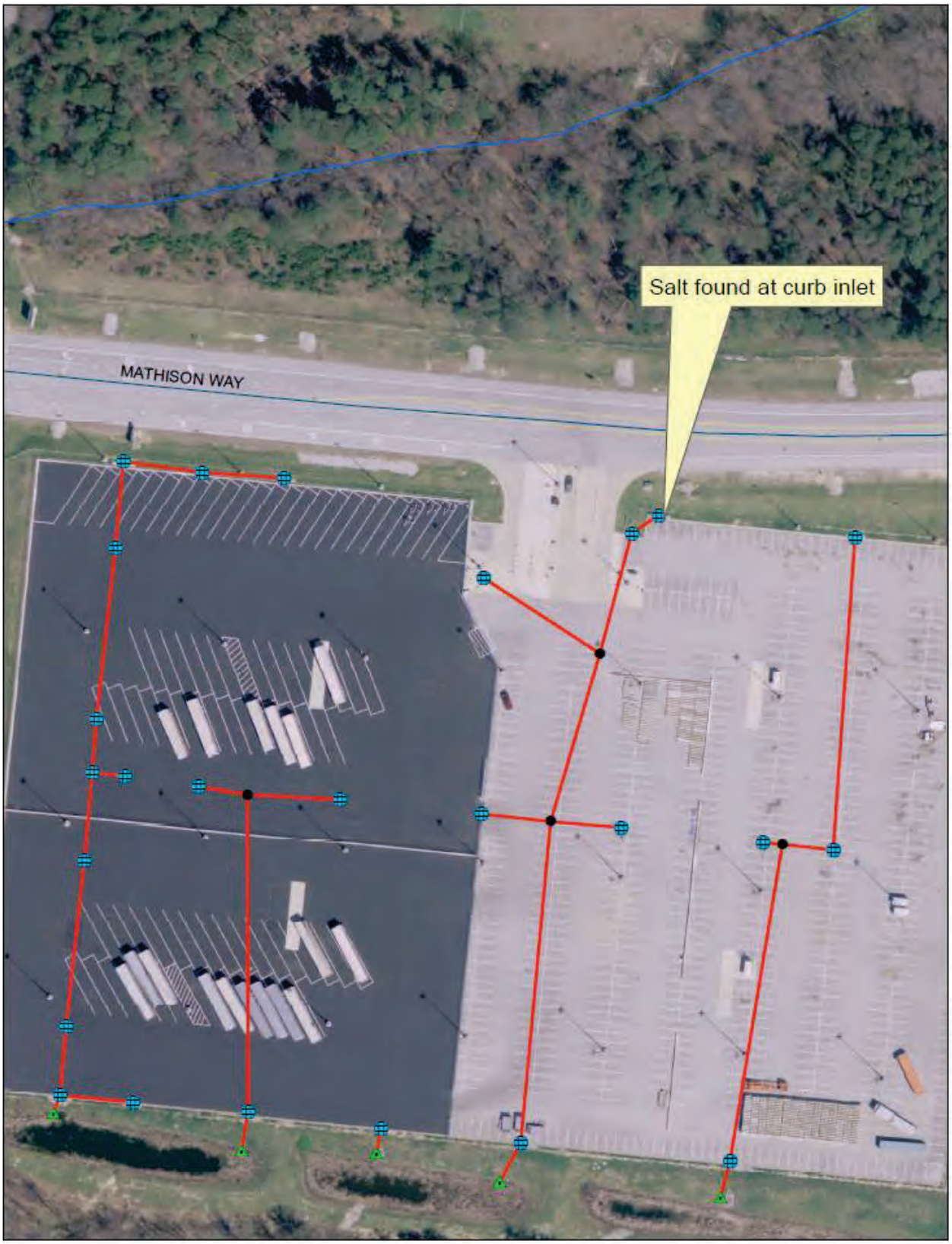


Figure 2. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Cromwell Center, 6938 Aviation Blvd., Ferndale
Date: March 12, 2015
Investigators: B. Hood, M. Berlett
Concern: Cooking oil storage and waste management

A Versar field team discovered two issues of concern in the parking lot near the three restaurants at Cromwell Center at the above address. The field crew documented an improper cooking oil storage situation and a dumpster with debris around it on March 12.

The field team discovered a soiled biofuels collection container, intended for the disposal of waste kitchen oil, alongside the parking lot at Cromwell Center. The field crew photo-documented fresh oil on and around the container, and extensive stains on the pavement (Figure 1); this suggests that oil may be coming from a leak in the container and spills during attempts to empty materials into the container. Cooking oil on an impervious surface poses a hazard to pedestrians; in a rain event, the oil may also distribute contaminants to adjacent impervious surfaces and eventually to storm drain inlets or open water. There is also a concern for attracting pests to the site.



Figure 1. Oil collection container with fresh residue on top of the container and surrounding it; older stains are also present

The Versar field team also found a dumpster surrounded by scattered debris in the same area alongside the parking lot (Figure 2). Debris deposited on the ground may allow trash to blow off-site or leak potentially contaminating contents onto surfaces that could lead to adjacent storm drain inlets or open water. An area map, indicating the locations of the oil collection container and the dumpster, is provided in Figure 3.

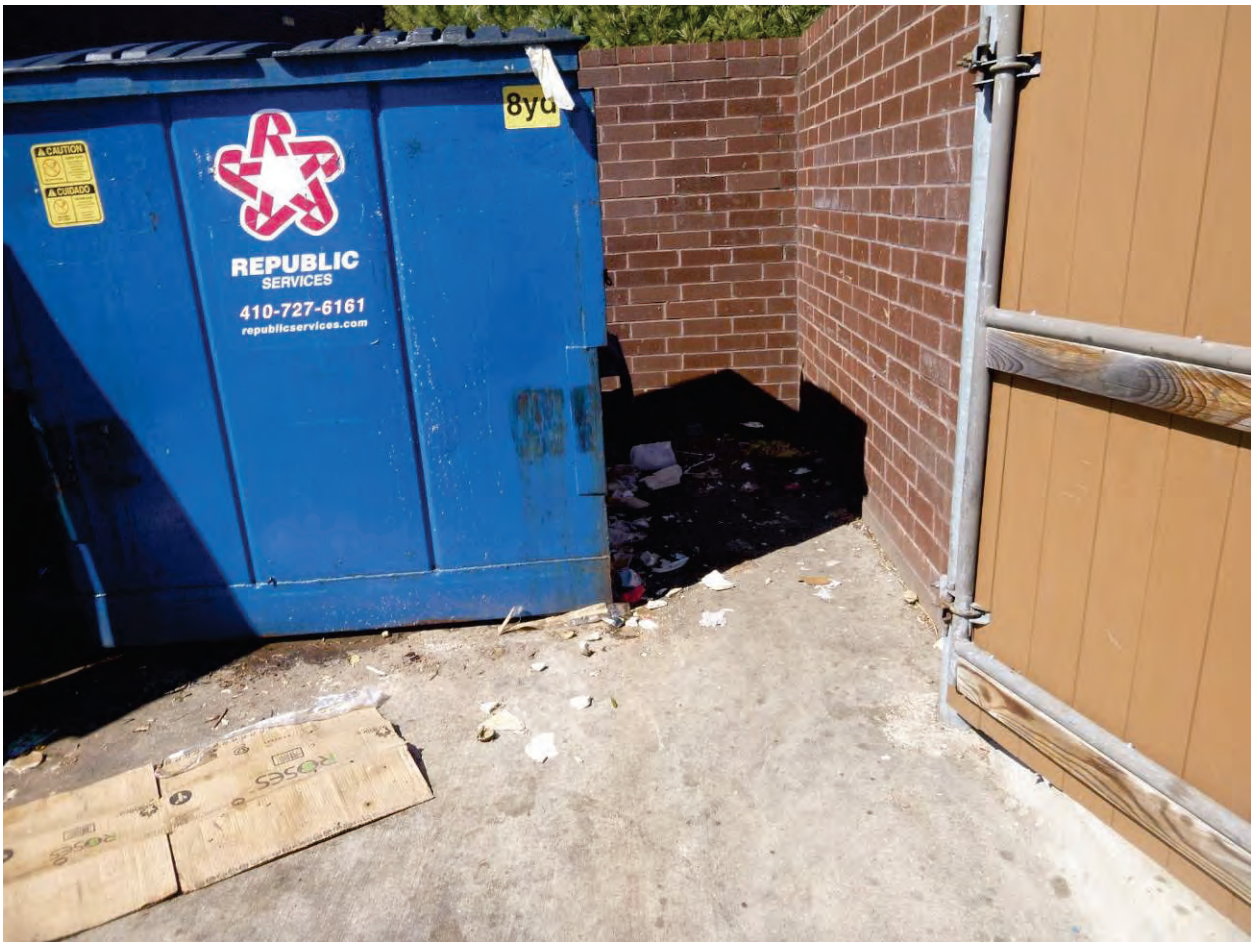


Figure 2. Dumpster found with debris scattered around it



Figure 3. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Shell fuel station, 1001 Aviation Blvd., Baltimore
Date: March 12, 2015
Investigators: B. Hood, M. Berlett
Concern: Liquid storage and waste management

A Versar field team discovered two issues of concern at the Shell fuel station at the above address. The field crew documented an inadequate drum storage situation and an overloaded dumpster with debris around it on March 12.

In an enclosure on the edge of the parking lot, the field team observed unmarked storage drums among other stored items (Figure 1). The field crew counted six 55-gallon drums in this storage area. Liquid materials in barrels should have secondary containment if placed on an impervious surface. Drums for liquids should also be labeled appropriately with content descriptions and hazard notices. As the contents of these containers were not specified, it is possible that the storage arrangements need to be modified to accommodate these guidelines.



Figure 1. Unmarked drums found in an enclosure associated with the Shell fuel station

The Versar field team also documented an overflowing dumpster on the property at the same Shell fuel station (Figure 2). On closer inspection, the field team noted debris scattered on the pavement around the dumpster (Figure 3). The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site and into the storm drain system. Debris deposited on the ground may leak potentially contaminating contents onto surfaces that could also lead to adjacent storm drain inlets or open water. Some debris may also attract pests to the site. An area map, indicating the location of the enclosures that house the drums and the nearby dumpster, is provided in Figure 4.



Figure 2. Open dumpster found overfilled with trash on March 12

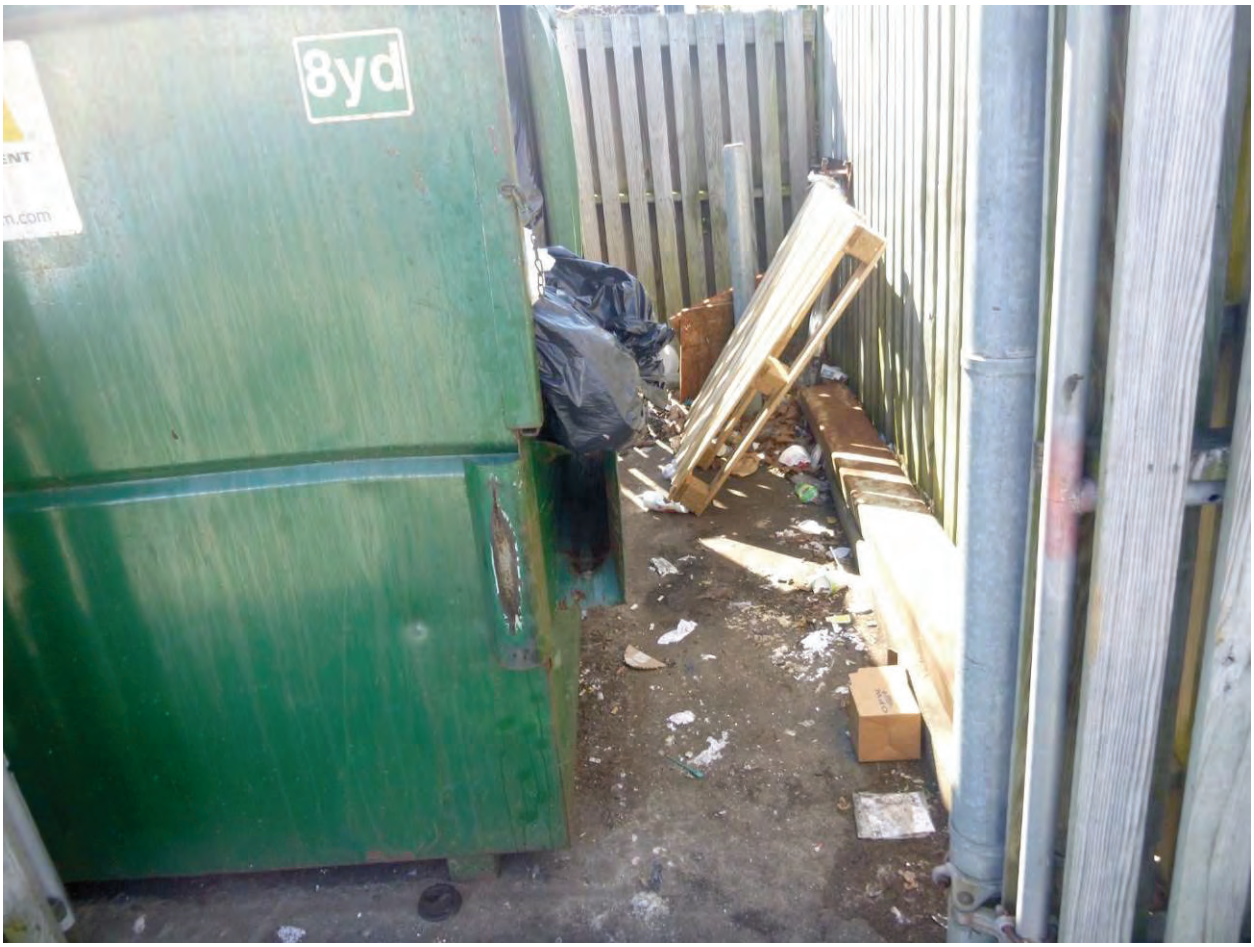


Figure 3. Dumpster found with debris scattered around it on March 12



Figure 4. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Hampton Inn, 829 Elkridge Landing Road, Linthicum Heights
Date: March 12, 2015
Investigators: B. Hood, M. Berlett
Concern: Waste management

A Versar field team discovered a large amount of debris surrounding an open dumpster associated with the Hampton Inn hotel at the above address (Figure 1). The open dumpster was not full (Figure 2); this suggests that the debris may have been deposited on the ground at an earlier time, perhaps when the unit was full, or that the dumpster is not being used routinely for trash disposal. The field team documented debris on all sides of the unit, including a mattress (Figure 3) and bagged and loose trash, including food containers (Figure 4). Alongside the dumpster enclosure, the field crew observed several discarded ventilation units (Figure 5). The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site and into the storm drain system. Debris deposited on the ground may leak potentially contaminating contents onto surfaces that could also lead to adjacent storm drain inlets or open water. Some debris may also attract pests to the site. An area map, indicating the location of the dumpster, is provided in Figure 6.



Figure 1. An open dumpster with debris and loose bins deposited around it



Figure 2. A view inside the open side of the dumpster showing that the unit is not full



Figure 3. A mattress and other large pieces of trash deposited alongside the dumpster



Figure 4. Bagged and loose trash, including food containers, found behind the dumpster



Figure 5. Several ventilation units and associated parts found on the ground near the dumpster

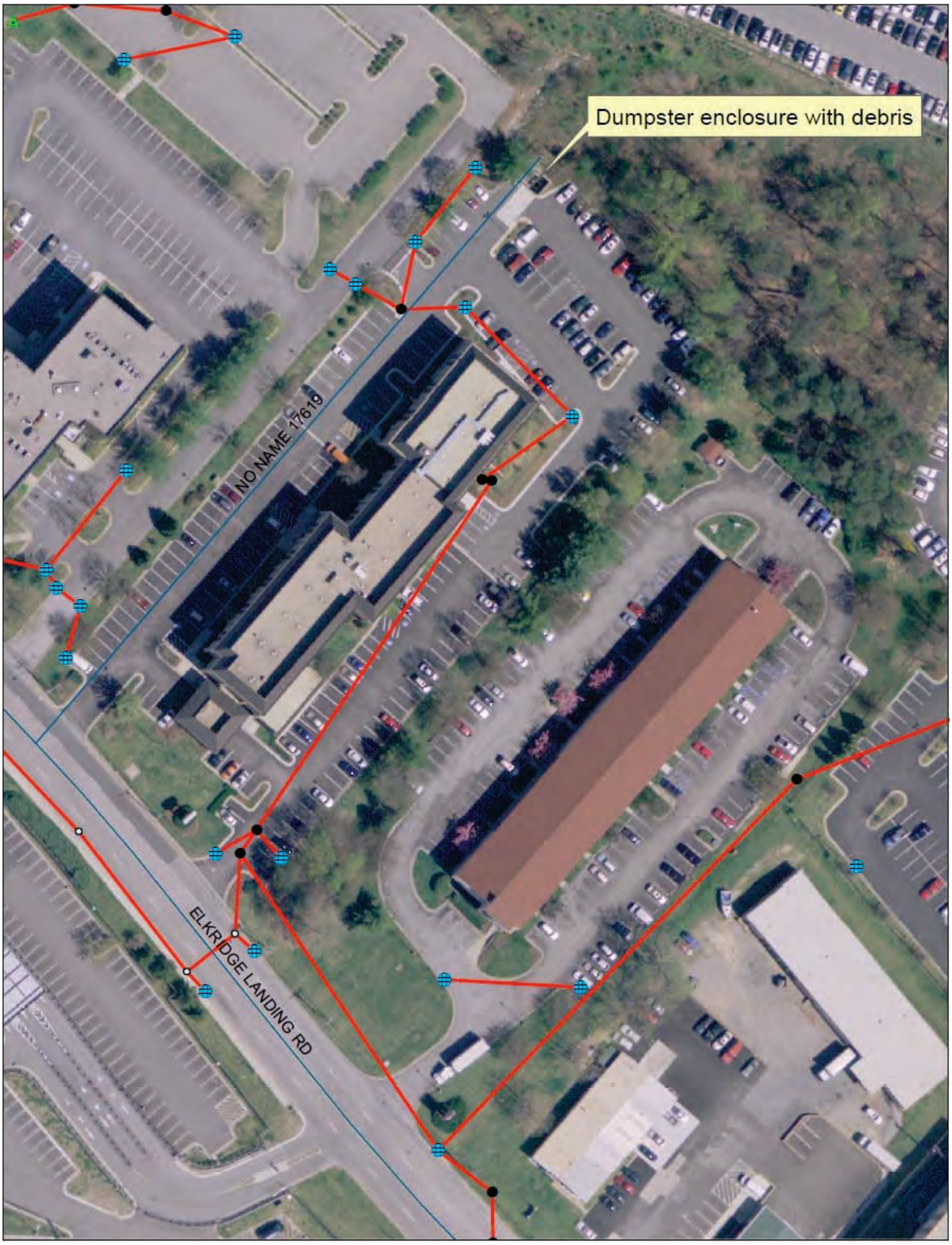


Figure 6. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Cinemark Egyptian 24 and XD (theater), 7000 Arundel Mills Circle, Hanover
Date: March 13, 2015
Investigators: M. Berlett, A. Vanko
Concern: Waste management

A Versar field team found two dumpsters that had been placed over a storm drain curb inlet alongside the Cinemark Egyptian 24 and XD (movie theater) at the above address (Figure 1). The field team noted that there were stains leading to the curb inlet, suggesting that materials other than water have been entering the storm system at this location (Figure 2). Although the field crew found the dumpsters appropriately closed, any trash alongside the containers, or exposed when the lids are open may blow off-site or into the adjacent opening to the storm drain system. Any debris deposited on the ground may also leak potentially contaminating contents onto surfaces that could enter the storm drain inlet easily. An area map, indicating the location of the dumpsters, is provided in Figure 3.



Figure 1. Dumpsters found immediately adjacent to a curb inlet to the storm system



Figure 2. Stains found leading to the curb inlet



Figure 3. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Arundel Mills Mall near Modell's Sporting Goods store, 7000 Arundel Mills Circle, Hanover
Date: March 13, 2015
Investigators: M. Berlett, A. Vanko
Concern: Waste management

A Versar field team found an overfilled roll-off dumpster in the parking lot near the Modells Sporting Goods store at the above address (Figure 1). The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site and into the storm drain system. Debris that falls to the ground may leak potentially contaminating contents onto surfaces that could also lead to adjacent storm drain inlets or open water. Some debris may also attract pests to the site. An area map, indicating the location of the dumpster, is provided in Figure 2.



Figure 1. Overfilled roll-off dumpster found near Modell's Sporting Goods store on March 13



Figure 2. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Arundel Mills Mall near the restaurant The Cheesecake Factory, 7002 Arundel Mills Circle, Hanover
Date: March 13, 2015
Investigators: M. Berlett, A. Vanko
Concern: Cooking oil storage and waste management

A Versar field team discovered two issues of concern in the parking lot near the restaurant The Cheesecake Factory at the above address. The field crew documented an improper cooking oil storage situation and a dumpster with debris around it on March 13.

The field team found a kitchen oil collection container with an open lid in the parking lot associated with the restaurant when they visited the site at 2:45 p.m. (Figure 1). The team noted that the open container was located uphill of a curb inlet for the parking area (Figure 2). Cooking oil on an impervious surface poses a hazard to pedestrians; in a rain event, the oil may also distribute contaminants to adjacent impervious surfaces and eventually to storm drain inlets or open water. There is also a concern for attracting pests to the site.



Figure 1. Cooking oil collection container found with an open lid; the container was located uphill of a curb inlet in the same parking lot



Figure 2. Photograph showing the relative location of the cooking oil storage bin to the nearby curb inlet

The Versar field team found some trash - including food - littering the area around a dumpster adjacent to the cooking oil bin in the same parking lot (Figure 3). Debris on the ground may be carried by wind or water to nearby storm drain inlets; it may also leak potentially contaminating contents onto surfaces that could also lead to adjacent storm drain inlets or open water. Food debris may also attract pests to the site. An area map, indicating the locations of the cooking oil bin and the dumpster, is provided in Figure 4.



Figure 3. Debris, including food, found scattered around a dumpster near the Cheesecake Factory restaurant on March 13



Figure 4. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Red Lobster restaurant, 7063 Arundel Mills Circle, Hanover
Date: March 13, 2015
Investigators: M. Berlett, A. Vanko
Concern: Improper cooking oil storage

A Versar field team discovered a grease collection container, intended for the disposal of waste kitchen grease, in the parking lot associated with the Red Lobster restaurant at the above address. The field crew members found the container lid open when they visited the site at 2:55 p.m. (Figure 1). Cooking oil on an impervious surface poses a hazard to pedestrians; in a rain event, the oil may also distribute contaminants to adjacent impervious surfaces and eventually to storm drain inlets or open water. There is also a concern for attracting pests to the site. An area map is provided as Figure 2.



Figure 1. Kitchen grease collection container found with an open lid



Figure 2. Area map (imagery was derived from Google Earth because the Anne Arundel County orthophotography was not recent enough to show the target features)

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Bass Pro Shops, 7000 Arundel Mills Circle, Hanover
Date: March 13, 2015
Investigators: M. Berlett, A. Vanko
Concern: Vehicle washing outdoors

A Versar field team discovered a man washing a boat with water from a hose at the service entrance of Bass Pro Shops at the above address (Figure 1). This activity, conducted on impervious surface, may allow tap water to enter the storm drain system; the activity would constitute an illicit discharge. The field crew photo-documented the wastewater entering the roadway via paved surfaces. The current storm drain network is not available in digital format for this location to assess the relative location of the wastewater to an inlet. An area map, indicating the location of the washdown activity, is provided in Figure 2.



Figure 1. Boat washdown observed at the service entrance to Bass Pro Shops



Figure 2. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Staples store, 7661 Arundel Mills Blvd, Hanover
Date: March 13, 2015
Investigators: M. Berlett, A. Vanko
Concern: Waste management

A Versar field team found an open dumpster with debris scattered around it behind the Staples store at the above address (Figure 1). The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site and into the storm drain system. Debris on the ground may be carried by wind or water to nearby storm drain inlets; it may also leak potentially contaminating contents onto surfaces that could also lead to nearby storm drain inlets or open water. Some debris may also attract pests to the site. An area map, indicating the location of the dumpster, is provided in Figure 2.



Figure 1. An open dumpster with debris scattered around in found near the Staples store on March 13

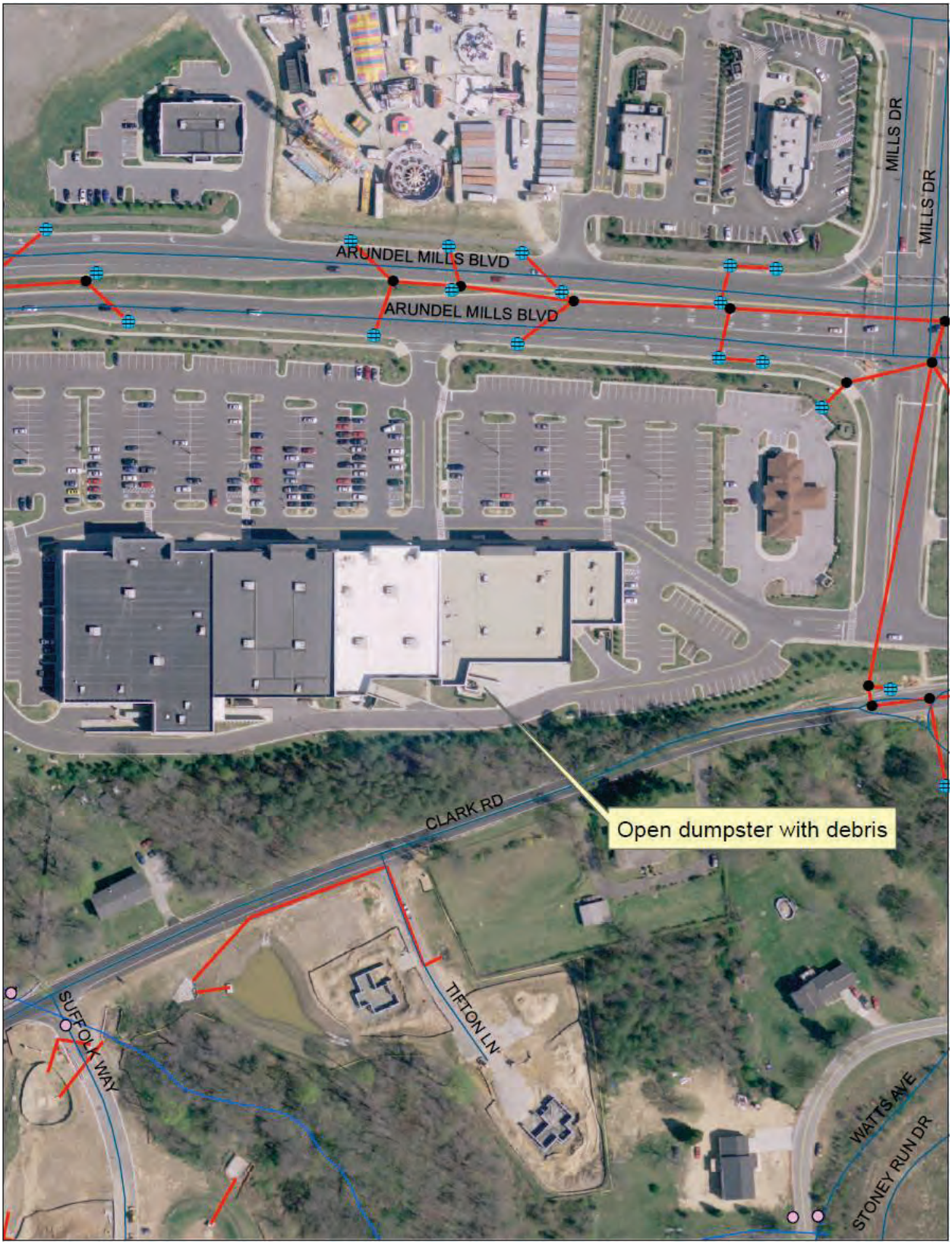


Figure 2. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Baja Fresh restaurant, 7645 Arundel Mills Blvd., Hanover
Date: March 13, 2015
Investigators: M. Berlett, A. Vanko
Concern: Cooking oil storage

A Versar field team discovered two cooking oil collection containers, intended for the disposal of waste kitchen oil, in the parking lot associated with the Baja Fresh restaurant at the above address. The field crew documented significant oil stains around the containers; the oil may be coming from leaks in the containers and spills during attempts to empty materials into the containers. Cooking oil on an impervious surface poses a hazard to pedestrians; in a rain event, the oil may also distribute contaminants to adjacent impervious surfaces and eventually to storm drain inlets or open water. There is also a concern for attracting pests to the site. An area map is provided as Figure 2.



Figure 1. Cooking oil collection bins with oil stains surrounding both of the containers



Figure 2. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Computer Sciences Corporation, 7459 Candlewood Road, Hanover
Date: March 13, 2015
Investigators: M. Berlett, A. Vanko
Concern: Waste management

A Versar field team found an open, overfilled dumpster near a yard grate in the parking lot associated with the Computer Sciences Corporation at the above address (Figure 1). The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site or into the nearby storm drain system. Debris that falls on the ground may also leak potentially contaminating contents onto surfaces that could lead to nearby storm drain inlets or open water. Some debris may also attract pests to the site. An area map, indicating the location of the dumpster, is provided in Figure 2.



Figure 1. An open, overfilled dumpster located near a yard grate that was found on March 13



Figure 2. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: United Stationers, 7441 Candlewood Road, Hanover
Date: March 13, 2015
Investigators: M. Berlett, A. Vanko
Concern: Loose debris on-site

A Versar field team discovered a large amount of debris on a slope leading to a stream alongside a parking lot associated with United Stationers at the above address (Figure 1). The material deposited on the slope included bottles, cans, and plastic containers. In one area, there were also larger pieces: plastic bags, a box, and strips of foam (Figure 2). The trash was found strewn along a wide stretch of the woods along the stream. The sloped land would contribute to a significant pollution source from this site, as materials could enter the stream easily, carried by wind or rain. Debris deposited on the ground may also leak potentially contaminating contents onto surfaces that could lead to the open water. Some debris may also attract pests to the site. An area map, indicating the location of the debris, is provided in Figure 3.



Figure 1. Abundant loose debris found on a slope alongside a stream



Figure 2. Larger items documented among the debris



Figure 3. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: 7572 Ritchie Highway, Glen Burnie
Date: April 13, 2015
Investigators: G. Zuknick and B. Crary
Concern: ~~Infrastructure, manhole cover missing~~Liquid storage

A LimnoTech field team discovered several open buckets of blacktop sealer on a sidewalk behind the D J Liquidators store (approximately) at the above address (Figure 1). The field crew noted that there was extensive staining on the sidewalk (Figure 2) suggesting that sealer has been transferred or spilled in this location in other recent incidents. Residue washed from the buckets or the sidewalk could easily enter the nearby curb inlet and introduce petroleum-based contaminants to the storm sewer system and receiving waters. An area map, indicating the location of the open buckets of sealer, is provided in Figure 3.



Figure 1. Open containers of blacktop sealer found on the sidewalk



Figure 2. Extensive staining on the sidewalk near the open buckets of sealer



Figure 3. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: 2421 Crofton Lane, Crofton
Date: April 16, 2015
Investigators: T. Jones and I. Turcsányi
Concern: Waste management

A Versar field team identified several issues of concern related to waste management in an area of the parking lot associated with 2421 Crofton Lane (multiple businesses). The field team discovered an open dumpster (Figure 1). The dumpsters were located next to an enclosed outdoor storage area. The field crew documented that some large pieces of debris have been placed both inside and outside of this enclosure (Figure 2). In a nearby corner of the parking lot, the field crew found more debris blocking a corner drain opening for the lot (Figure 3). The nearest stormwater system inlet is some distance away from the dumpsters and debris; the field team photo-documented its position relative to the storage area (Figure 4). The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site or into the nearby storm drain system. Debris that falls on the ground may also leak potentially contaminating contents onto surfaces that could lead to nearby storm drain inlets or open water. Large debris may pose a hazard to drivers in the parking lot, or block efficient drainage of rainwater across the impervious surface to the stormwater inlets. An area map, indicating the location of the dumpster and the debris, is provided in Figure 5.



Figure 1. An open dumpster found on April 16



Figure 2. Large pieces of debris placed outside of the storage enclosure



Figure 3. Pipes and other debris found in a parking lot corner drain area



Figure 4. Relative location of the inlet that would receive drainage from the dumpsters and storage areas

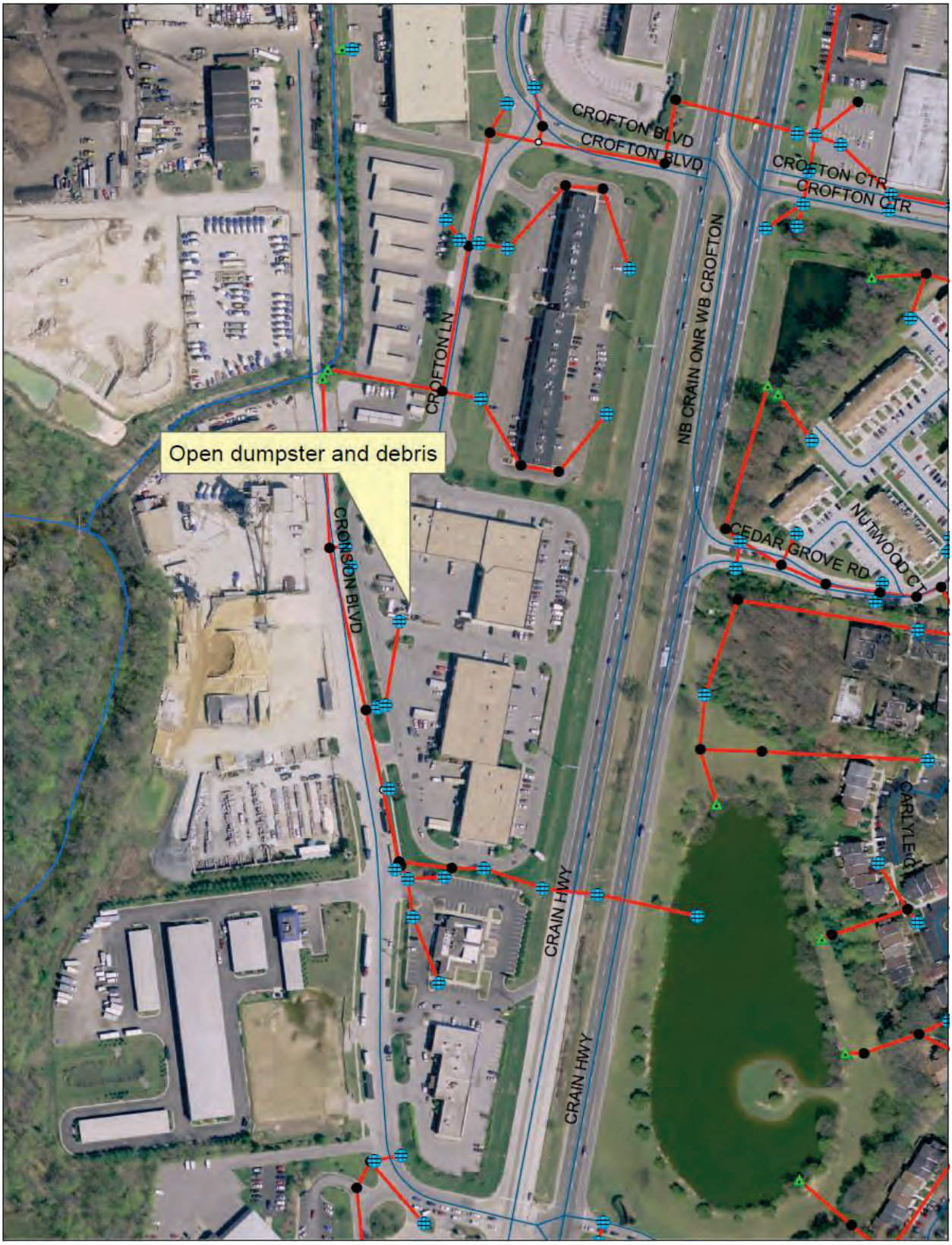


Figure 5. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: West Marine, 595 East Ordnance Road, Glen Burnie
Date: April 24 and 29, 2015
Investigators: G. Zuknick, B. Crary, and L. Vander Linden
Concern: Waste management

A LimnoTech field team discovered an overfilled roll-off dumpster in the parking lot behind the West Marine store at the above address (Figure 1). Debris evident at the top of the pile included several open, used containers; the field crew was unable to determine the contents of these visible containers. The field crew also found large pieces of debris scattered around the dumpster (Figure 2). The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site or into the nearby storm drain system. Large pieces of debris, already on the ground or blown to the ground with a strong wind, may create hazards for drivers in the parking lot. Debris that falls onto the ground may also leak potentially contaminating contents onto surfaces that could lead to nearby storm drain inlets or open water; open containers in the dumpster may also release contaminants into the dumpster during rain events. Some debris may also attract pests to the site. An area map, indicating the location of the dumpster, is provided in Figure 3.



Figure 1. An overfilled dumpster investigated on April 24 and 29; several open containers are evident in the debris (photography date: April 29, 2015)



Figure 2. Large pieces of debris scattered around the overfilled dumpster (photography date: April 24, 2015)



Figure 3. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: 713 East Ordnance Road, Glen Burnie
Date: April 24, 2015
Investigators: G. Zuknick and L. Vander Linden
Concern: Bulk solid storage

A LimnoTech field team discovered what appeared to be a large pile of road de-icing salt in the parking lot at the corner of the building (multiple businesses) at the above address (Figure 1). At the time of the site visit, the pile was partially uncovered. The field crew noted that a line of residue could be traced from the area of the pile along part of the parking lot (Figure 2). Investigations conducted for this report included confirmation with imagery from Google Maps (https://www.google.com/maps/); the image available at the time of the report draft (May 11, 2015) showed a significant line of residue from the same corner where the road salt was being stored on April 24 to an area of distinct but indeterminate use along the parking lot (Figure 3). The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could drift into adjacent storm drain inlets or open water. An area map, indicating the location of the large salt pile, is provided in Figure 4.



Figure 1. A large, partially uncovered pile of road de-icing salt found on April 24



Figure 2 Evidence of the distribution of salt residue along the parking lot surface from the exposed pile of road salt

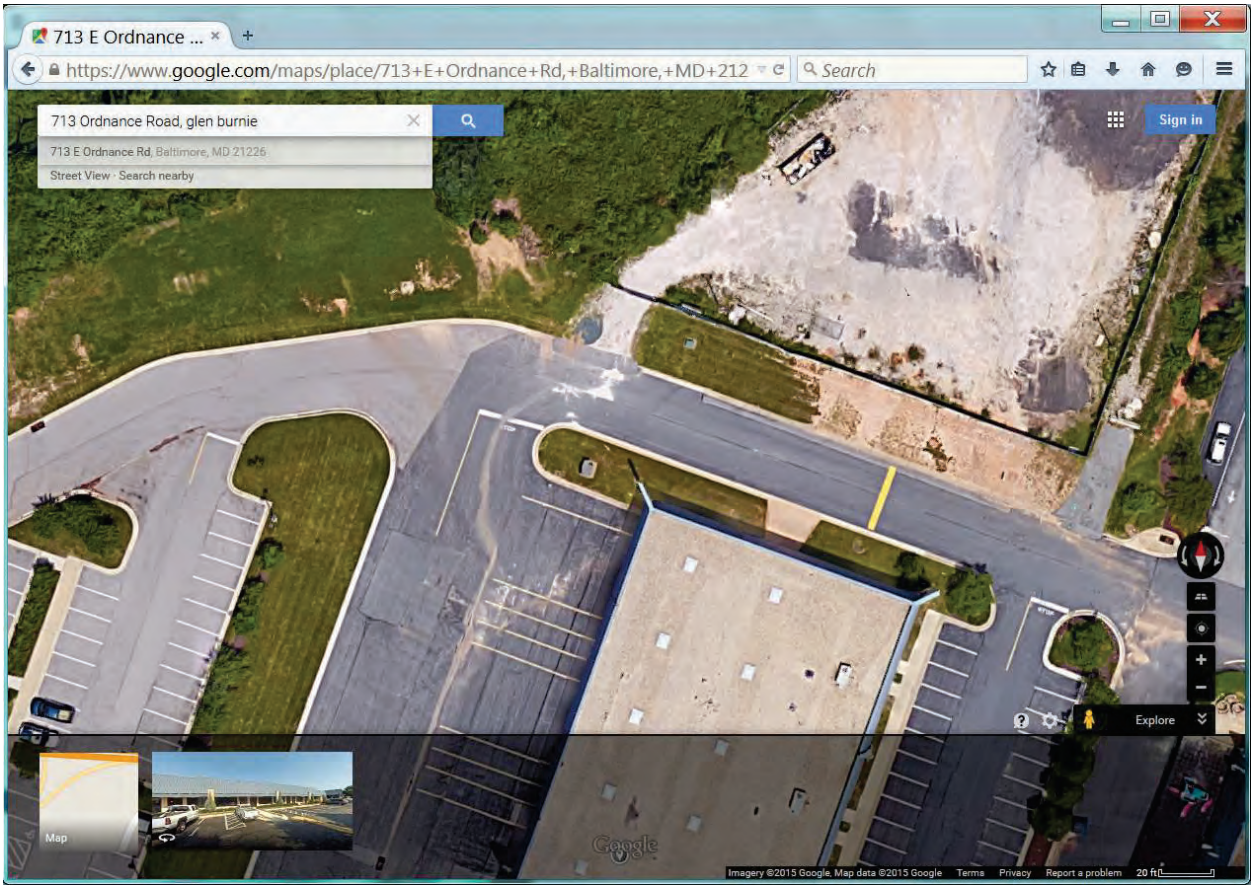


Figure 3. Similar evidence of a trail of residue from the corner of the parking lot where the exposed road salt was found apparent in an image available on the Internet from Google Maps (source: https://www.google.com/maps/place/713+E+Ordnance+Rd,+Baltimore,+MD+21226/@39.2047719,-76.5954318,92m/data=!3m1!1e3!4m2!3m1!1s0x89b7fd7ffce1ba43:0x26055e1250fdd82d!6m1!1e1?hl=en, obtained May 11, 2015)



Figure 4. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Target store, 6717 Governor Ritchie Highway, Glen Burnie
Date: April 24, 2015
Investigators: G. Zuknick and L. Vander Linden
Concern: Bulk solid storage

A LimnoTech field team discovered what appeared to be a large pile of road de-icing salt in the parking lot behind the Target store at the above address (Figure 1). The large pile of road salt was found uncovered on the pavement. Small piles of salt were found scattered on the ground above the curb. In the same area, the field crew also found several bags of salt crystals; this material is intended for use in water softening systems. The placement of salt on an impervious surface introduces the risk of distribution, by wind or rain, of salt particles and associated nutrients which could drift into adjacent storm drain inlets or open water. The salt piles already on the ground pose a hazard to animals passing through the area; with rain events, the salt could infiltrate the soil, lead to elevated sodium and chloride levels in the soil, and damage nearby plants. With repeated rains, the salt and its derivatives could enter the nearby stream headwaters behind the parking lot; elevated chloride levels can be toxic to aquatic life. An area map, indicating the location of the large salt pile, is provided in Figure 2.



Figure 1. A large, uncovered pile of road de-icing salt in the parking lot, small piles of road salt on the ground, and several bags of water softener salt crystals found on the day of the site visit



Figure 2. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Cromwell Business Park, 801 Cromwell Park Drive, Glen Burnie
Date: April 24, 2015
Investigators: G. Zuknick and L. Vander Linden
Concern: Waste management

A LimnoTech field team discovered a pair of open dumpsters in an enclosure alongside the parking lot behind the Cromwell Business Park building (multiple businesses) at the above address. One dumpster, intended for the disposal of recyclable material, was overfilled (Figure 1). The other dumpster, intended for trash, had many bags of garbage strewn around it and some loose debris; food containers were apparent in some of the bags (Figure 2). The dumpsters were situated on a concrete pad above the curb. There were curb inlets near the dumpsters, one approximately 65 feet north and the other approximately 117 feet south of the enclosure. The lack of proper storage (preferably in closed containers under shelter) may allow trash to blow off-site or into the nearby storm drain system. Debris on the ground may leak potentially contaminating contents onto surfaces that could lead to nearby storm drain inlets or open water. Some debris may also attract pests to the site. An area map, indicating the location of the dumpsters, is provided in Figure 3.



Figure 1. An overfilled dumpster (left), intended for materials to be recycled; the nearby curb inlet to the north is evident on the left side of the photograph

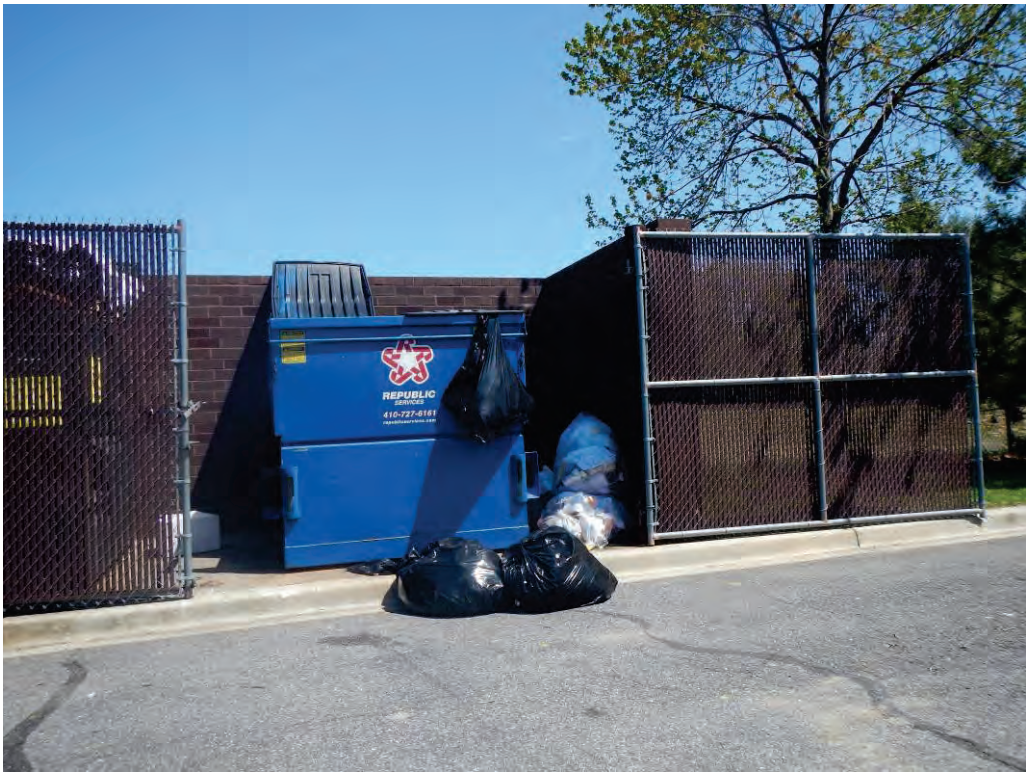


Figure 2. Many bags of garbage found on and around an open trash dumpster



Figure 3. Area map

Anne Arundel County Hotspot Site Investigation Visit Report

Location: Belair Produce, 7226 Parkway Drive, Hanover
Date: June 25, 2015
Investigators: C. Tonkin, J. Rella
Concern: Waste management

While in the area to screen an outfall, a Versar field team discovered an actively polluting condition at a roll-away dumpster found behind a Belair Produce building at the above address (Figure 1). The team observed the dumpster leaking a red liquid of sufficient quantity (Figure 2) to span the rear of the parking area (Figure 3) and enter the adjacent wooded land (Figure 4). In light of the nature of the business, one could surmise that the leachate may contain material from fruits and vegetables that have been discarded to the trash compactor; as such, the fluid may contain nutrients, bacteria, waxes, pesticides, and fungicides, among other constituents. In 2014, field crews documented a dumpster in the same location leaching sour-smelling liquid which followed a similar path to the woods. The trail of liquids, apparently emanating from the dumpster, is evident in aerial photographs, since at least 2007 (the date for the photograph used in Figure 5 in this report). An area map, indicating the location of the dumpster, is provided in Figure 5.



Figure 1. Red liquid observed leaking from a roll-away dumpster found behind the Belair Produce building on June 25, 2015



Figure 2. Fluid observed leaking from the dumpster on June 25, 2014 in amounts sufficient to run a course along the edge of the parking lot



Figure 3. Fresh leachate trail as observed facing the dumpster on June 25, 2015

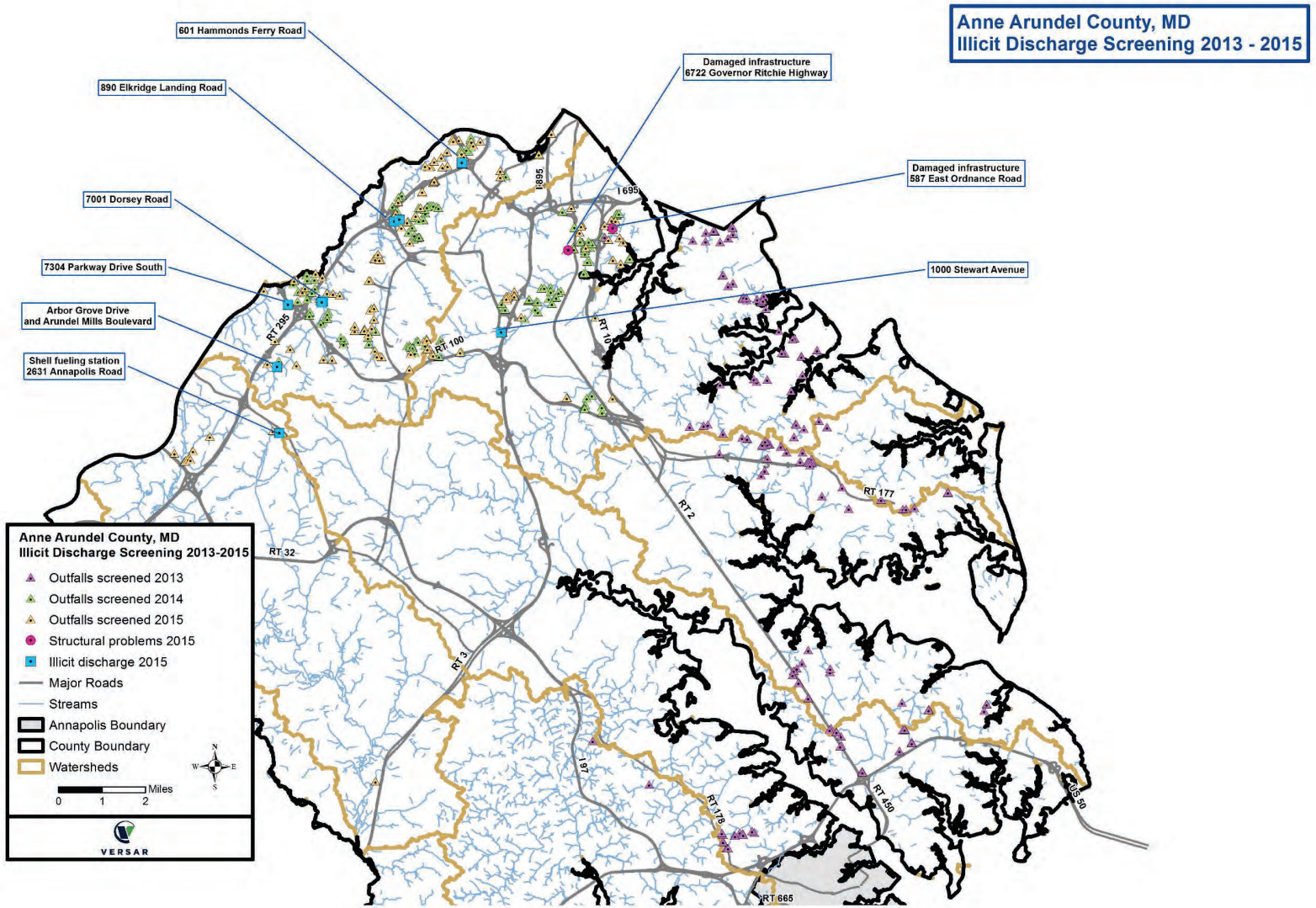


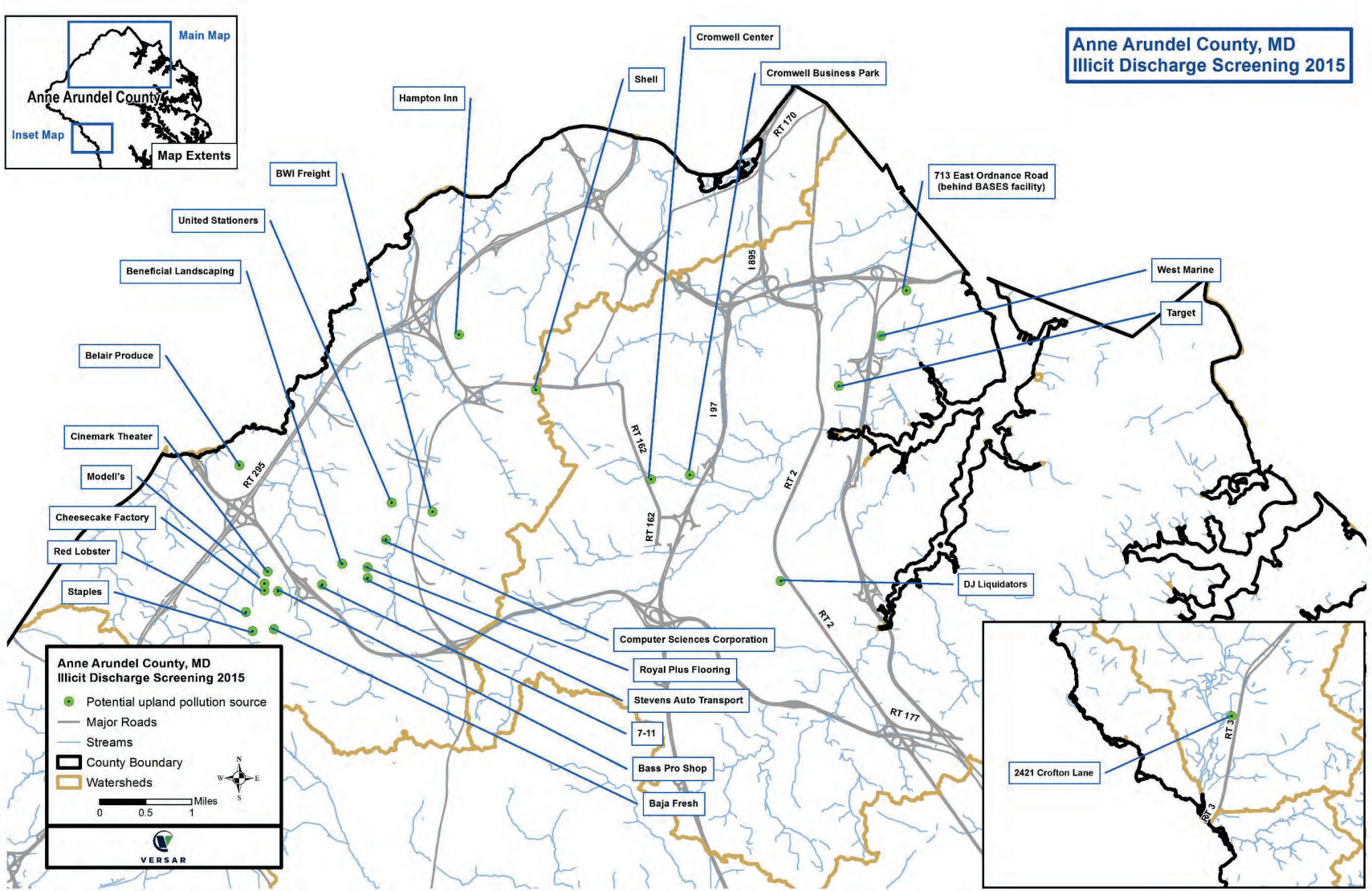
Figure 4. Red liquid leachate leading into the woods from the parking lot, as observed on June 25, 2015



Figure 5. Area map (note that the leachate trail is evident in this aerial photograph from 2007)

APPENDIX D
MAPS


Anne Arundel County, MD
Illicit Discharge Screening 2013 - 2015
601 Hammonds Ferry Road
890 Elkridge Landing Road
7001 Dorsey Road
7304 Parkway Drive South
Arbor Grove Drive and Arundel Mills Boulevard
Shell fueling station 2631 Annapolis Road
Damaged infrastructure 6722 Governor Ritchie Highway
Damaged infrastructure 587 East Ordnance Road
1000 Stewart Avenue
I 695
RT 295
RT 100
RT 10
RT 2
RT 177
RT 32
RT 3
197
RT 178
RT 450
RT 50
RT 665
Anne Arundel County, MD
Illicit Discharge Screening 2013-2015
Outfalls screened 2013
Outfalls screened 2014
Outfalls screened 2015
Structural problems 2015
Illicit discharge 2015
Major Roads
Streams
Annapolis Boundary
County Boundary
Watersheds
Miles
0 1 2
VERSAR


Anne Arundel County, MD
Illicit Discharge Screening 2015
Main Map
Anne Arundel County
Inset Map
Map Extents
Cromwell Center
Shell
Cromwell Business Park
Hampton Inn
BWI Freight
713 East Ordnance Road (behind BASES facility)
United Stationers
Beneficial Landscaping
West Marine
Target
Belair Produce
Cinemark Theater
Modell's
Cheesecake Factory
Red Lobster
Staples
DJ Liquidators
Computer Sciences Corporation
Royal Plus Flooring
Stevens Auto Transport
7-11
Bass Pro Shop
Baja Fresh
2421 Crofton Lane
RT 170
I 895
I 97
RT 162
RT 295
RT 2
RT 177
RT 3
Potential upland pollution source
Major Roads
Streams
County Boundary
Watersheds
Miles
0
0.5
1
N
S
E
W
VERSAR

APPENDIX E
ACCESS DATABASE FOR ILLICIT DISCHARGE DETECTION PROGRAM INSPECTIONS

APPENDIX F
COUNTY INSPECTION COMPLIANCE DATABASE REPORTS

9/2/2015 Anne Arundel County Department of Inspections and Permits

Environment Section Complaint

Case ID:	E - 2015 - 69	Location:	2421 CROFTON LN
Tax ID:	220690059752		CROFTON OFF/WRHSE CONDO CROFTON 21114
Received:	3/11/2015	Details:	
Tickler:		Completed:	3/12/2015
	ILLEGAL DISCHARGES COMPLAINT		

Receiver:		Inspector:		
Date Assigned:	3/11/2015	Permit Number:		Original ID:
ADC Map:		Related Cases:		
Water Front:	N	Critical Area:	N	Violation:
Cty. Council Ind:	N	Case Org:		
Complainant:				

Owner Information		Violator Information	
Owner 1:	CROFTON DEVLPRS II LTD PTNSHP	Violator 1:	CLOTHES CALL
Owner 2:		Violator 2:	
Address:	2421 CROFTON LN CROFTON 21114	Address:	
		Phone:	

State Map:	Map No:	Suffix	Block	Parcel	County Map:	Plat	Sect	Block	Lot No
	42		05	0146		1	1		2A

Date	Event	Due Date	Request for Trial Date
3/11/2015	OPENED COMPLAINT CASE	3/16/2015	

TIP OR COMPLAINT: I WAS PASSING THE CLOTHES CALL ON SUNDAY 8 MAR ABOUT 2:00 PM ON THE WAY TO MY STORAGE FACILITY AND IN BACK OF THE CLOTHES CALL I SAW 2 OR 3 EMPLOYEES WHO WERE WASHING RUGS. I SAW THEM USING BIG 40 GALLON WHITE PLASTIC SOAP DRUMS TO POUR SOAP SCRUB USING PUSH BROOMS AND I BELIEVE ONE DRUM WITH CLEAN WATER TO RINSE THE RUGS. I KNOW THESE DRUMS BECAUSE I GOT SOME FROM A CAR WASH FREE TO BUILD WATER CATCHERS. THE SOAP AND WATER WAS RUNNING DIRECTLY INTO A STORM DRAIN. I DONT KNOW IF THIS WAS OFFICIAL OFFICE BUSINESS OR THEY WERE JUST WASHING THE OFFICE OR HOME RUGS. BUT THE SOAP WAS DEFINITELY RUNNING DIRECTLY INTO THE SOTRM DRAIN AND IT WAS OBVIOUS THEY PCIKED THAT SPOT BECAUSE OF THE PROXIMITY TO THE DRAIN. COULD BE ENVIRONMENTALLY FIRENDLY SOAP OR THEIR CLOTHES WASHING. I DON'T KNOW. SAVE THE BAY! THE DRAIN WAS DIRECTLY BEHIND THE LEFT MOST AS YOU FACE IT FROM THE REAR OF THE BUILDING END OF THE BUILDING. VIOLATION STILL OCCURRING?

3/12/2015 CLOSE COMPLAINT

NO CARPET CLEANING GOING ON AT THE LOCATION AT TIME OF INSPECTION. INSPECTED SITE AT 11:50 AM ON WEDNESDAY, MARCH 11, 2015. A DRY CLEANING COMPANY CALLED CLOTHES CALL OCCUPIES THE BUILDING LOCATION. INSPECTOR TALKED TO PATRICK BERGMANN PRESIDENT OF THE COMPANY. HE INFORMED HIM THAT ON OCCASION HIS COMPANY DOES TEXTILE RESTORATION. IN THIS CASE, ON SUNDAY MARCH 8, 2015 HIS EMPLOYEES WERE DOING A RUG CLEAN UP, OUTSIDE AT THE REAR OF BUILDING NEAR A GARAGE TYPE DOOR, WHICH WAS OPEN. THEY WERE SOAKING A WATER DAMAGED RUG AND SQUEE -GEEING WATER FROM THE WET RUG AND USING THE WATER HOSE WHICH IS ATTACHED TO THE BUILDING. HE SAID THAT HIS EMPLOYEES WERE NOT USING CHEMICALS OR SOAPS. THERE WAS HOWEVER A SOAP DRUM WHICH CAME OFF THE MECHANICAL TRUCK,

WHICH WAS PLACED ON THE PAVING. THIS DRUM GOES WITH THE TRUCK AND THE SOAP IS USED AT RESTORATION SITES.. I LOOKED INTO THREE STORM DRAIN INLETS DOWNSTREAM OF THE REAR OF THE BUILDING. I SAW NO EVIDENCE OF SOAP RESIDUES OR BUBBLES IN THE DOWNSTREAM INLETS. THE OUTFALL FOR THE COUNTY STORM DRAIN IS LOCATED ABOUT A CITY BLOCK AWAY IN A LARGE POND LOCATED TO THE EAST ON RT. 3 NORTH. THE OUTFALL IS UNDER WATER AND THE POND IS FROZEN. NO VIOLATION AT THIS ADDRESS.

9/8/2015 Anne Arundel County Department of Inspections and Permits

Environment Section Complaint

Case ID:	E - 2015 - 70	Location:	121 JENNIFER RD
Tax ID:	200000211375		BESTGATE ANNAPOLIS 21401
Received:	3/11/2015	Details:	
Tickler:		Completed:	3/11/2015
	ILLEGAL DISCHARGES COMPLAINT		

Receiver:		Inspector:		
Date Assigned:	3/11/2015	Permit Number:		Original ID:
ADC Map:		Related Cases:		
Water Front:	N	Critical Area:	N	Violation:
Cty. Council Ind:	N	Case Org:		
Complainant:				

Owner Information		Violator Information	
Owner 1:	ANNE ARUNDEL COUNTY	Violator 1:	
Owner 2:		Violator 2:	
Address:	121 JENNIFER RD ANNAPOLIS 21401	Address:	
		Phone:	

State Map:	45	H	14	0074	County Map:				
	Map No:	Suffix	Block	Parcel		Plat	Sect	Block	Lot No

Date	Event	Due Date	Request for Trial Date
3/11/2015	OPENED COMPLAINT CASE	3/16/2015	
	NOTICED A PETROLEUM SHEEN ON WEEMS CREEK AT THE INTERSECTION OF ADMIRAL DR AND JENNIFER RD, ANNAPOLIS.		
3/11/2015	CLOSE COMPLAINT		
	INVESTIGATED THE SHEEN AND DETERMINED THAT THE PETROLEUM DISCHARGE ORIGINATED AT THE WEST ANNAPOLIS FIRE DEPARTMENT LOCATED AT 121 JENNIFER RD, ANNAPOLIS. UPON SPEAKING WITH THE OFFICER ON DUTY, BECAME AWARE THAT THERE HAD BEEN A DISCHARGE OF TRANSMISSION FLUID FROM A BREAK IN A TRANSMISSION LINE FROM ONE OF THE ENGINES. THE DISCHARGE IS TEMPORARY AND WILL NOT BE A REGULAR OCCURRENCE. THIS COMPLAINT IS CLOSED.		

9/8/2015 Anne Arundel County Department of Inspections and Permits

Environment Section Complaint

Case ID:	E - 2014 - 392	Location:	252 SEVERN RD
Tax ID:	325017526350		ELVATON ACRES MILLERSVILLE 21108
Received:	8/5/2014	Details:	
Tickler:		Completed:	8/21/2014
	ILLEGAL DISCHARGES COMPLAINT		

Receiver:		Inspector:		
Date Assigned:	8/5/2014	Permit Number:		Original ID:
ADC Map:		Related Cases:		
Water Front:	N	Critical Area:	N	Violation:
Cty. Council Ind:	N	Case Org:		
Complainant:				

Owner Information		Violator Information	
Owner 1:	ASHLEY DONALD D	Violator 1:	
Owner 2:		Violator 2:	
Address:	252 SEVERN RD MILLERSVILLE 21108	Address:	
		Phone:	

State Map:	Map No:	Suffix	Block	Parcel	County Map:	Plat	Sect	Block	Lot No
	23		02	0628					86

Date	Event	Due Date	Request for Trial Date
8/5/2014	CASE NOTE	8/12/2014	8/5/2014

AUGUST 1ST, 2014 INSPECTOR DID A DRIVE BY AND NO WORK HAD BEEN DONE NOR STARTED. AUGUST 4TH 2014 INSPECTOR HAD DRIVEN BY THE ABOVE STATED ADDRESS AT ABOUT NOON AND NOTICED THAT WORK HAD BEEN DONE. THE ILLICIT DISCHARGE 3" PVC PIPE HAD BEEN CUT BACK ABOUT 25' AND IS NOW SPILLING ONTO THE HOMEOWNER'S PROPERTY. THE PIPE HAS A STEADY DISCHARGE COMING FROM IT AND DOES NOT APPEAR TO BE CAPPED OFF. PHOTOGRAPHS WERE TAKEN OF THE PREMISES AND RECORD MADE OF WHAT WAS SEEN. ON A SIDE NOTE HE HAD ALSO ATTEMPTED TO RE GRADE THE COUNTY DITCH. INSPECTOR DID MAKE THE COUNTY GRADING INSPECTOR AWARE OF THIS.AUG 5TH 2014 INSPECTOR MADE A TELEPHONE CALL TO MR. ASHLEY'S CELL PHONE NUMBER AND RECEIVED HIS VOICEMAIL. CALL WAS MADE AT 9:00 A.M. INSPECTOR DID LEAVE HIS NAME AND NUMBER AND ASKED THAT HE CALL WHEN HE RECEIVES THIS MESSAGE.

8/5/2014	OPENED COMPLAINT CASE	8/12/2014	

WEDNESDAY JULY 30, 2014 1:00 P.M. INSPECTOR ALONG WITH INSPECTOR ARRIVED AT THE RESIDENCE OF ASHLEY DONALD D ASHLEY JESSIE L LOCATED AT 252 SEVERN ROAD IN MILLERSVILLE, MARYLAND TO INVESTIGATE AN ILLICIT DISCHARGE COMPLAINT PER THE REQUEST OF ANNE ARUNDEL COUNTY DPW. UPON OUR ARRIVAL AT THE ABOVE STATED ADDRESS WE NOTICED A 3" PVC PIPE THAT WAS DIRECT BURIED UNDERGROUND IN THE FRONT YARD WHICH APPEARED TO BE COMING FROM THE HOUSE LOCATED ON THE ABOVE ADDRESS. THE 3" PIPE VISIBLY HAD SOAPY WATER DISCHARGING FROM THE PIPE. WE WERE ABLE TO SPEAK WITH THE PROPERTY OWNER MR. ASHLEY AT THE RESIDENCE AND HE ADMITTED THAT HIS WASHING MACHINE AND A SINK ARE IN FACT ATTACHED AND DRAIN IN TO THIS 3" PVC DISCHARGE PIPE WHICH DIRECTLY DISCHARGES INTO THE COUNTY STORM WATER AND DRAINAGE SYSTEM/DITCH. THIS TYPE OF DISCHARGE INTO THE MUNICIPAL STORM DRAIN SYSTEM IS STRICTLY PROHIBITED. SANITARIAN INSPECTOR FROM THE COUNTY HEALTH DEPARTMENT HAS ALSO BEEN OUT TO THE ABOVE STATED ADDRESS AND NOTIFIED MR. ASHLEY THAT THIS ISSUE NEEDS TO BE

FIXED ACCORDING TO COUNTY CODE. THE HEALTH DEPARTMENT IS FOLLOWING UP THERE INSPECTION WITH NOTICE TO CORRECT THIS ISSUE.

8/21/2014 CLOSE COMPLAINT

AS OF AUGUST 15, 2014, MR. ASHLEY IS NO LONGER IN VIOLATION OF AN ILLICIT DISCHARGE. NO FURTHER ACTION REQUIRED.

9/8/2015 Anne Arundel County Department of Inspections and Permits

Environment Section Complaint

Case ID:	E - 2014 - 549	Location:	134 MEADOW RD
Tax ID:	369390048504		RIVIERA BEACH PASADENA 21122
Received:	10/8/2014	Details:	
Tickler:		Completed:	10/27/2014
	ILLEGAL DISCHARGES COMPLAINT		

Receiver:		Inspector:		
Date Assigned:	10/8/2014	Permit Number:		Original ID:
ADC Map:		Related Cases:		
Water Front:	N	Critical Area:	N	Violation:
Cty. Council Ind:	N	Case Org:		
Complainant:				

Owner Information		Violator Information	
Owner 1:	WITTIG JOANN C	Violator 1:	
Owner 2:		Violator 2:	
Address:	134 MEADOW RD PASADENA 21122	Address:	
		Phone:	

State Map:	Map No:	Suffix	Block	Parcel	County Map:	Plat	Sect	Block	Lot No
	11		16	0180		22			3

Date	Event	Due Date	Request for Trial Date
10/8/2014	OPENED COMPLAINT CASE	10/15/2014	
	PUMPING WATER FROM HOUSE TO OUTSIDE (LOOKS LIKE WASHING MACHINE WATER).		
10/27/2014	CLOSE COMPLAINT		
	INSPECTOR COMPLAINT. INVESTIGATED COMPLAINT. NO SIGN OF ILLICIT DISCHARGE. CLOSE		

9/9/2015 Anne Arundel County Department of Inspections and Permits

Environment Section Complaint

Case ID:	E - 2015 - 322	Location:	1054 DEEP CREEK AVE
Tax ID:	374919905004		SHORE ACRES ARNOLD 21012
Received:	6/24/2015	Details:	
Tickler:		Completed:	6/26/2015
	ILLEGAL DISCHARGES COMPLAINT		

Receiver:		Inspector:		
Date Assigned:	6/24/2015	Permit Number:		Original ID:
ADC Map:		Related Cases:		
Water Front:	N	Critical Area:	N	Violation:
Cty. Council Ind:	N	Case Org:		
Complainant:				

Owner Information		Violator Information	
Owner 1:	G & H GROUP LLC	Violator 1:	
Owner 2:		Violator 2:	
Address:	1054 DEEP CREEK AVE ARNOLD 21012	Address:	
		Phone:	

State Map:	33		22	0037	County Map:				93
	Map No:	Suffix	Block	Parcel		Plat	Sect	Block	Lot No

Date	Event	Due Date	Request for Trial Date
6/24/2015	OPENED COMPLAINT CASE	7/10/2015	
	REPORTED ISSUE WITH SEWAGE OVERFLOW (OR SOME ILLICIT DISCHARGE) RUNNING OUT OF THE DEEP CREEK RESTAURANT INTO DEEP CREEK.		
6/26/2015	CLOSE COMPLAINT		
	RECEIVED A COMPLAINT DESCRIBING SEWAGE BEING DISCHARGED FROM PIPES IN THE BULKHEAD ON DEEP CREEK AT DEEP CREEK RESTAURANT. UPON INVESTIGATION, NO SEWAGE DISCHARGE WAS FOUND. HOWEVER, HIGHER THAN NORMAL LEVELS OF DETERGENT WERE FOUND ON THE WESTERN-MORE SIDE OF THE RESTAURANT AND CORRESPONDING PIPES EXITING THE BULKHEAD. AFTER SPEAKING WITH OWNER OF THE RESTAURANT, MR. HUNDERMAN, I WAS ABLE TO DETERMINE THAT HIS SANITARY STAFF IS DISPOSING OF CLEANING WASTE (MOP BUCKETS) OUTSIDE THE RESTAURANT. HE HAS ASSURED ME THAT HE WILL DISCONTINUE THIS PRACTICE. I WILL FOLLOW UP WITH REGULAR RE-INSPECTIONS.		

9/8/2015 Anne Arundel County Department of Inspections and Permits

Environment Section Complaint

Case ID:	E - 2015 - 231	Location:	433 ELM TWIN CT
Tax ID:	582190060081		TWIN OAKS LINTHICUM 21090
Received:	5/21/2015	Details:	
Tickler:		Completed:	5/22/2015
	ILLEGAL DISCHARGES COMPLAINT		

Receiver:		Inspector:		
Date Assigned:	5/21/2015	Permit Number:		Original ID:
ADC Map:		Related Cases:		
Water Front:	N	Critical Area:	N	Violation:
Cty. Council Ind:	N	Case Org:		
Complainant:				

Owner Information		Violator Information	
Owner 1:	MARTZ JR DONALD	Violator 1:	
Owner 2:	MARTZ DEBORAH A	Violator 2:	
Address:	433 ELM TWIN CT LINTHICUM 21090	Address:	
		Phone:	

State Map:	Map No:	Suffix	Block	Parcel	County Map:	Plat	Sect	Block	Lot No
	04		03	0002		3	2		13

Date	Event	Due Date	Request for Trial Date
5/21/2015	OPENED COMPLAINT CASE	6/26/2015	
	OWNER PARKS HIS VEHICLES OVER STORM DRAIN AND CHANGES THE OIL INTO A BUCKET.		
5/22/2015	CLOSE COMPLAINT		

RECEIVED COMPLAINT ON THURSDAY, 5/21/2015. A RESIDENT WAS COMPLAINING THAT: THE OWNER OF A PICKUP TRUCK WAS PARKING OVER TOP OF A STORM INLET; AND THEN CHANGING THE TRUCK'S OIL INTO A BUCKET WHILE SITTING IT ALL OVER TOP OF THE INLET. IF OIL CHANGES ARE BEING DONE HERE, THIS WOULD PRESENT AN ISSUE BECAUSE ANY OIL THAT DOESN'T MAKE IT INTO THE OIL BUCKET WOULD GO STRAIGHT INTO THE INLET, THUS BECOMING A SOURCE OF ILLICIT DISCHARGE. INSPECTOR ARRIVED ON-SITE ON THURSDAY, 5/21/2015, AT APPROXIMATELY 2:45 PM. INSPECTOR'S INVESTIGATION PRODUCED THE FOLLOWING FINDINGS: 1. THERE IS A TRUCK SITTING NEXT TO A STORM INLET WITH AN OIL BUCKET SITTING UNDERNEATH OF IT. NEITHER ONE IS SITTING "OVER TOP" OF AN INLET AS PREVIOUSLY THOUGHT. 2. THE STORM INLET IN QUESTION HAS NO ROAD GRATE. THE OPENING FOR THE INLET IS A CURB CUT. THUS, AS STATED IN ITEM 1, THE TRUCK AND OIL BUCKET ARE NOT SITTING OVER TOP OF AN INLET AND/OR INLET GRATE. 3. THERE IS NO EVIDENCE OF OIL CHANGES BEING DONE AT THIS LOCATION. NO RUNOFF OBSERVED AT THE TIME SHOWED EVIDENCE OF OIL SHEEN. THERE WAS NO EVIDENCE OF CRACKS IN THE OIL BUCKET, OR OIL LEAKING FROM THE TRUCK. INSPECTOR SPOKE WITH MRS. MARTZ, THE WIFE / CO-HOMEOWNER OF THE OWNER OF THE TRUCK, MR. MARTZ. SHE EXPLAINED TO THE INSPECTOR THAT DURING A PAST OIL CHANGE DONE TO THE TRUCK, TOO MUCH OIL WAS ADDED TO IT. THIS CAUSED THE OIL TO OVERFLOW AND LEAK DOWN INTO THE STORM INLET. A NEIGHBOR COMPLAINED, AND THEY PLACED THE OIL BUCKET UNDERNEATH IT TO PREVENT THE LEAK FROM GETTING INTO THE STORM INLET. MRS. MARTZ EXPLAINED TO THE INSPECTOR THAT HER HUSBAND DOES NOW DO HIS OWN OIL CHANGES TO PREVENT THIS PROBLEM IN THE FUTURE. HOWEVER, SHE CLAIMS HE DRIVES TO A NEARBY PARKING LOT, WHERE HE PERFORMS THE OIL CHANGE. WHILE THERE, HE DRAINS THE OLD OIL INTO THE OIL BUCKET. WHEN HE RETURNS HOME, HE DISPOSES THE OIL FROM THE OIL BUCKET

INTO A 5-GALLON DRUM, AND PLACES THE OIL BUCKET BACK UNDERNEATH THE TRUCK TO CATCH ANY POTENTIAL ONGOING LEAKS. WHEN THE 5-GALLON DRUM REACHES CAPACITY, HE TAKES IT TO A PROPER DISPOSAL FACILITY AND GETS A NEW ONE. AT THIS TIME, INSPECTOR HAS CONCLUDED THAT THERE IS NO EVIDENCE OF ANY ILLICIT ACTIVITY, OR ANY POTENTIAL ILLICIT DISCHARGES AT THIS LOCATION. COMPLAINT CASE MAY BE CLOSED AT THIS TIME.

9/8/2015 Anne Arundel County Department of Inspections and Permits

Environment Section Complaint

Case ID:	E - 2015 - 230	Location:	3601 LAUREL FT MEADE RD LAUREL LAUREL 20724
Tax ID:	400001778002		
Received:	5/20/2015	Details:	
Tickler:		Completed:	7/30/2015
	ILLEGAL DISCHARGES COMPLAINT		

Receiver:			Inspector:		
Date Assigned:	5/20/2015		Permit Number:		Original ID:
ADC Map:			Related Cases:		
Water Front:	N		Critical Area:	N	Violation:
Cty. Council Ind:	N		Case Org:		
Complainant:					

Owner Information		Violator Information	
Owner 1:	PMIG 1001 LLC	Violator 1:	
Owner 2:		Violator 2:	
Address:	3601 LAUREL FT MEADE RD LAUREL 20724	Address:	
		Phone:	

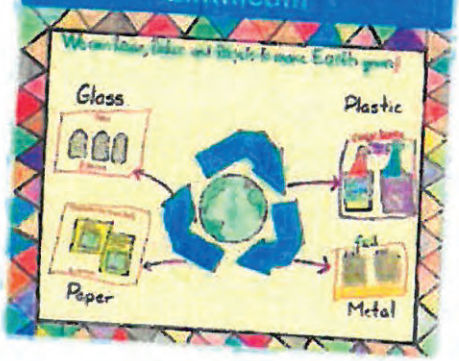
State Map:	19		17	0201	County Map:				
	Map No:	Suffix	Block	Parcel		Plat	Sect	Block	Lot No

Date	Event	Due Date	Request for Trial Date
5/20/2015	OPENED COMPLAINT CASE	6/25/2015	
	CAR WASH AREA NOT USING PROPER DRAINAGE. DRAINS ARE JAMMED UP AND IT FILLS UP LIKE A POND. THEY END UP PUMPING IT ON TO GRASS AREA OF DELTA BINGO.		
6/24/2015	CASE NOTE	7/31/2015	6/24/2015
	UNABLE TO CONTACT THE OWNER OF THE GULF GAS STATION/CAR WASH. HAVE INSTRUCTED THE WORKERS TO NO LONGER PUMP WATER ON TO THE GRASS AREA OF DELTA BINGO. INSTRUCTIONS TO CLEAN OUT THE JAMMED PARKING LOT DRAINS WILL BE GIVEN TO THE PROPERTY OWNER ONCE CONTACT IS MADE.		
7/30/2015	CLOSE COMPLAINT		
	THE CAR WASH HAS BEEN DIRECTED TO NO LONGER PUMP WATER FROM THEIR PARKING LOT ON TO THE GRASS AREA OF DELTA BINGO.		

2015 Recycle More Often Poster Contest

1ST PLACE

Linthicum



2ND PLACE

Edgewater



3RD PLACE

Hilltop



West Annapolis



THANK YOU FOR YOUR PARTICIPATION!

THE SCHOOLS Benfield • Eastport • Edgewater • Folger McKinsey • Four Seasons • F. Hebron Harman • Germantown • Hilltop • Jacobsville • Lake Shore • Linthicum • Nantucket • Oakwood • Odenton • Richard Henry • Tyler Heights • West Annapolis

ANNE ARUNDEL COUNTY MARYLAND

NEWS YOU CAN USE

Winter Storms



CURBSIDE COLLECTION SERVICES

When winter storms affect the County, curbside collection of recyclables, yard waste and trash will be attempted unless travel conditions are severe.

Customers should expect that collections may begin and end later than usual.

If crews are unable to complete collections due to conditions in certain communities or along certain streets, they will return later in the day or the following day as weather and travel conditions allow.

Customer Service Representatives will be available whenever collections are occurring. Call **410-222-6100** for information or to report concerns.

COUNTY LANDFILL and RECYCLING FACILITIES

The County landfill and recycling centers follow County Government work schedule announcements during inclement weather.

In the event of a late opening of County Government, the landfill and recycling centers will open late as well. In the event of a County Government closure, the landfill and recycling centers will close for the day.

Announcements will be made on **www.aacounty.org**, **Facebook**, and through the news media.

Recycled Paper

WHAT CAN I RECYCLE?

TOP 10 IN THE BIN

1. CARDBOARD
2. PAPER
3. FOOD BOXES
4. MAIL
5. BEVERAGE CANS
6. FOOD CANS
7. GLASS BOTTLES
8. JARS (GLASS & PLASTIC)
9. JUGS
10. PLASTIC BOTTLES AND CAPS



ALSO RECYCLABLE

BUT NOT IN CURBSIDE BIN

SCRAP METAL

ELECTRONICS

BATTERIES

Find out about your local recycling options at

Recycle.More.Often.com

KEEP AMERICA BEAUTIFUL

National Waste & Recycling Association

Collect. Recycle. Innovate.

SWANA

SOLID WASTE ASSOCIATION of North America


Recycle.
More.Often.
Heading to the beach before summer's end? Take a bag. Recycle on the go!

NEW Curbside Collection Schedule

for select communities beginning the week of **July 6, 2015**

Click for details

Fall in Love WITH RECYCLING!



Did you know 26% of what county residents dispose of as trash could have been recycled?

Recycle. More. Often. .com

2015 LABOR DAY Service Schedule

Monday, September 7	NO curbside collections. All Waste Management Services facilities are CLOSED.

Important Information

Curbside collections normally scheduled for Monday will occur on Tuesday, and collections normally scheduled for Tuesday will occur on Wednesday. All County facilities will reopen on Tuesday, September 8.

Managing YARD WASTE at the curb.

- Place leaves, grass, branches, and limbs in bags or reusable containers marked with an "X" visible to the crew on the yard waste collection truck.
- Branches and limbs must be in a container or bundle that weighs 40 lbs or less.
- Branches must be 4 feet or less and 4 inches or less in diameter.



- Natural Christmas trees, wreaths, and garland are accepted. Remove all lights and ornaments. Cut tall trees in half.

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- Use a mulching mower. They leave clippings in an even layer that blends in with your lawn.
- Grass clippings are 75-85% water - so you can water less by leaving them on your lawn. They also return nutrients to the soil and can generate up to 50% of your lawn's fertilizer needs.
- Grass-cycling reduces the amount of organic material you dispose, which helps the environment and saves money.
- Have you tried composting? Grass clippings, leaves and other yard waste can be composted in your own backyard!

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Managing YARD WASTE at the CURB

- ✓ Place leaves, grass, branches, and limbs in bags or reusable containers marked with an "X" visible to the crew on the yard waste collection truck.
- ✓ Branches and limbs must be in a container or bundle that weighs 40 lbs. or less.
- ✓ Branches must be 4 feet or less in length and 4 inches or less in diameter.

ANNE ARUNDEL COUNTY
MARYLAND
County Executive Steven R. Schuh

Department of Public Works
Waste Management Services
2662 Riva Road
Annapolis, Maryland 21401

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YOUR RECYCLABLES
This photo is a snapshot of the paper, plastic, metal and glass still found in our trash!
We're finding too many recyclables in Anne Arundel County's trash.
Every time you throw something away, you have a choice. You can put it into the trash where it will end up in a landfill forever, or you can recycle and give it a new life while also saving money and preserving the environment.
It takes the same amount of effort, no matter which container you choose. So, make the right choice and choose the recycling bin for all your paper, plastic, metal and glass.
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MARYLAND

RECYCLE ALL OF THESE ITEMS

USING YOUR YELLOW CART, CONTAINER, BIN OR CONTAINER OF CHOICE.

PAPER: Paper, newspapers and inserts, junk mail, catalogs, pizza boxes, food boxes, books, cardboard, cardboard egg cartons, milk and juice cartons, and juice boxes

PLASTIC: Jars, jugs, tubs, trays, plastic bags and shrink wrap (secure in plastic bag), plastic cups, plates and utensils, plastic buckets, storage totes, plastic flower pots, plastic furniture, trash cans and old recycling bins, plastic toys, pools, playsets, and bottles

METAL: Aluminum foil and pans, aluminum cans, tin and steel cans, empty aerosol cans, and wire hangers

GLASS: Bottles and jars (any color)

For more information call **410-222-7951**

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Waste Management Services
2662 Riva Road
Annapolis, Maryland 21401

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MAKE THE RIGHT CHOICE.



Here's what **SHOULD** be recycled:

PAPER:
Paper, newspaper and inserts, junk mail, catalogs, pizza boxes, food boxes, books, cardboard, cardboard egg cartons, milk and juice cartons, and juice boxes

PLASTIC:
Jars, jugs, tubs, trays, plastic bags and shrink wrap (bundled together), plastic cups, plates and utensils, plastic buckets, storage totes, plastic flower pots, plastic furniture, trash cans and old recycling bins, plastic toys, pools, playsets, and bottles

METAL:
Aluminum foil and foil pans, aluminum cans, tin/steel cans, empty aerosol cans, wire hangers, but NO SCRAP METAL (examples on back)

GLASS:
Bottles and jars

REMEMBER:
You can place all your paper, plastic, metal, and glass recyclables in the same container. Recyclables should be empty, no need to rinse completely, and lids and labels are recyclable too!



RECYCLING IS GOOD FOR THE ENVIRONMENT.
Recycling extends the life of your County Landfill. When you throw a recyclable item in the trash, it's buried... FOREVER!

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Otto knows what CAN'T be recycled curbside... do you?

- Automotive parts
- Batteries
- Chip bags and snack wrappers
- Clothing
- Electronics
- Food
- Garden tools
- Mirror or window glass
- Motor oil containers
- Pots and pans
- Soiled paper products (napkins, tissues, plates)
- Styrofoam
- Puppets



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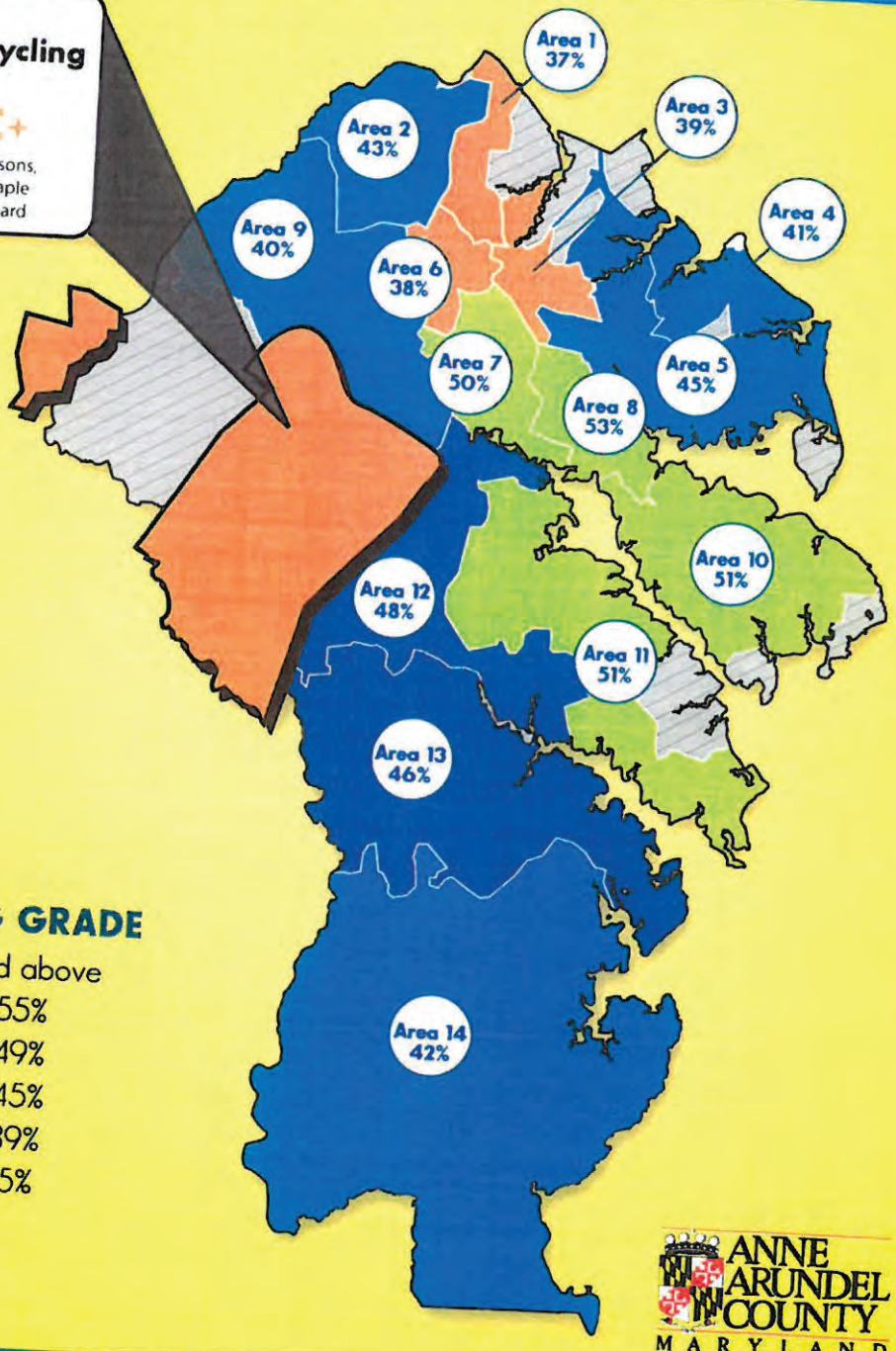
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- B 40% to 45%
- C+ 36% to 39%
- C 31% to 35%

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YOU CAN IMPROVE YOUR GRADE!

- Recycle more of what you throw away
- Challenge your neighbors to recycle more
- For more tips visit **RecycleMoreOften.com**

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RECYCLE ALL OF THESE ITEMS

PAPER: Paper, newspapers inserts, junk mail catalogs, pizza boxes, food boxes, books, cardboard, cardboard egg cartons, milk and juice cartons, and juice boxes

PLASTIC: Jars, jugs, tubs, trays, plastic bags and shrink wrap (secure in plastic bag), plastic cups, plates and utensils, plastic buckets, storage totes, plastic flower pots, plastic furniture, trash cans and old recycling bins, plastic toys, pools, playsets, and bottles

METAL: Aluminum foil and pans, aluminum cans, tin steel cans, empty aerosol cans, wire hangers, and NO SCRAP METAL

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Total Maximum Daily Load Restoration Plan for Bacteria
Anne Arundel County
February 2016 Draft Submittal

Response
to
MDE Comments of May 19, 2015

1. Introduction

Anne Arundel County (the County) currently has 19 U.S. Environmental Protection Agency (EPA)-approved bacteria Total Maximum Daily Loads (TMDLs) associated with the County waterways for various bacteria impairments. Fecal coliform is identified as the cause of impairment in the TMDLs for 15 of the 19 waterways. E. coli and Enterococci are identified as the impairments for two TMDLs each. The County is required by its National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit (11-DP-3316, MD0068306) to develop a TMDL Restoration Plan to address the Stormwater Waste Load Allocations (SW-WLAs) identified in the TMDL reports developed by the Maryland Department of Environment (MDE). The Anne Arundel County Department of Public Works (DPW) Watershed Protection and Restoration Program (WPRP), with the help of the URS/ESA Joint Venture (the project team), developed a combined Draft Bacteria TMDL Restoration Plan to address the 19 bacteria TMDLs; that report was submitted to MDE on February 12, 2015. MDE provided comments on the Restoration Plan in a letter to the County Project Manager (Janis Markusic) dated May 19, 2015. MDE's letter included two attachments with comments on the Bacteria TMDL Restoration Plan.

This technical memorandum briefly describes the County's response and revisions incorporated to address MDE comments on the Bacteria TMDL Restoration Plan. The project team discussed these comments with the County Project Manager and DPW WPRP personnel and identified appropriate responses during a meeting on June 24, 2015. Below is a list of the MDE-provided review comments (in italics) and the County's responses. Although MDE also provided comments on Sediment TMDL Restoration Plans, Watershed Assessments, and Chesapeake Bay TMDL compliance, this technical memorandum addresses only the MDE comments that apply to the Bacteria TMDL Restoration Plan.

2. MDE's Attachment 1 Comments

The following comments are from Attachment 1 of MDE's letter dated May 19, 2015. The comments are provided for Watershed Assessments, Restoration Plans, Public Participation and TMDL Compliance under the column "MDE Assessment and Recommendations." The comment numbers below refer to the sub-bullet points listed under the "Restoration Plans" and "Public Participation" sections. Comments 1 through 4 and comment 6 (under Restoration Plans) correspond to comments on the Sediment TMDL Restoration Plans developed by the County and are not applicable to the Bacteria TMDL Restoration Plan.

MDE Comment 5:

Any best management practices (BMPs) used in the modeling of baselines or current load analyses shall be maintained according to State regulations. BMPs that are not inspected at least once every three years and maintained may not be included as treatment when modeling loads.

County Response:

The BMP data included in the Restoration Plan is based on the BMP data compiled by the County for the 2014 NPDES MS4 Annual Report.

MDE Comment 7:

Information used to develop the individual TMDL restoration plans is not consistent with similar information found in other sections of the County's Annual Report and associated databases. For example, the County's urban BMP database indicates that there are ten Bioretention practices with a total drainage area of 23 acres that could be applied to the baseline for the Little Patuxent River watershed. However, the total drainage treated by these practices for the baseline analysis in the restoration plan (see Table 10) is 70.9 acres.

County Response:

The County updated the drainage and impervious areas in the BMP database developed for the 2014 NPDES MS4 Annual Report. The water quality models were revised based on the updated BMP database to maintain consistency in BMP drainage areas in the model with the drainage areas reported in the 2014 NPDES MS4 Annual Report.

Appendix A of the Restoration Plan, which describes the water quality modeling methodology and supporting data in detail, was modified to present the updated methodology and data used to revise the water quality models.

MDE Comment 8:

Anne Arundel County is using an expanded pet waste education program as one of the strategies for reducing bacteria in receiving waters. The credits claimed for this strategy are significant for several of the bacteria TMDLs within the County (e.g., Magothy Mainstem, Forked Creek, Severn River Mainstem). MDE considers this an opportunity to further monitor and research this BMP to verify the water quality benefits claimed. A thorough report shall be provided by the end of the permit term and include adaptive management strategies for achieving the expected load reductions for bacteria.

County Response:

Based on MDE's recommendation, the County's DPW WPRP is in the process of developing a pet waste program and methodologies to evaluate its effectiveness. A list of potential evaluation methodologies that can be adopted by the County to evaluate pet waste program is included in the Section 8 (Methods for Evaluating Progress) of the Restoration Plan. Development/implementation of this

program is also included in the recently submitted Anne Arundel County Phase II WIP Milestones for 2016-2017.

MDE Comment 9:

Each of the restoration plans lacks specificity in how individual TMDLs will be addressed. These plans need to be of sufficient detail to ensure that expected interim milestones can be achieved and the TMDL addressed. Each plan should include a list of specific BMPs that will be implemented during the current permit term to address the TMDLs. This list should include BMP locations, drainage areas, impervious area treated, load reductions, estimated costs, and implementation schedule (e.g., design, construction). This list shall coincide with interim targets identified in the restoration plans.

County Response:

The proposed BMP restoration strategies were revised to include projects that are currently a part of the six-year County Capital Improvement Program (CIP) to be more site-specific. The water quality models for the proposed conditions were also revised to estimate the percent load reductions that would be achieved from each CIP project. The Restoration Plan was updated based on the revised BMP restoration strategies and water quality models.

MDE Comment 10 (Public Participation Comment 1):

Anne Arundel County has developed a website (www.aarivers.org) and an interactive, online application to provide public access to information on watershed assessments and restoration activities.

County Response:

The County is using the above-listed website to list all ongoing restoration programs in the County for public review. The watershed assessments conducted by the County are also available on this website.

MDE Comment 11 (Public Participation Comment 2):

As TMDL implementation plans and new watershed assessments are developed, the information also will be made available on the County website.

County Response:

After updating the Restoration Plan based on MDE and internal County agency comments, the Restoration Plan will be uploaded to the County website for a period of 30-days for public review.

MDE Comment 12 (Public Participation Comment 3):

Anne Arundel County must accept public comments on watershed assessments and watershed restoration plans. The County must provide a summary of how comments received were addressed in its next annual report.

County Response:
The revised Restoration Plan that incorporates MDE and internal County agency comments will be uploaded for a 30-day public comment period. After the end of the public comment period, the County project team will develop a "Response to Public Comments" document addressing the public comments received. This document will be included as a part of the NPDES MS4 Annual Report and as part of the final Restoration Plan.

3. MDE's Attachment 2 Comments

The following comments are from Attachment 2 of MDE's letter dated May 19, 2015. Note that comment numbers below are consistent with those used in Attachment 2 except for the first comment, which was not given a number in the attachment and was included as a general comment for all County TMDL Restoration Plans. In addition, MDE provided one general comment and six specific comments for the Bacteria TMDL Restoration Plans, which are addressed below.

MDE General Comment (see third paragraph on first page of Attachment 2):
These [TMDL restoration plans] lack specificity at a site level scale, probably due to planning uncertainties such as, finding sites, purchasing or gaining access to land, obtaining all required permits and designing BMPs. This is understandable, and MDE recognizes that these plans are still works in progress. During subsequent annual reports, and by the time of the next permit issuance, the county should plan on including a much higher level of site-specific detail on planned implementation.
County Response:
This comment is similar to Comment 9 of Attachment 1 (see above). The water quality models and restoration strategies were updated to include County CIP projects, which are more site-specific.

MDE General Comment 1 (see table on page 2 of Attachment 2):
There is no clear demonstration of consistency between the modeled baseline year and the TMDL's baseline year. MDE suggests adding in a table comparing the TMDL baselines to the Watershed Treatment Model (WTM) baselines in the next revision.
County Response:
The TMDL baseline years for all the watersheds are included in Table 3-1 of the Restoration Plan and, as noted in the Section 2.10 of the plan, 2014 is the modeled baseline year for all the watersheds.

MDE Specific Comment 1:

The numbers for "TMDL Current Load" and "TMDL Allowable load" in Table 3-1 do not match any numbers in the TMDL reports. An example or calculation showing how the TMDL numbers have been translated into the table should be included in the next revision.

County Response:

The County project team researched the discrepancies in TMDL current and allowable loads data published in the MDE TMDL reports and the TMDL Data Center and updated Table 3-1 of the Restoration Plan accordingly.

MDE Specific Comment 2:

Although the required percent reduction in Table 3-1 does match the TMDL, it represents the entire watershed, not just the County's portion. The footnote states differently. Further clarification in the next plan revision should explain the scale at which the percent reduction is applied.

County Response:

The Table 3-1 of the Restoration Plan was modified to clearly identify the reduction goals for the Anne Arundel County portion of the TMDL watersheds. The table was modified based on the SW-WLA search on the MDE's TMDL Data Center website and research of the MDE published TMDL documents.

MDE Specific Comment 3:

The TMDL percent reductions presented in Table 4-6 do not match anything from the TMDL documents, nor do they match Table 3-1. In the next revision of the plan, more clarification should be included as to the origin of these reduction percentages.

County Response:

The Restoration Plan was reviewed to ensure all the percent reductions identified for the TMDL watersheds (in Table 3-1 and 4-6) are consistent throughout the Restoration Plan. The SW-WLA for the County portion of the watersheds published on the MDE TMDL Data Center website and the TMDL documents were used as guidance to revise the Restoration Plan.

MDE Specific Comment 4:

Section 8 on methods for evaluating progress, does not outline the county's monitoring efforts. It provides the contractor's recommendations to the county regarding monitoring. The county should include a more detailed strategy for adaptive management or for using monitoring data to assess general implementation efforts or specific practices. A paragraph could be added to Section 8 about using tracking, monitoring, and evaluation to assess and revise their strategies if the current plan is not achieving the desired results.

County Response:
The County's current monitoring efforts are outlined in Section 8 of the Restoration Plan. The County and the project team developed additional potential bacteria monitoring ideas which were incorporated into Section 8 of the Restoration Plan. Section 8.1.2 was renamed to "Water Quality Monitoring and Evaluation" and includes a description of the methods to be used for evaluating the monitoring data to determine the effectiveness of specific implementation strategies. The strategies will be adjusted in future if the evaluation determines that they are not providing the expected results.

MDE Specific Comment 5:
Although applied bacteria removal efficiencies are referenced in the county's 2014 MS4 annual report, the report does not actually list those referenced efficiencies. The county should elaborate on the origin of the applied efficiencies, including a link to the supporting document if available.
County Response:
The County updated the bacteria removal efficiencies using the data identified in the Center for Watershed Protection's document "Urban Subwatershed Restoration Manual Series" and other related publications. The water quality models and the Restoration Plan were updated based on the revised BMP removal efficiency. The source of the BMP removal efficiencies is also included in the Restoration Plan's Table 2-2 and the Reference section (Section 9).

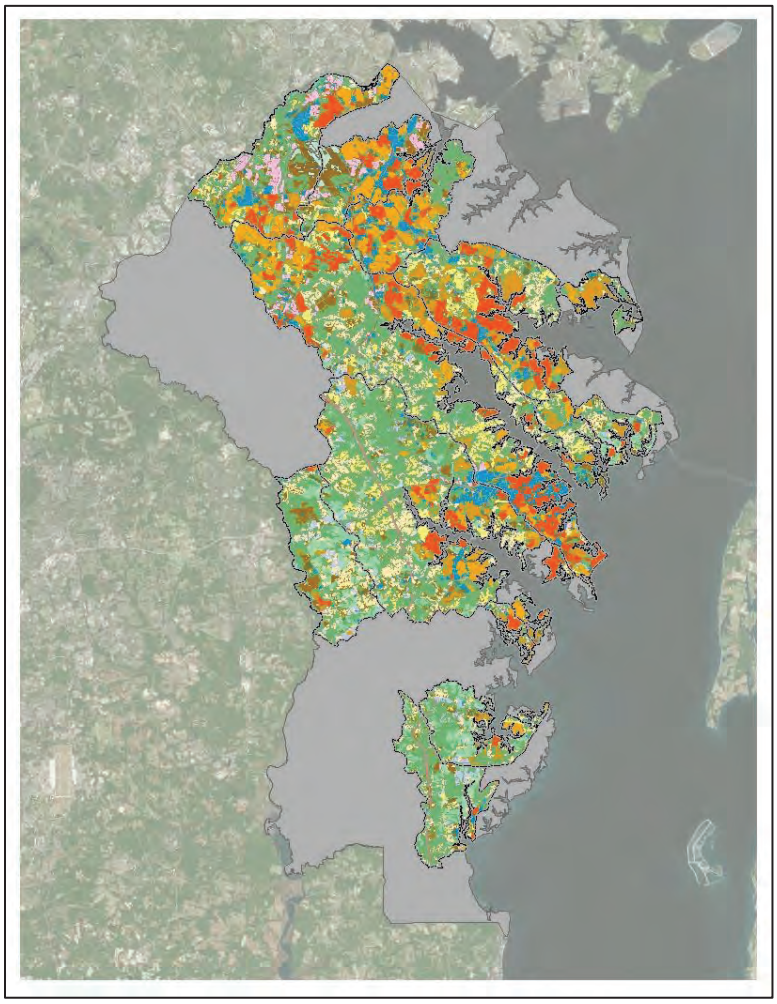
MDE Specific Comment 6:
The proposed strategies do not meet the required reductions in all watersheds. For example, the Patapsco River Lower North Branch watershed is stated to require a 50% reduction after counting existing practices. The proposed strategies are expected to achieve only 40% reduction (Table 4-7B). This is acknowledged in the report with the statement that "additional restoration opportunities with bacteria removal benefits will need to be identified" (Page 4-16). MDE recommends that the county continue to build upon its ongoing activities toward meeting the reduction target in the next permit cycle.
County Response:
This comment was addressed by incorporating adaptive management strategies in the Restoration Plan.

4. Conclusion

The Bacteria TMDL Restoration Plan was updated based on the MDE comments and is being submitted as an appendix to the Annual NPDES MS4 Report in February 2016. The plan will also be uploaded to the County's web site for a 30-day public comment period.

Draft Total Maximum Daily Load Restoration Plan for Bacteria

For Public Comment



Prepared for:

Anne Arundel County
Department of Public Works
Watershed Protection and Restoration Services Division
2664 Riva Road
Annapolis, Maryland 21401

February 2016

URS ESA JOINT VENTURE

ACRONYMS AND ABBREVIATIONS vi

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AACC	Anne Arundel Community College
AACCMP	Anne Arundel County Citizen Monitoring Program
AASCD	Anne Arundel County Soil Conservation District
BMP	best management practice
CIP	Capital Improvement Program
CMOM	Capacity, Management, Operations, and Maintenance
COMAR	Code of Maryland Regulations
CWA	Clean Water Act
CWP	Center for Watershed Protection
DNR	Department of Natural Resources
DPW	Department of Public Works
EMCs	event mean concentrations
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESD	environmental site design
GIS	Geographic Information System
IDDE	Illicit Discharge Detection and Elimination
LA	Load Allocation
LNB	Lower North Branch
MACS	Maryland Agricultural Water Quality Cost-Share
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
ml	milliliters
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
NRU	Nitrogen Removal Unit
OSDS	Onsite sewage disposal system (septic system)
PSA	Public Service Announcement
SPS	Sewage Pump Station
SPSC	Step Pool Storm Conveyance

SSO	sanitary sewer overflow
SW	stormwater
SWM	stormwater management
TMDLs	Total Maximum Daily Loads
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
WIP	Watershed Implementation Plan
WLA	wasteload allocation
WRF	Water Reclamation Facility
WTM	Watershed Treatment Model

EXECUTIVE SUMMARY

The Anne Arundel County Department of Public Works (DPW) Watershed Protection and Restoration Program (WPRP) developed this restoration plan to address local water quality impairments for watersheds with an approved bacteria Total Maximum Daily Load (TMDL) issued by the Maryland Department of the Environment (MDE) and approved by the U.S. Environmental Protection Agency (EPA). As defined by EPA, a TMDL sets a maximum load of a specific pollutant or stressor that a water body can assimilate and still meet water quality standards for its designated use.

There are currently 19 approved bacteria TMDLs associated with Anne Arundel County watersheds. MDE developed most of the TMDLs in the early 2000s. Fecal coliform is the impairing pollutant for 15 of the TMDLs, while E. coli and Enterococci are identified as the impairing pollutant for two TMDLs each. These bacteria are indicator organisms that suggest a potential for pathogenic bacteria to be present in the waterways. Anne Arundel County, via the requirements of its National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit (11-DP-3316, MD0068306), has developed this plan to address the Stormwater Waste Load Allocation (SW-WLA) associated with each of the 19 approved bacteria TMDLs.

This restoration plan estimates bacteria load reductions for identified strategies based on modeling and literature review. The strategies were broken down into Tier A strategies (i.e., strategies that treat human sources) and Tier B strategies (i.e., strategies that treat non-human sources). Of the Tier B strategies, pet waste education was found to achieve the greatest load reductions for the least cost.

This Bacteria TMDL Restoration Plan recommends implementing a multi-media-based pet waste education program including increasing educational signage on public lands, adding pet waste stations on public lands, providing grant-funding for pet waste stations in targeted residential communities, and improving management of pet waste at existing dog parks. It is recommended that the target areas for the pet waste program be prioritized because certain watersheds need more intensive outreach than others to reach the required TMDL load reductions.

Other non-structural Tier B strategies such as riparian buffer improvements and possibly localized waterfowl and wildlife management in specific areas (e.g., ponds, public parks, golf courses, campuses) were highly cost-effective, although the load reductions of these strategies may be difficult to measure. Lastly, livestock fencing was identified as a useful cost-effective tool for agricultural pastures that support livestock populations; however, there are only two TMDL watersheds where this strategy would be applicable.

An additional Tier B strategy is the County's effort to comply with the County's NPDES MS4 Permit (11-DP-3316, MD0068306) that requires the County to undertake efforts to restore 20 percent of the currently unmanaged impervious cover, within the County's MS4 area, before the end of the 5-year permit term. The County's Chesapeake Bay TMDL Phase II Watershed

Implementation Plan [Phase II WIP]) suggests this will be accomplished by implementing new and retrofit stormwater projects such as conversion of pre-2002 dry ponds and other stormwater management facilities to shallow wetland/marsh filtering systems and step pool storm conveyance (SPSC) retrofits at impaired stream channels and outfalls. Currently 132 CIP projects are identified in the TMDL watersheds that would include implementation of outfall and pre-2002 stormwater management retrofits. As the County continues to implement additional CIP projects, additional bacteria load reductions would be achieved.

Tier A strategies are a priority, as human bacteria sources pose a greater risk to public health than non-human sources. Implementation of Tier A strategies to treat human sources of bacteria are generally less cost-effective. These strategies primarily involve large projects in the County's CIP (e.g., wastewater capital improvement projects or septic system retirement).

Overall, it is clear that a suite of strategies in combination are necessary to achieve bacteria TMDL SW-WLA goals in each watershed. For many of the bacteria TMDL SW-WLAs, all of the strategies are needed, and where load reduction gaps still exist, it is recommended to prioritize pet waste education in high pet-waste areas. There were no meaningful differences in the strategies needed from one watershed to the next, with the slight exception that livestock fencing is applicable in only the two watersheds with agricultural areas.

SECTION ONE: INTRODUCTION

All natural water bodies contain bacteria of some kind, but in excessive amounts, bacteria can have deleterious ecological impacts and potentially cause serious health problems in humans. Most bacteria are beneficial to the ecosystem because they break down organic matter, help to recycle nutrients and carbon, and serve as part of the food chain. Certain types of bacteria, however, are pathogenic and may cause waterborne illnesses in humans.

Per Maryland State regulations, the Anne Arundel County (County) Health Department monitors more than 80 County beaches for Enterococci bacteria, a type of fecal bacteria that comes from the intestines of warm-blooded mammals, including humans. Enterococci are an indicator organism, meaning they indicate the potential presence of pathogens that cannot be directly measured because they are difficult to isolate and identify in a laboratory (EPA, 2001). While monitoring results establish a general characterization of the water, the data provide no information about the sources of bacteria in the watershed. The sources of bacteria can be difficult to discern, as many factors are involved, (e.g., amount of recent rainfall; presence of waterfowl and wildlife; and location of sewage spills, septic systems, and pet waste).

After rainfall, all Anne Arundel County beaches are under a no swimming/no direct water contact advisory for at least 48 hours due to predicted high bacterial levels.

(Source: http://www.aahealth.org/programs/env-hlth/rec-water)

The Maryland Department of the Environment (MDE) currently monitors, and has done so for years, various shellfish harvesting waters (Use II waters) in the County for fecal coliform, which is the indicator organism specified in the Code of Maryland Regulations (COMAR) for Use II waters. According to COMAR 26.08.02.03-3, the median fecal coliform concentration cannot exceed 14 Most Probable Number (MPN) per 100 milliliters (ml), and more than 10 percent of samples taken cannot exceed 43 MPN per 100 ml.

In the early 2000s, these monitoring data were used to develop the fecal coliform bacteria Total Maximum Daily Loads (TMDLs) for 19 bacteria-impaired waters in the County. Fifteen of the 19 total TMDLs in this TMDL Restoration Plan are for fecal coliform and occur in shellfish harvesting areas. Since the monitoring data at the time of TMDL development indicated that fecal coliform counts periodically exceeded water quality criteria, the 15 fecal coliform TMDL waterways are listed by MDE as restricted for shellfish harvesting. In addition to Use II waters, four of the 19 TMDL waterways are in designated Use I waters for public recreational use and are impaired for either E. coli or Enterococci (Figure 1-1). For Use I waters, the water quality criteria are: for freshwater, the steady state geometric mean cannot exceed 33 counts/100 ml for *Enterococci* and 126 counts/100 ml for *E. coli*; in marine water, the steady state geometric mean cannot exceed 35 counts/100 ml *Enterococci*. For more details, see COMAR 26.08.02.03-3.

To address the concerns about bacteria pollution in the County's waterways, and to meet the requirements of the federal Clean Water Act (CWA), the MDE developed 19 bacteria TMDLs for areas in Anne Arundel County.

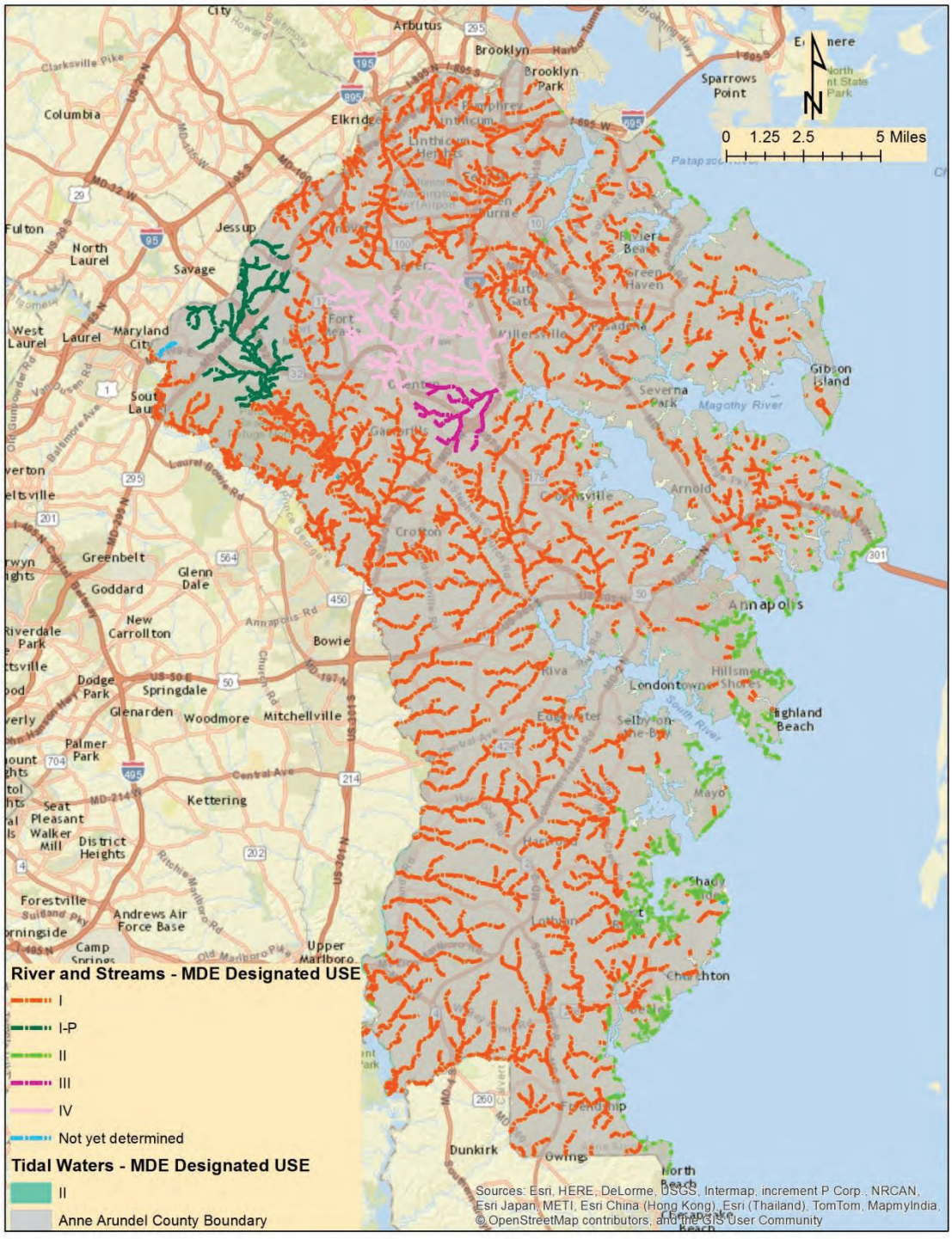


Figure 1-1: MDE Designated Uses for Surface Waters in Anne Arundel County

1.1 DEFINITION OF A TMDL

A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet State water quality standards and designated uses. TMDLs are typically developed using pollutant load models calibrated with monitoring data. The TMDL is made up of two major components. The first component is the wasteload allocation (WLA), which includes point sources such as municipal wastewater treatment plants (called Water Reclamation Facilities, or WRFs,) and National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4)-regulated urban stormwater (referred to as the SW-WLA). The second component is the Load Allocation (LA), which includes nonpoint sources such as pet waste, wildlife, non-regulated stormwater, and septic systems. Some TMDLs also include a Margin of Safety, which accounts for uncertainty in the TMDL analyses, and a Future Allocation, which accounts for future increases in pollutant loads due to population growth and/or land use changes. However, these are not applicable to the County's bacteria TMDLs because they are built into the TMDL analyses. In summary, a TMDL can be expressed as follows:

$$TMDL = \text{total allowable load to waterway} = \text{point sources} + \text{nonpoint sources}$$
$$= WLA + LA$$

1.2 ANNE ARUNDEL COUNTY BACTERIA TMDLS

The U.S. Environmental Protection Agency (EPA)-approved bacteria TMDLs are listed in Table 1-1 and shown in Figure 1-2. The table lists TMDL watersheds and subwatersheds, along with each waterway's State-designated use. Throughout this plan, the TMDLs are presented in alphabetical order of watershed.

MDE requires the County to develop an SW-WLA Restoration Plan and it is enforceable, under the County's NPDES MS4 permit. All but two of the subject TMDL watersheds (i.e., Patapsco River Lower North Branch and Patuxent River Upper) are located entirely within the County.

1.3 DEFINITION AND REQUIREMENTS OF A TMDL RESTORATION PLAN

A TMDL Restoration Plan is a planning-level document that identifies water quality-based strategies that a local jurisdiction may implement to control existing point and nonpoint pollutant sources in a degraded watershed. MDE allows flexibility in how local jurisdictions develop their TMDL Restoration Plans, provided that the approach is reasonable and that the Plan identifies management actions and practices that, when implemented, will restore the State water quality standards and designated uses of the impaired waterway (MDE, 2014).

The County's NPDES MS4 permit (Part IV.E.2.B) requires the development of a TMDL Restoration Plan to address SW-WLA allocated by MDE and approved by EPA. Once approved by MDE, the Restoration Plan is enforceable under the NPDES MS4 permit.

Table 1-1: U.S. Environmental Protection Agency-Approved Bacteria TMDLs in Anne Arundel County

TMDL Watershed	TMDL Subwatershed	Impairment	Designated Use[1]	Jurisdiction
Magothy River	Mainstem	Fecal Coliform	Use II	Anne Arundel County
	Forked Creek	Fecal Coliform	Use II	Anne Arundel County
	Tar Cove	Fecal Coliform	Use II	Anne Arundel County
Patapsco River	Furnace Creek	Enterococci	Use I	Anne Arundel County
	Marley Creek	Enterococci	Use I	Anne Arundel County
Patapsco River Lower North Branch	Patapsco River Lower North Branch	E. Coli[2]	Use I	Anne Arundel, Baltimore, Carroll, and Howard Counties, and Baltimore City
Patuxent River Upper	Patuxent River Upper	E. Coli	Use I	Anne Arundel and Prince George's Counties
Rhode River	Bear Neck Creek	Fecal Coliform	Use II	Anne Arundel County
	Cadle Creek	Fecal Coliform	Use II	Anne Arundel County
Severn River	Mainstem	Fecal Coliform	Use II	Anne Arundel County
	Mill Creek	Fecal Coliform	Use II	Anne Arundel County
	Whitehall and Meredith Creeks	Fecal Coliform	Use II	Anne Arundel County
South River	Mainstem	Fecal Coliform	Use II	Anne Arundel County
	Duvall Creek	Fecal Coliform	Use II	Anne Arundel County
	Ramsey Lake	Fecal Coliform	Use II	Anne Arundel County
	Selby Bay	Fecal Coliform	Use II	Anne Arundel County
West Chesapeake Bay Mainstem	Tracy and Rockhold Creeks	Fecal Coliform	Use II	Anne Arundel County
West River	Mainstem	Fecal Coliform	Use II	Anne Arundel County
	Parish Creek	Fecal Coliform	Use II	Anne Arundel County

1-Use I water = Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life; Use II water = Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting
2-Multiple bacteria indicators were used in the TMDL analyses; however, the TMDL is written for E. coli.



Figure 1-2: Location of Bacteria TMDL Watersheds

Pertinent to the development of a TMDL Restoration Plan is acknowledgement that other pollution source sectors such as agriculture or septic systems may contribute to the need for the TMDL. Although the NPDES MS4 permit requires only the SW-WLA to be addressed in the Restoration Plan, if greater load reductions can be achieved for less cost from another sector (i.e., upgrading of septic systems), the County has the option to pursue these strategies to meet the SW-WLA. Per MDE guidance, "if achieving [TMDL] targets is deemed to be technically infeasible via traditional stormwater controls, the jurisdictions are encouraged to offer alternative options to MDE for consideration" (MDE, 2014c). One of the objectives of this TMDL Restoration Plan is to provide the County with a wide array of strategies that can be implemented in all source sectors to maximize the potential for load reductions and achieve TMDL water quality goals.

At the federal level, EPA identifies nine required elements for an approvable watershed Restoration Plan (EPA, 2013b). These elements are commonly called the "a through i criteria." While these elements are specific to CWA Section 319 nonpoint source grants, they are strongly recommended by EPA and others for watershed restoration plans because they provide the basic framework needed for effective watershed planning and implementation (MDE, 2006; EPA, 2013a; EPA, 2013b). This Bacteria TMDL Restoration Plan is prepared in accordance with the EPA's nine elements for watershed planning. The nine elements are listed below along with the corresponding section in this document. For further explanation of the elements, see EPA (2013b).

a. Identification of causes and sources of bacteria (Section 2)
b. An estimate of the load reductions expected from management measures (Section 4.3)
c. Description of management measures needed (Section 4.1)
d. Financial and technical assistance needed to implement the above management measures (Section 6)
e. Information and education activities to enhance public understanding of the Restoration Plan and encourage the public's participation (Section 5)
f. Schedule for implementing the above management measures (Section 7)
g. Description of interim measurable milestones to determine whether the above management measures are being implemented (Section 7)
h. Set of indicators to evaluate progress toward water quality standards (Section 8)
i. Monitoring program to evaluate effectiveness of implementation efforts (Section 8)

1.4 FOUR CATEGORIES OF BACTERIA SOURCES

MDE's TMDL analyses identify four categories of bacteria sources in each of the 19 TMDL watersheds. The four categories are: pet waste, wildlife, humans, and livestock. During the

development of the TMDLs, MDE quantified the contribution for each of these categories to the observed impairment in the waterway. Among all 19 TMDL watersheds, the average percent contribution for each category was determined to be:

- pet waste – 46.0 percent
- wildlife – 34.5 percent
- human – 6.9 percent
- livestock – 12.6 percent

Throughout this Restoration Plan, this is referred to as the "bacteria source distribution." The following sections briefly describe and characterize the four primary categories of bacteria.

Pet waste: Pets (mainly domestic dogs) contribute bacteria to a waterway through their waste products that seep into waterways during storms. It is estimated that about 40 percent of households own a dog, and of these, 60 percent pick up their pet's waste (Swann, 1999). Dog waste may contain up to 23 million bacteria per gram, much more than wildlife waste (e.g., deer) and about twice as much as human waste (Van der Wel, 1995; RIDEM, 2014). This is typically due to the diet of many dogs, which contains animal products (unlike herbivores such as deer). EPA (2012) states that in watersheds up to 20 square miles or 12,800 acres (about the size of the Magothy River Watershed), two to three days of droppings from a population of about 100 dogs may contribute enough bacteria to temporarily close a waterway to swimming and shellfish harvesting.

Unlike wildlife waste, pet waste is usually concentrated (e.g., in residential communities where people walk their dogs, yards where dog waste is not routinely cleaned up). According to a fact sheet published by Clear Choices Clean Water, other harmful effects of dog waste include:

- Dog waste may take up to a year to fully decompose; therefore, there is a high likelihood of it being transported to local waterways
- Dog waste may potentially contain parasites and pathogens that remain infectious in contaminated soil and water
- Dog waste is a poor fertilizer and does not enrich the soil (in fact, it can seriously harm soil quality)
- Dog waste attracts rodents and nuisance insects
- Dog waste poses a public health risk, especially to children playing outside

Wildlife: Wildlife contribute bacteria through their waste products that are either directly deposited into streams or on land subject to stormwater runoff. In MDE's TMDL reports, the following are considered to be part of the "wildlife" category: beaver, deer, goose, duck, muskrat, raccoon, and wild turkey. Depending on the analysis method used, some TMDLs also identify foxes, rabbits, swans, squirrels, and herons as potential sources of bacteria. In general,

most wildlife is distributed throughout the landscape wherever food and water resources are available. Wildlife diffuse bacteria widely, with the possible exception of Canada geese, which tend to congregate in small open water areas (e.g., a pond). Wildlife may occur in urban or non-urban settings. Some examples of urban wildlife include deer and fox in residential communities, waterfowl in urban ponds, and raccoons feeding on food scraps in poorly managed urban trash receptacles. Non-urban wildlife include beaver, deer, fox, and turkeys in wooded habitats, especially woods with abundant water resources.

Livestock: Livestock in pasture areas are another potential source of bacteria. This category includes farm animals such as horses, chicken, cattle, and sheep. During the grazing season, livestock may deposit their waste products directly into the stream (if the stream is unfenced), or on land near the stream that is subject to runoff. Livestock areas are limited in the County TMDL watersheds, which tend to be urbanized. Although there aren't significant livestock areas in the County TMDL watersheds, according to the Watershed Treatment Model (WTM) and the MDE published TMDL documents, dairy cattle are assumed to contribute the highest per-animal loads of bacteria relative to other farm animals. The methodology used for estimating the number of livestock in the County TMDL watershed is included in Appendix A.

Humans: Bacteria from human sources are typically associated with aging urban infrastructure, which is more prone to failure than new infrastructure. Potential sources include sanitary sewer overflows, illicit sewer connections to the MS4, point source discharge from municipal WRFs, and poorly maintained or failing septic systems. Additional sources of human bacteria include homeless encampments, public facilities that lack adequate sanitary services, and marinas without sewage pump-out stations or where boaters do not utilize them. In general, human sources of bacteria pose a much greater public health risk than non-human sources (i.e., pets, wildlife, and livestock) due to the potential for waterborne disease transmission. Therefore, strategies that reduce or mitigate human bacteria sources are considered a top priority in this Restoration Plan and are discussed in Section 4.

SECTION TWO: EXISTING CONDITIONS

This section describes the existing conditions in each of the 19 watersheds in the County with EPA-approved bacteria TMDLs. The description includes current land use (from the County's 2011 land use and impervious cover Geographic Information System [GIS] data), existing best management practices (BMPs), water resource conditions, and the TMDL bacteria source distribution from MDE's TMDL reports.

Existing land use information from the County GIS for the TMDL watersheds is summarized in Table 2-1. County land uses can be grouped into five broad categories: residential urban, non-residential urban, agricultural, forested, and open water. The residential urban category includes low-density, medium-density, and high-density residential land uses. The non-residential urban category includes urban open space, commercial airport, roadways, and industrial land uses. The agricultural category includes pasture/hay and row crops, and the forest category includes forests and forested wetlands type land uses. Land use maps of the TMDL watersheds are provided in their respective sub-sections (i.e., Sections 2.1 through 2.9).

Table 2-1: Existing Land Use in Anne Arundel County's Bacteria TMDL Watersheds

Bacteria TMDL Watershed	Residential Urban	Non-Residential Urban	Agricultural	Forested	Open Water	Total	Total Acres	Total % Impervious
Magothy River Mainstem	56%	15%	0.03%	28%	1%	100%	14,567	20%
Magothy River/Forked Creek	67%	6%	0.00%	26%	1%	100%	849	20%
Magothy River/Tar Cove	50%	14%	0.00%	34%	1%	100%	2,103	15%
Patapsco River Lower North Branch	26%	39%	0.23%	34%	1%	100%	15,022	27%
Patapsco River/Furnace Creek	34%	48%	0.07%	17%	0%	100%	8,579	34%
Patapsco River/Marley Creek	46%	23%	0.84%	30%	0%	100%	8,737	28%
Patuxent River Upper	24%	17%	19.77%	39%	1%	100%	10,449	6%
Rhode River/Bear Neck Creek	50%	16%	0.45%	33%	2%	100%	880	16%
Rhode River/Cadle Creek	70%	9%	0.00%	20%	2%	100%	320	20%
Severn River Mainstem	44%	19%	1.59%	35%	1%	100%	37,011	19%
Severn River/Mill Creek	47%	15%	3.47%	34%	1%	100%	3,256	14%
Severn River/Whitehall and Meredith Creeks	37%	15%	12.63%	35%	1%	100%	2,945	12%
South River Mainstem	32%	15%	6.08%	46%	1%	100%	33,549	12%
South River/Duvall Creek	76%	14%	0.00%	9%	1%	100%	601	23%
South River/Ramsey Lake	65%	17%	0.00%	17%	2%	100%	384	21%
South River/Selby Bay	62%	12%	2.01%	22%	3%	100%	349	20%
W. Chesapeake Bay/Tracy and Rockhold Creeks	18%	15%	14.68%	52%	1%	100%	7,962	5%

Bacteria TMDL Watershed	Residential Urban	Non-Residential Urban	Agricultural	Forested	Open Water	Total	Total Acres	Total % Impervious
West River Mainstem	25%	8%	20.72%	45%	1%	100%	6,304	6%
West River/Parish Creek	41%	25%	0.00%	31%	4%	100%	324	18%
Average:	**46%**	**18%**	**4%**	**31%**	**1%**			**18%**

Residential Urban = low-density, medium-density, and high-density residential land uses
Non-Residential Urban = urban open space, commercial, airport, roadway, and industrial land uses
Agricultural = pasture/hay and row crops
Forested = forests and forested wetlands

The existing BMPs located in the TMDL watersheds were identified using County GIS data and grouped into the following three performance categories based on their bacteria removal efficiency: non-performing (0 percent bacteria removal efficiency), mid-performing (up to 50 percent removal efficiency), and high-performing (70 percent or greater removal efficiency). Drainage areas for the BMPs were obtained using the County GIS data. The County is in the process of compiling the drainage areas for all the BMPs, and as result, drainage areas and impervious areas associated with some of the BMPs were not populated. The Restoration Plan database will be updated when the new information becomes available.

The bacteria removal efficiency for each type of practice was compiled from various literature sources (provided at the end of Table 2-2). Based on review of various literature sources, infiltration and filtering practices such as infiltration trenches, bioretention systems, step pool storm conveyance systems (SPSC), and environmental site design (ESD) practices have high bacteria removal efficiencies. Stormwater management practices that provide limited water quality management, such as permeable pavements and sand filters, are mid-performing BMPs in terms of bacteria removal efficiency. Hydrodynamic structures and grass swales are categorized under non-performing BMPs and have 0 percent bacteria pollutant removal. Bacteria removal efficiencies are provided in Table 2-2, as well as Table A-8 in Appendix A.

Table 2-2: Anne Arundel County BMPs and Pollutant Removal Efficiencies

BMP Type	Bacteria Pollutant Removal Efficiency (%)	Category
Bioretention	70[2]	high-performing
Detention Structure Dry (Dry Pond)	88[1]	high-performing
Disconnection of Non-Rooftop Runoff	0[10]	non-performing
Disconnection of Rooftop Runoff	0[10]	non-performing
Dry Swale	0[6]	non-performing
Dry Wells	96[3]	high-performing
Extended Detention Structure, Dry	88[1]	high-performing
Extended Detention Structure, Wet	70[1]	high-performing

BMP Type	Bacteria Pollutant Removal Efficiency (%)	Category
Forestation on Pervious Areas	42[5]	mid-performing
Grass Swale	0[6]	non-performing
Green Roof	0[11]	non-performing
Impervious Surface Elimination	0[10]	non-performing
Infiltration Basin	96[3]	high-performing
Infiltration Berms	96[3]	high-performing
Infiltration Trench	96[3]	high-performing
Landscape Infiltration	96[3]	high-performing
Level Spreader	0[9]	non-performing
Micropool Extended Detention Pond	70[1]	high-performing
Oil-Grit Separator	0[7]	non-performing
Other	0[7]	non-performing
Permeable Pavements	37[1]	mid-performing
Rain Gardens	70[2]	high-performing
Rain Water Harvesting	0[10]	non-performing
Retention Pond	70[1]	high-performing
Sand Filter	37[1]	mid-performing
Shallow Marsh	78[1]	high-performing
Sheetflow to Conservation Areas	42[5]	mid-performing
Step Pool Conveyance System	70[4]	high-performing
Stream Restoration	0[10]	non-performing
Submerged Gravel Wetland	78[1]	high-performing

[1] Fraley-McNeal, L., Schueler, T., Winer, R. 2007. National Pollutant Removal Performance Database - Version 3. Center for Watershed Protection, Ellicott City, MD.
[2] Hunt, W. F., Smith, J.T., Jadlocki, S.J., Hathaway, J.M., Eubanks, P.R., 2008. Pollutant Removal and Peak Flow Mitigation by a Bioretention Cell in Urban North Carolina. Biological and Agriculture Engineering, North Carolina State University, Raleigh, NC.
[3] Birch, G. F., Fazeli,M.S., Matthai, C., 2006. Efficiency of an Infiltration Basin in Removing Contaminants from Urban Stormwater. Environmental Geology Group School of Geo Sciences, University of Sydney, Sydney, Australia.
[4] According to Accounting for Wasteload Allocations and Impervious Acres Treated (MDE, 2014d) , Step Pool Storm Conveyance (SPSC) function similar to bioretention and efficiencies of bioretention basins can be used (Page 48). Therefore, efficiency will be the same as that of bioretention, which is 70%.
[5] Parajuli P.B., K.R.Mankin, P.L. Batnes, 2008. Applicability of targeting vegetative filter strips to abate fecal bacteria and sediment yield using Soil and Water Assessment Tool SWAT.
[6] http://water.epa.gov/polwaste/npdes/swbmp/Grassed-Swales.cfm.
[7] Hathaway, J.M., W.F. Hunt, and S.J. Jadlocki. 2009. "Indicator Bacteria Removal in Stormwater Best Management Practices in Charlotte, North Carolina." *Journal of Environmental Engineering*, 135(12), 1275-1285.
[8] Green roofs filter runoff in a similar way to bioretention systems, so a removal efficient of 70% assumed.
[9] http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-02-020.pdf.
[10] Substantial data not available; therefore, 0 was used.
[11] Stormwater captured by green roofs has negligible bacteria concentrations; therefore, 0 was used.

2.1 MAGOTHY RIVER WATERSHED – MAGOTHY RIVER MAINSTEM, FORKED CREEK, AND TAR COVE

The Magothy River Watershed is located in the northeastern portion of the County near Pasadena and Severna Park. The Magothy River flows southeast into the Chesapeake Bay near Gibson Island. Forked Creek is a small tidal creek located along the south shoreline of the river near its mouth and has a mainstem about 2.5 miles long. Tar Cove is on the opposite shoreline (north), adjacent to Sillery Bay. The primary land use category in all three watersheds is residential (Table 2-1and Figure 2-1).

The Magothy River Watershed has approved bacteria TMDLs for the Magothy River Mainstem, Forked Creek, and Tar Cove. All three of these waterways are designated as Use II waters and are classified as "restricted" shellfish harvesting areas (MDE, 2005c). The Magothy River Mainstem is restricted only in the upper portion; the lower 12.4 miles of the river is unrestricted and is not considered part of the listed bacteria TMDLs.

The bacteria TMDL source distribution provided in MDE's TMDL report for Magothy River Watershed, as shown in Table 2-3, identifies pet waste as the largest bacteria source in all three watersheds: Magothy River Mainstem, Forked Creek, and Tar Cove (MDE, 2005e).

Table 2-3: Bacteria Source Distribution in the Magothy River Watershed

Bacteria TMDL Watershed	Percent of Fecal Coliform Source Loads				Total
	Pets	Wildlife	Livestock	Human	
Magothy River Mainstem	65.2%	22.0%	10.8%	2.0%	100%
Magothy River/Forked Creek	85.8%	13.2%	0.4%	0.6%	100%
Magothy River/Tar Cove	54.4%	32.6%	9.9%	3.1%	100%

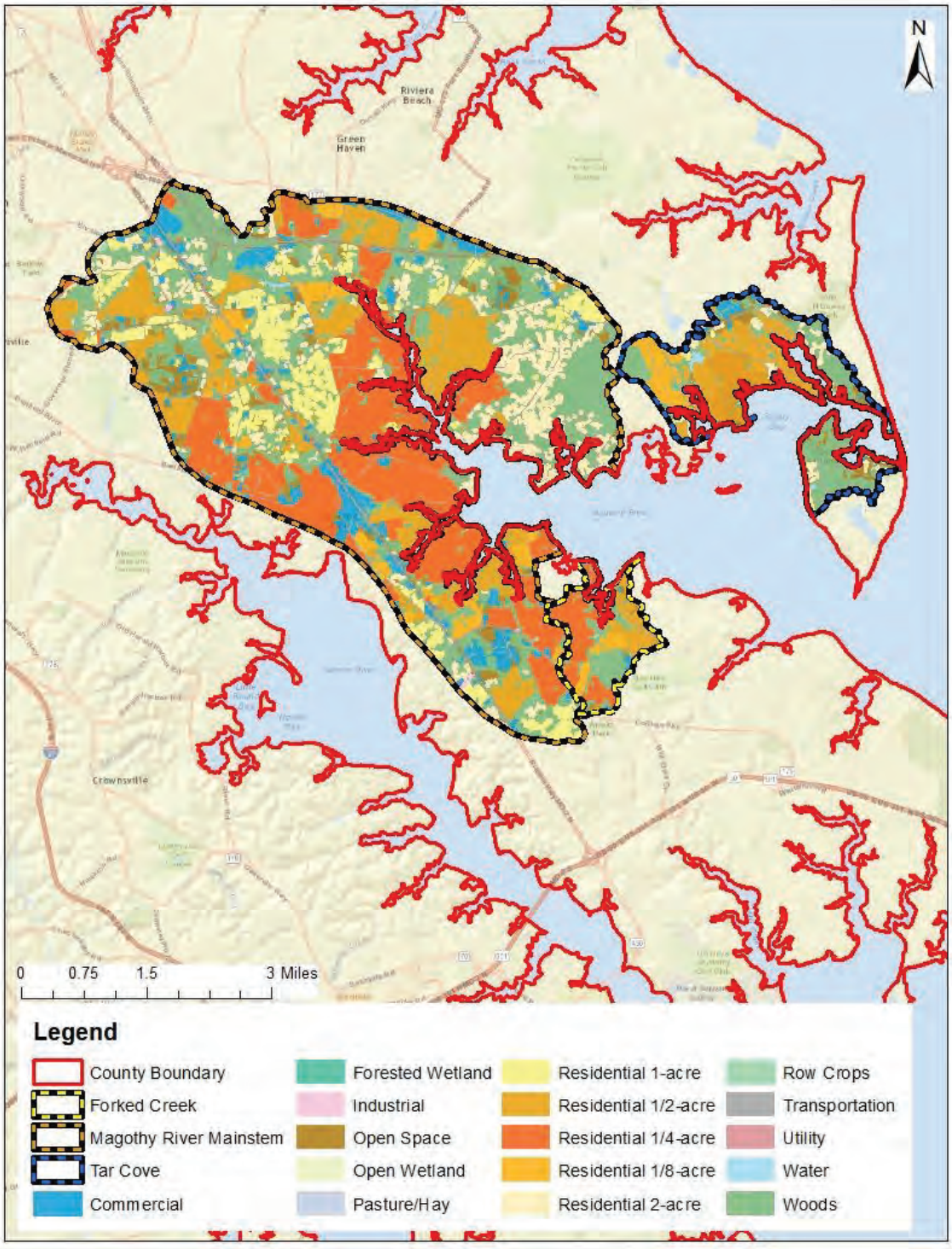


Figure 2-1: Land Use Map of Magothy River Watershed

The Magothy River Mainstem has 1,288 existing BMPs, Tar Cove has 132, and Forked Creek has 87, most of which are high-performing BMPs with 70 percent or greater bacteria removal efficiency (Table 2-4). In 2015, County completed approximately eight projects in the Magothy River Watershed and one project in the Forked Creek Watershed as a part of its Capital Improvement Program (CIP). The projects in the Magothy River Watershed involved converting old stormwater management facilities to wet ponds to comply with current MDE stormwater management standards, and the project in Forked Creek included retrofitting an existing outfall to a SPSC.

Table 2-4: Number of Existing BMPs in the Magothy River Watershed

Bacteria TMDL Watershed	Non-Performing BMPs	Mid-Performing BMPs	High-Performing BMPs	No. (%) of BMPs Without Drainage Area Data	Total
Magothy River Mainstem	96	80	1,112	37 (3%)	1,288
Magothy River/Forked Creek	1	4	82	1 (1%)	87
Magothy River/Tar Cove	9	31	92	0 (0%)	132

2.2 PATAPSCO RIVER LOWER NORTH BRANCH

The Patapsco River Lower North Branch (LNB) forms the northwestern boundary of Anne Arundel County. The Patapsco River LNB TMDL covers Baltimore County, Carroll County, Howard County, and Baltimore City in addition to Anne Arundel County. The County's portion of the watershed (15,022 acres) is on the south side of the Patapsco River and includes numerous tributaries that flow north to the mainstem of the LNB, which then flows into the Baltimore Harbor in Baltimore City. The Patapsco River LNB is generally nontidal, which differentiates it from tidal areas of the Patapsco drainage (e.g., Furnace and Marley Creeks; see Section 2.3). The County's portion of the watershed is highly developed, and much of it was built in the 1980s and early 1990s, before modern stormwater regulations (Anne Arundel County, 2011). The watershed is 34 percent forested and 26 percent residential (Table 2-1and Figure 2-2). Total imperviousness is 27 percent. The Patapsco River LNB Watershed also includes green spaces such as riverine wetlands, forested floodplains, greenways, and Critical Area lands which help protect water quality. The State-owned Baltimore-Washington International Airport occupies a large portion of this watershed.

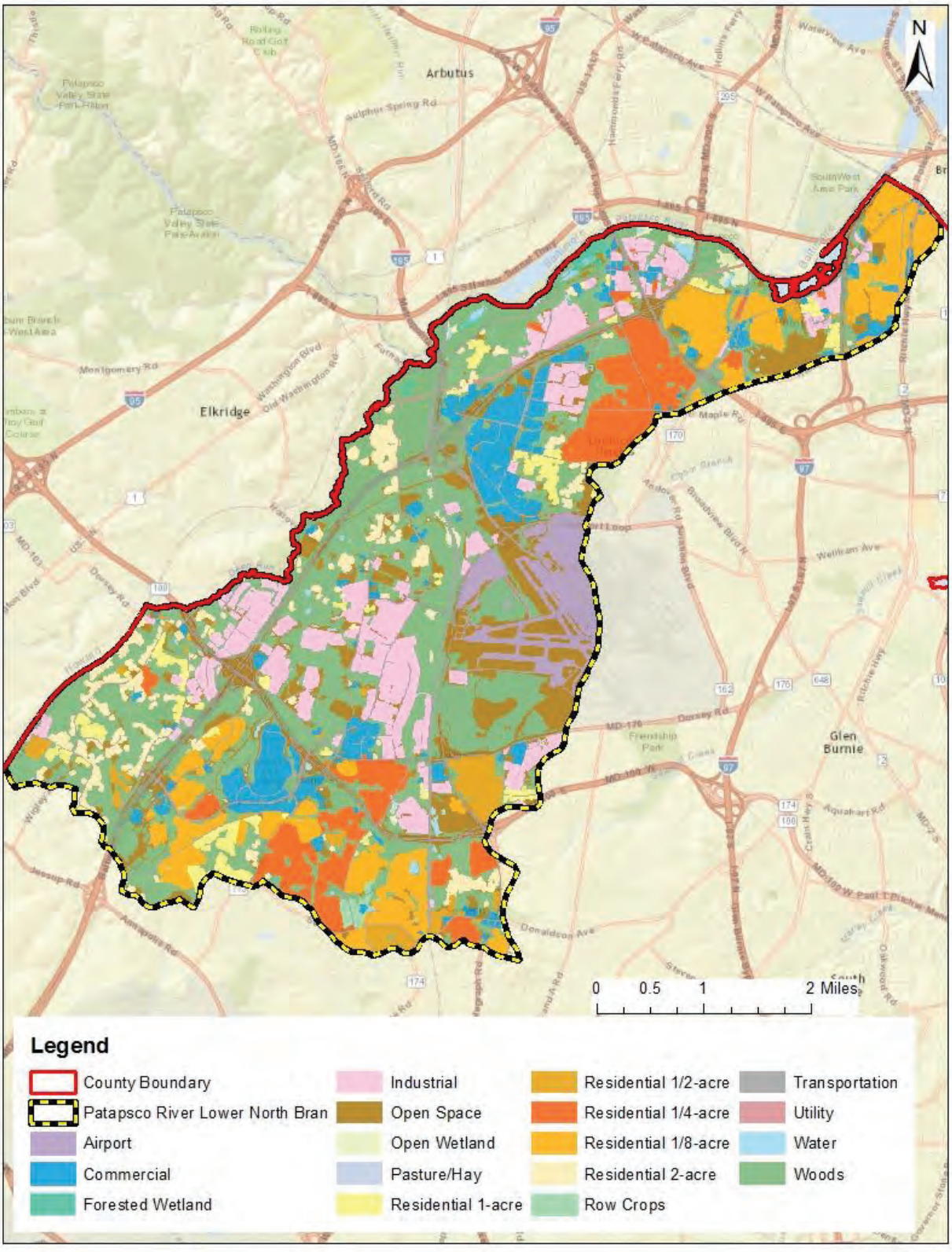


Figure 2-2: Land Use Map of the Patapsco River Lower North Branch Watershed

The Patapsco River LNB has an approved E. coli bacteria TMDL (MDE, 2009b) and is a State-designated Use I water (Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life). The bacteria source distribution from MDE's TMDL report for Patapsco River LNB (MDE, 2009b) is shown in Table 2-5. Holiday Mobile Estates is the only Water Reclamation Facility (WRF) in the Patapsco River LNB; it is a privately owned and operated WRF with an average flow (based on their NPDES permit) of 0.108 million gallons per day and reported monthly average bacteria concentrations of 3.0 MPN/100 ml. Given the low daily average flow, this WRF is a relatively minor source of bacteria compared to other sources in the watershed.

Table 2-5: Bacteria Source Distribution in the Patapsco River Lower North Branch Watershed

Bacteria TMDL Watershed	Percent of Fecal Coliform Source Loads				Total
	Pets	Wildlife	Livestock	Human	
Patapsco River LNB	20.7%	36.7%	9.7%	32.9%	100%

There are 601 existing BMPs in the watershed, and the majority are high-performing BMPs (Table 2-6). Drainage area information is unavailable for 2 percent of the BMPs at this time.

As a part of its 2015 CIP projects, the County has restored approximately 200 linear feet of stream at Leeds Road; however, the project will not reduce bacteria loads.

Table 2-6: Number of Existing BMPs in the Patapsco River Lower North Branch Watershed

Bacteria TMDL Watershed	Non-Performing BMPs	Mid-Performing BMPs	High-Performing BMPs	No. (%) of BMPs Without Drainage Area Data	Total
Patapsco River LNB	35	77	489	10 (2%)	601

2.3 PATAPSCO RIVER – FURNACE CREEK AND MARLEY CREEK

Furnace Creek and Marley Creek are tidal creeks in the northern portion of the County, a few miles east of Baltimore-Washington International airport. The Furnace Creek and Marley Creek watersheds are similar in size (8,579 acres for Furnace Creek, 8,737 acres for Marley Creek), are highly urbanized with much residential development (Table 2-1and Figure 2-3), and are each about 30 percent impervious. Some developments in these watersheds date back to the 1940s (Anne Arundel County, 2012b).

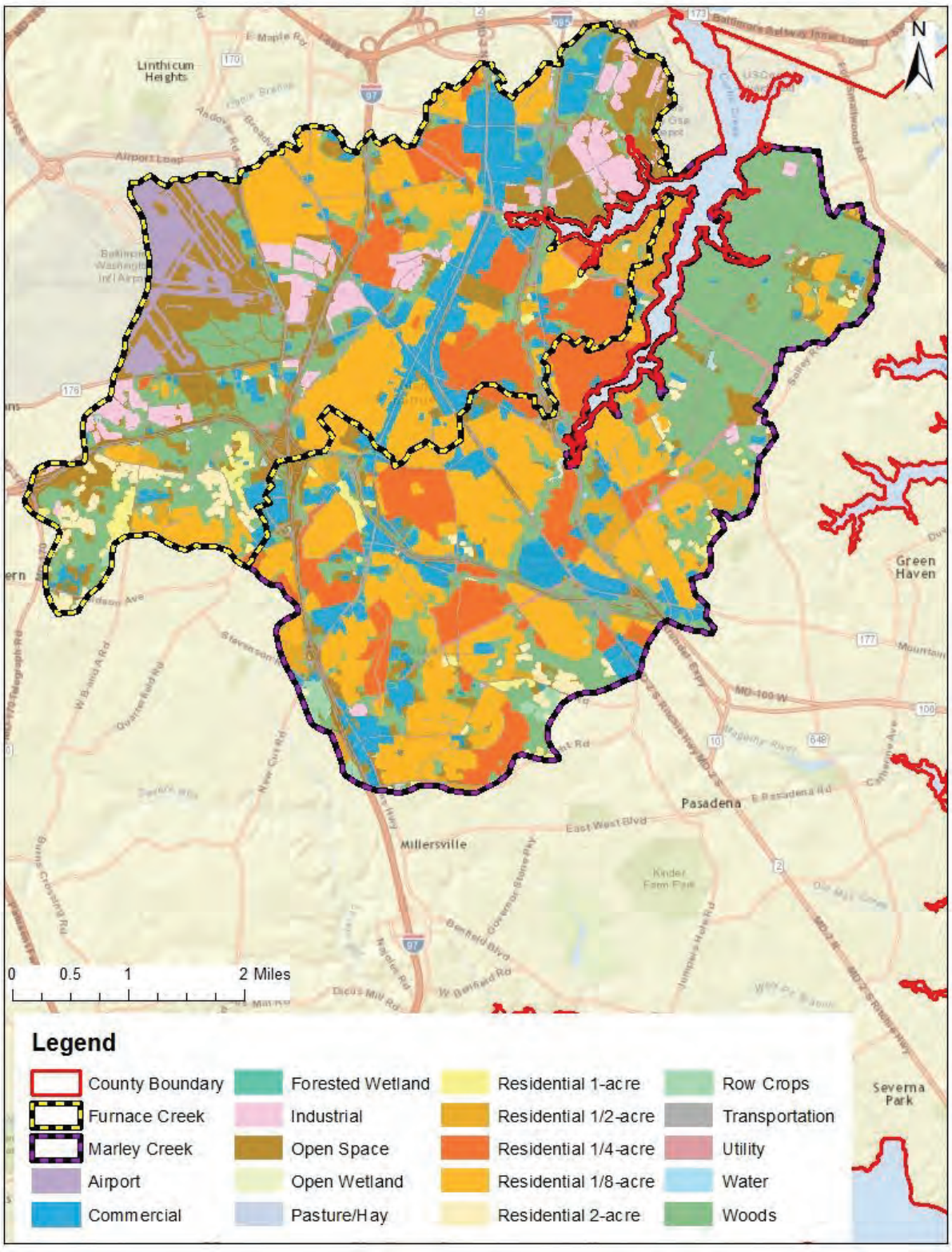


Figure 2-3: Land Use Map of the Furnace Creek and Marley Creek Watersheds

Furnace and Marley Creeks are MDE-designated Use I waters, and the bacteria TMDL impairment is Enterococci (MDE, 2010a). These are the only two watersheds in the County that have TMDLs for Enterococci (see Table 1-1 in Section 1).The Furnace Creek and Marley Creek watersheds have similar bacteria source distributions (Table 2-7 below) as identified by MDE (2010c). There are no livestock loads identified in either watershed. In each watershed, the contribution from human sources and wildlife is greater than 30 percent of total source loads. Pet waste contributes slightly less than 30 percent of the total loads in Furnace Creek and 34.6 percent of the total loads in Marley Creek. There are no point sources within the watersheds other than permitted MS4 stormwater discharges.

Table 2-7: Bacteria Source Distribution in the Furnace Creek and Marley Creek Watersheds

Bacteria TMDL Watershed	Percent of Fecal Coliform Source Loads				Total
	Pets	Wildlife	Livestock	Human	
Furnace Creek	29.4%	38.1%	0.0%	32.5%	100%
Marley Creek	34.6%	31.2%	0.0%	34.2%	100%

There are 430 and 556 existing BMPs in the Furnace Creek and Marley Creek Watersheds, respectively (Table 2-8). A majority of them are high-performing BMPs for bacteria, which include various types of infiltration BMPs and ESD practices. Four percent of the existing BMPs in the Furnace Creek Watershed and 3 percent of the existing BMPs in the Marley Creek Watershed do not have drainage area data.

Table 2-8: Number of Existing BMPs in the Furnace Creek and Marley Creek Watersheds

Bacteria TMDL Watershed	Non-Performing BMPs	Mid-Performing BMPs	High-Performing BMPs	No. (%) of BMPs Without Drainage Area Data	Total
Furnace Creek	45	26	359	19 (4%)	430
Marley Creek	49	40	467	15 (3%)	556

2.4 PATUXENT RIVER UPPER

The Patuxent River is one of the largest watersheds in Maryland. It flows from north to south and forms the boundary between Anne Arundel County to the east and Prince George's County to the west. The river is a designated Use I waterway. The impaired portion for the TMDL consists of a small subwatershed known as the Patuxent River Upper. This subwatershed is in the west central part of Anne Arundel County and extends across the river into Prince George's County. Anne Arundel County's portion is 10,450 acres and extends from the confluence with the Little Patuxent River in the north to the Queen Anne Bridge Road crossing in the south. Over 200,000 additional acres drain from upriver, outside the listed TMDL portion.

The Patuxent River valley is largely forested and includes numerous riparian wetlands. On the Anne Arundel County side of the river (eastern shore), there are several green spaces, including

the Globecom Wildlife Management Area, Patuxent River Park, and Davidsonville Park. The upland area is agricultural interspersed with low- to medium-density residential developments (Table 2-1and Figure 2-4). Major tributaries include Ropers Branch, Kings Branch, and Davidsonville Branch, which all flow from east to west into the Patuxent River Upper Mainstem.

The Patuxent River was placed on the State's 303(d) list in 2008 for fecal coliform impairments, and the bacteria TMDL was approved by EPA in 2011 (EPA, 2011). The TMDL is based on *E. coli*; however, the bacteria source distribution is based on *Enterococci*. This is because the monitoring datasets used to develop the TMDL included multiple pathogen indicators. MDE's TMDL report uses the generic term "fecal bacteria" to refer to all types of bacteria (MDE, 2010b).

MDE's bacteria source distribution in the Patuxent River Upper Watershed is shown in Table 2-9 (MDE, 2010d). Wildlife (35.0 percent) and livestock (28.0 percent) are the dominant bacteria sources, but human (19.0 percent) and pet sources (18.0 percent) are also present. Wildlife are the largest source of bacteria in the Patuxent River Upper Watershed, probably due to wildlife waste deposited in the river's riparian zone where there is abundant habitat and water resources for animals.

Livestock is the second largest contributor based on MDE's TMDL analyses, which includes not just cattle but also horses, sheep, chickens, and other farm animals. This part of the County has been identified to have a growing equestrian sector. Approximately 20 percent of the land use in the Patuxent River Upper Watershed is agricultural. There are no point sources in the listed portion of the Patuxent River Upper Watershed other than permitted MS4 stormwater discharges.

Table 2-9: Bacteria Source Distribution in the Patuxent River Upper Watershed

Bacteria TMDL Watershed	Percent of Fecal Coliform Source Loads				Total
	Pets	Wildlife	Livestock	Human	
Patuxent River Upper	18.0%	35.0%	28.0%	19.0%	100%

There are 122 existing BMPs in the Patuxent River Upper Watershed (Table 2-10). Of these, 99 are high-performing BMPs for bacteria. Three percent of the existing BMPs do not have drainage area data.

Table 2-10: Number of Existing BMPs in the Patuxent River Upper Watershed

Bacteria TMDL Watershed	Non-Performing BMPs	Mid-Performing BMPs	High-Performing BMPs	No. (%) of BMPs Without Drainage Area Data	Total
Patuxent River Upper	16	7	99	4 (3%)	122

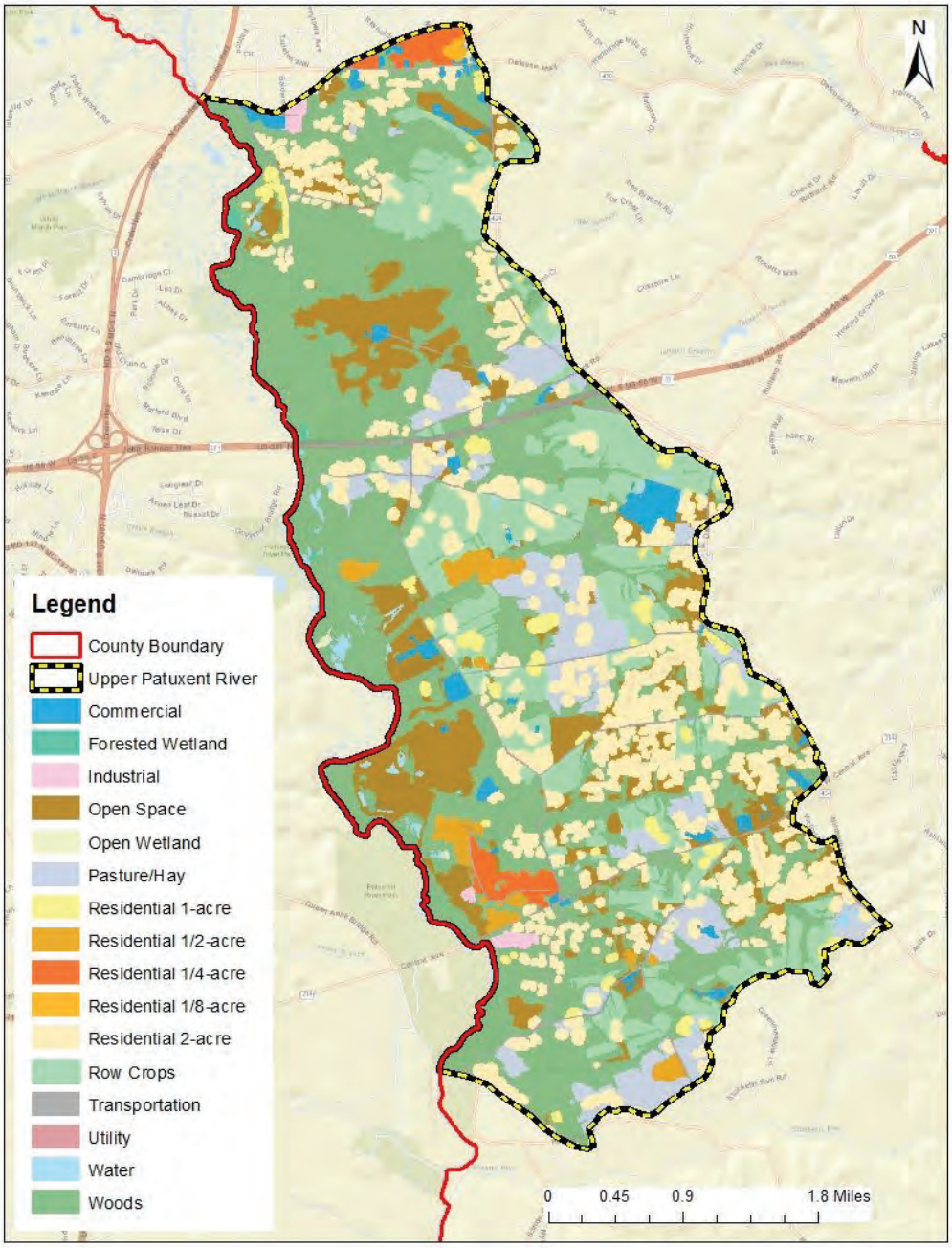


Figure 2-4: Land Use Map of the Patuxent River Upper Watershed

2.5 RHODE RIVER – BEAR NECK CREEK AND CADLE CREEK

Bear Neck Creek and Cadle Creek are located in the Rhode River Watershed. Even though Bear Neck Creek and Cadle Creek are tributaries of Rhode River, their TMDLs are not associated with Rhode River. According to MDE's TMDL report (MDE, 2005g), Bear Neck and Cadle Creeks are fairly large creeks at approximately 1,000 feet wide and about 3 feet deep on average. The Bear Neck Creek Watershed is 880 acres with 50 percent of its land use being residential,

mainly consisting of the community of Mayo. Most of the developments are on the east side of the creek, while the western shore is mainly forested (Table 2-1and Figure 2-5). The Bear Neck Creek Watershed as a whole is 16 percent impervious, which consists of roofs, driveways, roads, parking lots, and a few marina lots. The Cadle Creek Watershed is 320 acres. Approximately 70 percent of the land use is residential and 20 percent is impervious.

Bear Neck Creek and Cadle Creek have approved TMDLs for bacteria. Both of the creeks are Use II waterways and are classified as "conditionally approved" for shellfish harvesting (MDE, 2005b).

The bacteria source distribution for Bear Neck and Cadle Creeks from the MDE's TMDL report (MDE, 2005g) is shown in Table 2-11. Livestock is listed as the primary source of bacteria at 46.3 percent in Bear Neck. However, this is not consistent with current land use, which is < 1 percent agricultural according to the County's 2011 GIS land use data. This discrepancy may be due to conversion of farmland in the watershed to urban developments in the last 10 or so years (i.e., since the TMDL was developed). It should also be noted that a sizeable co-educational summer residence camp and conference center is located within both the Bear Neck Creek watershed and the adjacent Sellman Creek watershed. Equestrian facilities associated with this camp, however, are primarily within the Sellman Creek drainage area. Therefore, it may be that livestock sources are somewhat less of a factor now than when the TMDL data were collected. Pet waste contributes 33.9 percent of the bacteria load and is likely generated in residential communities. In the Cadle Creek Watershed, pet waste contributes 80.2 percent of the total bacteria source loads.

Table 2-11: Bacteria Source Distribution in the Rhode River Watershed

Bacteria TMDL Watershed	Percent of Fecal Coliform Source Loads				Total
	Pets	Wildlife	Livestock	Human	
Bear Neck Creek	33.9%	19.7%	46.3%	0.1%	100%
Cadle Creek	80.2%	19.5%	0.0%	0.3%	100%

The Bear Neck Creek Watershed has 75 existing BMPs and the Cadle Creek Watershed has 55 existing BMPs (Table 2-12). These two are among the watersheds for which the County is currently updating the drainage area database for the BMPs. One restoration project in the Bear Neck Creek Watershed is the Ponder Cove storm drain retrofit project in the Holly Hill Harbor community. The County was able to retrofit about 40 linear feet of storm drain pipe with perforated pipe to facilitate infiltration. The total drainage area treated by this retrofit is approximately 11.9 acres, of which 2.6 acres are impervious.

Table 2-12: Number of Existing BMPs in the Rhode River Watershed

Bacteria TMDL Watershed	Non-Performing BMPs	Mid-Performing BMPs	High-Performing BMPs	No. (%) of BMPs Without Drainage Area Data	Total
Bear Neck Creek	4	16	55	2 (3%)	75
Cadle Creek	4	18	33	2 (4%)	55

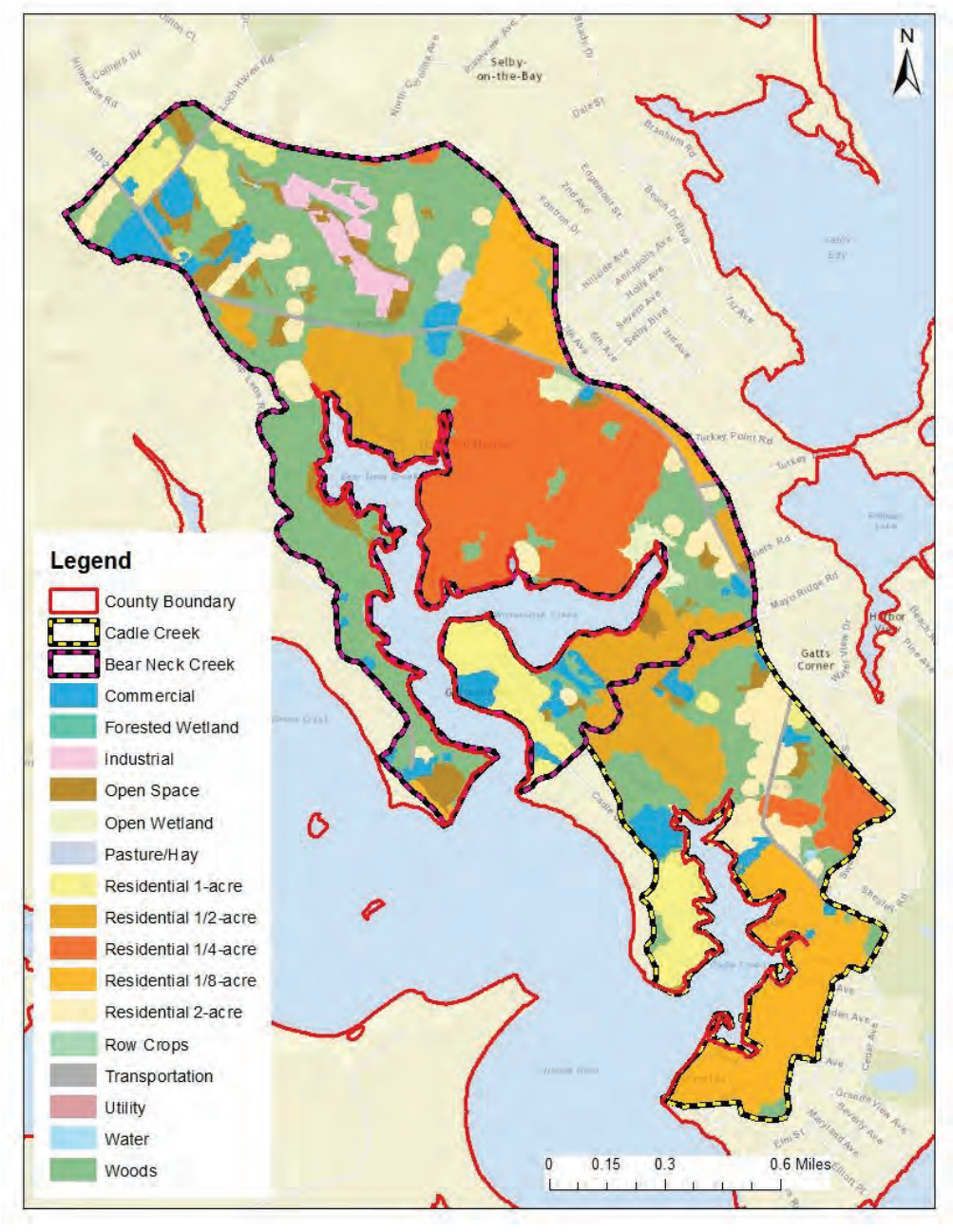


Figure 2-5: Land Use Map of the Bear Neck Creek and Cadle Creek Watersheds

2.6 SEVERN RIVER WATERSHED – SEVERN RIVER MAINSTEM, MILL CREEK, AND WHITEHALL / MEREDITH CREEKS

The Severn River Mainstem flows from northwest to southeast across the center of the County, from the community of Severn at the headwaters to the city of Annapolis near the mouth. According to MDE's TMDL report (MDE, 2008), the river is fairly deep, with an average depth of about 11 feet. The total watershed area is 37,011 acres, and the dominant land uses are residential at 44 percent and forested at 35 percent (Table 2-1and Figure 2-6). Approximately 20 percent of the watershed is impervious.

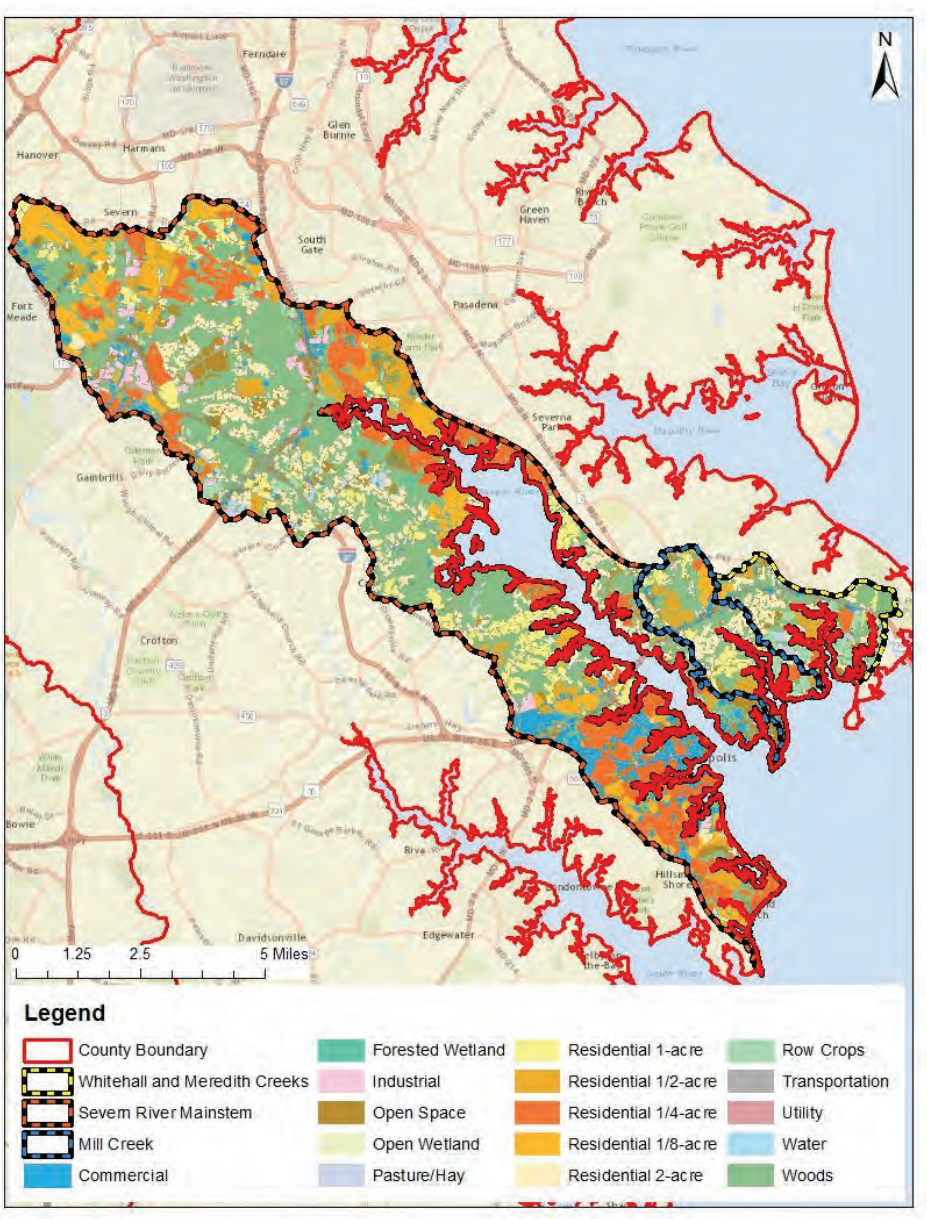


Figure 2-6: Land Use Map of the Severn River Mainstem, Mill Creek, and Whitehall-Meredith Creeks Watersheds

Mill Creek, Whitehall Creek, and Meredith Creek are all located a few miles northeast of the Severn River's mouth and discharge into the Chesapeake Bay just west of the Bay Bridge. Mill Creek has a watershed area of 3,256 acres, of which 14 percent is impervious, and consists of residential developments along the shoreline. The Whitehall and Meredith Creeks' combined watershed is 12 percent impervious. These creeks are shallow with an average depth of approximately 3 feet (MDE, 2008).

The Severn River Mainstem, Mill Creek, and Whitehall/Meredith Creeks have approved TMDLs for fecal coliform. Whitehall and Meredith Creeks have one combined TMDL due to their proximity. The Severn River, Mill Creek, and Whitehall/Meredith Creeks are MDE-designated Use II waters and are "restricted" for shellfish harvesting (EPA, 2008). MDE's bacteria source distributions are shown in Table 2-13. The largest bacteria source in the Severn River Mainstem is pet waste (68.8 percent), while the largest source in Mill Creek and Whitehall and Meredith Creeks is wildlife at 59.0 percent and 71 percent, respectively. The Severn River Watershed has two permitted point sources: the Annapolis WRF and the U.S. Naval Academy. Dreams Landing WRF, a privately owned and operated facility, was listed as one of the point sources by MDE at the time of TMDL development; however, the WRF is now defunct. The total combined load from both point sources is 7.41×10^9 fecal coliform counts per day based on the allowable (NPDES-permitted) monthly median concentration of 14 MPN/100 ml. Aside from urban stormwater, which can also contribute substantial fecal coliform loads to the receiving waters, there are no other permitted point sources in the Whitehall/Meredith Watershed.

Table 2-13: Bacteria Source Distribution in the Severn River Mainstem, Mill Creek, and Whitehall/Meredith Creek Watersheds

Bacteria TMDL Watershed	Percent of Fecal Coliform Source Loads				Total
	Pets	Wildlife	Livestock	Human	
Severn River Mainstem	68.8%	28.9%	1.4%	0.9%	100%
Mill Creek	38.0%	59.0%	1.0%	2.0%	100%
Whitehall/Meredith Creeks	26.0%	71.0%	2.0%	1.0%	100%

The Severn River Mainstem Watershed has 1,995 existing BMPs, which include 1,675 high-performing BMPs (Table 2-14). The Mill Creek Watershed has 225 existing BMPs of which 200 are high-performing. The Whitehall/Meredith Creek Watershed has 136 existing BMPs with 113 high-performing BMPs. The number of BMPs without drainage area data is provided in Table 2-14.

The County implemented six projects in 2015 in the Severn River Watershed as a part of its CIP projects. Two of the CIP projects included converting extended detention dry ponds to wet ponds and the remaining four involved installing SPSCs.

Table 2-14: Number of Existing BMPs in the Severn River Mainstem, Mill Creek, and Whitehall/Meredith Creek Watersheds

Bacteria TMDL Watershed	Non-Performing BMPs	Mid-Performing BMPs	High-Performing BMPs	No. (%) of BMPs Without Drainage Area Data	Total
Severn River Mainstem	123	197	1,675	113 (6%)	1,995
Mill Creek	16	9	200	19 (8%)	225
Whitehall/Meredith Creeks	6	17	113	9 (7%)	136

2.7 SOUTH RIVER WATERSHED – SOUTH RIVER MAINSTEM, DUVALL CREEK, RAMSEY LAKE, AND SELBY BAY

The South River Watershed has four impaired waterways with approved bacteria TMDLs: the South River Mainstem, Duvall Creek, Ramsey Lake, and Selby Bay. The South River is located immediately south of the Severn River in the central portion of the County. Like the Severn, it flows from northwest to southeast. The headwaters are near the town of Crownsville. The mouth, where it discharges to the Chesapeake Bay, is near Thomas Point Park. According to MDE's TMDL report (MDE, 2005f), the South River has an average width of 1.2 miles and an average water depth of 8.6 feet. The river drains 33,549 acres and has mixed land use consisting primarily of residential developments (32 percent) and forest (46 percent) (Table 2-1 and Figure 2-7). About 12 percent of the South River Watershed is impervious. Duvall Creek, Ramsey Lake, and Selby Bay are small embayments near the mouth of the South River. Duvall Creek is on the north shore of the river and has 76 percent residential land use. Recreational activities in Duvall Creek include boating, canoeing, and windsurfing, and there are many individually moored vessels. Ramsey Lake and Selby Bay are on the south shore of the river. Like Duvall Creek, the majority of the land use in the Ramsey Lake and Selby Bay areas is residential.

The four TMDLs are mostly in restricted shellfish harvesting areas (designated Use II waters) due to fecal coliform impairments; the exception is the lower 3 miles of the South River Mainstem from near the mouth of Almshouse Creek to the mouth, which is not restricted and is currently open to shellfish harvesting according to MDE's shellfish harvesting closure area map (MDE, 2014e).

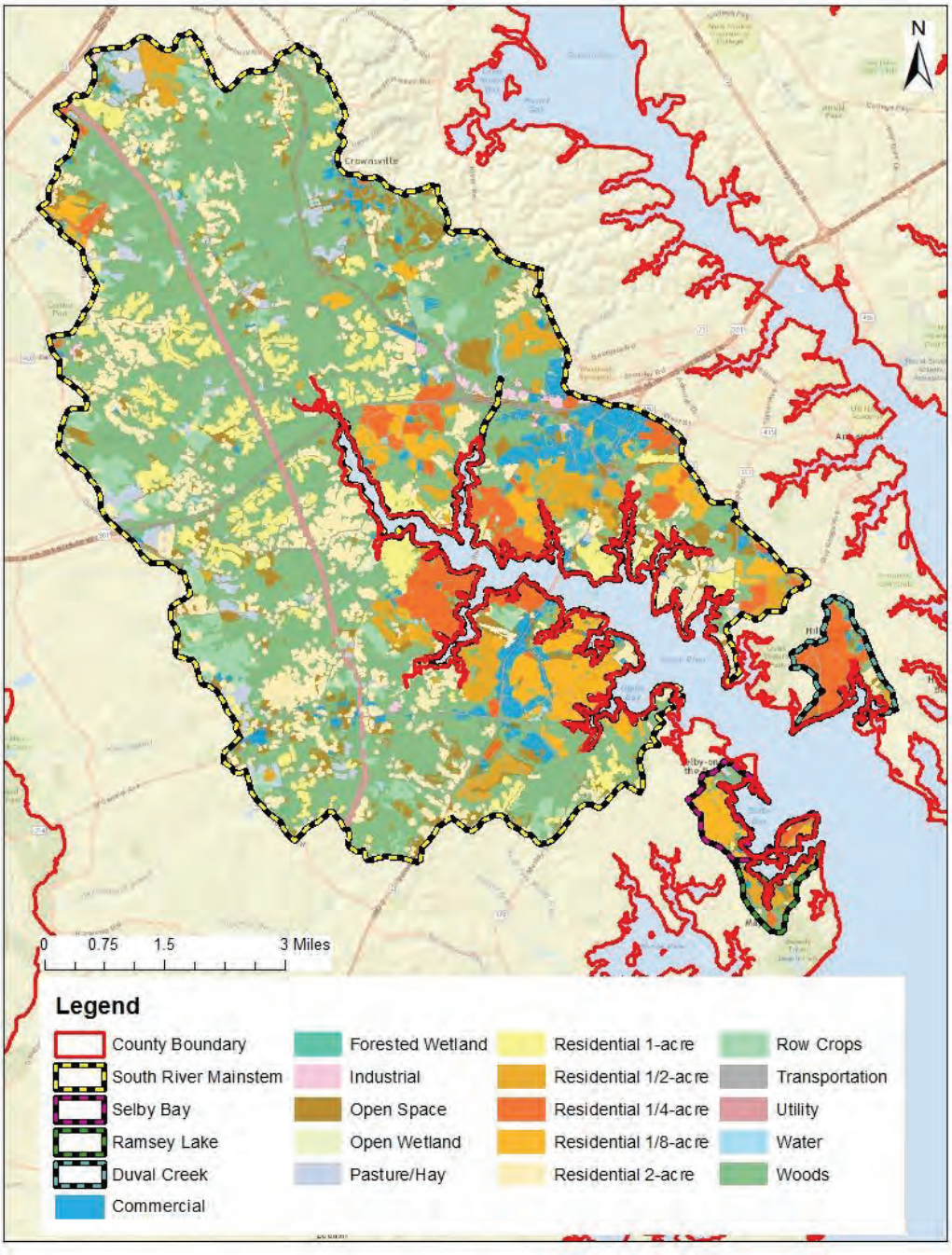


Figure 2-7: Land Use Map of the South River Mainstem, Duvall Creek, Ramsey Lake, and Selby Bay Watersheds

Based on MDE's TMDL report for South River Watershed (MDE, 2005f), the primary sources of fecal coliform bacteria in the South River Mainstem, Duvall Creek, Ramsey Lake, and Selby Bay are pet waste and wildlife (Table 2-15). Livestock sources also occur in the South River Mainstem and Duvall Creek Watersheds. However, the County's GIS data from 2011 shows very little land in agricultural use, suggesting that some of the formerly agricultural land may

have been converted to urban developments in the last 10 or so years. Therefore, livestock sources may be less significant today, although this cannot be quantified. Human sources are relatively minor (≤ 2 percent) in all the watersheds. There are no point sources other than permitted MS4 stormwater discharges.

Table 2-15: Bacteria Source Distribution in the South River Mainstem, Ramsey Lake, Selby Bay, and Duvall Creek Watersheds

Bacteria TMDL Watershed	Percent of Fecal Coliform Source Loads				Total
	Pets	Wildlife	Livestock	Human	
South River Mainstem	43%	34%	22%	1%	100%
Duvall Creek	68%	17%	15%	0.1%	100%
Ramsey Lake	63%	37%	0%	0.3%	100%
Selby Bay	63%	35%	0%	2%	100%

The South River Watershed has 1,329 existing BMPs (Table 2-16), of which 1,066 are high-performing; these are mainly infiltration type BMPs with 96 percent bacteria removal efficiency. Duvall Creek and Ramsey Lake also have high-performing BMPs, which make up 71 percent and 70 percent of the total BMPs in the respective watersheds. In Selby Bay, 41 percent of BMPs are high-performing and 47 percent are mid-performing.

As a part of its 2015 CIP, the County implemented two projects in the South River Watershed involving converting an existing extended detention dry pond to a wet pond and installing an SPSC. One project was implemented in Duvall Creek that converted an existing extended detention dry pond to a wet pond.

Table 2-16: Number of Existing BMPs in the South River Mainstem, Ramsey Lake, Selby Bay, and Duvall Creek Watersheds

Bacteria TMDL Watershed	Non-Performing BMPs	Mid-Performing BMPs	High-Performing BMPs	No. (%) of BMPs Without Drainage Area Data	Total
South River Mainstem	79	184	1,066	46 (3%)	1,329
Duvall Creek	4	10	34	1 (2%)	48
Ramsey Lake	4	15	44	0 (0%)	63
Selby Bay	10	38	33	0 (0%)	81

2.8 WEST CHESAPEAKE BAY – TRACY AND ROCKHOLD CREEKS

The West Chesapeake Bay Watershed, also known as the Herring Bay Watershed is in the southeast corner of the County. Tracy Creek is lined with mature forests and riparian wetlands. Upland areas consist mainly of agricultural uses including livestock pastures. Rockhold Creek is

located immediately east of Tracy Creek. The watershed is slightly more developed and includes the community of Deale along the eastern shoreline.

Tracy and Rockhold Creeks have a combined watershed area of 7,962 acres, about half of which is forest. Residential developments make up 18 percent of the watershed, and agricultural uses make up 15 percent (Table 2-1 and Figure 2-8). Imperviousness is approximately 5 percent.

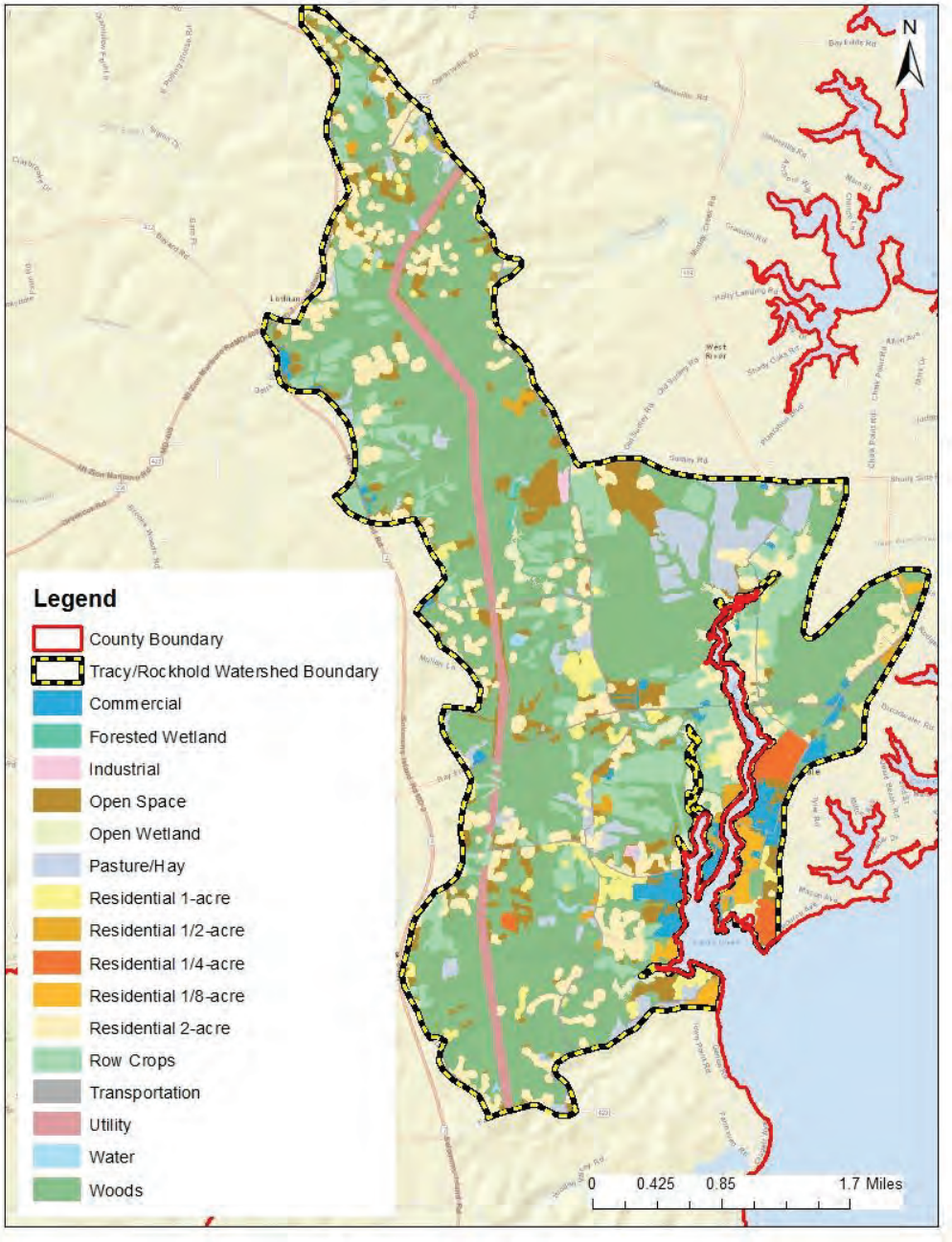


Figure 2-8: Land Use Map of the Tracy and Rockhold Creeks Watershed

The West Chesapeake Bay Watershed has an approved bacteria TMDL for Tracy Creek and Rockhold Creek due to fecal coliform impairment. Both are designated as Use II waters and are classified as "restricted" for shellfish harvesting area (MDE, 2005d). In MDE's TMDL report, Tracy and Rockhold Creeks are represented as one watershed and have one associated TMDL because they are close and both drain to Herring Bay (MDE, 2005h).

The bacteria source distribution for the Tracy and Rockhold Creeks Watershed is shown in Table 2-17. Wildlife is the primary bacteria source at 72 percent, and pet waste is the secondary source at 21 percent. There are no point source facility discharges in the watershed other than permitted MS4 stormwater discharges.

Table 2-17: Bacteria Source Distribution in the Tracy and Rockhold Creeks Watershed

Bacteria TMDL Watershed	Percent of Fecal Coliform Source Loads				Total
	Pets	Wildlife	Livestock	Human	
Tracy and Rockhold Creeks	21%	72%	7%	<1%	100%

There are 70 existing BMPs in the watershed (Table 2-18). Thirty-five of them are high-performing BMPs with 70 percent or greater bacteria removal efficiency. Drainage area data are unavailable for 9 percent of the BMPs.

Table 2-18: Number of Existing BMPs in the Tracy and Rockhold Creeks Watershed

Bacteria TMDL Watershed	Non-Performing BMPs	Mid-Performing BMPs	High-Performing BMPs	No. (%) of BMPs Without Drainage Area Data	Total
Tracy and Rockhold Creeks	15	20	35	6 (9%)	70

2.9 WEST RIVER WATERSHED – WEST RIVER MAINSTEM AND PARISH CREEK

The West River is a tidal estuary and river system in the southeast portion of the County near the town of Galesville. The restricted portion is 0.6 mile wide and 3.2 feet deep on average. It flows northeast into the unrestricted lower river and then into the Chesapeake Bay. The watershed area is 6,304 acres, about 45 percent of which is forest. Residential developments make up 25 percent of the watershed, and agricultural land use (pasture/hay and row crops) makes up 20 percent (Table 2-1and Figure 2-9). Imperviousness is relatively low compared to the other watersheds in the County with bacteria impairment at 6 percent. Parish Creek is a small estuary east of the West River, near the town of Shadyside. Parish Creek drains an area of 324 acres, of which 41 percent is residential and 31 percent is forest.

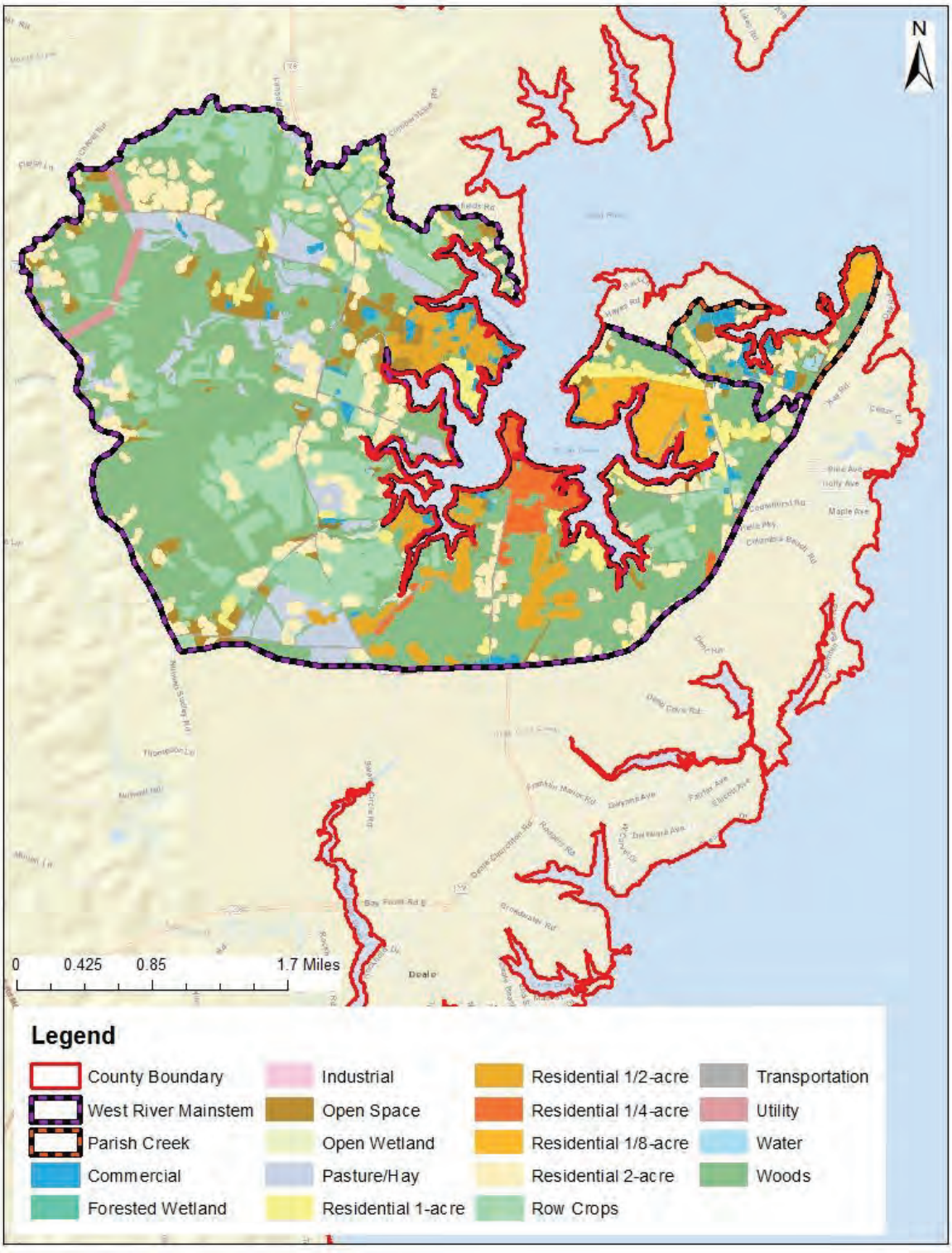


Figure 2-9: Land Use Map of the West River Mainstem and Parish Creek Watersheds

The West River Watershed has approved bacteria TMDLs for the West River Mainstem and Parish Creek. Both are in restricted shellfish harvesting areas (designated Use II waters) due to fecal coliform impairments. Only the upper portion of the West River Mainstem is restricted; the lower river from Chalk Point to the mouth (a distance of about 1.5 miles) is unrestricted.

The bacteria source distribution in the West River Mainstem is shown in Table 2-19 below. The primary bacteria source is livestock (57.1 percent), which is consistent with the agricultural land use. In Parish Creek, the primary sources are wildlife at 59.0 percent and pets at 40.2 percent (Table 2-19). There are no point sources in either the West River Mainstem or Parish Creek Watershed other than permitted MS4 stormwater discharges.

Table 2-19: Bacteria Source Distribution in the West River Mainstem and Parish Creek Watersheds

Bacteria TMDL Watershed	Percent of Fecal Coliform Source Loads				Total
	Pets	Wildlife	Livestock	Human	
West River Mainstem	15.7%	26.8%	57.1%	0.4%	100%
Parish Creek	40.2%	59.0%	0.0%	0.8%	100%

The West River Mainstem Watershed has 134 BMPs, and the Parish Creek Watershed has 15. West River Mainstem and Parish Creek are among the watersheds for which the County is currently updating drainage area information (Table 2-20).

Table 2-20: Number of Existing BMPs in the West River Mainstem and Parish Creek Watersheds

Bacteria TMDL Watershed	Non-Performing BMPs	Mid-Performing BMPs	High-Performing BMPs	No. (%) of BMPs Without Drainage Area Data	Total
West River Mainstem	13	53	68	9 (7%)	134
Parish Creek	4	6	5	1 (7%)	15

2.10 DEVELOPMENT OF EXISTING CONDITIONS WATERSHED TREATMENT MODEL

As a part of development of TMDL Restoration Plan for bacteria impairments, water quality models were developed for all the study watersheds. The Watershed Treatment Model (WTM), a spreadsheet-based model developed by the Center for Watershed Protection (Caraco 2013a and b) was used to characterize and quantify the bacteria loads for existing conditions from primary (land use) and secondary sources of pollutants (e.g., illicit discharges, sanitary sewer overflows) and estimate the potential bacteria load reductions from existing BMPs. The WTM models were developed using the County GIS data and literature review. Appendix A contains the approach adopted to develop the existing conditions model along with the results.

2.11 IMPACT OF TMDL RESTORATION PLAN TO TIER II WATERS

Maryland State water quality standards consist of three components:

- The designated use of the waterway (Use I or Use II in this case)
- Numerical water quality criteria (i.e., bacteria concentrations below certain levels) that are protective of that designated use
- An anti-degradation policy specifically for Tier II waters that maintains high quality waters so they do not degrade

According to COMAR 26.08.02.04-1, high quality waters are where the water quality is better than the minimum requirements specified by the water quality standards. They are listed by MDE as “Tier II” waters. Based on MDE data, Tier II waters occur in two locations in the County:

- Lyons Creek, just west of the Tracy and Rockhold Creeks; it is not part of any watersheds in this restoration plan
- Patuxent River, just upstream of the Patuxent River Upper; it is not part of any watersheds in this restoration plan

Any watershed restoration or other activities that would affect the above Tier II waters, such as new or major modifications to discharges to the water bodies, are restricted by MDE. However, Lyons Creek flows west, away from Tracy and Rockhold Creeks, and the Tier II portion of the Patuxent River is upstream of the listed Patuxent River Upper TMDL portion. Therefore, the presence of Tier II waters is not expected to impact restoration plans for the 19 TMDL watersheds.

SECTION THREE: RESTORATION PLAN GOALS

The goal of this TMDL Restoration Plan is to reduce or mitigate existing sources of bacteria so that water quality standards and designated uses of the impaired waterways are restored. The approved TMDLs require significant reductions in bacteria loads ranging from 12.8 percent reduction to 90 percent reduction among the 19 TMDL watersheds (average 51 percent, see Section 3.1); therefore, extensive restoration efforts will be required to meet the TMDL goals.

In addition to meeting the TMDL goals as required by the County's NPDES MS4 permit, this restoration plan will help the County meet overarching goals, which include protecting environmental features such as riparian buffers, forests, and green spaces, as well as restoring water quality and improving habitat conditions. This restoration plan will help prevent further degradation of water resources and help to off-set any future load increases due to population growth and new development.

3.1 TMDL REDUCTION GOALS FOR BACTERIA

To restore the designated uses in each of the impaired waterways and ensure they meet State water quality standards, the MDE requires that loads from bacteria sources be reduced or mitigated by a specific amount. This is expressed in each of the MDE-published TMDLs as a required percent reduction in bacteria loads. The percent reduction is calculated as the difference between the current load (at the time the TMDL was developed) and the allowable load, divided by the current load, as follows:

$$Required\ Load\ Reduction = \frac{Current\ Load - Allowable\ Load}{Current\ Load}\ x\ 100\%$$

The current load is the mass of all bacteria sources in the watershed that drain to the water body and contribute to the observed impairment. It represents the "existing conditions" at the time the TMDLs were developed, typically in the early 2000s. The MDE calculated the current load using a pollutant load model calibrated with monitoring data collected at the base of each watershed.

The allowable load is the amount of pollutant a water body can take in without exceeding its maximum allowable water quality standard for that pollutant. The allowable load is computed using the same approach as the current load except that the applicable State water quality criteria are used instead of the monitoring data.

The MDE published TMDL documents for each watershed set a reduction goal, which is allocated to point and nonpoint sources. As a part of the NPDES MS4 requirements, MDE has set goals for SW-WLAs for all watersheds in Anne Arundel County with bacteria TMDLs. These SW-WLAs are provided in the MDE's WLA search portal.

Seventeen of the 19 TMDL watersheds are located entirely in the Anne Arundel County, therefore the overall watershed level reduction goals published in the MDE TMDL documents

for the 17 watersheds with the exception of South River TMDL watersheds is the same as the SW-WLAs provided in the MDE's WLA search portal. For South River TMDL watersheds, including South River Mainstem, Duvall Creek, Selby Bay and Ramsey Lake, the required load reductions presented in the MDE published TMDL document do not match the SW-WLAs goals provided in the MDE's WLA search portal. For all the South River TMDL watersheds, except for Duvall Creek, the reduction requirements published in MDE's SW-WLAs portal are higher compared to the reductions published in the TMDL document. This discrepancy is noted in Table 3-1. For these watersheds, the reduction requirement provided in the TMDL documents is used as the ultimate reduction requirements.

The TMDL reduction requirements for Tar Cove and Selby Bay watersheds are higher than the loads at the time of TMDL development, resulting in no reduction requirements for these watersheds as noted in the last two columns of Table 3-1. However, restoration strategies have been proposed for both the watersheds to prevent future bacteria impairment of these watersheds.

As Patapsco Lower North Branch Watershed and Patuxent River Upper Watersheds are located in multiple counties, the reduction requirement for Anne Arundel County was scaled based on the loads contributed from the Anne Arundel County portion of these watersheds. The load reduction requirement for Anne Arundel County portion of these watersheds is shown below.

SWA-WLA Reduction Requirements for the Anne Arundel County Portion of the Patapsco Lower North Branch Watershed:

- Stormwater baseline loads for Anne Arundel County: 60,361 billion MPN/year[a]
- Stormwater allocations for Anne Arundel County: 47,814 billion MPN/year[b]
- SW-WLA goals for Anne Arundel County: (60,361-47,814)/60,361=**20.7%**

Source:

[a] – From table 4.9.2 of the MDE document "Total Maximum Daily Loads of Fecal Bacteria for the Patapsco River Lower North Branch Basin in Anne Arundel, Baltimore, Carroll and Howard Counties and Baltimore City, Maryland", August 2009
[b] – From table 4.9.3 of the MDE document "Total Maximum Daily Loads of Fecal Bacteria for the Patapsco River Lower North Branch Basin in Anne Arundel, Baltimore, Carroll and Howard Counties and Baltimore City, Maryland" August 2009

SWA-WLA Reduction Requirements for the Anne Arundel County Portion of the Patuxent River Upper Watershed:

- Stormwater baseline loads for Anne Arundel County: 50,616 billion MPN/year[c]
- Stormwater allocations for Anne Arundel County: 39,283 billion MPN/year[d]
- SW-WLA goals for Anne Arundel County: (50,616-39,283)/50,616=**22.3%**

Source:

[a] – From table 4.9.2 of the MDE document "Total Maximum Daily Loads of Fecal Bacteria for the Patuxent River Upper Basin in Anne Arundel and Prince George's County, Maryland", September 2010
[b] – From table 4.9.2 of the MDE document "Total Maximum Daily Loads of Fecal Bacteria for the Patuxent River Upper Basin in Anne Arundel and Prince George's County, Maryland", September 2010

The data presented in the Table 3-1 were obtained from the MDE-published TMDL reports for each watershed and the MDE's WLA search portal; and include the percent reductions required to restore the designated use and water quality of the waterways. The ultimate goals used for this restoration plan are provided in farthest right column and represent the end point of implementation for the County.

Table 3-1: TMDL Reduction Goals for Bacteria

TMDL Watershed	Impairment	TMDL Baseline Year[a]	TMDL Baseline Year Load[b]	Unit	TMDL Allowable Load[c]	Unit	SW-WLAs for the County[d] (percent)	Overall Watershed Reduction Requirement[e] (percent)	Target Reduction Requirement Used for this Plan (percent)
Magothy Mainstem	Fecal Coliform	2001	4.97×10^{12}	counts/day	4.33×10^{12}	counts/day	12.8	12.8	12.8
Magothy River/Forked Creek	Fecal Coliform	2001	1.83×10^{11}	counts/day	1.35×10^{11}	counts/day	26.3	26.3	26.3
Magothy River/Tar Cove	Fecal Coliform	2001	9.82×10^{11}	counts/day	2.07×10^{12}	counts/day	0.0	0.0	0.0
Patapsco River/Furnace Creek	Enterococci	2006	3.66×10^{12}	counts/day	8.14×10^{11}	counts/day	77.7	77.7	77.7
Patapsco River Lower North Branch	E. Coli	2003	2.37×10^{15}	MPN/year	1.99×10^{15}	MPN/year	20.7	16[f]	20.7
Patapsco River/Marley Creek	Enterococci	2006	6.19×10^{12}	counts/day	1.50×10^{12}	counts/day	75.7	75.7	75.7
Patuxent River Upper	E. Coli	2009	1.20×10^{16}	MPN/year	6.01×10^{15}	MPN/year	22.3	49.9[g]	22.3
Rhode River/Bear Neck Creek	Fecal Coliform	2001	3.55×10^{11}	counts/day	2.01×10^{11}	counts/day	43.3	43.3	43.3
Rhode River/Cadle Creek	Fecal Coliform	2001	3.54×10^{11}	counts/day	9.85×10^{10}	counts/day	72.2	72.2	72.2
Severn River Mainstem	Fecal Coliform	2002	6.07×10^{12}	counts/day	4.92×10^{12}	counts/day	19.0	19.0	19.0
Severn River/Mill Creek	Fecal Coliform	2002	1.78×10^{12}	counts/day	2.49×10^{11}	counts/day	86.0	86.0	86.0
Severn River/Whitehall and Meredith Creek	Fecal Coliform	2002	4.92×10^{11}	counts/day	4.92×10^{10}	counts/day	90.0	90.0	90.0
South River/Duvall Creek	Fecal Coliform	2001	1.52×10^{11}	counts/day	8.27×10^{10}	counts/day	17.4[h]	45.6[i]	45.6
South River Mainstem	Fecal Coliform	2001	1.32×10^{13}	counts/day	9.31×10^{12}	counts/day	68.0[h]	29.5[i]	29.5
South River/Ramsey Lake	Fecal Coliform	2001	5.57×10^{11}	counts/day	2.27×10^{11}	counts/day	65.0[h]	59.3[i]	59.3
South River/Selby Bay	Fecal Coliform	2001	3.27×10^{11}	counts/day	3.75×10^{11}	counts/day	45.1[h]	0.0[i]	0.0
W. Chesapeake Bay/Tracy and Rockhold Creeks	Fecal Coliform	2001	1.67×10^{12}	counts/day	3.06×10^{11}	counts/day	81.6	81.6	81.6
West River Mainstem	Fecal Coliform	2001	1.77×10^{12}	counts/day	1.15×10^{12}	counts/day	35.3	35.3	35.3
West River/Parish Creek	Fecal Coliform	2001	2.56×10^{11}	counts/day	1.20×10^{11}	counts/day	53.1	53.1	53.1

[a, b ,c, e-] Based on the MDE published TMDL document for bacteria impaired watersheds in Anne Arundel County.
[d-] Based on the MDE published SW-WLAs for Anne Arundel County Storm Sewer System (from MDE TMDL Data Center: http://wlat.mde.state.md.us/ByMS4.aspx).
[f-] Overall watershed level reduction requirement and includes Anne Arundel, Baltimore, Carroll and Howard Counties and Baltimore City
[g-] Overall watershed level reduction requirement and includes Anne Arundel and Prince George's Counties
[h,i-] There is a discrepancy in bacteria load reduction requirements for South River TMDL watersheds from SW-WLAs provided in the MDE's WLA portal and from the MDE published TMDL documents.

3.2 TIMELINE FOR MEETING BACTERIA TMDL

The EPA-approved TMDL reports do not include a specific final date for bacteria TMDL compliance. MDE, through the NPDES MS4 Permit, requires that the TMDL Restoration Plan be an iterative process until the TMDL goals are met. It is proposed that the restoration schedule be integrated with the Chesapeake Bay TMDL implementation schedule; therefore, 2025 can be considered the target timeline for meeting the bacteria TMDL. Merging the bacteria restoration activities with the Bay TMDL implementation is proposed because its bacteria reduction strategies are similar to those required by the County's Phase II Watershed Implementation Plan (WIP) (Anne Arundel County, 2012a). For example, retrofitting impaired pipe outfalls and degraded stream channels with SPSCs, a requirement of the WIP, has removal efficiency per acre of 57 percent for nitrogen, 66 percent for phosphorus, and 70 percent for sediment (MDE, 2014d). For bacteria, the removal efficiency is 70 percent, which makes it a highly desirable BMP to meet goals for bacteria and Bay TMDLs. A detailed implementation schedule for meeting the County's bacteria TMDLs is provided in Section 7.

SECTION FOUR: RESTORATION STRATEGIES

This section outlines restoration strategies proposed to meet the required TMDL load reductions and restore State water quality standards in the County's impaired waterways. The proposed restoration strategies were developed in consultation with several County departments, including the Department of Health, the Department of Public Works' (DPW's) Watershed Protection and Restoration Program (WPRP) and Utility Planning divisions, using existing County data and reports. This section also includes planning-level implementation costs for each restoration strategy along with potential load reductions estimated using Center for Watershed Protection's WTM and literature review. The proposed strategies address both point and nonpoint bacteria sources as identified in MDE's bacteria TMDL reports for all 19 TMDL watersheds.

The proposed strategies are broadly grouped into Tier A and Tier B strategies. Tier A strategies are proposed to reduce human bacteria sources and Tier B strategies are proposed to reduce non-human sources (i.e., from wildlife waste, pet waste, and livestock waste). Tier A strategies are considered high priority for the County because human sources of bacteria pose a higher potential public health risk (MDE, 2014b), and these strategies are already part of the County's NPDES MS4 program (e.g., illicit discharge detection and elimination) and the County DPW wastewater program (e.g., sanitary sewer repairs and septic system retirement). However, per the MDE guidance document for developing restoration plans for addressing bacteria TMDL, jurisdictions have considerable flexibility in selecting the order of implementation of the proposed strategies, provided that the required TMDL load reductions are achieved in a reasonable time frame (MDE, 2006; MDE, 2014a; J. White pers. communication, January 8, 2015). Therefore, it is recommended that the County initially implement additional and new strategies that are the most cost-effective while concurrently continuing the existing programs (e.g., illicit discharge detection and elimination and the DPW wastewater program); these new strategies are identified below and more specific recommendations are provided in this section.

Certain strategies are not proposed in this restoration plan because preliminary modeling and information in the TMDL reports indicated that the bacteria load reductions achievable with these strategies is minimal. These strategies include upgrades to County-owned WRFs and management of deer populations. The preliminary modeling results and the MDE-published TMDL documents indicated that the County-owned WRFs were a relatively minor bacteria point source in the TMDL watersheds where they occur due to the low effluent concentrations permitted by their WRF NPDES point source discharge permits (14 MPN/100 ml) for fecal coliform bacteria. Upgrades to all the County-owned WRFs have been implemented and are nearing completion. Further, MDE's TMDL reports assume that deer waste represents a relatively minor source of bacteria relative to other wildlife species such as waterfowl.

4.1 PROPOSED STRATEGIES

4.1.1 Tier A Strategies

Tier A strategies are those that address potential human sources of bacteria such as septic system effluent from poorly maintained septic systems, sanitary sewage overflows, and illicit connections that discharge household human wastewater into the MS4. For all Tier A strategies, bacteria load reductions were estimated using WTM, one of MDE's recommended tools for identifying source loads and estimating pollutant load reductions (MDE, 2014b). County GIS data and related reports were used to develop the existing and proposed conditions WTM to produce a representative estimate of bacteria load reductions. Details on the modeling methodology are included in Appendix A. The Tier A strategies are described below.

Elimination of Household Illicit Connections

Residential household illicit connections are sanitary sewers connected directly to the storm drain instead of to the sanitary sewer, leading to discharge of raw untreated human wastewater into the local waterway. Wash water illicit connections occur when either commercial washwater (from carwashes, fleet washing, commercial laundry wastewater, or floor washing of shop drains) or residential grey water (laundry) is discharged into the MS4 rather than being disposed of properly (CWP, 2004). Commercial washwater and residential grey water primarily contain pollutants such as detergents/surfactants, ammonia, and others, and have a low percentage of bacteria (CWP, 2004).

The County's NPDES MS4 permit (11-DP-3316, MD0068306) requires the County to conduct dry weather field screening and outfall sampling of approximately 150 outfalls annually to detect potential illicit residential household and commercial waste water connections. This Tier A strategy assumes that all illicit connections detected by the County will be enforced and eliminated. From 2005 to 2014, 32 illicit connections were detected out of 1,500 outfalls surveyed, as documented in the County's Annual NPDES MS4 Reports; this makes the County-wide illicit detection rate approximately 2 percent. It is assumed that the same detection rate of illicit connections would continue through 2020. The County-wide rate of 2 percent was apportioned among the 19 TMDL watersheds based on the amount of impervious cover in each TMDL watershed relative to the total impervious cover in the County (based on 2011 impervious data). It was further assumed that half of the illicit connections detected would be from households that discharge bacteria. The obtained proportioned rate of illicit detection and elimination was modeled in the proposed conditions WTM for each watershed to estimate the potential bacteria load reductions from this Tier A strategy.

Abatement of Sanitary Sewer Overflows

In the County, Sanitary Sewer Overflows (SSOs) generally occur as a result of power and mechanical failures at sewage pump stations (SPSs). According to data provided by the County, 533 SSOs of varying intensity and duration have occurred in the last 14 years (2001 to 2014); of

these, approximately 101 have occurred in areas that affected the bacteria TMDL waterways. Table 4-1 below provides a summary of the County data related to SSOs.

Table 4-1: List of Sanitary Sewer Overflows Occurring in Bacteria TMDL Watersheds from 2001 to 2014

TMDL Watershed	TMDL Subwatershed	Number	Frequency (times per year on average)	Volume Range (gallons)
Magothy River	Mainstem	12	1.0	0 – 3,000,000
	Forked Creek	1	n/a (only one occurrence)	4,500
	Tar Cove	n/a	n/a	n/a
Patapsco River	Furnace Creek	8	0.7	100 – 78,000
	Marley Creek	13	1.2	0 – 222,000
Patapsco River Lower North Branch	Patapsco River Lower North Branch	2	0.7	290 – 1,200
Patuxent River Upper	Patuxent River Upper	2	0.6	0 – 50,000
Rhode River	Bear Neck Creek	11	1.0	0 – 79,600
	Cadle Creek	8	1.1	100 - 550
Severn River	Mainstem	14	2.0	0 – 54,000
	Mill Creek	2	0.3	200 – 350
	Whitehall and Meredith Creeks	1	n/a (only one occurrence)	200
South River	Mainstem	7	0.9	0 – 11,000
	Duvall Creek	3	0.6	200 – 2,000
	Ramsey Lake	10	1.3	0 – 500
	Selby Bay	4	0.8	200 – 2,000
West Chesapeake Bay Mainstem	Tracy and Rockhold Creeks	1	n/a (only one occurrence)	800
West River	Mainstem	2	0.5	300 – 8,000
	Parish Creek	n/a	n/a	n/a

This Tier A strategy proposes to reduce the number of SSOs and thereby reduce the discharge of human bacteria to surface water. Specific wastewater projects that are considered SPS upgrades or otherwise designed to improve the reliability of the sanitary system were identified by the County (G. Heiner, pers. Communication November 6, 2014). A total of 34 wastewater projects in 12 of the 19 TMDL watersheds were identified as of 2015. Some of the identified projects, such as the upgrades to the existing sewage pump stations, are recurring, and some of the projects are finite in nature. Table 4-2 and Table 4-3 list the discrete and recurring SPS projects

in the TMDL watersheds as identified by the County's Wastewater Capital Budget and Program annual reports along with cost estimates. The Marley SPS Upgrade (S805400), Parole SPS (S804900), Mill Creek SPS Upgrade (S804700), and Sylvan Shores PS Upgrade (S80400) are completed by DPW's Utility Planning Division, therefore they are listed as complete in Table 4-2. All projects were entered into the proposed conditions WTM to estimate the bacteria load reductions from implementing the SPS upgrades. All the SPS projects can be categorized under two categories: (i) short term projects such as generator replacement and (ii) projects that are recurring such as upgrades to existing pump stations. Table 4-2 and Table 4-3 list the discrete (i.e., short term) and the recurring SPS projects in the TMDL watersheds as identified by the County's Wastewater Capital Budget and Program annual reports along with cost estimates.

Table 4-2: List of Discrete Sewage Pump Station Upgrade Projects in the TMDL Watersheds

Project	Project Title	Current Status	Description	TMDL Watershed	Qty. of Pump Stations Being Upgraded	Total Budgeted Costs[1]	Expended and/or Encumbered as of 12/23/2015
S804700	Mill Creek SPS Upgrade	Complete	Various upgrades to the Mill Creek sewage pumping station	Magothy River Mainstem	1	$11,377,000	$10,970,909
S805400	Marley SPS Upgrade	Complete	Construction of various upgrades to Marley Sewage Pumping Station to improve operation and reliability	Patapsco River/Marley Creek	1	$4,229,000	$4,127,181
S804900	Parole SPS Upgrade	Complete	Construction of miscellaneous improvements to the Parole Sewage Pumping Station to increase operation and reliability	South River Mainstem	1	$4,737,000	$4,630,427
S804000	Sylvan Shores PS Upgrade	Complete	Construction of improvements to Sylvan Shore Sewage Pumping Station to improve reliability and efficiency of system	South River Mainstem	1	$3,899,000	$3,717,286

Project	Project Title	Current Status	Description	TMDL Watershed	Qty. of Pump Stations Being Upgraded	Total Budgeted Costs[1]	Expended and/or Encumbered as of 12/23/2015
S799200	Mayo Collection Sys Upgrade	Active	Expansion of Mayo Wastewater Collection and Conveyance System to accommodate planned growth within Mayo Sewer service area	Rhode River/Cadle Creek	12	$10,740,393	$5,290,266
S806200[2]	SPS Fac Gen Replacement	Active	Generator replacement (Phase 5 contract)	Magothy River Mainstem, Patapsco River LNB, South River/Duvall Creek	6	$44,809,000	$1,081,508
S806200	SPS Fac Gen Replacement	Active	Generator replacement (Design 1 and Phase 6 contracts)	Patapsco River LNB, Baltimore Harbor, Stony Creek, Rock Creek	8	See above	$5,826,661
S806200	SPS Fac Gen Replace	Active	Generator replacement (Design 2 and Phase 7 contracts)	Unknown	multiple	See above	$3,325,716
S806200	SPS Fac Gen Replace	Active	Generator replacement/CMI services at all sites	Multiple	multiple	See above	$ 455,214
S805300	Cinder Cove SPS Mods	Active	Pump station reliability improvements necessary to minimize risks of sanitary sewer overflows	Patapsco River/ Furnace Creek	1	$10,765,000	$$6,823,132
S806300	Big Cypress SPS Retro	Active	Upgrades to Big Cypress sewage pump station	Magothy River Mainstem	1	$3,756,000	$2,742,248
S804200	Riva Woods SPS Upgrades	Complete	Design/construct improvements to Riva Woods SPS	South River Mainstem	1	$1,180,500	$1,177,722

Project	Project Title	Current Status	Description	TMDL Watershed	Qty. of Pump Stations Being Upgraded	Total Budgeted Costs[1]	Expended and/or Encumbered as of 12/23/2015
S804300	Jennifer Road SPS Upgrade	Active	Upgrades to Jennifer Rd sewage pump station; pump station force main replacement	Severn River Mainstem	1	$10,140,000	$8,006,761
				Total	**34**	$105,632,893	$51,351,899

[1] - Total Budgeted Cost derived from FY2016 Anne Arundel County Approved Capital Budget and Program and includes current and prior appropriation as well as projected appropriation requests for FY2017 through FY2021.

[2] - Total Budgeted Cost for this project includes completed and active SPS upgrades Countywide; however, the total budget is not broken down at the level of bacteria TMDL watersheds, therefore total project costs are listed

Table 4-3: List of Recurring Sewage Pump Station Upgrade Projects in the TMDL Watersheds

Project	Project Title	Current Status	Description	TMDL Watershed	Qty. of Pump Stations Being Upgraded	Annual Budget Allocation for Parent Project[1]	Expended and/or Encumbered as of 12/23/2015
S791800	Upgr/ Retrofit SPS	Multi-Year	Upgraded existing sewage pump stations	Magothy River Mainstem	5	$4,775,000	$2,745,830
S791800	Upgr/ Retrofit SPS	Multi-Year	Upgraded existing sewage pump stations	Patapsco River LNB	1	See above	$87,617
S791800	Upgr/ Retrofit SPS	Multi-Year	Upgraded existing sewage pump stations	Patapsco River/Furnace Creek	1	See above	$200,733
S791800	Upgr/ Retrofit SPS	Multi-Year	Upgraded existing sewage pump stations	Patapsco River/Marley Creek	5	See above	$749,653
S791800	Upgr/ Retrofit SPS	Multi-Year	Upgraded existing sewage pump stations	Severn River Mainstem	6	See above	$2,852,641
S791800	Upgr/ Retrofit SPS	Multi-Year	Upgraded existing sewage pump stations	South River Mainstem	10	See above	$7,354,907
S791800	Upgr/ Retrofit SPS	Multi-Year	Upgraded existing sewage pump stations	West River/Parish Creek	3	See above	$1,095,576
				Totals	31	$4,775,000	$15,086,957

[1] - Annual Budgeted Allocation derived from FY2016 Anne Arundel County Approved Capital Budget and Program and includes current as well as projected appropriation requests for FY2017 through FY2021. The Annual Budget Allocation for this project applies to SPS upgrades Countywide and is not broken down at the level of bacteria TMDL watersheds.

Retirement of County Septic Systems

Retirement of septic systems by connecting them to the public sanitary system can reduce human bacteria sources in the watershed. Based on GIS data provided by the County DPW, a total of 21,793 septic systems were identified for the entire County of which 16,007 septic systems were located in 10 of the 19 TMDL watersheds. These septic systems were previously identified by the County (as part of the Chesapeake Bay TMDL Phase II WIP) as contributing nitrogen to the Chesapeake Bay and are considered eligible to be retired for the purpose of meeting the Chesapeake Bay TMDL. The Anne Arundel County Department of Health has indicated that the current rate of retirement of septic systems in the County is 20 to 40 per year. The retirement of septic systems is dependent on several factors, such as availability of funding and willingness of the homeowner to connect to a sanitary sewer system. The current rate of retirement was proportioned to each watershed to identify the septic systems that could be retired by 2025. This information was entered into the proposed conditions WTM to estimate the bacteria load reductions that would be achieved by implementing this strategy. Table 4-4 below, presents the total number of septic systems that are identified to be retired in the TMDL watersheds and the anticipated number of septic systems that could be retired by 2025 based on current County rate.

Table 4-4: Anticipated Number of Septic Systems That Could Be Retired as Identified by the County Department of Public Works and Department of Health

Bacteria TMDL Watershed	No. of Septic Systems Identified by DPW as Eligible to be Retired	No. of Septic Systems That Could be Retired by 2025 Based on Current Rate of Retirement
Magothy River Mainstem	4,814	88
Magothy River/Forked Creek	113	2
Magothy River/Tar Cove	1,708	31
Patapsco River/Furnace Creek	252	5
Patapsco River LNB	174	3
Patapsco River/Marley Creek	0	0
Patuxent River Upper	289	5
Rhode River/Bear Neck Creek	0	0
Rhode River/Cadle Creek	0	0
Severn River Mainstem	5,475	100
Severn River/Mill Creek	1,168	21
Severn River/Whitehall and Meredith Creek	320	6
South River/Duvall Creek	0	0
South River Mainstem	1,694	31
South River/Ramsey Lake	0	0
South River/Selby Bay	0	0
W. Chesapeake Bay/Tracy and Rockhold Creeks	0	0

Bacteria TMDL Watershed	No. of Septic Systems Identified by DPW as Eligible to be Retired	No. of Septic Systems That Could be Retired by 2025 Based on Current Rate of Retirement
West River Mainstem	0	0
West River/Parish Creek	0	0
Total	**16,007**	**292**

4.1.2 Tier B Strategies

Tier B strategies are those that address non-human sources of bacteria, such as pet waste, wildlife waste, and livestock waste. Many of the Tier B strategies are non-structural measures that are expected to have relatively low implementation costs and are considered a cost-effective means for the County to achieve credit for bacteria load reductions. Non-human sources are considered secondary in importance relative to human sources for public health reasons (MDE, 2014b). As implementation of new and retrofit stormwater management facilities to treat 20 percent of the currently unmanaged impervious area is required by County's NPDES MS4 Permit, anticipated bacteria reductions from managing urban stormwater runoff is also included as a part of Tier B strategies. Bacteria load reductions for Tier B strategies were estimated using the WTM, as well as literature review. Each of the Tier B strategies and the assumptions and methods used to develop each strategy are described below. Per MDE's guidance, (MDE, 2014b), the priority of implementing Tier A or Tier B strategies is at the County's discretion.

Implementing New Stormwater Management Projects and Retrofitting Pre-2002 Stormwater Management Facilities to Meet Current MDE Criteria

Tier B strategies that address urban stormwater retrofits include restoring 20 percent of currently unmanaged impervious cover through: (i) implementing new stormwater management projects and (ii) retrofitting pre-2002 ponds and other stormwater management facilities to meet current MDE stormwater criteria. This strategy was developed based on the Anne Arundel County's Urban Phase II Watershed Implementation Plan (2012a) and requirements of the current NPDES MS4 Permit (11-DP-3316, MD0068306). The current NPDES MS4 Permit requires the County to treat 20 percent of the impervious area that currently has limited or no stormwater management. Based on the County's Impervious Area Baseline Assessment (Anne Arundel County, 2015c), 1,639 acres of impervious area throughout the County is managed through various stormwater management practices, and 29,311 acres of impervious area is currently unmanaged. This results in 5,862 acres of impervious area required to be treated by the County by the end of the current permit term.

As one of the strategies to meet the 20 percent restoration requirements, the County is evaluating retrofitting existing outfalls by implementing BMPs having high pollutant-removal efficiency, such as SPSCs. Because SPSCs are a relatively cost-effective BMP for treating larger drainage areas compared to BMPs such as bioretention (see the Regenerative Stormwater Conveyance factsheet on the County's website [Anne Arundel County, 2012c]), they are considered a high priority for implementation. According to the County's Phase II WIP, SPSC retrofits are

proposed for sites in the County that meet the following criteria: streams with physical habitat index rankings of "degraded" or "severely degraded"; and outfalls that are 24 inches or greater in diameter, have a D ranking for impairment, and occur in watersheds that are a high priority for restoration. In 2014–2015, the County implemented six SPSCs, all of which were located in the TMDL watersheds. As new projects are identified through the County CIP, the proposed conditions WTM will be modified to quantify the benefits of the proposed new projects.

According to the County's Phase II WIP, existing pre-2002 dry ponds and other stormwater management facilities in the TMDL watersheds are recommended to be retrofitted to meet current Maryland stormwater management criteria. The goal for retrofitting these facilities is to increase nutrient and sediment removal capacity by converting the facilities to either wet ponds or SPSCs. Dry ponds are usually ideal candidates for retrofits because they have larger areas draining to them. Currently, dry ponds have a bacteria removal efficiency of 88 percent and are considered high-performing BMPs for bacteria removal. Converting the dry ponds to shallow wetland/marsh filtering systems, wet ponds, or SPSCs, as recommended in the County's Phase II WIP, would still maintain a bacteria removal efficiency of 70 or 78 percent, which in either case is considered a high-performing BMP for bacteria. The County retrofitted approximately 12 pre-2002 stormwater management facilities in 2014–2015 by converting them to wet ponds, and all of them are located in the bacteria TMDL watersheds. The number of ponds proposed for retrofit for each TMDL watershed is shown in Table 4-5 below. This information was entered into the proposed conditions WTM to estimate the load reductions obtained from implementing this strategy.

The County plans to retrofit 141 pre-2002 stormwater management facilities and 69 outfalls to convert them to SPSCs, wet ponds, infiltration basins, and other high-pollutant-removal BMPs. Of these, 34 outfall retrofits and 98 pre-2002 stormwater management facility retrofits are planned in the TMDL watersheds targeted for bacteria reduction.

To simulate the impact of the proposed stormwater management projects, the proposed conditions WTM for these watersheds were configured to include the drainage area and impervious area that will be managed by these proposed projects. Table 4-5 below presents the impervious area proposed to be managed by the planned projects to meet the 20 percent NPDES MS4 restoration goal in the respective TMDL watersheds.

Table 4-5: County CIP Urban Stormwater Retrofit Projects Proposed in the Bacteria TMDL Watersheds

Proposed Urban Retrofit Project	Proposed Project Type	BMP Classification Based on Table 2-2	Bacteria TMDL Watershed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)	Potential Bacteria Removal Efficiency (percent)
Pinewood & Sycamore Roads	SPSC	SPSC	Magothy River Mainstem	29.66	7.79	70
College Parkway	Riser Modifications for Water Quality	Retention Pond	Magothy River Mainstem	19.00	0.83	70
Tarks Lane	Infiltration Basin	Infiltration Basin	Magothy River Mainstem	7.35	0.14	96
Copperwood Drive	Wet Pond & SPSC	SPSC	Magothy River Mainstem	8.06	0.79	70
Lahinch Drive	Infiltration Basin	Infiltration Basin	Magothy River Mainstem	33.74	0.62	96
Collington Court	Wet Pond	Retention Pond	Magothy River Mainstem	29.66	4.11	70
Mayfield Road at Gladnor Road	Wet Pond	Retention Pond	Magothy River Mainstem	5.15	1.23	70
Amesbury Court	Wet Pond	Retention Pond	Magothy River Mainstem	32.42	0.80	70
Longfellow Drive	Infiltration Basin	Infiltration Basin	Magothy River Mainstem	16.77	0.89	96
Jumpers Hole Road at Sylvan Avenue	Wet Pond	Retention Pond	Magothy River Mainstem	9.00	4.10	70
262 Finnegan Drive	Wet Pond & SPSC	SPSC	Magothy River Mainstem	5.15	1.23	70
103 Evon Court	Wet Pond	Retention Pond	Magothy River Mainstem	7.88	0.12	70
240 Waycross Way	Wet Pond	Retention Pond	Magothy River Mainstem	46.51	5.22	70
Colleen Garden Lane - Pond 2	Wet Pond	Retention Pond	Magothy River Mainstem	1.30	0.60	70
Earleigh Heights B&A Trail Facility	Wet Pond	Retention Pond	Magothy River Mainstem	12.50	3.10	70
790 Richie Highway	Wet Pond	Retention Pond	Magothy River Mainstem	150.32	3.47	70
249 Armstrong Lane	Wet Pond	Retention Pond	Magothy River Mainstem	TBD	TBD	70
109 Chelsea Grove Court	Wet Pond with Micro-Pool	Micropool Extended Detention Pond	Magothy River Mainstem	9.2	2.0	70

Proposed Urban Retrofit Project	Proposed Project Type	BMP Classification Based on Table 2-2	Bacteria TMDL Watershed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)	Potential Bacteria Removal Efficiency (percent)
8013 Tickneck Road	Wet Pond	Retention Pond	Magothy River Mainstem	9.1	0.9	70
603 Deering Road	Wet Pond with Micro-Pool	Micropool Extended Detention Pond	Magothy River Mainstem	52.6	TBD	70
725 Bridge Drive	Wet Pond	Retention Pond	Magothy River Mainstem	No Data	No Data	70
244 Kennedy Drive	Wet Pond with Micro-Pool	Micropool Extended Detention Pond	Magothy River Mainstem	2.0	0.7	70
Anne Arundel Community College (AACC)	Wet Pond	Retention Pond	Magothy River Mainstem	20.9	2.8	70
AACC	Pond	Retention Pond	Magothy River Mainstem	No Data	No Data	70
AACC	Bioretention	Bioretention	Magothy River Mainstem	2.7	No Data	70
Buena Vista neighborhood in Glen Burnie	SPSC	SPSC	Magothy River Mainstem	45.9	10.9	70
Barrensdale Neighborhood Outfall from Pond	SPSC	SPSC	Magothy River Mainstem	18.5	7.9	70
Will-O-Brooke Dive	SPSC	SPSC	Magothy River Mainstem	4.7	1.3	70
College Parkway	SPSC	SPSC	Magothy River Mainstem	9.3	0.1	70
College Parkway	SPSC	SPSC	Magothy River Mainstem	12.0	0.1	70
College Parkway	SPSC	SPSC	Magothy River Mainstem	19.4	0.9	70
College Parkway	SPSC	SPSC	Magothy River Mainstem	No Data	No Data	70
College Parkway	SPSC	SPSC	Magothy River Mainstem	13.0	1.2	70
College Parkway	SPSC	SPSC	Magothy River Mainstem	9.8	0.4	70
College Parkway	SPSC	SPSC	Magothy River Mainstem	74.0	46.1	70

Proposed Urban Retrofit Project	Proposed Project Type	BMP Classification Based on Table 2-2	Bacteria TMDL Watershed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)	Potential Bacteria Removal Efficiency (percent)
Riverside Park	Stormwater Wetland and Grass Filter Strip	Micropool Extended Detention Pond	Patapsco River LNB	124.0	55.8	78
Located on 10th Avenue. between Valley Road and Chatham Road, Brooklyn	Infiltration Trench and SPSC	SPSC	Patapsco River LNB	3.3	1.1	70
Brooklyn Park - located on 10th Avenue between Valley Road, and Chatham Road, Brooklyn	Micro-Bioretentions and Permeable Pavements	Bioretention	Patapsco River LNB	3.6	1.6	70
Bingo World - Bounded by Belle Grove Road, 10th Avenue and Harbor Valley Drive.	Grass Filters and Bioretention Basins	Bioretention	Patapsco River LNB	9.3	8.2	70
Brooklyn Middle School - off Hammonds Lane, Brooklyn, MD	Grass Swale; Stormwater Wetland	Shallow Marsh	Patapsco River LNB	195.0	66.9	78
Flows parallel to I-895 then underneath Belle Grove Road	Stream Restoration (SPSC)	SPSC	Patapsco River LNB	199.0	73.2	70
Bound by I-895 on east & private commercial property on St Thomas Ave on the west	Stream Restoration (SPSC)	SPSC	Patapsco River LNB	33.0	6.3	70
East of I-895 and north of Hammonds Lane	Stream Restoration (SPSC)	SPSC	Patapsco River LNB	25.0	4.1	70
Off of Belle Grove Road & owned by American Legion	Stream Restoration (SPSC)	SPSC	Patapsco River LNB	5.0	4.2	70
Located along Belle Grove Road & owned by State of Maryland	Stream Restoration (SPSC)	SPSC	Patapsco River LNB	48.0	10.8	70
Bordered on the north by Baltimore Washington Parkway on the east by Hammonds Ferry, & on the west by West Nursery Road	Stream Restoration (SPSC)	SPSC	Patapsco River LNB	6.6	1.7	70

Proposed Urban Retrofit Project	Proposed Project Type	BMP Classification Based on Table 2-2	Bacteria TMDL Watershed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)	Potential Bacteria Removal Efficiency (percent)
Bordered on the north by Baltimore Washington Parkway on the east by Hammonds Ferry and on the west by West Nursery Road	Stream Restoration (SPSC)	SPSC	Patapsco River LNB	55.7	23.9	70
Bordered on the north by Baltimore Washington Parkway on the east by Hammonds Ferry and on the west by West Nursery Rd	Constructed Wetland	Shallow Marsh	Patapsco River LNB	57.8	3.7	78
Bordered on the north by Baltimore Washington Parkway on the east by Hammonds Ferry and on the west by West Nursery Rd	Constructed Wetland	Shallow Marsh	Patapsco River LNB	2.9	0.9	78
601-611 North Hammonds Ferris, Linthicum, MD	Wet Pond	Retention Pond	Patapsco River LNB	48.0	10.0	70
806 Central Avenue, Linthicum	Wet Pond	Retention Pond	Patapsco River LNB	10.2	3.1	70
Behind 419 Jerome Avenue, Linthicum Heights	Infiltration Basin	Infiltration Basin	Patapsco River LNB	3.7	0.4	96
Behind 1467 Fairbanks Drive, Hanover, MD	Wet Pond	Retention Pond	Patapsco River LNB	58.0	5.5	70
7306 Musical Way, Severn	Infiltration Basin	Infiltration Basin	Patapsco River LNB	13.9	2.7	96
7900 Severn Hills Way, Severn	Wet Pond	Retention Pond	Patapsco River LNB	10.1	1.4	70
Gesna Drive (off Pinyon Road), Hanover	Wetland	Shallow Marsh	Patapsco River LNB	36.1	4.4	78
Gesna Drive (South of Siden) Hanover, MD	Wet Pond	Retention Pond	Patapsco River LNB	13.1	1.8	70
East of 7924 Green Moss Glen, Severn, MD	Wet Pond	Retention Pond	Patapsco River LNB	21.5	3.0	70
Behind 7508 Terrain Court, Hanover	Wet Pond	Retention Pond	Patapsco River LNB	10.1	0.8	70
Harmons Woods; south of Strider Court	SPSC	SPSC	Patapsco River LNB	20.9	2.5	70
Harmons Woods; south of Strider Court	SPSC	SPSC	Patapsco River LNB	75.5	8.3	70

Proposed Urban Retrofit Project	Proposed Project Type	BMP Classification Based on Table 2-2	Bacteria TMDL Watershed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)	Potential Bacteria Removal Efficiency (percent)
Behind 6202 Grovel Road, Linthicum Heights MD	SPSC	SPSC	Patapsco River LNB	16.1	4.4	70
Sheckells Road	Infiltration Basin	Infiltration Basin	Patapsco River/Furnace Creek	1.3	0.2	96
East end of Chalmers Avenue	Infiltration Basin	Infiltration Basin	Patapsco River/Furnace Creek	21.8	4.1	96
711 Towering Oaks Court, Glen Burnie	Infiltration	Infiltration Basin	Patapsco River/Furnace Creek	7.8	1.1	96
Baby Bear Court	Infiltration	Infiltration Basin	Patapsco River/Furnace Creek	11.5	1.2	96
1506 Lochaber Court	Wet Pool	Micropool Extended Detention Pond	Patapsco River/Furnace Creek	16.9	1.6	70
17 McNeil Ct, Glen Burnie, MD[1]	Wet Pond	Retention Pond	Patapsco River/Furnace Creek	11.9	1.1	70
Intersection of Foxwell Bend Road and Hospital Drive	Wet pond with high and low marsh	Shallow Marsh	Patapsco River/Marley Creek	29.0	2.9	78
Fox Cub Court	Wet pond with high and low marsh	Shallow Marsh	Patapsco River/Marley Creek	14.5	1.8	78
Fox Cub Court	Wet pond with high and low marsh	Shallow Marsh	Patapsco River/Marley Creek	14.5	1.8	78
Hospital Drive [2]	SPSC	SPSC	Patapsco River/Marley Creek	6.8	0.9	70
Hospital Drive[2]	SPSC	SPSC	Patapsco River/Marley Creek	13.0	5.8	70
Intersection of Veterans Highway & Harpers Mill Road Millersville[3]	Constructed Wetland	Shallow Marsh	Patapsco River/Marley Creek	48.6	5.2	78

Proposed Urban Retrofit Project	Proposed Project Type	BMP Classification Based on Table 2-2	Bacteria TMDL Watershed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)	Potential Bacteria Removal Efficiency (percent)
600 Rolling Hill Walk Odenton	Constructed Wetland	Shallow Marsh	Severn River Mainstem	8.2	3.6	78
2016 Governor Thomas Bladen Way Annapolis	SPSC	SPSC	Severn River Mainstem	24.8	3.6	70
550 Francis Nicholson Way Annapolis	SPSC	SPSC	Severn River Mainstem	13.0	5.8	70
412 Headquarters Drive Millersville	SPSC	SPSC	Severn River Mainstem	22.3	5.4	70
South of Watch House Circle South, Severn	Constructed Wetland	Shallow Marsh	Severn River Mainstem	29.6	4.5	78
North of Watch House Circle North, Severn	Constructed Wetland	Shallow Marsh	Severn River Mainstem	31.3	3.6	78
2059 Generals Hwy, Annapolis	Wet Pond	Retention Pond	Severn River Mainstem	6.5	0.5	70
Council Oaks Dr, Severn, MD[4]	Wetland Pond	Shallow Marsh	Severn River Mainstem	15.2	4.5	78
Western District Police Station	Wet Pond	Retention Pond	Severn River Mainstem	6.6	1.3	70
East of Ft. Meade, West of Railroad	Wet Pond	Retention Pond	Severn River Mainstem	654.9	60.2	70
On Pasture Brook Road between Silo Road & Loft Court	Constructed Wetland	Shallow Marsh	Severn River Mainstem	30.2	3.0	78
Myers Drive, between Hyde Park Drive & Radnor Court Severn	SPSC	SPSC	Severn River Mainstem	51.6	6.5	70
West of Rustling Oaks Drive, off of Benfield Boulevard	SPSC	SPSC	Severn River Mainstem	78.5	7.9	70
East of FT. Meade, West of Railroad	TBD	Other	Severn River Mainstem	No Data	No Data	70
Mill Race Community Pond, southeast of Veterans Highway & Harpers Mill Road	Constructed Wetland	Shallow Marsh	Severn River Mainstem	48.0	No Data	78
Isabella Court, Millersville	Wetland	Shallow Marsh	Severn River Mainstem	140.2	7.7	78
Old Herald Harbor Road	Constructed Wetland	Shallow Marsh	Severn River Mainstem	35.0	No Data	78

Proposed Urban Retrofit Project	Proposed Project Type	BMP Classification Based on Table 2-2	Bacteria TMDL Watershed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)	Potential Bacteria Removal Efficiency (percent)
Old County Road	SPSC	SPSC	Severn River Mainstem	22.0	No Data	70
West Benefield Road & Pixie Drive	Box Culvert	Other	Severn River Mainstem	338.0	30.7	0
Annapolis Mall	Pond	Retention Pond	Severn River Mainstem	No Data	No Data	70
Various locations around US 50 & Medical Parkway	SPSC	SPSC	Severn River Mainstem	6.4	3.4	70
Brietwert Avenue and Oakton Road	SPSC	SPSC	Severn River Mainstem	13.8	1.7	70
Buttonwood Trail	SPSC	SPSC	Severn River Mainstem	No Data	No Data	70
Benfield Boulevard	SPSC	SPSC	Severn River Mainstem	72.9	7.9	70
Benfield Boulevard	SPSC	SPSC	Severn River Mainstem	TBD	TBD	70
Benfield Boulevard	SPSC	SPSC	Severn River Mainstem	TBD	TBD	70
Benfield Boulevard	SPSC	SPSC	Severn River Mainstem	TBD	TBD	70
Benfield Boulevard	SPSC	SPSC	Severn River Mainstem	TBD	TBD	70
Benfield Boulevard	SPSC	SPSC	Severn River Mainstem	0.5	0.2	70
Benfield Boulevard	SPSC	SPSC	Severn River Mainstem	42.1	6.3	70
Benfield Boulevard	SPSC	SPSC	Severn River Mainstem	No Data	No Data	70
Olde Severna Park Neighborhood	SPSC	SPSC	Severn River Mainstem	37.8	15.9	70
Lakeview Road	SPSC	SPSC	Severn River Mainstem	1.3	0.6	70
LakeView Road	SPSC	SPSC	Severn River Mainstem	7.3	2.5	70
LakeView Road	SPSC	SPSC	Severn River Mainstem	0.6	0.2	70
South of the First United Pentecostal Church, 1535 Richie Highway, Arnold	Constructed Wetland	Shallow Marsh	Severn River/Mill Creek	22.0	1.5	78

Proposed Urban Retrofit Project	Proposed Project Type	BMP Classification Based on Table 2-2	Bacteria TMDL Watershed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)	Potential Bacteria Removal Efficiency (percent)
1550 Comanche Road	Dry Pond	Detention Structure Dry (Dry Pond)	Severn River/Mill Creek	11.8	1.5	88
48 Old Sturbridge Road	Dry Pond	Detention Structure Dry (Dry Pond)	Severn River/Mill Creek	No Data	No Data	88
1681 Nickerson Way	Dry Pond	Detention Structure Dry (Dry Pond)	Severn River/Mill Creek	No Data	No Data	88
Off Broadneck Creek Road at the end of Pennington Lane South	SPSC	SPSC	Severn River/Whitehall and Meredith Creek	24.7	2.3	70
Loch Haven Road & Havenhill Road	Wet Pond	Retention Pond	South River Mainstem	7.5	0.8	70
Wordsworth & Breckenridge Way	Updated Wet Pond	Retention Pond	South River Mainstem	70.3	10.6	70
Howards Point Road & Stepney Lane, Edgewater	Updated Pond	Retention Pond	South River Mainstem	52.2	9.2	70
619 Dillon Court	Wet Pond	Retention Pond	South River Mainstem	12.2	1.5	70
Southdown Road	SPSC	SPSC	South River Mainstem	84.6	24.8	70
2930 Spring Lakes Drive[5]	Wet Pond	Retention Pond	South River Mainstem	80.3	No Data	70
Riva Road. North Broad Creek	SPSC	SPSC	South River Mainstem	10.4	4.2	70
Truman Parkway	SPSC	SPSC	South River Mainstem	10.7	3.4	70
Truman Parkway/Golf Ridge Road	SPSC	SPSC	South River Mainstem	25.9	10.7	70
Across from 3233 Homewood Road	SPSC	SPSC	South River Mainstem	27.5	4.0	70
On Breckenridge Way south of Wordsworth	SPSC	SPSC	South River Mainstem	104.3	31.2	70
Admiral Cochrane & Route 2	SPSC	SPSC	South River Mainstem	5.4	4.1	70
Riva Road at Camp Woodlands	SPSC	SPSC	South River Mainstem	8.4	2.4	70

Proposed Urban Retrofit Project	Proposed Project Type	BMP Classification Based on Table 2-2	Bacteria TMDL Watershed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)	Potential Bacteria Removal Efficiency (percent)
Admiral Cochrane & Route 2	SPSC	SPSC	South River Mainstem	27.3	6.8	70
Admiral Cochrane & Route 2	SPSC	SPSC	South River Mainstem	18.8	15.3	70
Admiral Cochrane & Route 2	SPSC	SPSC	South River Mainstem	17.7	4.6	70
Admiral Cochrane & Route 2	SPSC	SPSC	South River Mainstem	41.5	13.3	70
Old Annapolis Neck	Wet Pond	Retention Pond	South River/Duvall Creek	13.1	2.0	70

[1]-This project even though listed under the Patapsco Non-Tidal Watershed, it is included in Furnace Watershed in this Plan. This is due to discrepancy in the watershed boundaries between the County and the MDE GIS data.
[2]-This project even though listed under the Patapsco Non-Tidal Watershed, it is included in Marley Watershed in this Plan. This is due to discrepancy in the watershed boundaries between the County and the MDE GIS data.
[3]-This project even though listed under the Severn River Mainstem Watershed, it is included in Marley Watershed in this Plan. This is due to discrepancy in the watershed boundaries between the County and the MDE GIS data.
[4]-This project even though listed under the Patuxent River Watershed, it is included in Severn River Mainstem Watershed in this Plan. This is due to discrepancy in the watershed boundaries between the County and the MDE GIS data.
[5]-This project even though listed under the South River Watershed, it is included in Severn River Mainstem Watershed in this Plan. This is due to discrepancy in the watershed boundaries between the County and the MDE GIS data.

Riparian Buffer Education

Riparian buffers help reduce non-human bacteria source loads from the watershed by slowing down and filtering stormwater runoff before it discharges to the waterway. COMAR requires a 100-foot minimum riparian buffer, or larger if steep slopes, hydric soils, highly erodible soils, nontidal wetland, or a Nontidal Wetland of Special State Concern are present (see COMAR 27.02.01.01). Maintaining a minimum buffer size helps preserve the water quality function of the buffer. Development pressure may potentially alter the buffer over time, resulting in a reduced ability of the buffer to filter pollutants (Caraco, 2013b). For this Tier B strategy, the proposed conditions WTM was used to estimate the expected bacteria load reductions from implementing a riparian buffer education program in areas where the buffer is reduced or altered, or where private property abuts the waterway. The education program is recommended to include buffer enhancement components, such as no mow areas, planting trees and shrubs, and promoting the growth of native vegetation.

Expanded Pet Waste Education Program

This strategy involves implementing a multi-media-based pet waste education program to encourage pet owners to pick up after their pets. Other related practices such as dog park improvements, more pet waste stations, and increased enforcement of leash laws may also help to instill behavior change in pet owners and reduce bacteria loads from pet waste. According to MDE's published TMDL reports, pet waste is one of the primary bacteria sources in many of the TMDL watersheds (see Table 2-11); therefore, implementing a strategy to reduce pet waste at its source may potentially have a large impact on improving water quality in the County's impaired waterways.

Some possibilities for an expanded pet waste education program and related practices include:

- Expanding the number of pet waste stations in residential areas and County public parks. Based on a website developed by Winters (2015), there are 11 mapped pet waste stations along the Baltimore and Annapolis Trail, 20 mapped stations in the Annapolis area, and 5 mapped stations in Crofton, although these are only the mapped stations and there are likely many more opportunities throughout the County.
- Increasing signage about leash laws and ranger presence at public parks to enforce leash laws and issue citations
- Developing Public Service Announcements (PSAs) for television and post professionally made videos to the County website. An example of a PSA video, which was developed by the state of Washington and cost $27,000 to develop, is available at http://mynorthwest.com/11/512462/Washington-uses-dog-doogity-music-video-to-encourage-pet-waste-cleanup
- Improving management of pet waste at existing dog parks

- Providing grants to communities to install pet waste stations on community properties.

Bacteria load reductions from implementing a pet waste education program were estimated using the methodology proposed in the Virginia Department of Environmental Quality's (DEQ's) *Bacterial Implementation Plan Development for the James River and Tributaries – City of Richmond Technical Report* (VA DEQ, 2011). The bacteria loads from pet waste were computed by applying the percent of bacteria load contribution from pet waste from the TMDL reports (Table 2-19). To estimate the load reduction, 25 percent bacteria removal efficiency was used, again based on VA DEQ (2011). The amount of load reduction was subtracted from the total load to get the adjusted load. The percent load reduction was then calculated as the difference between the total load and the adjusted load. This is summarized as follows:

1. $TMDL\ Total\ Load\ x\ \%\ Pet\ Sources\ from\ TMDL\ Bacteria\ Source\ Distribution\ x\ 25\%\ Removal\ Efficency = Amount\ of\ Load\ Reduction$
2. $TMDL\ Total\ Load - Amount\ of\ Load\ Reduction = Adjusted\ Load$
3. $\frac{(TMDL\ Total\ Load - Adjusted\ Load)}{TMDL\ Total\ Load}\ x\ 100 = \%\ Estimated\ Load\ Reduction$

Livestock Fencing (Two TMDL Watersheds Only)

This Tier B strategy proposes to install livestock fencing along streams in pasture areas to prevent grazing livestock from accessing the stream. A study by Zeckoski and Lunsford (2012) in Virginia found that water quality improved once livestock fencing was installed, and the excluded livestock put on 5 to 10 percent additional weight over 9 to 10 months when provided with alternative water sources such as springs and wells. The study also states that livestock fencing may potentially reduce the risk of livestock disease associated with the livestock drinking from the same stream water that is contaminated with their waste.

There are various types of livestock fencing systems available. A simple solution is to provide a trough or alternative water source in the upland area away from the stream; this measure alone may reduce the amount of time the livestock spend in the stream by 80 to 99 percent because livestock prefer drinking from troughs (Zeckoski and Lunsford 2012). More complex systems involve both streamside fencing and cross fencing, i.e., a hardened controlled access point where livestock may cross the stream to reach pasture on the other side without being able to drink from the stream.

The Tier B proposed strategy of livestock fencing is recommended in the Patuxent River Upper and West River mainstem watersheds because these are the only watersheds that have sufficient pastures to support livestock and have a relatively large contribution from livestock waste (see Table 2-9 and Table 2-19). Load reductions from implementing livestock fencing were estimated by reducing the existing loads from livestock waste by 50 percent.

Canada Goose Management (Site-Specific)

This Tier B strategy involves management of non-migratory Canada goose populations at sites that contain open water, such as ponds, parks, golf courses, campuses, and shorelines. There are many potential management techniques for Canada geese. These include lethal controls (euthanasia, egg addling/oiling, hunting), exclusion methods (fencing, vegetative barriers), habitat alteration (reducing mowing, planting less palatable grass species, steepening banks), public education (signs and handouts at public parks), bird dispersal methods (harassment with trained dogs), and molt capture programs where the captured geese can be processed for food through a program called Farmers and Hunters Feeding the Hungry**.** Multiple techniques are recommended, as geese readily adapt to any single technique. Over the long-term, the more effective methods will be those that reduce the population rather than those that simply disperse the geese to other areas. According to French and Parkhurst (2009), geese often return to the same nesting areas unless transported at least 200 miles away. The U.S. Department of Agriculture's Wildlife Services and Maryland Department of Natural Resources' (DNR's) Wildlife and Heritage Services are potential partners for the County to work with to develop goose management programs.

For the purposes of this TMDL Restoration Plan, the bacteria load reductions were estimated by assuming that 25 percent of existing Canada geese would be removed through various management techniques similar to those described above. The potential bacteria load reductions from this strategy were calculated as follows:

- $TMDL\ bacteria\ load\ from\ geese\ =$ $TMDL\ total\ load\ x\ \%\ wildlife\ x\ \%\ geese\ out\ of\ total\ wildlife$
- $Total\ bacteria\ load\ from\ geese\ x\ 25\%\ = Amount\ of\ load\ reduction$
- $TMDL\ total\ load - amount\ of\ load\ reduction\ = adjusted\ load$
- $\frac{(TMDL\ total\ load - adjusted\ load)}{TMDL\ total\ load}\ x\ 100\% = \%\ estimated\ load\ reduction$

4.2 IMPLEMENTATION COSTS OF PROPOSED RESTORATION STRATEGIES

The costs of the proposed Tier A and Tier B restoration strategies were estimated from local literature sources, the County's CIP annual budget reports, and in some cases best professional judgment based on a range of approximate costs from available literature. The costs of non-structural strategies such as pet waste education and goose management were generally more difficult to estimate due to the lack of available data. The available data unit costs were estimated as follows:

- **Urban Stormwater Management Retrofits**: County CIP and budget reports. Cost per project is currently unavailable at this time and a budgeted cost for all the projects planned at watershed level is included in this plan.

- **Abatement of SSOs**: varies by SPS upgrade project. Average cost of 34 planned or active projects is $9,950,171, estimated from CIP wastewater budget reports.
- **Retirement of County septic systems**: $51,000 per septic system, estimated from County Phase II WIP; this may be a high estimate and would be revised in the annual progress report for this restoration plan based on actual implementation costs
- **Livestock fencing**: $12,400 per system, $4.00 per linear foot to install and maintain fencing (Zeckoski and Lunsford 2012)
- **Identification and Elimination of household illicit connections**: $121,000 per year, estimated from County 2013 NPDES MS4 Annual Report (Anne Arundel County, 2014)
- **Expanded pet waste education program**: $150,000 per year (includes pet waste video for $27,000 and several television PSAs at $10,000 to $12,000 each)
- **Riparian buffer education program**: $60,000 per year, estimated from other types of education programs cited in the literature
- **Goose management program**: $25,000 to $300,000, depending on intensity of program

4.3 POLLUTANT LOAD REDUCTIONS

As mentioned previously, water quality models were developed using the Center for Watershed Protection's WTM to characterize and quantify the bacteria loads for existing conditions. The model was also used to estimate the pollutant load reductions from restoration measures as described in the following sections. Appendix A contains the WTM modeling approach and results.

4.3.1 Estimation of Load Reductions from Prior Management Measures

MDE (2014b) recommends estimating load reductions from prior management measures to account for progress toward TMDL goals made to date. In the case of the County's bacteria TMDLs, about 10 to 15 years have elapsed since the development of the TMDLs, during which time the County has implemented BMPs and retired septic systems, both of which provide credit for bacteria removal.

To estimate the credit for bacteria removal from the BMPs already implemented, a methodology was developed through correspondence with MDE staff. The methodology involved entering the original TMDL data from the MDE published TMDL reports from 2000 into the WTM and calibrating the WTM baseline loads to the MDE baseline loads. Then, the post-TMDL BMPs and the post-TMDL septic system retirements were entered in the model and the percent reduction relative to the MDE baseline was calculated. "Post-TMDL" refers to the period from 2000 to present (i.e. end of year 2014). The year 2000 was used as the cut-off because that was the year of the land use data MDE used to develop the TMDLs.

The calculated bacteria load reductions from prior management measures are presented in Table 4-6 below for each of the TMDL watersheds. The BMP data provided by the County as a part of the 2015 NPDES MS4 Annual Report (Anne Arundel County, 2015a) was used to estimate the potential load reductions from the BMPs implemented after 2000. Bacteria load reductions from septic system retirement were typically less than 1 percent (0.88 percent on average) because few have been retired since 2000. In many watersheds, no septic systems have been retired.

The prior percent load reductions from post-TMDL BMPs and from post-TMDL septic system retirements were added together and subtracted from the overall TMDL-required percent load reduction. The resulting "adjusted" TMDL required percent reduction represents the remaining bacteria load reduction that is required to be achieved to meet the TMDL water quality goals (Table 4-6). On average, the adjusted TMDL reduction was 4.19 percent lower than the original TMDL reduction (Table 4-6).

Table 4-6: Estimates of Load Reductions from Prior Management Measures and Corresponding Adjustments to TMDL Required Percent Reductions

Bacteria TMDL Watershed	Prior Load Reductions Since 2000		TMDL Targets	
	Post-TMDL BMPs (%)	Post-TMDL Septic System Retirement (%)	TMDL Target Reduction Requirements (%)	Adjusted TMDL Required Reduction (%)
Magothy Mainstem	3.04	0.61	12.80	9.15
Magothy River/Forked Creek	6.25	None	26.30	20.05
Magothy River/Tar Cove	2.23	None	0.00	0.00
Patapsco River/Furnace Creek	3.65	0.38	77.70	73.67
Patapsco River LNB	3.96	2.61	20.70	14.13
Patapsco River/Marley Creek	5.83	0.26	75.70	69.61
Patuxent River Upper	4.54	None	22.30	17.82
Rhode River/Bear Neck Creek	2.23	None	43.30	41.07
Rhode River/Cadle Creek	6.25	None	72.20	65.95
Severn River Mainstem	1.18	0.35	19.00	17.47
Severn River/Mill Creek	6.82	None	86.00	79.18
Severn River/Whitehall and Meredith Creek	4.42	0.43	90.00	85.15
South River/Duvall Creek	3.13	None	45.60	42.47
South River Mainstem	9.06	0.06	29.50	20.38
South River/Ramsey Lake	5.72	None	59.30	53.58
South River/Selby Bay	1.30	None	0.00	0.00
W. Chesapeake Bay/Tracy and Rockhold Creeks	0.35	2.70	81.60	78.55
West River Mainstem	1.38	0.48	35.30	33.44
West River/Parish Creek	0.45	None	53.10	52.65
Average:	3.78	0.88	Average Adjustment = 4.19% lower	

4.3.2 Estimation of Load Reductions for Proposed Strategies

This section provides estimations of potential bacteria load reductions for the proposed Tier A and Tier B strategies described in Sections 4.1.1 and 4.1.2. The load reductions were estimated using modeling techniques, local literature sources, and County data.

The estimated bacteria load reductions are presented in Table 4-7A through Table 4-7I below for all of the TMDL watersheds. Each table includes the estimated load reductions associated with each strategy, the total estimated cost of the strategy, a cost-benefit ratio, and the Tiered Recommendation (either A or B). Also included are the total estimated load reductions for implementing all Tier A strategies, all Tier B strategies, all Tier A and Tier B strategies combined, and the adjusted TMDL required percent reduction, which reflects the remaining reductions needed to meet the TMDL after prior load reductions are accounted for (see Section 4.3.1). The Tier B strategy of livestock fencing is presented as a strategy for only two of the TMDL watersheds (the Patuxent River Upper and the West River Mainstem) since these are the only two where sufficient pasture exists to support livestock.

The load estimation tables show that the greatest bacteria reductions were attributed to the Tier B strategy of pet waste education in seven of the 19 TMDL watersheds (Magothy Mainstem, Forked Creek, Bear Neck Creek, Cadle Creek, Duvall Creek, Ramsey Lake, and Selby Bay), and pet waste education was also one of the most cost-effective strategies. In other watersheds, the highest load reductions were correlated with various Tier A (human sources) and Tier B (non-human sources) strategies, as follows:

- Septic system retirement resulted in the greatest load reductions in Tar Cove, Mill Creek, Whitehall-Meredith Creeks, Patuxent River Upper and South River Mainstem watersheds
- Removal of household illicit connections resulted in the greatest load reductions in the Patapsco River LNB, Marley Creek, Severn River Mainstem and South River Mainstem watersheds
- Restoration of 20 percent impervious cover with high pollutant removal efficiency practices such as SPSCs resulted in the greatest load reductions in the Patapsco River LNB, South River Mainstem and Severn River Mainstem watersheds
- Riparian buffer education resulted in the greatest load reductions in the Patuxent River Upper watershed
- SSO abatement resulted in the greatest load reductions in the Patapsco River LNB, Cadle Creek and Parish Creek watershed
- Livestock fencing resulted in the greatest load reductions in the West River Mainstem watershed (of the two pasture watersheds where this strategy was applicable)
- Goose management resulted in the greatest load reductions in the Tracy and Rockhold Creeks, Whitehall-Meredith Creek, Mill Creek and Parish Creek watersheds.

Non-structural Tier B strategies such as pet waste education, riparian buffer education, and goose management were relatively cost-effective compared to structural Tier A strategies such as SPS upgrades and septic system retirement. Livestock fencing was also highly cost-effective in the two pasture watersheds where it was proposed as a strategy (Patuxent River Upper and West River mainstem). Even though urban stormwater management, including implementing new stormwater management facilities and retrofitting pre-2002 stormwater management facilities have high implementation costs, they are required to be implemented by the County to restore 20 percent of unmanaged impervious cover, and therefore these measures would be effective in reducing the bacteria loads.

The magnitude of the load reduction requirements indicates that multiple strategies will need to be implemented in combination in each TMDL watershed to achieve the required TMDL percent reductions. In many of the watersheds, implementing all Tier A and all Tier B strategies is sufficient to meet, or come close to meeting, the TMDL goals. However, this is not the case in ten of the watersheds, where implementing all the Tier A and Tier B strategies is still not enough to meet the TMDL required reductions. These watersheds are: Furnace Creek (Table 4-7C), Marley Creek (Table 4-7C), Bear Neck Creek (Table 4-7E), Cadle Creek (Table 4-7E), Mill Creek (Table 4-7F), Whitehall-Meredith Creek (Table 4-7F), Duvall Creek (Table 4-7G), Ramsey Lake (Table 4-7G),Tracy-Rockhold Creek (Table 4-7H), and Parish Creek (Table 4-7I). Load reductions in these watersheds are limited by factors such as lack of stormwater management retrofit projects, SPS upgrade, and septic system retirement opportunities. For example, in the Ramsey Lake watershed, there are no currently planned existing stormwater management projects or SPS upgrade projects.

Load reductions in Cadle Creek, Duvall Creek, and Ramsey Lake watersheds can be achieved by prioritizing the pet waste education in high-density residential areas. Additional reductions can be achieved in all the identified ten watersheds with the implementation of additional stormwater management practices by the County as a part of the CIP program. To achieve the TMDL goals in these watersheds, additional restoration opportunities with bacteria removal benefits will need to be identified, and multiple non-structural strategies such as pet waste education and possibly goose management will need to be implemented on a large scale to restore the water quality standards of the impaired waterways.

The costs provided for the urban stormwater management retrofits in Tables 4-7A through 4-7I are the costs for stormwater management CIP projects budgeted by the County at the watershed level and may include implementation costs for projects that are located in the portions of the watershed that do not have the bacteria TMDL.

Table 4-7A: Estimated Load Reductions for Proposed Strategies in the Magothy Mainstem, Forked Creek, and Tar Cove Watersheds

TMDL Watershed: Magothy Mainstem				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	1.95%	$54.29	2784.1	B
Eliminate Household Illicit Connections	9.05%	$0.61	6.7	A
Abatement of SSOs	1.12%	$82.26	7344.6	A
Septic Retirement/Connection	0.26%	$4.49	1726.2	A
Riparian Buffer Education	0.85%	$0.06	7.1	B
Expanded Pet Waste Education	16.30%	$0.15	0.9	B
Expanded Goose Management Program	2.88%	$0.03	1.0	B
All Tier A Strategies:	**10.43%**			
All Tier B Strategies:	**21.98%**			
All Strategies:	**32.41%**			
Adjusted TMDL Required % Reduction:	**9.15%**			
TMDL Watershed: Magothy River/Forked Creek				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	1.14%	$0.61	53.5	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	0.11%	$0.10	92.7	A
Riparian Buffer Education	1.74%	$0.06	3.4	B
Expanded Pet Waste Education	21.45%	$0.15	0.7	B
Expanded Goose Management Program	1.73%	$0.03	1.7	B
All Tier A Strategies:	**1.25%**			
All Tier B Strategies:	**24.92%**			
All Strategies:	**26.17%**			
Adjusted TMDL Required % Reduction:	**20.05%**			

Table 4-7A Continued: Estimated Load Reductions for Proposed Strategies in the Magothy Mainstem, Forked Creek, and Tar Cove Watersheds

TMDL Watershed: Magothy River/Tar Cove				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	0.67%	$0.61	91.0	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	0.46%	$1.58	343.7	A
Riparian Buffer Education	0.92%	$0.06	6.5	B
Expanded Pet Waste Education	13.60%	$0.15	1.1	B
Expanded Goose Management Program	4.27%	$0.03	0.7	B
All Tier A Strategies:	**1.13%**			
All Tier B Strategies:	**18.79%**			
All Strategies:	**19.92%**			
Adjusted TMDL Required % Reduction:	**0.0%**			

Table 4-7B: Estimated Load Reductions for Proposed Strategies in the Patapsco River Lower North Branch Watershed

TMDL Watershed: Patapsco River Lower North Branch				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	4.80%	$45.31	944.0	B
Eliminate Household Illicit Connections	11.76%	$0.61	5.2	A
Abatement of SSOs	4.96%	$101.39	2044.2	A
Septic Retirement/Connection	0.10%	$0.15	153.0	A
Riparian Buffer Education	2.73%	$0.06	2.2	B
Expanded Pet Waste Education	6.50%	$0.15	2.3	B
Expanded Goose Management Program	0.79%	$0.03	3.8	B
All Tier A Strategies:	**16.82%**			
All Tier B Strategies:	**14.82%**			
All Strategies:	**31.64%**			
Adjusted TMDL Required % Reduction:	**14.13%**			

Table 4-7C: Estimated Load Reductions for Proposed Strategies in the Furnace Creek and Marley Creek Watersheds

Proposed Strategy	Expected % Load Reduction	Total Estimated Cost in Millions	Cost-Benefit Ratio	Tiered Recommendation
TMDL Watershed: Patapsco River/Furnace Creek				
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	0.10%	$104.81	104810	B
Eliminate Household Illicit Connections	8.27%	$0.61	7.4	A
Abatement of SSOs	3.75%	$15.74	419.7	A
Septic Retirement/Connection	0.07%	$0.26	364	A
Riparian Buffer Education	1.41%	$0.06	4.3	B
Expanded Pet Waste Education	7.35%	$0.15	2.0	B
Expanded Goose Management Program	4.98%	$0.03	0.6	B
All Tier A Strategies:	**12.09%**			
All Tier B Strategies:	**13.84%**			
All Strategies:	**25.93%**			
Adjusted TMDL Required % Reduction:	**73.67%**			
TMDL Watershed: Patapsco River/Marley Creek				
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	0.53%	$93.30	17604	B
Eliminate Household Illicit Connections	11.21%	$0.61	5.4	A
Abatement of SSOs	2.12%	$13.88	654.7	A
Septic Retirement/Connection	N/A	N/A	N/A	A
Riparian Buffer Education	1.52%	$0.06	3.9	B
Expanded Pet Waste Education	8.65%	$0.15	1.7	B
Expanded Goose Management Program	4.08%	$0.03	0.7	B
All Tier A Strategies:	**13.33%**			
All Tier B Strategies:	**14.78%**			
All Strategies:	**28.11%**			
Adjusted TMDL Required % Reduction:	**69.61%**			

Table 4-7D: Estimated Load Reductions for Proposed Strategies in the Patuxent River Upper Watershed. Note that a Livestock Fencing Strategy is included since this Watershed Contains Some Agricultural Land.

Proposed Strategy	Expected % Load Reduction	Total Estimated Cost in Millions	Cost-Benefit Ratio	Tiered Recommendation
TMDL Watershed: Patuxent River Upper				
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	1.14%	$0.61	53.6	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	0.38%	$0.26	67.1	A
Riparian Buffer Education	20.57%	$0.06	0.3	B
Expanded Pet Waste Education	4.50%	$0.15	3.3	B
Expanded Goose Management Program	4.58%	$0.03	0.7	B
Livestock Fencing	14.00%	$0.13	0.9	B
All Tier A Strategies:	**1.52%**			
All Tier B Strategies:	**43.65%**			
All Strategies:	**45.17%**			
Adjusted TMDL Required % Reduction:	**17.82%**			

Table 4-7E: Estimated Load Reductions for Proposed Strategies in the Bear Neck and Cadle Creek Watersheds

TMDL Watershed: Rhode River/Bear Neck Creek				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	0.50%	$0.61	122.0	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	N/A	N/A	N/A	A
Riparian Buffer Education	0.11%	$0.06	54.5	B
Expanded Pet Waste Education	8.48%	$0.15	1.8	B
Expanded Goose Management Program	2.58%	$0.03	1.2	B
All Tier A Strategies:	**0.50%**			
All Tier B Strategies:	**11.17%**			
All Strategies:	**11.67%**			
Adjusted TMDL Required % Reduction:	**41.07%**			
TMDL Watershed: Rhode River/Cadle Creek				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	0.30%	$0.61	203.3	A
Abatement of SSOs	8.50%	$16.03	188.6	A
Septic Retirement/Connection	N/A	N/A	N/A	A
Riparian Buffer Education	0.70%	$0.06	8.6	B
Expanded Pet Waste Education	20.05%	$0.15	0.7	B
Expanded Goose Management Program	2.55%	$0.03	1.2	B
All Tier A Strategies:	**8.80%**			
All Tier B Strategies:	**23.30%**			
All Strategies:	**32.10%**			
Adjusted TMDL Required % Reduction:	**65.95%**			

Table 4-7F: Estimated Load Reductions for Proposed Strategies in the Severn River Mainstem, Mill Creek, and Whitehall-Meredith Creek Watersheds

TMDL Watershed: Severn River Mainstem				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	0.80%	$71.40	8925.0	B
Eliminate Household Illicit Connections	19.40%	$0.61	3.1	A
Abatement of SSOs	0.37%	$25.77	6946.1	A
Septic Retirement/Connection	0.20%	$5.10	2550.0	A
Riparian Buffer Education	1.43%	$0.06	4.2	B
Expanded Pet Waste Education	17.20%	$0.15	0.9	B
Expanded Goose Management Program	3.78%	$0.03	0.8	B
All Tier A Strategies:	**19.97%**			
All Tier B Strategies:	**23.21%**			
All Strategies:	**43.18%**			
Adjusted TMDL Required % Reduction:	**17.47%**			
TMDL Watershed: Severn River/Mill Creek				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	0.65%	$20.14	3098.5	B
Eliminate Household Illicit Connections	1.54%	$0.61	39.6	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	0.63%	$1.07	170.0	A
Riparian Buffer Education	2.50%	$0.06	2.4	B
Expanded Pet Waste Education	9.50%	$0.15	1.6	B
Expanded Goose Management Program	7.72%	$0.03	0.4	B
All Tier A Strategies:	**2.17%**			
All Tier B Strategies:	**20.37%**			
All Strategies:	**22.54%**			
Adjusted TMDL Required % Reduction:	**79.18%**			

Table 4-7F Continued: Estimated Load Reductions for Proposed Strategies in the Severn River Mainstem, Mill Creek Southern, and Whitehall-Meredith Creek Watersheds

TMDL Watershed: Severn River/Whitehall and Meredith Creek				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	0.63%	$16.71	2652.4	B
Eliminate Household Illicit Connections	0.96%	$0.61	63.5	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	0.42%	$0.31	72.9	A
Riparian Buffer Education	2.13%	$0.06	2.8	B
Expanded Pet Waste Education	6.50%	$0.15	2.3	B
Expanded Goose Management Program	9.29%	$0.03	0.3	B
All Tier A Strategies:	**1.38%**			
All Tier B Strategies:	**18.55%**			
All Strategies:	**19.93%**			
Adjusted TMDL Required % Reduction:	**85.15%**			

Table 4-7G: Estimated Load Reductions for Proposed Strategies in the South River Mainstem, Duvall Creek, Ramsey Lake, and Selby Bay Watersheds

TMDL Watershed: South River Mainstem				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	2.00%	$72.22	3611	B
Eliminate Household Illicit Connections	11.40%	$0.61	5.4	A
Abatement of SSOs	0.31%	$31.47	10152	A
Septic Retirement/Connection	0.29%	$1.58	545.2	A
Riparian Buffer Education	7.30%	$0.06	0.8	B
Expanded Pet Waste Education	10.83%	$0.15	1.4	B
Expanded Goose Management Program	4.44%	$0.03	0.7	B
All Tier A Strategies:	**12.00%**			
All Tier B Strategies:	**24.57%**			
All Strategies:	**36.57%**			
Adjusted TMDL Required % Reduction:	**20.38%**			
TMDL Watershed: South River/Duvall Creek				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	0.83%	$7.89	950.6	B
Eliminate Household Illicit Connections	0.65%	$0.61	93.8	A
Abatement of SSOs	6.40%	$45.89	717.0	A
Septic Retirement/Connection	N/A	N/A	N/A	A
Riparian Buffer Education	N/A	N/A	N/A	B
Expanded Pet Waste Education	17.00%	$0.15	0.9	B
Expanded Goose Management Program	2.16%	$0.03	1.4	B
All Tier A Strategies:	**7.05%**			
All Tier B Strategies:	**19.99%**			
All Strategies:	**27.04%**			
Adjusted TMDL Required % Reduction:	**42.47%**			

Table 4-7G Continued: Estimated Load Reductions for Proposed Strategies in the South River Mainstem, Duvall Creek, Ramsey Lake, and Selby Bay Watersheds

TMDL Watershed: South River/Ramsey Lake				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	0.11%	$0.61	554.5	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	N/A	N/A	N/A	A
Riparian Buffer Education	0.12%	$0.06	50.0	B
Expanded Pet Waste Education	15.73%	$0.15	1.0	B
Expanded Goose Management Program	4.81%	$0.03	0.6	B
All Tier A Strategies:	**0.11%**			
All Tier B Strategies:	**20.66%**			
All Strategies:	**20.77%**			
Adjusted TMDL Required % Reduction:	**53.58%**			
TMDL Watershed: South River/Selby Bay				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	0.16%	$0.61	381.3	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	N/A	N/A	N/A	A
Riparian Buffer Education	0.06%	$0.06	100.0	B
Expanded Pet Waste Education	15.68%	$0.15	1.0	B
Expanded Goose Management Program	4.58%	$0.03	0.7	B
All Tier A Strategies:	**0.16%**			
All Tier B Strategies:	**20.32%**			
All Strategies:	**20.48%**			
Adjusted TMDL Required % Reduction:	**0.0%**			

Table 4-7H: Estimated Load Reductions for Proposed Strategies in the Tracy and Rockhold Creek Watershed

TMDL Watershed: W. Chesapeake Bay/Tracy and Rockhold Creeks				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	0.23%	$0.61	265.2	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	N/A	N/A	N/A	A
Riparian Buffer Education	7.70%	$0.06	0.8	B
Expanded Pet Waste Education	5.20%	$0.15	2.9	B
Expanded Goose Management Program	9.38%	$0.03	0.3	B
All Tier A Strategies:	**0.23%**			
All Tier B Strategies:	**22.28%**			
All Strategies:	**22.51%**			
Adjusted TMDL Required % Reduction:	**78.55%**			

Table 4-7l: Estimated Load Reductions for Proposed Strategies in the West River Mainstem and Parish Creek Watersheds. Note that a Livestock Fencing Strategy is Included in the West River Mainstem Watershed since this Watershed Contains Some Agricultural Land.

TMDL Watershed: West River Mainstem				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	1.39%	$0.61	43.9	A
Abatement of SSOs	N/A	N/A	N/A	A
Septic Retirement/Connection	N/A	N/A	N/A	A
Riparian Buffer Education	11.90%	$0.06	0.5	B
Expanded Pet Waste Education	3.93%	$0.15	3.8	B
Expanded Goose Management Program	3.51%	$0.03	0.9	B
Livestock Fencing	28.55%	$0.13	0.5	B
All Tier A Strategies:	**1.39%**			
All Tier B Strategies:	**47.89%**			
All Strategies:	**49.28%**			
Adjusted TMDL Required % Reduction:	**33.44%**			
TMDL Watershed: West River/Parish Creek				
Proposed Strategy	**Expected % Load Reduction**	**Total Estimated Cost in Millions**	**Cost-Benefit Ratio**	**Tiered Recommendation**
Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	N/A	N/A	N/A	B
Eliminate Household Illicit Connections	0.19%	$0.61	321.1	A
Abatement of SSOs	12.90%	$5.87	45.5	A
Septic Retirement/Connection	N/A	N/A	N/A	A
Riparian Buffer Education	0.42%	$0.06	14.3	B
Expanded Pet Waste Education	10.05%	$0.15	1.5	B
Expanded Goose Management Program	7.72%	$0.03	0.4	B
All Tier A Strategies:	**13.09%**			
All Tier B Strategies:	**18.19%**			
All Strategies:	**31.28%**			
Adjusted TMDL Required % Reduction:	**52.65%**			

4.4 PROPOSED STRATEGIES WITH LARGEST IMPACT AND RECOMMENDED PRIORITIZATION OF STRATEGIES

The proposed Tier A strategies with the largest impacts are reducing the number of SSOs, retiring County septic systems, and eliminating household illicit connections to reduce human bacteria sources. The proposed Tier B strategies with the largest impacts are a pet waste education program and riparian buffer education program to reduce non-human bacteria sources.

In the 9 TMDL watersheds where SSO abatement is proposed, the bacteria load reductions ranged from 0.3 to 12.90 percent. In the 10 TMDL watersheds where County septic systems were identified for retirement based on County data, the bacteria load reductions ranged from 0.07 to 0.63 percent. Implementing a riparian buffer education program resulted in an estimated load reduction of 0.06 to 20.57 percent among 18 of the 19 TMDL watersheds where buffers occur.

Load reductions from implementing an expanded pet waste education program ranged from 3.93 to 21.45 percent in all 19 TMDL watersheds and were highest in the smaller watersheds with a large proportion of residential urban land, e.g., Forked Creek, Cadle Creek, and Duvall Creek, which have dense shoreline communities that could provide excellent case studies for implementing the pet waste education strategy. In addition, removal of pet waste from along or near the shoreline in these watersheds is likely to have an immediate impact on the water quality of the local impaired waterway due to the proximity of the bacteria sources to the receiving water body.

Prioritization of the proposed strategies considers that some are already part of existing County programs, such as eliminating illicit connections, urban stormwater management, and SPS upgrades, and retiring septic systems. The purpose of including these as strategies in this Bacteria TMDL Restoration Plan is to take advantage of the bacteria load reductions being achieved from the County's existing programs and operations, as well as future load reductions that will be achieved by these programs.

The magnitude of the TMDL required load reductions is such that many strategies will need to be implemented to restore TMDL water quality standards in the impaired waterways. In particular, implementation of a multi-media pet waste education program is strongly recommended due to the large bacteria load reductions that are likely to be achieved with this strategy. In addition, riparian buffer education is also recommended because it is also relatively cost-effective and has wide applicability.

Goose management and livestock fencing are generally cost-effective as well, but are not considered a priority since they have limited applicability, i.e., goose management is only relevant in small localized areas where geese are a nuisance and impact water quality, and livestock fencing is only applicable to the two TMDL watersheds where livestock are noted in the TMDL document as a potential source (i.e., Patuxent River Upper and West River Mainstem).

The proposed strategies are prioritized as listed in Table 4-8 below. The priorities are based on whether the program is in place or not, the estimated magnitude of bacteria load reductions, the relative cost-effectiveness of the strategy, and the applicability of the strategy among the 19 TMDL watersheds.

Table 4-8: General Priority of Proposed Strategies

Proposed Strategy	Tier (A or B)	Priority For Implementation	Relative Cost-Effectiveness	Current Status	Recommendation
Expanded Pet Waste Education Program	B - reduces non-human sources	1	High	Limited Implementation	Implement in all TMDL Watersheds
Riparian Buffer Education	B - reduces non-human sources	2	High	Limited Implementation	Implement in all TMDL Watersheds
Goose Management Program	B - reduces non-human sources	3	High	Limited Implementation	Implemented in Site-Specific Areas Only
Livestock Fencing	B - reduces non-human sources	4	High	Limited Implementation	Implemented in Two Pasture Watersheds Only[1]
Abatement of SSOs	A - reduces human bacteria sources	1 - already in place	Low	Being Implemented	Begin Accounting for Bacteria Load Reductions
Retirement of County Septic Systems	A - reduces human bacteria sources	1 - already in place	Low	Being Implemented	Begin Accounting for Bacteria Load Reductions
Eliminate Household Illicit Connections	A - reduces human bacteria sources	1 - already in place	Moderate	Being Implemented	Begin Accounting for Bacteria Load Reductions
Restore 20% Impervious Cover with Urban Stormwater Management Retrofits	B - reduces non-human sources	1 - already in place	Moderate	Being Implemented	Begin Accounting for Bacteria Load Reductions

1-Patuxent River Upper and West River Mainstem

SECTION FIVE: PUBLIC AND STAKEHOLDER PARTICIPATION

Public participation and stakeholder engagement play an important role in the successful implementation of a TMDL restoration plan. As part of its NPDES MS4 permit, the County is required to engage the public in the TMDL restoration plan development, solicit their input, and incorporate any relevant ideas and program improvements that help achieve the TMDL goals (Part IV.E.3). According to the County's Phase II Watershed Implementation Plan (WIP; Anne Arundel County, 2012a), approximately 64 percent of the land in the County is privately owned; therefore, increasing public awareness of TMDL impairment may result in fostering partnerships with private owners which would lead to greater pollutant load reductions. In addition, the participating public can offer useful on-the-ground information, such as confirmation of livestock and wildlife numbers (and locations where they occur), general knowledge of the local community (e.g., landowners' willingness to implement restoration projects), and information about the local impaired waterway (VA DEQ, 2011; EPA, 2013a).

According to the County, one of the major challenges to engaging the public is that "most citizens do not understand the degree that their individual actions affect waterway health and do not understand how they can be part of the solution" (Anne Arundel County, 2012). Specifically, many people are not aware that nonpoint source pollution can contribute to bacteria loads (WGCAC, 2011). Therefore, it is important to inform the public of the impacts of nonpoint source pollution, and to convey a sense of ownership so that individuals can be better stewards of the environment.

5.1 CURRENT OUTREACH PROGRAMS

Education and Outreach Programs Led by Anne Arundel County Departments

The County currently directs several outreach programs led by various departments, including the Department of Public Works. These outreach programs are aimed at increasing public awareness on issues related to water quality and include activities such as conducting workshops and providing information through brochures, fliers, volunteer programs etc. The County is also promoting public awareness using social media such as Facebook and Twitter. A description of current outreach programs is provided in the County's NPDES MS4 Annual Report (Anne Arundel County, 2014). Table 5-1 lists some of the County's current outreach programs that help increase public awareness related to bacteria impairment.

Table 5-1: County Outreach Programs/Materials that Promote Awareness Related to Bacteria Impairments

Department	Outreach Program/Outreach Materials	Media Type
Department of Public Works	• Rehabilitation and Maintenance of County Sewer Infrastructure • Information on Recent Wastewater Spills • Preventing Sewer Backups • Homeowner's Guide to Septic Tanks • Homeowner's Guide to Grinder Pumps • Recycling Programs/Waste Management • Watershed Stewards Academy • Stream Cleanups	Brochures, Fliers, Information Sessions, Presentation, Facebook, Twitter, Workshops, Volunteer Programs
Department of Health	• Water Quality and Swimming or Fishing in Anne Arundel County Rivers and Creeks • On-Site Sewage Disposal Systems and Private Water Wells • Bay Restoration Fund Program, for Nitrogen-Reducing Pretreatment Units for Septic Systems to Be Installed within the Chesapeake Bay Critical Area • Collapsed Septic Tanks, Overflowing Septic Systems and Failing Septic Systems Interim Health and Safety Requirements • Application Procedures for Property Improvements Where Well or On-Site Septic Systems are Utilized • Maryland Healthy Beaches Campaign	Factsheets, Brochures, Campaigns

Education and Outreach Programs for Livestock and Equine Operations

In addition to the outreach programs above, the Anne Arundel County Soil Conservation District (AASCD) and Maryland Department of Agriculture (MDA) work with farmers and livestock owners to educate them about conservation practices that would help protect natural resources while succeeding in their business operations. As a part of nutrient management, the MDA now requires waters of the State of Maryland to be fenced to prevent animals from accessing them. Based on information provided by AASCD and the U.S. Department of Agriculture (USDA) Animal Census Data (2012), chicken and dairy operations are uncommon in Anne Arundel County, and the majority of the animal population in the County consists of horses.

According to AASCD, the largest animal population in the County is of horses and the owners are not traditional farmers. To educate horse owners on pasture and manure management, MDA has assembled a "Horse Outreach Workgroup" and published a "Horse Owner's Guide" that describes the impact of equine management practices on water resources.

In addition, the AASCD has a "Horse Survey" to collect information from both experienced equine handlers and non-traditional farmers so additional County level education and outreach programs can be developed for them.

A list of MDA and AASCD conservation practices that reduce pathogens from agriculture and livestock operations in surface water is provided below (Table 5-2). Some of these practices are included as a part of MDA's Water Quality Cost-Share Program (MACS) where MDA provides grants to farmers to cover up to 87.5 percent of the implementation costs of these practices.

Table 5-2: List of MDA and AASCD Practices that Address Pathogen Control from Agriculture and Livestock Operations in Surface Waters (MDA, 2014)

Practice Type	Included in MACS	Practice Type	Included in MACS
Access Control	Yes	Riparian Herbaceous Cover	Yes
Alley Cropping	No	Roofs and Covers	No
Animal Mortality Facility	No	Waste Gasification Facility	No
Composting Facility	No	Waste Recycling	No
Conservation Cover	Yes	Waste Separation Facility	No
Constructed Wetland		Waste Storage Facility	No
Filter Strip	Yes	Waste Transfer	No
Karst Sinkhole Treatment	No	Waste Treatment	No
Pumping Plant	No	Waste Treatment Lagoon	Yes
Riparian Forest Buffer	Yes		

Marina Outreach Programs

Raw and poorly managed sewage from boats contain pathogens that cause detrimental effects through either direct contact (e.g., swimming) or other sources (e.g., consumption of shellfish contaminated with sewage). In general, boat waste discharges can have a significant impact on the aquatic environment, especially in small, poorly flushed waterways where pollutant concentrations may reach unusually high levels (Klein, 2007). It is estimated that a single weekend boater flushing untreated sewage into waterways produces the same amount of bacterial pollution as 10,000 people whose sewage passes through a treatment plant (CA DBW, 2014). Based on a survey of 227 Maryland boaters, Strand and Gibson (1990) determined that only 24.8 percent of boaters at marinas with pump-out facilities actually used the facility. According to federal and State law, it is illegal to discharge raw sewage, so enforcing this regulation may discourage illegal discharges. Seventeen of the 19 TMDL watersheds have shoreline and include marinas.

The "Clean Marina Program" is a Maryland DNR voluntary program that promotes environmentally friendly boating practices by certifying those marinas that exceed the State's minimum requirements to prevent polluted runoff. Marinas are designated as Clean Marinas if

they comply with all pertinent environmental regulations and permits while providing training and outreach to staff and customers on preventing polluted runoff (e.g., sewage handling, petroleum control, proper vessel cleaning, waste containment, and waste disposal). There are currently 129 certified Maryland Clean Marinas in the State of Maryland, and approximately 32 in Anne Arundel County bacteria TMDL watersheds (Maryland DNR, 2015).

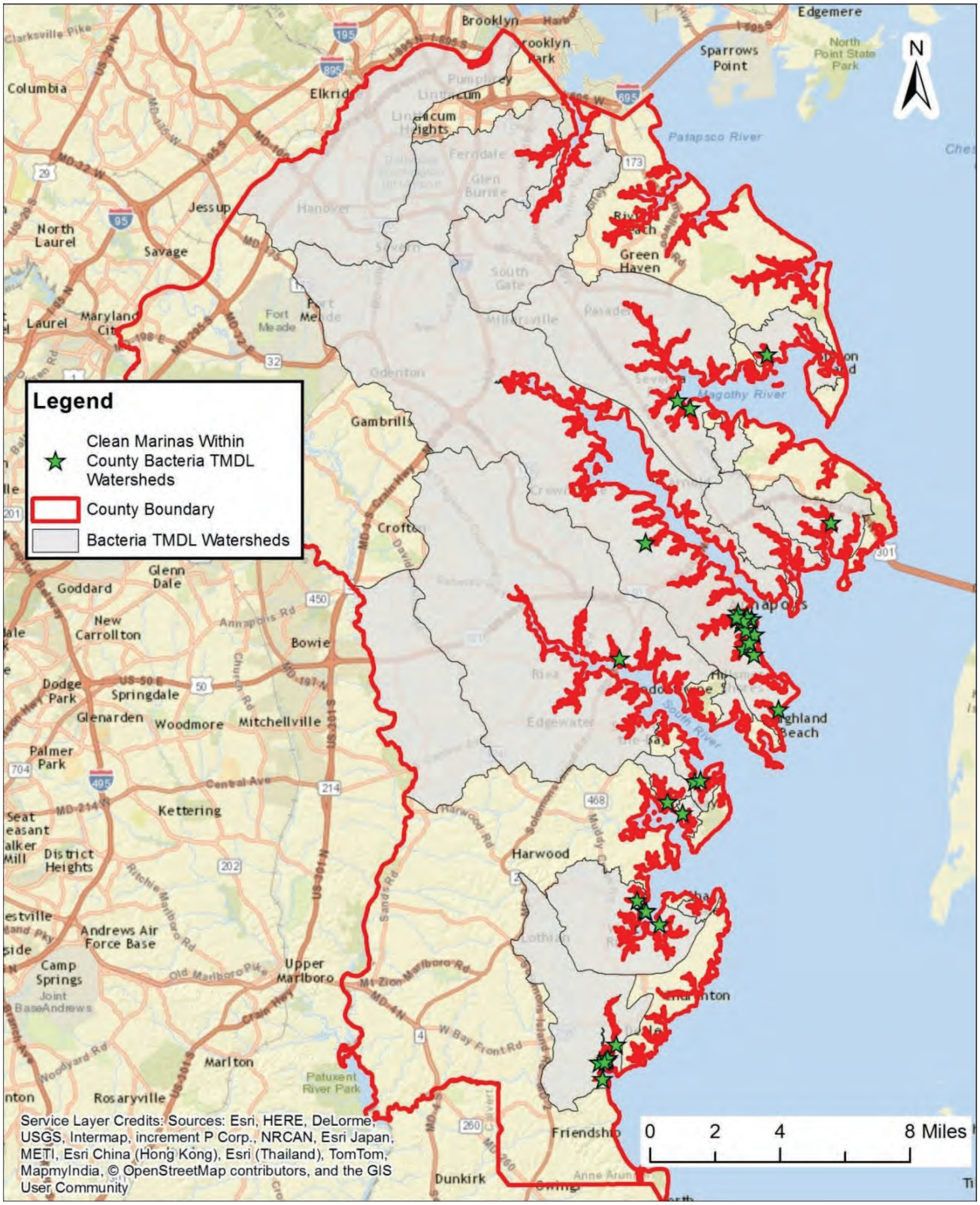


Figure 5-1: Location of Certified Clean Marinas in Bacteria TMDL Watersheds

5.2 POTENTIAL CHALLENGES AND SOLUTIONS TO IMPROVE THE COUNTY'S CURRENT OUTREACH PROGRAMS

Several agencies and jurisdictions have published cost-effective methods to engage the public and stakeholders in watershed restoration. Locally, the Anne Arundel County Watershed Steward Academy has been successful in training watershed stewards and implementing micro-scale stormwater practices, such as rain barrels, rain gardens, plantings, and forested buffers, and promoting pet waste management. However, they have had difficulty reaching the public on bacteria issues such as pet waste (Capital Gazette, 2014). Table 5-3 summarizes some of the challenges faced by the County's outreach programs and potential solutions for overcoming impediments to cooperative watershed restoration. This information was developed based on publications related to outreach from other jurisdictions and agencies. The proposed solutions apply to most types of watershed outreach and are recommended for this bacteria TMDL restoration plan.

Table 5-3: Challenges and Solutions to Public and Stakeholder Participation in the Watershed Restoration Process

Challenge	Potential Solution
Loss of momentum	Setting small, achievable goals throughout the implementation process to show success and keep the project energized; keeping the public and stakeholders actively engaged by periodically checking in with them during slow times (EPA, 2010).
Poor coordination and planning	Conducting organizational planning activities prior to beginning implementation process. Clearly communicating goals and load reduction strategies to achieve those goals. Making sure that the public and stakeholders all agree on the Restoration Plan. Defining roles and responsibilities (EPA, 2010). Identifying the target audience and all stakeholders, and deciding what messages are to be conveyed and the appropriate conveyance method (i.e., type of media). Determining how success will be measured (e.g., website hits, surveys, water quality monitoring).
Lack of communication or infrequent communication	Keeping the public and stakeholders informed at all times. For example the public and stakeholders should be informed if any issues arise during the implementation process, if there are any changes to the original load reduction strategies, and if any lessons were learned along the way. Keeping the public and stakeholders informed of achievements, however small (e.g., website received 500 hits this week) (EPA, 2010). Making sure new information (e.g., technical reports) is conveyed to the technical team, County, public participation team, and stakeholders. When information becomes available, disseminating it quickly to keep participants informed and engaged (EPA, 2013a).
Political controversy	Avoiding heated political debate on controversial implementation projects. Working quietly with individual stakeholder groups to settle disagreements in a satisfactory manner (EPA, 2010).
Fear of the unknown	Accepting that there may be less data available than optimally preferred. Pursuing objectives aggressively despite lack of sufficient information and data (EPA, 2010).
Letting money drive the implementation process	Identifying types of restoration strategies first, and then pursuing funding to support the strategies. Avoiding pursuing funding opportunities for low-priority activities that may distract from the overall goals of the Restoration Plan (EPA, 2010).
Letting the implementation process bog you down	Keeping meetings short such that stakeholders who are usually volunteers can provide complete attention (EPA, 2013a). Avoiding situations where participants are spending more time on meetings than on actual watershed restoration work (EPA, 2010).

Challenge	Potential Solution
Not seeing any results/evaluation of effectiveness not showing anything	Considering different methods of communication. The County of Los Angeles (2002) recommends the following for effective communication: • Give specific, action-oriented messages (e.g., "do's and don'ts"). • Emphasize personal responsibility and empowerment. Inspire and motivate people and convey that individuals can make a difference. • Emphasize aesthetic and health benefits of improving water quality (e.g., in the case of bacteria, removal of pet waste and other bacteria sources leads to cleaner neighborhoods and reduces health risk to children, swimmers, boaters). • Make information easily accessible on the Web so the public can follow up on initial interest. Alternatively, Bruce and Tiger (2009) suggest that the effectiveness of public outreach efforts may not be apparent immediately afterwards if the evaluation method does not capture the full long-term effects. In general, outreach campaigns may result in only small, incremental behavior changes that are difficult to measure. Outreach programs should focus on changing behaviors rather than just raising awareness. Better knowledge about water quality issues is not well-correlated with better behavior (CWEP, 2009).

5.3 ADDITIONAL OUTREACH OPPORTUNITIES

As described above, the County and other agencies currently conduct numerous outreach/education programs. Additional outreach programs that can reduce bacteria loads include expanding boater education with respect to marina pump-out stations, expanding outreach programs for stray animals and reducing waste due to homelessness via reduction in homeless populations or routine cleanup of encampment areas. Estimating the reduction in bacteria load from these programs is not possible at this time because of the amount of available quantitative information. However, based on other education and outreach programs, these programs are likely to be relatively cost effective in terms of reducing bacteria loads.

Outreach Programs for Homeless Populations

The County is considering an outreach program for homeless populations. Reducing homelessness would reduce human bacteria in runoff from homeless encampments. Based on a 2012 assessment of the County's homeless population, it was determined that 1,300 homeless individuals used emergency shelters, transitional housing, and permanent supportive housing during the 2012 Federal Fiscal Year (Anne Arundel County, 2012d). The MDE states that reaching homeless populations can take the form of surveying units of local government that serve the homeless, including social services, police, schools, the health department, and nongovernmental organizations, and also educate the public on the health concerns of bacteria (MDE, 2014b).

In other jurisdictions with similar bacteria TMDLs, homeless encampments are addressed by frequent river and green area clean-ups, enforcement by police and park rangers, and annual funding of social service programs that directly serve the local homeless population (CA Central Coast Regional Board, 2011). One local organization involved in meeting the needs of persons

who are homeless is the Anne Arundel and Annapolis Coalition to End Homelessness, a community-based planning and advocacy organization.

Expanded Outreach Programs for Stray Animals

Another potential outreach program is related to stray animals in the County. The Anne Arundel County Animal Control Division patrols the County for stray animals and gives them shelter and care and provides an "Adoption Program" to place them in suitable homes. In addition, the Division is also considering expanding their Animal Control Foster Program to encourage more volunteers to temporarily support the rescued animals. The County could advertise this beneficial program by issuing flyers, magnets, or newspaper advertisements to increase awareness.

Expanded Outreach Programs for Marinas

County agencies can promote MD DNR's Clean Marinas by providing maps with the locations of all Clean Marinas in the County, posting them online, and posting signage identifying Clean Marinas. By promoting the Clean Marinas Program, the County would encourage other marinas to join and could educate the public on the existence and benefits of the program. County agencies could also partner with the Maryland DNR to encourage environmentally friendly boating activities in watersheds with a large number of community marinas such as the Severn and South River Watersheds.

In addition to MD DNR's outreach program, the County could expand the outreach program to educate boat owners to raise awareness about the importance of always using pump-out stations at marinas for proper sewage disposal. This would reduce the amount of human bacteria discharged directly into waterways. The County could also promote pump-out boats that would be more convenient to boaters.

One of the best methods for conveying information about proper use of pump-out stations is posting signs, which are a more effective method of conveying information than distributing literature or conducting boater education workshops (EPA, 2014). Signage is required to enter the Clean Marinas program and is most beneficial at highly visible locations in marinas such as boat ramps, anchorages/moorings, fuel docks, and live-aboard docks. The cost of posting a sign is estimated to be $105 (RI Sea Grant, 1992).

In addition to signage, installing additional pump-out facilities at marinas would reduce human bacteria discharges from vessels. Strand and Gibson (1990) found that the availability of a pump-out facility at a marina increased the likelihood of pumping twofold. Additional boater outreach may also be conducted through the County's social media and website, as well as through cooperative efforts with local watershed organizations and RiverKeepers.

SECTION SIX: FUNDING SOURCES AND TECHNICAL ASSISTANCE

6.1 FUNDING SOURCES

Achieving proposed improvements to meet bacteria TMDLs requires adequate funding to cover the cost of project implementation, operating expenditures, administrative costs, and other programmatic costs. This section presents potential federal, State, and non-profit grants and loans that may be suitable for use for proposed restoration strategies. Many of the grant programs focus on reducing nonpoint source nutrients and sediment to improve general water quality, and a few of the programs include specific provisions for practices that address bacteria pollution. For example, the Maryland DNR has a grant program to fund installation of sewage pump-out stations at marinas, which reduce bacteria discharges from boats. Table 6-1 provides an overview of potential funding sources.

Table 6-1: Potential Funding Sources for Bacteria TMDL Implementation

Funding Type	Funding Agency	Restoration Activity	Purpose of Program	Available Funding
State	The Maryland Stormwater Pollution Control Cost-Share Program	Implementation of any urban stormwater BMPs	To fund the implementation of stormwater management retrofit projects to control pollutants from older developed areas	$20,000 - $500,000
Non-profit	Chesapeake Bay Trust	Varies: must contribute to the restoration of the Chesapeake Bay	To promote public awareness and participation in restoration and protection of the Chesapeake Bay	$2,000 - $50,000
State	Bay Restoration Fund - OSDS Grant Program	Sewer upgrades and connection of septic systems to public sewer	To upgrade septic systems with Nitrogen Reducing Units. Program has expanded to include connection of septic tanks to sewer system. Funding priority is given to Chesapeake Bay Critical Areas.	$5,000 - $15,000
Federal	EPA 319 Funds	Implementation of agricultural and residential BMPs	To restore impaired waters by implementing watershed-based plans	Varies
Federal	EPA Urban Waters Small Grants	Implementation of pet waste public education program	To help restore urban water quality and revitalize neighborhoods by engaging communities in activities that increase their connection to, understanding of, and stewardship of local urban waterways	$40,000 - $60,000

Funding Type	Funding Agency	Restoration Activity	Purpose of Program	Available Funding
State	MACS Program	Installation of stream protection systems to limit livestock access to streams	To help farmers protect natural resources on their farms, maintain farm productivity, and comply with state and federal regulations	Provides farmers with grants to cover up to 87.5% of the cost to install conservation BMPs on their farms. More than 30 BMPs are currently eligible for MACS grants, including livestock exclusion fencing.
Federal	USDA EQIP (Cost-Share)	Installation of stream protection systems to limit livestock access to streams and reduce sediment into streams	To implement conservation BMPs on land used for livestock and crop production	Total payments not to exceed $10,000/year or $50,000 for length of contract; average payment is $15,000
Private Funds	National Fish and Wildlife Foundation/Wells Fargo Environmental Solutions for Communities	Implementation of local water quality improvement projects that encourage broad-based citizen participation in project implementation	To support projects linking economic development and community well-being to the stewardship and health of the environment	$25,000 - $100,000 (median: $40,000)
State	The Sewerage Facilities Supplemental Assistance Program	OSDS upgrades, including connection of older OSDS to public sewers, correction of system deficiencies such as SSOs, excessive inflow and infiltration, or outdated pump stations	To fund local governments for planning, design, and construction of wastewater projects needed to address public health or water quality issues considered to be high priority to MDE	Varies
State	Linked Deposit Loan Program	OSDS upgrades or other NPS capital improvements on private lands	To provide a source of low-interest financing to encourage private landowners and water system owners to implement capital improvements that will reduce the delivery of nutrients to the Chesapeake Bay and its tributaries	Varies
State	Maryland DNR Boating Services Unit	Installation of marina pump-out stations	To reduce bacteria loads from marinas by providing boaters with a proper method of disposing of their sewage and thus prevent it from entering local waters	Up to $15,000

Funding Type	Funding Agency	Restoration Activity	Purpose of Program	Available Funding
State	Chesapeake and Coastal Bays 2010 Trust Fund Grants	Various restoration projects	To accelerate Chesapeake Bay restoration via innovative new technologies, by engaging the community, and accountability	$5,001 - $70,000 for Watershed Assistance Program grants; minimum $500,000 for Cost-Effective Non-Point Source Pollution Reduction grants (no maximum); up to $75,000 annually for *CoastSmart* Communities grants

BMP = Best management practice
CIP = Capital Improvement Program
DNR= Department of Natural Resources
EQIP = Environmental Quality Incentives Program
MACS = Maryland Agricultural Water Quality Cost-Share
MDE = Maryland Department of the Environment
NPS = Nonpoint source
OSDS = Onsite sewage disposal system (septic system)

Relatively recent changes to the legislative requirements for the Bay Restoration Fund allow the collected monies to be used to connect septic systems to public sewers. However, it is expected that use of this funding source will be limited because it is likely to cover only a portion of the cost (Anne Arundel County Phase II WIP, 2012a). Therefore, additional funding sources will need to be identified to implement proposed restoration strategies for septic systems. An additional source of funding may be the Maryland Supplemental Assistance Program administered by MDE, which finances repair and upgrade of existing septic systems.

For livestock source reduction practices, Maryland's Agricultural Water Quality Cost-Share, or MACS program, provides funding for various eligible agricultural BMPs, one of which is streamside livestock exclusion fencing (see MDA, 2013 and MDA, 2014). Use of this funding source for improvements related to livestock may have limited applicability in Anne Arundel County because livestock areas are limited in the TMDL watersheds and, further, agricultural land is increasingly being converted to residential uses.

Other grant programs are focused on community-based initiatives to improve water quality and are potentially applicable to pet waste outreach activities and associated installation of pet waste stations, doggy loos, etc. Two examples of community-based grant programs are EPA's Urban Waters Small Grants Program and the National Fish and Wildlife Foundation's Environmental Solutions for Communities. In addition, Chesapeake Bay Trust, a non-profit grant-making organization also awards funding for eligible restoration and outreach programs.

Projects to implement new and retrofit stormwater management facilities, or restoring degraded outfalls and stream channels with Step Pool Storm Conveyance (SPSC) systems are currently funded through the County CIP program. Funds are secured through revenue from the stormwater remediation fee that resulted from passage of County Bill 2-13. This provides a predictable source of dedicated funding for stormwater management purposes. Funding sources

such as the Chesapeake Bay Trust funds, may be used to supplement County funds for specific projects.

Wastewater CIP projects implemented through the County DPW are currently funded through wastewater bonds and wastewater PayGo (i.e., pay-as-you-go funds from wastewater utility operations, as provided in the annual budget). Improvements to the sewer infrastructure that would abate SSOs are expected to continue to be funded through the County's wastewater CIP projects.

6.2 TECHNICAL ASSISTANCE

Technical assistance refers to staffing and resources needed to oversee and implement the TMDL restoration plan. Since the passage of the Chesapeake Bay TMDL in 2010, the County passed County Bill 2-13, which established the Watershed Protection and Restoration Fund to support Chesapeake Bay Restoration activities. As a result, the County has been aligning resources needed to meet the requirements of the Chesapeake Bay TMDL and individual TMDLs as required by the NPDES MS4 permit. This resulting framework enables the County to move forward with design and installation of urban stormwater BMPs based on the Phase II WIP strategy proposed by the County. This includes pre-2002 dry pond and other stormwater management facility retrofits, and especially degraded stream and outfall restoration projects that are likely to figure prominently in the County's restoration activities over the next decade, primarily in areas where degraded stream channels are observed.

The changes in the County's program will also support the implementation of restoration strategies to meet the bacteria TMDL. For example, County programs can be expanded to install and deploy the pet waste stations, doggy loos, etc. in the County park system; to ramp up outreach activities and notify owners of existing pet waste pick-up laws; and to engage specialized outreach personnel to develop videos, County website content, public service announcements for television, social media, etc. Expansion of the County's program can also include developing buffer education programs to instruct residential owners on acceptable and unacceptable practices in buffer areas, and developing educational materials and signage for posting in buffer zones.

SECTION SEVEN: IMPLEMENTATION SCHEDULE AND MILESTONES

Based on MDE's recommendations and published guidance document for developing restoration plans for bacteria impairment, TMDL restoration plans should begin by addressing controllable sources of bacteria in the watershed (e.g., from humans, livestock, and pets) (MDE, 2014b). Further, as mentioned previously, reductions in human sources are given a priority because they pose a greater public health risk than non-human sources. Even though wildlife is one of the contributing factors of bacteria impairment, elimination of wildlife is considered "undesirable and impracticable" by MDE and EPA and is not listed as an intended goal of the TMDL.

Load reduction strategies that address urban stormwater (Tier B) are structural in nature and are in line with the strategies proposed to meet the Chesapeake Bay TMDL. The County is required to meet the Chesapeake Bay TMDL requirements by 2025, therefore integrating bacteria Restoration Plan schedules with the Bay TMDL schedule has a beneficial impact on both programs. Adhering to the Bay TMDL schedule would result in 60 percent of the implementation efforts to reduce bacteria loads being implemented by 2017. Under this scenario, milestone review would occur every 2 years to determine whether the proposed strategies are being implemented, and to what extent.

A generalized implementation schedule is provided in Table 7-1. This schedule is based on implementing strategies incrementally to reduce bacteria loads with achievement of all of the TMDL required percent load reductions by 2025. Since all of the TMDLs require the same combination of load reduction strategies (i.e., highly cost-effective Tier B non-structural controls to reduce non-human bacteria sources, followed by less cost-effective Tier A structural controls to reduce human sources of bacteria), the schedule applies to all the bacteria TMDLs. The only watersheds where TMDLs need a slight adjustment to the strategies is Patuxent River Upper and West River mainstem, both of which have agricultural pastures that support livestock populations. In these cases, livestock fencing is recommended as a part of Tier B strategies. This is noted in the table below. In addition, there is considerable flexibility for conducting pet waste education. It is recommended that the County identify and prioritize specific high-density residential areas, especially those where the expected load reductions otherwise fall short of the TMDL (see Section 4.4).

Table 7-1: Bacteria TMDL Implementation Schedule by Milestone Year

Milestone Year	Programmatic Criteria
2015-2016	• Begin securing any funding sources needed • Make programmatic adjustments and identify any additional staffing needs • Identify drainage areas for existing BMPs, as required (data compiled for majority of the BMPs) • Begin planning and developing pet waste education program, prioritize watersheds, and identify funds needed • Conduct survey to determine pet waste education needs • Begin site identification and design process for new and retrofit stormwater management

Milestone Year	Programmatic Criteria
	facilities (already underway)
2017	• 25% of all planned new and retrofit stormwater management facilities complete • Continued triennial inspection and maintenance of constructed BMPs • 25% of planned septic systems connected to sewers, if funding allows • Pet waste education program fully planned and coordinated, begin media campaign via television PSAs, videos on County website, and social media • Implement livestock fencing in two agricultural watersheds*
2019 (end of NPDES MS4 permit cycle)	• 20% of impervious area managed with SPSC or other high-performing BMP (meet NPDES MS4 Permit/WIP goal) • Continued triennial inspection and maintenance of constructed BMPs • 50% of planned septic systems connected to sewers, if funding allows • Pet waste education program continues; implement additional television PSAs, videos, social media, etc. as funds allow • Streamside livestock fencing completed
2021	• 75% of all planned SPS upgrades completed • 30% of impervious area managed with SPSC or other high-performing BMP • Continued triennial inspection and maintenance of constructed BMPs • 75% of planned septic systems connected to sewers, if funding allows • Pet waste education program continues; implement additional television PSAs, videos, social media, etc. as funds allow • Maintain livestock fencing and inspect triennially
2023	• 100% of all planned SPS upgrades completed (wastewater CIP goals met) • 40% of impervious area managed (permit/WIP goal achieved) • 100% of planned septic systems connected to sewers, if funding allows (goal achieved) • Pet waste education program continues; implement additional television PSAs, videos, social media, etc. as funds allow
2025 (bacteria TMDLs achieved)	• Maintain the achieved WIP/permit goal for impervious area treatment through inspections and maintenance of stormwater management facilities. • Conduct survey to evaluate effectiveness of pet waste education program • Continued triennial inspection of constructed BMPs/retrofits

*Patuxent River Upper and West River mainstem.

BMPs = best management practices
CIP = Capital Improvement Program
NPDES = National Pollutant Discharge Elimination System
MS4=Municipal Separate Storm Sewer System
PSAs = Public Service Announcements
SPS = Sewage Pump Station
SPSC= Step Pool Storm Conveyance
WIP = Watershed Implementation Plan

SECTION EIGHT: METHODS FOR EVALUATING PROGRESS

8.1.1 Evaluating Progress of Proposed Restoration Strategies

Establishing methods for tracking and evaluating progress toward TMDL water quality goals is important to determine whether the proposed restoration strategies are being implemented according to the stated schedule or if adjustments are required. The methods for evaluating progress vary depending on the restoration strategy. For strategies related to the NPDES MS4 permit program such as urban stormwater retrofits and Illicit Discharge Detection and Elimination (IDDE), it is recommended to use a water quality model that can estimate bacteria load reductions from proposed restoration strategies. Water quality models can also be used to estimate potential pollutant load reductions from SSO abatements and on-site disposal system (OSDS) retirements/connections. Potential options for water quality models include the WTM that was used to develop this restoration plan (see Section 4) or other water quality models that include bacteria loading. The County's Watershed Management Tool does not include a bacteria specific model module, so it is not proposed for use.

Data compiled for the NPDES MS4 annual report could be used to model the load reductions achieved over the previous year. Modeling the SSO abatement and septic system retirement would entail coordination with the County Department of Health to obtain the required information. Information on SSOs is compiled for Wastewater Capacity, Management, Operations, and Maintenance (CMOM) Program reports submitted to MDE.

Table 8-1 lists potential methods for tracking the progress of bacteria load reduction for each of the proposed strategies.

Table 8-1: Potential Methods to Evaluate Progress

Proposed Strategy	Potential Method to Evaluate Progress	Frequency	Data Source
Restore 20% Impervious Area with Urban Stormwater Projects	Water Quality Modeling*	Annually	NPDES MS4 reporting
Eliminate Illicit Connections (IDDE)	Water Quality Modeling*	Annually	NPDES MS4 reporting
Abatement of SSOs	Water Quality Modeling*	Annually	CMOM reporting
Septic Retirement/Connection	Water Quality Modeling*	Annually	Dept. of Health
Stricter Buffer Ordinance/Education	Walk-through of buffer area with adjacent homeowners	Annually	n/a
Expanded Pet Waste Education	Pre- and post-implementation surveys of residential pet owners	Would depend on implementation time frame, pre-implementation survey could occur in 2016	n/a

Proposed Strategy	Potential Method to Evaluate Progress	Frequency	Data Source
Expanded Goose Management Program	Annual survey of goose population by USFWS and Maryland DNR	Annually as part of waterfowl survey	USFWS/ Maryland DNR
Livestock Stream Exclusion Fencing	Pre- and post-implementation surveys of farmers	Annually	Soil Conservation District Office

*Watershed Treatment Model or other applicable water quality models
CMOM = Capacity, Management, Operations, and Maintenance
DNR = Department of Natural Resources
IDDE = Illicit Discharge Detection and Elimination
n/a = Not Applicable
NPDES = National Pollutant Discharge Elimination System
SSOs = Sanitary Sewer Overflows
USFWS = U.S. Fish and Wildlife Service

Evaluation of Pet Waste Education and Outreach Programs

As expanded pet waste outreach program has been identified as one of the most cost-effective strategies, with modeled results showing the greatest bacteria reduction in seven out of 19 TMDL watersheds, the County could develop ways to evaluate the effectiveness of an expanded pet waste program. There are several ways to evaluate effectiveness of the pet waste outreach program. Methods include:

- Measuring pet owner behavior changes
- Measuring pet waste at target sites
- Measuring bacteria loads at target sites

Each method of determining program effectiveness would involve different assumptions.

Measuring pet owner behavior changes: To measure pet owner behavior changes as a result of the program, surveys can be sent during the baseline year and again after the program is implemented. This survey should ask whether the citizen has a pet, how and where the pet's waste is disposed of, and what locations the pet has access to within the County (i.e., local dog park, hiking trails, or backyards of houses). The survey should ask whether the owner picks up pet waste if disposed of outside and where they dispose of it. It should also ask why the owner does or does not pick up waste outside and if they have seen any of the County's outreach materials (perhaps include a dropdown list of materials published). The surveys could be taken once each year to show progress in pet owner behavior in the "Public Education and Outreach" section of the County's annual NPDES MS4 report.

Assumptions made for this assessment are that the only item influencing behavior change in citizens is the County's efforts, that survey responders are honest, and that the data collected can be generalized to the whole pet owner community (because not all pet owners will respond). This method does not directly tie actual conditions to contributed bacteria loads since bacteria loads are not measured. A sample survey developed by the Watershed Stewards Academy is provided in Appendix B.

Measuring pet waste at target sites: Another method to measure effectiveness of the expanded pet waste outreach program is to compare the amount of pet waste collected in the pet waste stations over the period of the outreach education program to the baseline year. The County would need to know the total number pet owners in the County, which could be collected from pet registration documentation.

The assumptions for this method is that an increase in pet waste collection at the stations indicates a decrease of pet waste in the field, that all pets are registered, and that number of pet owners corresponds to the number of pets.

Measuring bacteria loads at target sites: To determine the actual bacteria load reduction effectiveness of the expanded pet waste program, runoff could be sampled in targeted areas like trails and dog parks without existing pet waste stations, and then sampled again after pet waste stations and/or increased signage is added through the expanded program. Bacteria load transport varies in different seasons of the year, so runoff sampling should be done seasonally for a year to determine actual conditions. Additional seasonal sampling should be done after the program is implemented, either at defined increments or annually since the NPDES MS4 permit requires annual updates on restoration plan goal progress.

This method more directly ties the actual bacteria loading from pet waste to that transported to surface water and reduces assumptions based on community response. The assumption for this method would be that contributions of bacteria from wildlife would be relatively similar in each sampling event.

A similar pet waste education and outreach program was implemented by Anne Arundel County Watershed Steward Academy in which they canvassed and sent mailings to influence the Southgate Community in Glen Burnie in the Marley Creek Watershed. The impact of the outreach program was assessed by analyzing samples of the tributaries of Marley Creek for bacteria. The Academy is currently expanding its outreach program and plans to analyze stream samples again in spring 2016 to evaluate its effectiveness. If this program proves successful, the County can implement a similar method to evaluate the expanded pet waste education and outreach program in all County watersheds.

Conclusion: Ideally, all three of these methods could be implemented to measure behavior change, waste reduced from the land, and actual runoff. An analysis of the results could give a full indication of how effective the outreach program is in reducing bacteria loads.

8.1.2 Water Quality Monitoring and Evaluation

The above methods for evaluating TMDL Restoration Plan progress will provide a general measurement of the implementation progress and the resulting bacteria load reductions from the proposed strategies. To confirm whether on-the-ground actions in the watershed are leading to measurable water quality improvements in the impaired TMDL waterways, MDE recommends water quality monitoring.

Existing Bacteria Monitoring Programs

It is important to leverage existing monitoring programs as much as possible to save cost and effort, and minimize the need to initiate new monitoring programs, which would require significant start-up and administrative time. Currently, several County and other monitoring programs are in place that measure bacteria concentrations in various County waterways. These programs include the County's ongoing NPDES MS4 monitoring of the Parole Plaza outfall and Church Creek; MDE's shellfish harvesting area monitoring; the County Health Department's bacteria monitoring of public bathing beaches; and the community-sponsored Operation Clearwater, which is (as of summer 2015) monitoring water quality at select locations along the Severn River, South River, West River, Rhode River, and Rock Creek. All of these programs measure bacteria concentrations in local waterways according to information on their websites and available monitoring reports. The County's NPDES MS4 IDDE program does not measure bacteria.

Note that many of these programs are not focused on meeting bacteria TMDL objectives. They are driven by permitting needs (NPDES MS4), public health (beach monitoring), and general characterization of water quality in a limited number of watersheds (Operation Clearwater). A summary of the existing monitoring programs is provided in Table 8-2.

Table 8-2: Description of County and Other Monitoring Programs in Maryland

Monitoring Program	Number of Location of Monitoring Stations	Bacteriological Parameter Measured	Type/Frequency of Bacteria Sampling
County's NPDES MS4 chemical monitoring	2 (Church Creek and Parole Plaza outfall, part of South River watershed)	E. coli	12 storm events per year at each monitoring location
MDE's shellfish harvesting area monitoring	Dozens throughout the County in estuaries and along shoreline[a]	Fecal coliform	Samples collected monthly, weather permitting
County Health Department's beach monitoring	>80 public bathing beaches throughout County	Enterococci	Samples collected as needed after rainfall events
County's NPDES MS4 IDDE program	150 outfalls/year throughout County	None	n/a; bacteria currently not being monitored
Operation Clearwater	Currently monitoring at 4 sites along Rock Creek and 33 sites along Severn River[b]	Enterococci	Several times a month during both dry and wet weather
County's Stream Restoration Project Monitoring	Cowhide Branch/Weems Creek Furnace Branch	E. coli	Monthly baseflow, Storm flows (minimum of twice per quarter)

[a]-see map of monitoring stations at: http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/pop_up/shellfishmaps.aspx

[b]-see map of monitoring stations at: https://www.google.com/maps/d/viewer?mid=zfiDnsNAg-ak.knZ5RgPdZmWw&msa=0&ll=39.104489%2C-76.522179&spn=0.158785%2C0.338173

Trends in Bacteria Concentration in Impaired Watersheds

MDE collects monitoring data from MDE's shellfish harvesting monitoring stations throughout the year. The collected monitoring data is used by MDE to prepare the Integrated Report for Surface Water Quality which includes a surface water quality assessment of the State waters. This report is published by MDE every two tears and it is recommended that Anne Arundel County continue to review this report to determine if any of the bacteria TMDL waterbodies are removed from the TMDL list through achievement of water quality standards for bacteria.

Monitoring data from MDE's shellfish harvesting area monitoring stations was reviewed for all the watersheds with fecal coliform impairment. A comparison of bacteria trends to the water quality criterion was conducted using the MDE's bacteria monitoring data and the data collected by the various agencies. For consistency, the monitoring stations that were used in the TMDL development were used. For most stations, monitoring was available since 2012. Anne Arundel County Department of Health has three monitoring stations on Patapsco River; however the stations are not located in Marley and Furnace Creek Watersheds, therefore latest enterococci monitoring data was not available for these watersheds. Similarly, latest e-coli monitoring data was not available for Patapsco River LNB and Patuxent River Upper Watersheds. Table 8-3 provides a comparison of the latest monitoring data with the MDE criterion for median and 90th percentile fecal coliform concentration. Except for Tar Cove and Selby Bay, all the watersheds had at least one monitoring station which equaled or exceeded the MDE's 90th percentile fecal coliform concentration criteria. This is consistent with the monitoring data published in the MDE's TMDL document as both Tar Cove and Selby Bay Watersheds have a TMDL reduction requirement of "0". Monitoring data from all the stations along with plots is included in Appendix C.

Table 8-3: Comparison of Latest Monitoring Data to Water Quality Criterion

Bacteria TMDL Watershed	Monitoring Data Source	Monitoring Station	Period of Data Collected	Median (MPN/100ml)	MDE Criteria for Median Sample (MPN/100ml)	90th Percentile (MPN/100ml)	MDE Criteria for 90th Percentile Sample (MPN/100ml)
Magothy Mainstem	MDE	0301001	July 2012 – June 2015	12.1	14	46.2	43
Magothy Mainstem	MDE	0301001A	June 2012 – June 2015	23.0	14	82.5	43
Magothy Mainstem	MDE	0101001A	July 2012 – June 2015	3.6	14	25	43
Magothy Mainstem	MDE	0301800	July 2012 – June 2015	3.6	14	23	43
Magothy River/Forked Creek	MDE	0301011	July 2012 – June 2015	9.1	14	262	43
Magothy River/Tar Cove	MDE	0301005C	July 2012 – June 2015	3.6	14	23	43
Magothy River/Tar Cove	MDE	0301006B	July 2012 – June 2015	9.1	14	39.4	43
Magothy River/Tar Cove	MDE	0301801	July 2012 – June 2015	1	14	7.5	43
Magothy River/Tar Cove	MDE	0301802	July 2012 – June 2015	2.3	14	9.7	43
Rhode River/Bear Neck Creek	MDE	0307120A	June 2012 – June 2015	12.1	14	62.7	43
Rhode River/Cadle Creek	MDE	0307019	July 2012 – June 2015	8.2	14	84.7	43
Severn River Mainstem	MDE	0304152	March 2013 – June 2015	9.1	14	262	43
Severn River Mainstem	MDE	0304150	March 2013 – June 2015	3.6	14	48	43
Severn River Mainstem	MDE	0304002A	March 2013 – June 2015	3.6	14	43	43
Severn River Mainstem	MDE	0304005	March 2013 – June 2015	2.3	14	43	43
Severn River Mainstem	MDE	0304008	March 2013 – June 2015	3.6	14	23	43
Severn River Mainstem	MDE	0304011	March 2013 – June 2015	3.6	14	43	43
Severn River Mainstem	MDE	0304016	March 2013 – June 2015	3.6	14	43	43
Severn River Mainstem	MDE	0304020	March 2013 – June 2015	3.6	14	10.5	43
Severn River Mainstem	MDE	0304028	March 2013 – June 2015	1	14	9.1	
Severn River Mainstem	MDE	0304029	March 2013 – June 2015	1	14	15.8	43

Bacteria TMDL Watershed	Monitoring Data Source	Monitoring Station	Period of Data Collected	Median (MPN/100ml)	MDE Criteria for Median Sample (MPN/100ml)	90th Percentile (MPN/100ml)	MDE Criteria for 90th Percentile Sample (MPN/100ml)
Severn River Mainstem	MDE	0303200	March 2013 – June 2015	1	14	7.5	43
Severn River Mainstem	MDE	0303202	March 2013 – June 2015	1	14	1	43
Severn River Mainstem	MDE	0303204	March 2013 – June 2015	3.6	14	9.1	43
Severn River/Mill Creek	MDE	0306006	March 2013 – June 2015	6.4	14	48.0	43
Severn River/Whitehall and Meredith Creek	MDE	0303005	March 2013 – June 2015	7.3	14	23.0	43
Severn River/Whitehall and Meredith Creek	MDE	0303005A	March 2013 – June 2015	9.1	14	43.0	43
South River/Duvall Creek	MDE	0306104	September 2012 – June 2015	7.3	14	23.0	43
South River/Duvall Creek	MDE	0306013A	September 2012 – June 2015	8.2	14	75.0	43
South River Mainstem	MDE	0306110	September 2012 – June 2015	19	14	75.0	43
South River Mainstem	MDE	0306211	September 2012 – June 2015	3.6	14	43.0	43
South River Mainstem	MDE	0306002	September 2012 – June 2015	9.1	14	23.0	43
South River Mainstem	MDE	0306205	September 2012 – June 2015	3.6	14	23.0	43
South River Mainstem	MDE	0306111	September 2012 – June 2015	9.1	14	43.0	43
South River Mainstem	MDE	0306208A	September 2012 – June 2015	9.1	14	53.0	43
South River/Ramsey Lake	MDE	0306115A	September 2012 – June 2015	5.5	14	43	43
South River/Selby Bay	MDE	0306801	September 2012 – June 2015	3.6	14	25.0	43
South River/Selby Bay	MDE	0306115	September 2012 – June 2015	1	14	12.5	43
W. Chesapeake Bay/Tracy and Rockhold Creeks	MDE	0501004	August 2011 – June 2015	23	14	93.0	43
W. Chesapeake Bay/Tracy and Rockhold Creeks	MDE	0501004A	August 2011 – June 2015	9.1	14	150.0	43
West River Mainstem	MDE	0307205	June 2012 – June 2015	9.1	14	43	43
West River/Parish Creek	MDE	0307011	June 2012 – June 2015	8.2	14	84.7	43

Expansion of Bacteria Monitoring

To verify that water quality is improving as a result of implementing restoration strategies in the 19 TMDL watersheds, a comprehensive monitoring effort could be undertaken. There are cost-saving measures and ways to conserve on effort that would facilitate this type of monitoring. First, only certain TMDL watersheds or subwatersheds should be sampled. Priority would be given to those watersheds with distinct differences in size, geographic setting, and land use rather than duplicating efforts in watersheds that are very similar (e.g., Furnace and Marley Creeks).

Water quality improvements related to watershed restoration projects can be difficult to detect because of such factors as time lag between project implementation and detectable results, wet and dry years, and uncertainty in the success of implementation (e.g., whether there is actual behavior change in dog owners leading to more pet waste pickup. A minimum of 5 years of monitoring data would be collected under various climatic conditions and seasons to account for variations in flow and inter-annual changes related to wet years and dry years. A minimum of 5 years of monitoring is desired, because there will be a delay from the time restoration strategies are implemented to when a water quality improvement may be detected. More years of data will provide a much better basis for evaluating the success of the TMDL Restoration Plan so that required load reductions can be met in a timely fashion. Targeted monitoring downstream of restoration projects to evaluate their effectiveness should be implemented depending on the availability of the County's resources.

One way to expand bacteria monitoring is to continue incorporation of bacteria as a measured constituent in the County's project-specific monitoring programs. County field personnel are trained in proper sample collection methods and already collect samples for bacteria analyses at project specific restoration sites and as part of the NPDES MS4 Permit required stormwater monitoring program in the Church Creek subwatershed of the South River. As additional project specific restoration projects are brought on-line (e.g., Furnace Branch stream restoration), pre and post-construction monitoring plans will include bacteria as a water quality analytes. Should consultants be utilized in assessing the bacteria composition of non-tidal waterways in the County, the County will utilize Standard Operating Procedures to ensure that consultants' methods are standardized. All bacteria samples collected by County staff or their consultants are analyzed by a certified laboratory.

Volunteer bacteria monitoring programs in targeted watersheds could also be developed by collaborating with watershed groups. As with the use of consultants for bacteria monitoring, the County would require adherence to a Standard Operating Procedure to ensure consistency in methodology among all parties involved.

Monitoring equipment and test kits are commercially available for purchase and use by volunteer personnel to directly quantify bacteria concentrations in the impaired TMDL waterways. Typically, once the samples are collected, there is a 16- or 24-hour incubation period before bacteria levels can be measured using the test kits. A list of potential test kits and equipment is provided in Table 8-4 . Alternatively, rather than having volunteers test for bacteria on their own,

water samples can be sent to a certified laboratory for testing. While this is the most accurate way to measure bacteria concentrations, the costs involved could be significant; furthermore, bacteria samples have a very short hold time (typically 6 hours), which can make logistics of sample delivery to the lab difficult.

Table 8-4: Potential Testing Equipment and Methods to Measure Bacteria Concentrations

Equipment	Type of Bacteria Measured	Description of Method	For More Information
Coliscan CSK 10	E. Coli / Total Coliforms	Petri dish, 24-hour incubation (count)	See link 1 below
Quantitube	E. Coli / Total Coliforms	16-hour recovery, no petri dish; snap shut tube (count)	See link 2 below
Lovibond E.Coli Test Kit	E. Coli / Total Coliforms	Collect sample, allow to incubate for 24 hours. The color change indicates the presence of total coliforms. E. Coli must be viewed under UV light.	See link 3 below
Colilert	E. Coli / Total Coliforms	EPA approved method for measuring E. Coli and Total Coliforms. May potentially require additional equipment. Allow for a 24-hour incubation period, but takes less than 1 minute of hands-on time	See link 4 below

1- http://www.lamotte.com/en/microbiological/coliform
2- http://coliform.com/Ecoli_test.html
3- http://www.lovibondwater.com/product/coliformecoli-test-kit.aspx
4- https://www.idexx.com/water/products/colilert.html

The monitoring approach for evaluating progress will incorporate existing monitoring programs, as possible, and make small adjustments to County programs as needed to obtain a more comprehensive picture of the effectiveness of the TMDL Restoration Plan in the County.

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Appendix A: Watershed Treatment Model Methodology

A.1 INTRODUCTION

As a part of the development of the Total Maximum Daily Load (TMDL) Restoration Plan for bacteria impairments for the nineteen approved TMDLs in Anne Arundel County (County), the URS/ESA team developed water quality models for each of the 19 TMDL watersheds. The Watershed Treatment Model (WTM), a spreadsheet-based model developed by the Center for Watershed Protection (Caraco, 2013a) was used to characterize and quantify the bacteria loads for existing conditions and estimate the pollutant load reductions from future Best Management Practices (BMPs) to meet the TMDL requirements.

The WTM is a planning level model that quantifies bacteria loads based on both point and nonpoint sources of pollution. The model calculates the fate and transport of bacteria from pollutant sources to the receiving water bodies. In addition to the bacteria loads, the model also has the capability to estimate annual loads for total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS). The model has several tabs where pollutant sources and treatment options can be input. The Pollutant Sources tabs estimate the pollutant loads from primary sources such as land use and secondary sources such as channel erosion, illicit connections etc. The Treatment Options tabs of the model estimate the pollutant load reductions from structural and non-structural treatment options for existing and future conditions.

The URS/ESA team used the Maryland Department of Environment (MDE)-provided watershed boundaries, County geographic information system (GIS) data, and additional information on County operations to develop the baseline models for the study watersheds. The sections below provide a detailed description of the inputs and the methodology adopted in developing the WTM models for the study watersheds.

A.2 EXISTING CONDITIONS MODELING

An existing conditions model was developed to estimate the pollutant loads from primary sources such as existing land use and secondary sources such as illicit discharges, on-site sanitary disposal systems, and sanitary sewer overflows and the current pollutant reductions from existing BMPs. The data that were used in the model to estimate the current pollutant loads were based on the following:

Primary Sources

The Primary Sources tab of the WTM estimates pollutant loads in the stormwater runoff from land uses such as residential, commercial, industrial, rural, forest, and water. It also has an option to include acreage of land under active construction as one of the land uses. The model uses Simple Method (Schueler, 1987) to estimate the annual pollutant loads from different type of land uses based on their event mean concentrations (EMCs) and impervious cover, annual rainfall, and runoff coefficients. A description of the input information for primary sources is provided below.

- **Land use:** GIS data for existing land cover and impervious cover developed by the County in 2011 was used to identify the acreage of each land use type in the study watersheds. The default impervious cover percentage per land use type was adjusted in the WTM model to reflect existing watershed conditions by intersecting the land use and impervious cover GIS data. The default EMCs for TN, TP, TSS, and bacteria for each land use category were modified in the WTM model based on literature review of the watershed management plans developed by the County. Land cover categories with similar runoff characteristics and EMC values were grouped for the model input. Table A-1 below provides information on the land use and the EMCs used in the model.

Table A-1: Land Use Classification and EMCs

County Land Cover Classification	WTM Land Use Category	Event Mean Concentration (EMC)			
		TN (mg/L)	TP (mg/L)	TSS (mg/L)	Bacteria (MPN/100 ml)
Airport	Airport	2.24	0.30	99	4,500
Commercial	Commercial	2.24	0.30	43	4,500
Forested Wetland	Forest	1.00	0.11	34	500
Industrial	Industrial	2.22	0.19	77	2,614
Open Space	Open Space	1.15	0.15	34	3,100
Open Wetland	Forest	1.00	0.11	34	500
Pasture/Hay	Pasture/Hay	7.83	2.09	341	500
Residential 1 acre	Medium Density Residential (1-4 DU)	2.74	0.32	43	7,750
Residential 1/2 acre	Medium Density Residential (1-4 DU)	2.74	0.32	43	7,750
Residential ¼ acre	Medium Density Residential (1-4 DU)	2.74	0.32	43	7,750
Residential 2 acre	Low Density Residential (<1 DU)	2.74	0.32	43	7,750
Residential 1/8 acre	High Density Residential (>4 DU)	2.74	0.32	43	7,750
Row Crops	Row Crops	16.06	2.63	1,046	500
Transportation	Transportation	2.59	0.43	99	1,400
Utility	Open Space	1.15	0.15	34	3,100
Water	Water	1.20	0.03	43	500
Woods	Forest	1.00	0.11	34	500

DU = Dwelling Units
mg/l = milligrams per liter
MPN/100 ml = most probably number per 100 milliliters

- **Annual rainfall:** The average annual rainfall recorded the by National Oceanic and Atmospheric Administration at the Baltimore-Washington International Thurgood

Marshall Airport (BWI) was used as the input. An average annual rainfall of 42 inches was observed at BWI based on 143 years of recorded precipitation data.

- **Streams:** The stream GIS data obtained from the County website was used as the source to input stream length in miles in the study watersheds. The GIS data were analyzed, and features such as shoreline and pipes were not included in estimating the total stream length per watershed.
- **Soils:** The soils data downloaded from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service were used to estimate the percentage of each hydrologic soil groups in the study watersheds. The downloaded soils data was also used to determine hydric soils in the watershed to classify average depth to groundwater.

Secondary Sources

The input information for secondary sources was obtained from County GIS data, operations information, and research. The secondary sources are as follows:

- **Onsite sewage disposal systems (OSDSs):** The model estimates the loads from OSDSs to surface water and groundwater based on the volume and concentration of pollutants in wastewater (Table A-2). The obtained pollutant loads are further adjusted based on several factors such as efficiency of the OSDSs, percent of OSDSs that are less than 100 feet away from any water bodies, general soil types, level of maintenance, and their density in the watershed. Based on the County-provided information, the following data were used as input for wastewater characteristics:

Table A-2: WTM Pollutant Concentration in Wastewater

Water Use (gallons/capita/day)	Wastewater Characteristics			
	TN (mg/l)	TP (mg/l)	TSS (mg/l)	Bacteria (MPN/100 ml)
75	60	10	400	10,000,000

mg/l = milligrams per liter
MPN = most probable number

- The Anne Arundel County Department of Health developed GIS coverage of all the properties in the County that have an OSDS, and this information was used to identify properties in the study watersheds with no sewer connection. The GIS data also categorized the OSDSs as Best Available Technology (BAT) and Engineering (ENG) Nitrogen Removal Units (NRUs). The performance efficiency of both the type of NRUs (Table A-3) was obtained based on research and WTM literature. Properties that were not categorized as an NRU type were assumed to have a conventional system. Based on the spatial analysis of the GIS stream layer with the OSDS properties, 10 percent of the properties were assumed to have an OSDS less than 100 feet from a waterway. A 5-foot separation from groundwater was assumed for all the systems. Based on research on the

Anne Arundel County website, a medium level of septic system management that includes inspection at installation and education to encourage ongoing maintenance were factored in to adjust the obtained pollutant loads through OSDSs.

Table A-3: Bacteria Pollutant Removal Efficiency of OSDSs

Nitrogen Removal Unit (NRU) Type	Bacteria Log Reduction
Conventional System	3.5
ENG	2.9
BAT	3.0

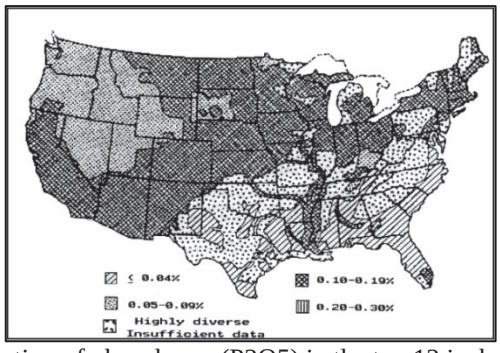
- **Sanitary sewer overflows (SSOs):** Pollutant loads due to SSOs are estimated based on total SSO volume and effluent concentration (Table A-2). Based on County-provided information, a volume of 55,650 gallons per SSO, which is the County-wide median value, was used to estimate the loads, and approximately 30 SSOs were assumed to occur for every 1,000 miles of sewer line. The sanitary sewer GIS data obtained from the County website was used to estimate the total length in miles of the sewer system in each study watershed.
- **Combined sewer overflows:** None of the study watersheds have any combined sewer outfalls.
- **Illicit connections:** Pollutant loads due to illicit connections of residences and businesses were estimated based on the County's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Annual Reports. According to the NPDES MS4 reports and illicit discharge detection and elimination annual report (IDDE, 2013), the County-wide detection rate of illicit connections is approximately 2 percent (32 cases out of 1,500 outfalls surveyed from 2005 to 2014). This detection rate was proportioned to each TMDL watershed based on the amount of impervious cover in the watershed relative to the total impervious area in the County. This obtained percent of illicit connections for each watershed was distributed equally among residential and commercial illicit connections. Among the percent of businesses illicitly connected, the majority (90 percent) was assumed to be illicit wash water connections, and 10 percent of the businesses were assumed to be illicit waste water connections. The concentrations of pollutants for business illicit connections used in the model are provided in Table A-4 below. The pollutant concentration of residential illicit connections is the same as that of wastewater (Table A-3).

Table A-4: Pollutant Concentrations for Illicit Business Connections

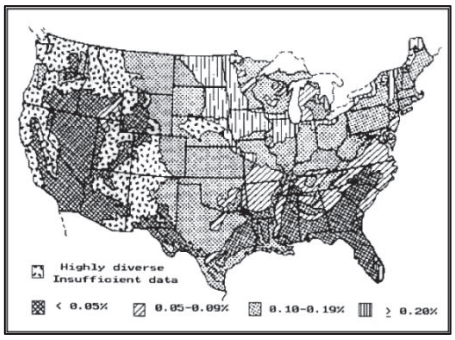
Pollutant	Pollutant Concentration	
	Wash Water	Wash Water and Wastewater
TN (mg/l)	15	30
TP (mg/l)	10	10
TSS (mg/l)	150	225
Bacteria (MPN/100 ml)	0	3,300,000

mg/l = milligrams per liter
MPN = maximum probable number

- **Urban channel erosion:** Urban channel erosion is a required input parameter in the model, however, it only affects nutrients and sediment, not bacteria. The sediment loads due to urban channel erosion in each study watersheds were assumed to be a fraction of total sediment loads from other urban sources in the watershed. Moderate rates of erosion (50 percent of total watershed sediment loads) in the channel were assumed to estimate the sediment loads for all the study watersheds. Phosphorus and nitrogen concentrations of 0.064 percent and 0.07 percent, respectively, were used to estimate the nutrient loads due to channel erosion. These are default percentages for the State of Maryland and were obtained using Figures 4.1 and 4.2 of the Watershed Treatment Model (Caraco, 2013b) documentation.



Distribution of phosphorus (P2O5) in the top 12 inch of soil
(Source: Figure 4.1, CWP 2013)



Distribution of nitrogen in the top 12 inch of soil
(Source: Figure 4.2, CWP 2013)

- **Livestock:** USDA's 2012 farm censuses were used to get the count of livestock such as horses, cattle (dairy and beef), broilers, turkeys, hogs, and pigs. The livestock numbers were associated with the County's rural land use (crops and pastures/hay). An aerial imagery survey of the rural land use was conducted to further narrow down the livestock area in all watersheds where crops and pastures/hay was determined to be 10 percent or more of the total land use. Based on the acreage of rural land use in the study watersheds, the livestock numbers were estimated proportionally. Table A-5 lists the census data obtained from USDA. The estimated bacteria loads per animal type were obtained from TMDL plans developed by MDE for various impaired watersheds.

Table A-5: Livestock Census Data for Anne Arundel County (USDA, 2012) and Associated Bacteria Loads (MDE)

Animal	Census Data for County	Fecal Coliform Production (count/animal/day)[2]	Percent Manure Available for Washoff (%)[2]
Dairy	586	1.01+10	40
Beef	584	1.20+10	40
Horse	1,791	4.20+08	40
Sheep	316	1.20+08	40
Broilers	300[1]	1.36+08	10
Turkeys	34	9.30+07	10
Chicken and Layers	1,133	1.36+08	10
Hogs and Pigs	42	1.08+10	40

1- 2007 data used as 2012 data was unavailable in the USDA Report
2- From MDE published TMDL reports

- **Marinas:** Pollutant loads from marinas were estimated based on the number of boats, flow rates, and number of boating days per year. The County-published document *Marinas of Anne Arundel County* (2010) was used to obtain information on type of marina and number of slips in each marina. For the model, 50 percent of the slips were assumed to be occupied during a 5-month boating season. The Maryland Department of Natural Resources' (DNR's) website was used to obtain information on the number of pump-outs in each TMDL watershed. Note that the model does not have a parameter for estimating bacteria load reductions due to educational outreach to the boating community about proper disposal of onboard sewage. Therefore, marinas are included as a source in the model, but not as a load reduction. Educational outreach is discussed in Section 5.3 of the main report.
- **Road sanding:** Based on County provided information; road sanding is not performed by the County.
- **Non-stormwater point sources:** Based on research and County-provided information, one of the seven County-owned Water Reclamation Facilities (WRFs), Annapolis WRF, discharges to the TMDL watershed. The remaining WRFs do not discharge to any of the TMDL watersheds. In addition to the County-owned WRF, two other point sources listed in the MDE-published TMDL documents with permitted discharges for bacteria were included in the models. Table A-6 below lists all the point sources in the study watersheds with permitted discharges for bacteria that were included in the models.

Table A-6: Permitted Discharges of Non-stormwater Point Sources in the Study Watersheds

TMDL Watershed	Facility	Design Flow (MGD)	Permitted Bacteria Loads (MPN/100 ml)
Severn (Mainstem, Mill, Meredith and Whitehall Creeks)	Annapolis Water Reclamation Facility	13	14
Severn (Mainstem, Mill Southern, Meredith-Whitehall Creeks)	U.S. Naval Academy	1	14
Patapsco River Lower North Branch	Holiday Mobile Estates Wastewater Treatment plan	0.108	3.0

MGD = million gallons per day
MPN = maximum probable number

Existing Management Practices

Input data for existing management practices were developed based on County-provided information, research and GIS data, and other management practices data related to County operations.

- **Turf condition and management practices in residential and other land uses:** As field reconnaissance was not included as a part of this study, it was assumed that approximately 10 percent of the lawns in the watershed are bare or compacted and 10 percent were assumed to be highly managed as a result of excess fertilization to estimate the annual TN and TP loads. The turf management for other land uses such as commercial, transportation, and industrial was also assumed to be managed at the same level as residential areas.
- **Erosion and sediment control:** Active construction sites were not included as a part of the model input; therefore, sediment load reduction due to the County's existing erosion and sediment control program was not estimated in the model.
- **Pet waste education:** Based on the WTM documentation, bacteria loads from pet waste are calculated based on the assumption that 40 percent of the homeowners in a study area have dogs, and approximately 50 percent of the dog owners walk their dogs. Approximately 60 percent of the dog owners who walk their dogs are assumed to clean up after their pets. The pollutant load reductions achieved by a pet waste education program in the model are calculated based on its effectiveness in educating the pet owners. Table A-7 lists various media outlets used for educating the pet owners and their effectiveness in reducing the bacteria loads from pets.

Table A-7: Effectiveness of Media for Pet Waste Education Program

Media Outlet	Effectiveness (%)
Television	40
Radio	25
Newspaper	30
Billboard	13
Brochure	8
Workshop	7

- Based on research of current County outreach programs, it was observed that the County currently provides information on pet waste management through its website and that it includes some educational brochures. A corresponding effectiveness of 8 percent was used in the model to estimate the reduction in bacteria loads through pet waste education.
- **Street sweeping:** The model estimates the load reductions in TSS, TN, and TP that would be achieved by street sweeping based on acreage of streets swept and the type of street sweeping technique used. The pollutant load reductions are further adjusted by factoring in efficiency of the street sweeping program. According to the County, arterial, collector, and roads in business districts are swept four times a year. The County GIS data were used to input the acres of roads swept in each study watershed. A program efficiency of 75 percent was used in the model based on the assumption that operators are not effectively trained and that parking restrictions are in place during the street sweeping period.
- **Structural stormwater management (SWM) practices:** Information on existing structural SWM practices was obtained from the stormwater management GIS BMP database developed by the County as a part of 2014 NPDES MS4 Annual Report (Anne Arundel County, 2015) and input into the model. The County is in the process of compiling the drainage areas for all the BMPs, and as result, drainage areas and impervious areas associated for some of the BMPs were not populated. The pollutant removal efficiencies of the practices were modified to match the bacteria BMP removal efficiencies compiled by the County and learned through various literature sources. All BMPs input into the model are inspected at least once every 3 years as required by the County's NPDES MS4 permit. The pollutant load reductions achieved by structural SWM practices were further adjusted based on the assumptions that 90 percent of annual rainfall is captured by the structures (0.9), the County has design criteria that will result in high pollutant removal efficiencies for practices (1.2), and that regular maintenance of the practices is enforced and conducted by the County (0.9). Table A-8 shows the bacteria pollutant removal efficiencies of BMPs input into the model. Most of the TMDLs in the study watersheds were developed in the early 2000s. Therefore, the baseline WTM included BMPs that were implemented only until the year 2000 to

account for load reductions that would be achieved from BMPs at the time of TMDL development.

Table A-8: Anne Arundel County BMPs and Pollutant Removal Efficiencies

BMP Type	Bacteria Pollutant Removal Efficiency (%)	BMP Type	Bacteria Pollutant Removal Efficiency (%)
Bioretention	70[2]	Landscape Infiltration	96[3]
Detention Structure Dry (Dry Pond)	88[1]	Level Spreader	0[9]
Disconnection of Non-Rooftop Runoff	0[10]	Micropool Extended Detention Pond	70[1]
Disconnection of Rooftop Runoff	0[10]	Oil-Grit Separator	0[7]
Dry Swale	0[6]	Other	0[7]
Dry Wells	96[3]	Permeable Pavements	37[1]
Extended Detention Structure, Dry	88[1]	Rain Gardens	70[2]
Extended Detention Structure, Wet	70[1]	Rain Water Harvesting	0[10]
Forestation on Pervious Areas	42[5]	Retention Pond	70[1]
Grass Swale	0[6]	Sand Filter	37[1]
Green Roof	0[11]	Shallow Marsh	78[1]
Impervious Surface Elimination	0[10]	Sheetflow to Conservation Areas	42[5]
Infiltration Basin	96[3]	Step Pool Conveyance System	70[4]
Infiltration Berms	96[3]	Stream Restoration	0[10]
Infiltration Trench	96[3]	Submerged Gravel Wetland	78[1]

[1] Fraley-McNeal, L., Schueler, T., Winer, R. 2007. National Pollutant Removal Performance Database - Version 3. Center for Watershed Protection, Ellicott City, MD.
[2] Hunt, W. F., Smith, J.T., Jadlocki, S.J., Hathaway, J.M., Eubanks, P.R., 2008. Pollutant Removal and Peak Flow Mitigation by a Bioretention Cell in Urban North Carolina. Biological and Agriculture Engineering, North Carolina State University, Raleigh, NC.
[3] Birch, G. F., Fazeli,M.S., Matthai, C., 2006. Efficiency of an Infiltration Basin in Removing Contaminants from Urban Stormwater. Environmental Geology Group School of Geo Sciences, University of Sydney, Sydney, Australia.
[4] According to Accounting for Wasteload Allocations, Step Pool Storm Conveyance function similar to bioretention and efficiencies of bioretention basins can be used (Page 48). Therefore, efficiency will be the same as that of bioretention, which is 70%.
[5] Parajuli P.B., K.R.Mankin, P.L. Batnes, 2008. Applicability of targeting vegetative filter strips to abate fecal bacteria and sediment yield using Soil and Water Assessment Tool (SWAT).
[6] http://water.epa.gov/polwaste/npdes/swbmp/Grassed-Swales.cfm.
[7] Hathaway, J.M., W.F. Hunt, and S.J. Jadlocki. 2009. "Indicator Bacteria Removal in Stormwater Best Management Practices in Charlotte, North Carolina." *Journal of Environmental Engineering*, 135(12), 1275-1285.
[8] Green roofs filter runoff in a similar way to bioretention systems, so a removal efficient of 70% assumed.
[9] http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-02-020.pdf.
[10] Substantial data not available; therefore, 0 was used.
[11] Stormwater captured by green roofs has negligible bacteria concentrations; therefore, 0 was used.

- **Riparian buffers:** The effectiveness of riparian buffers in reducing pollutant loads is estimated based on stream length and buffer width. The County 2011 land cover data downloaded from the County website was used to identify all the forested areas in the study watersheds. A GIS analysis was conducted to identify stream length in study watersheds that had 100 feet and 50 feet of riparian buffers on either side. The default

pollutant removal efficiencies in the model were modified to match the County-approved pollutant removal efficiencies for vegetated buffers (Table A-8). The estimated pollutant load reductions were further adjusted (to 60 percent) based on the assumption that the County does not have effective signage at all places that specify acceptable and unacceptable activities.

- **Catch basin cleanouts:** The model estimates the pollutant load reductions achieved by catch basin cleanouts based on the number of impervious acreage captured by the inlets. Based on the Phase II WIP developed by the County for the Chesapeake Bay TMDL, approximately 5,281 acres of impervious area was captured by cleaning 12,625 of the 34,095 inlets in the County. This data was used to find the proportion of inlets cleaned in each study watershed and to obtain the approximate impervious area captured by them. The County GIS data was used to identify the number of inlets in each study watershed.

The bacteria pollutant loads contributing to surface water from primary and secondary sources and subsequent load reductions from existing management practices for all the study watersheds is provided in Table A-9.

Table A-9: Baseline Bacteria Loads Contributing to Surface Water for Study Watersheds

Bacteria TMDL Watershed	Local Waterway	Bacteria Loads (billion/year)	Bacteria Loads (billion/day)
Chesapeake Bay Mainstem	Tracy and Rockhold Creeks	542,407	1,486
Magothy River	Forked Creek	78,350	215
Magothy River	Magothy River Mainstem	1,731,125	4,743
Magothy River	Tar Cove	262,855	720
Patapsco River Lower North Branch	Patapsco Lower North Branch	1,190,776	3,262
Patapsco River	Furnace Creek	1,084,267	2,971
Patapsco River	Marley Creek	992,234	2,718
Severn River	Mill Creek	234,320	642
Severn River	Severn River Mainstem	4,935,668	13,522
Severn River	Whitehall/Meredith Creeks	173,222	475
South River	Duvall Creek	67,854	186
South River	Ramsey Lake	109,101	299
South River	Selby Bay	105,511	289
South River	South River Mainstem	2,074,463	5,683
Upper Patuxent River	Patuxent River Upper	210,791	578
West River and Rhode River	Bear Neck Creek	63,684	174
West River and Rhode River	Cadle Creek	32,192	88
West River and Rhode River	Parish Creek	22,860	63
West River and Rhode River	West River Mainstem	176,084	482

A.3 ESTIMATION OF LOAD REDUCTIONS FROM PRIOR MANAGEMENT MEASURES

Based on the MDE's TMDL guidance document, *Guidance for Developing a Stormwater Wasteload Allocation Implementation Plan for Bacteria Total Maximum Daily Loads* (May 2014), load reductions from prior management measures should be estimated to account for progress towards TMDL goals at the time the TMDL Restoration Plan is developed. Most of the TMDLs for bacteria in Anne Arundel County were developed in the early 2000s. The County has since implemented several BMPs. Additionally, based on the County-provided GIS data, several OSDS have also been retired in the TMDL watersheds since development of the TMDLs by MDE 15 years ago. Potential credits from both these management measures were estimated by developing a WTM using the TMDL data. This method was developed based on correspondence with MDE.

For the prior-load reductions WTM model, the 2000 land use data used by MDE to develop the TMDLs was input as the primary source. The secondary sources in the model remained unchanged. The annual bacteria loads in the model were calibrated such that the baseline loads from the WTM matched the MDE-published TMDL baseline loads.

Credits from Post-TMDL BMPs

The potential credits that would be achieved from the "Post-TMDL" BMPs were calculated by including all the BMPs that were implemented after the TMDL was published by MDE. Since the majority of the TMDLs were developed in the early 2000s, 2000 was used as the cut-off year to estimate the number of post-TMDL BMPs for each watershed. The drainage area and impervious cover for all the post-TMDL BMPs were obtained from the County-provided GIS data. All the Post-TMDL BMPs were not accounted in the WTM as drainage area and impervious area information was not available for some of the BMPs. This is because the County is in the process of updating this information for the County wide BMPs. Impervious area treated was not available for some BMPs in the County database. In such cases, it was assumed that 50 percent of the treated drainage area was impervious. The bacteria removal efficiencies provided in Table A-8 were used for the post-TMDL BMPs as well.

Credits from Retired Septic Systems

The County provided GIS coverage of all the OSDS that were retired or connected to a public sewer from 2008 to 2013. The County-provided GIS data were clipped to the TMDL watersheds to obtain the number of retired OSDS in each watershed. The obtained numbers were input into the calibrated WTM to estimate the credits that would be achieved towards meeting the TMDL goals for all the study watersheds.

Table A-10 shows the TMDL credits that would be achieved for all the study watersheds from post-TMDL BMPs and retired septic systems.

Table A-10: Prior Load Reductions from Implemented Strategies Since 2000

Bacteria TMDL Watershed	Prior Load Reductions Since 2000		TMDL Targets	
	Post-TMDL BMPs (%)	Post-TMDL Septic System Retirement (%)	TMDL Target Reduction Requirements (%)	Adjusted TMDL Required Reduction (%)
Magothy Mainstem	3.04	0.61	12.80	9.15
Magothy River/Forked Creek	6.25	None	26.30	20.05
Magothy River/Tar Cove	2.23	None	0.00	0.00
Patapsco River/Furnace Creek	3.65	0.38	77.70	73.67
Patapsco River LNB	3.96	2.61	20.70	14.13
Patapsco River/Marley Creek	5.83	0.26	75.70	69.61
Patuxent River Upper	4.54	None	22.30	17.82
Rhode River/Bear Neck Creek	2.23	None	43.30	41.07
Rhode River/Cadle Creek	6.25	None	72.20	65.95
Severn River Mainstem	1.18	0.35	19.00	17.47
Severn River/Mill Creek	6.82	None	86.00	79.18
Severn River/Whitehall and Meredith Creek	4.42	0.43	90.00	85.15
South River/Duvall Creek	3.13	None	45.60	42.47
South River Mainstem	9.06	0.06	29.50	20.38
South River/Ramsey Lake	5.72	None	59.30	53.58
South River/Selby Bay	1.30	None	0.00	0.00
W. Chesapeake Bay/Tracy and Rockhold Creeks	0.35	2.70	81.60	78.55
West River Mainstem	1.38	0.48	35.30	33.44
West River/Parish Creek	0.45	None	53.10	52.65

A.4 PROPOSED CONDITIONS MODELING

A proposed conditions model was developed to estimate the potential reductions in baseline loads that could be achieved from implementation of certain future management practices in the TMDL watersheds. The goal of this modeling was to identify and prioritize the most effective strategies. These strategies were categorized into Tier A and Tier B strategies.

Tier A included strategies such as elimination of illicit discharges, abatement of sanitary sewer overflows, and retirement of septic systems which addressed human sources of bacteria. Pollutant load reductions that would be achieved by implementing Tier A strategies were quantified using the WTM.

Tier B strategies were recommended to address non-human sources of bacteria and included strategies such as urban stormwater retrofits, improvement of the riparian buffer ordinance/education program, expanded pet waste education program, livestock stream exclusion

fencing, and Canada goose management. Load reductions that would be achieved by implementing Tier B strategies were quantified using WTM and available literature. Load reductions from urban stormwater retrofits and a riparian buffer ordinance/education program were calculated using WTM, as it effectively captures loads from urban sources. As WTM does not effectively capture load reductions from an expanded pet waste education program, livestock stream exclusion fencing, and Canada goose management were quantified using available literature. Based on MDE's recommendations, Tier A strategies were given higher priority than Tier B strategies because they address human sources of bacteria.

Tier A Strategies

- **Retirement of County septic systems:** This Tier A strategy proposes retirement of existing septic systems in the TMDL watersheds and connecting them to public sanitary systems to reduce the bacteria loads from OSDSs. The County provided County-wide GIS coverage of all the OSDSs that would be retired to be connected to a WRF or to a cluster treatment system. This GIS coverage was based on the County's OSDS Evaluation Study (2008). The County-provided GIS layer was clipped to the TMDL watersheds to obtain the number of septic systems that are proposed to be retired in each watershed. An implementation rate of 40 septic disconnections was used based on the information provided by Anne Arundel County Health Department. The number of septic systems that would be retired in all the watersheds by the year 2025 was calculated by proportioning the current County implementation rate. Thus obtained data was entered into the future management practices of WTM under "Septic System Retirement (Convert to WWTP)" option to calculate the load reductions that would be achieved from this strategy. The table below (Table A-11) provides information on the number of septic systems proposed to be retired in each watershed by the year 2025.

Table A-11: Septic Systems Identified by the County to Be Connected to a Public Sewer System

TMDL Watershed ID	No. of Septic Systems Identified to Be Connected to Sewer	Number of Septic Systems that would be Retired by 2025 (%)
Magothy Mainstem	4,814	88
Magothy River/Forked	113	2
Magothy River/Tar Cove	1,708	31
Patapsco River Lower North Branch	174	3
Patapsco River/Furnace Creek	252	5
Patapsco River/Marley Creek	0	0
Patuxent River Upper	289	5
Rhode River/Bear Neck Creek	0	0
Rhode River/Cadle Creek	0	0
Severn River Mainstem	5,475	100

TMDL Watershed ID	No. of Septic Systems Identified to Be Connected to Sewer	Number of Septic Systems that would be Retired by 2025 (%)
Severn River/Mill Creek	1,168	21
Severn River/Whitehall and Meredith Creek	320	6
South River Mainstem	1,694	31
South River/Duvall Creek	0	0
South River/Ramsey Lake	0	0
South River/Selby Bay	0	0
W. Chesapeake Bay/Tracy and Rockhold Creeks	0	0
West River Mainstem	0	0
West River/Parish Creek	0	0

- **Abatement of sanitary sewer overflows:** This strategy involved minimizing the volume of SSOs discharging to the waterways after a storm event. The County provided historic SSO data that included approximately 500 SSOs documented since 2001. Based on the County-provided information, the majority of the SSOs were primarily caused by sewage pump station (SPS) failure. The proposed strategy to reduce the SSOs included SPS "upgrades," which involves projects such as improving SPS operations and relieving capacity problems, and replacing SPS generators. Based on the County-provided Capital Improvement Program (CIP) projects for wastewater, approximately 34 discrete projects and 31 recurring projects related to SPS upgrades were identified in 9 of the 19 TMDL watersheds. The obtained information was entered in the future management practices under the "SSO Repair/Abatement" options to estimate the load reductions that would be achieved from the County CIP projects. The number of SPS upgrades in each TMDL watershed based on the County CIP data is provided in the table below (Table A-12).

Table A-12: List of SPS Upgrades in the TMDL Watersheds

TMDL Watershed	No. of Discrete SPS Upgrade Projects	No. of Recurring SPS Upgrade Projects
Magothy River Mainstem	2	5
Magothy River Mainstem, Patapsco River LNB, South River/Duvall Creek	6	N/A
Patapsco River Lower North Branch	N/A	1
Patapsco River/Furnace Creek	1	1
Patapsco River/Marley Creek	1	5

TMDL Watershed	No. of Discrete SPS Upgrade Projects	No. of Recurring SPS Upgrade Projects
Patapsco River LNB, Baltimore Harbor, Stony Creek, Rock Creek	8	N/A
Rhode River/Cadle Creek	12	N/A
Severn River Mainstem	1	6
South River Mainstem	3	10
West River/Parish Creek	N/A	3

- **Elimination of illicit connections:** The County currently conducts field screening of outfalls to identify illicit connections from residences and businesses. This is required to meet the County's NPDES MS4 permit requirement. As a part of this program, approximately 150 outfalls are sampled every year, and all identified illicit connections are enforced/eliminated immediately. Based on the County-provided data from 2005 to 2014, the rate of illicit connections detection/elimination is approximately 2 percent (32 cases out of 1,500 outfalls surveyed). Assuming the County will continue the illicit detection/elimination program at the same rate in the future, an average of 41 percent of outfalls would be surveyed by 2020 in all the TMDL watersheds, and all identified illicit connections are assumed to be eliminated. This proposed rate was input into the "Illicit Connection Removal" option under the future management practices of the WTM to quantify the load reductions from this strategy.

Tier B Strategies

Urban stormwater retrofits in Tier B strategies include restoring 20 percent of currently unmanaged impervious cover through constructing new stormwater management facilities and retrofitting pre-2002 ponds and other stormwater management facilities to meet current MDE stormwater criteria. This strategy was developed based on the Anne Arundel County's Urban Phase II Watershed Implementation Plan (2012) and requirements of the current NPDES MS4 permit. The current NPDES MS4 permit requires the County to treat 20 percent of the impervious area that currently has limited or no stormwater management practice in place. The restoration projects planned as a part of the County's CIP include retrofitting existing outfalls to step pool storm conveyance systems (SPSCs) or retrofitting pre-2002 ponds to wet ponds, wetlands, and SPSCs. Table A-13 lists the number of CIP projects planned by the County in the TMDL watersheds along with the proposed impervious area that they would treat.

The proposed urban stormwater retrofit strategies were input in the "Retrofit Worksheet" of the WTM to estimate the load reductions that would be achieved from this strategy. The load reductions were further adjusted based on the assumptions that the proposed practices would

capture 90 percent of annual rainfall, the County has design criteria that will result in high pollutant removal efficiencies for practices (1.2), and that regular maintenance of the practices will be enforced and conducted by the County (0.9).

Table A-13: Proposed Urban Stormwater Retrofits in the TMDL Watersheds

Bacteria TMDL Watershed	Number of Urban Retrofit Projects Proposed	Drainage Area Proposed to Be Treated (acres)	Impervious Area Proposed to Be Treated (acres)
Magothy Mainstem	35	717.6	110.3
Magothy River/Forked	N/A	N/A	N/A
Magothy River/Tar Cove	N/A	N/A	N/A
Patapsco Lower North Branch	27	1105.3	310.7
Patapsco River/Furnace Creek	6	71.0	9.4
Patapsco River/Marley Creek	6	126.3	18.3
Patuxent River Upper	N/A	N/A	N/A
Rhode River/Bear Neck Creek	N/A	N/A	N/A
Rhode River/Cadle Creek	N/A	N/A	N/A
Severn River Mainstem	35	1738.6	187.3
Severn River/Mill Creek	4	33.8	3.0
Severn River/Whitehall and Meredith Creek	1	24.7	2.3
South River Mainstem	17	605.0	146.8
South River/Duvall Creek	1	13.1	2.0
South River/Ramsey Lake	N/A	N/A	N/A
South River/Selby Bay	N/A	N/A	N/A

- **Riparian Buffer Education:** This Tier B strategy aims at improving the buffer areas along the stream by implementing a riparian buffer education program for private property owners adjacent to buffer areas. The education programs will include buffer enhancement components such as no mow areas, planting trees and shrubs and promoting growth of native vegetation. The pollutant load reductions from this strategy were obtained by adjusting the buffer maintenance factor to 0.9 in future management practices of WTM indicating the County would have implemented a buffer education program.

The expected pollutant load reductions from Tier A and Tier B strategies that were quantified using WTM are provided in Table A-14 below.

Table A-14: Bacteria Load Reductions from Proposed Tier A and Tier B Strategies That Were Quantified Using WTM

Bacteria TMDL Watershed	Septic Retirement/Connection	Abatement of SSOs	Restoration of 20% Untreated Impervious Area through Urban Stormwater Management Retrofits	Eliminate Household Illicit Connections	Riparian Buffer Education
Magothy Mainstem	0.26%	1.12%	1.95%	9.05%	0.85%
Magothy River/Forked Creek	0.11%	N/A	N/A	1.14%	1.74%
Magothy River/Tar Cove	0.46%	N/A	N/A	0.67%	0.92%
Patapsco River/Furnace Creek	0.07%	3.75%	0.10%	8.27%	1.41%
Patapsco River LNB	0.10%	4.96%	4.80%	11.76%	2.73%
Patapsco River/Marley Creek	N/A	2.12%	0.53%	11.21%	1.52%
Patuxent River Upper	0.38%	N/A	N/A	1.14%	20.57%
Rhode River/Bear Neck Creek	N/A	N/A	N/A	0.50%	0.11%
Rhode River/Cadle Creek	N/A	8.50%	N/A	0.30%	0.70%
Severn River Mainstem	0.20%	0.37%	0.80%	19.40%	1.43%
Severn River/Mill Creek	0.63%	N/A	0.65%	1.54%	2.50%
Severn River/Whitehall and Meredith Creek	0.42%	N/A	0.63%	0.96%	2.13%
South River/Duvall Creek	N/A	6.40%	0.83%	0.65%	N/A
South River Mainstem	0.29%	0.31%	2.00%	11.40%	7.30%
South River/Ramsey Lake	N/A	N/A	N/A	0.11%	0.12%
South River/Selby Bay	N/A	N/A	N/A	0.16%	0.06%
W. Chesapeake Bay/Tracy and Rockhold Creeks	N/A	N/A	N/A	0.23%	7.70%
West River Mainstem	N/A	N/A	N/A	1.39%	11.90%
West River/Parish Creek	N/A	12.90%	N/A	0.19%	0.42%

A.5 REFERENCES

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Appendix B: Sample Pet Waste Survey from Anne Arundel County Watershed Stewards Academy

BASELINE: Pet Waste Behavior Survey

Check Box after responses are entered into Survey Monkey:

Date_____ Time_____ Surveyor_____

Responder's Name_____Phone_____

Address_____Email_____

Introduce yourself and your purpose (separate text).

1. Do you have a dog?
   - ☐ **Yes** ☐ **No/Not sure/Refused** *(Skip to **Classification (question 9.)***

If YES, ask the following questions.

2. Not everyone picks up their dog's [waste/poop], especially in their own yard. What about you? Typically, do you pick up the dog waste from your back yard … *(Read categories, ALTERNATING high to low and low to high for each survey you take.)*
   - ☐ **Every day**
   - ☐ **Once or twice a week**
   - ☐ **Once or twice a month**
   - ☐ **Less than once a month**
   - ☐ **Never**
   - ☐ *(DO NOT READ):* Dog never poops in own yard
   - ☐ *(DO NOT READ):* Refused to say
   - ☐ *(DO NOT READ):* Not sure

3. When you do pick up your dog waste, where do you put it?
   - ☐ **In the trash can**
   - ☐ **Flush down the toilet**
   - ☐ **In the woods or other natural area**
   - ☐ **In a pile in the yard**
   - ☐ **Other: _____**
   - ☐ *(DO NOT READ):* Refused to say
   - ☐ *(DO NOT READ):* Not sure

4. How about outside of your own yard? Do you pick up your dog's waste… *(Read categories, ALTERNATING high to low and low to high for each survey you take.)*
   - ☐ **Always**
   - ☐ **Usually**
   - ☐ **Sometimes**
   - ☐ **Seldom**
   - ☐ **Never**
   - ☐ *(DO NOT READ):* Dog is never outside its own yard

- ☐ *(DO NOT READ):* Refused to say
- ☐ *(DO NOT READ):* Not sure

5. When you do pick up your dog waste outside of your yard, where do you put it?

- ☐ **In the trash can**
- ☐ **Flush down the toilet**
- ☐ **In the woods or other natural area**
- ☐ **In a pile in the yard**
- ☐ **Other: _____**
- ☐ *(DO NOT READ):* Refused to say
- ☐ *(DO NOT READ):* Not sure

If they do not responded "always" in previous question, ask:

6. *What is the main reason you don't always pick up after your dog?*
   ☐ *(Specify. Record VERBATIM, and clarify.)*

_____

_____

7. Are you or someone else always with your dog when he or she is outside your yard, or does your dog sometimes roam on its own?
   - ☐ **Always with the dog**
   - ☐ **Sometimes roams on its own**
   - ☐ *(DO NOT READ):* Sometimes escapes/roams by accident
   - ☐ *(DO NOT READ):* Refused to say
   - ☐ *(DO NOT READ):* Not sure

8. Do you think disposing of your pet's waste in the trash can would make a big difference, a little difference, or no difference in cleaning up our local waters?
   - ☐ **Big difference**
   - ☐ **Little difference**
   - ☐ **No difference**
   - ☐ *(DO NOT READ):* **Not sure**

Tell me a little bit about why you say it would make a (big, little, no) difference?

CLASSIFICATION

9. We have almost completed the survey. Which of these do you tend to rely on fairly regularly for local news and events?

(Record all that apply.)

- ☐ **The Capital newspaper**
- ☐ **The Patch**
- ☐ **A neighborhood email group**
- ☐ **A printed neighborhood newsletter**
- ☐ **Emails from other local organizations** (Which ones?)

_____

- ☐ **Posters or signs you see in the neighborhood** (Where?)

_____

- ☐ **Any other sources of local information?** (Record what.)

_____

- ☐ **None of those**

10. Just to classify the survey, what is your age?

- ☐ **Less than 24**
- ☐ **25 – 34**
- ☐ **35 – 44**
- ☐ **45 – 54**
- ☐ **55 – 64**
- ☐ **65 and over**
- ☐ *(DO NOT READ):* Not sure/Refused

11. Do you own or rent your home?
☐ **Own** ☐ **Rent** ☐ Not sure/Refused

12. How many years have you lived in this neighborhood?
(Record years.)

_____

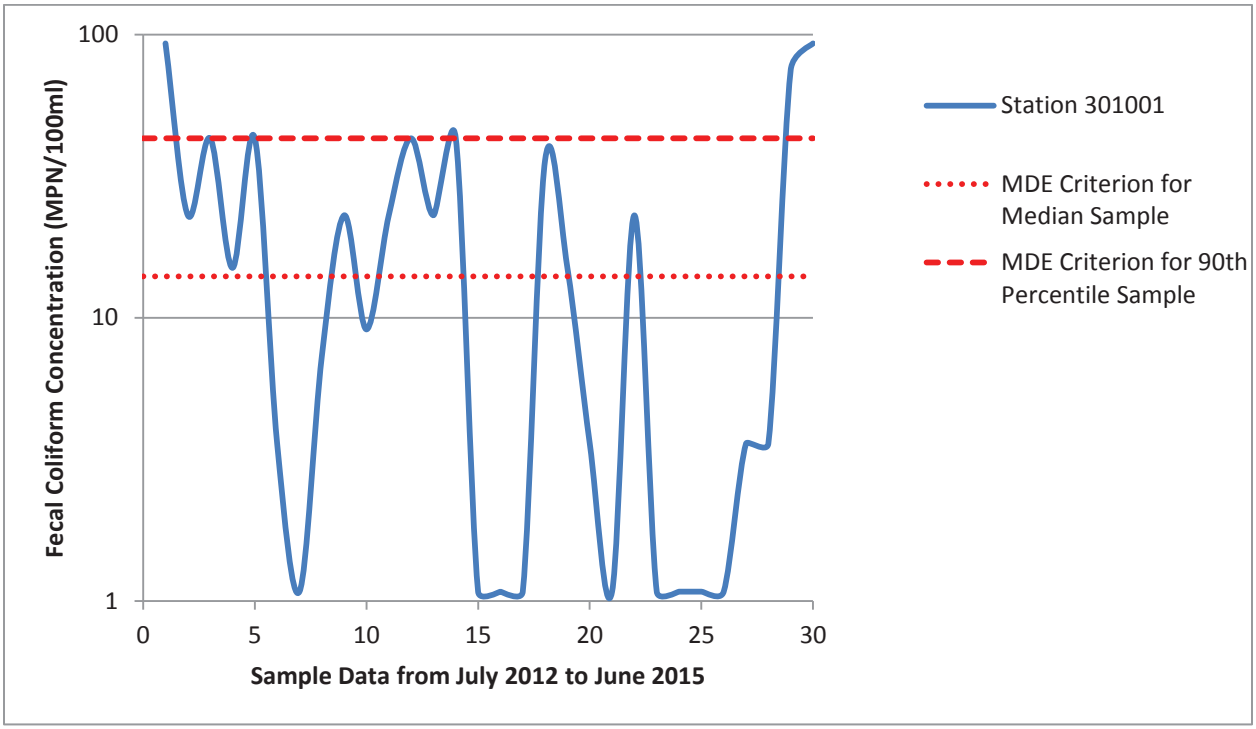
13. Which of these comes closest to describing your own race or ethnic background?
(RANDOMIZE [read list in a different order each time]):
☐ **White**
☐ **African-American**
☐ **Hispanic**
☐ **Asian**
☐ **Mixed race**
☐ **Other**
☐ Not sure/Refused to say

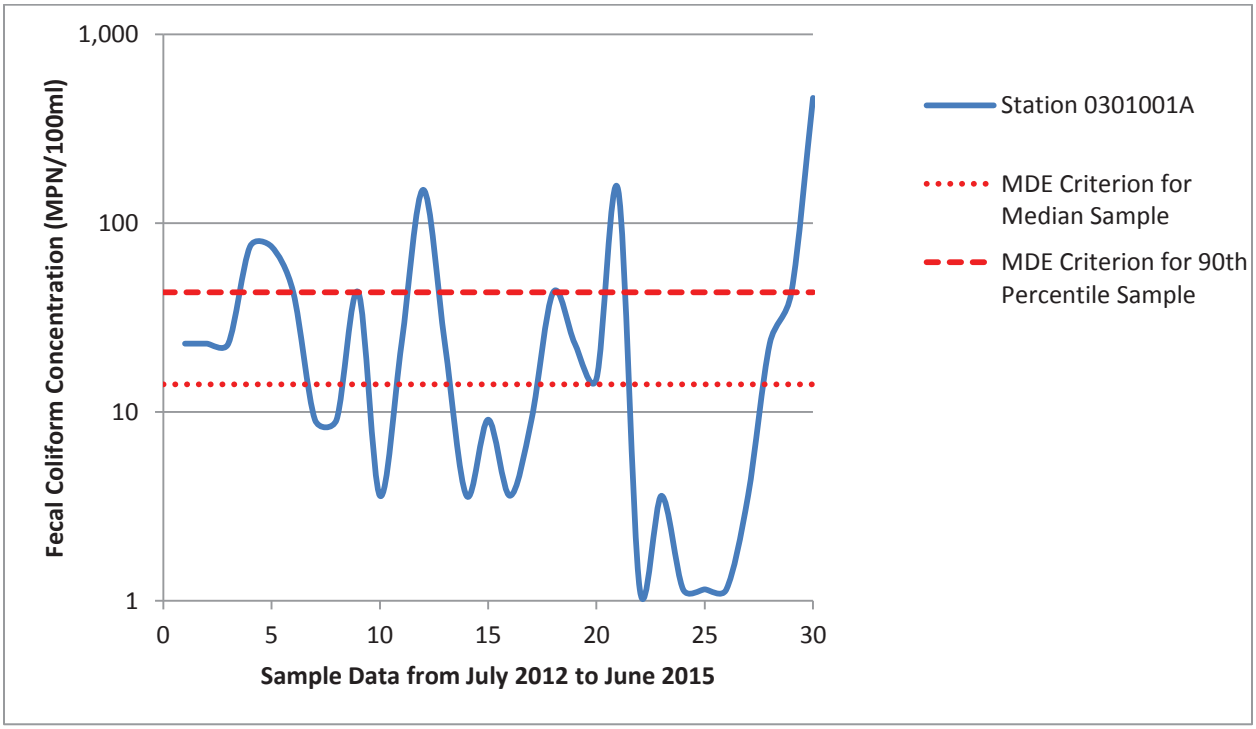
14. Gender *(By observation)*
☐ **Female** ☐ **Male**

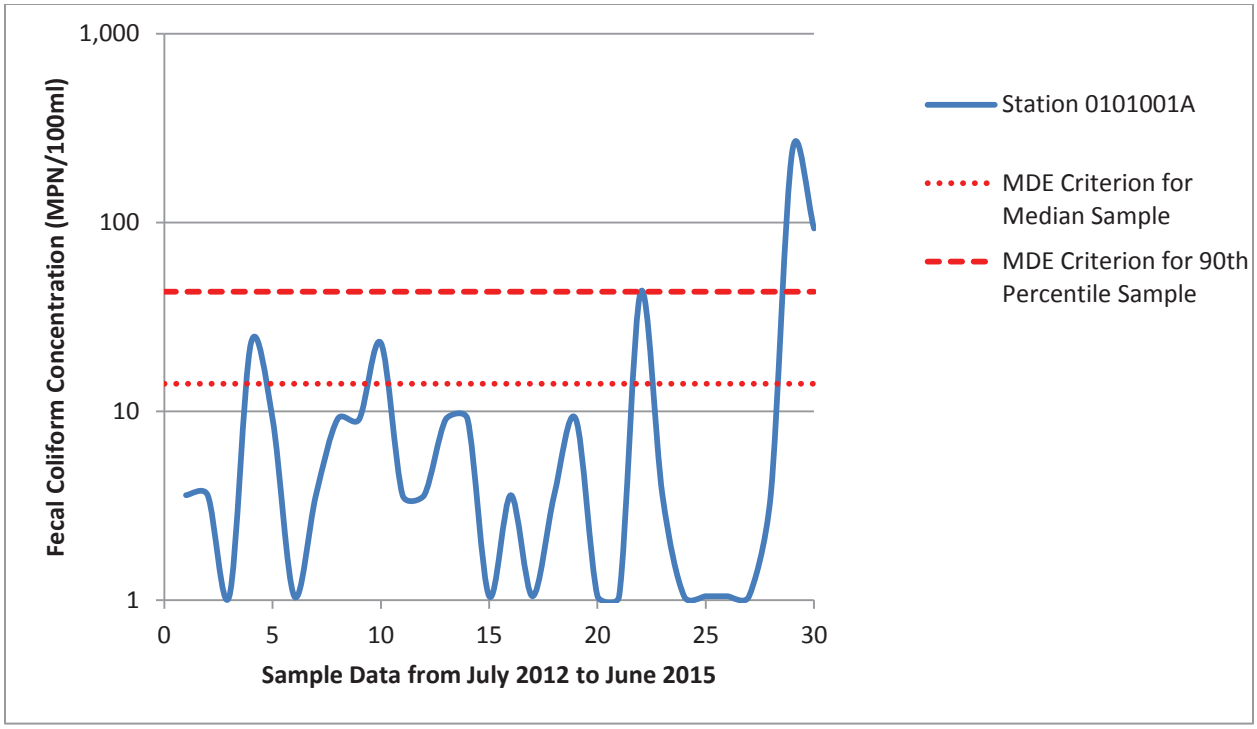
That completes the survey. Thanks very much for your time.

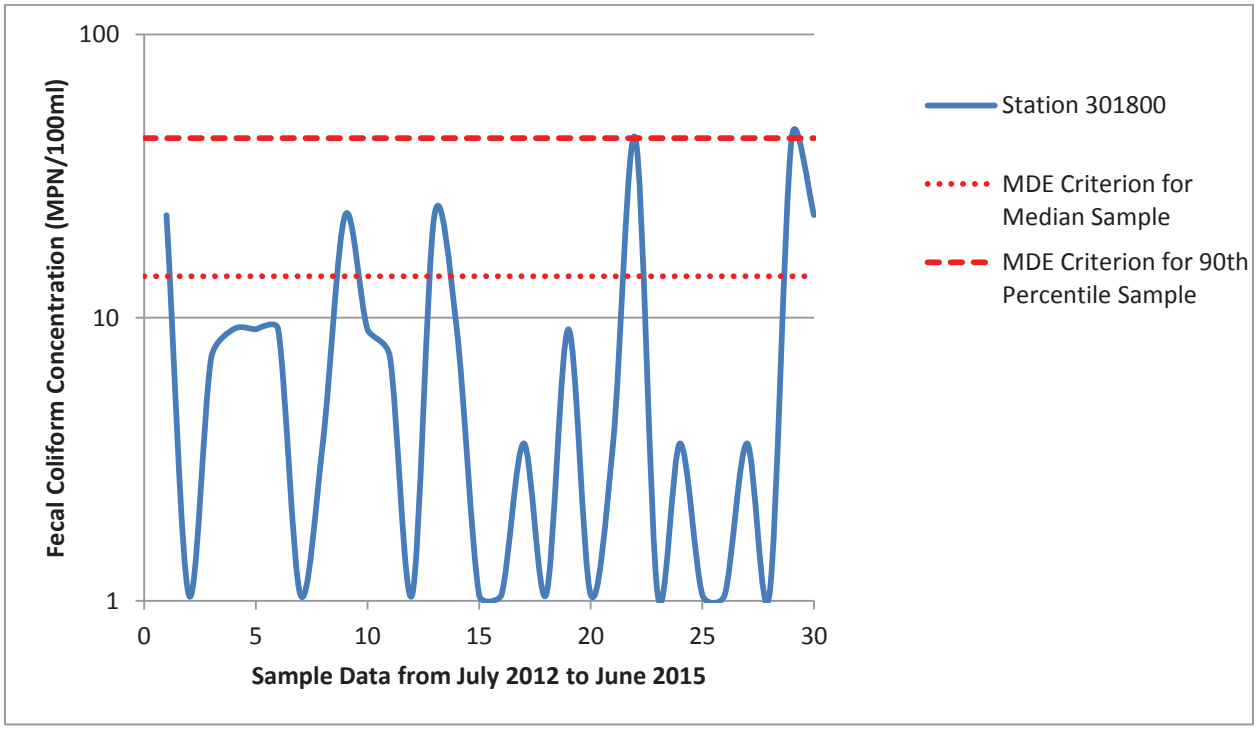
Appendix C: Monitoring Data

C.1 Magothy River Mainstem

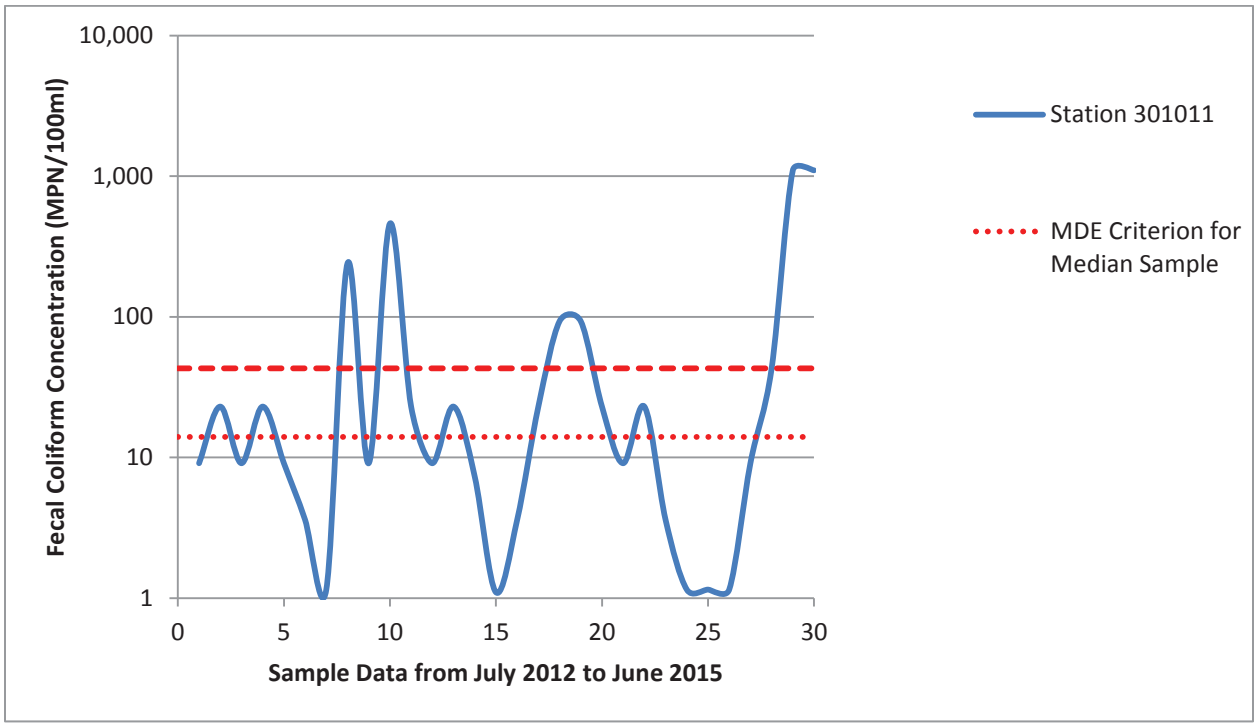




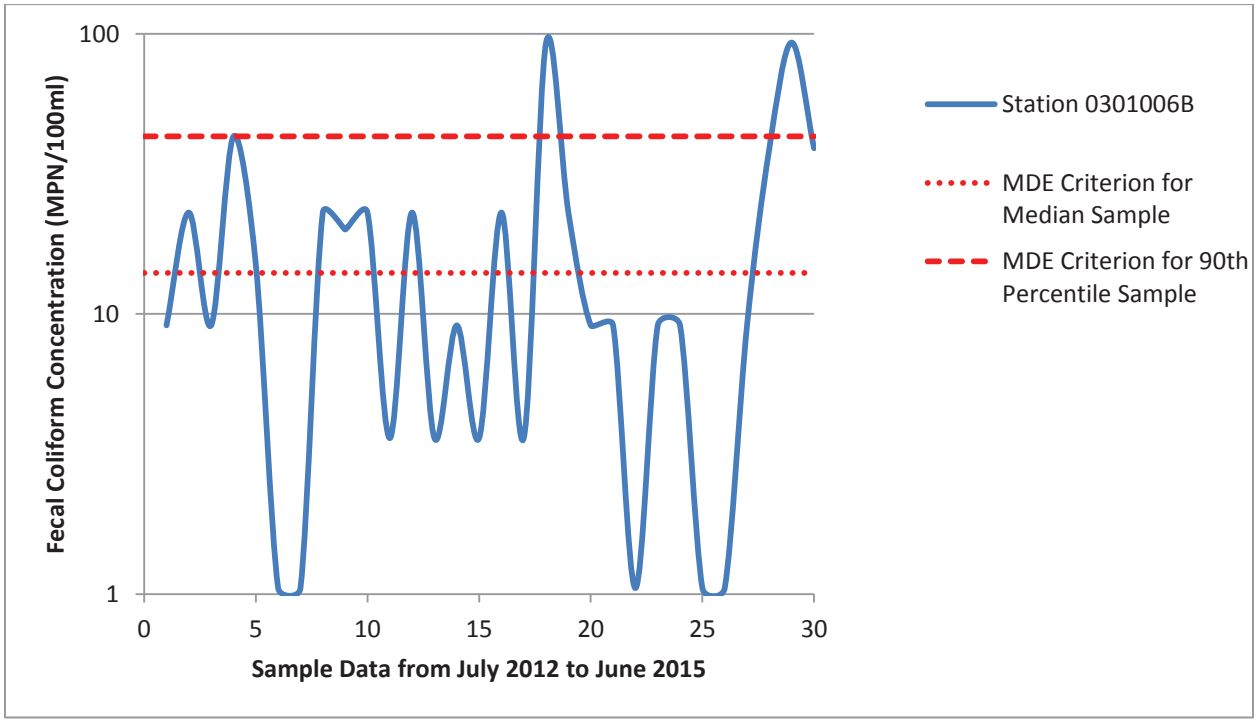

1,000
100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from July 2012 to June 2015
Station 0101001A
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

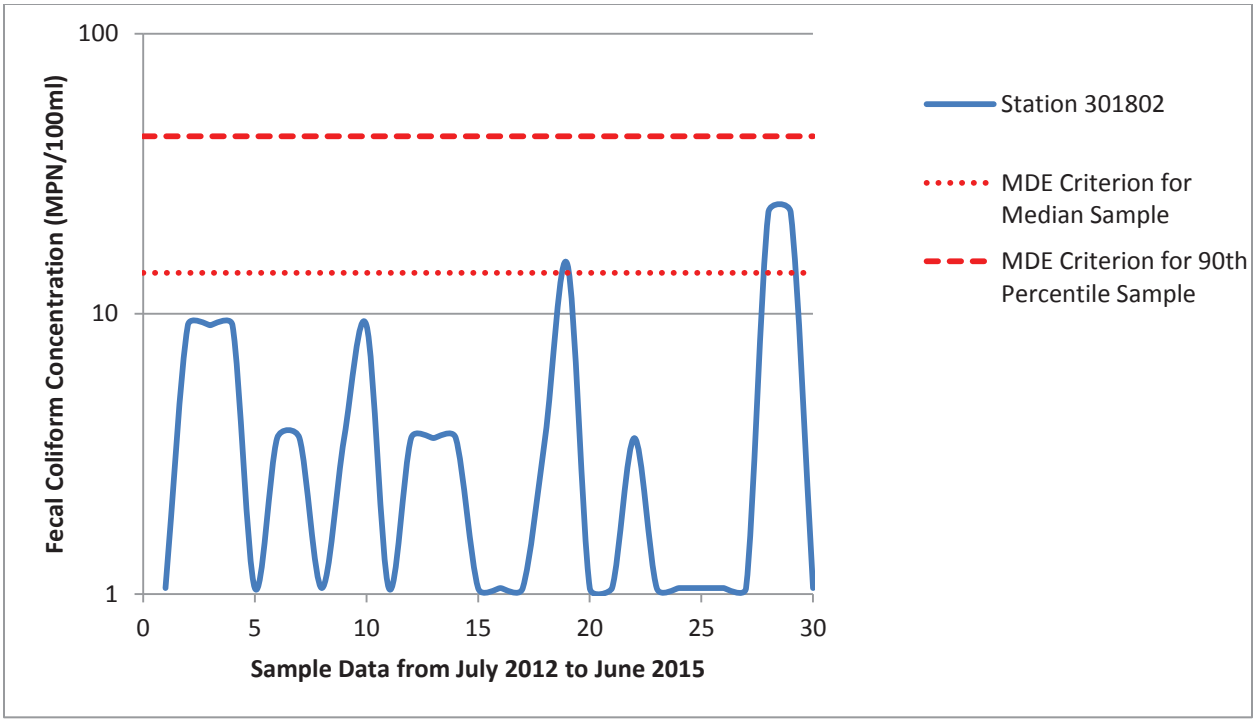

100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from July 2012 to June 2015
Station 301800
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

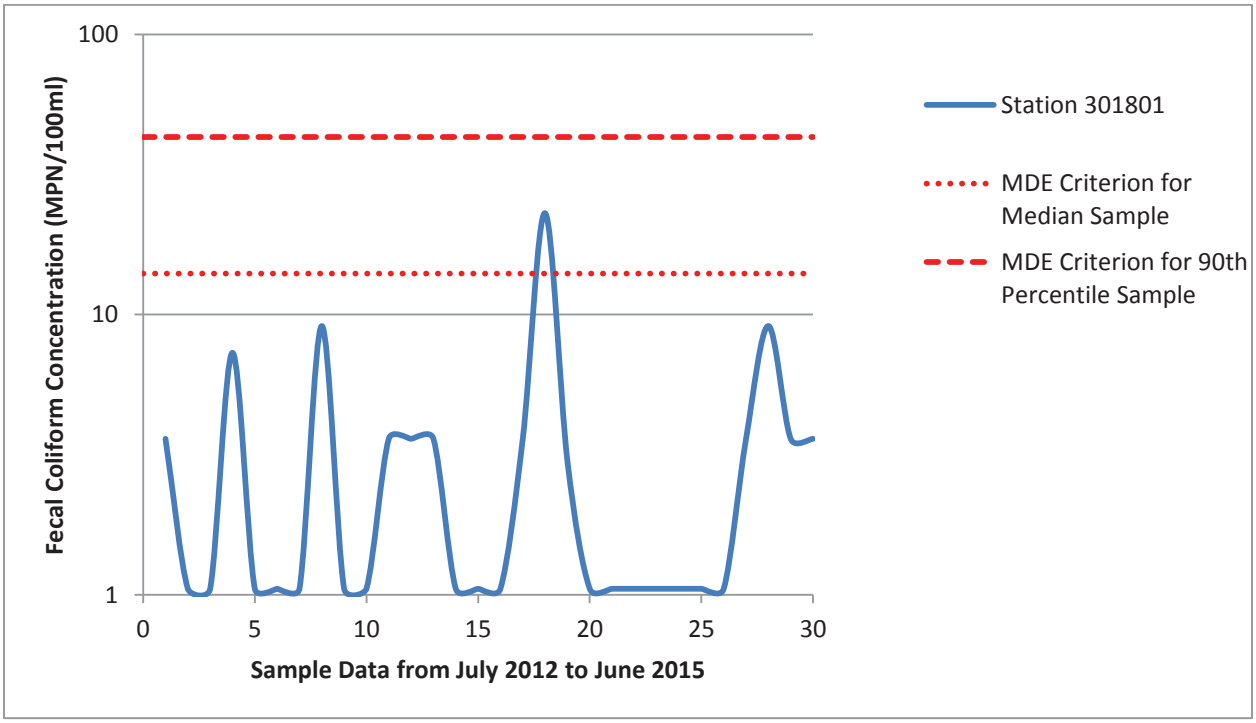
C.2 Magothy River Mainstem/Forked Creek

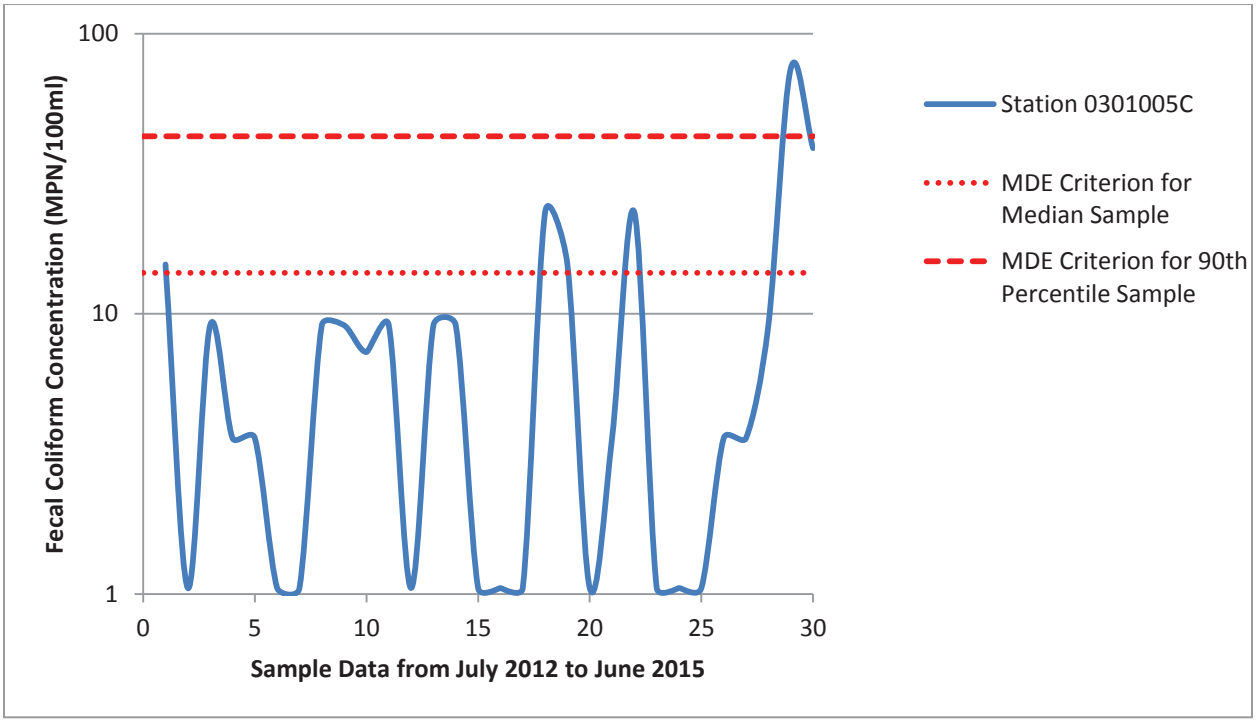


C.3 Magothy River Mainstem/Tar Cove

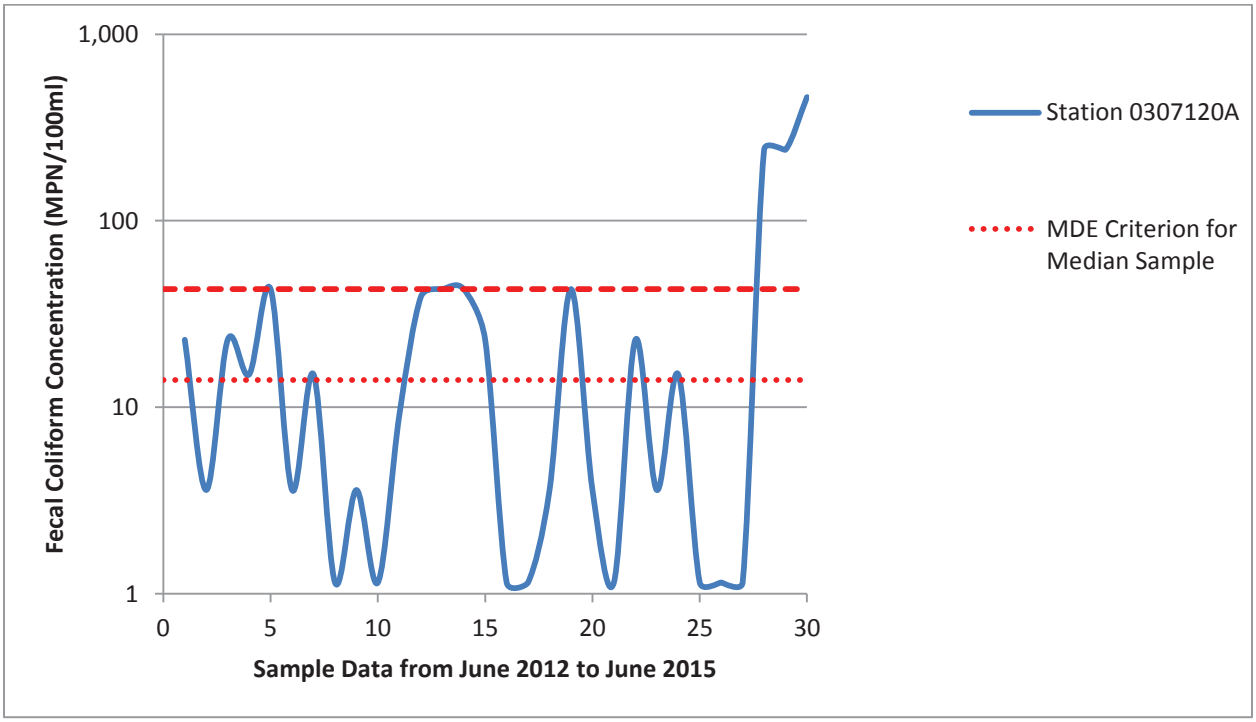



100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from July 2012 to June 2015
Station 301802
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

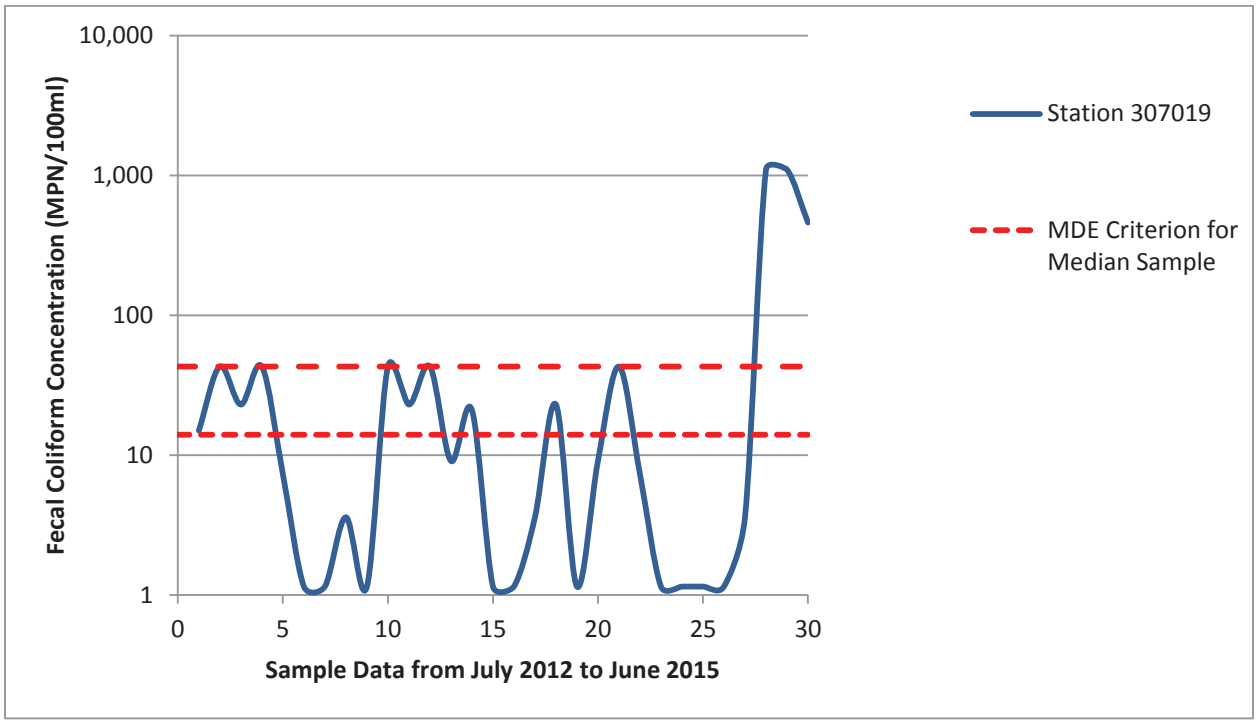

100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from July 2012 to June 2015
Station 301801
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample



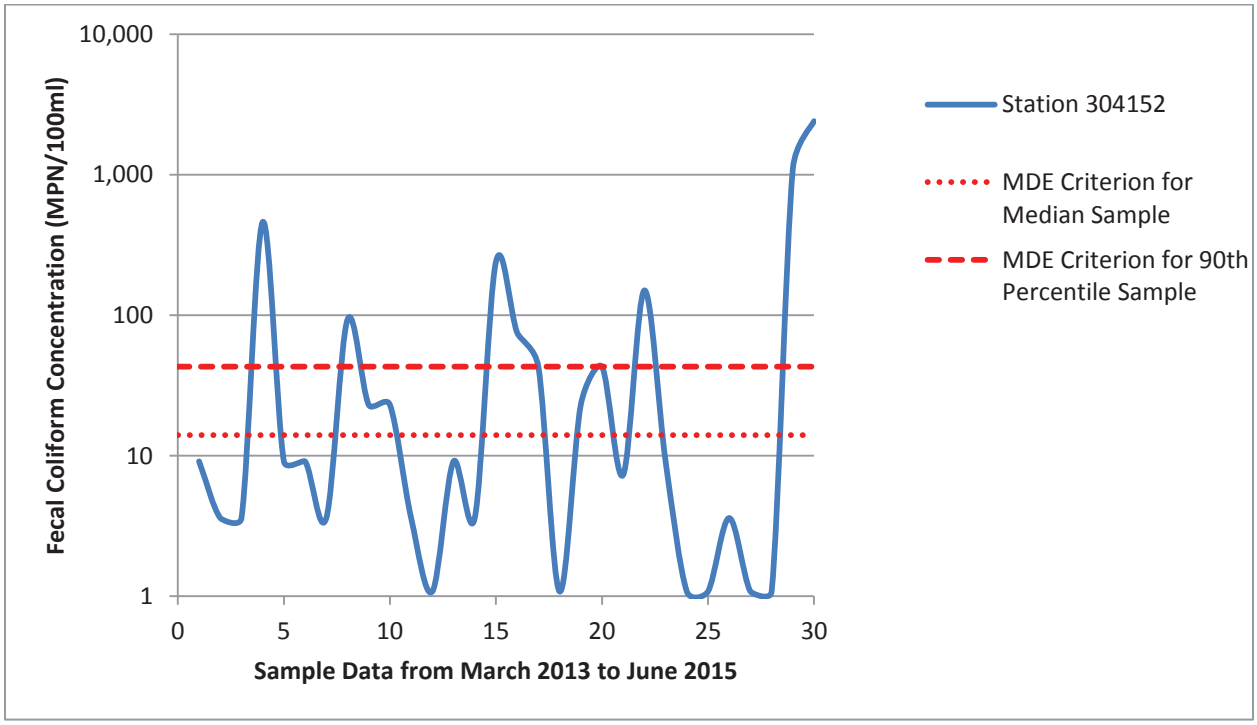
C.4 Rhode River/Bear Neck Creek

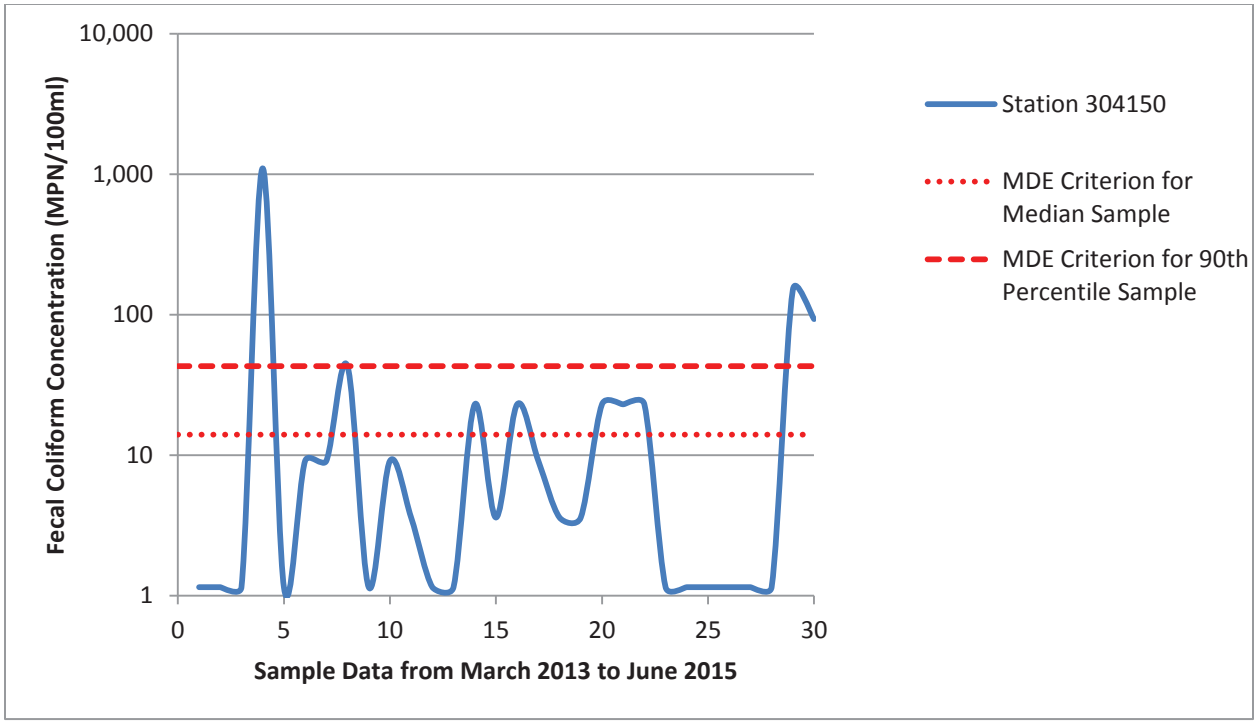


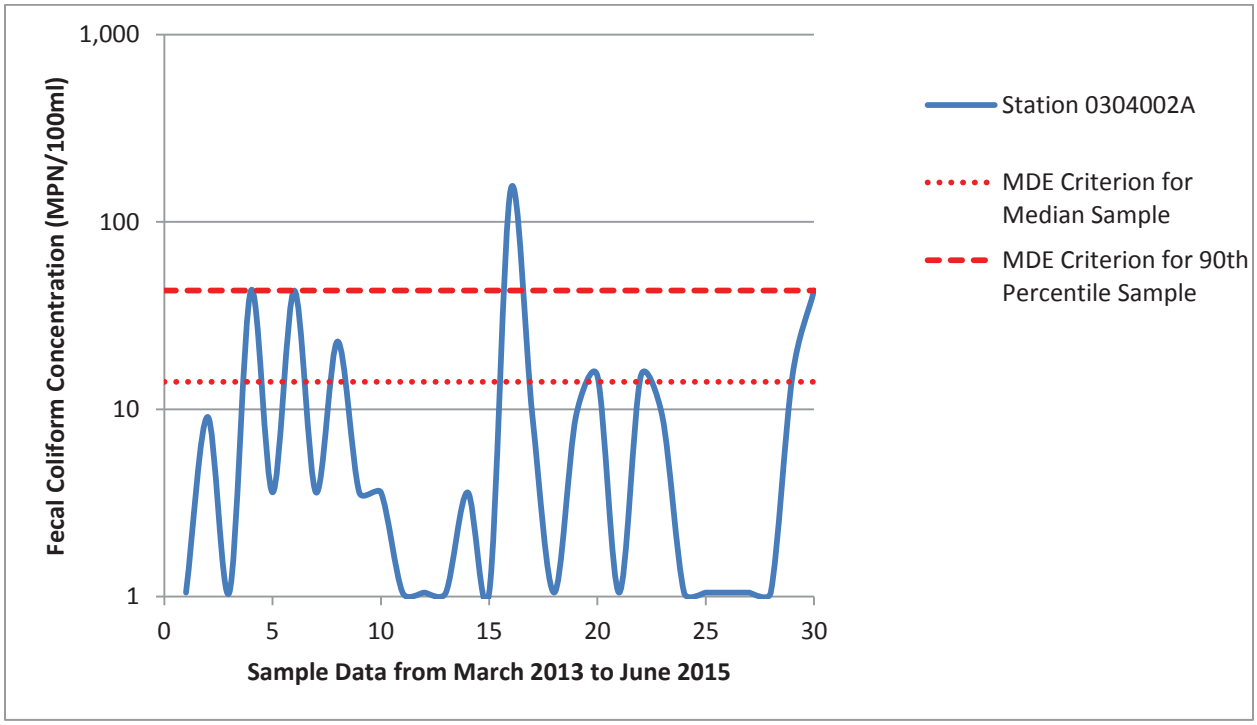
C.5 Rhode River/Cadle Creek

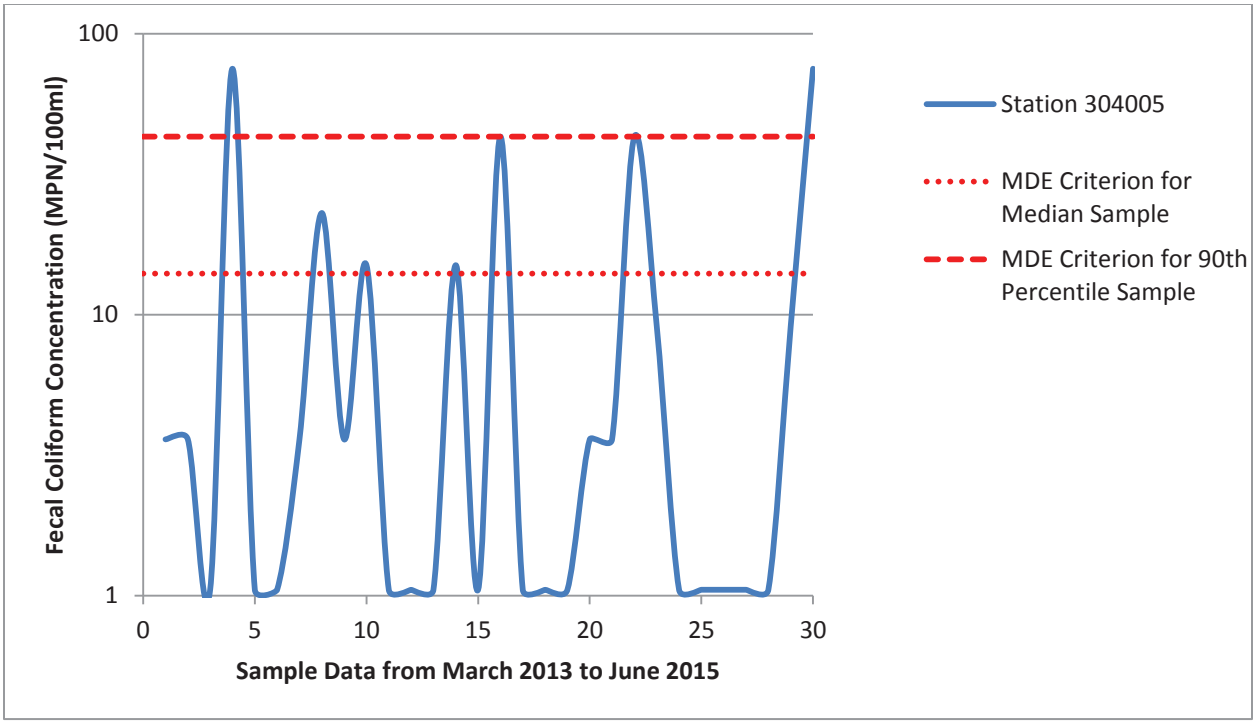


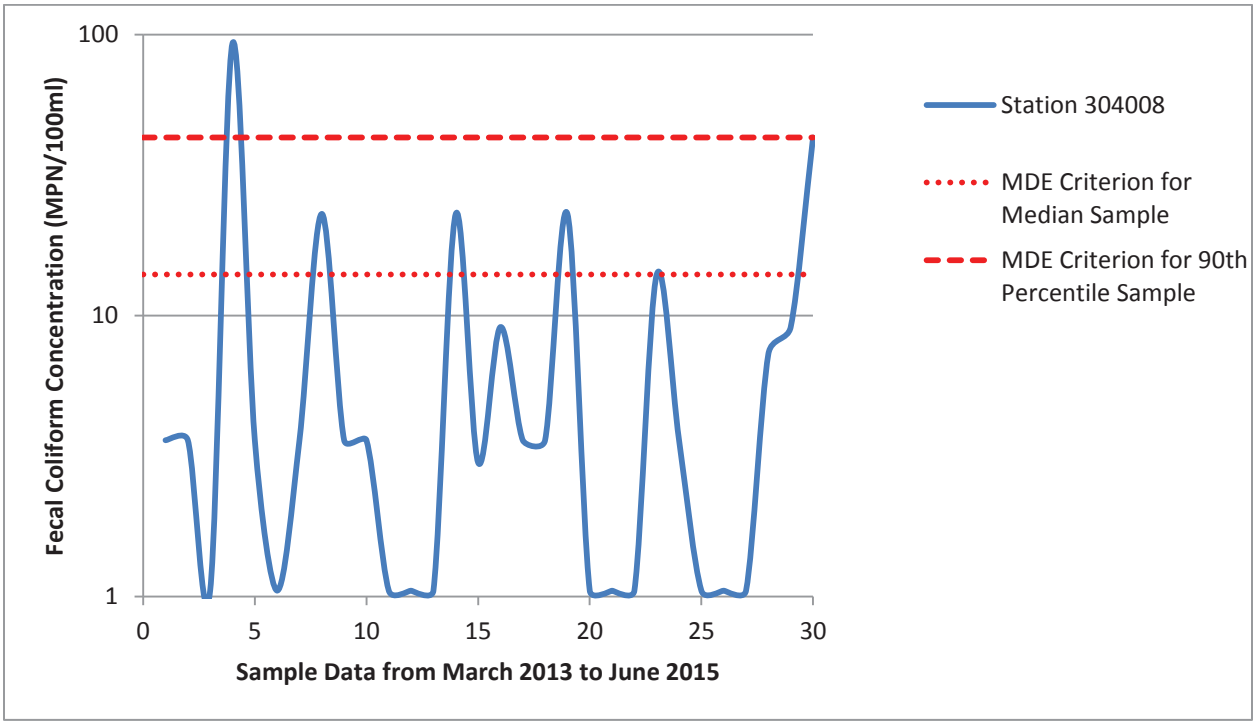
C.6 Severn River Mainstem

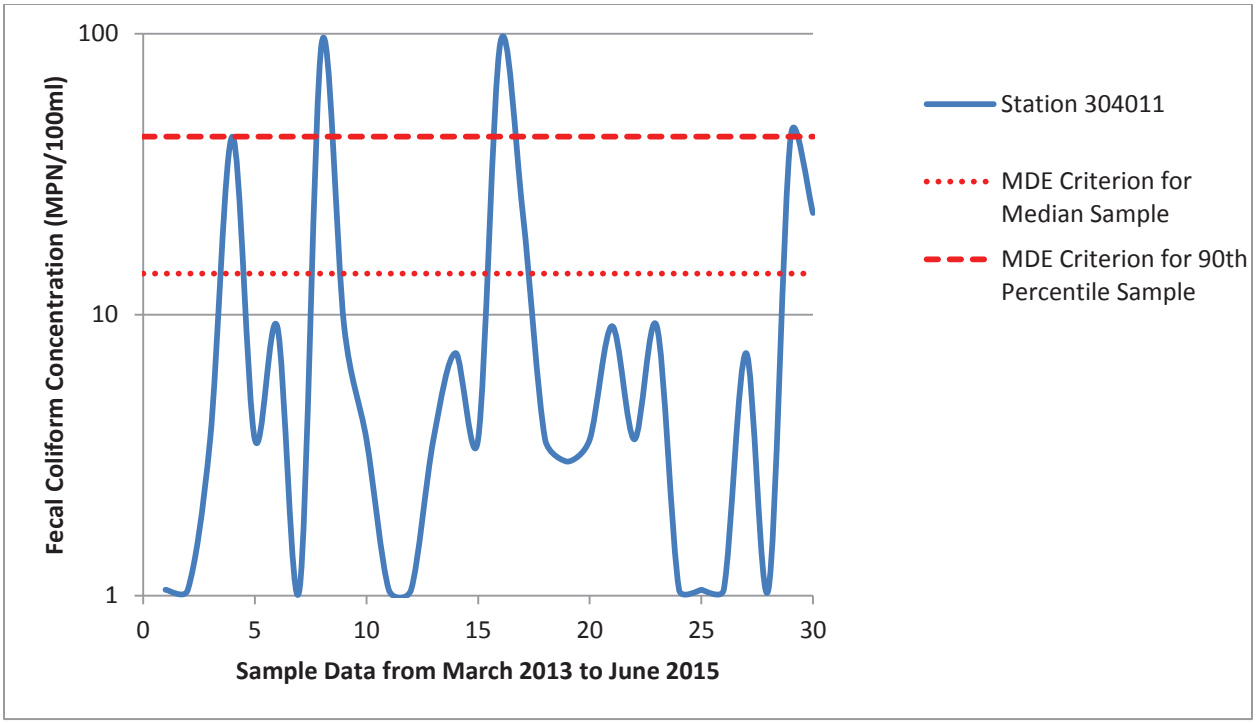


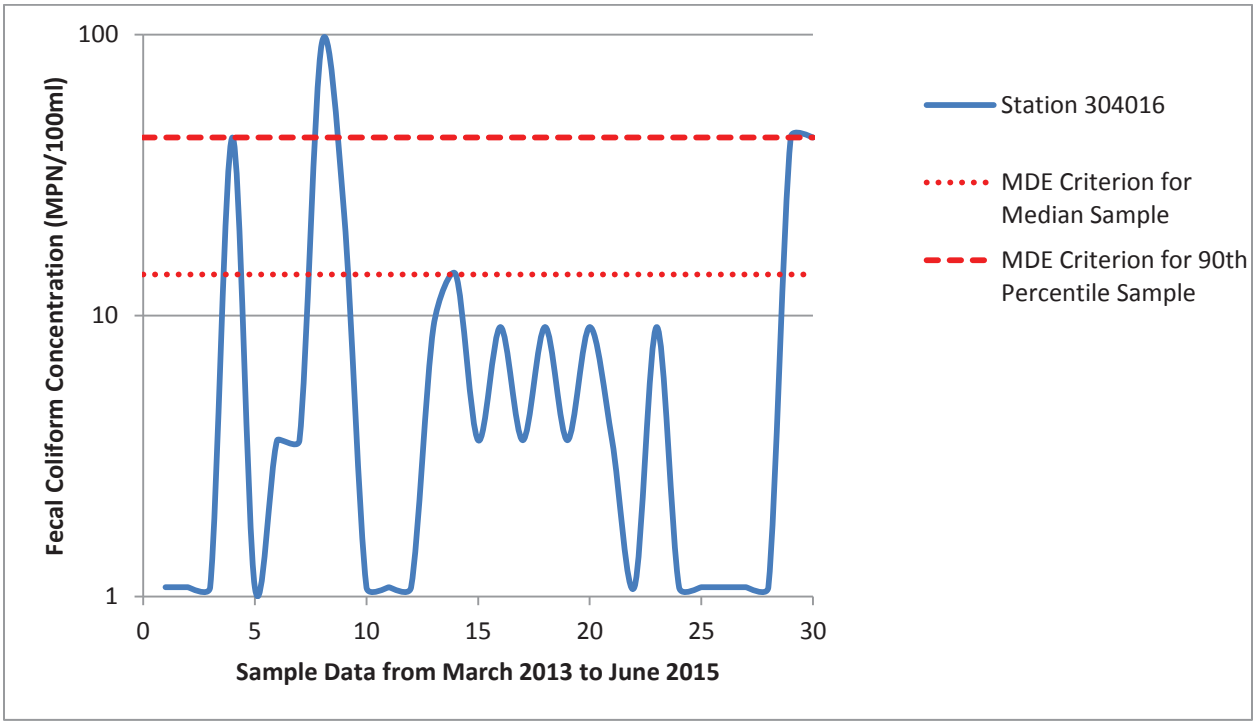

10,000
1,000
100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 304150
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

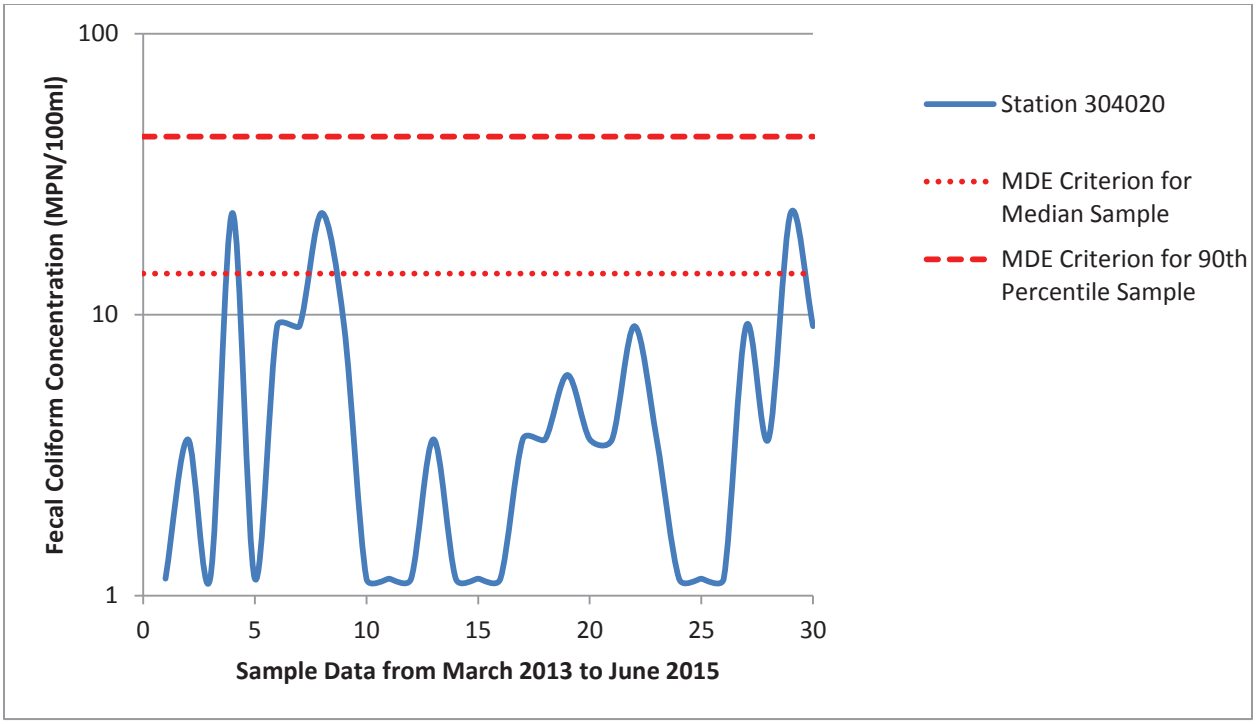

1,000
100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 0304002A
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

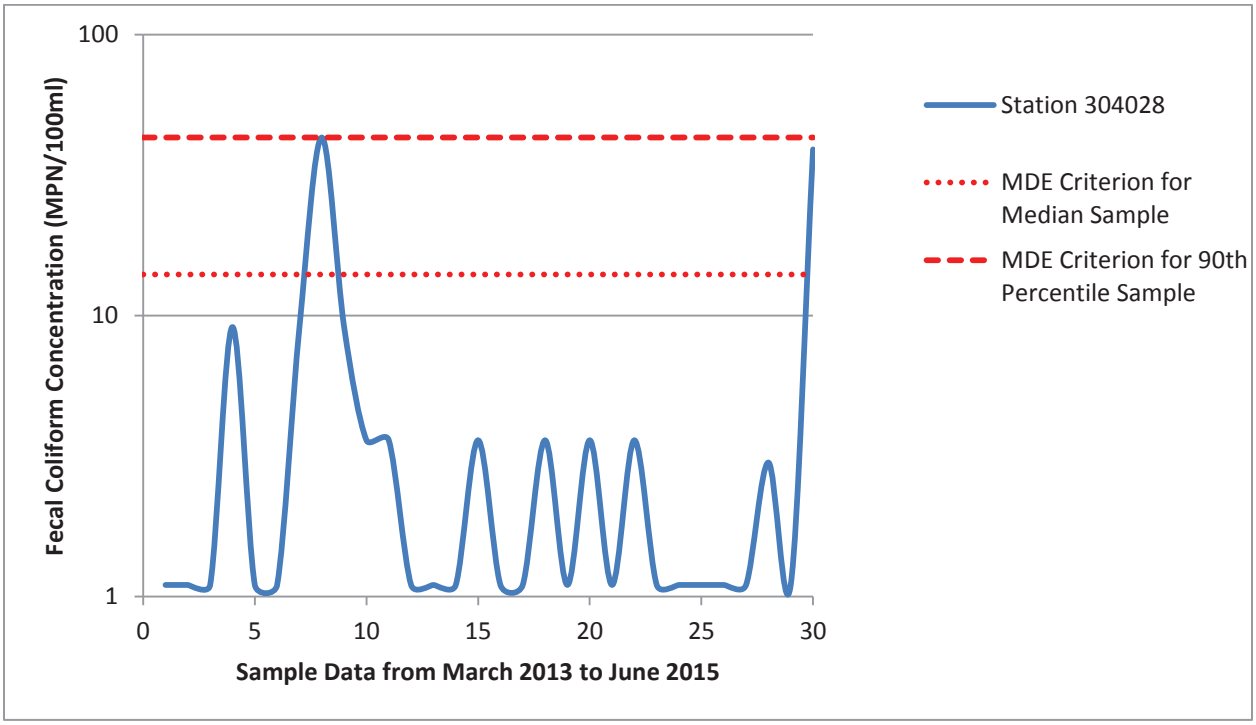

100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 304005
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

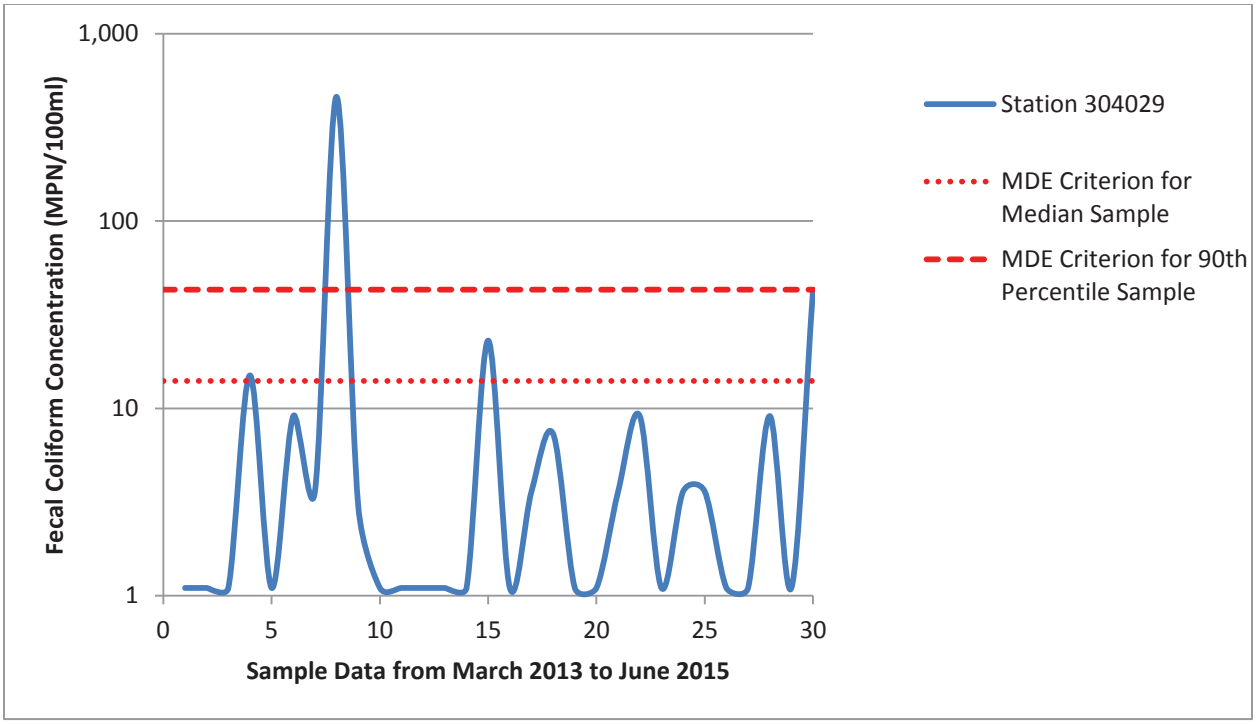

100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 304008
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

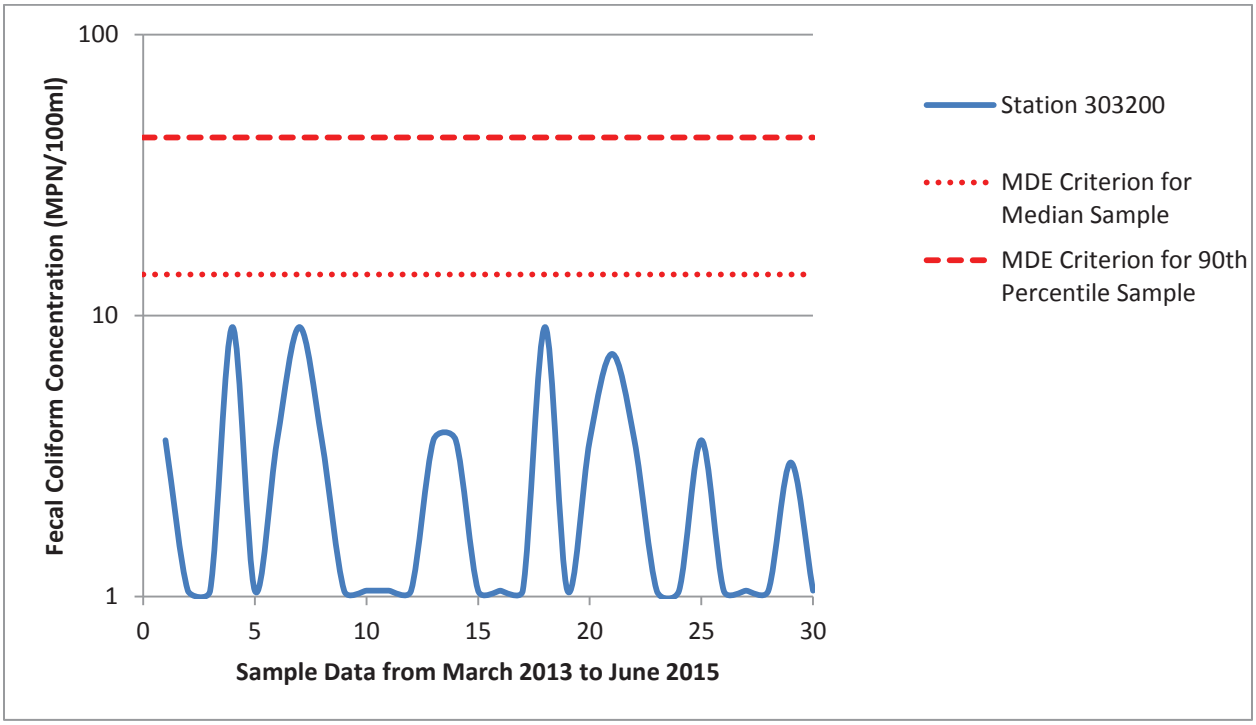

100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 304011
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

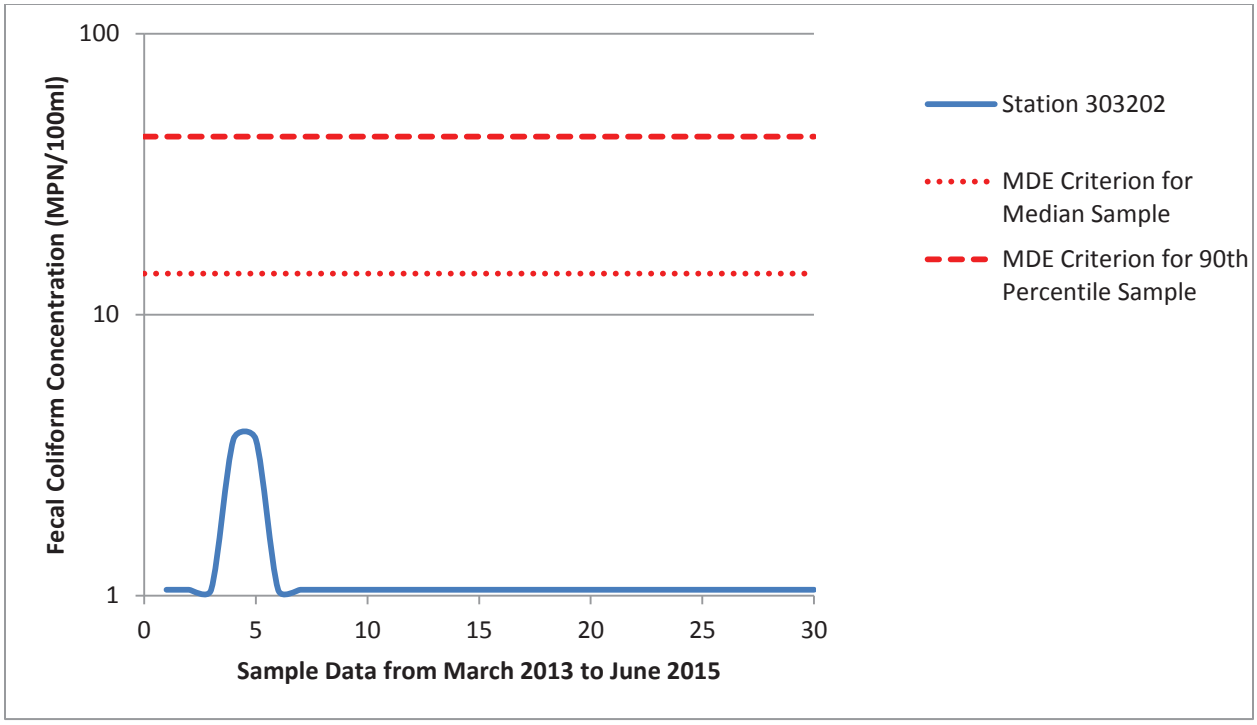

100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 304016
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

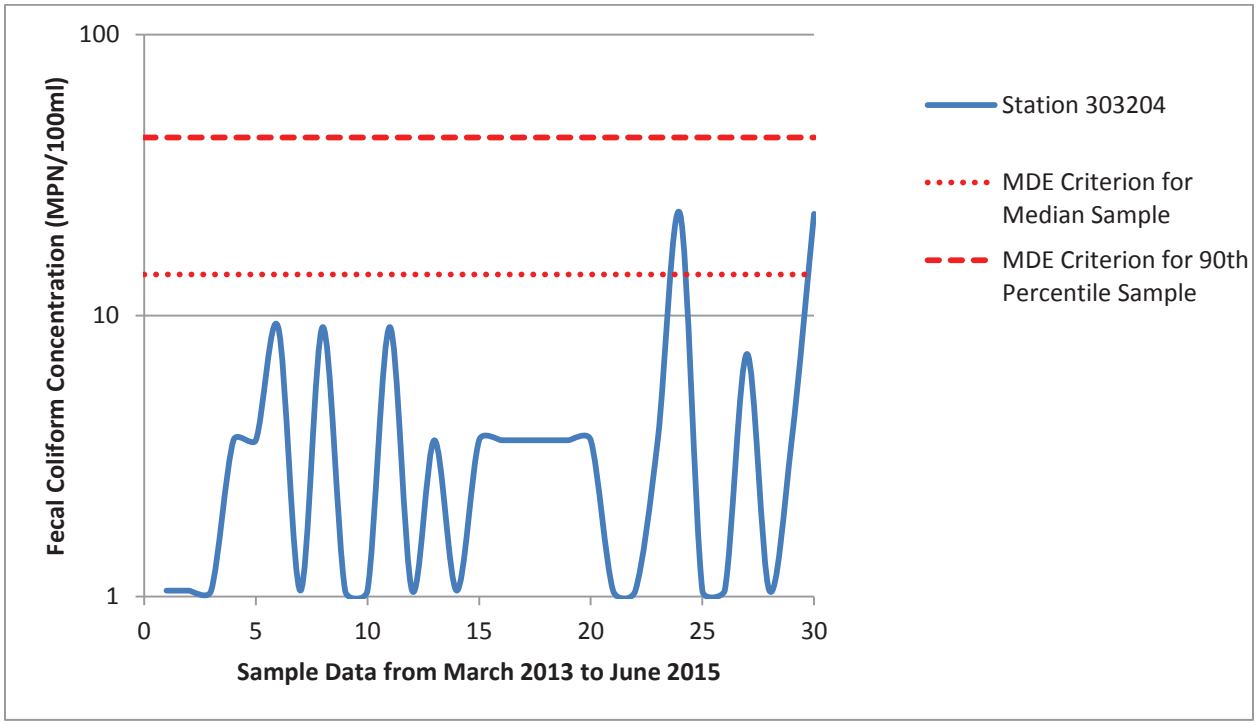

100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 304020
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample


100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 304028
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

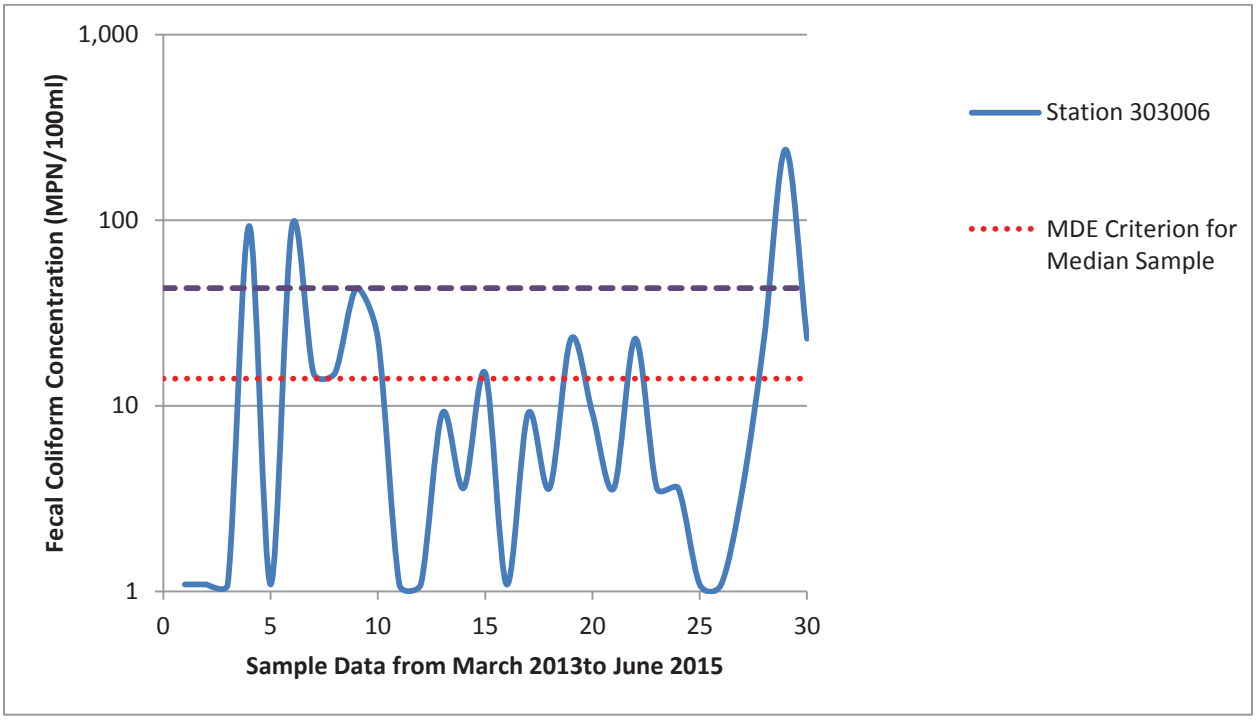

1,000
100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 304029
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample


100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 303200
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

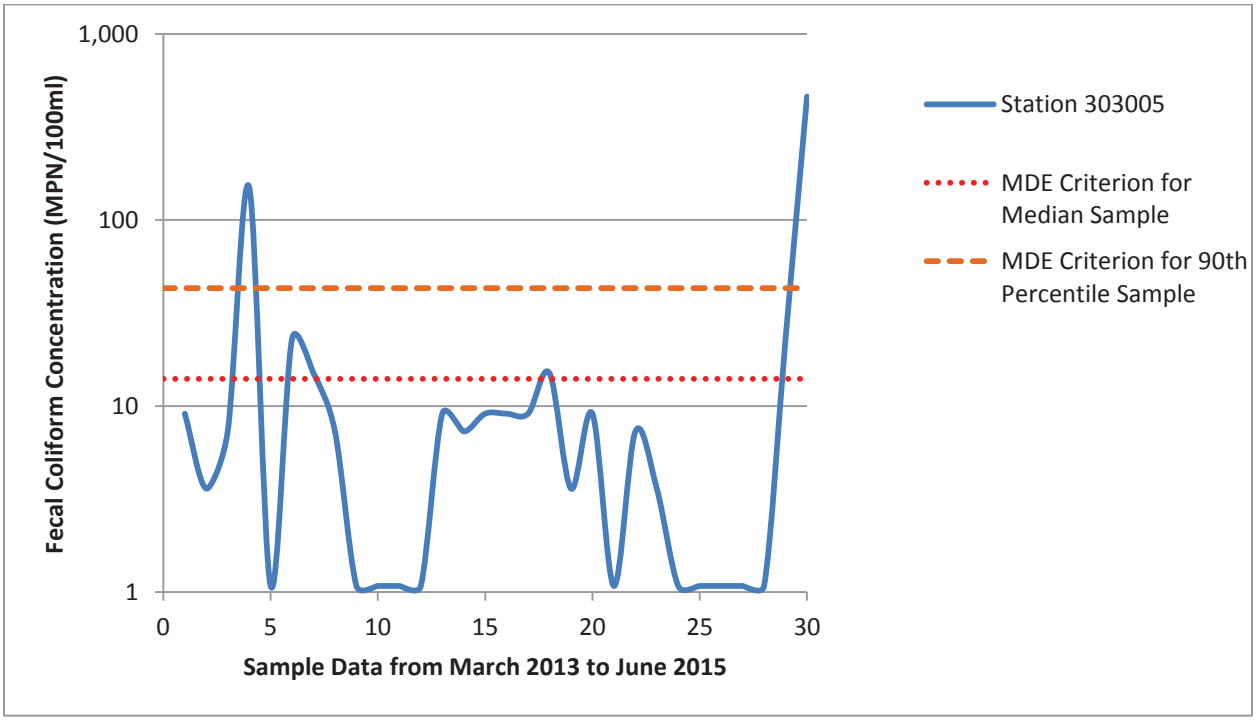

100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 303202
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

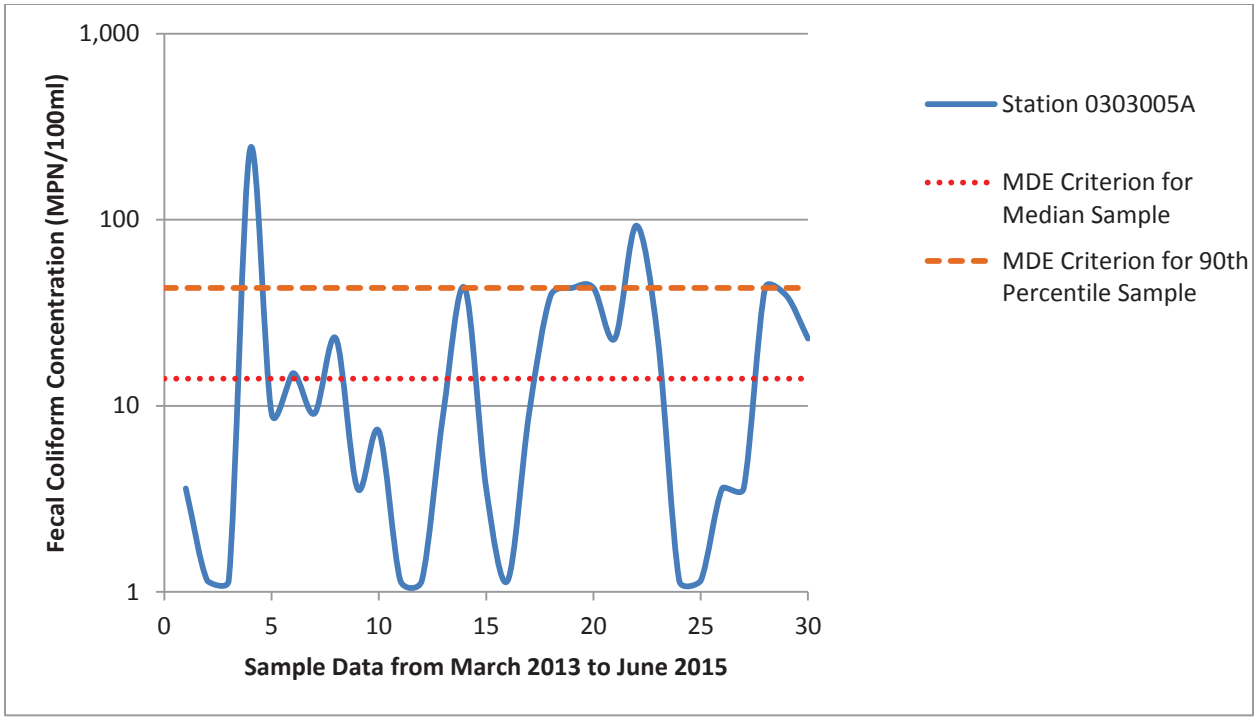

100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from March 2013 to June 2015
Station 303204
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

C.7 Severn River Mainstem/Mill Creek

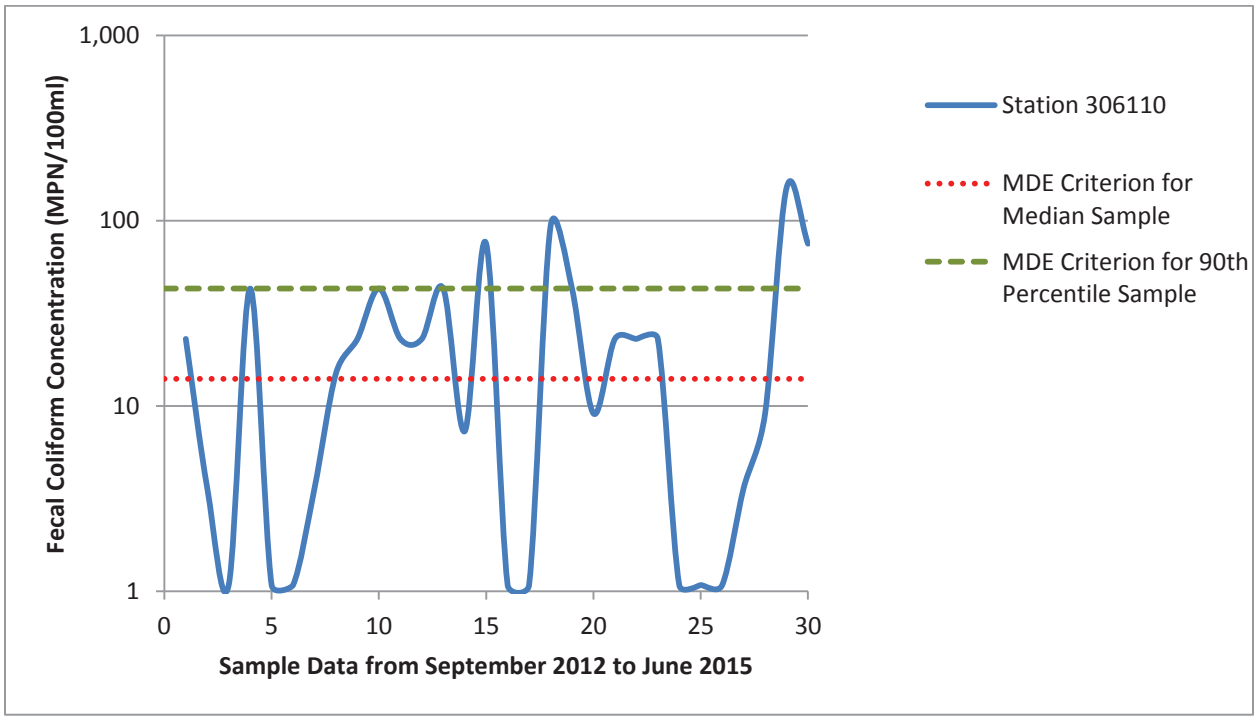


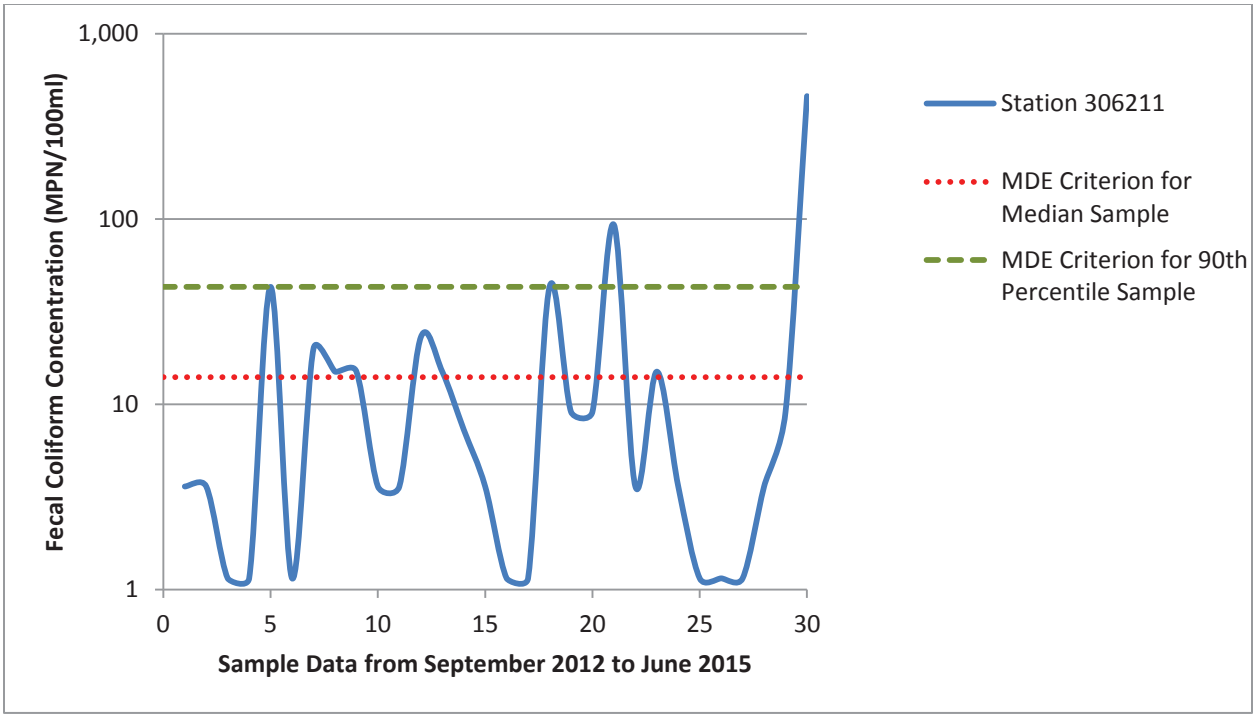
C.8 Severn River Mainstem/Whitehall and Meredith Creeks

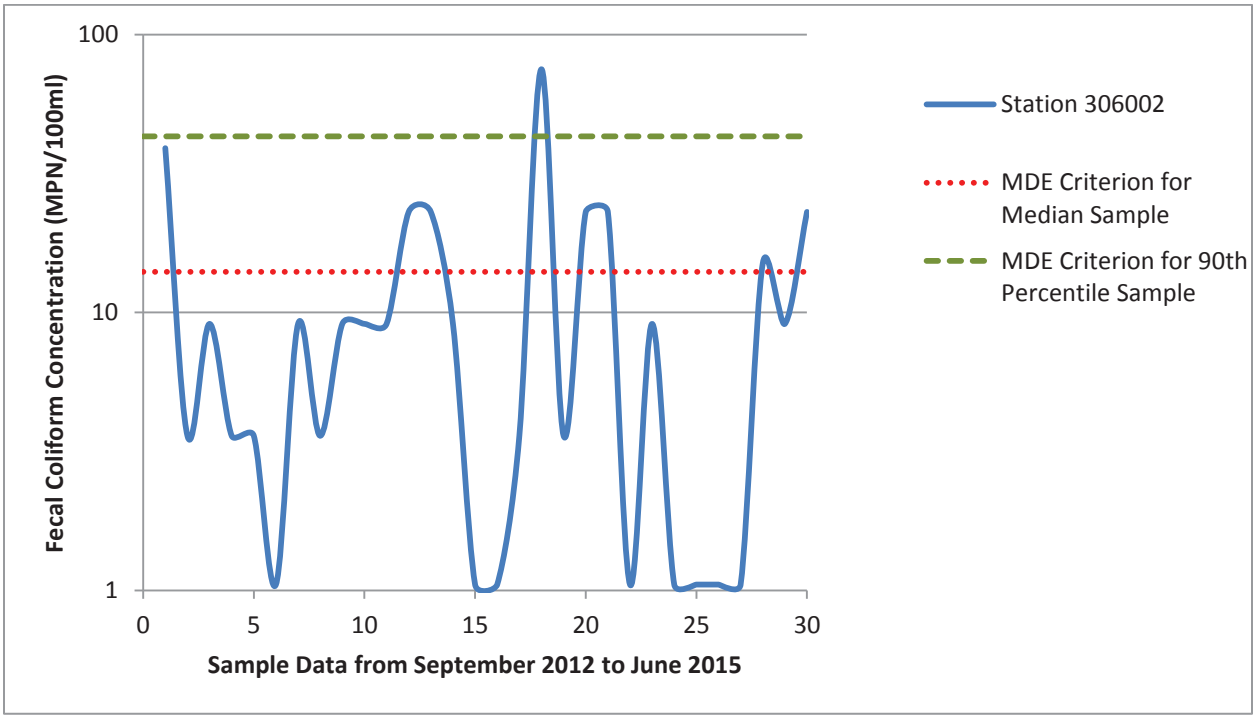


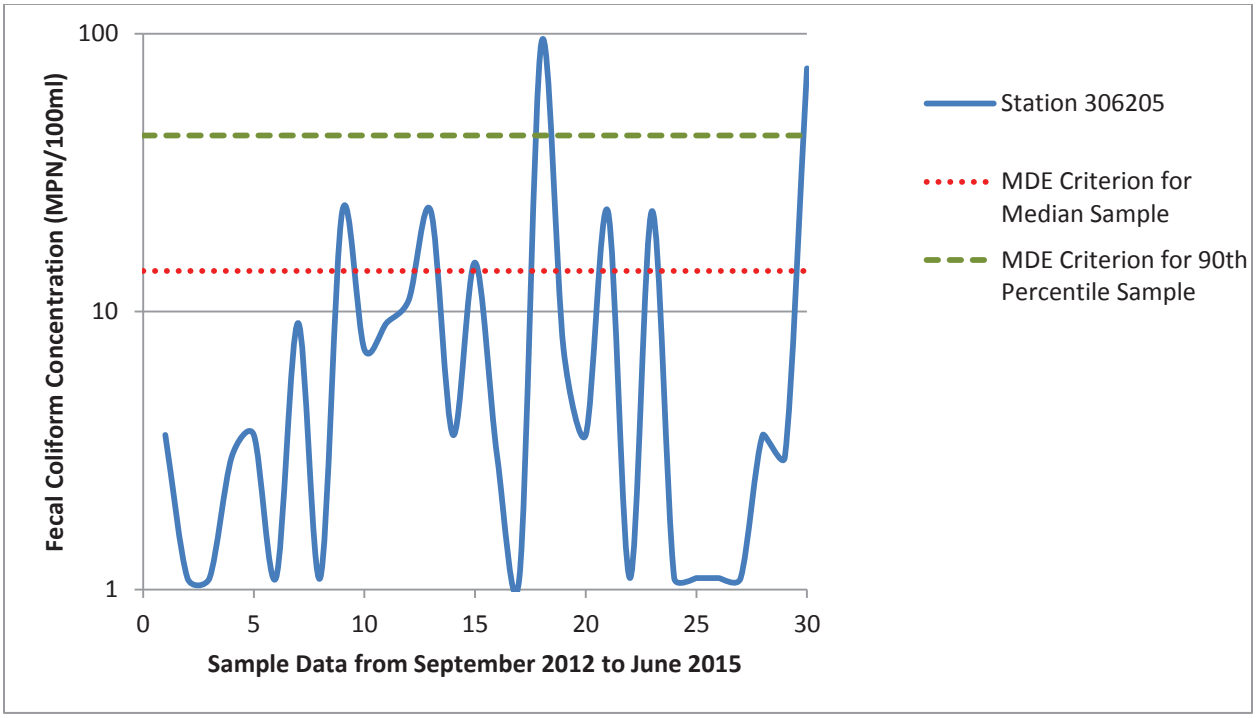


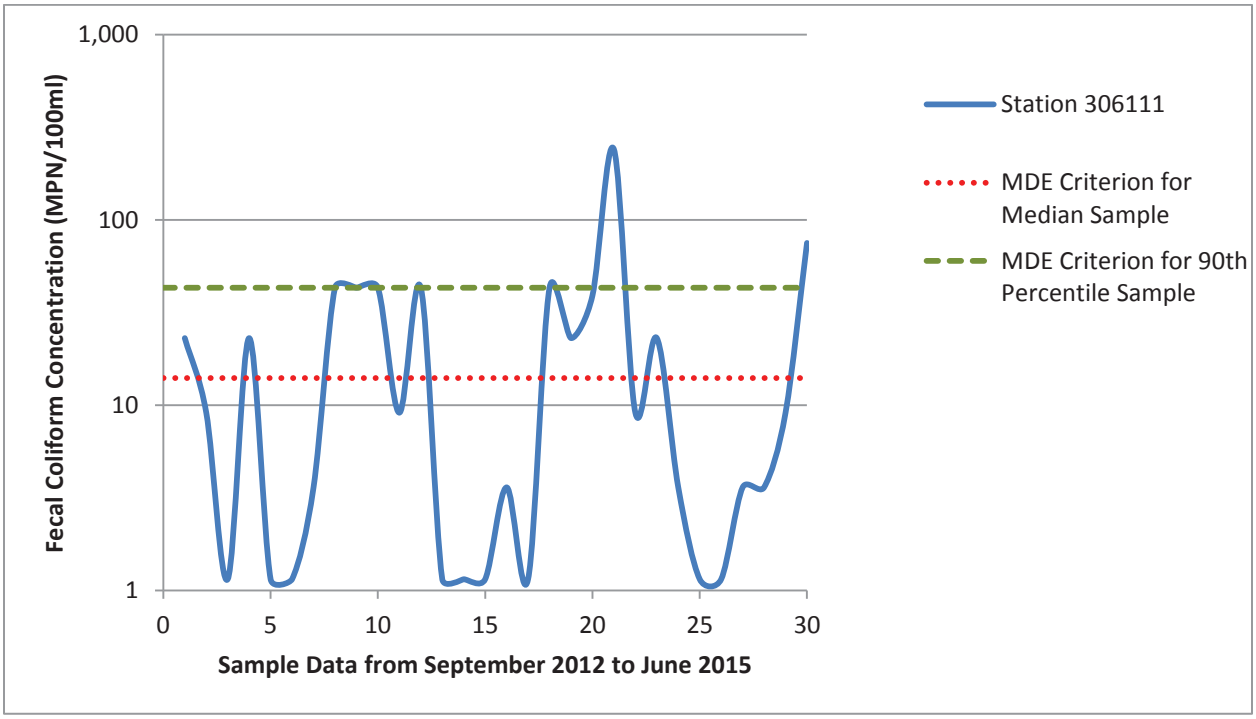
C.9 South River Mainstem

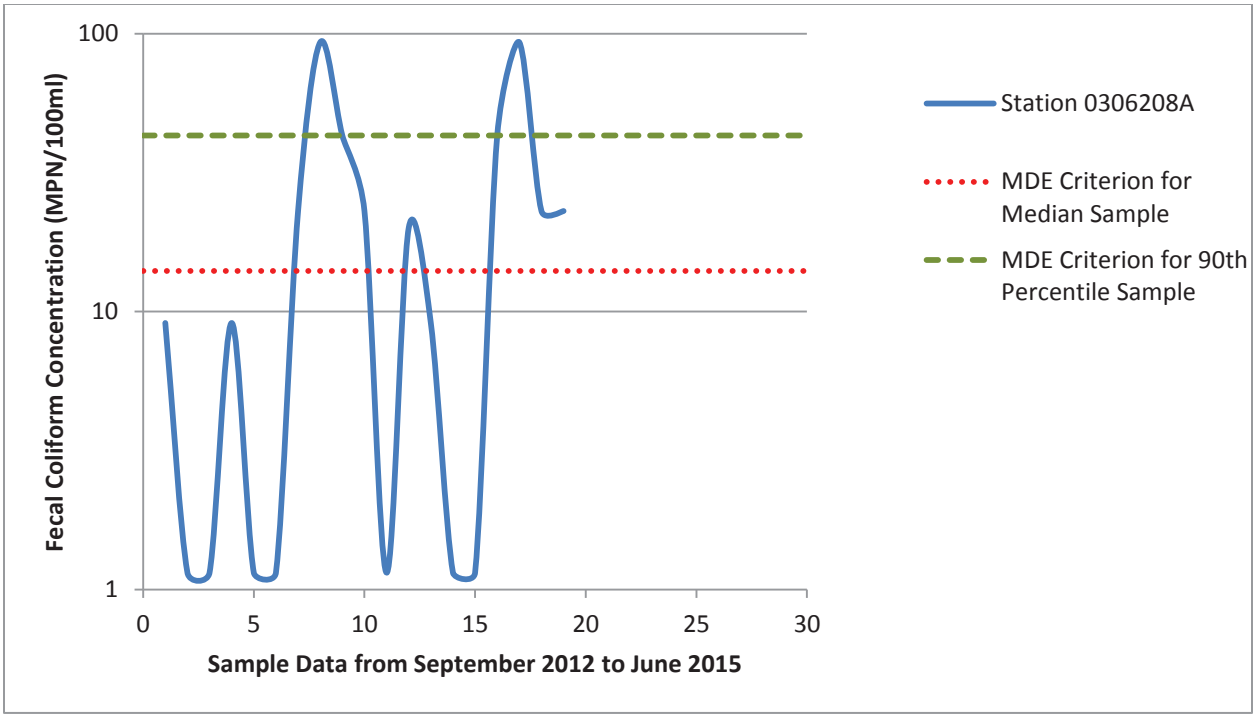



1,000
100
10
1
Fecal Coliform Concentration (MPN/100ml)
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5
10
15
20
25
30
Sample Data from September 2012 to June 2015
Station 306211
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

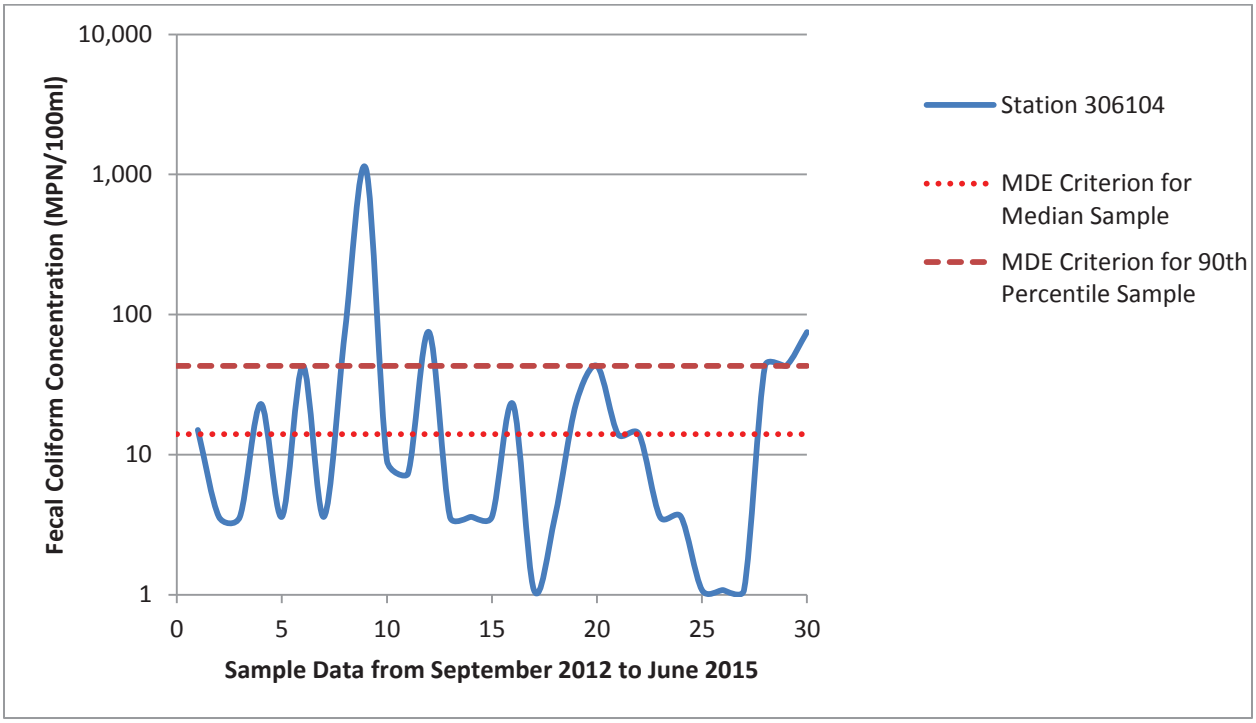

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10
1
Fecal Coliform Concentration (MPN/100ml)
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5
10
15
20
25
30
Sample Data from September 2012 to June 2015
Station 306002
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

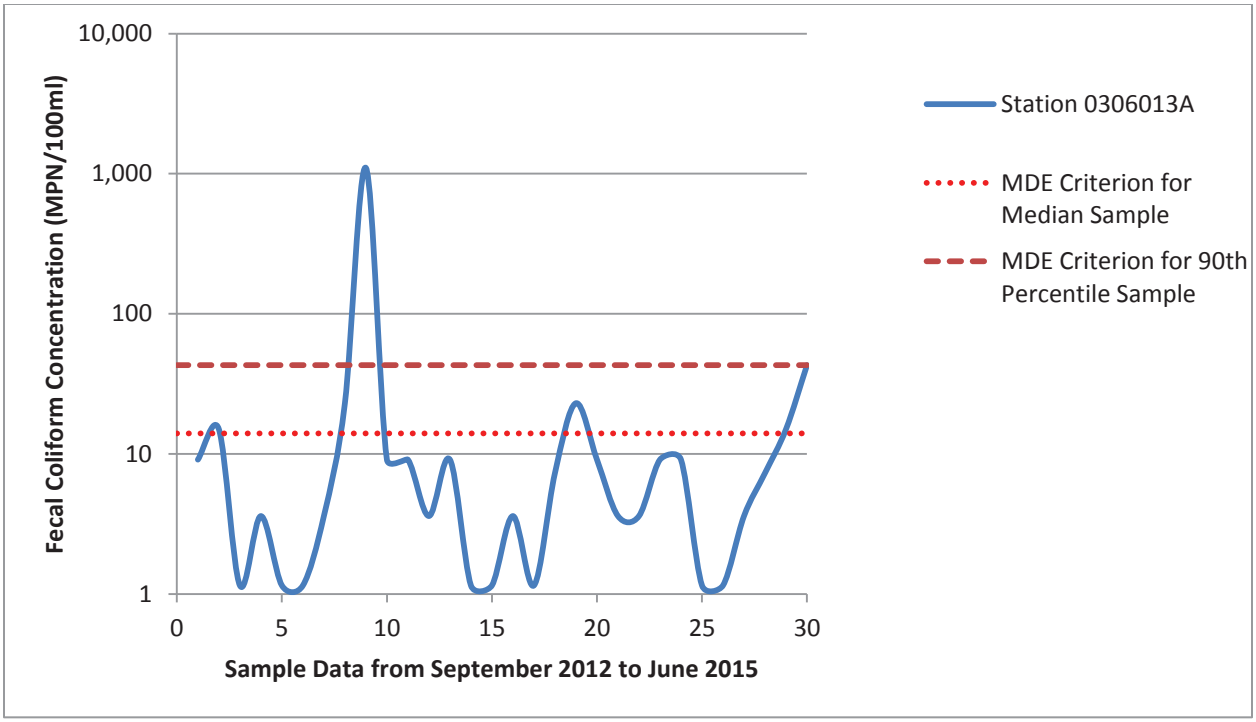

100
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1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from September 2012 to June 2015
Station 306205
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample


1,000
100
10
1
Fecal Coliform Concentration (MPN/100ml)
0
5
10
15
20
25
30
Sample Data from September 2012 to June 2015
Station 306111
MDE Criterion for Median Sample
MDE Criterion for 90th Percentile Sample

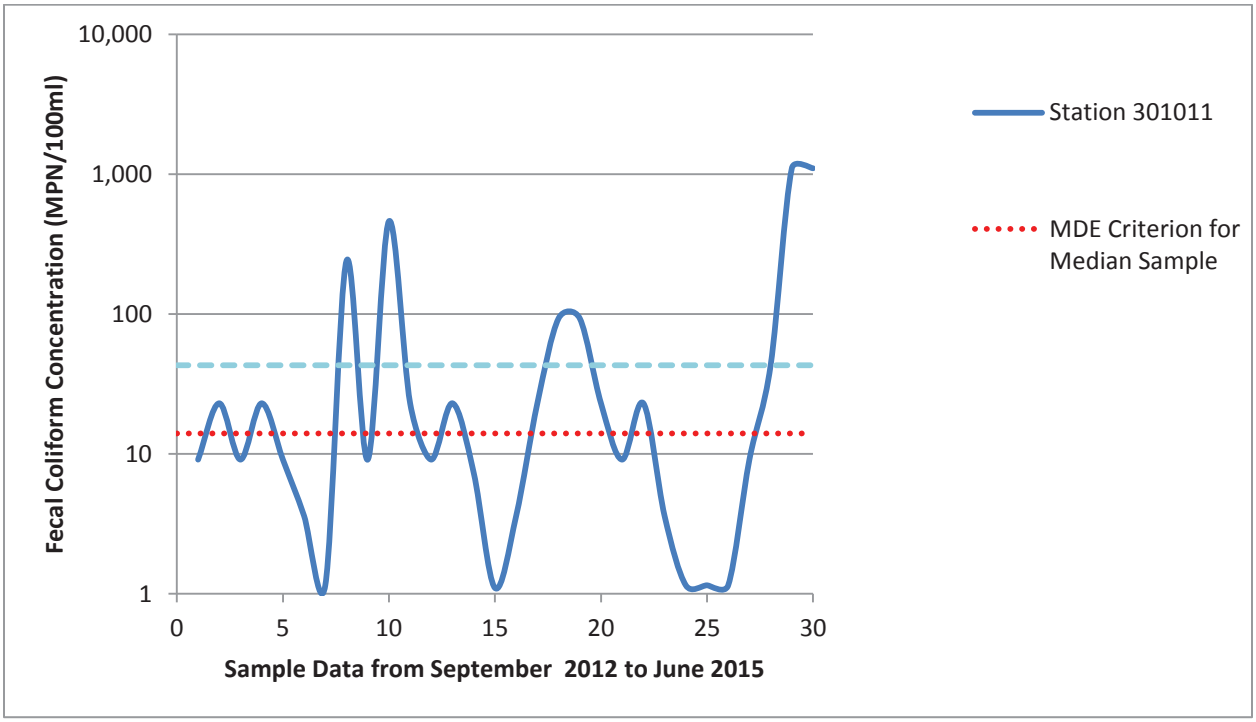


C.10 South River Mainstem/Duvall Creek

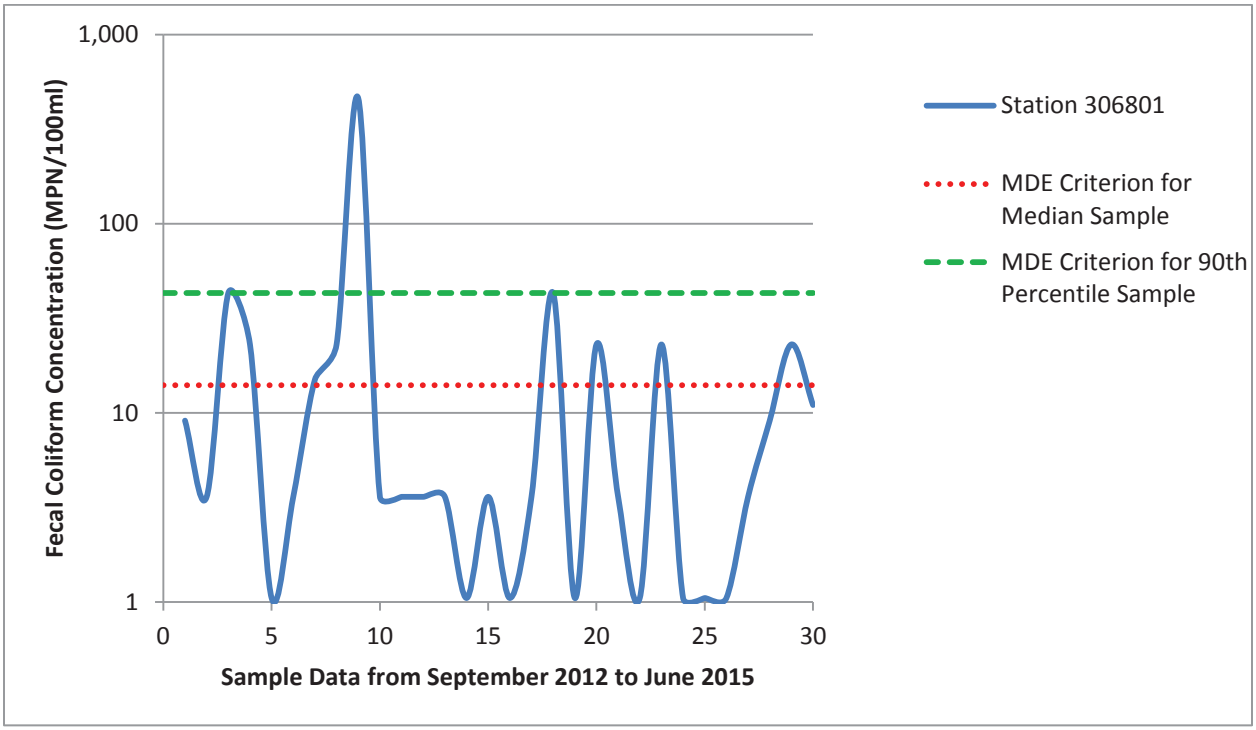


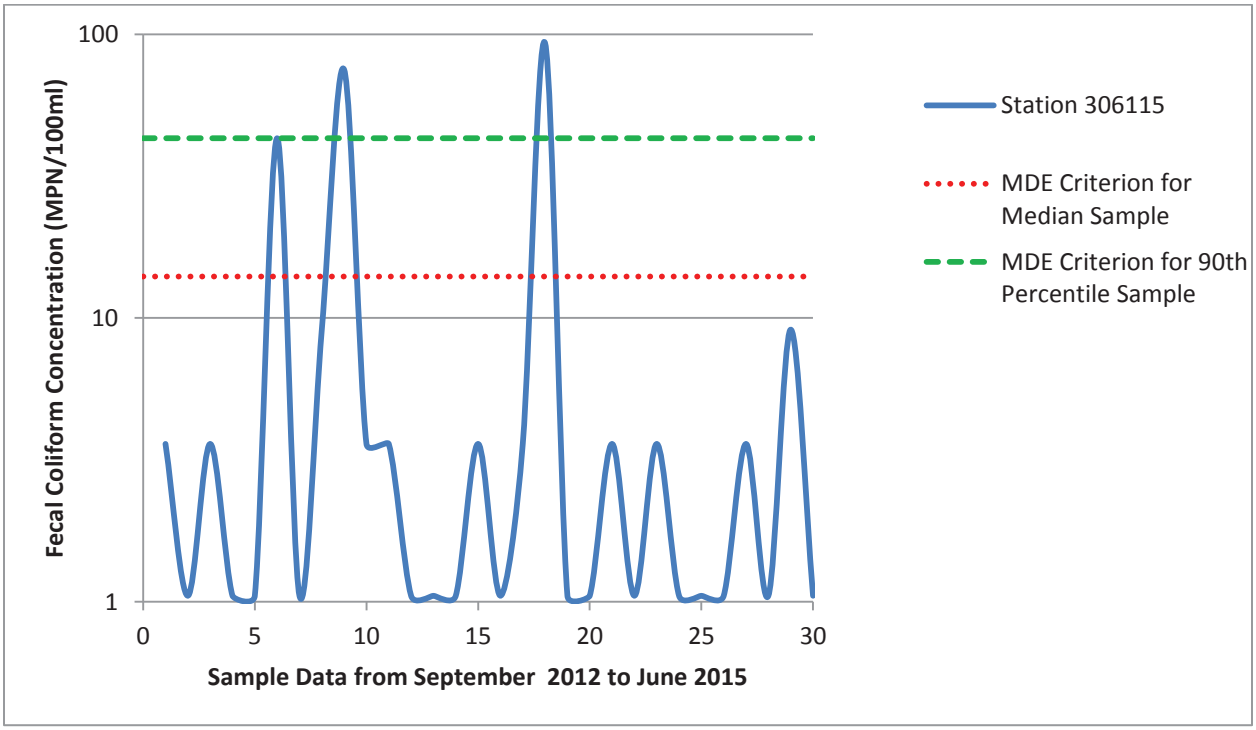


C.11 South River Mainstem/Ramsey Lake

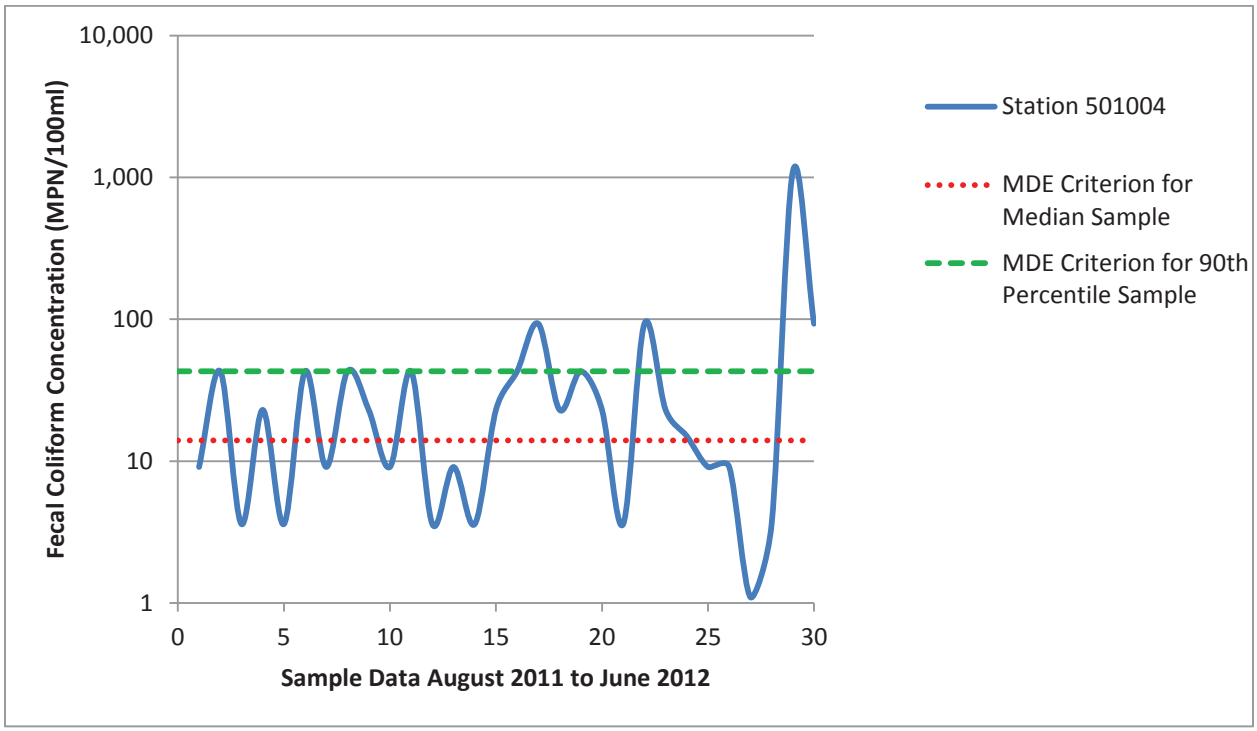


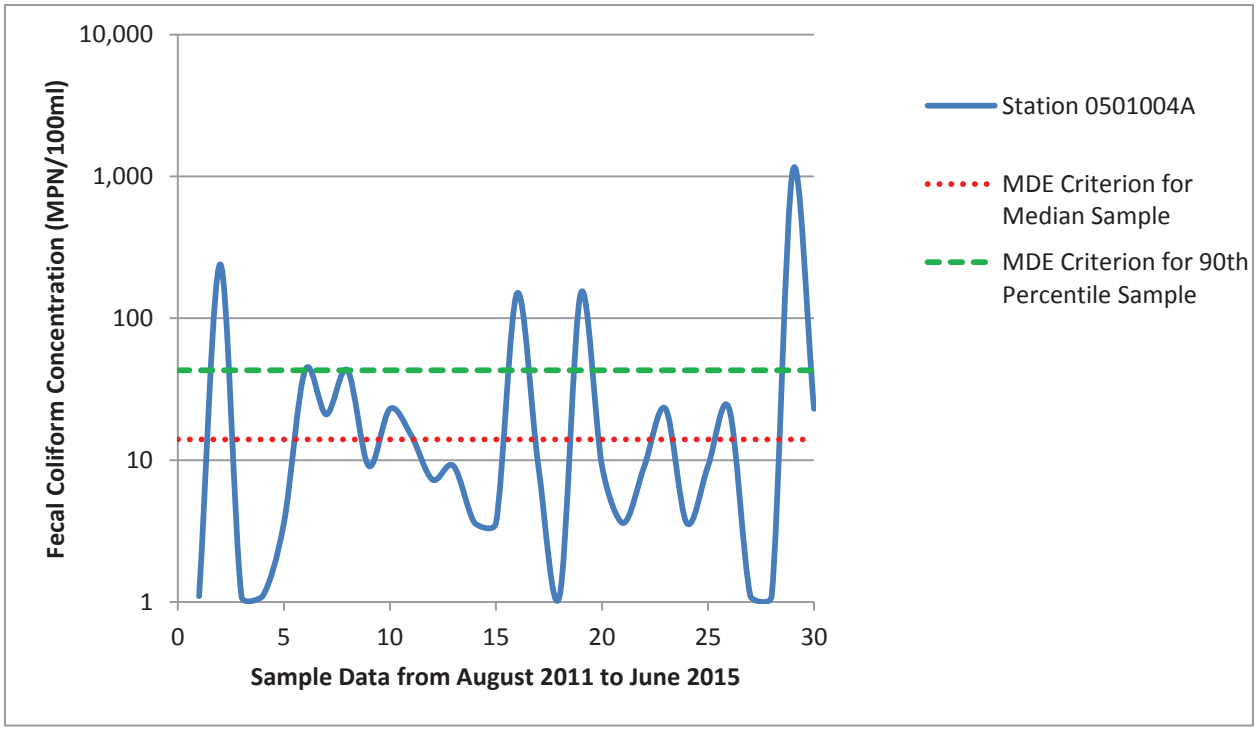
C.12 South River Mainstem/Selby Bay



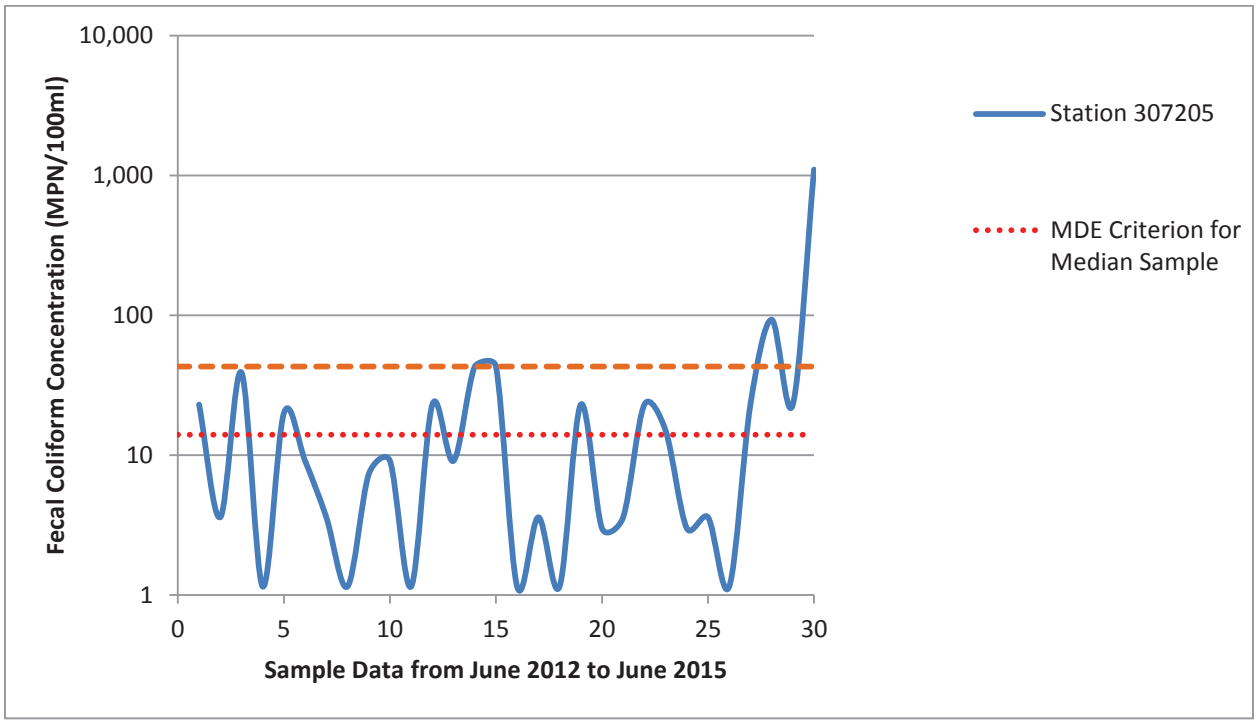


C.13 Chesapeake Mainstem/Tracey and Rockhold Watersheds

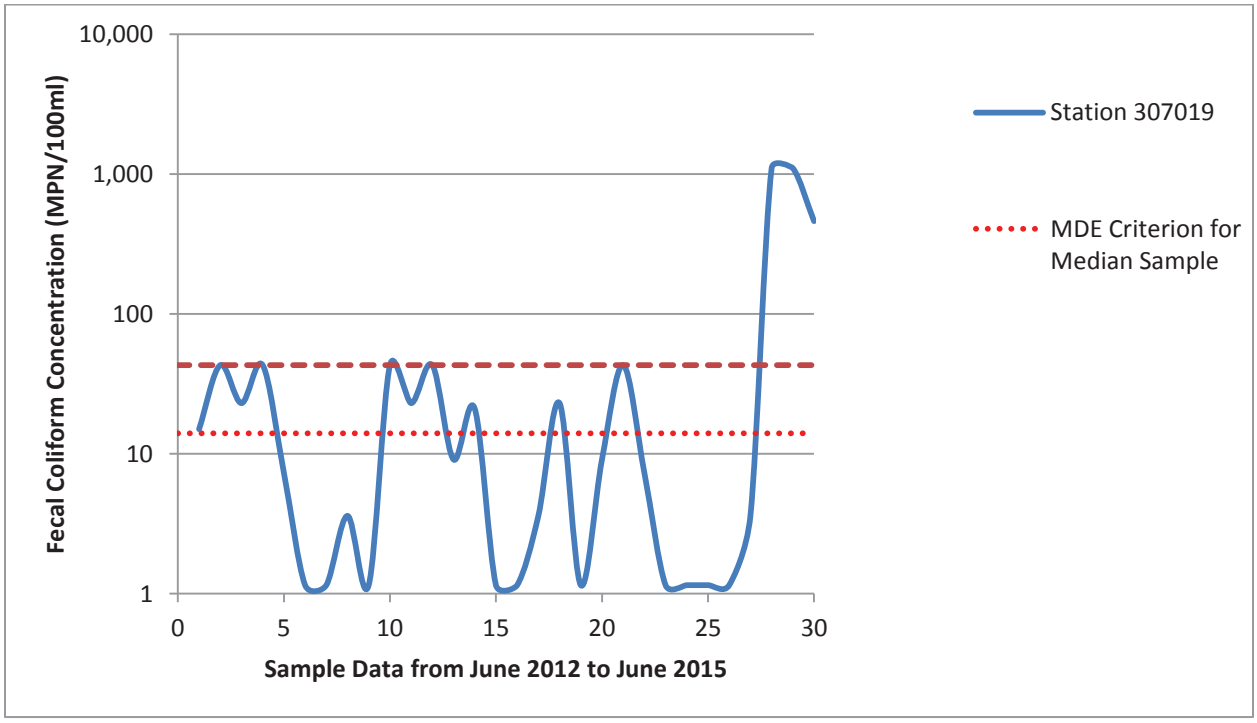




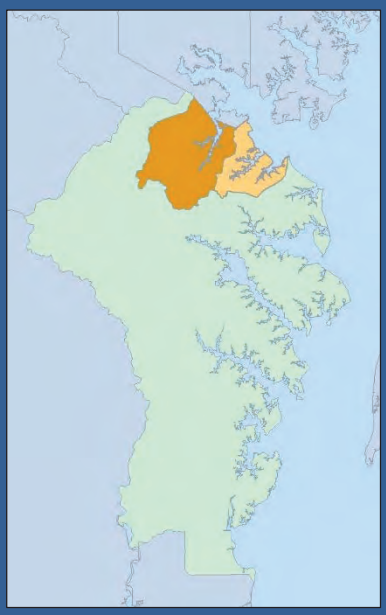
C.14 West River Mainstem



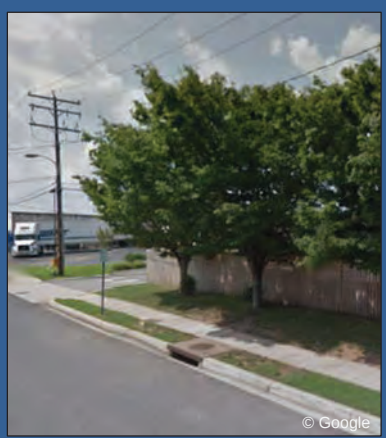
C.15 West River Mainstem/Parish Creek













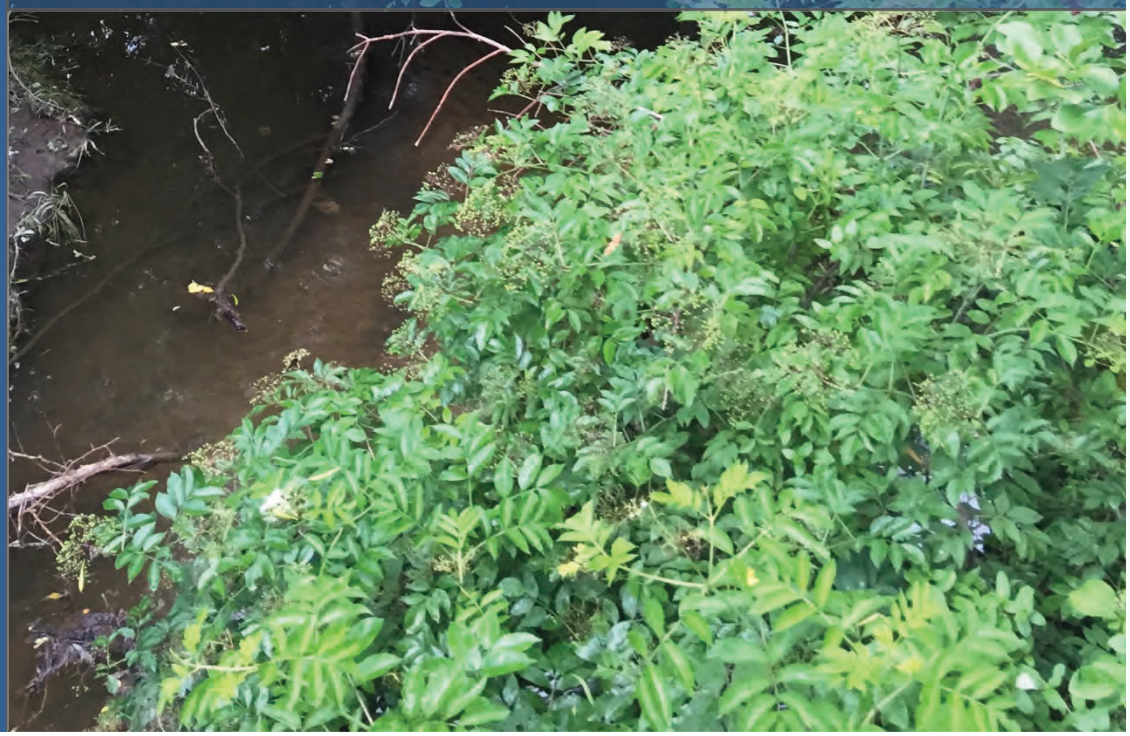
Baltimore Harbor and Curtis Creek/Bay Polychlorinated Biphenyls (PCB) TMDL Restoration Plan

Final Draft

Anne Arundel County, Maryland

Submitted to MDE February 2016

Anne Arundel County WATERSHED Protection & Restoration PROGRAM



Baltimore Harbor and Curtis Creek/Bay Polychlorinated Biphenyls (PCB) TMDL Restoration Plan

Final Draft

Submitted to MDE February 2016

Prepared for:

Anne Arundel County
Department of Public Works
Watershed Protection and Restoration Program
2662 Riva Road, P.O. Box 6675
Annapolis, Maryland 21401

Prepared by:

Biohabitats, Inc.
2081 Clipper Park Road
Baltimore, Maryland 21211

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List of Acronyms

AACO	Anne Arundel County
BMP	Best Management Practice
CBP	Chesapeake Bay Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COMAR	Code of Maryland Regulations
Curtis Creek	Curtis Creek/Bay
CWP	Center for Watershed Protection
DNR	Maryland Department of Natural Resources
DPW	Department of Public Works
EMC	Event mean concentration
EPA	U.S Environmental Protection Agency
ERM	Effects Range Median
g	grams
GSA	General Services Administration
HSG	Hydrologic Soil Group
L	Liter
LA	Load Allocation
LRP	Land Restoration Program
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
mg	Milligrams
MS4	Municipal Separate Storm Sewer System
ng	Nanograms
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	National Response Center
PCBs	Polychlorinated biphenyls
SW-WLA	Stormwater Waste Load Allocation
the County	Anne Arundel County
TMDL	Total maximum daily load
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
ug	micrograms

USCG	United States Coast Guard
VCP	Voluntary Cleanup Program
WIP	Watershed Implementation Plan
WLA	Waste Load Allocation
WPRF	Watershed Protection and Restoration Fee/Fund
WQS	Water quality standard
WTM	Watershed Treatment Model
yd^3	Cubic yard

1 Introduction

1.1 Background and Purpose of Restoration Planning

In 2012, the U.S. Environmental Protection Agency (EPA) Region III approved Maryland Department of the Environment's (MDE) Total Maximum Daily Load (TMDL) for Polychlorinated Biphenyls (PCBs) for the Baltimore Harbor, Curtis Creek/Bay, and Bear Creek portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment (MDE 2012). This report will be referred to as the Baltimore Harbor PCB TMDL. Among other objectives, the Baltimore Harbor PCB TMDL established PCB waste load allocations (WLAs) for PCB sources to achieve reductions needed to meet water quality standards (WQSs).

An aggregate stormwater WLA (SW-WLA) was assigned to regulated stormwater from National Pollutant Discharge Elimination System (NPDES) permit holders in Anne Arundel County for portions of the Baltimore Harbor Embayment and Curtis Creek/Bay subwatersheds within Anne Arundel County. Anne Arundel County (the County) is an NPDES Phase I Municipal Separate Storm Sewer System (MS4) permit holder. As part of the 4th generation MS4 permit, effective February 2014, Anne Arundel County is required to develop restoration plans for each SW-WLA approved by EPA prior to the effective date of the permit. This restoration plan addresses the WLAs as established in the Baltimore Harbor PCB TMDL applicable to the Anne Arundel County MS4 permit (MD0068306).

The purpose of this PCB TMDL restoration plan is to develop a strategy to achieve the reductions required to meet the PCB SW-WLA. In doing so, the County will be doing its part to reduce PCB pollution in the Patapsco River Mesohaline Tidal Chesapeake Bay. The restoration plan supplements broader watershed restoration actions underway for the MS4 permit by outlining targeted actions intended to specifically reduce PCB loads. Through source targeting, modeling, and proposed monitoring, the restoration plan provides a blueprint that will guide the County's efforts to efficiently reduce PCB pollution.

1.2 Impaired Water Bodies and TMDL Allocated and Planned Loads Summary

The Baltimore Harbor PCB TMDL addressed three PCB impairments in water bodies as listed in Table 1.

Table 1: PCB Impairments addressed in Baltimore Harbor PCB TMDL

Water Bodies	Impairment
Baltimore Harbor Embayment	PCBs in Fish Tissue
Curtis Creek	PCBs in Fish Tissue and Sediment
Bear Creek	PCBs in Fish Tissue and Sediment

These water bodies and corresponding subwatershed areas are shown in Figure 1, excerpted from the Baltimore Harbor PCB TMDL. The portions of the Curtis Creek/Bay (Curtis Creek) and Baltimore Harbor Embayment – Direct Drainage located within Anne Arundel County are the focus of this restoration plan (MDE 2012) and are shown in Figure 2. Throughout the report, the Curtis Creek subwatershed within Anne Arundel County will be referred to as Curtis Creek AACO. Similarly, the Baltimore Harbor Embayment – Direct Drainage subwatershed within Anne Arundel County will be referred to as Baltimore Harbor AACO.

Tributary drainages to the Baltimore Harbor were only assigned a load allocation (LA) in the Baltimore Harbor PCB TMDL. With no specific SW-WLA assigned to NPDES holders within

Anne Arundel County for tributary drainage, this area is not addressed in the restoration plan. However, efforts underway as part of MS4 watershed restoration and the Patapsco River Lower North Branch Sediment TMDL Restoration Plan are anticipated to have a positive impact on reducing PCBs within the Anne Arundel County portion the Patapsco River tributary drainage.

The WLAs for Anne Arundel County NPDES regulated stormwater are shown in Table 2. Since the WLAs are an aggregate, the regulated stormwater to be addressed by the County MS4 permit within each subwatershed is only a portion of the aggregate WLAs shown. Additionally, the Baltimore Harbor PCB TMDL defined the Baltimore Harbor Embayment as inclusive of both Bear Creek and Curtis Creek subwatershed in the WLAs. To prevent double counting as each subwatershed is modeled independently, Table 2 lists the NPDES regulated stormwater WLA to Anne Arundel County for Baltimore Harbor Embayment and Curtis Creek separately. Note the disaggregated WLA is provided in Section 4.3

Table 2: Anne Arundel County NPDES regulated stormwater PCB WLA by Subwatershed

Subwatershed	**NPDES regulated stormwater PCB WLA (grams (g)/year)**
Baltimore Harbor AACO	43.84
Curtis Creek AACO	23.13

While PCB transport modeling was used in the development of the Baltimore Harbor PCB TMDL, there are no watershed planning modeling tools available that directly model PCBs. Watershed planning tools commonly used in Maryland thus far have focused on modeling total phosphorus, total nitrogen, and total suspended solids (TSS) for which reduction efficiencies for Best Management Practices (BMPs) both structural and non-structural have been developed. PCB concentrations are known to correlate with TSS as PCBs adsorb to particles. As such, this restoration plan takes a similar approach as that used by Prince George's County in the development of their *Restoration Plan for PCB-Impacted Water Bodies in Prince George's County* (Tetra Tech 2014) in which PCB loads and reductions were modeled by using TSS as a surrogate for PCBs and relating TSS to PCBs using regression equations developed for the Tidal Potomac and Anacostia River PCB TMDL (Haywood and Buchanan 2007). While the regressions were originally developed for the Tidal Potomac and Anacostia River, regional proximity and similarity in PCB sources suggest it is a reasonable approach to apply the regressions to Anne Arundel County modeling efforts.

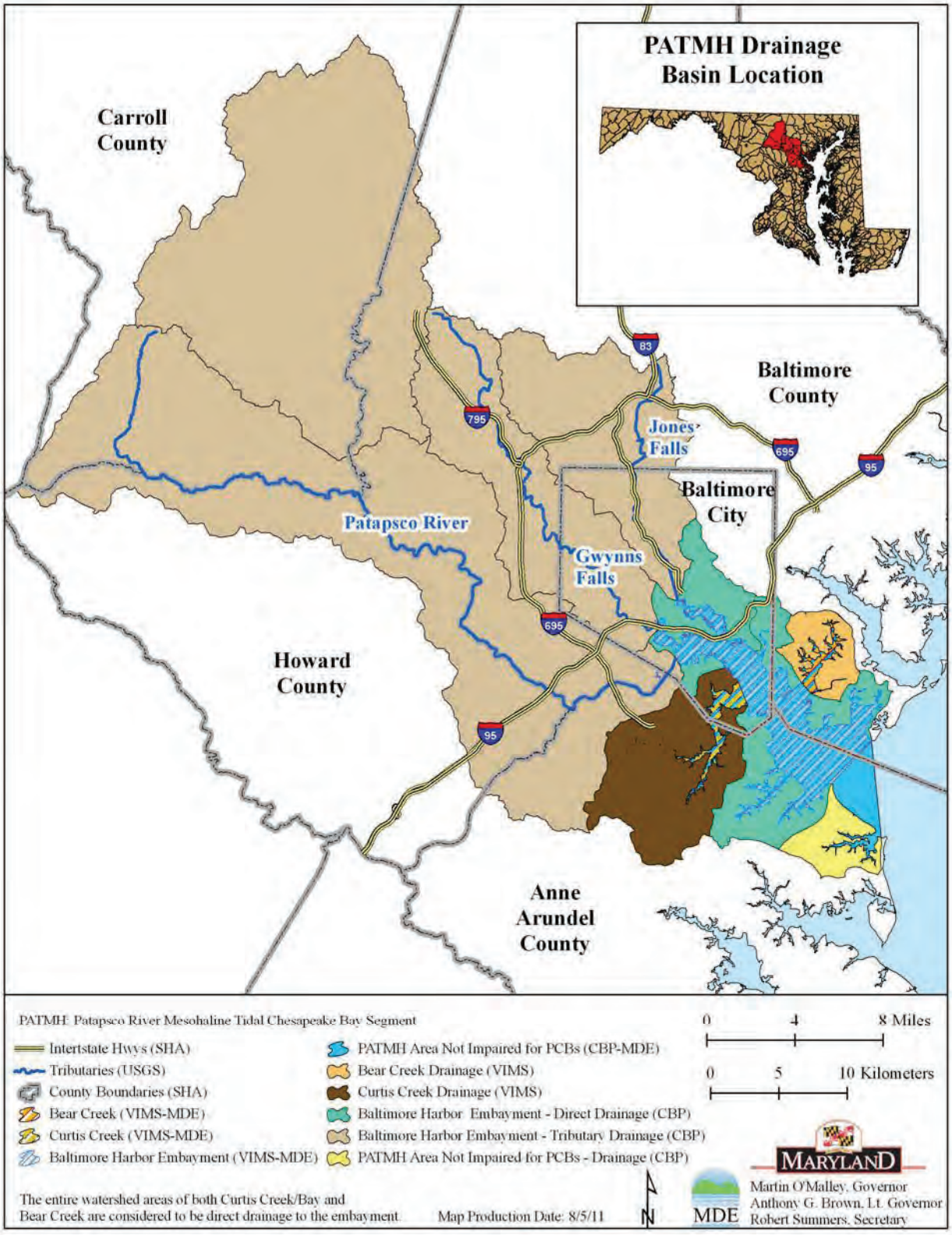


Figure 1: Impaired Waterbodies and Corresponding Watersheds (Baltimore Harbor PCB TMDL Figure 1)

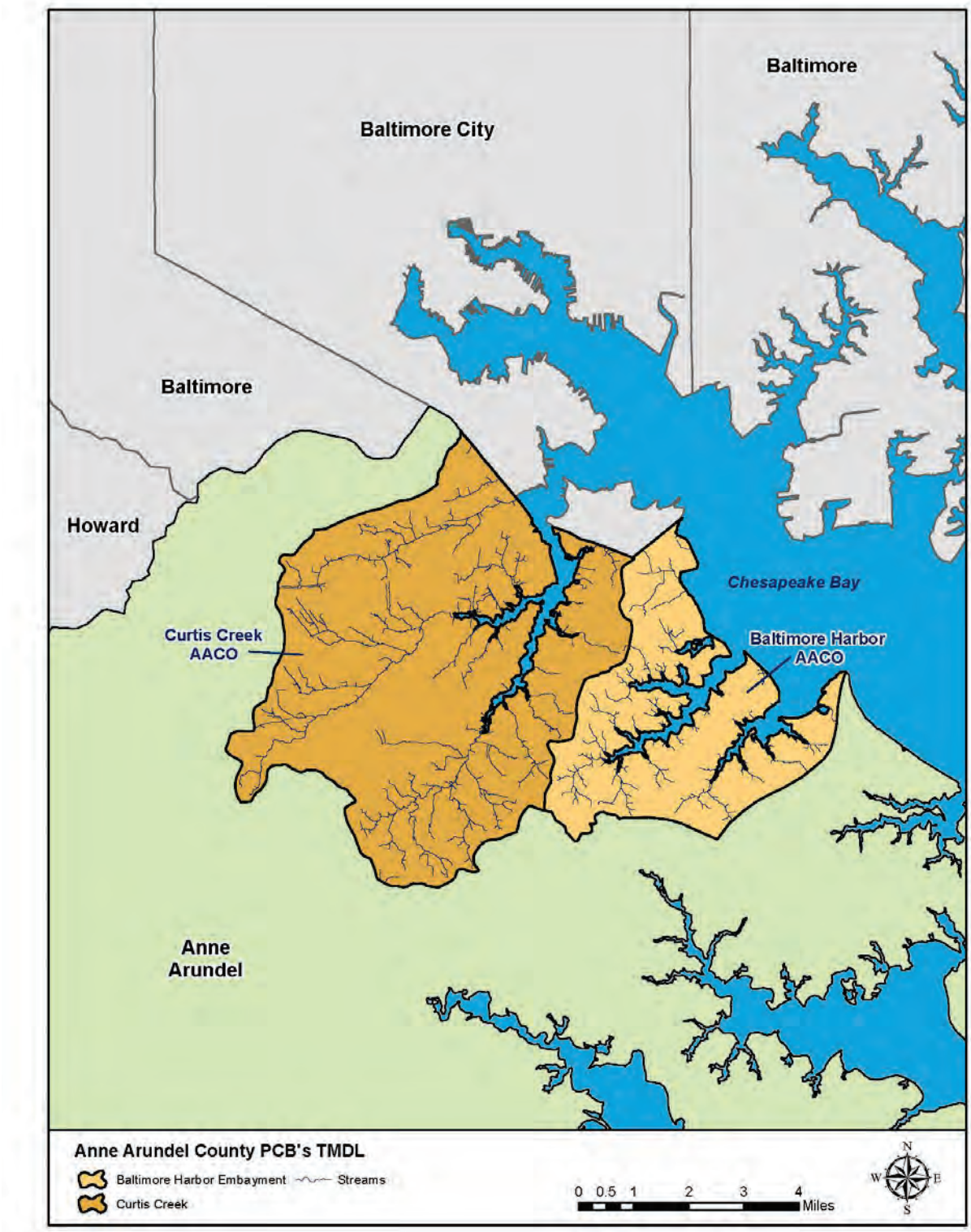


Figure 2: Portions of the Curtis Creek and Baltimore Harbor Embayment – Direct Drainage located within Anne Arundel County Addressed in Restoration Plan

1.2.1 Water Quality Standards

Water quality standards (WQSs) for the state of Maryland relating to PCBs are described in detail in Section 2.2 of the Baltimore Harbor PCB TMDL report. WQSs are set to protect surface waters for uses such as recreation, fishing and protection of aquatic life as well as special uses designated by use category. The water quality standard designation of use categories for the water bodies addressed in this report are described in Section 2.4. The Baltimore Harbor PCB TMDL and associated WLAs were developed to meet PCB WQSs as shown in Table 3. The designated impairments listed in Section 1.2 were a result of failing to meet one or more of the PCB WQSs.

Table 3: Summary of Maryland PCB WQSs

Type	Water Quality Standard
Human Health (associated with consumption of PCB contaminated fish), Water Column tPCB Criterion	0.64 nanograms/liter (ng/L)
Saltwater Aquatic Life, Water Column tPCB Criterion	30 ng/L
Freshwater Aquatic Life, Water Column tPCB Criterion	14 ng/L
Sediment, Sediment tPCB concentration in the presence of toxicity and degraded benthic community	180ng/g*
***** Not an official WQS, corresponds to the Effects Range Median (ERM) in accordance with methodology developed to assess toxic impairments in sediment.	

1.2.2 Problem Identification

Polychlorinated biphenyls (PCBs) are a man-made class of synthetic organic compounds. PCBs are a concern because they are a probable carcinogen, are able to bioaccumulate, and are persistent in the environment. PCBs in the environment primarily pose health risks for aquatic species as well as humans consuming PCB contaminated fish.

PCBs were produced in the United States starting in1929 and by 1979 the manufacturing, processing, distribution, and use of PCBs was banned under the Toxic Substances Control Act (TSCA) (Oregon DEQ 2012). PCBs are thermally and chemically stable and were therefore widely used in coolants, lubricants, heat transfer fluids, flame retardants, hydraulic fluids, and dielectric fluids in commercial and industrial applications (MDE 2015b).

The stability of PCBs means they do not readily breakdown and therefore, while banned in 1979, PCBs are still found throughout the environment (MDE 2015b). PCBs bind strongly to sediment because they are non-polar and only slightly soluble. As such, PCBs continue to enter surface waters via contaminated sediment in surface runoff. In addition, volatilized PCBs are transported near and far distances through the air and then redeposited to land or surface waters (Oregon DEQ 2012).

The WLAs set by the Baltimore Harbor PCB TMDL establish required load reductions of PCBs entering the already impaired water bodies. Reducing PCB loads from Anne Arundel County MS4 regulated stormwater to the Baltimore Harbor Embayment and Curtis Creek is an important step in addressing PCB contamination.

1.2.3 Previous Studies

Previous studies and data collection in the watersheds addressed in this restoration plan include:

> Patapsco Tidal and Bodkin Creek Watershed Assessment Comprehensive Summary Report, August 2012 (Anne Arundel 2012)

The watershed assessment was completed as part of the 3rd generation MS4 permit watershed restoration requirements. The assessment identifies impaired streams, models baseline and restoration reduction of pollutant loads, and develops a watershed implementation plan outlining planned BMP strategies. The watershed assessment provides excellent background information on the watershed and is used in calibrating the modeling efforts of this plan.

Previous studies and data collection contributing to the development of the Baltimore Harbor PCB TMDL are summarized in Section 2.2 and Appendix K of the Baltimore Harbor PCB TMDL report.

1.3 Restoration Plan Overview

The following guidance documents were used in the development of this restoration plan:

- MDE's Final General Guidance for Developing Stormwater Wasteload Allocations (SW-WLA) Implementation Plan, October 2014 (MDE 2015c)
- MDE's Recommendations for Addressing the PCB SW-WLA, 2015 (MDE 2015d)
- MDE's Guidance for Using the Maryland Assessment Scenario Tool to Develop Wasteload Allocation Implementation Plans for Local Nitrogen, Phosphorus, and Sediment TMDLs, June 2014
- MDE's Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, August 2014

Several documents served as primary sources of information supporting the modeling and strategies developed. These documents are:

- MDE Total Maximum Daily Load (TMDL) for polychlorinated biphenyls (PCBs) for the Baltimore Harbor, Curtis Creek/Bay, and Bear Creek portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment, October 2012 (MDE 2012)
- Anne Arundel County Patapsco Tidal and Bodkin Creek Watershed Assessment Comprehensive Summary Report, August 2012 (Anne Arundel County 2012)
- Restoration Plan for PCB-Impacted Water Bodies in Prince George's County, December 2014 (Tetra Tech 2014)

This restoration plan is organized into six sections that follow the progression of the restoration plan development. Following the introduction, the plan provides important context with a basic characterization of the PCB-impacted watersheds (Section 2). Section 3 builds on the watershed characterization by identifying causes of PCB-impairment and pollutant sources and presents the results of source tracking efforts and plans for reduction accounting intended to inform and guide the programmatic initiatives of the restoration plan. Section 4 documents and provides the results of the watershed treatment model (WTM) and outlines the proposed

strategy for meeting the PCB TMDL. With the proposed strategy developed, Section 5 presents the estimated load reductions achieved by implementation of the proposed strategy and includes associated costs. The final section addresses the implementation schedule and the public outreach and involvement component.

2 Watershed Characterization

2.1 Watershed Delineations and Hydrology

Curtis Creek AACO and Baltimore Harbor AACO subwatersheds are specific subwatersheds within the Patapsco River Mesohaline Chesapeake Bay Segment and the Baltimore Harbor 8-Digit watershed (02130903). Both Curtis Creek AACO and Baltimore Harbor AACO subwatersheds are located on the southwest shore of the Baltimore Harbor and share political boundaries with Baltimore City to the north.

The Curtis Creek/Bay watershed is approximately 23,539 acres (36.8 square miles). Within Anne Arundel County, the Curtis Creek AACO is 21,524 acres (33.6 square miles). Curtis Creek AACO contains approximately 98.1 miles of streams (Table 4). The subwatershed includes several named streams including Back Creek, Cabin Branch, Curtis Creek, Furnace Creek, Marley Creek, and Sawmill Creek. To reach the Chesapeake Bay, the subwatershed flows to Furnace and Marley Creeks, to Curtis Creek to Curtis Creek Bay to Patapsco River finally to the Chesapeake Bay.

The Baltimore Harbor Embayment – Direct Drainage watershed is approximately 53,995 acres (84.4 square miles). Within Anne Arundel County, the Baltimore Harbor AACO is approximately 8,756 acres (13.7 square miles). Baltimore Harbor AACO subwatershed contains approximately 33.1 miles of streams (Table 4). The subwatershed includes several named streams including Brookfield Branch, Cox Creek, Nabbs Creek, Stony Creek, Swan Creek, and Rock Creek. To reach the Chesapeake Bay, the subwatershed flows to Stony Creek and Rock Creek both flowing to Patapsco River and finally to the Chesapeake Bay. The data source used for streams was the Anne Arundel County 2011 Streams GIS file.

Table 4: Subwatershed Drainage Area and Stream Miles

Subwatershed Name	Drainage Area (Acres)	Drainage Area (Square Miles)	Stream Miles
Curtis Creek AACO	21,524	33.6	98.1
Baltimore Harbor AACO	8,756	13.7	33.1

2.2 Geology and Soils

Curtis Creek AACO and Baltimore Harbor AACO subwatersheds are both located within the Atlantic Coastal Plan Province and Glen Burnie Rolling Upland District characteristic of flat to gently rolling uplands underlain by unconsolidated sediments including quarzitic sands, gravels, silts and clays (MGS 2008).

Curtis Creek AACO

The dominant soil map units within Curtis Creek AACO include Patapsco-Fort Mott-Urban land complex, 0 to 5 percent slopes (PgB), Urban land (Uz), and Patapsco-Evesboro-Fort Mott complex, 0 to 5 percent slopes (PeB) at 19.8, 10.5, and 8.3 percent of total Curtis Creek AACO subwatershed, respectively. PgB and PeB soil map units are well to excessively drained soils

formed in sandy eolian deposits over loamy fluviomarine deposits. Both soil map units are mapped on summits of broad interstream divides. Uz soil map unit is characterized as areas covered with impervious cover (i.e. pavement, driveways, and buildings). Based on the soil survey mapping, the majority of the subwatershed has low slopes ranging from 0 to 5 percent. It is also important to note that a large portion of the soil map units contain an urban land component indicating there are areas throughout the subwatershed covered by impervious surfaces.

Each soil map unit, with the exception of Water (W), is assigned a hydrologic soil group (HSG) based on the estimate of runoff potential. Table 5 presents the HSGs within Curtis Creek AACO. Almost half of the subwatershed, approximately 49.3%, is classified as Group A or as soils having high infiltration and low runoff potential. The remainder of the subwatershed is dominated by Group C and D at 22.0% and 18.8%, respectively. Group C soils have a slow infiltration rate while Group D have a very slow infiltration rate and high runoff potential. The dominate HSGs are directly related to the dominate soil map units. PgB and PeB are well to excessively drained sandy soils and are classified as Group A, while Uz and soil map units with urban land components have impervious surfaces present that would increase runoff and are therefore classified as Group C and/or D.

Table 5: Curtis Creek AACO Hydrologic Soil Groups

Hydrologic Soil Group	Acres	Percent of Total (%)
A	10617.7	49.3
A/D	27.8	0.1
B	664.3	3.1
B/D	1395.1	6.5
C	4728.7	22.0
D	4037.8	18.8
Not Applicable*	52.9	0.2
Total		**100.0**
*Applies to Water (W) map units.		

Baltimore Harbor AACO

Similar to Curtis Creek AACO, the dominant soil map units within Baltimore Harbor AACO include Patapsco-Fort Mott-Urban land complex, 0 to 5 percent slopes (PgB), Russerr-Christiana-Hambrock complex, 0 to 5 percent slopes (RhB), Patapsco-Evesboro-Fort Mott complex, 0 to 5 percent slopes (PeB), and Udorthents, loamy, 0 to 5 percent slopes (UoB) at 22.4, 11.5, 8.4, and 8.1 percent of total Baltimore Harbor AACO subwatershed, respectively. PgB and PeB soil map units are mapped on summits of broad interstream divides and are well to excessively drained soils formed in sandy eolian deposits over loamy fluviomarine deposits. Similarly, RhB soil map unit is a moderately well to well-drained soil formed in loamy to clayey fluviomarine deposits on summits and footslopes of broad interstream divides. UoB soil map unit is a well-drained soil that has formed in soils manipulated by anthropogenic activities. Based on the soil survey mapping, the majority of the subwatershed has low slopes ranging from 0 to 5 percent. Like Curtis Creek AACO, Baltimore Harbor AACO also has soil map units that contain an urban land components and thus impervious cover (i.e. pavement, driveways, and buildings), but to a lesser extent.

The HSGs within Baltimore Harbor AACO are presented in Table 6. More than half of the subwatershed, approximately 61.8%, is classified as Group A or a soils having high infiltration

and low runoff potential. Group C dominated the remainder of the subwatershed at 24.7%. Group C soils have a slow infiltration rate and moderately high runoff potential. The dominate HSGs are directly related to the dominate soil map units. PgB and PeB are well to excessively drained sandy soils and are classified as Group A, while RhB, UoB, and soil map units with urban land components have finer textured soil and impervious surfaces and are classified as Group C and/or D.

Table 6: Baltimore Harbor AACO Hydrologic Soil Groups

Hydrologic Soil Group	Acres	Percent of Total (%)
A	5411.5	61.8
A/D	176.5	2.0
B	141.5	1.6
B/D	355.8	4.1
C	2160.0	24.7
D	381.6	4.4
Not Applicable	125.4	1.4
Total		**100.0**
*Applies to Water (W) map units.		

As previously described, soil type affects infiltration and runoff potential. As such, soil classification by hydrologic soil group is an input parameter to the WTM. Soils designated as A/D or B/D are included in group D in the WTM to be conservative.

2.3 Existing Land Use and Land Cover

Water quality is affected by the type and density of the various land uses within a watershed. Vegetated areas (i.e. woods and open space) slow stormwater flow allowing water to gradually infiltrate into the soil. As the stormwater infiltrates into the soil, nutrients and pollutants are filtered out improving water quality. In contrast, developed areas (i.e. residential, commercial, industrial, etc.) do not reduce runoff or nutrients and sediment in the stormwater due to the high percentages of impervious surfaces that prevent infiltration. Since PCBs bind to sediment, developed areas that act as sources of sediment may also be sources of PCBs. In addition, watersheds and smaller areas within a watershed with a higher concentration of commercial and industrial land use are of particular interest regarding PCB pollution since PCBs were primarily used in commercial and industrial applications. Land use presented in Table 7 was used to characterize the subwatersheds and show potential pollution sources.

2.3.1 Land Use / Land Cover Distribution

According to County 2011 land use data for Curtis Creek AACO and Baltimore Harbor AACO (Table 7), the dominant categories in both subwatersheds is woods (23.2 and 29.0% respectively) followed closely by residential 1/8-acre (22.6 and 27.6% respectively).

In Curtis Creek AACO, developed land accounts for 63.8% of the subwatershed and largely consists of residential (39.1%) and commercial (9.5%). Similarly in Baltimore Harbor AACO, developed land accounts for 62.0% of the subwatershed and largely consists of residential (47.0%) and industrial (7.3%). Land use distribution across the subwatershed is shown in Figure 3. Land use is a direct input to the WTM.

Table 7: 2011 Land Use / Land Cover for Curtis Creek AACO and Baltimore Harbor AACO

Land Use	Curtis Creek AACO		Baltimore Harbor	
	Acres	Percent of Subwatershed (%)	Acres	Percent of Subwatershed (%)
Airport	552.0	2.6	0.0	0.0001
Commercial	2053.5	9.5	319.8	3.7
Industrial	1188.6	5.5	641.7	7.3
Open Space	2603.0	12.1	546.7	6.2
Open Wetland	6.4	0.03	34.0	0.4
Pasture/Hay	2.2	0.01	0.0	0.0
Residential 1-acre	230.6	1.1	426.2	4.9
Residential 1/2-acre	495.7	2.3	539.7	6.2
Residential 1/4-acre	2450.2	11.4	454.1	5.2
Residential 1/8-acre	4864.7	22.6	2413.1	27.6
Residential 2-acre	378.6	1.8	280.0	3.2
Row Crops	76.7	0.4	0.0	0.0
Transportation	1352.1	6.3	279.6	3.2
Utility	176.5	0.8	72.7	0.8
Water	89.2	0.4	206.1	2.4
Woods	5004.3	23.2	2539.2	29.0
	Total	**100.0**	**Total**	**100.0**

2.3.1 Impervious Surfaces

Impervious surfaces make up 31.1% of Curtis Creek AACO and 23.0% of Baltimore Harbor AACO land areas as presented in Table 8. Roads/highways (8.9%), buildings (7.9%), and parking lots (7.4%) are the dominant impervious cover types within Curtis Creek AACO. In Baltimore Harbor AACO, the dominant impervious cover types include buildings (7.3%), road/highways (6.2%), driveways (3.2%) and parking lots (3.0%). The impervious cover types are reflective of the dominant land uses (i.e. residential, commercial and industrial) identified within each subwatershed. The data source used for impervious cover was the Anne Arundel County 2011 Countywide Impervious GIS file. Distribution of impervious surfaces is illustrated in Figure 4. Imperviousness associated with different land uses is also used in the WTM.

Table 8: Impervious Cover in Curtis Creek AACO and Baltimore Harbor AACO

Impervious Cover Type	Curtis Creek AACO (Drainage Area = 21,524 acres)		Baltimore Harbor (Drainage Area = 8,756 acres)	
	Acres	Percent of Subwatershed (%)	Acres	Percent of Subwatershed (%)
Athletic courts	23.0	0.1	4.5	0.1
Building	1695.9	7.9	641.8	7.3
Driveways	529.4	2.5	278.2	3.2
Other paved areas	439.2	2.0	101.7	1.2
Parking lots	1598.3	7.4	266.1	3.0
Patios/Decks	124.6	0.6	80.0	0.9
Piers	0.7	0.003	3.4	0.04
Rails	29.4	0.1	1.3	0.01
Roads/Highways	1919.3	8.9	541.5	6.2
Sidewalks	287.1	1.3	74.5	0.9
Swimming pools	42.0	0.2	21.0	0.2
Impervious Cover Totals	**6688.9**	**31.1**	**2013.8**	**23.0**

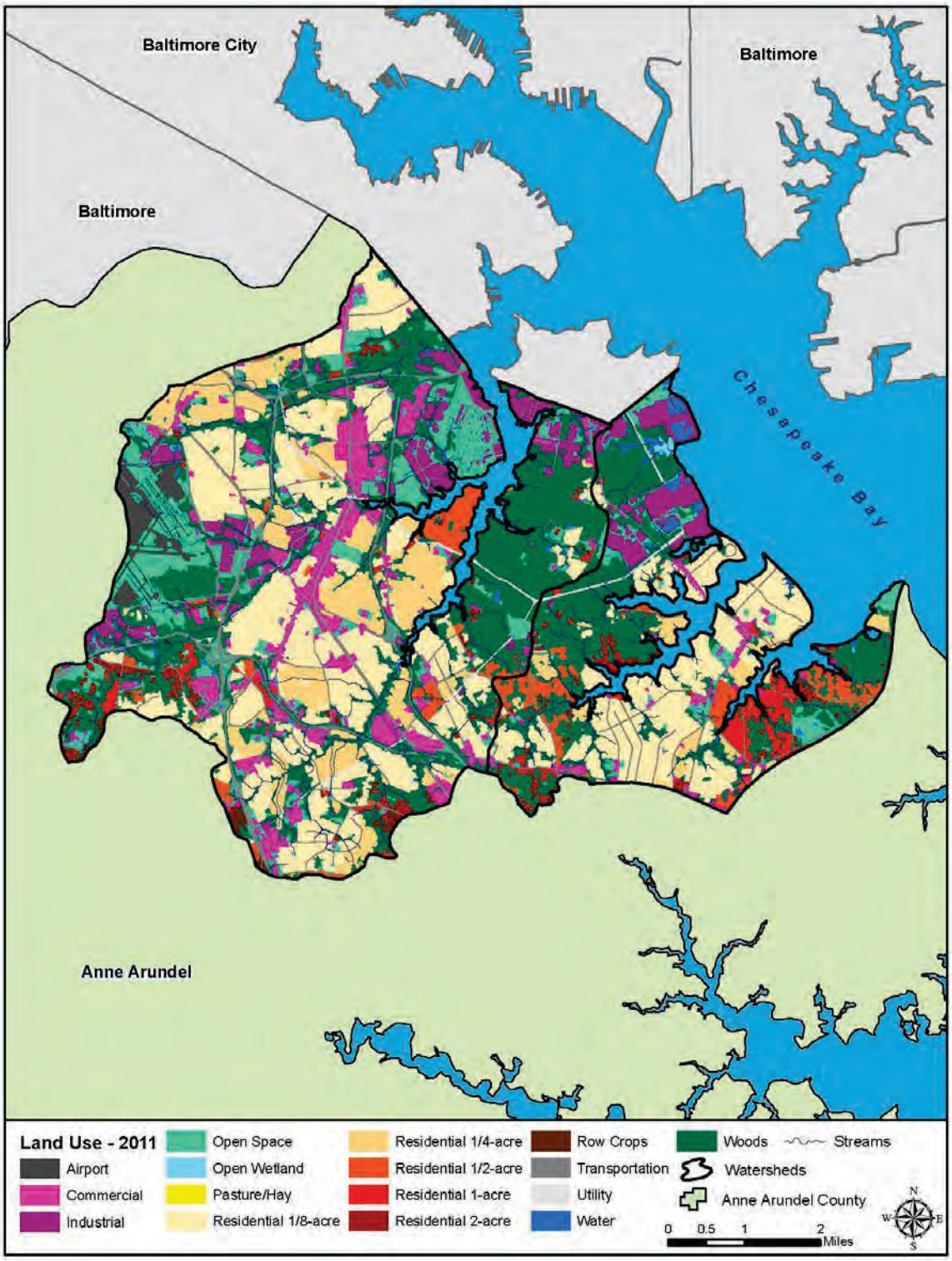


Figure 3: 2011 Land Use/Land Cover for Curtis Creek AACO and Baltimore Harbor AACO Subwatersheds

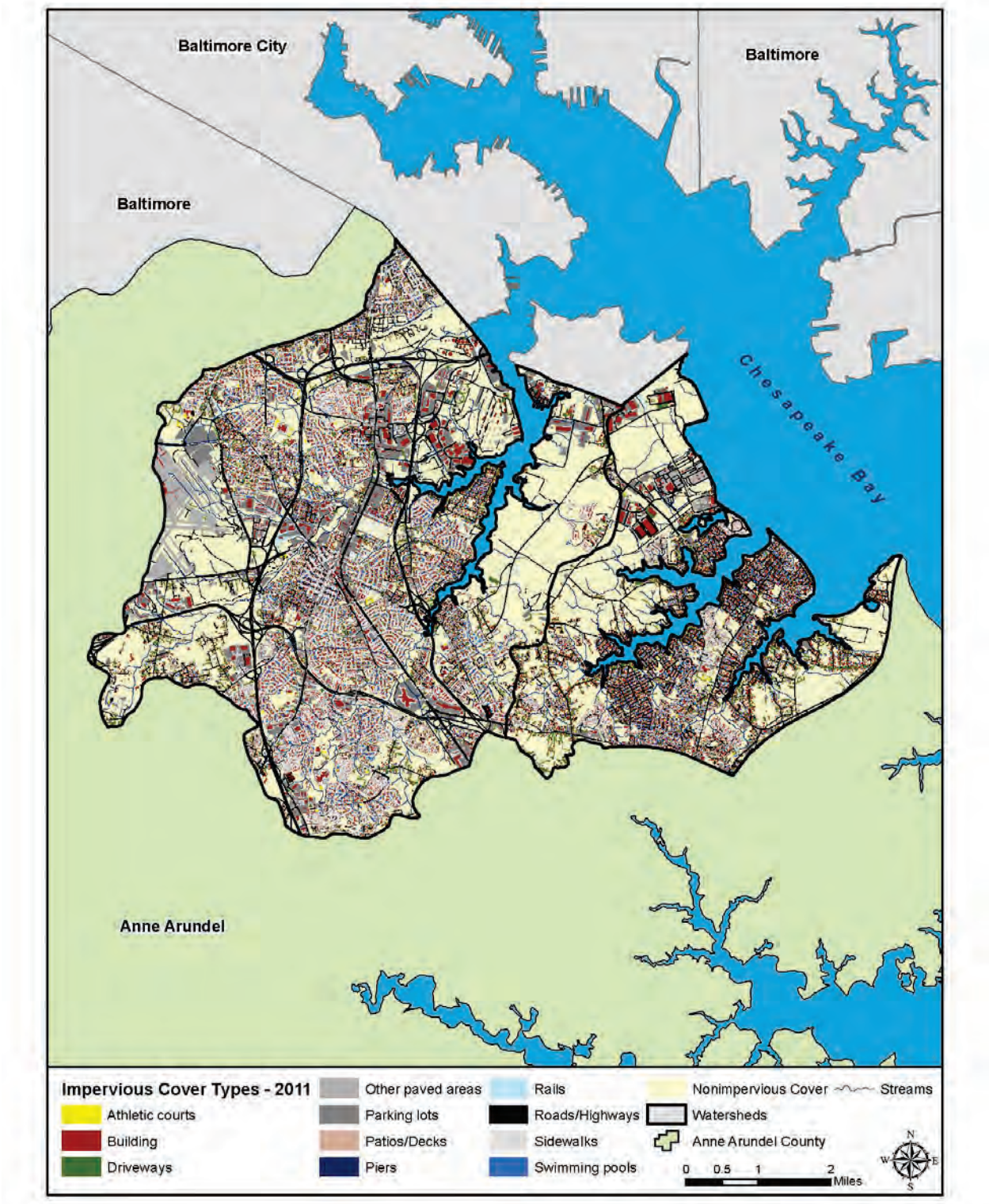


Figure 4: 2011 Impervious Curtis Creek AACO and Baltimore Harbor AACO Subwatersheds

2.4 Watershed Health and Water Quality

In 1993, Maryland Department of Natural Resources (DNR) created the Maryland Biological Stream Survey (MBSS) to characterize the health of Maryland's freshwater streams. Stream sites are selected through a random statistical design and physical, chemical, and biological (fish and macroinvertebrates) data is collected at each selected site. The collected data is combined into an overall rating (i.e. good, fair, or poor) enabling Anne Arundel County and DNR to estimate stream health in medium to large watersheds. Curtis Creek AACO and Baltimore Harbor AACO subwatersheds are comprised of the following DNR 12-digit watersheds: 021309031010, 021309031008, 021309031009, and 021309031006 (DNR 2014a). The current health of each DNR 12-digit watershed is ranked as poor (DNR 2014b).

According to Code of Maryland Regulations (COMAR) Section 26.08.02.08 – Stream Segment Designations, stream segments within Curtis Creek AACO and Baltimore Harbor AACO are classified as Use I waters (MDE 2014a). Use I waters are designated to support water contact recreation and protection of non-tidal warm water aquatic life. Table 9 shows the individual uses for Use I.

Table 9: Designated Uses pertaining to Use I Waters

Designated Uses	Stream Segments within Curtis Creek AACO & Baltimore Harbor AACO
Growth and propagation of fish (not trout), other aquatic life and wildlife	X
Water contact sports	X
Leisure activities involving direct contact with surface water	X
Fishing	X
Agricultural water supply	X
Industrial water supply	X
Propagation and harvesting of shellfish	
Seasonal migratory fish spawning and nursery use	
Seasonal shallow-water submerged aquatic vegetation use	
Open-water fish and shellfish use	
Seasonal deep-water fish and shellfish use	
Seasonal deep-channel refuge use	
Growth and propagation of trout	
Capable of supporting adult trout for a put and take fishery	
Public water supply	
Source:http://www.mde.state.md.us/programs/Water/TMDL/Water%20Quality%20Standards/Pages/programs/waterprograms/tmdl/wqstandards/wqs_designated_uses.aspx	

According to Maryland's final 303(d) list of impaired waters provided in the Final 2014 Integrated Report of Surface Water Quality (MDE 2014b), two basins in which Curtis Creek AACO and Baltimore Harbor AACO are located, are listed for PCB water quality impairments. Both water bodies are listed as Category 4a indicating each are still impaired but have a TMDL developed to address the impairment.

Curtis Creek AACO and Baltimore Harbor AACO subwatersheds are also listed as impaired for other water quality parameters including chlordane, sediment, nutrients, metals, biological, and bacteria. Approved TMDLs pertaining to both Curtis Creek AACO and Baltimore Harbor AACO exist for sediment and nutrients (nitrogen and phosphorus). An approved chlordane TMDL applies to the Baltimore Harbor AACO, and an approved bacteria TMDL for enterococci applies to Furnace Creek and Marley Creek both located within the Curtis Creek AACO subwatershed.

2.5 MS4 Area

The above sections of the watershed characterization include all of the area within the Curtis Creek AACO and Baltimore Harbor AACO subwatersheds to provide a complete context. However, as mentioned in Section 1.2, the Anne Arundel County MS4 permit is one of several NPDES permits active within the Curtis Creek AACO and Baltimore Harbor AACO subwatersheds. Other permit holders include Maryland State Highway Administration (SHA), federal facilities, and individual facilities.

The jurisdictional areas within the Curtis Creek AACO and Baltimore Harbor AACO subwatersheds to which the Anne Arundel County MS4 permit applies is shown in Figure 5. Anne Arundel County MS4 area covers 79% and 95% of the total area of Curtis Creek AACO and Baltimore Harbor AACO subwatersheds respectively. Detailed areas are provided in Table 10 in Section 3.2. This plan addresses PCB load reductions for the areas within the County MS4 area only. Load reductions from areas outside of the County MS4 area and from sources within the MS4 area specifically identified and addressed in the Baltimore Harbor PCB TMDL are the responsibility of other entities.

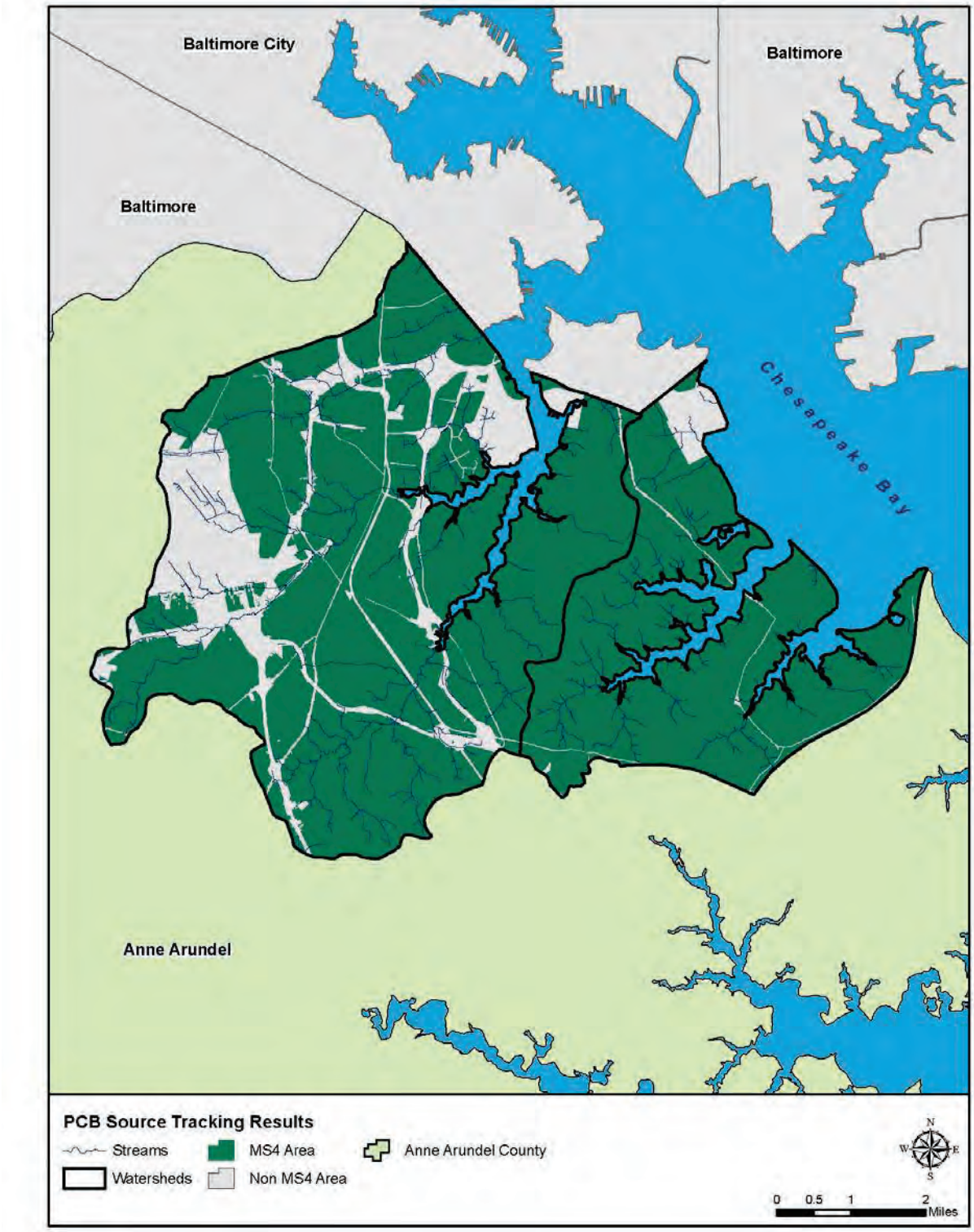


Figure 5: Anne Arundel County MS4 Jurisdictional Area

3 Causes and Sources of Impairment

3.1 Causes of Impairments

The 303(d) listings described in Section 2.5 and local TMDL requirements confirm that elevated levels of PCBs currently impair the Curtis Creek AACO and Baltimore Harbor AACO subwatersheds. PCBs are non-naturally occurring, therefore their presence anywhere in the environment signifies a release. Initially released at discrete locations, or hot spots, PCBs then disperse through volatilization into the atmosphere or adsorption to sediment that is then transported away from the release area.

From both hot spots and areas with disperse contamination, PCBs attached to sediment are transported by stormwater runoff into the network of streams which flow to Curtis Creek and Baltimore Harbor depositing PCBs in the waterbodies. The sediment can remain suspended in the water column or settle to the bottom depending on particle size. Over time, small amounts of PCBs are released from the sediment to the water (Oregon DEQ 2012). PCBs in sediment and the water column are consumed by bottom-dwelling organisms that concentrate PCBs in their tissue and are then eaten by small fish. As predator species consume small fish, PCBs continue to bioaccumulate leading to elevated levels in fish tissue qualifying as an impairment (MDE 2015b). Deposition of PCBs from the atmosphere directly to water surfaces, as well as surrounding watershed surfaces, also contributes to elevated levels of PCBs (MDE 2012).

3.2 Pollutant Sources

Prior to regulation under TSCA in 1979, PCBs were released to land and aquatic environments, either accidentally or intentionally, through sewers, smokestacks, stormwater runoff, spills, and, more rarely, direct application for the purpose of dust reduction or in agricultural pesticides. Used primarily in commercial and industrial applications, PCB-containing products were burned, application of coatings and materials containing PCBs allowed for vaporization, PCB-containing fluids were directly released into sewers and streams, and equipment containing PCBs was improperly disposed of in non-secure landfills sites and municipal disposal facilities (Oregon DEQ 2012). These unregulated, historic practices have led to “legacy” PCBs in the form of both hot spots and disperse contamination. Current sources of “new” PCBs introduced to the environment are limited and include illegal or outdated landfills or scrap yards and spills or explosions of pre-1979 electrical and other equipment containing PCBs (Oregon DEQ 2012).

Since introduction of “new” PCBs into the environment is limited and can be addressed as situations and the need arise, this restoration plan focuses on addressing “legacy” PCB contamination sources within the County MS4 areas of the Curtis Creek AACO and Baltimore Harbor AACO subwatersheds that are not otherwise addressed in the Baltimore Harbor PCB TMDL report. Other PCB pollutant sources identified and addressed in the Baltimore Harbor PCB TMDL include industrial process water, effluent from waste water treatment plants, specific contaminated sites, atmospheric deposition, and non-regulated stormwater run-off. These sources as well as the other NPDES-permitted facilities within the Curtis Creek AACO and Baltimore Harbor AACO subwatersheds are intentionally omitted from and not addressed in this plan as the County is not responsible for load reductions from these sources.

For dispersed contamination, areas considered as potential pollutant sources include all urban areas within the County MS4 area. Within the broader category of urban areas, areas with commercial and industrial land use have even greater potential to be a PCB pollutant source due to the use of PCBs in commercial and industrial applications. The potential PCB pollutant

source areas in acres of urban, commercial, and industrial land use within the County MS4 area are shown in Table 10 for the Curtis Creek AACO and Baltimore Harbor AACO watersheds. Table 10 also provides total MS4 and total subwatershed areas for context.

Table 10: Potential PCB pollutant source areas with the County MS4 Area

	MS4 Areas within Curtis Creek AACO	MS4 Areas within Baltimore Harbor AACO
Urban Land Use (acres)	13,137	5,503
Commercial (acres)	1936	314
Industrial (acres)	914	487
MS4 area (acres)	17,022	8,278
Subwatershed area (acres)	21,524	8,754

For hot spot contamination, pollutant sources are locations where PCB releases have occurred in the past and where elevated concentrations of PCB persist in the area. Hot spot sources are of particular concern as they continue to slowly disperse PCBs. The process of identifying potential hot spot sources is addressed in the following Section 3.3.

Existing BMPs such as stormwater ponds that trap stormwater runoff and sediment from urban, and especially commercial and industrial, areas may build up PCBs overtime. In this way, BMPs can serve the beneficial purpose of re-concentrating dispersed contamination. If contaminated BMP materials are removed and properly disposed, PCBs loads can be effectively reduced. However, if an unusually large storm event washes out the sediment collected in the BMP, the BMP could re-release PCBs further downstream. Finding and removing PCBs from existing BMPs is discussed more in Sections 3.3.2 and 4.4.3.

3.3 Pollutant Source Tracking

Since PCBs are transported by sediment, addressing dispersed contamination involves addressing sediment loading. Reducing sediment loading reduces the PCB load to the degree that the sediment is contaminated. For dispersed contamination, this is best achieved through BMPs as discussed in Section 4.4 with load reductions estimated through a more general regression relating TSS and PCBs concentrations. Addressing hot spots, however, offers a unique opportunity to significantly reduce PCB loads by removing material with an elevated and known PCB concentration. To address hot spot sources, first locations with significant potential for PCB contamination need to be identified. This step is called source tracking or source targeting. Next, sites are screened and/or monitored to determine if PCBs are present and at what concentration. If PCBs are detected and PCB containing materials are removed, the PCB load reduction is calculated to reflect the known removal of PCBs and can be counted as progress towards meeting the PCB TMDL.

The guidance document titled MDE Recommendations for Addressing the PCB SW-WLA (MDE 2015d) provides recommendations for source targeting, monitoring, and accounting for load reductions. Incorporating the provided guidance, a source tracking desktop analysis was performed for the Curtis Creek AACO and Baltimore Harbor AACO subwatersheds. The source tracking desktop analysis identified both specific site locations as well as prioritized structural BMPs with significant potential for PCB soil contamination. MDE recommendations for monitoring and accounting for load reductions are discussed in Section 4.4.3.

3.3.1 Locations with Significant Potential for PCB Soil Contamination

MDE recommendations suggest a desktop analysis to review existing State and County records to identify locations with significant potential for PCB soil contamination. Following this recommendation, records from seven sources were reviewed:

- EPA PCB Transformer Registry Database
- PCB Activities Database
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA also known as Superfund) Sites Database
- Toxic Release Inventory (TRI) Database
- MDE Land Restoration Program (LRP)
- National Response Center (NRC) Database
- MDE Historic Landfill Initiatives (HLI) Report

The goal of the analysis was to identify sites with the potential for PCB release from the records located in the MS4 area within the Curtis Creek AACO and Baltimore Harbor AACO subwatersheds. Once identified, the sites were classified as Tier 1, Tier 2, or Tier 3 based on the source of the record as some sources are more directly related to PCBs than others.

The results of the review are summarized for each source and the combined results presented in Table 11. The location of the identified sites are shown in Figure 6.

EPA PCB Transformer Registry Database

Searching the EPA Transformer Registry Database resulted in 30 records for Maryland. Most records were located outside of the study subwatersheds. However, two records, both with the same address, were located in the Baltimore Harbor AACO subwatershed. The records indicated that in 2010, 16 transformers were located at the site and that in 2011, the number of transformers on the site was down to zero. Since this database source documents sites where known PCB-containing transformers are or were located, this site is classified as Tier 1.

PCB Activities Database

Searching the PCB Activities Database reports resulted in 63 entries for Maryland. While most records were located outside of the study subwatersheds, one entry was located in the Curtis Creek AACO subwatershed. However, this entry corresponded to the Curtis Bay United States Coast Guard (USCG) Yard, a federal facility, which is an area that is excluded from the County MS4 area. Therefore, no identified sites were from this source are included in the results.

CERCLA (Superfund) Sites Database

The CERCLA database search identified 10 active sites within Anne Arundel County with two located in the Curtis Creek AACO subwatershed. However, the sites (one the Curtis Bay USCG Yard, and the other the General Services Administration (GSA) Curtis Bay Depot) are both federal facilities and located outside of the County MS4 area. In addition, 29 archived sites were found within Anne Arundel County with seven located in the study subwatersheds and MS4 area. Therefore, seven identified sites from this source are included in the results and are classified as Tier 3 as they are not PCB specific sites and have received the designation of “Archived” indicating the sites are of no further interest for cleanup under CERCLA.

TRI Database

The TRI database search identified nine records of PCB releases for Maryland. However, zero records were located within the study subwatersheds. Therefore, no identified sites from this source are included in the results.

NRC Database

The NRC database of reported spills and accidents was searched via the Right to Know search engine. The search resulted in 30 unique report records for Anne Arundel County in which PCBs were suspected to be involved. Most reports involved a downed and/or leaking transformer for which PCB content was unknown. There were two records with locations within the study subwatersheds and MS4 area that are included in the results. Since these records were specific to potential PCB releases, they are classified as Tier 1.

MDE LRP

The MDE LRP focuses on cleaning up uncontrolled hazardous waste sites throughout Maryland (MDE 2008). The GIS shapefile provided through the LRP website contains the locations of various National Priorities List (NPL) sites, other contaminated sites not on the NPL, brownfield sites, and Voluntary Cleanup Program (VCP) sites. This listing also includes landfills currently designated as hazardous waste sites. The data was reviewed and 41 sites were found within the study subwatershed with 29 sites within the MS4 area, excluding CERCLA sites already identified through the CERCLA database and contaminated sites specifically addressed in the Baltimore Harbor PCB TMDL. Of the 29 sites, two were designated as having PCBs in soil at the site. The two sites with PCBs in soil were classified as Tier 1 since PCB contamination is known to be present, the remaining sites were classified as Tier 2 since hazardous contamination is known to exist, but PCBs have not been confirmed.

MDE Historic Landfill Initiatives Report

Prior to the1950s, landfills and open burning dumps were mostly unregulated. Since PCBs were in use starting in 1929, landfill and dump sites, especially those receiving industrial waste could be potential PCB sources. While the MDE LRP included landfill sites currently designated as hazardous waste sites, additional review of the MDE 2009 the Maryland Historic Landfill Initiative (HLI) report was carried out to determine if any additional historic landfills may have been located within the study subwatersheds.

This report listed numerous historic landfill and dump sites within Anne Arundel County. However, the specific location of many of the sites is not known. Historic landfill and dump sites with known locations within the watershed, but not listed in the LRP database, included the Johnson and Speake Dump and the Garrett Dump. However, these two historic sites were associated with larger landfills already identified in the LRP, Solley Road Landfill and Snow Hill Lane Landfill respectively. While the HLI report did not provide any new locations, it confirmed the inclusion of Solley Road Landfill and Snow Hill Lane Landfill as possible source locations. The B&O Railroad Landfill, also located within the study subwatersheds and MS4 area, was excluded from the results as the site was addressed specifically in the Baltimore Harbor PCB TMDL as a PCB contaminated site that was assigned a LA.

Table 11: Combined Results of Source Tracking Desktop Analysis

Tier	Source	Site Name/Identification	Address/Location	City
1	EPA PCB Transformer Database	Baltimore Gas & Electric Company - Generating Station (H.A. Wagner/Brandon Shores)	1000 Brandon Shores Road	Baltimore
1	NRC Database	Indicent ID 1029996 - Call Received 11/8/2012 7:15 AM	110 Carroll Rd	Glen Burnie
1	NRC Database	Indicent ID 556425 - Call Received 2/12/2001 8:56 AM	106 Oak Rd	Glen Burnie
1	MDE LRP	Tanyard Cove	Northwest end of Tanyard Cove Road	Glen Burnie
1	MDE LRP	Snow Hill Lane Site Phase III	(Parcel 46); Abutting Snow Hill Lane Phase II	Brooklyn
2	MDE LRP	Drumco Drum Dump	1500 Arundel Boulevard	Baltimore
2	MDE LRP	Nova-Kote Inc.	7615 Energy Parkway	Baltimore
2	MDE LRP	Snow Hill Lane Site Phase I	Abutting Snow Hill Lane	Brooklyn
2	MDE LRP	Snow Hill Lane Site Phase IV	Parcel 60, northeast of interchange of Route 2 and I-695	Brooklyn
2	MDE LRP	Snow Hill Lane Site	Snow Hill Lane and Cedar Hill Lane	Brooklyn
2	MDE LRP	Diamond Shamrock Corp. - Chemetals Division (Erachem Comilog, Inc.)	711 Pittman Road; 610 Pittman Road	Curtis Bay
2	MDE LRP	Arundel Plaza (Sears, PoFolks Restaurant, Sears Automotive)	6650 Governor Ritchie Highway	Glen Burnie
2	MDE LRP	Baymeadow Property (Martin Marietta; Gould Electronics)	6711 Baymeadow Road	Glen Burnie
2	MDE LRP	Marley Neck Property	Marley Neck Road and Marley Neck Boulevard	Glen Burnie
2	MDE LRP	Patriot's Plaza (Former Ida's Dry Cleaning)	8039 Ritchie Highway	Pasadena
2	MDE LRP	Southgate Marketplace	337 Hospital Drive	Glen Burnie
2	MDE LRP	Former Reichold Site (NL Chemicals, NL Industries Baltimore, Textron Inc)	6401 Chemical Road	Baltimore
2	MDE LRP	Snow Hill Lane Site Phase II	East of Cedar Hill Lane and north of I-695	Brooklyn
2	MDE LRP	Snow Hill Lane Site Phase V	Aspen Street And Pennington Avenue	Brooklyn
2	MDE LRP	Parcel 247	1600 Aspen Street	Baltimore
2	MDE LRP	Harundale Well Field (Harundale Plaza/ Mall; Lord Baltimore Cleaners)	7700 Ritchie Highway	Glen Burnie
2	MDE LRP	Cherry Hill/Pittman Road/Waldorf Trailer/Cherry Pit Drum Site B (Pittman Location)	701 Pittman Road	Baltimore
2	MDE LRP	Cromwell Fields Shopping Center (Carousel Cleaners)	7389 Baltimore-Annapolis Boulevard (Intersection with Dorsey Road)	Glen Burnie
2	MDE LRP	Fila U.S.A., Inc. - Brandon Woods Business Park	7630 Gambrills Cove Road	Baltimore
2	MDE LRP	Anne Arundel County Landfill	100 Dover Road	Glen Burnie
2	MDE LRP	Brandon Woods Business Park; Commerce Corporation	7603 Energy Parkway	Baltimore

Tier	Source	Site Name/Identification	Address/Location	City
2	MDE LRP	Energy Parkway	7621 Energy Parkway	Baltimore
2	MDE LRP	7246 Mockingbird Circle	7246 Mockingbird Circle	Glen Burnie
2	MDE LRP	Praxair, Inc. (Union Carbide Plant)	7350 Carbide Road	Baltimore
2	MDE LRP	Auto Emporium (Auto Clinic)	7595 Baltimore and Annapolis Blvd.	Glen Burnie
2	MDE LRP	Rock Creek Village Shopping Center	8531-8541 Fort Smallwood Road	Pasadena
2	MDE LRP	Brandon Woods II	7629 Gambrills Cove Road	Curtis Bay
3	CERCLA Database	Alco-Gravure Inc. (Quebecor Printing, Inc.; Maxwell Communication)	7364 Baltimore Annapolis Boulevard	Glen Burnie
3	CERCLA Database	Joy Reclamation Company (Phelps Co.)	402 Arundel Corporation Road	Glen Burnie
3	CERCLA Database	Fresh Pond	Forest Glen Drive, 0.25 miles north of Mountain Road	Pasadena
3	CERCLA Database	Browning Ferris Industries - Solley Road Landfill - BFI	7890 Solley Road	Glen Burnie
3	CERCLA Database	Fort Smallwood - Control Nike BA-43	Old Nike Missile Site Road (off Fort Smallwood Road)	Pasadena
3	CERCLA Database	MCS Baltimore Site	605 Pittman Road	Baltimore
3	CERCLA Database	Kanasco Ltd. (Consolidated Pharmecutical)	6110 Robinwood Road	Glen Burnie

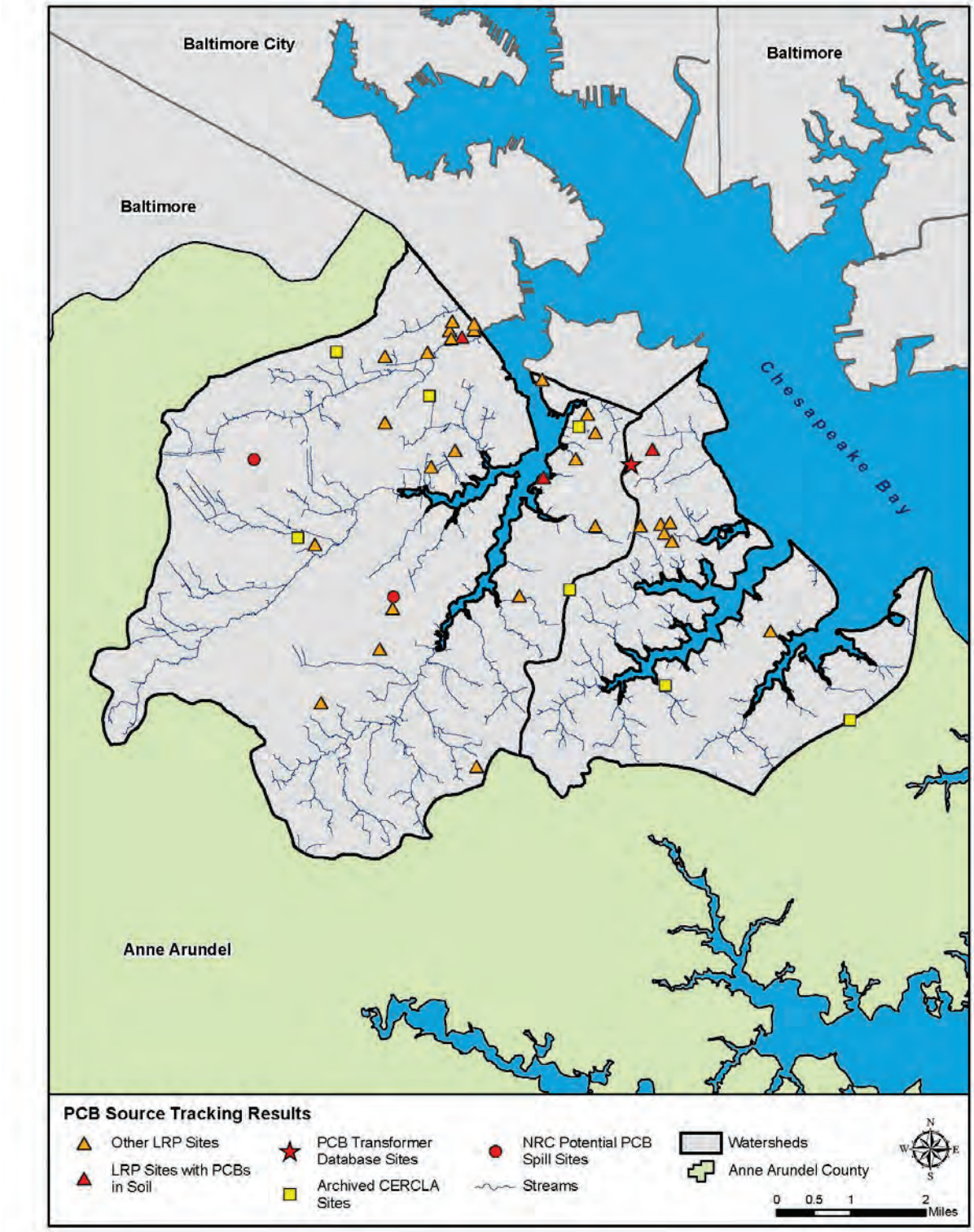


Figure 6: Location Results of PCB Source Tracking Desktop Analysis

3.3.2 Structural BMPs with Potential for PCB Soil Contamination

The MDE PCB SW-WLA recommendations for source tracking also notes structural stormwater BMPs, specifically stormwater ponds, as locations with significant potential PCB soil contamination thus potential sources of PCBs. Additional source tracking desktop analysis identified and prioritized BMPs with potential for PCB soil contamination.

Two separate analyses and prioritizations were carried out. The first analysis looked at land use and prioritized BMPs located within and/or with drainage areas containing commercial, industrial or utility land uses. The second analysis looked at the location of BMPs and BMP drainage areas in proximity to sites identified as having significant potential for PCB contamination. The analyses were carried out using Excel and ArcGIS utilizing BMP data (Urban BMP 2014 County GIS), land use data (2011 County GIS), and source tracking results data. The analysis is briefly described for each approach and the resulting lists of prioritized BMPs are presented. Note that a summary of the type and distribution of existing BMPs by group within each subwatershed MS4 area is described in Section 4.2.

Land Use

The desktop analysis looked first at 474 BMPs without polygon delineated drainage areas and determined that 89 were located within commercial, industrial or utility land use areas within the MS4 area in both subwatersheds combined. Since BMPs with a larger drainage area have greater potential to collect PCBs and in order to narrow the list of possible BMPs, a minimum drainage area of 2 acres was set. BMPs with drainage areas less than 2 acres within the land use categories of interest were excluded, leaving 17 BMPs. All 17 BMPs are included in the results with the priority to spatially delineate their drainage areas. Once spatially delineated, the next step would be to prioritize these alongside the BMPs with polygon delineated drainage areas for future monitoring and maintenance.

Next the desktop analysis looked at 1387 BMPs with polygon delineated drainage areas and found that 415 BMPs had drainage areas intersecting commercial, industrial or utility land use areas within the MS4 area in both subwatersheds combined. Since BMPs with a larger drainage area have greater potential to collect PCBs and in order to narrow the list of possible BMPs, a minimum drainage area of 2 acres was set. BMPs with drainage areas less than 2 acres within the land uses of interest were excluded. Additionally, BMPs with a build date after 1/1/2005, 10 years from the approximate date of this restoration plan, were excluded as the newer BMPs will have had less time to accumulate sediment than older BMPs. This left 66 BMPs included in the priority list (11 in Baltimore Harbor AACO, and 55 in Curtis Creek AACO).

BMPs were prioritized into four categories with 1 being highest priority and 4 being lowest priority based on land use type, drainage area within land use, and type of BMP. Dry detention ponds, extended dry detention ponds and wet ponds were prioritized as 1 or 2 based on the drainage area. If the drainage area was greater than 3 acres of industrial or greater than 5 acres of commercial or utility the BMP received priority 1, all others received priority 2. Other BMPs, primarily infiltration practices, received priority 3 or 4 based on the same land use area criteria. The results are shown in Table 12 and Table 13 for Curtis Creek AACO and Baltimore Harbor AACO respectively. BMPs are organized and listed first by type, then priority, then land use (industrial, utility, and commercial), and finally drainage area in land use. The BMP Storm_ID corresponds to the unique BMP identifier in the County BMP geodatabase. The location of the prioritized BMPs with accompanying drainage areas are shown in Figure 7.

Table 12: Curtis Creek – Land Use BMP Prioritization Results

Type of BMP	BMP Storm_ID	Land Use	Total Drainage Area (acres)	Drainage Area in Land Use (acres)	Build Date	Priority
Detention Dry	190	Industrial	29.8	20.4	12/17/2002	1
	63	Industrial	22.3	16.1	1/1/1980	
	1398	Industrial	4.5	3.3	1/1/1991	
	2137	Commercial	21.8	16.2	7/3/1997	
	13201	Commercial	21.9	4.0	4/8/1997	2
	1924	Commercial	2.6	2.5	11/1/1999	
	1224	Commercial	75.0	2.3	7/1/1993	
	132	Commercial	19.0	2.3	2/10/1985	
	795	Commercial	42.0	2.0	9/8/1989	
	9769	Commercial	4	Unknown	11/19/2008	Spatially Delineate DA
	9770	Commercial	4	Unknown	11/19/2008	
	8991	Commercial	2.65	Unknown	7/15/2009	
Extended Detention Dry	2586	Industrial	24.3	13.7	2/9/2000	1
	6158	Industrial	12.3	11.5	7/23/2002	
	1747	Industrial	29.7	8.7	2/8/1999	
	6159	Industrial	8.1	7.1	7/23/2002	
	1746	Industrial	5.6	4.8	6/18/2002	
	1745	Industrial	5.8	4.6	6/18/2002	
	298	Commercial	29.0	6.9	9/14/1995	
	1687	Commercial	6.1	5.3	11/20/1991	
	6332	Commercial	9.7	4.6	12/11/2003	2
	6489	Commercial	16.9	4.3	2/24/2004	
	1689	Commercial	4.3	3.7	6/2/2000	
Wet Ponds	4309	Industrial	15.0	12.4	11/25/1998	1
	1078	Industrial	7.0	6.2	12/11/1991	
	322	Commercial	56.8	45.8	10/9/1991	
	3956	Commercial	272.5	37.9	10/9/2000	
	187	Commercial	29.1	15.2	6/22/1988	
	296	Commercial	24.0	14.5	7/1/1993	
	1366	Commercial	19.3	10.6	11/5/1992	
	715	Commercial	9.7	7.5	9/23/1987	
	167	Commercial	7.4	7.3	7/24/1996	
	4796	Commercial	25.8	6.7	10/14/1999	
	169	Commercial	5.1	4.9	6/24/1988	2
	3925	Commercial	23.2	4.3	9/18/1998	
	4020	Industrial	8.95	Unknown	10/15/2007	Spatially Delineate DA
Infiltration	1915	Industrial	8.6	7.3	4/28/1990	3
	559	Industrial	6.6	6.6	5/17/1993	
	1819	Industrial	7.0	6.5	8/9/1995	
	1077	Industrial	4.5	4.4	12/11/1991	
	1425	Industrial	10.7	4.3	11/2/1995	
	1076	Industrial	4.2	4.1	12/11/1991	
	3413	Industrial	3.7	3.7	8/9/1995	
	4604	Industrial	3.8	3.7	3/8/2003	
	454	Industrial	3.3	3.2	3/20/1993	
	182	Commercial	32.8	19.4	4/8/1986	
	1607	Commercial	18.3	14.8	6/20/2001	

Type of BMP	BMP Storm_ID	Land Use	Total Drainage Area (acres)	Drainage Area in Land Use (acres)	Build Date	Priority
	5315	Commercial	19.5	10.0	1/3/2000	
	1858	Commercial	9.6	8.2	2/4/2004	
	3339	Commercial	7.5	7.5	11/4/1992	
	6696	Commercial	6.3	6.3	8/11/2004	
	2661	Commercial	5.8	5.8	11/4/1992	
	2341	Commercial	5.4	5.4	11/20/1991	
	5833	Commercial	5.0	5.0	8/11/2004	
	3031	Industrial	2.6	2.5	2/15/1993	
	2221	Industrial	2.8	2.5	11/9/1994	
	2834	Commercial	6.3	4.3	10/14/1992	4
	513	Commercial	4.5	3.9	4/26/1995	
	369	Commercial	3.0	2.9	4/21/1995	
	1810	Industrial	7.9	Unknown	11/2/1995	Spatially Delineate DA
	896	Industrial	7.75	Unknown	1/2/2001	
Filtration	9474	Industrial	2.4	Unknown	12/1/2008	
	9475	Industrial	2.4	Unknown	12/1/2008	
	9476	Industrial	2.4	Unknown	12/1/2008	
	7902	Commercial	7.09	Unknown	8/12/2006	Spatially Delineate DA
	7898	Commercial	6.17	Unknown	8/12/2006	
	7899	Commercial	5.45	Unknown	8/12/2006	
	10450	Commercial	5.3	Unknown	1/9/2010	
	8102	Commercial	2	Unknown	7/10/2011	
ESD	9768	Commercial	7	Unknown	11/19/2008	Spatially Delineate DA
Wetlands	6514	Commercial	2	Unknown	7/1/2009	Spatially Delineate DA

Table 13: Baltimore Harbor – Land Use BMP Prioritization Results

Type of BMP	BMP Storm_ID	Land Use	Total Drainage Area (acres)	Drainage Area in Land Use (acres)	Build Date	Priority
Detention Dry	4451	Commercial	22.3	4.9	6/1/2000	
	4177	Commercial	12.8	8.3	5/18/2001	1
	872	Commercial	41.6	9.3	7/1/1993	
	6139	Industrial	41.6	Unknown	1/26/2009	Spatially Delineate DA
Extended Detention Dry	2880	Industrial	25.2	21.0	4/4/2002	
	4798	Industrial	6	3.6	1/12/2001	1
	1692	Utility	14.6	4.9	7/16/1997	
	1875	Commercial	6.8	3.5	10/1/1990	2
	1097	Commercial	3.5	2.8	10/10/1995	
Wet Ponds	498	Industrial	141.9	94.2	12/17/1997	1
	4326	Industrial	4.6	2.8	8/17/2001	2
Infiltration	1812	Commercial	14.3	4.7	11/2/1995	4

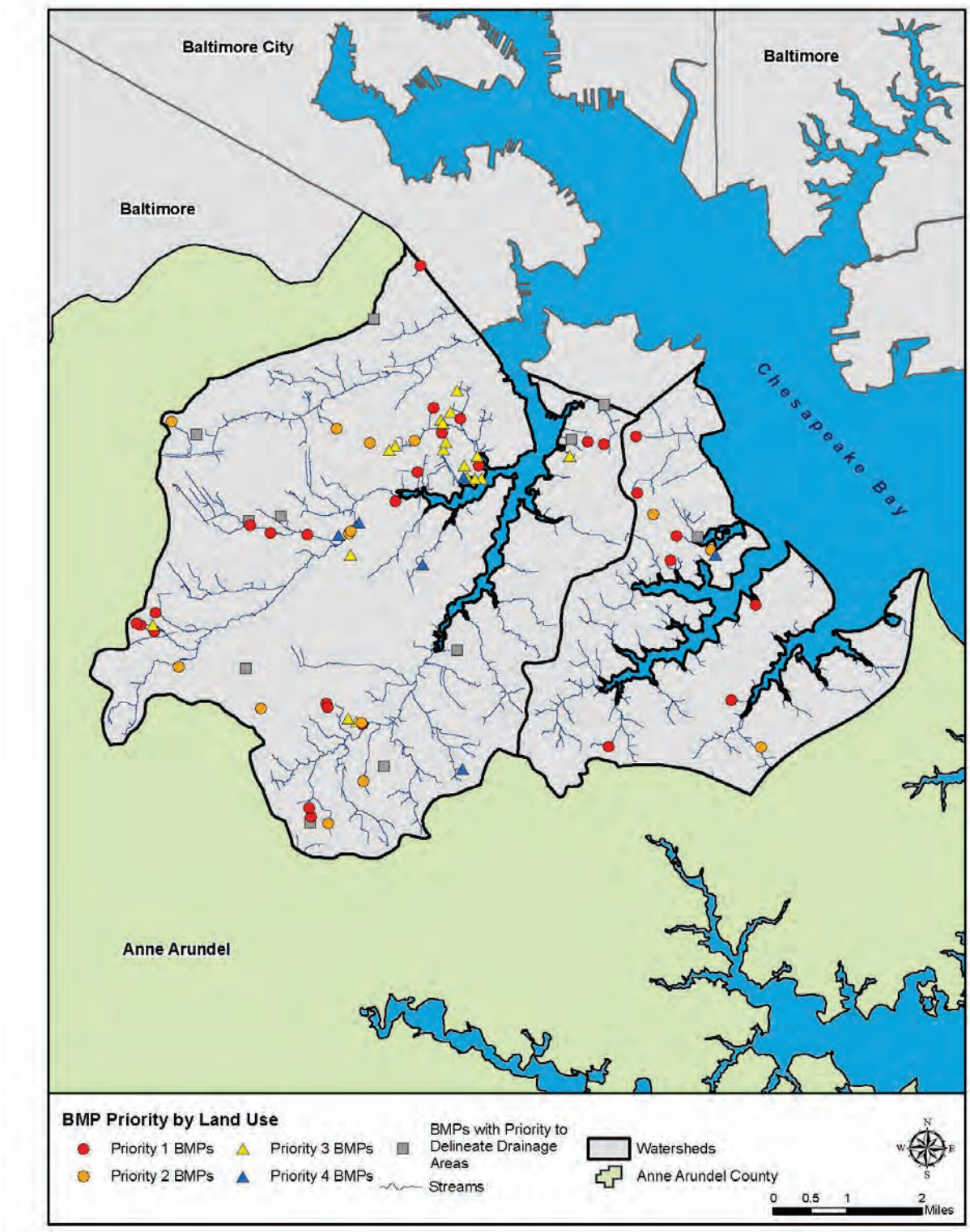


Figure 7: BMP Land Use Prioritization Results

Proximity to Sites Identified Through Source Tracking

This desktop analysis first looked at BMPs with polygon delineated drainage areas. Four BMPs were identified as having a drainage area containing one or more of the source tracking identified sites. The BMPs and source tracking sites are provided in Table 14. Three of the four BMPs were also identified as priority sites through the land use analysis. These BMPs are denoted with an asterisk. Notably, there were no BMPs whose polygon delineated drainage areas contained a source tracking Tier 1 site.

Table 14: BMPs with Polygon Delineated Drainage Areas Containing Source Tracking Sites

Source Tracking Site	Source Tracking Site Source	Source Tracking Tier	BMP Storm_ID	BMP Type
Praxair, Inc.	MDE LRP	2	1425*	Infiltration
Southgate Marketplace	MDE LRP	2	4796*	Wet Pond
5 Sites: Nova-Kote, Inc. Fila U.S.A, Inc. Brandon Woods Business Park Energy Parkway Brandon Woods II	MDE LRP	2	498*	Wet Pond
Fort Smallwood - Control Nike BA-43	CERCLA Database	3	4958	Wet Pond
*BMPs also identified as priority through land use analysis.				

For the BMPs without polygon delineated drainage areas, analysis involved identifying BMPs within a designated search radius from the source tracking site. For each source tracking site source, the search radius started at 500 feet and expanded to up to 0.75 miles or until a sufficiently large number of BMPs were located. Similar to land use analysis, the priority action for these BMPs would be to spatially delineate the drainage areas associated with the BMPs. If the delineated drainage areas encompass a source tracking site, the BMP should be given priority in targeted monitoring and maintenance actions. Table 15 provides the Storm_IDs for BMPs within the designated search radius proximity to source tracking sites. Results are organized by source tracking site source.

Table 15: BMPs without Polygon Delineated Drainage Areas in Proximity to Source Tracking Sites

Source Tracking Site Source	Source Tracking Tier	Search Radius	BMP Storm_ID
NRC Database Sites	1	0.25 miles	10611, 9992, 13411, 2723 (plus additional BMPs at same location)
EPA PCB Transformer Database Site	1	0.75 miles	2185, 4526, 4249
MD LRP – PCBs in Soil Sites	1	0.75 miles	9387, 6728, 1810, 8669, 10125, 10735, 7497, 7815, 7807, 7022, 6313, 7964
MDE LRP Sites	2	750 feet	2847, 11221, 6757, 5986, 9992, 8838, 8839, 532, 8723
CERCLA Database Sites	3	0.25 miles	1810, 5861, 6644, 7546, 9994, 11884, 11885, 2847, 1178, 2362, 8669

Next steps planned to address PCB source contamination from identified potential sites and prioritized structural BMPs are addressed in Section 4.4.3 that describes the County's restoration plan strategy for targeted PCB actions.

4 Management Activities and Strategy Development

4.1 Modeling Approach

To aid in planning restoration efforts to achieve the PCB TMDL reductions, a watershed treatment model was developed to estimate how conditions will improve in response to various treatment options. The basis of the modeling approach was the Custom 2013 version of the Center for Watershed Protection (CWP) Watershed Treatment Model (WTM). The WTM is a spreadsheet based model that uses the Simple Method to estimate stormwater runoff pollutant loads (CWP 2013). The Custom 2013 version is designed to model total nitrogen, total phosphorus, TSS, and bacteria. The Custom 2013 version was adapted to estimate PCB loads utilizing the process for modeling TSS.

Since the TMDL baseline loading and required reductions are subwatershed specific, separate WTMs were developed for each subwatershed. The WTM process involved developing several versions of the model representing important time steps such as a baseline version representing loads at the start of 2011 (approximating the date of Baltimore Harbor PCB TMDL), a progress version representing loads at the start of 2015 (approximating date of restoration plan), and future versions representing loads at specific points in the future incorporating various planned treatment options.

Input data to the WTM included land use (2011 County GIS), soil (2015 National Resource Conservation Service GIS), and percent impervious (2011 County GIS) for the MS4 area only. Event mean concentrations (EMCs) used to estimate pollutant concentration in stormwater runoff and removal rates for BMPs were set to match the values used in the watershed model developed for the Patapsco Tidal and Bodkin Creek Watershed Assessment. BMP data (Urban BMP 2014 County GIS) was incorporated at the appropriate step based on the build date of the BMP.

The first step in adjusting the WTMs to estimate PCB loads was to set up the models to accurately estimate TSS. The results of the initial TSS setups were compared to the TSS loads presented in the Patapsco Tidal and Bodkin Creek Watershed Assessment and were found to be similar. This confirmed an acceptable initial model setup. The next step in adjusting the model from calculating TSS loads to calculating PCB loads was to convert the EMCs to represent PCB runoff concentrations. This was achieved by using the regression equations developed for the Tidal Potomac and Anacostia River PCB TMDL (Haywood and Buchanan 2007) which relate the concentration of TSS to a concentration of PCBs. The EMCs were converted using the regression best applicable to the land use type. Non-urban land uses (forest, open wetland, pasture/hay, row crops, and open water) were assigned an EMC of 0 since historic use of PCBs suggest non-urban land use types are unlikely to contribute significant PCB pollution. Further explanation of the conversion of EMCs from TSS to PCBs including regression equations is provided in Appendix A. The removal rates remained unchanged as Chesapeake Stormwater Network's December 2015 publication "Potential Benefits of Nutrient and Sediment Practices to Reduce Toxic Contaminants in the Chesapeake Bay Watershed" suggests that PCB removal rates will be comparable to suspended sediment removal rates for most urban BMPs

The EMC conversion resulted in PCB baseline loading estimates that were within the correct order of magnitude, but outside of reasonable variation from the Baltimore Harbor PCB TMDL baseline estimate. This initial difference was not unexpected as the Baltimore Harbor PCB

TMDL baseline estimates were calculated using time-series to predict the subwatershed load from measured PCB concentrations and flow rates at specific monitoring stations whereas the WTM estimates are based on Simple Method calculation of pollutant loads. To calibrate the model to correct for this difference, a subwatershed specific multiplier was applied to the EMCs. The multiplier was selected such that the results in WTM 2011 baseline loads were similar to but did not exceed the Baltimore Harbor PCB TMDL baseline load for each subwatershed. The EMCs with applicable multiplier were compared with the range of research documented EMCs (Gilbreath et al. 2012) and were found to be within the range. In general, research on PCB loads in stormwater documented in Gilbreath et al. (2012) suggest EMCs for PCBs can be quite variable and that urban or percent impervious might not be the strongest predictors of PCB yield in an unmonitored watershed. However, until further research is complete and better models based on other factors such as older industrial landscape or presence of specific historic industries are developed, the approach described above provides a functioning method in which the multiplier accounts for differences in the subwatersheds that influence PCB loads as calculated in the Baltimore Harbor PCB TMDL that are not otherwise accounted for in the WTM. Table 16 documents the TSS EMC, the regression applied, the converted PCB EMC, and the PCB EMC with the subwatershed multiplier used in the WTM models.

Table 16: Conversion of TSS EMCs to PCB EMCs

	TSS EMC (mg/L)	Regression	PCB EMC (ng/L)*	PCB EMC with Curtis Creek AACO multiplier 0.7 (ng/L)*	PCB EMC with Baltimore Harbor AACO multiplier 3.6 (ng/L)*
Residential 1-acre	43	Near DC	2.39	1.68	8.63
Residential 1/2-acre	43	Near DC	2.39	1.68	8.63
Residential 1/4-acre	43	Near DC	2.39	1.68	8.63
Residential 1/8-acre	43	Near DC	2.39	1.68	8.63
Residential 2-acre	43	Near DC	2.39	1.68	8.63
Commercial	43	DC Urban	35.72	25.21	128.61
Airport	99	Near DC	3.66	2.56	13.16
Transportation	99	Near DC	3.66	2.56	13.16
Utility	34	DC Urban	28.44	19.91	102.41
Open Space	34	Near DC	2.12	1.49	7.66
Industrial	77	DC Urban	62.87	44.01	226.34
* PCB EMCs are expressed in ng/L for ease of comparison, however, the values are entered into the WTM as mg/L.					

The 2011 PCB Baseline WTM included BMPs with a build date through the end of 2010. The next step, modeling progress to 2015, added BMPs with a build date between the start of 2011 through the end of 2014. Existing BMPs are discussed in greater detail in Section 4.2. BMP data continued to be adjusted for each iteration of the WTM representing estimates from planned restoration efforts both structural as well as programmatic. The results of the 2011 baseline and 2015 progress are detailed in Section 4.3 along with the calculation of the disaggregated subwatershed-specific baseline loads and WLAs from the Baltimore Harbor PCB TMDL.

4.2 Existing Practices

Anne Arundel County maintains a geodatabase of structural BMPs throughout the county (Urban BMP 2014 County GIS). Within the combined MS4 area of the subwatersheds, the geodatabase contains 1861 BMPs with delineated drainage areas (1387 delineated with accompanying polygons) that were reported to MDE in 2014 and were included in the WTM analysis.

BMPs were organized into eight categories in accordance with MDE BMP codes using the same grouping as the Patapsco Tidal and Bodkin Creek Watershed Assessment (Table 3.4, Section 3.1.2). The total number of BMPs, total drainage area, and impervious area for each of the categories is shown in Table 17 and Table 18 for Curtis Creek AACO and Baltimore Harbor AACO, respectively with grouping of pre-2011 BMPs and post-2011 BMPs used in the 2011 baseline and 2015 progress iterations of the WTM. In Table 17 and Table 18, ESD stands for Environmental Site Design and represents small scale stormwater management practices such as green roofs, rain barrels, and rain gardens, and Alternative - FPU stands for forestation on pervious urban and represents BMPs coded as "plantings" in the geodatabase. Each BMP group has a specified percent removal efficiency (removal rate) for TSS from the Patapsco Tidal and Bodkin Creek Watershed Assessment which is included in the WTM. The removal efficiencies are shown in Table 19.

Table 17: Curtis Creek AACO BMPs

BMP Groups	Total BMP Count	Total Drainage Area	Total Impervious Area
Pre-2011			
Detention Dry	62	757.4	269.3
Extended Detention Dry	54	461.8	152.9
Filtration	104	215.8	75.0
Infiltration	598	579.0	304.0
Wet Ponds	48	931.6	416.5
Wetlands	9	39.3	6.2
ESD	18	10.0	5.6
Alternative - FPU	14	1.3	0.1
Totals	**907**	**2996.1**	**1229.5**
Post-2011			
Detention Dry	4	5.9	1.6
Extended Detention Dry	3	9.1	3.8
Filtration	36	45.1	12.6
Infiltration	56	48.1	14.8
Wet Ponds	4	43.4	3.8
Wetlands	-	-	-
ESD	37	6.6	2.8
Alternative - FPU	3	0.2	0.0
Totals	**143**	**158.4**	**39.5**

Table 18: Baltimore Harbor AACO BMPs

BMP Groups	Total BMP Count	Total Drainage Area	Total Impervious Area
Pre-2011			
Detention Dry	36	344.5	122.4
Extended Detention Dry	31	165.8	62.0
Filtration	61	218.2	23.9
Infiltration	455	222.7	79.7
Wet Ponds	16	310.6	103.8
Wetlands	5	12.2	5.8
ESD	33	16.7	2.7
Alternative - FPU	66	3.6	0.9
Totals	**703**	**1294.3**	**401.0**
Post-2011			
Detention Dry	-	-	-
Extended Detention Dry	-	-	-
Filtration	19	11.9	4.8
Infiltration	30	11.1	8.2
Wet Ponds	2	2.2	0.04
Wetlands	-	-	-
ESD	50	10.2	1.9
Alternative - FPU	7	0.3	0.1
Totals	**108**	**35.7**	**15.1**

Note for BMPs with polygon delineated drainage areas, the geodatabase contained values for both the total drainage area and impervious area which were used in the BMP analysis. For BMPs without a polygon delineated drainage, the geodatabase contained only a value for the total drainage area. The impervious area for these remaining 474 BMPs was estimated by determining the land use on which the BMP was located and multiplying the total drainage area by the subwatershed specific average percent impervious for the particular land use. Additionally, the WTM requires setting three discount factors that take into account reduction of BMP effectiveness due to imperfect capture, design standards, and maintenance. These discount factors were set to 0.9, 0.8 and 0.6 respectively based on descriptions provided in the WTM 2013 Documentation (CWP 2013).

Table 19: BMP Category Removal Rates

BMP Category	Percent Removal Efficiency TSS (unchanged for PCBs)
Detention Dry	10
Extended Detention Dry	60
Filtration	80
Infiltration	95
Wet Ponds	60
Wetlands	60
ESD	90
Alternative - FPU	57

In addition to existing structural BMPs, the County also routinely carries out street sweeping, inlet cleaning, and public outreach as part of its broader watershed restoration efforts. While these programmatic practices also serve to reduce pollutant loads, street sweeping and inlet

cleaning were not incorporated in the 2011 baseline or 2015 progress WTM versions because subwatershed specific data is unavailable for these time periods. However, street sweeping and inlet cleaning are included in the future scenarios incorporating planned actions at the subwatershed level.

4.3 PCB WLA Disaggregation, 2011 Baseline, and Progress through 2015

The Baltimore Harbor PCB TMDL presented the WLAs as aggregate values for all NPDES holders within the subwatershed. To determine the WLA applicable to the Anne Arundel County MS4 NPDES permit for each subwatershed, the WLAs needs to be disaggregated. MDE provides guidance for disaggregating TMDL WLAs as part of their TMDL Stormwater Toolkit (MDE 2015). Following the process outlined in the toolkit for each subwatershed, the acres of urban land use within the MS4 area were divided by the total number of urban acres in the subwatershed. This fraction represented the portion of the WLA applicable to the MS4 permit. Urban land use was calculated using the 2006 USGS-CBP Land-Cover shapefile available from the TMDL Stormwater Toolkit website. The results of the disaggregation documenting the County MS4 specific baseline load, WLA, and required load reductions are shown in Table 20.

Table 20: Calculation of MS4 Specific Baseline Load, WLA, and required Load Reductions

	Curtis Creek AACO	Baltimore Harbor AACO
A. Total Subwatershed Urban (acres)	17102	5810
B. MS4 Subwatershed Urban (acres)	13138	5540
C. Fraction of MS4 urban over Total Urban (B/A)	**0.768**	**0.947**
D. NPDES Aggregate Baseline Load (g/year)	357.68	493.06
E. MS4 only Baseline Load (C*D) (g/year)	**274.77**	**467.09**
F. NPDES Aggregate TMDL WLA (g/year)	23.13	43.84
G. MS4 TMDL WLA (C*F) (g/year)	**17.77**	**41.53**
H. MS4 Load Reduction (E-G) (g/year)	**257**	**425.56**
I. MS4 Load Reduction (H/E) (%)	**93.5**	**91.1***
* This percent reduction is slightly less than what is shown in the Baltimore Harbor PCB TMDL due to subtracting out the Curtis Creek area to prevent double counting.		

4.3.1 WTM Baseline Load 2011 Modeling Results

The WTM 2011 baseline load results for each subwatershed are shown in Table 21. The results are compared with the TMDL baseline and in both cases the WTM slightly underestimates the TMDL baseline. While very similar with percent differences of less than 5%, but given that differences still exist between the TMDL baseline and the WTM baseline, the goal WLA for each subwatershed is calculated relative to the WTM baseline based on the required percent reduction. This WTM based goal WLA will be used throughout the remainder of this restoration plan to compare progress and effects of planned restoration efforts.

Table 21: WTM Baseline Load 2011 Results

	Curtis Creek AACO	Baltimore Harbor AACO
A. WTM 2011 Baseline PCB load (g/year)	262.89	454.55
B. TMDL MS4 Baseline PCB load (g/year)	274.77	467.09
C. Percent difference between TMDL baseline and WTM baseline ((A-B)/B*100)	-4.3%	-2.7%
D. Required percent reduction from Table 20 Line I	93.5%	91.1%
E. Goal WLA based on WTM 2011 Baseline PCB Load ((1-D)*A) (g/year)	**17.09**	**40.45**

4.3.2 WTM Progress Load 2015 Modeling Results

The WTM 2015 progress load results for each subwatershed are shown in Table 22. The 2015 progress results estimate the reductions in PCB loading from the structural BMPs added between the time of the baseline (start of 2011) and the start of 2015. This progress load documents the County's approximately current status towards achieving the WLA. This value is the approximate current status as the County BMP geodatabase documents BMPs completed through the end of 2014, BMPs added in 2015 are not yet included in the geodatabase and therefore were not included in the model.

Table 22: WTM Progress Load 2015 Results

	Curtis Creek AACO	Baltimore Harbor AACO
A. WTM 2015 Progress PCB load (g/year)	**262.09**	**453.33**
B. WTM 2011 Baseline PCB load (g/year)	262.89	454.55
C. Reduction (B-A) (g/year)	**0.8**	**1.22**
D. WLA based on WTM 2011 Baseline PCB Load (g/year)	17.09	40.45
E. Remaining Reduction (A-D) (g/year)	**245.00**	**412.88**
Additional drainage acres controlled by newly constructed BMPs	158.4	35.7
Additional impervious acres controlled by newly constructed BMPs	39.5	15.1

The 2015 progress added 143 and 108 BMPs in the Curtis Creek AACO and Baltimore Harbor AACO subwatershed respectively. However, these BMPs respectively only controlled for 39.5 and 15.1 acres of impervious cover. As a result, the PCB load reduction was very small, 0.8 for Curtis Creek AACO and 1.22 Baltimore Harbor. In order to achieve significant reduction in the PCB loads as required by the Baltimore Harbor PCB TMDL, substantially more impervious cover will need to be controlled with BMPs in the future and/or restoration efforts will need to specifically target potential PCB sources.

4.4 Restoration Plan Activities

The WTM results for the 2015 Progress Load indicate significant PCB load reductions are still required in order to meet the PCB WLAs for Curtis Creek AACO and Baltimore Harbor AACO subwatersheds, 245.0 g/year and 412.9 g/year respectively.

This restoration plan includes three primary strategies for reducing PCB loads including structural BMPs, non-structural BMPs, and targeted PCB actions. A description and estimate of the projected reductions are provided for each strategy. Load reductions are projected in 2-year time steps through 2025 to be consistent with the timeframe and planning efforts for meeting the Chesapeake Bay TMDL. Time steps modeled include 2017, 2019, 2021, and 2025. Current budget data past 2021 is not refined enough to model the 2023 time step.

For the structural BMPs and non-structural BMPs, the strategy first looks at anticipated load reductions from projects already planned and budgeted through the Anne Arundel County Watershed Protection and Restoration Program. These projects within the Curtis Creek AACO and Baltimore Harbor AACO were developed to meet the Chesapeake Bay TMDL WLAs for total nitrogen and total phosphorus and will also serve to reduce PCB loads. Recommendations for any additional structural or non-structural BMPs are discussed in light of the relative load reductions anticipated, as well as cost-effectiveness.

4.4.1 Restoration Plan Structural BMPs and Projected Reductions

The structural BMP strategy includes stormwater pond retrofits and new structural BMPs. Stormwater pond retrofits are one of the Core Tier I Watershed Implementation Plan (WIP) strategies outlined in the Patapsco Tidal and Bodkin Creek Watershed Assessment and numerous projects are underway to retrofit stormwater ponds in both subwatersheds. The other core WIP strategies of stream restoration and outfall retrofits are not included in this restoration plan strategy as it is less likely that the reduced sediment loads from these types of projects have come in contact with PCBs. New structural BMPs would include BMPs constructed to control currently uncontrolled impervious areas.

The structural BMP strategy first looks at reductions from already planned and budgeted stormwater pond retrofits. The planned stormwater pond retrofits (also referred to as simply pond retrofits) are documented in the Patapsco Tidal and Bodkin Creek Watershed Assessment. Data analysis was based on the County GIS source data layers “PondRetrofits”, “PondRetrofitsDA”, and “Urban_BMP_2014_DA” as well as the approved FY14, FY15, and FY16 budgets for Watershed Protection and Restoration Program.

From the County GIS data, 68 and 26 pond retrofits were identified within Curtis Creek AACO and Baltimore Harbor AACO, respectively. This includes both private and publically owned ponds. The drainage area and impervious cover within each drainage area was estimated for each pond. For 87 of the 94 ponds that could be joined to the polygon delineated BMP drainage areas from the Urban_BMP_2014_DA layer, the joined layer data provided the drainage area and impervious estimates. For the 7 remaining ponds that did not join, the drainage areas were estimated from the PondRetrofitsDA layer data and impervious was calculated by multiplying the drainage area by the average percent impervious for the land use type where the pond was located.

Each pond retrofit was then assigned to a model time step based on the original retrofit construction date estimated in the watershed assessment and refined using the FY14, FY15, and FY16 budgets that provide updates on project and funding status. It was assumed that for a

given pond type, the retrofit would result in shifting to the BMP type with the next highest removal efficiency. For example, dry ponds (10% removal efficiency) would shift to wet ponds or dry ponds with extended detention (60% removal efficiency) and wet ponds or dry ponds with extended detention would shift to filtration (80% removal efficiency). The drainage area and impervious area were summed for the same retrofit types within a specific time step. The retrofits by time step are shown in Table 23 for Curtis Creek AACO and Table 24 for Baltimore Harbor AACO.

Table 23: Summary of stormwater pond retrofits by time step for Curtis Creek AACO

Time Step	Number of Ponds	Existing BMP/Pond Type (% removal efficiency)	Assumed Retrofit BMP Type (% removal efficiency)	Sum of Drainage Areas (acres)	Sum of Impervious Area (acres)
2017 (2015-2017)	22	Dry Ponds (10%)	Wet Ponds (60%)	839.5	396.1
	1	Dry Extended Detention (60%)	Filtration (80%)	12.3	8.2
	9	Wet Ponds (60%)	Filtration (80%)	256.2	144.9
	4	Wetlands (60%)	Filtration (80%)	47.2	14.5
2019 (2017-2019)	6	Dry Ponds (10%)	Wet Ponds (60%)	208.6	56.5
	5	Dry Extended Detention (60%)	Filtration (80%)	77.0	25.3
	6	Wet Ponds (60%)	Filtration (80%)	410.1	174.1
2021 (2019-2021)	1	Dry Ponds (10%)	Wet Ponds (60%)	10.1	5.1
	2	Dry Extended Detention (60%)	Filtration (80%)	39.6	9.3
	1	Wet Ponds (60%)	Filtration (80%)	23.2	9.6
2025 (2021-2025)	6	Dry Ponds (10%)	Wet Ponds (60%)	63.7	23.3
	3	Dry Extended Detention (60%)	Filtration (80%)	64.0	7.3
	2	Wet Ponds (60%)	Filtration (80%)	39.5	10.5
Totals	**68**			**2091.0**	**884.9**

Table 24: Summary of stormwater pond retrofits by time step for Baltimore Harbor AACO

Time Step	Number of Ponds	Existing BMP/Pond Type (% removal efficiency)	Assumed Retrofit BMP Type (% removal efficiency)	Sum of Drainage Areas (acres)	Sum of Impervious Area (acres)
2017 (2015-2017)	5	Dry Ponds (10%)	Wet Ponds (60%)	54.7	20.6
2019 (2017-2019)	5	Dry Ponds (10%)	Wet Ponds (60%)	67.5	25.0
	3	Wet Ponds (60%)	Filtration (80%)	175.6	80.0
	1	Wetlands (60%)	Filtration (80%)	6.53	2.67
2021 (2019-2021)	No retrofits assigned to this time step.				
2025 (2021-2025)	6	Dry Ponds (10%)	Wet Ponds (60%)	106.7	24.4
	3	Dry Extended Detention (60%)	Filtration (80%)	55.1	22.5
	3	Wet Ponds (60%)	Filtration (80%)	106.0	14.5
Totals	**26**			**572.1**	**189.7**

Incorporating the time-step pond retrofit data into the Progress Load 2015 WTM resulted in the incremental projected PCB load reductions shown in Table 25. The total estimated PCB load reduction from pond retrofits through 2025 is 13.78 g/year for Curtis Creek AACO and 13.5 g/year for Baltimore Harbor ACCO. Table 26 summarizes the progress towards meeting the PCB WLAs by 2025 from pond retrofits and the required reductions remaining.

Based on the preliminary costs provided in the watershed assessment, the estimated cost for the above 94 retrofits likely falls within the range of $20M-$30M. Combining reductions from subwatersheds for a total of 26.28 g/year, the cost per gram of PCB load reduction from pond retrofits is within the range of $750K – $1.1M.

Table 25: Anticipated Incremental Reductions by Time Step for Pond Retrofits

	Incremental PCB Load Reduction from Time Step (g/year)	
Time Step	**Curtis Creek AACO**	**Baltimore Harbor AACO**
2017	8.79	1.76
2019	3.81	6.24
2021	0.37	0
2025	0.81	5.5
Total	**13.78**	**13.5**

Table 26: Progress towards meeting WLAs by 2025 from Pond Retrofits

	Curtis Creek AACO (g/year)	**Baltimore Harbor AACO (g/year)**
WTM 2015 Progress Load	262.09	453.33
WTM 2025 Progress Load with Pond Retrofits	248.31	439.83
PCB WLAs	17.09	40.45
Required Reduction Remaining	231.22	399.38

As shown in Table 26 the anticipated reductions from stormwater pond retrofits are not sufficient to meet the PCB WLAs. New BMPs were not part of the WIP strategies and as such none are currently planned for the subwatersheds.

Planned Strategy: The County will continue to implement the planned stormwater retrofits and will update the progress loads and projected reductions as projects are completed and/or implementation schedules shift. The County has the option to complete additional pond retrofits and/or implement new BMPs to address existing uncontrolled impervious. These efforts would continue to reduce loads and the County will investigate the feasibility and potential beneficial impact of implementing additional pond retrofits or new BMPs on an individual basis and as situations present themselves. However, comparing the cost of the planned retrofits to the estimated reductions on a cost-effectiveness basis, the County will not actively pursue untargeted additional pond retrofits and new BMPs projects solely for the purpose of PCB load reduction because the load reductions from these efforts would continue to make only incrementally small improvements. Instead, the County plans to focus additional PCB TMDL specific reduction efforts on targeted PCB actions. Yet if additional pond retrofits or new BMPs are implemented as part of other efforts within the subwatersheds, the PCB load reductions from such projects would be calculated and incorporated into future WTM updates.

4.4.2 Restoration Plan Non-Structural BMPs and Projected Reductions

The non-structural BMP or programmatic strategies includes street sweeping and inlet cleaning. Street sweeping and inlet cleaning are two Core Tier II WIP strategies outlined in the Patapsco Tidal and Bodkin Creek Watershed Assessment. The County Department of Public Works (DPW) through the Bureau of Highways currently carries out an impressive program of street sweeping and inlet cleaning that reduces trash and stormwater pollution throughout the County with program details documented in the MS4 Annual Reports. Estimates of pollution reduction from roads swept and inlets cleaned can be counted towards meeting TMDL WLAs.

The non-structural BMP strategy first looks at reductions from already planned street sweeping and inlet cleaning as documented in the Patapsco Tidal and Bodkin Creek Watershed Assessment. Data analysis was based on the County GIS source data layers “StreetSweeping” and “ClosedSectionRd_Inlets”.

To calculate PCB load reductions from street sweeping using the WTM, the area of street swept was calculated for non-residential land uses within the MS4 area in each subwatershed. Since the County is currently not routinely sweeping residential streets, residential streets were not included. Road areas in the land use category of woods were also omitted since woods are not likely sources of PCBs. Planned frequency of sweeping is monthly using a regenerative air sweeper. The technique discount factor was assumed to be 0.75 based on descriptions provided in the WTM 2013 Documentation (CWP 2013).

To calculate PCB load reductions from inlet cleaning using the WTM, impervious area captured was estimated for inlets identified for cleaning within the MS4 area. Drainage areas to inlets have not been delineated, and therefore an assumption was made that each inlet captures a 0.25 acre drainage area. This assumption was based on the maximum drainage area to various inlet types as noted in SHA Field Guide for Erosion and Sediment Control (SHA 2013). Impervious area was estimated by multiplying the assumed drainage area by the average impervious for the land use type where the inlet is located. All inlets except for those located on the land use category woods were included. The inlets are cleaned annually. To be consistent with the WTM input option of semi-annual cleaning the total impervious captured was divided by two when entered into the WTM. The disposal discount was set to 1.0 based on descriptions provided in the WTM 2013 Documentation (CWP 2013).

A summary of the area of road to be swept, number of inlets to be cleaned and impervious area captured by inlets annually is provided by subwatershed in Table 27

Table 27: Planned Street Sweeping and Inlet Cleaning Summary

	Curtis Creek AACO	Baltimore Harbor AACO
Area of road swept monthly (acres)	165.1	59.6
Number of inlets to be cleaned	1221	804
Impervious area captured by inlets (acres)	81.7	117.1

Since street sweeping and inlet cleaning numbers represent one year of activity, the area inputs were multiplied by the number of years represented in each time step. Removal efficiencies were kept as the default WTM values.

The anticipated incremental PCB load reductions from non-structural practices are shown by time step in Table 28. The total estimated PCB load reduction from non-structural BMPs through 2025 is 12.95 g/year for Curtis Creek AACO and 26.79 g/year for Baltimore Harbor ACCO.

Continued progress towards meeting the PCB WLAs by 2025 and required reduction remaining are summarized in Table 29 with total reductions from non-structural BMPs subtracted from the WTM 2025 progress load with pond retrofits.

The Bureau of Highways provided an estimate of operational unit costs for both street sweeping and inlet cleaning to be approximately $120 per street mile swept (includes both sides of the street) and approximately $25 per inlet if cleaned by hand and $70 per inlet if cleaned mechanically. This estimate does not include acquisition cost of the street sweeper. Based on the number of miles of street sweeping and number of inlets to be cleaned, the cost for 10 years of the non-structural BMPs program is estimated to be between approximately $2.0M and $2.9M, with 10 years of street sweeping costing $1.5M and 10 years of inlet cleaning costing between $0.5M and $1.4M depending on whether inlets are cleaned by hand or mechanically. This estimate assumes the combined area of road swept monthly in acres is equivalent to 108 miles based on GIS analysis. Combining reductions from subwatersheds for a total of 39.74 g/year, the cost per gram of PCB load reduction from non-structural BMPs is estimated to be between approximately $52K and $73K. While much more cost-effective than the pond retrofits, the cost of reducing PCB loads via non-structural BMPs is still very high.

Table 28: Anticipated Incremental Reductions by Time Step for Non-Structural BMPs

	Incremental PCB Load Reduction from Time Step (g/year)			
	Curtis Creek AACO		**Baltimore Harbor AACO**	
Time Step	**Street Sweeping**	**Inlet Cleaning**	**Street Sweeping**	**Inlet Cleaning**
2017	2.49	0.10	4.60	0.76
2019	2.49	0.10	4.60	0.76
2021	2.49	0.10	4.60	0.76
2025	4.98	0.20	9.20	1.51
Total	**12.45**	**0.50**	**23**	**3.79**

Table 29: Progress towards meeting WLAs by 2025 from Pond Retrofits and Non-Structural BMPs

	Curtis Creek AACO (g/year)	**Baltimore Harbor AACO (g/year)**
WTM 2025 Progress Load with Pond Retrofits	248.31	439.83
WTM 2025 Progress Load with Pond Retrofits and Non-Structural BMPs	235.36	413.04
PCB WLAs	17.09	40.45
Required Reduction Remaining	218.27	372.59

The WTM results indicate PCB load reductions from planned street sweeping and inlet cleaning combined with reductions from pond retrofits will not be sufficient to meet the PCB WLAs.

Planned Strategy: The County will continue to implement and track the street sweeping and inlet cleaning as planned for in the Patapsco Tidal and Bodkin Creek Watershed Assessment. In addition, the County has a 2016-2017 milestone for the Chesapeake Bay TMDL to increase street sweeping frequency to bi-monthly. Future PCB load reduction accounting will incorporate this frequency increase as it is implemented. Based on the minimal PCB reductions gained from already planned street sweeping and inlet cleaning, the County does not propose expanding these non-targeted programs for the purpose of PCB load reductions. Instead, the County will focus additional PCB TMDL efforts on targeted PCB actions. However, if street sweeping and/or inlet cleaning efforts are further expanded as a result of other initiatives, additional PCB load reductions will be calculated and incorporated into future WTM updates.

4.4.3 Targeted PCB Actions and Projected Reductions

After implementing the structural and non-structural strategies through the 2025 time step, the required reductions remaining to meet the PCB WLAs are still significant for both Curtis Creek AACO and Baltimore Harbor AACO at 218.27 and 372.59 g/year respectively. This remaining reduction is not surprising as these strategies are comprised of the restoration efforts developed for the Patapsco Tidal and Bodkin Creek Watershed Assessment to achieve the Chesapeake Bay nutrient TMDLs which call for lesser percent reductions than the PCB TMDL. In addition, the very low PCB EMCs used in the WTM represent more diffuse PCB pollution and result in restoration project and programmatic efforts having a lesser impact on reducing pollutant loads than would be observed if more concentrated PCB pollution was addressed.

Rather than investing additional efforts in the structural and non-structural strategies that result in small reductions because it must be assumed that they address only diffuse PCB pollution, the County proposes to focus additional PCB TMDL specific efforts on the targeted PCB actions strategy. Targeted PCB actions look to address elevated, site-specific, and quantified levels of PCB pollution and will be relied upon to achieve the remaining reductions required to meet the PCB WLAs.

The targeted PCB actions strategy builds on the source tracking results and includes screening and monitoring, addressing PCB contaminated materials, and accounting for load reductions.

Screening and Monitoring

The source tracking desktop analysis completed as part of this restoration plan first identified sites within the subwatershed MS4 areas that have significant potential for PCB soil contamination and then prioritized BMPs with potential for PCB soil contamination based on land use and proximity to the identified sites. According to the MDE Recommendations for Addressing the PCB SW-WLA (MDE 2015d) guidance document, the next step is to monitor for PCBs at selected locations. MDE recommends the County apply best professional judgement to determine which sites should be monitored. Based on the potential of BMPs to accumulate PCBs in sediment and ease of access for monitoring, the County plans to first pursue structural BMPs and then look to specific identified sites as warranted.

MDE recommends that monitoring samples should be analyzed by EPA method 1668 for total PCBs. The analytical method EPA 1668 provides a breakdown according to PCB congeners, specific chemical compounds in the PCB category, and can be costly at $600-$700 per sample analysis (Biohabitats 2016). Many analytical laboratories offer discounts if multiple samples are processed.

Prior to monitoring at the level recommended by MDE, the County may choose to first screen locations for total PCBs using analytical EPA method 8082. This method is less sensitive than EPA 1668, but the cost for analysis is much less at $80 per sample, again with discounts offered for multiple samples (Biohabitats 2016). With the lower cost screening analysis, the County would be able to screen more BMPs and then advance to monitor select BMPs using the more rigorous recommended analytical method. This approach would maximize the County's ability to identify BMPs with elevated PCB levels.

MDE suggests collecting and testing one sediment sample in an area where fine sediments have accumulated before maintenance and sediment removal (MDE 2015d). The method for collecting sediment samples from BMPs should follow the guidance provided in EPA's 2001 "Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological

Analyses; Technical Manual" (EPA 2001). Sampling container and equipment used, volume of sediment collected, and sample storage, hold times, and temperatures should be in accordance with the requirements of the intended analytical method.

Screening and monitoring is an important step because minimal data is available regarding accumulated PCB concentrations in BMP sediments. Published research on the topic is limited to stormwater ponds in Arizona (Parker et al 2000). However, Parker et al (2000) found that PCBs were detected in all 24 stormwater control basins sampled. The concentrations detected were considerably variable with the maximum concentration more removed from the median values than for other pollutants such as metals. Given the ubiquity of PCB contamination in BMP sediment and the variability in detected concentrations, the proposed sequence of screening and then monitoring is the most efficient and cost-effective approach to locating elevated PCB concentrations within the subwatersheds.

Addressing PCB Contaminated Sediment

MDE recommendations indicate that based on monitoring results, the County should then decide whether remediation steps will be taken. For all BMPs in which PCBs are found above the detection limit, but below required mitigation levels, the County will document and justify its decision on whether remediation steps will be taken (MDE 2015d). In the absence of specific MDE mitigation levels for PCBs in BMPs, the County will use the MDE VCP cleanup standards for comparison of screening and monitoring results.

In the case of BMPs, the most common option for addressing PCB contaminated sediment is removal through excavation or dredging and disposal of the contaminated sediment at an appropriate facility. With removal of sediment, the County is then able to account for the PCB load reduction. Other options include capping, as well as employing cutting-edge techniques for in-situ remediation using PCB degrading bacteria or fungi. In order to account for PCB load reductions from non-removal options, the County would need to document and validate PCB load reductions for MDE approval. The County plans to stay abreast of technological developments in remediating PCBs and plans to consider incorporating new methods that prove to be cost-effective and feasible as they become available.

Cost of disposal and available disposal options for PCB contaminated sediment would depend on the concentration of PCBs. As part of the targeted PCB actions strategy, the County plans to investigate acceptable disposal options such as the County landfill or commercial waste handling facilities, acceptable relocation methods, as well as any permitting requirements for addressing PCB contaminated sediment. Based on estimated disposal cost, the County plans to develop an approach for addressing PCB contaminated sediment that most cost-effectively maximizes PCB load reductions.

Generally the party responsible for the contamination pays for cleanup. As such, the County plans to make every effort to identify the party responsible for the release and hold the party liable. Additional source tracking, working in the upstream direction from the BMP, may be required and may involve desktop analysis and/or field verification. The County and/or responsible party may pursue working through the MDE VCP on site cleanup if a specific source of PCBs is located. A BMP with elevated sediment PCB concentrations would not be considered a source, but may lead to locating a hot spot source contributing to continued environmental release of PCBs within the BMP drainage area.

Accounting for PCB Load Reductions

MDE provides specific recommendations for accounting for load reductions when PCB contaminated sediment is removed and properly disposed of at encapsulated or contained facility. The County may take credit for removal of PCB contamination equal to the product of the sediment PCB concentration and the volume of sediment removed (MDE 2015d).

Planned Strategy: The County will develop a plan for carrying out targeted PCB actions. The proposed elements of the plan include:

- Number of BMPs to be screened annually.
- Criteria for selecting a BMP for more rigorous MDE recommended monitoring.
- Identification of specific disposal facilities for contaminated sediment along with the criteria for facility acceptance and unit cost for disposal.
- Decision framework for determining which BMPs will be remediated as screening and monitoring results become available and a timeframe for completion.

This plan will form the basis for a budget request to fund the proposed activities. The County also plans to work to integrate PCB screening, monitoring, and contaminated sediment removal efforts with the ongoing BMP maintenance program run through the Bureau of Highways that services County-maintained BMPs with mowing, inspection, and general maintenance. In addition, the County plans to investigate the potential for incorporating PCB screening, monitoring, and contaminated sediment removal efforts with ongoing stormwater retrofit projects. In this case, there would be potential for the pond retrofit projects to reduce PCB loads through improved removal efficiency as well as a site-specific and quantified PCB load reduction from contaminated sediment removal.

Projected Reduction

Based on the planned strategies, this restoration plan projects that the targeted PCB actions will achieve the remaining required reductions to meet the WLA. Screening and monitoring is required to identify the specific BMPs to be targeted for PCB contaminated sediment removal. As such, it is not possible to estimate the reductions from specific removal actions that will be carried out in the future. Instead, based on some simplifying assumptions regarding PCB concentrations in sediment, an estimated range of required remediation effort is calculated for each subwatershed.

The required remediation effort range is then evaluated for feasibility based on the number of existing BMPs and total drainage areas, specifically looking at prioritized BMPs. The efforts required to carry out the targeted PCB actions strategy are then reasonably distributed across the time steps to roughly approximate the anticipated PCB load reductions by time step.

PCB concentrations in stormwater detention basin sediments sampled in Parker et al (2000), ranged from 1-2000 ug/kg with a median value of 6 ug/kg and mean value of 21 ug/kg, excluding the outlier of 2000 ug/kg. Another PCB concentration of interest is the residential clean up standard for MDE VCP of 320 ug/kg for total PCBs. Assuming a sediment density of 1.5 US tons per cubic yard (yd^3), the estimated removal effort for the targeted PCB actions to meet the WLA is shown in Table 30 for Curtis Creek AACO and Table 31 for Baltimore Harbor AACO. In addition to volume for removal, the tables also present an estimate of the surface area of BMPs that would need to be remediated based on an assumed removal depth of 1ft.

Table 30: Estimated Removal Effort for Targeted PCB Actions to Meet Curtis Creek AACO PCB WLA Based on a Range of PCB Concentrations

	PCB concentrations of interest to demonstrate range of efforts.		
Concentration of PBC in Sediment (ug/kg)	6	21	320
Estimated volume of sediment needing to be remediated (yd^3)	27,000	7,600	500
Area to be remediated (acres)*	16.6	4.7	0.3
*Assuming 1ft depth of contaminated sediment removed.			

Table 31: Estimated Removal Effort for Targeted PCB Actions to Meet Baltimore Harbor AACO PCB WLA Based on a Range of PCB Concentrations

	PCB concentrations of interest to demonstrate range of efforts.		
Concentration of PBC in Sediment (ug/kg)	6	21	320
Estimated volume of sediment needing to be remediated (yd^3)	46,000	13,000	900
Area to be remediated (acres)*	28.3	8.1	0.5
*Assuming 1ft depth of contaminated sediment removed.			

The higher the PCB concentration in the sediment, the smaller the total volume of sediment that will need to be remediated. As such, finding BMPs with more elevated PCB concentrations will be important to cost-effectively reducing PCB loads.

There are 36 and 11 priority 1 and 2 BMPs identified in Section 3.3.2 which include dry ponds, dry ponds with extended dry detention, and wet ponds in Curtis Creek AACO and Baltimore Harbor AACO, respectively. These priority BMPs drain 905 acres in Curtis Creek AACO and 320 acres in Baltimore Harbor AACO. Assuming the surface area of BMPs available for remediation is 2% of the total drainage area, there are 18.1 acres of priority BMPs in Curtis Creek AACO and 6.4 acres of priority BMPs in Baltimore Harbor AACO. Even at a PCB concentration of 6 ug/kg, there is sufficient area of BMPs available to be remediated in Curtis Creek AACO to meet the PCB WLA.

For Baltimore Harbor AACO, at a PCB concentration of 6 ug/kg, there is insufficient area available to meet the WLA. When expanding the BMPs considered to include all dry ponds, dry ponds with extended dry detention, and wet ponds within Baltimore Harbor AACO, the available area increases to 16.4 acres. This is sufficient for a PCB concentration of 21 ug/kg, but still short of what is needed at lower PCB concentrations. Meeting the Baltimore Harbor AACO PCB WLA through the targeted PCB actions will depend on the identification of BMPs within the subwatershed with higher PCB levels.

Based on the estimated range of removal efforts required and the available BMP area, it is feasible and anticipated that the targeted PCB actions will reduce PCB loads to achieve the WLAs. However, the PCB load reduction potential ultimately depends on the level of PCBs that have accumulated in the BMPs in each subwatershed. If the screening and monitoring efforts fail to locate ponds with elevated PCB levels, the County will re-evaluate the planned strategies and make adjustment as necessary to ensure the WLAs can and will be met. Moreover, the planned strategies rely heavily on the targeted PCB actions under the reasonable assumption that removing more concentrated PCBs will be more cost-effective than addressing more diffuse pollution. If after initial implementation of the targeted PCB actions plan, the County anticipates

or finds the targeted PCB action reductions to be less cost-effective than the structural BMPs or non-structural BMPs, the County will re-evaluate the planned strategies and make adjustments as necessary.

A rough estimate for PCB load reductions by time step from the targeted PCB actions strategy is shown in Table 32 which also includes explanation of actions that would likely take place during the time step. These estimates will be revised as needed as the targeted PCB actions strategy is implemented. Progress towards meeting the WLA by 2025 through implementation of the targeted PCB actions in addition to the pond retrofits and non-structural BMPs are summarized Table 33.

Table 32: Anticipated Incremental Reductions by Time Step for Non-Structural BMPs

	Incremental PCB Load Reduction from Time Step (g/year)		**Actions likely taking place during time step.**
Time Step	**Curtis Creek AACO**	**Baltimore Harbor AACO**	
2017	0	0	Targeted PCB Actions Plan development and beginning screening and monitoring process.
2019	54.57	93.15	Finalize Targeted PCB Actions Plan. Continued screening and monitoring and beginning remediation of selected BMPs accounting for 1/4 of required reduction remaining.
2021	109.14	186.30	Screening and monitoring complete. Concerted efforts in remediation of selected BMPs accounting for 1/2 of required reduction remaining.
2025	54.57	93.15	Complete remediation of selected BMPs accounting for 1/4 of required reduction remaining
Total	**218.27**	**372.60**	

Table 33: Progress towards meeting WLAs by 2025 from Pond Retrofits Non-Structural BMPs, and Targeted PCB Actions

	Curtis Creek AACO (g/year)	**Baltimore Harbor AACO (g/year)**
WTM 2025 Progress Load with Pond Retrofits and Non-Structural BMPs	235.36	413.04
Progress Load with Pond Retrofits and Non-Structural BMPs and Targeted PCB Actions	17.09	40.45
PCB WLAs	17.09	40.45
Required Reduction Remaining	0	0

5 Expected Load Reductions and Cost Estimates

5.1 Summary of Estimated Load Reductions

Sections 4.4.1 through 4.4.3 calculated the load reductions from the planned restoration strategies for structural BMPs, non-structural BMPs, and targeted PCB actions. The incremental reductions are summarized in Table 34 and Table 35 for Curtis Creek AACO and Baltimore Harbor AACO respectively. Figure 8 and Figure 9 illustrate the cumulative reduction as well as the percent reductions achieved at each time step relative to the required percent reduction.

Table 34: Summary of Incremental PCB Reductions for Curtis Creek AACO

	Completed	Planned Strategies				
Time Step	PCB load reduction from BMPs added between 2011 and 2015 (g/year)	PCB load reduction from Structural BMPs (g/year)	PCB load reduction from Non-Structural BMPs (combining street sweeping and inlet cleaning) (g/year)	PCB load reduction from Targeted PCB Actions (g/year)	Total PCB load reduction for time step (g/year)	Percent of overall reduction required from 2011 Baseline (245.8 g/year)
2015 Progress	0.8	-	-	-	0.8	0.3%
2017	-	8.79	2.59	0	11.4	4.6%
2019	-	3.81	2.59	54.57	61.0	24.8%
2021	-	0.37	2.59	109.14	112.1	45.6%
2025	-	0.81	5.18	54.57	60.6	24.7%
Total	0.8	13.78	12.95	218.27	245.8	100%

Table 35: Summary of Incremental PCB Reductions for Baltimore Harbor AACO

	Completed	Planned Strategies				
Time Step	PCB load reduction from BMPs added between 2011 and 2015 (g/year)	PCB load reduction from Structural BMPs (g/year)	PCB load reduction from Non-Structural BMPs (combining street sweeping and inlet cleaning) (g/year)	PCB load reduction from Targeted PCB Actions (g/year)	Total PCB load reduction for time step (g/year)	Percent of overall reduction required from baseline (414.1 g/year)
2015 Progress	1.22	-	-	-	1.2	0.3%
2017	-	1.76	5.36	0	7.1	1.7%
2019	-	6.24	5.36	93.15	104.8	25.3%
2021	-	0	5.36	186.30	191.7	46.3%
2025	-	5.5	10.71	93.15	109.4	26.4%
Total		13.5	26.79	372.60	414.1	100%

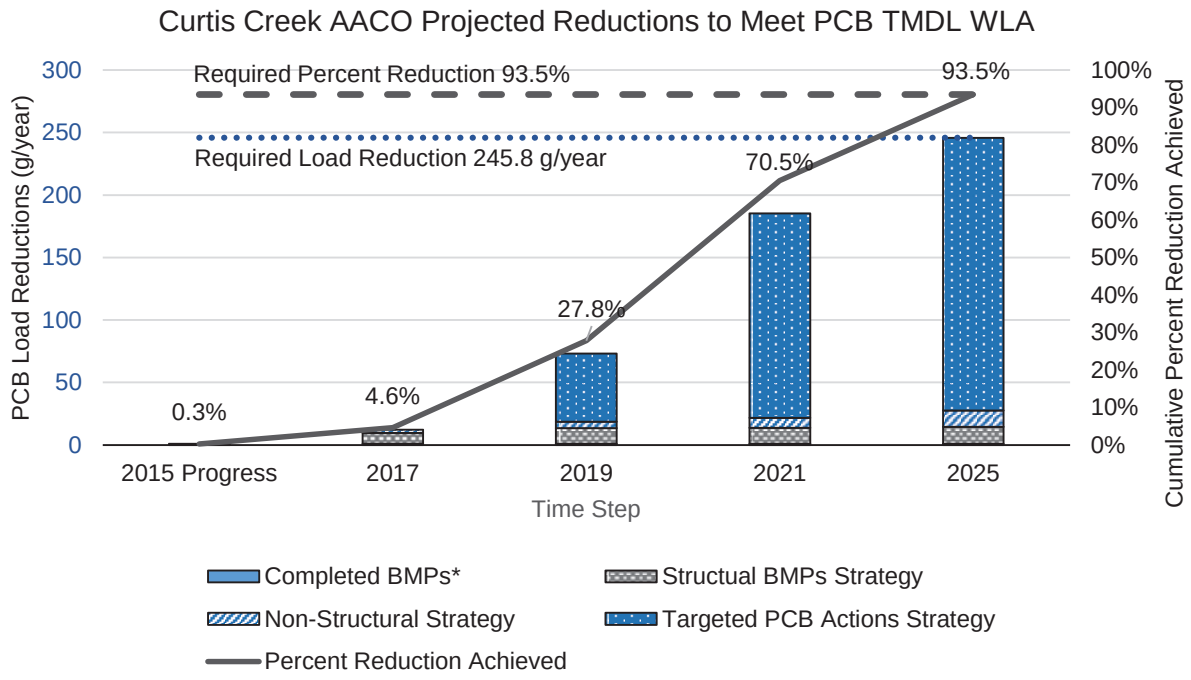


Figure 8: Graphical Illustration of Projected PCB TMDL Progress for Curtis Creek AACO

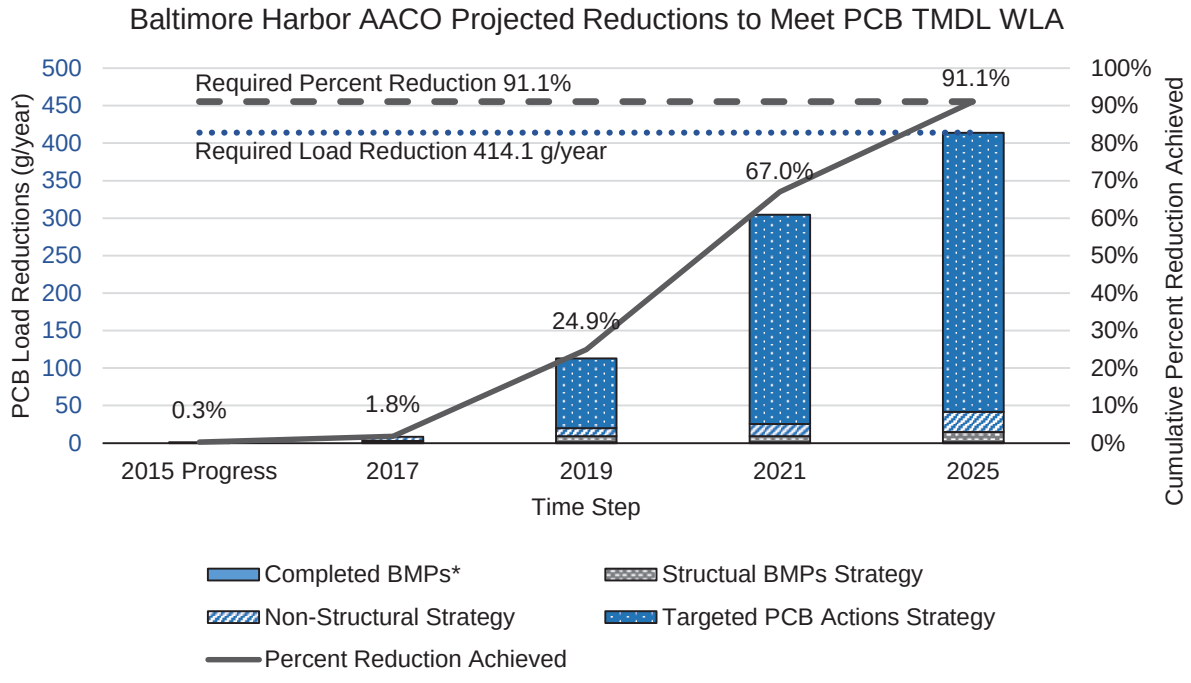


Figure 9: Graphical Illustration of Projected PCB TMDL Progress for Baltimore Harbor AACO

*Reductions from Completed BMPs for both subwatersheds are small compared to the restoration plan strategy reductions and therefore are not as visible on the figures. Completed BMPs account for the 0.3% reduction at the 2015 Progress Time Step for both subwatersheds.

The most significant PCB load reductions are anticipated from the targeted PCB actions strategy with structural and non-structural BMP strategies contributing relatively small reductions. Based on the projected implementation, the most significant percent reduction is anticipated at the 2021 time step representing efforts from 2019-2021. These trends apply to both subwatersheds.

5.2 Cost Estimates

The overall cost estimate for meeting the PCB WLAs is calculated as the sum of the individual cost estimates for each of the three strategies.

Structural BMP Strategy

The costs associated with the structural BMP strategy are based on the preliminary costs presented in the Patapsco Tidal and Bodkin Creek Watershed Assessment. The watershed assessment estimates $22.4M for pond retrofits. This point estimate is broadened to a range of $20M-$30M to develop an upper and lower estimate for the structural BMP strategy.

- **Total of $20M-30M for structural BMP strategy**

Non-structural BMP Strategy

The costs associated with the non-structural BMP strategy were estimated based on operational cost estimates provided by the Bureau of Highways. The unit cost estimates are as follows:

- Approximately $120 per mile of street swept (includes both sides of the street)
- Approximately $25 per inlet cleaned by hand and $70 per inlet cleaned mechanically

This estimate does not include acquisition cost of the street sweeper. The implementation time frame through 2025 represents approximately 10 years of program implementation. Multiplying the miles of road swept annually (108 miles per month x 12 months) and inlets cleaned annually (2025) by 10 years results in a total of 12,960 miles of street swept and 20,250 inlets cleaned. This assumes the combined area of road swept monthly in acres is equivalent to 108 miles based on GIS analysis. The estimated cost for implementing the non-structural BMP strategy through 2025 is:

- $1.5M for street sweeping
- $0.5M to $1.4M for inlet cleaning
- **Total of $2.0M-$2.9M for non-structural BMP strategy**

Targeted PCB Actions

The costs associated with the targeted PCB actions strategy depend heavily on the screening and monitoring plan to be developed as well as the costs for remediation that are contingent on the concentrations of PCBs detected. To develop a cost estimate, fixed costs and variable costs are considered separately. All costs described are rough order of magnitude estimates for the purpose of this restoration plan and are subject to significant revision in the future.

The fixed costs associated with the strategy would include development and ongoing updating of the strategy plan and program administration and documentation. Given a 10-year program horizon, fixed costs are roughly estimated to be between $600K and $1.4M, assuming plan development and updating costs within $100K-$400K and program administration and documentation costs within $500K-$1M.

The variable costs associated with the strategy would include screening and monitoring efforts along with remediation efforts. Screening and monitoring costs would involve labor to collect the samples and laboratory analytical cost. This assumes coordination and interpretation of results are covered by program administration fixed costs. An upper bound on the screening and monitoring costs is estimated to be $620K. This assumes $800 per BMP in analytical costs, $1600 per BMP in labor costs with screening and monitoring carried out at all 260 BMPs with the subwatershed MS4 area that are dry ponds, dry ponds with extended dry detention, and wet ponds.

Remediation costs would involve project planning and authorization, construction, disposal, and close-out. This assumes higher-level coordination and documentation are covered by program administration fixed costs. Since these costs are highly dependent on the magnitude of the required remediation, an estimate is not developed. Rather, a metric for cost-effectiveness is proposed by which to evaluate potential targeted PCB actions.

Potential targeted PCB actions should be considered for implementation if they are at least as cost-effective as the next best alternative. The alternatives for PCB reductions include the structural BMPs and non-structural BMPs strategies. Of the two alternatives, the most cost-effective PCB reduction comes from the non-structural BMPs strategy at between $52K and $73K per gram of PCB removed. This range for cost per gram of PCB reduction should be metric against which potential targeted PCB actions are evaluated. It should be noted however, that PCB reductions from the non-structural BMPs strategy may eventually be limited by miles of street and number of inlets present within the subwatersheds. Thus, in addition to cost, feasibility of the next best alternative should also be considered when evaluating potential targeted PCB actions.

Overall Cost Estimate to Achieve the PCB TMDL WLAs

The overall cost estimate as the sum of the individual strategy costs are represented by the equation below:

$$\begin{Bmatrix} \boldsymbol{Structural\ BMP\ Strategy} \\ \$20M - \$30M \end{Bmatrix}$$

$$+ \begin{Bmatrix} \boldsymbol{Non - Structural\ BMPs\ Strategy} \\ \$2.0M - \$2.9M \end{Bmatrix}$$

$$+ \begin{Bmatrix} \boldsymbol{Targeted\ PCB\ Actions\ Strategy} \\ (\$0.6M - \$1.4M) + 0.6M + (Remediation\ Costs) \end{Bmatrix}$$

- **Overall cost estimate range: $23.2M to $34.9M + (Remediation Costs)**

In the unlikely event that targeted PCB actions are less cost-effective than the alternatives, or there is insufficient contaminated sediment to remove, the remaining required reductions, would have to be achieved through the non-structural and structural BMPs strategies at a cost of between $52K-$73K and $1.1M per gram of PCB reduction.

6 Implementation Schedule and Milestones

6.1 Implementation Schedule and Milestones

Similar to estimated costs, the overall implementation schedule is a combination of the schedules for implementing each of three restoration plan strategies as presented in Sections 4.4.1-4.4.3.

Funding is allocated for 71 of 94 structural BMP stormwater pond retrofits. Projected completion dates were used in assigning each project to a time step. However, actual completion dates may vary due to project delays or other complications. This may cause the reductions to shift to later time steps. Additionally, the 23 projects not already allocated funding as of FY2016 budget were assigned to the 2025 time step. Some of these projects may extend beyond 2025 for completion or may be ultimately eliminated due to infeasibility, high costs, or other reasons.

The Non-Structural BMPs strategy assumes a constant implementation effort for street sweeping and inlet cleaning over ten years based on routes and inlets identified in the Patapsco Tidal and Bodkin Creek Watershed Assessment. Actual implementation may vary due to unpredicted mechanical issues or funding changes. Also initial estimated load reductions could be revised if additional information becomes available that enables refining the conservative assumption of drainage area caught by each inlet. In general, implementation of the Non-Structural BMPs strategy should result in a fairly consistent annual reduction through 2025 and beyond as the County DPW's street sweeping and inlet cleaning program is anticipated to continue into the foreseeable future.

The Targeted PCB Actions strategy implementation schedule assumes availability of funding and timely review and acceptance of this restoration plan to initiate targeted PCB action plan development. Once the plan is developed, it is anticipated the screening and monitoring can be completed within several years. Implementation of remediation will be dependent on the availability of funding and actual time required to carry out remediation which is likely to vary by project. The schedule proposed in 4.4.3 assumes funding will be available to cover remediation efforts that will conclude by 2025 and reduce PCB loads to meet the WLA. There are numerous assumptions and unknowns at this point which may cause the remediation activities to extend beyond the 2025 time frame proposed.

The Baltimore Harbor PCB TMDL does not establish specific milestones or a timeframe in which the TMDL WLAs must be met. In accordance with the MS4 permit reporting requirements (Part V. A.e), the County plans to provide an annual update on progress towards attaining the PCB TMDL WLA, implementation status of the PCB TMDL restoration plan, and will make adjustments to the planned strategies as needed. The County plans to carry out a more comprehensive assessment of the effectiveness of this restoration plan in 2025, the timeframe for meeting the Chesapeake Bay TMDL, and complete additional modeling or make adjustments to the plan as needed to achieve any reductions remaining to meet the WLA. The County also plans to maintain communication with other jurisdictions working towards achieving PCB TMDL WLAs to share knowledge and information to further improve and accelerate the implementation.

The County proposes two-year PCB load goal milestones through 2025 as shown in Table 36. The milestones loads are based on reductions from Structural BMPs and Non-Structural BMPs strategies only. Numerical reductions from targeted PCB actions are currently omitted from the since the proposed implementation schedule hinges on too many uncertainties to comfortably

include in the reductions in the milestones. However, completion of specific activities are noted along with the milestone loads to ensure the Targeted PCB Actions strategy is implemented.

Table 36: PCB TMDL WLA Goal Milestones

Milestone	Curtis Creek AACO – Goal PCB Load g/year	Baltimore Harbor AACO – Goal PCB Load g/year	Targeted PCB Actions – Activities
2017	233.62	405.78	Targeted PCB Actions Plan Initiated
2019	227.22	394.18	Targeted PCB Actions Plan Complete
2021	224.26	388.82	Screening and Monitoring Complete
2023*	221.67	383.46	
2025	218.27	372.60	
* Milestone loads at 2023 only include reductions only from Non-Structural BMPs strategy.			

6.2 Potential Funding Sources and Technical Needs

Cost estimates for each of three restoration plan strategies are presented in Section 5.2 and represent the financial needs of the County to meet the WLAs. In addition to providing specific dollar value estimates where possible, Section 5.2 also identified actions for which actual costs must be estimated in the future once additional information is gathered.

Watershed restoration efforts are primarily funded through the Watershed Protection and Restoration Fee/Fund (WPRF). Additional information regarding the WPRF can be found in the County's Annual MS4 Reports. The WPRF has provided funding for the 71 structural BMP stormwater pond retrofits already budgeted. A portion of the street sweeping and inlet cleaning is also funded through the WPRF in addition to the general DPW budget allocation. The WPRF will be relied upon as the primary funding source for carrying out the targeted PCB actions strategy. Additional funding sources for the targeted PCB actions strategy may also include any identifiable responsible parties. Outside of the WPRF, the County may seek financial support for PCB TMDL related activities through actively pursuing grant funding from federal, states, and non-governmental agencies.

Technical needs to meet the PCB TMDL WLAs depend on the specific activities required by each strategy. According to MDE guidance document, Final General Guidance for Developing Stormwater Wasteload Allocations (SW-WLA) Implementation Plan, MDE offers technical assistance to local governments through training, outreach and tools, and technical review and assistance of implementation of BMPs at the local level (MDE 2015c). In addition, the County has several contract vehicles available to contract with consultants to provide a variety of technical services. County DPW staff actively manage consultant contracts, review and approve plans and designs, carry out assessment, and track progress among many other tasks. Through contracting consultants, the County's staff has access to the additional technical support provided by planners, engineers, environment scientists and GIS specials.

6.3 Public Outreach and Involvement

The County supports a robust public outreach and involvement program as part of its Watershed Protection and Restoration Program. Specifics of the County's MS4 public outreach efforts are documented in the County's MS4 Annual Reports available on the County's website. Citizen education through public outreach and involvement reduces stormwater pollution by encouraging improved behavioral habits and providing support for small scale projects. This restoration plan does not account for PCB load reductions from public outreach and involvement activities.

Requirements for public involvement in the development of TMDL restoration plans are outlined in Part 4.E.3 of the County's MS4 permit. The County will fulfill these requirements by providing notice in a local newspaper outlining how the public may obtain information on the development of this restoration plan and opportunities for comment. The County will have a procedure for providing copies of this restoration plan to parties upon request. The County will allow for a minimum 30-day comment period before finalizing this restoration plan and will include a summary in the next annual report of how the County addressed or will address any material comment received from the public.

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Appendix A: Conversion of Event Mean Concentrations from TSS to PCBs

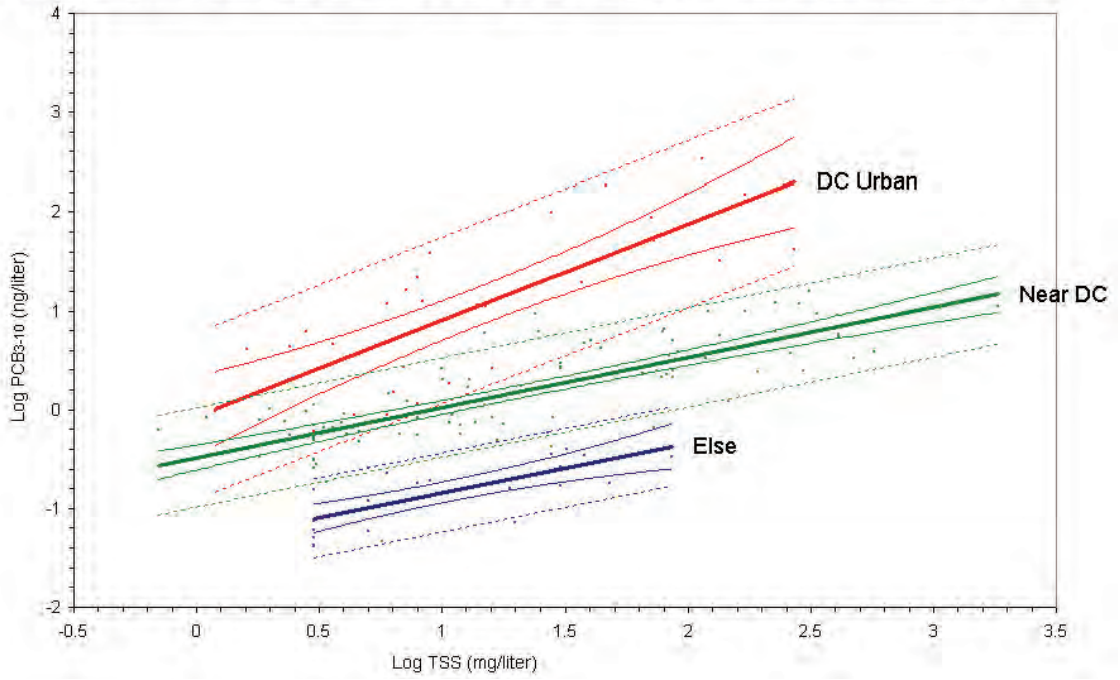
Event mean concentrations (EMCs) are important input components of the Watershed Treatment Model (WTM) that represent pollutant loading and are used in total load and load reduction calculations. Since limited data is available regarding PCB concentrations in urban stormwater runoff there are no available default values to use for PCB EMCs. As such, PCB EMCs were estimated by converting TSS EMCs. This conversion was based on the relationship between concentrations of TSS and PCBs documented in Appendix A of the Tidal Potomac and Anacostia River PCB TMDL (Haywood and Buchanan 2007) calculating PCB external loads for the Potomac PCB model.

The Tidal Potomac and Anacostia River PCB TMDL developed three regressions, one for each watershed-based zone including DC Urban, Near DC, and Else. The regressions relate concentration of TSS (mg/L) with the concentration of PCB3+ (ng/L), a subset of total PCBs, according to the following equations.

Zone	Regression Equation	Correlation Coefficient (r^2) and number of samples (n)
DC Urban	[PCB3+] = 0.855 [TSS]$^{0.9702}$	0.61 (n=30)
Near DC	[PCB3+] = 0.3290 [TSS]$^{0.5059}$	0.63 (n=94)
Else	[PCB3+] = 0.0458 [TSS]$^{0.5008}$	0.52 (n=25)

Figure A-7 excerpted from Appendix A of the Tidal Potomac and Anacostia River PCB TMDL and shown below illustrates the regression equations and underlying data. DC Urban has the steepest regression, followed by Near DC, and Else resulting in significantly different [PCB3+] estimates when inputting the same TSS concentration into all three regressions.

Figure A-7. The TSS:PCB3+ regressions with their underlying data. Symbols: DC Urban, red squares and thick line; Near DC, green diamonds and thick line; Else, dark blue triangles and thick line; thin solid lines, 90th% confidence interval around the slopes; dashed lines, 90th% confidence intervals around the individual estimates of PCB3+ (prediction interval). See text for details. Note the scale is log-log.



The TSS EMCs converted using the above equations were those provided in the Patapsco Tidal and Bodkin Creek Watershed Assessment that have been compiled from literature sources or calculated directly from export coefficients used by the Chesapeake Bay Program (CBP) and are conservatively set to be equal to or greater than the values used by the CBP (Anne Arundel County 2012).

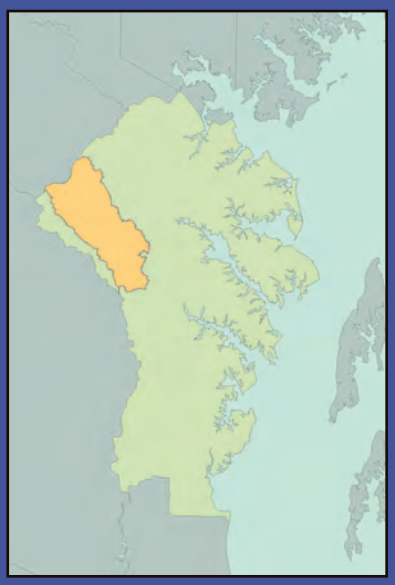
The regression used for each EMC was based on the land use type. Land uses where PCBs were historically used were assigned the DC Urban regression and all other land uses were assigned the Near DC regression.

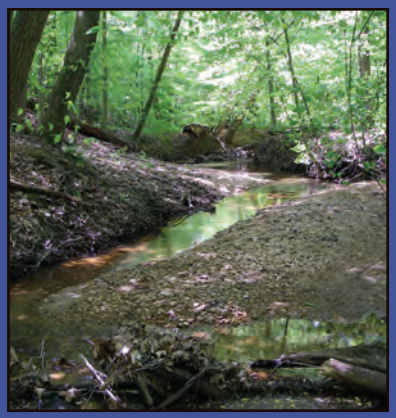
The table below summarizes the land use, original TSS EMC, regression used, resulting EMC in terms on PCB3+ and the resulting EMC in terms of total PCBs. Values in terms of [PCB3+] are translated to total PCBs by dividing by 0.92. (See Appendix B of the Tidal Potomac and Anacostia River PCB TMDL for additional explanation regarding relationship between PCB3+ and total PCBs.) Note, unless otherwise specified, the term PCBs refers to total PCBs.

Land Use	**TSS EMC (mg/L)**	**Regression**	**PCB3+ EMC (ng/L)**	**PCB EMC (ng/L)***
Residential 1-acre	43	Near DC	2.21	2.39
Residential 1/2-acre	43	Near DC	2.21	2.39
Residential 1/4-acre	43	Near DC	2.21	2.39
Residential 1/8-acre	43	Near DC	2.21	2.39
Residential 2-acre	43	Near DC	2.21	2.39
Commercial	43	DC Urban	32.87	35.72
Airport	99	Near DC	3.36	3.66
Transportation	99	Near DC	3.36	3.66
Utility	34	DC Urban	26.17	28.44
Open Space	34	Near DC	1.96	2.12
Industrial	77	DC Urban	57.84	62.87
* PCB EMCs are expressed in ng/L for ease of comparison, however, the values are entered into the WTM as mg/L.				

Following the conversion of the TSS EMCs to PCB EMCs as detailed above, the values were further adjusted using a multiplier to calibrate the WTM as described in Section 4.1.









Little Patuxent River Sediment TMDL Restoration Plan

Anne Arundel County, Maryland
February 2016

Anne Arundel County WATERSHED Protection & Restoration PROGRAM

Little Patuxent River
Sediment TMDL Restoration Plan

February 2016

Prepared for:

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Appendices

Appendix A	Little Patuxent Project List
Appendix B	Response to MDE Comments on Draft Plan

List of Acronyms

AAWSA	Anne Arundel Watershed Stewards Academy
BayFAST	Chesapeake Bay Facility Assessment Scenario Tool
BMP	Best Management Practices
BSID	Biological Stressor Identification
CBP	Chesapeake Bay Program
CIP	Capital Improvement Program
EOS	Edge of Stream
H&H	Hydrologic and Hydraulic
LULC	Land use / Land cover
MAST	Maryland Assessment Scenario Tool
MDE	Maryland Department of the Environment
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
OSDS	On-site Disposal Systems
SPSC	Step Pool Storm Conveyance
SW to MEP	Stormwater to the Maximum Extent Practicable
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
WIP	Watershed Implementation Plan
WPRP	Watershed Protection and Restoration and Program

1 Introduction

1.1 Background and Purpose

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

Under the Federal Clean Water Act (CWA), the State of Maryland is required to assess and report on the quality of waters throughout the state. Where Maryland's water quality standards are not fully met, Section 303(d) requires the state to list these water bodies as impaired waters. States are then required to develop a TMDL for pollutants of concern for the listed impaired waters. The Little Patuxent River watershed has several impaired waters listings in Maryland's Integrated Report of Surface Water Quality [303(d) list and 305(b) Report] including nutrients, sediment, heavy metals, *Escherichia coli*, and polychlorinated biphenyls (PCBs). There are currently three final approved TMDLs within the Little Patuxent; a total suspended solids (TSS; sediment) TMDL from urban stormwater sources approved in 2011, a sedimentation/siltation TMDL from agricultural sources approved in 2002, and a phosphorus TMDL from agricultural sources approved in 2002. These TMDLs apply to several jurisdictions including Howard, Prince Georges, and Anne Arundel Counties. This plan will specifically address the Little Patuxent sediment TMDL under the responsibility of Anne Arundel County. The sedimentation/siltation and phosphorus TMDLs are being addressed by Anne Arundel County in separate plans.

Responsibility for Little Patuxent sediment reduction is divided among the contributing jurisdictions, listed above. The TMDL loading targets, or allocations, are also divided among the pollution source categories, which in this case includes non-point sources (termed load allocation or LA) and point sources (termed waste load allocation or WLA). The WLA consists of loads attributable to regulated process water or wastewater treatment, and to regulate stormwater. For the purposes of the TMDL and consistent with implementation of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Discharge Permit (MS4), stormwater runoff from MS4 areas is considered a point source contribution.

Anne Arundel County's current MS4 permit (11-DP-3316, MD0068306) issued in its final form by the MDE in February of 2014 requires development of restoration plans for each stormwater WLA approved by EPA prior to the effective date of the permit (permit section IV.E.2.b). This plan satisfies this permit requirement and provides the loading target, recommended management measures, load reduction estimates, schedule, milestones, cost estimates and funding sources, and the tracking and monitoring approaches to meet the stormwater WLA (SW-WLA).

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

This plan demonstrates that Anne Arundel County will meet its sediment SW-WLA for the Little Patuxent River Watershed by 2025. The strategies proposed will provide treatment to reduce current sediment loads from the urban stormwater sector.

1.2 TMDL Allocated and Planned Loads Summary

The following Restoration Plan only addresses loads allocated to Anne Arundel County NPDES regulated stormwater point source sediment. Additional SW-WLAs for the Little Patuxent watershed TMDL assigned to Howard County, Maryland State Highway Administration, and other NPDES regulated stormwater are not the responsibility of Anne Arundel County and will not be addressed in this plan. A large section of Fort George G. Meade, a federal property owned by the U.S. Army, is located in the central portion of the watershed. Pollutant loads from Fort Meade are the responsibility of the federal government and are not addressed in this plan.

The Little Patuxent watershed TMDL requires a 20.5% reduction of sediment loads from 2005 baseline levels to achieve the target SW-WLA for Anne Arundel County NPDES regulated stormwater. A planning horizon of 2025 will be used as the date to achieve these load reductions with 2017 proposed as a milestone to assess progress.

Based on MDE guidance, growth in the stormwater load since the TMDL baseline year was not accounted for in the analysis conducted in the development of this plan. Local TMDLs are considered met, from a planning perspective, when the load reductions associated with 2015 restoration progress coupled with the planned restoration load reductions exceed the load reduction required.

This section of the plan, including Table 1, provides a concise summary of the loads and reductions at important timeline intervals including the 2005 baseline, 2015 progress, 2017 milestone and 2025 final planning intervals. These terms and dates are used throughout the plan and explained in more detail in the following sections. They are presented here to assist the reader in understanding the definitions of each, how they were derived, and to provide an overall summary demonstrating the percent reduction required and percent reduction achieved through full implementation of this plan. Sediment loads and wasteload allocations are presented as tons/year in the local TMDL but will be discussed as lbs/year in this restoration plan.

- **2005 Baseline Loads**: Baseline levels (i.e., land use loads with baseline BMPs) from 2005 conditions in the Lower Patuxent watershed using the Chesapeake Bay Facility Assessment Scenario Tool (BayFAST) Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) model. Baseline loads were used to calculate the stormwater allocated sediment loads, or SW-WLA.
- **2015 Progress Loads and Reductions**: Progress loads and load reductions achieved from stormwater best management practice (BMP) implementation through 2013. The 2015 Progress Loads are calculated from the 2005 Baseline Loads by the following calculations: 2005 Baseline – 2015 Progress Reduction.
- **2017 Interim Milestone Goal Loads and Planned Loads and Reductions**: Planned 2017 loads and reductions will result from implementation of strategies through 2017. The 2017 Planned Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 Baseline – 2017 Planned Reduction.
- **2025 Allocated Load**: Allocated loads are calculated from the 2005 baseline levels, calibrated to CBP P5.3.2 as noted above, using the following calculation: 2005 Baseline – (2005 Baseline x 0.205); or, 2005 Baseline x (1 – 0.205).

- **2025 Planned Loads and Planned Reductions**: Loads and reductions that will result from implementation of this plan. The 2025 Planned Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 – 2025 Planned Reduction.

Table 1: Little Patuxent Local TMDL Allocated and Planned Loads

	Sediment (tons/year)	Sediment (lbs/year)
2005 Baseline Loads	604	1,207,534
2015 Progress Loads	521	1,042,473
2015 Progress Reductions	83	165,061
2017 Planned Loads*	493	986,043
2017 Planned Reductions	111	221,491
2025 TMDL Allocated Loads	480	959,989
2025 Planned Loads*	390	779,873
2025 Planned Reductions	214	427,661
Required Percent Reduction	20.5%	20.5%
Planned Percent Reduction Achieved	35.4%	35.4%

*2017 and 2025 planned loads are calculated by subtracting planned restoration sediment reductions from the 2005 Baseline Load. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal.

1.3 Restoration Plan Elements and Structure

This plan is developed within the context of on-going watershed management planning, restoration, and resource protection being conducted by Anne Arundel County. The County initiated comprehensive watershed assessment and management plans in 2000 and has currently completed plans for seven of the 12 major watersheds. A draft comprehensive watershed assessment for the Little Patuxent watershed is currently underway with expected completion at the beginning of 2015. The County also prepared a Phase II Watershed Implementation Plan (WIP) in 2012 in response to requirements set forth in the Chesapeake Bay TMDL for nitrogen, phosphorus and sediment. Information synthesized and incorporated into this plan for the Little Patuxent watershed draws upon these sources with updates and additions where necessary to meet the specific goals of the SW-WLA. The TMDL analyses and reports developed by MDE are also referenced. These primary sources include:

- Little Patuxent River Watershed Assessment Comprehensive Summary Report (Anne Arundel County, 2014 DRAFT)
- Chesapeake Bay TMDL, Phase II Watershed Implementation Plan, Final (Anne Arundel County, 2012)
- Total Maximum Daily Load of Sediment in the Little Patuxent River Watershed, Howard and Anne Arundel Counties, Maryland (MDE, 2011a)

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

- General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan (MDE, May 2014)
- Guidance for Using the Maryland Assessment Scenario Tool to Develop Stormwater Wasteload Allocation Implementation Plans for Local Nitrogen, Phosphorus, and Sediment TMDLs (MDE, June 2014)
- Guidance for Developing Stormwater Wasteload Allocation Implementation Plans for Nutrient and Sediment Total Maximum Daily Loads (MDE, November 2014)
- Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated (MDE, August 2014)

The Little Patuxent plan has been prepared in accordance with the EPA's nine essential elements for watershed planning. These elements, commonly called the 'a through i criteria' are important for the creation of thorough, robust, and meaningful watershed plans and incorporation of these elements is of particular importance when seeking implementation funding. The EPA has clearly stated that to ensure that Section 319 (the EPA Nonpoint Source Management Program) funded projects make progress towards restoring waters impaired by nonpoint source pollution, watershed-based plans that are developed or implemented with Section 319 funds to address 303(d)-listed waters must include at least the nine elements.

The Little Patuxent watershed restoration plan is organized based on these elements. A modification to the order has been incorporated such that element c., a description of the management measures, is included before element b., the expected load reductions. We feel this modified approach is easier to follow. The letters (a. through i.) are included in the headers of the plan's major sections to indicate to the reader the elements included in that section. The planning elements are:

a. An identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the plan and to achieve any other watershed goals identified in the plan, as discussed in item (b) immediately below. (Section 3)

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time. (Section 5)

c. A description of the management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above as well as to achieve other watershed goals identified in the plan, and an identification of the critical areas in which those measures will be needed to implement this plan. (Section 4)

d. An estimate of the amount of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. (Section 6)

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the recommended management measures. (Section 7)

f. A schedule for implementing the management measures identified in this plan that is reasonably expeditious. (Section 8)

g. A description of interim, measurable milestones for determining whether management measures or other control actions are being implemented. (Section 8)

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised. (Section 9)

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above. (Section 10)

The outcomes of the planning effort are to provide guidance for the strategic implementation of watershed protection and restoration efforts that will advance progress toward meeting Anne Arundel County's local TMDLs pollutant loading allocations, and ultimately meeting water quality standards. Successful implementation of the plan will lead to improvements in local watershed conditions and aquatic health.

2 Watershed Characteristics

2.1 Watershed Delineation

The Little Patuxent is one of 12 major watersheds in Anne Arundel County, Maryland, and is situated in the western portion of the County (Figure 1). The watershed shares political boundaries with Howard County. The Little Patuxent watershed is a part of the Chesapeake Bay watershed with the Little Patuxent River mainstem joining the Patuxent River just southeast of the Patuxent Research Refuge before discharging to the tidal portions of the Patuxent River in Calvert County before entering the Chesapeake Bay.

2.2 Little Patuxent River

The Little Patuxent watershed is approximately 27,752 acres (43.4 square miles) in area and contains approximately 1,200 total miles of stream reaches. The watershed includes several named streams including Dorsey Run, Midway Branch, Towsers Branch, and the mainstem of the Little Patuxent River. These named streams are distributed among 21 subwatersheds, as shown below in Table 2 and on Figure 2. These subwatersheds were used as planning units for the watershed assessment and management plan completed for this watershed by the County in 2014 (Draft). Although the average subwatershed size is 1,321 acres, the subwatersheds range in size from 485 in LPH to 2,646 in LPI. The channel length in each subwatershed also varies similarly.

Communities within the Little Patuxent include Gambrills and Crofton. A large section of Fort George G. Meade, a U.S. Army owned installation, and approximately half of the Patuxent Research Refuge North, a federal property owned and operated by the Fish and Wildlife Service of the U.S. Department of Interior, are located in the central portion of the watershed (Figure 2).

Table 2: Little Patuxent River Watershed Drainage Area and Perennial Stream Miles

Subwatershed Code	Subwatershed Name	Drainage Area (Acres)	Drainage Area (Square Miles)	Stream Miles
LP0	Little Patuxent 2	670	1.0	6.3
LP1	Dorsey Run 1	621	1.0	6.0
LP2	Dorsey Run 3	876	1.4	8.7
LP3	Towsers Branch 1	1,334	2.1	6.1
LP4	Rogue Harbor 1	1,902	3.0	11.3

Subwatershed Code	Subwatershed Name	Drainage Area (Acres)	Drainage Area (Square Miles)	Stream Miles
LP5	Little Patuxent 1	1,158	1.8	8.7
LP6	Towsers Branch 2	1,013	1.6	2.4
LP7	Little Patuxent 5	1,701	2.7	10.2
LP8	Little Patuxent 4	1,096	1.7	8.2
LP9	Rogue Harbor 2	2,287	3.6	12.1
LPA	Oak Hill	1,031	1.6	7.9
LPB	Dorsey Run 6	1,732	2.7	12.8
LPC	Towsers Branch 3	1,954	3.1	8.3
LPD	Dorsey Run 4	1,592	2.5	10.0
LPE	Piney Orchard	932	1.5	7.0
LPF	Little Patuxent 6	1,503	2.3	13.4
LPG	Crofton Golf	1,690	2.6	10.0
LPH	Little Patuxent 3	485	0.8	3.7
LPI	Dorsey Run 5	2,660	4.2	153.0
LPJ	Dorsey Run 2	919	1.4	299.6
LPK	Jessup	594	0.9	593.3
Little Patuxent River Total		**27,752**	**43.4**	**1,198.8**

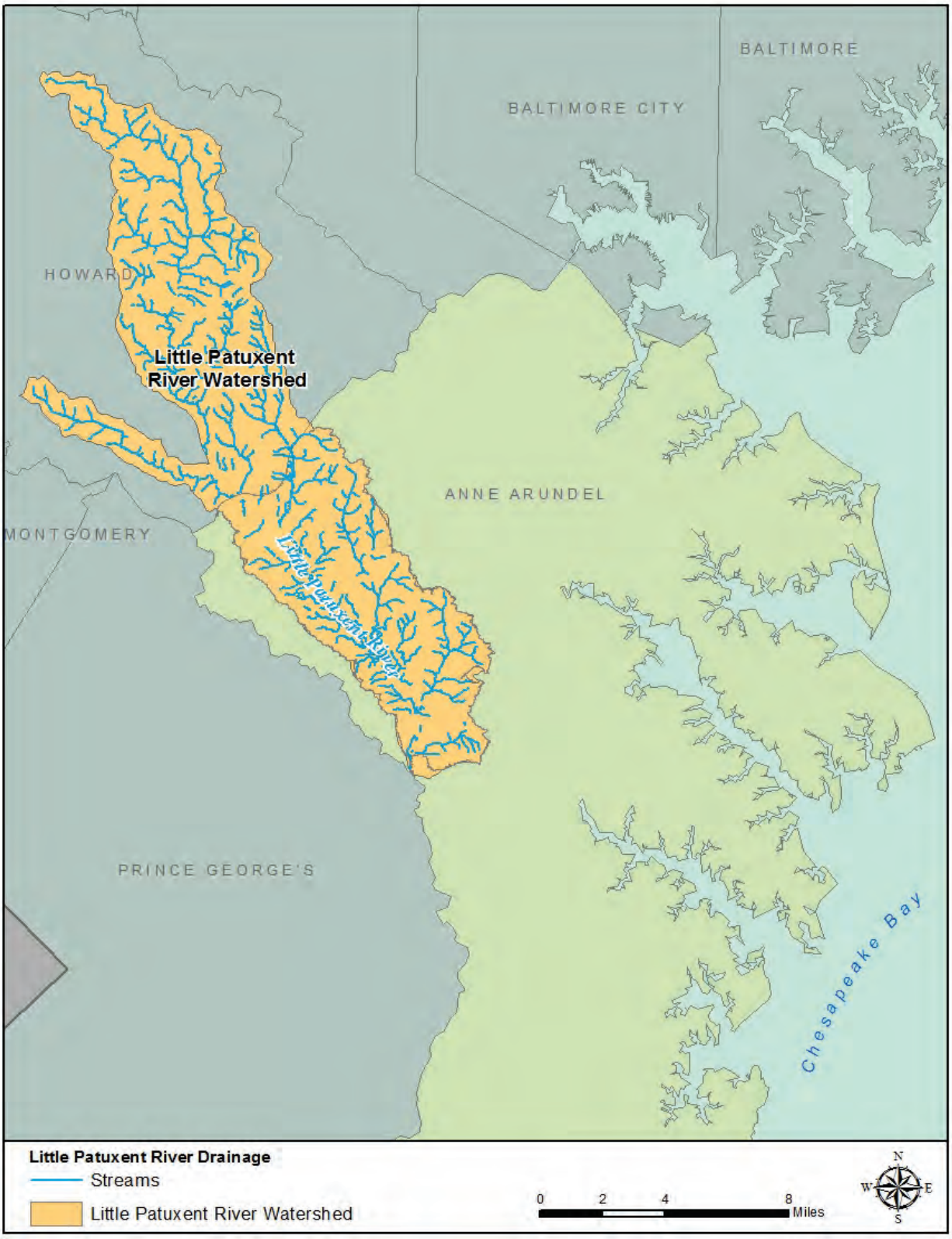
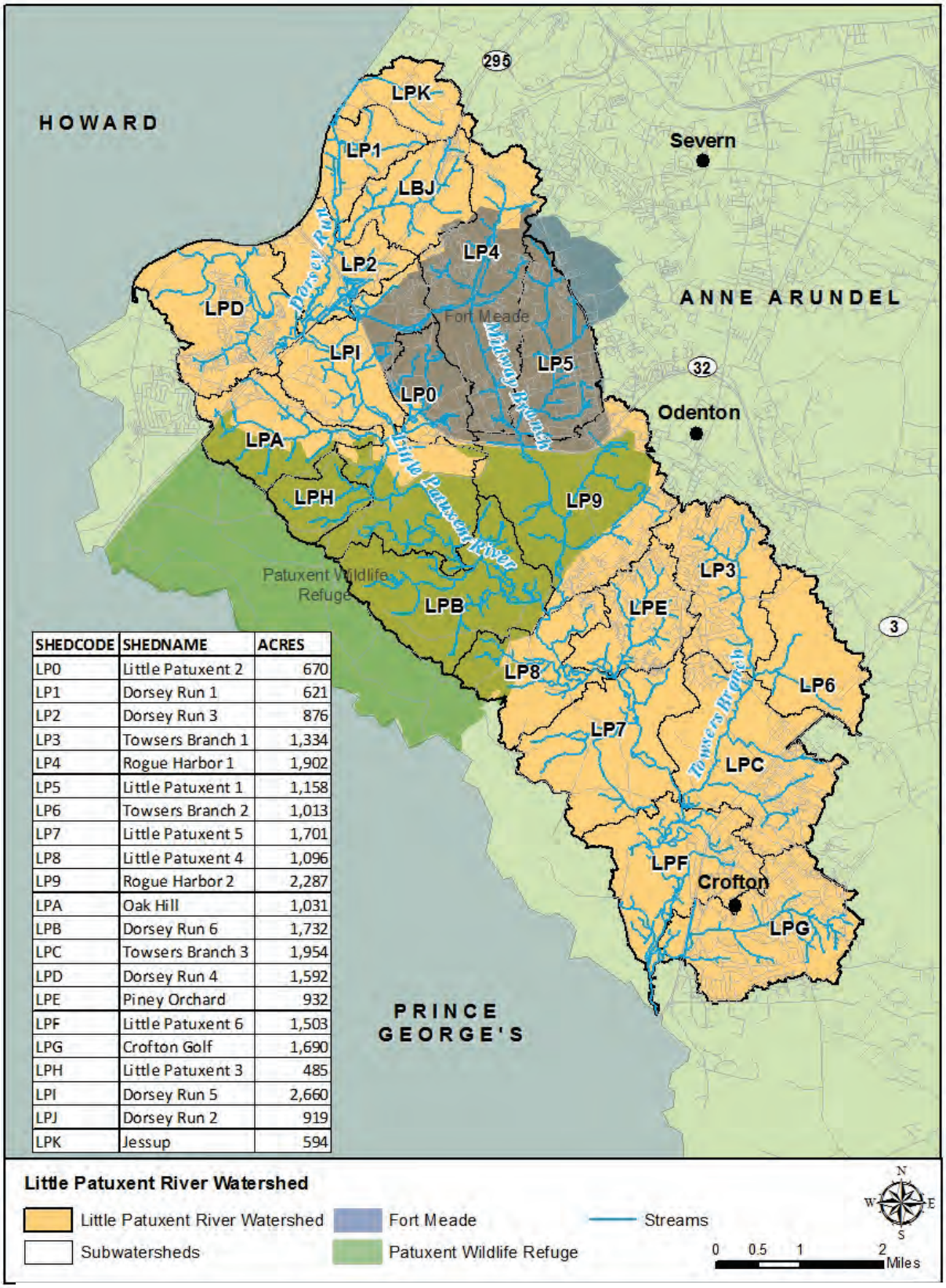


Figure 1: Little Patuxent River Watershed



SHEDCODE	SHEDNAME	ACRES
LP0	Little Patuxent 2	670
LP1	Dorsey Run 1	621
LP2	Dorsey Run 3	876
LP3	Towsers Branch 1	1,334
LP4	Rogue Harbor 1	1,902
LP5	Little Patuxent 1	1,158
LP6	Towsers Branch 2	1,013
LP7	Little Patuxent 5	1,701
LP8	Little Patuxent 4	1,096
LP9	Rogue Harbor 2	2,287
LPA	Oak Hill	1,031
LPB	Dorsey Run 6	1,732
LPC	Towsers Branch 3	1,954
LPD	Dorsey Run 4	1,592
LPE	Piney Orchard	932
LPF	Little Patuxent 6	1,503
LPG	Crofton Golf	1,690
LPH	Little Patuxent 3	485
LPI	Dorsey Run 5	2,660
LPJ	Dorsey Run 2	919
LPK	Jessup	594

Figure 2: Little Patuxent River Subwatershed Location

2.3 Land Use/Land Cover

The type and density of various land uses can have a dramatic effect on water quality and stream habitat. Forested areas slow stormwater flow and allow water to gradually seep into soils and drain into streams. Vegetation and soils bind nutrients and pollutants found within stormwater—improving water quality as it infiltrates the ground. Developed areas, with a high percentage of impervious surfaces (buildings, paved roads, parking lots, etc.), do not reduce either the volume or flow of stormwater—increasing the amount of pollutants entering streams. Increased stormflow affects stream habitat negatively by increasing bank erosion and decreasing instream and riparian habitat. Agricultural land, if managed incorrectly, can also impair streams with increases nutrients and bacteria.

See Figure 3 for aerial imagery of the Little Patuxent River watershed. Land use / land cover (LULC) data from the Anne Arundel County Office of Information Technology (2011) is presented in Figure 4. Data presented in the figures below were used to characterize the watershed and show potential pollution sources. These LULC data were not used in the calculations of loads and load reduction, which were based instead on the land-river segment scale from the Chesapeake Bay Program Partnership Watershed Model.

2.3.1 Existing Land Use/Land Cover

According to 2011 LULC data (Table 3), the largest category in the Little Patuxent is forested land, or woods (45.9%) followed by open space (11.8%). Developed land accounts for 36.6% of the watershed and largely consists of residential (1/8 acre 10.2%, 1/4 acre 6.2%), and commercial (8.4%). Residential areas as a total make up 19.6% of the watershed.

Table 3: 2011 Land Use / Land Cover

Land Use / Land Cover	Acres	Percent of Watershed
Airport	66	0.2%
Commercial	2,323	8.4%
Forested Wetland	52	0.2%
Industrial	756	2.7%
Open Space	3,274	11.8%
Open Wetland	100	0.4%
Pasture/Hay	454	1.6%
Residential 1/2-acre	154	0.6%
Residential 1/4-acre	1,723	6.2%
Residential 1/8-acre	2,836	10.2%
Residential 1-acre	169	0.6%
Residential 2-acre	568	2.0%
Row Crops	471	1.7%
Transportation	1,179	4.2%
Utility	384	1.4%
Water	503	1.8%
Woods	12,740	45.9%
Total	**27,752**	**100.0%**

2.3.2 Impervious Surfaces

Impervious surfaces concentrate stormwater runoff, accelerating flow rates and directing stormwater to the receiving stream. This accelerated, concentrated runoff can cause stream erosion and habitat degradation. Runoff from impervious surfaces picks up and washes off pollutants and is usually more polluted than runoff generated from pervious areas. In general, undeveloped watersheds with small amounts of impervious cover are more likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover. Impervious cover is a primary factor when determining pollutant characteristics and loadings in stormwater runoff.

The degree of imperviousness in a watershed also affects aquatic life. There is a strong relationship between watershed impervious cover and the decline of a suite of stream indicators. As imperviousness increases the potential stream quality decreases with most research suggesting that stream quality begins to decline at or around 10 percent imperviousness (Schueler, 1994; CWP, 2003). However, there is considerable variability in the response of stream indicators to impervious cover observed from 5 to 20 percent imperviousness due to historical effects, watershed management, riparian width and vegetative protection, co-occurrence of stressors, and natural biological variation. Because of this variability, one cannot conclude that streams draining low impervious cover will automatically have good habitat conditions and a high quality aquatic life.

Impervious surfaces make up 15.7% of the overall Little Patuxent drainage (Table 4; impervious surfaces data obtained from Anne Arundel County Office of Information Technology - 2011). Impervious surface is highest in areas surrounding Odenton and Crofton.

Table 4: Little Patuxent River Watershed Percent Impervious Cover

Subwatershed Code	Subwatershed Name	% Impervious Cover
LP0	Little Patuxent 2	31.5%
LP1	Dorsey Run 1	14.2%
LP2	Dorsey Run 3	20.5%
LP3	Towsers Branch 1	21.3%
LP4	Rogue Harbor 1	21.0%
LP5	Little Patuxent 1	24.5%
LP6	Towsers Branch 2	12.4%
LP7	Little Patuxent 5	4.6%
LP8	Little Patuxent 4	4.8%
LP9	Rogue Harbor 2	14.3%
LPA	Oak Hill	6.7%
LPB	Dorsey Run 6	0.4%
LPC	Towsers Branch 3	22.6%
LPD	Dorsey Run 4	21.6%
LPE	Piney Orchard	22.5%
LPF	Little Patuxent 6	18.3%
LPG	Crofton Golf	26.5%
LPH	Little Patuxent 3	0.1%
LPI	Dorsey Run 5	12.4%

Subwatershed Code	Subwatershed Name	% Impervious Cover
LPJ	Dorsey Run 2	12.1%
LPK	Jessup	14.0%
Little Patuxent River Total		**15.7%**

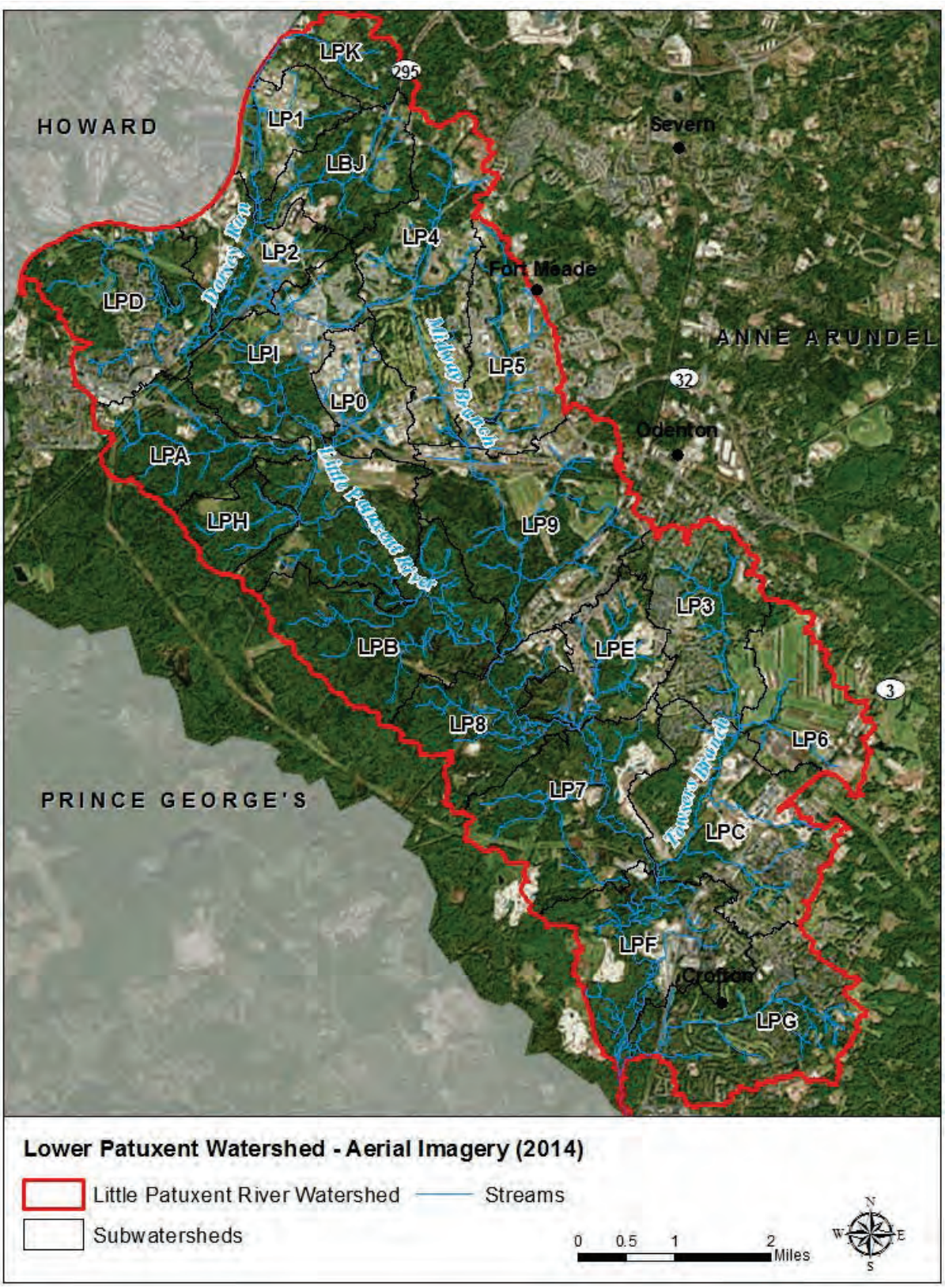


Figure 3: Little Patuxent River Watershed Aerial Imagery (2014)

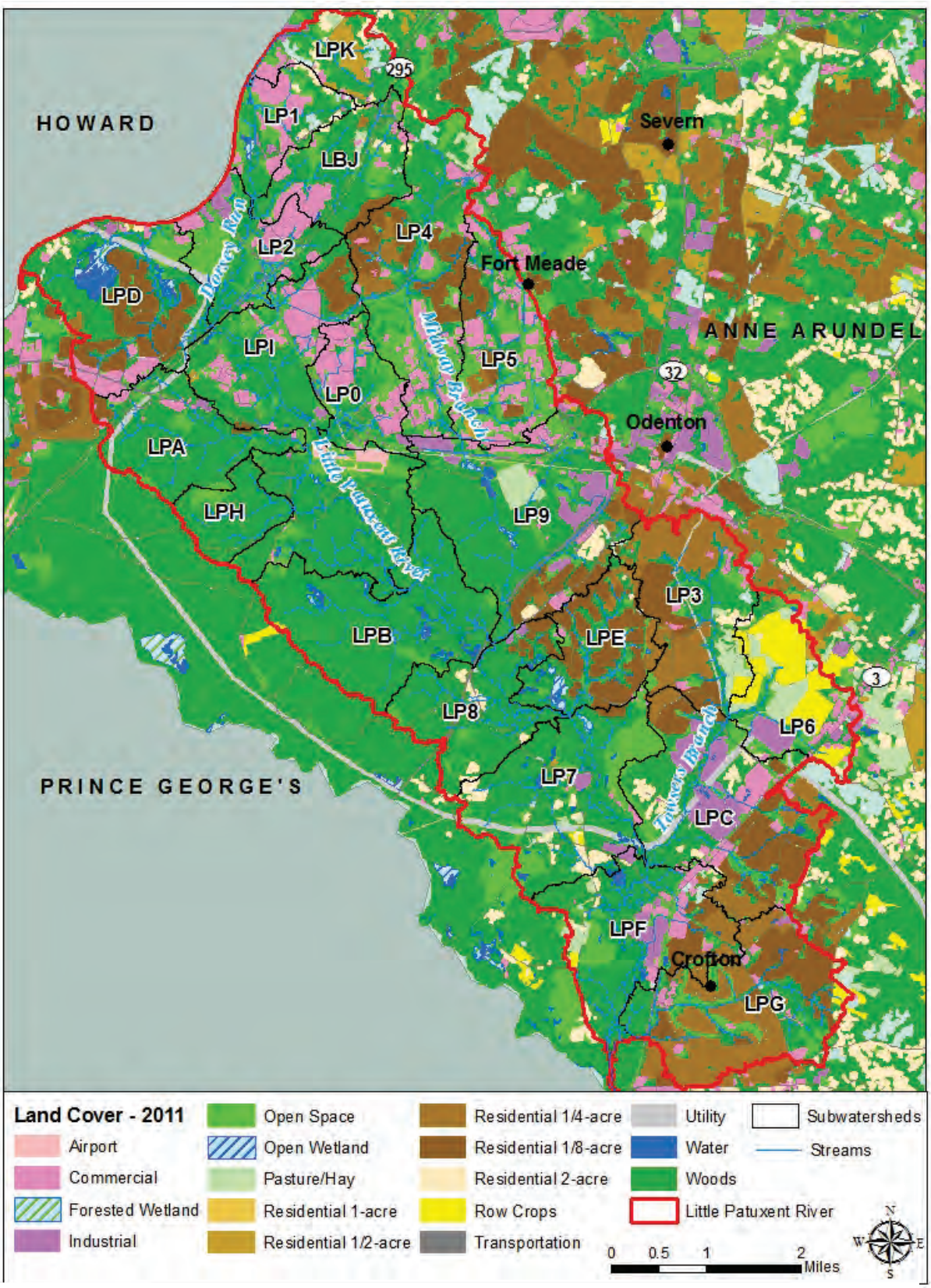


Figure 4: Little Patuxent River Watershed Land Cover (2011)

2.4 Water Quality

2.4.1 Use Designations

According to water quality standards established by MDE in the Code of Maryland Regulations (COMAR) 26.08.02.03-.03 - Water Quality, Little Patuxent is classified as Use I waters which are designated to support water contact recreation, and protection of non-tidal warmwater aquatic life. Designations include recreation; industrial and agricultural water supply; and fish, aquatic life, and wildlife (Table 5).

Table 5: Use Designations of the Little Patuxent River

Designated Uses	Little Patuxent
Growth and propagation of fish (not trout), other aquatic life and wildlife	X
Water contact sports	X
Leisure activities involving direct contact with surface water	X
Fishing	X
Agricultural water supply	X
Industrial water supply	X
Propagation and harvesting of shellfish	-
Seasonal migratory fish spawning and nursery use	-
Seasonal shallow-water submerged aquatic vegetation use	-
Open-water fish and shellfish use	-
Seasonal deep-water fish and shellfish use	-
Seasonal deep-channel refuge use	-
Growth and propagation of trout	-
Capable of supporting adult trout for a put and take fishery	-
Public water supply	-

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

2.4.2 303(d) Impairments

According to Maryland's final 2012 and draft 2014 303(d) list of impaired waters (MDE, 2012a; MDE, 2014a), several segments within the Little Patuxent watershed are listed for water quality impairments.

The Little Patuxent watershed contains three Category 4a stream segments which include those waters that are not meeting their use designation but for which a TMDL has been developed to address the impairments. Category 4a waters include the entire watershed listed for sediment from urban runoff sources and two listings from agricultural sources for Centennial Lake in Howard County, one for sedimentation/siltation and another for phosphorus.

Category 5 waters for the Little Patuxent watershed, which include those waters that are not meeting their use designation and require a TMDL, include the entire watershed for chlorides and sulfates. These listings were added in 2014 and replace the 2006 category 5 biological listing for "cause unknown."

2.4.3 TMDLs

Total Maximum Daily Loads (TMDLs) are established for waterbodies on Maryland's 303(d) integrated list of impaired waterbodies to set pollutant limits to achieve attainment of the designated use. For each

combination of waterbody and pollutant, the State must estimate the maximum allowable pollutant load, or TMDL, that the waterbody can receive and still meet water quality standards. TMDLs are required by Clean Water Act.

Category 4a of the 303(d) list describes impaired waters with a TMDL or other reduction measure in place. Category 5 lists impaired waters in need of a TMDL. Listings for chlorides and sulfates in the Little Patuxent is currently in need of a TMDL.

The Little Patuxent currently has three final TMDLs completed - one for sediment from urban runoff sources (approved 2011), a second for sediment from agricultural sources (approved 2002), and a third for phosphorus from agricultural sources (approved 2002). This Restoration Plan focuses on implementing strategies to address the sediment TMDL which requires a 20.5% reduction of Anne Arundel County NPDES regulated stormwater point source sediment.

In addition to local TMDLs in the Little Patuxent, the County must also meet WLAs allocated from the *Chesapeake Bay Total Maximum Daily Loads for Nitrogen, Phosphorus, and Sediment* (USEPA, 2010). The Bay TMDL is a result of requirements under the CWA to meet water quality standards and executive order 13508 signed by President Barack Obama in 2009 that put a renewed emphasis and focus on the Chesapeake Bay. The local sediment TMDL for the Little Patuxent is more geographically specific than the Bay-wide allocated loads assigned in the Bay TMDL. However, all load reductions achieved from implementation efforts described in this plan will help support the County's Bay TMDL goals.

2.4.4 NPDES

Section 402(p) of the Clean Water Act required the EPA to add Municipal Separate Storm Sewer System (MS4) discharges to the NPDES permit program. In 2002, EPA directed permit writers to include WLA requirements in NPDES permits, including those for MS4 discharges. Anne Arundel County holds a Phase I – Large Jurisdiction (greater than 250,000 population) MS4 permit (11-DP-3316, MD0068306) issued by the MDE. The County's first generation permit was issued in 1993. The current fourth generation permit was issued in February of 2014.

TMDL Permit Requirements

The objective of this plan is to meet the County's MS4 NPDES permit requirement to develop restoration plans for local TMDLs per permit condition IV.E.2.b. Plans must be developed within the first year of permit issuance. Anne Arundel County's final permit was issued on February 12, 2014 therefore the restoration plans must be complete by February 11, 2015.

The permit states the County must submit "…a restoration plan for each stormwater Waste Load Allocation (WLA) approved by EPA prior to the effective date of the permit." For each WLA, the County is required to:

PART IV. Standard Permit Conditions
E. Restoration Plans and Total Maximum Daily Loads
2. Restoration Plans
b. Within one year of permit issuance, Anne Arundel County shall submit to MDE for approval a restoration plan for each stormwater WLA approved by EPA prior to the effective date of the permit. The County shall submit restoration plans for subsequent TMDL WLAs within one year of

EPA approval. Upon approval by MDE, these restoration plans will be enforceable under this permit. As part of the restoration plans, Anne Arundel County 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 restoration plans 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 County's watershed assessments.

Further, the permit requires continual outreach to the public regarding the development of its watershed assessments and restoration plans and requires public participation in the TMDL process (permit section IV.E.3.a-d).

The permit requires an annual progress report presenting the assessment of the NPDES stormwater program based on the fiscal year. A TMDL assessment report to include complete descriptions of the analytical methodology used to evaluate the effectiveness of the County's restoration plans and how these plans are working to achieve compliance with EPA approved TMDLs is a component of the annual report. The assessment will include: estimated net change in pollutant load reductions from water quality improvement projects; a comparison of the net change to targets, deadlines, and applicable WLAs; cost data for completed projects; cost estimates for planned projects; and a description of a plan for implementing additional actions if targets, deadlines, and WLAs are not being met (permit section IV.E.4.a-e).

Impervious Surface Permit Requirements

The County's permit requires implementation of restoration efforts for 20% of the County's impervious surface area that has not already been restored to the maximum extent practicable (MEP) (permit section (IV.E.2.a). Though projects and strategies outlined in this plan will certainly add treatment of impervious surfaces, accounting for impervious treatment is not included in this report.

3 Causes and Sources of Impairment (a)

3.1 Impairments

Elevated levels of sediment currently impair the Little Patuxent watershed as evident through the 303(d) listings and local TMDL requirement. Sediment, both from upland and in-stream sources, can impact in-stream habitat by covering and filling gravelly and rocky substrate, which is a preferred substrate habitat for some aquatic organisms (fish and benthic community) and necessary for some fish species for spawning. Finer clays, silts and sands associated with sediment as a pollutant are more mobile and

transient and provide less liveable space for more sensitive benthic macroinvertebrate species by filling the interstitial spaces between larger substrate particles in the channel bottom. Increases in sediment loads in channels that cannot adequately transport the load can lead to deposition and aggrading streams. These factors often negatively impact channel flow, causing additional erosion and increases in flooding, particularly if road crossing capacity is limited by sediment accumulation. Suspended sediment in the water column may limit light penetration and prohibit healthy propagation of algae and submerged aquatic vegetation. Suspended sediments can cause gill abrasion in fish and can limit clarity which impacts aquatic species that rely on sight for feeding.

3.2 Sources

The majority of sediment loads in the Little Patuxent originate from urban stormwater runoff from development and in-stream sources related to channel erosion.

3.2.1 Urban Stormwater Runoff

The contribution of urban stormwater to sediment loading was analyzed in the Little Patuxent Watershed Assessment (Anne Arundel County, 2014 Draft). Figure 5 presents the annual total suspended solids runoff load as the relative quantity of sediment contributed from each subwatershed (i.e., lowest to highest). The water quality model used for the assessment was based on EPA's Simple Method (Schueler, 1987) and PLOAD models (EPA, 2001) using event mean concentrations (EMCs) for each LULC type. The results presented here are only the sediment associated with runoff, and do not reflect in-stream sources. The most significant contributing LULC categories related to urban stormwater in terms of loading rates include airport, transportation, and commercial and industrial areas. Residential development, while a lower loading rate, makes up a large portion of the watershed (19.6%) and is therefore also a significant contributor.

Subwatersheds contributing the lowest amount of existing sediment loads include LP8, LPA, LPB, LPH, and LPK. Subwatersheds contributing the highest amount of existing sediment loads include LP4, LP6, LP9, LPG, and LPI and to a lesser extent, subwatersheds LP3, LPC, LPD, and LPF. Management measures targeted in subwatersheds with high existing sediment loads will be the priority of this restoration plan to ensure required reductions are achieved and maintained.

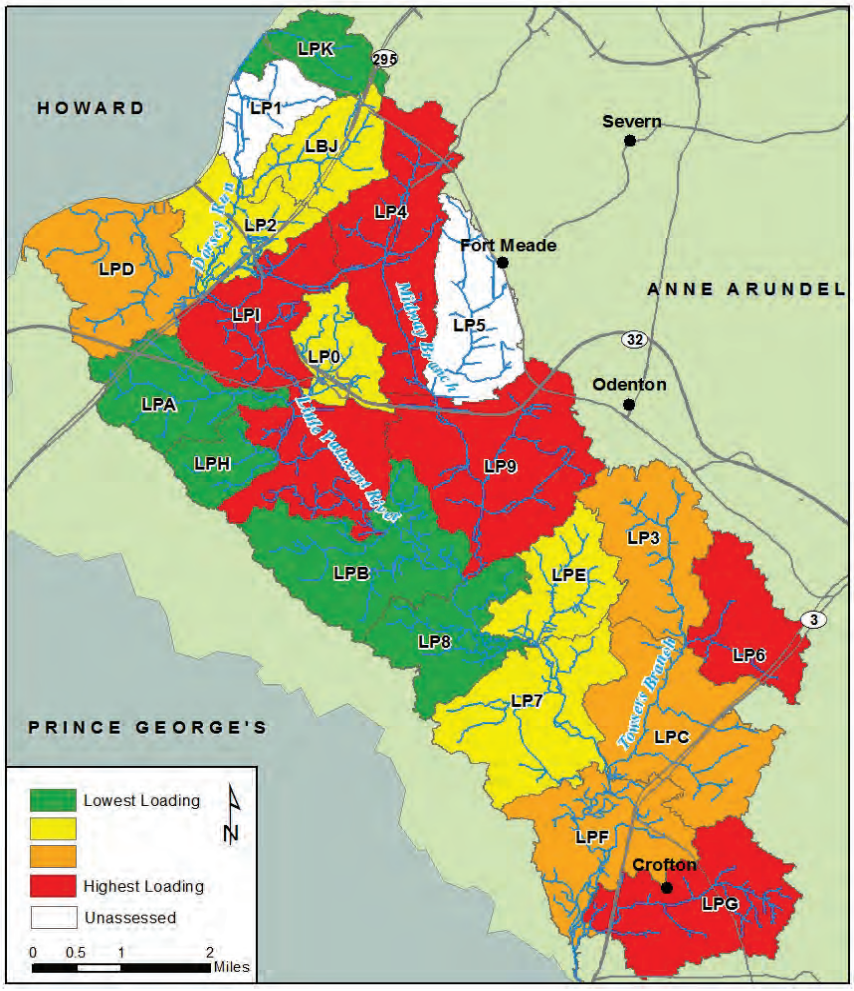


Figure 5: Total Suspended Solids Load from Runoff Based on Existing Conditions - Includes BMP Reductions (Anne Arundel County, 2014 Draft)

3.2.2 In-stream Sources

Although channel bed and bank erosion occurs naturally as streams work to maintain a state of dynamic equilibrium, excessive erosion can occur due to increased stream velocities associated with development activities that increase imperviousness within the watershed. Channel erosion can deliver excessive pollutants, such as sediment and phosphorus, downstream, where water quality can be impacted and important habitat for fish spawning and benthic invertebrates can be smothered. Excessive erosion can also threaten the stability of other nearby built infrastructure. The Biological Stressor Identification Analysis (BSID; MDE, 2011b) for the Little Patuxent has determined that biological communities in this watershed are likely degraded due to flow/sediment related stressors. These stressors often result from altered hydrology and increased runoff from impervious area, specifically from channel erosion and subsequent elevated suspended sediment transport through the watershed. Thus, suspended sediment was identified as a probable cause and confirmed the Category 5 listing for total suspended sediment as an impairing substance in this watershed.

Approximately 116 miles of streams were assessed and characterized for the Little Patuxent Watershed Assessment (Anne Arundel County, 2014 Draft). Streams located on Fort Meade and Jessup Correctional Institute property were not assessed, which included the majority of streams within subwatersheds LP1

and LP5 and portions of subwatersheds LP0, LP4, LP9, and LPI. Collected data included stream classifications, physical habitat condition assessment, inventory of infrastructure and environmental features, habitat scores, channel geomorphology, road crossing flood potential, bioassessments, and aquatic resource indicators. Within each perennial reach, channel erosion was assessed and scored based on severity. A score of 5 was considered Moderate impact, a score of 7 was considered Severe, and a score of 10 was considered an Extreme condition. A total of 431 erosion locations impacting approximately 49,000 linear feet of stream reaches were cataloged in the Little Patuxent with the majority of points scored as moderate or severe erosion (Table 6 and Table 7). Over half of the erosion sites (53.3%) were located in Towsers Branch (LP3 and LPC), Dorsey Run (LPD and LPJ), and Oak Hill (LPA).

Table 6: Erosion Inventory and Severity per Subwatershed (Anne Arundel County, 2014 DRAFT)

Subwatershed and stream miles assessed		Number of Erosion Impacts			Total
		5	7	10	
LP0	1.2	3	1		4
LP1	0.1				0
LP2	3.7	12	1		13
LP3	6.1	19	14	2	35
LP4	1.8	4			4
LP5	0.0	Not Assessed			
LP6	2.3	6	1		7
LP7	7.8	16	13		29
LP8	6.9	20	1		21
LP9	7.1	9			9
LPA	7.0	44	15		59
LPB	10.6	10	1		11
LPC	7.0	25	4	4	33
LPD	8.6	19	7	4	30
LPE	6.1	22	14	3	39
LPF	10.7	11	5		16
LPG	8.7	20	5	3	28
LPH	3.7	22	5		27
LPI	10.3	8	2	2	12
LPJ	4.0	19	15		34
LPK	2.0	17	3		20
Total number per rating		**306**	**107**	**18**	
Total number per type		**413**			

Table 7: Linear Feet of Erosion per Subwatershed (Anne Arundel County, 2014 DRAFT)

Subwatershed	Erosion Impacts and Linear Feet			Total Linear Feet
	5	7	10	
LP0	110	15	0	125
LP1	Not Assessed			
LP2	1,360	120	0	1,480
LP3	3,565	4,020	140	7,725
LP4	200	0	0	200
LP5	Not Assessed			
LP6	1,870	50	0	1,920
LP7	2,000	825	0	2,825
LP8	3,040	100	0	3,140
LP9	370	0	0	370
LPA	2,825	1,180	0	4,005
LPB	2,025	100	0	2,125
LPC	2,160	510	405	3,075
LPD	1,211	1,845	185	3,241
LPE	4,940	3,640	130	8,710
LPF	1,550	280	0	1,830
LPG	1,320	395	500	2,215
LPH	1,655	260	0	1,915
LPI	950	100	250	1,300
LPJ	805	885	0	1,690
LPK	1,075	90	0	1,165
Total	**33,031**	**14,415**	**1,610**	**49,056**

An assessment of channel geomorphology utilizing Rosgen Level I geomorphic classifications was also administered for each single-threaded, perennial reach throughout the watershed as part of the Little Patuxent Watershed Assessment (Anne Arundel County, 2014 Draft). An assessment of channel geomorphology is useful to better understand the stability of a stream and its associated behaviors including channel entrenchment. The Rosgen classification system has four levels. The Level I classification is a geomorphic characterization that groups streams as Types A through G based on aspects of channel geometry, including water surface slope, entrenchment, width/depth ratio, and sinuosity.

Over half of the assessed perennial streams (54%) in the Little Patuxent watershed were Type C channels, which exhibit a well-developed floodplain, higher sinuosity, and susceptibility to de-stabilization when flow regimes are altered. Approximately one-quarter of streams (21%) were Type B channels, which are very stable, moderate gradient channels with low sinuosity and low erosion rates. Sixteen percent were Type F and G channels (7% and 9%, respectively), which are generally low gradient, entrenched channels with high erosion rates.

3.3 Anticipated Growth

Future urban sector growth and the anticipated increase in urban loads that may result are expected to be controlled by two elements: stormwater management to the MEP that is required with new

development, and anticipated "Accounting for Growth" policies. This CIS is developed to treat the reduction required from the initial baseline year load, calibrated to the current Bay model. Based on coordination with MDE, TMDL restoration planning should focus on the untreated and undertreated areas associated with the urban footprint at the time of the TMDL baseline. Future loads and loads potentially added to the urban sector since the baseline year to present are not accounted for here as they are addressed under other programs. MDE has requested in restoration plan development guidance (MDE, 2014d) that jurisdictions begin estimating potential additional loads, therefore estimates are included in section 3.3.1.

3.3.1 Estimates of Future Growth

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

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

The Anne Arundel County General Development Plan was finalized April 2009 and was adopted in October 2009 (Bill No. 64-09; Anne Arundel County, 2009). The next update of the plan is due by 2019. Anne Arundel County is considered one of the fastest growing counties in the region with 14.6% population growth (427,239 to 489,656 persons) over 1990-2000 compared to 6.9% growth in the Baltimore region and 10.8% growth throughout the State of Maryland (Anne Arundel County, 2009). The population in Anne Arundel County is projected to increase to 564,925 persons by 2025, which is an increase of 15.4% from 2000 data and to 579,137 persons by 2035, an increase of 18.3% from 2000 data.

The primary developed areas located in Little Patuxent watershed are Crofton and the outer limits of Odenton, which includes various commercial developments, specifically the shops at Waugh Chapel Towne Centre. Portions of the Little Patuxent, including Crofton and Piney Orchard, are a part of the County's Priority Funding Areas which are areas where the County directs new growth. Anne Arundel County continues to utilize strategies such as promoting low impact development and implementing stormwater BMPs for water quality treatment. However, increased urban stormwater related loads will inevitably occur as growth continues.

To estimate potential increases in loads over time due to growth, an analysis was completed using a combination of MAST modeled loading estimates, and estimates based on recent growth patterns. Figure 6 shows initial conditions loads without BMPs as modeled in MAST (grey bars) at the Little Patuxent 8-digit subwatershed scale as well as projected loads with (blue bars) and without (orange bars) the application of stormwater BMPs to the maximum extent practicable (SW to the MEP). Projected loads were calculated by applying the average percent change observed between MAST loading results from 2010 through 2015 (2.0%) to loads of the previous year. In this manner a 2.0% annual increase in loads would be expected from 2015 to 2025 if development were to occur at the same rate and be implemented without BMPs. Because in actuality new development will follow Maryland's stormwater regulations, the resultant loading increases were reduced by 90% based on the MAST removal rates for sediment treated

by stormwater treatment to the maximum extent practicable (SW to the MEP). The results are shown as the blue bars in Figure 6. Additional projected loads without the application of SW to the MEP sediment removal rates are shown as the orange bars in Figure 6.

Projected loading in 2025 with the application of SW to the MEP, will be incorporated in TMDL modeling efforts to account for growth in the watershed.

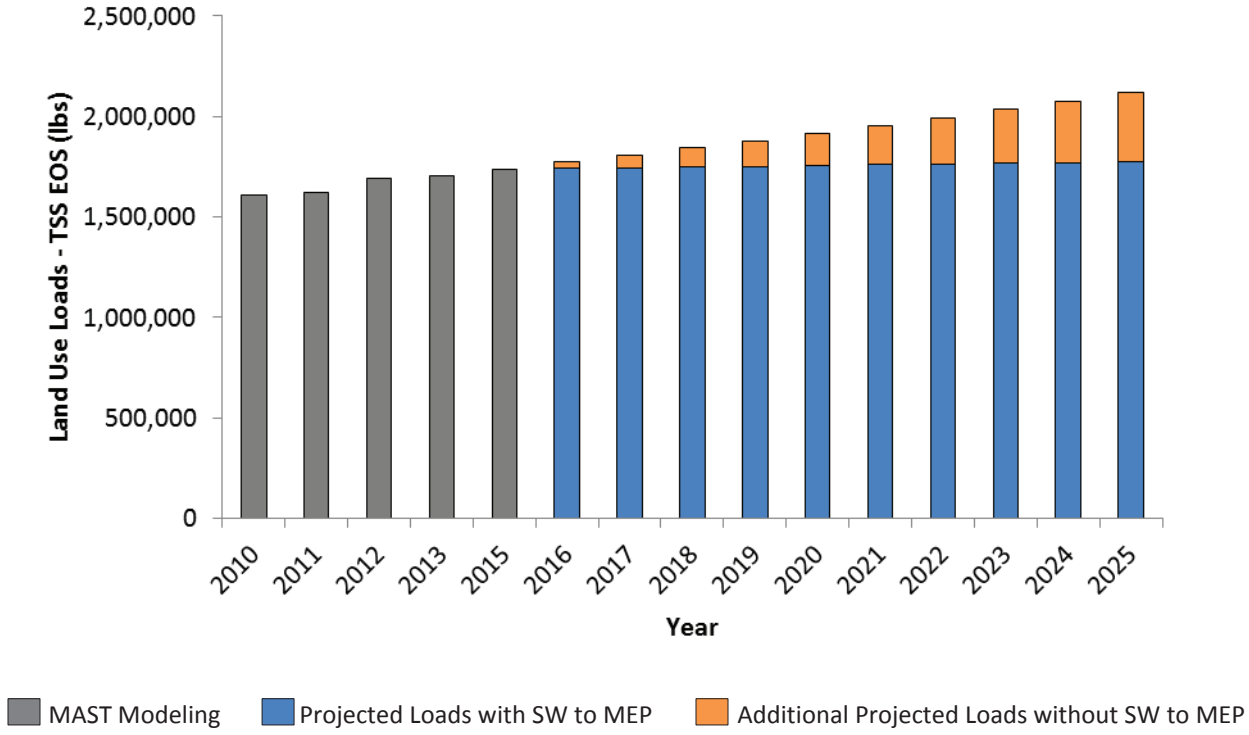


Figure 6: Modeled and Projected Land Use Loads

Figure 7 depicts sediment runoff loading by subwatershed based on a future conditions modeling scenario with the implementation of projects funded in the County's Capital Improvement Program (CIP) as recommended in the Little Patuxent Watershed Assessment (Anne Arundel County, 2014 Draft) and discussed further in Section 4: Management Measures. In general, future sediment loading is projected to be highest in the Rogue Harbor and Towsers Branch subwatersheds (LP4, LP6, LP9, LPC) in addition to the Crofton Golf subwatershed (LPG).

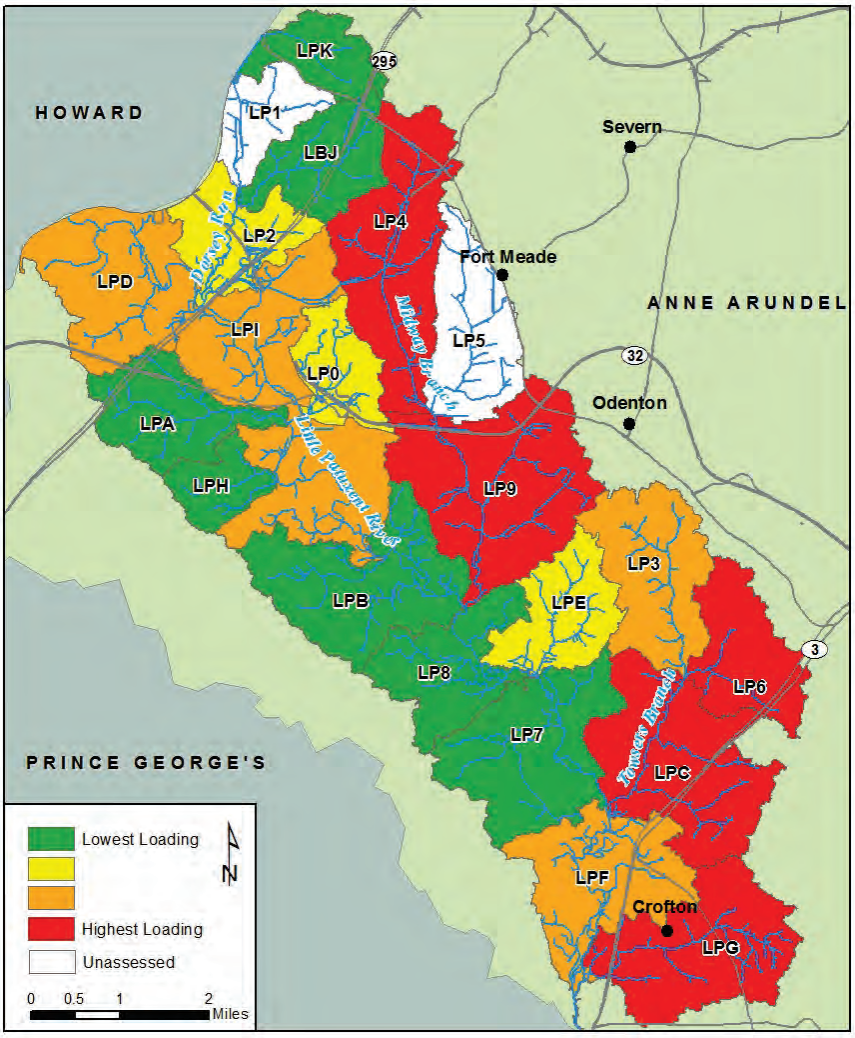


Figure 7: Total Suspended Solids Loads from Runoff Based on Future Conditions - Includes BMP Reductions (Anne Arundel County, 2014 Draft)

3.3.2 Offsetting Sediment Loads from Future Growth

Growth and development is expected to occur throughout Anne Arundel County, and depending on when and where this growth occurs, pollutant loading from urban stormwater sources may also increase. It is anticipated that new development will make use of ESD stormwater treatment according to MDE's Stormwater Regulations.

Maryland's 2007 Stormwater Management Act went into effect in October of 2007, with resulting changes to COMAR and the 2000 Maryland Stormwater Design Manual in May of 2009. The most significant changes relative to watershed planning are in regard to implementation of ESD. The 2007 Act defines ESD as "using small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources." As such Anne Arundel County has updated Articles 16 and 17 of the County Code to incorporate the requirements for ESD. Anne Arundel County finalized the *Anne Arundel County*

Stormwater Management Practices and Procedures Manual to incorporate criteria specific to the County that are not addressed within the Maryland Design Manual (Anne Arundel County, 2010).

Figure 6 in Section 3.3: Anticipated Growth shows projected land use loads with and without the application of SW to the MEP. TMDL modeling efforts include the application of SW to the MEP to represent ESD treatment for new development in the watershed. SW to the MEP will control 90% of sediment loads for that new development.

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

4 Management Measures (c)

Best management practices (BMPs) are either already implemented or are planned for implementation to achieve and maintain the Little Patuxent local TMDL load reductions. This section serves to describe the types of BMPs and management measures being implemented in the watershed. Load reductions that result from these measures are discussed in the following section, Section 5: Expected Load Reductions.

4.1 Modeling Approach

Each BMP provides a reduction for nitrogen, phosphorus, and sediment, along with other pollutants. The pollutant load for the Upper Patuxent watershed was determined using BayFAST, which calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program Partnership Watershed Model. BayFAST, created by Devereux Environmental Consulting for MDE, is a web-based pollutant load estimating tool that streamlines environmental planning. Users specify, delineate facility boundaries (e.g., watershed, parcel, drainage area), and alter land use information within the delineated boundary depending on the model year. Local TMDL baseline loads were calibrated in BayFAST by modeling BMPs installed prior to the TMDL baseline year on top of baseline land use background loads. This ensures that the same set of baseline BMPs are used throughout future progress and planned scenarios.

BayFAST estimates of load reductions for point and nonpoint sources include: agriculture, urban, forest, and septic loading. Load reductions are not tied to any single BMP, but rather to a suite of BMPs working in concert to treat the loads. Both BayFAST and the Chesapeake Bay Program Partnership Watershed Model calculate reductions from all BMPs as a group, much like a treatment train. Reductions are processed in order, with land use change BMPs first, load reduction BMPs next, and BMPs with individual effectiveness values at the end. The overall the load reduction can vary depending on which BMPs are implemented.

Pollutant load reductions achieved by maintenance efforts (e.g., street sweeping and inlet cleaning) are calculated outside of BayFAST. As discussed in the following section 4.2: Best Management Practices, inlet

cleaning and street sweeping will be practiced in the Little Patuxent watershed. Sediment reduction credit for street sweeping and inlet cleaning is calculated following methods described in MDE (2014b). Vacuum-assisted street sweeping at a rate of 2 times per month reduces the load on the swept area by 25%. Inlet cleaning receives credit based on the mass of material collected, at the rate of 420 lb TSS per ton of wet material.

Both the Chesapeake Bay Program Partnership Watershed Model and BayFAST provide loads at two different scales: Edge-of-Stream (EOS) and Delivered (DEL). Delivered loads show reductions based on in-stream processes, such as nutrient uptake by algae or other aquatic life. This TMDL plan focuses on reducing load on the land, so EOS estimates are more appropriate and were used for all the modeling analysis.

This section presents the level of BMP implementation. Section 9 presents information on how progress toward load reductions will be evaluated and management plans adapted on an on-going basis.

4.2 Best Management Practices

Many stormwater BMPs address both water quantity and quality, however, some BMPs are more effective at reducing sediment than others. The stormwater practices listed below keep the focus on "green technology" to reduce the impacts of stormwater runoff from impervious surfaces. These BMPs were selected specifically for three reasons: 1) effectiveness for water quality improvement, 2) willingness among the public to adopt, and 3) implementable in multiple facility types without limitations by zoning or other controls.

These practices are consistent with those currently being implemented by Anne Arundel County DPW as water quality improvement projects. The County has the technical expertise, operational capacity, and system resources in place to site, design, construct and maintain these practices.

The recommended practices are also consistent with those proposed in the County's Phase II WIP for the Chesapeake Bay TMDL and in the County's comprehensive watershed planning efforts. Exceptions to this are dry ponds which include dry detention ponds and dry extended detention ponds. These practices are no longer considered for future implementation; however, there are many existing facilities that are still actively treating runoff throughout the County so they are described here as well. The practices include:

- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. Rain gardens may be engineered to perform as a bioretention.
- **Bioswales** —An open channel conveyance that functions similarly to bioretention. Unlike other open channel designs, there is additional treatment through filter media and infiltration into the soil.
- **Dry Detention Ponds** – Depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow MAST modeling includes hydrodynamic structures in this category. These devices are designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.

- **Dry Extended Detention Ponds** - Depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. They are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, allowing additional wet sedimentation to improve treatment effectiveness.
- **Impervious Surface Reduction** - Reducing impervious surfaces to promote infiltration and percolation of runoff storm water. Disconnection of rooftop and non-rooftop runoff, rainwater harvesting (e.g., rain barrels), and sheetflow to conservation areas are examples of impervious surface reduction.
- **Infiltration** — A depression or trench to form a shallow basin where sediment is trapped and stormwater infiltrates into the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil; they are not constructed on poor soils, such as C and D soil types. Yearly inspections to determine if the basin or trench is still infiltrating runoff are planned. Dry wells, infiltration basins, infiltration trenches, and landscaped infiltration are all examples of this practice type.
- **Outfall Enhancement with Step Pool Storm Conveyance (SPSC)** – The SPSC is designed to stabilize outfalls and provide water quality treatment through pool, subsurface flow, and vegetative uptake. The retrofits promote infiltration and reduce stormwater velocities. This strategy is modeled in MAST as bioswales.
- **Stream Restoration -** Stream restoration in urban areas is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape of a stream, help improve habitat and water quality conditions in degraded streams.
- **Stormwater Retrofits –** Anne Arundel County plans to construct a variety of retrofits throughout the County. Stormwater retrofits may include converting dry ponds, dry extended detention ponds, or wet extended detention ponds into wet pond structures, wetlands, infiltration basins, or decommissioning the pond entirely to install SPSC (step pool storm conveyance).
- **Urban Filtering** - Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit.
- **Urban Tree Plantings** - Urban tree planting is planting trees on urban pervious areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting
- **Vegetated Open Channels** - Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff then releases it at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached pollutants. Until 2002 in Maryland, these practices were generally designed to meet water quantity, not water quality objectives. There is little or no vegetation within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.

The measured effectiveness for each of these practices may be found in Table 8.

Table 8: Typical Sediment Reduction from Stormwater BMPs

BMP	Sediment Reduction
Bioretention A/B soils	80%
Bioretention C/D soils	55%
Bioswales	80%
Dry Detention Ponds	10%
Dry Extended Detention Ponds	60%
Impervious Surface Reduction*	-
Infiltration	95%
Outfall Enhancement with SPSC**	80%
Stream Restoration	15.13 lbs/linear ft
Urban Filtering	80%
Urban Tree Plantings*	-
Vegetated Open Channels	70%
Wet Ponds or Wetlands	60%

Sources: Simpson and Weammert, 2009; and Maryland Assessment Scenario Tool (MAST) documentation
* Calculated as a land use change to a lower loading land use
**Outfall enhancement with SPSC modeled as bioswales in MAST

Along with the structural BMPs listed above, treatment will also be provided through non-structural measures. These are treatments that rely on programs that continue throughout the year and are repeated annually.

- **Inlet Cleaning -** Storm drain cleanout practice ranks among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with their NPDES stormwater permits. Sediment reduction credit is based on the mass of material collected, at the rate of 420 lb TSS per ton of wet material (MDE, 2014b).
- **Street sweeping** — Starting Fiscal Year 2015, Anne Arundel County has enhanced their street sweeping program which now includes sweeping curb-miles and parking lots within the Little Patuxent (Anne Arundel County DPW, 2015; Figure 8). This enhanced program targets impaired watersheds and curbed streets that contribute trash/litter, sediment, and other pollutants. For full credit by MDE, street sweeping should occur twice a month or 26 times a year on urban streets. This frequent sweeping of the same street will reduce nitrogen and phosphorus as well as sediment. Under the enhanced street sweeping program Anne Arundel County is sweeping arterial streets within the Little Patuxent watershed on a bi-weekly basis (26 times a year) and collector and local streets on a monthly basis (12 times a year). Vacuum-assisted street sweeping at a rate of 2 times per month reduces the load on the swept area by 25%. In order to quantify sediment load reductions from monthly sweeping efforts, the removal rate of 22% for vacuum-assisted monthly sweeping was applied to total sediment collected from collector and local streets (CWP, 2008).



Figure 8: Street Sweeping Routes in Anne Arundel County, Maryland

5 Expected Load Reductions (b)

WLAs in the sediment TMDL were developed using the Chesapeake Bay Program Phase 5 (CBP P5) watershed model. Currently, MAST is using a computational framework that is compatible with an updated version of the model: CBP P5.3.2. Because the TMDL was developed under an older version of the model, the TMDL WLA needed to be translated into a MAST-compatible target load. In order to do this, the 2005 baseline sediment load was re-calculated in MAST with the 8-digit county split geography (Little Patuxent 02131105, Anne Arundel County). The required reduction percent assigned to the Anne Arundel County Phase I MS4 source (20.5%) in the local TMDL regulation was then applied to the new baseline load to calculate required sediment reduction. The required sediment reduction was then subtracted from the new baseline load to calculate the MAST-compatible target TMDL WLA. Sediment loads required for the Little Patuxent Anne Arundel County Phase I MS4 source are shown in Table 9.

Table 9: Sediment Loads Required for the Little Patuxent River Local TMDL Anne Arundel County Phase I MS4 Source

2005 Baseline Load (lbs/yr)	Required Reduction %	Required Reductions (lbs/yr)	TMDL Load Allocation (lbs/yr)
1,207,534	20.5%	247,544	959,989

5.1 2015 Progress – Actual Implementation

Anne Arundel County maintains an extensive geodatabase of stormwater urban BMP facilities and water quality improvement projects (WQIP). Approximately 2,630 acres of County Phase I MS4 land has been treated through 2015 in addition to 10,504 linear feet of stream restoration and the implementation of other non-structural BMPs (source: WPRP urban BMP and WQIP database, 2014). Current BMP implementation through 2015 in the Little Patuxent is shown in Table 10. A list of completed projects is included in Appendix A.

Table 10: Current BMP Implementation through 2015 for Little Patuxent River

BMP	Unit	2015 Current Implementation
Bioretention	acre	8.0
Bioswale	acre	0.0
Dry Ponds	acre	582.5
Extended Detention Dry Ponds	acre	665.2
Impervious Surface Reduction	acre	2.7
Infiltration	acre	91.6
Inlet Cleaning	no. of inlets	202
Stormwater Retrofits[1]	acre	15.2
SW to the MEP	acre	0.0
Urban Filtering	acre	0.0

BMP	Unit	2015 Current Implementation
Urban Tree Plantings	acre	0.0
Urban Stream Restoration	linear feet	7,210
Vegetated Open Channels	acre	0.4
Wet Ponds or Wetlands	acre	1,078.6

Source: WPRP urban BMP and WQIP database

[1]Includes projects that will convert dry ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds.

2015 Progress results are shown in Table 11.

Table 11: 2015 Progress Reductions Achieved

Baseline Load and TMDL WLA	TSS-EOS lbs/yr
2005 Baseline Scenario Load	1,207,534
Required Percent Reduction	20.5%
Required Reduction	247,544
Local TMDL WLA	959,989
2015 Progress Results	**TSS-EOS lbs/yr**
2015 Progress Scenario Load	1,042,473
2015 Progress Reduction Achieved	165,061
2015 Percent Reduction Achieved	13.7%

5.2 Planned Implementation

Table 12 compares implementation of existing BMPs with planned levels of implementation. This increase in implementation will continue to achieve the loads required in the local TMDL and ensure that future growth (through 2025) is treated. These loads meet the TMDL required reductions for the Little Patuxent (Table 13). A list of completed projects and projects programmed out to FY19 is included in Appendix A.

Figure 9 shows baseline and progress loads (green bars) and planned loads (yellow bars) compared to milestone goal loads (red bars and red line). As discussed in Section 3.3: Anticipated Growth, initial conditions loads (2011 – 2015) without BMPs were modeled in MAST at the Little Patuxent 8-digit subwatershed scale.. This comparison shows that all background loads will be treated to the required TMDL allocated load with current and future BMP implementation.

Table 12: BMP Implementation - Current 2015 and Planned 2025 Levels for the Little Patuxent River

BMP	Units	2015 Current Implementation	2025 Planned Implementation
Bioretention	acre	8.0	-
Bioswale	acre	0.0	
Dry Ponds	acre	582.5	-
Extended Detention Dry Ponds	acre	665.2	-

BMP	Units	2015 Current Implementation	2025 Planned Implementation
Impervious Surface Reduction	acre	2.7	-
Infiltration	acre	91.6	101.1
Inlet Cleaning	no. of inlets	202	202
Outfall Enhancement with SPSC	acre	0.0	396.4
Stormwater Retrofits[1]	acre	0.0	15.2
Street Sweeping (parking lots)	acres	0.7	0.7
Street Sweeping (roads)[2]	curb-miles	26.0	26.0
SW to the MEP	acre	0.0	-
Urban Filtering	acre	0.0	-
Urban Tree Plantings	acre	0.0	-
Urban Stream Restoration	linear feet	7,210	11,100
Vegetated Open Channels	acre	0.4	-
Wet Ponds or Wetlands	acre	1,078.6	104.6

[1]Includes projects that will convert dry ponds or dry extended detention ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds

[2]Includes curb-miles for arterial, collector, and local streets. Arterial streets swept bi-weekly (26 times a year) and collector and local streets swept monthly (12 times a year).

Table 13: 2025 Planned Reductions

Baseline Load and TMDL WLA	TSS-EOS lbs/yr
2005 Baseline Scenario Load	1,207,534
Required Percent Reduction	20.5%
Required Reduction	247,544
Local TMDL WLA	959,989
2025 Planned Results	**TSS-EOS lbs/yr**
2025 Planned Load[1]	779,873
2025 Planned Reduction Achieved	427,661
2025 Percent Reduction Achieved	35.4%

[1]2025 Planned load is the 2025 Planned Reduction Achieved subtracted from the 2005 Baseline Loads. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and Accounting for Growth policies will address the remaining 10%.

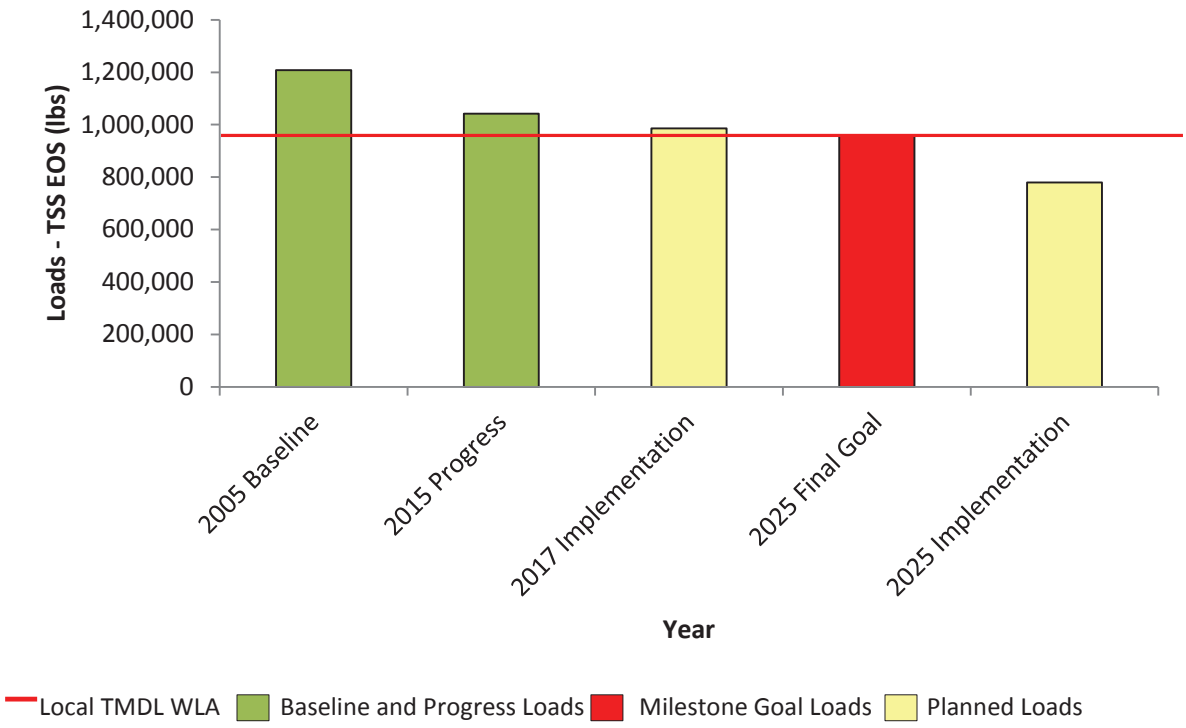


Figure 9: Progress and Planned Reductions in the Little Patuxent River Watershed

6 Technical and Financial Assistance Needs (d)

Technical Needs

Technical assistance to meet the reductions and goals of a TMDL takes on many forms including MDE assistance to local governments, state and local partner assistance to both MDE and municipalities, and technical consultants contracted to provide support across a wide variety of service areas related to BMP planning and implementation.

MDE has and will provide technical assistance to local governments through training, outreach and tools, including recommendations on ordinance improvements, technical review and assistance for implementation of BMPs at the local level, and identification of potential financial resources for implementation (MDE, 2014b).

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

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

Technical assistance for Public Participation and Education and for Monitoring will also be necessary to fully implement and track progress towards meeting the goals of the local TMDL. These elements are discussed in sections 7 and 10 of this plan.

Financial Needs

The total projected cost to implement the County's CIP projects described in this plan for the Little Patuxent watershed is $22,438,745 including $14,945,417 towards outfall enhancements with SPSC, $4,677,801 towards stormwater pond retrofits, $1,522,400 for inlet cleaning, and $1,293,127 for street sweeping. Structural BMP project costs are estimated based on the average cost per pound of nitrogen removed based on a group of completed projects consisting of various BMP types. Since these practices reduce nitrogen and phosphorus as well as sediment, costs derived from this method translate for sediment removal. This approach was used to calculate structural BMP costs in the County's Phase II WIP. Non-structural BMP costs for inlet cleaning and street sweeping were derived from historic County data and include equipment, operations, and maintenance costs.

Table 14 includes a summary of funding need per CIP project BMP type and project phase. Project cost is split throughout the implementation timeframe with design and land ROW estimated costs to occur the first year of the project, construction costs to occur in the second year, and overhead costs split between the first and second year.

Table 14: Little Patuxent River Cost Over Milestone Periods

BMP	2014-2015	2016-2017	2018-2019	2020-2021	2022-2025	Total Cost
Outfall Stabilization	**$532,944**	**$6,939,765**	**$7,472,709**			**$14,945,417**
Design	$289,015	$470,098	$759,113			$1,518,226
Land ROW	$57,803	$94,020	$151,823			$303,645
Construction		$6,072,904	$6,072,904			$12,145,808
Overhead	$186,126	$302,743	$488,869			$977,738
SWM Pond Retrofit	**$1,521,576**			**$1,578,113**	**$1,578,113**	**$4,677,801**
Design	$158,004			$160,312	$160,312	$478,628
Land ROW	$0			$32,062	$32,062	$64,125
Construction	$1,264,030			$1,282,497	$1,282,497	$3,829,024
Overhead	$99,542			$103,241	$103,241	$306,024
Inlet Cleaning	**$80,800**	**$80,800**	**$360,000**	**$360,000**	**$640,800**	**$1,522,400**
Street Sweeping	**$168,106**	**$168,106**	**$281,255**	**$281,255**	**$394,404**	**$1,293,127**

6.1 Funding Sources

Prior to the passage of Maryland House Bill 987 and, as stated in the Anne Arundel County Phase II WIP (Anne Arundel County, 2012), the County's funding capacity to implement urban stormwater restoration/retrofit projects was limited by the County's Capital Improvement Program (CIP) budget for

environmental restoration and water quality improvement projects. To comply with forthcoming requirements of the Phase I NPDES MS4 permit, and to support restoration efforts towards reducing pollutant loads required for both the Chesapeake Bay TMDL and local TMDLs throughout Maryland, the State Legislature passed a law in 2012 (House Bill 987) mandating that Maryland's 10 largest jurisdictions (those with Phase I MS4 permits), including Anne Arundel County, develop a Watershed Protection and Restoration Program and establish a Stormwater Remediation Fee. To comply with the State legislation, Anne Arundel County passed legislation in 2013, Bill 2-13.

The County's Stormwater Remediation Fee provides a dedicated source of revenue for the implementation of local stormwater management plans through stormwater management practices and stream and wetland restoration activities and is assessed to Anne Arundel County property owners based on the amount of impervious surface on their property. The Stormwater Remediation Fee is structured to provide sufficient funding for projects to meet the pollutant load reduction required by the Chesapeake Bay TMDL, EPA approved individual TMDLs with a stormwater WLA and to meet the impervious surface management requirements as well as other stormwater obligations set forth in the County's NPDES MS 4 Permit. The fee is assessed to Anne Arundel County property owners as a separate line item on the owner's real property tax bill.

In addition to the Stormwater Remediation Fee, Anne Arundel County actively pursues grant funding from Federal, State and non-governmental organizations (NGOs) to leverage funding for its restoration projects. And, with the creation of the Stormwater Remediation Fee, the County has developed a Grant Program to provide funding to local NGOs to facilitate implementation of restoration projects that further the County's ability to meet its regulatory requirements.

7 Public Participation / Education (e)

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

In order to implement an effective strategy to meet water quality standards and achieve pollutant load reduction, an effort to engage a very broad audience of landowners was a necessity. The Anne Arundel Watershed Stewards Academy (AAWSA), a pre-eminent non-profit (501(c)3) environmental organization, was formed through Anne Arundel County Department of Public Works and the County Board of Education's Arlington Echo Outdoor Education Center (Anne Arundel County, 2012). AAWSA's mission is to identify, train, and support citizens to become Master Watershed Stewards who take action with their neighbors to restore local waterways in Anne Arundel County. This program is a unique way to integrate education as a vital element in its role in preservation, conservation and advocacy. There are currently more than 100 certified Master Watershed Stewards throughout Anne Arundel County and adjacent areas.

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

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

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

These programs and others like them could be more focused on the Little Patuxent watershed.

In addition to the AAWSA, the following organizations have been identified for possible partnerships and education and outreach for the Little Patuxent:

- Master Gardeners
- Audubon Society
- Students for the Environment
- Maryland civic associations and service clubs:
    - Maryland Home Builders Assoc.
    - Audubon Naturalist Society of the Central Atlantic States
    - Audubon Society of Central Maryland
    - Blue Water Baltimore
    - Chesapeake Audubon Society
    - Chesapeake Bay Program
    - Chesapeake Bay Foundation

- Chesapeake Bay Trust
- Chesapeake Ecology Center
- Center for Watershed Protection
- Alliance for the Chesapeake Bay
- Alliance for Sustainable Communities
- Baywise Master Gardeners
- Sierra Club – Maryland Chapter
- Magothy River Association
- Patuxent Riverkeeper
- West/Rhode Riverkeeper
- Nature Conservancy
- Smithsonian Environmental Research Center
- Anne Arundel Community College
- University of Maryland
- University of Maryland Extension
- Volunteer Center for Anne Arundel County

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

Part 4.E.3 of the County's NPDES MS4 permit outlines requirements for public involvement in the development of TMDL restoration plans. The County will fulfill these requirements by providing notice in *The Capital* newspaper which serves all of Anne Arundel County. This notice will outline how the public may obtain information on the restoration plan and provide comments. The County will provide copies of the restoration plan to parties upon request. The County will provide for a minimum 30-day comment period before finalizing the plan and will include a summary in the text of the annual report of how the County addressed or will address any material comments received from the public.

8 Implementation Schedule and Milestones (f & g)

This section presents the target loads and the activities required to achieve those targets based on the 2017 interim and 2025 final loads and implementation targets. The following schedule and milestones follows the Chesapeake Bay TMDL milestone date framework (60% progress by 2017) and end date (2025; USEPA, 2010). This schedule has previously been approved by the CBP for the applicable Bay TMDLs and is believed to be a good option for tracking progress towards reduction goals of the Little Patuxent local TMDL.

8.1 Loading Allocations and Milestone Targets

Planning loads for 2017 and final loads for 2025 for the Little Patuxent watershed are presented in Table 15 below. As mentioned in Section 5: Expected Load Reductions (b) (see Tables 10 and 11), progress is already underway with the implementation of strategies throughout the watershed. As a result of current

implementation efforts, the 2015 Progress sediment load is greater than the 2025 TMDL Allocated load but 2015 reduction is 13.7%. The 2025 Planned Load is less than the 2025 TMDL Allocated load.

Table 15: Little Patuxent Planning and Target Loads (edge-of-stream loads)

Load	Sediment Load (lbs/year)
2005 Baseline Load	1,207,534
2015 Progress Load	1,042,473
2017 Planned Load	986,043
2025 Planned Load	779,873
2025 TMDL Allocated Load	959,989
Percent Reduction between 2005 Baseline and 2025 Loads	20.5%

8.2 Implementation Milestones

To meet the loading allocations and milestones outlined in the previous section, implementation of programs and BMPs must keep pace and meet planned implementation targets. Table 16 details the implementation for each tracked BMP with the associated unit of measure. The 2015 data reflects existing BMPs while the 2017, 2021, and 2025 values reflect the planned implementation for those years. A list of completed projects and projects programmed out to FY19 is included in Appendix A.

The majority of 2025 planned management strategies incorporate CIP stormwater retrofits and outfall enhancement projects. Feasibility studies of the planned strategies may reveal that some existing structures identified for retrofitting or enhancement may not be feasible candidates for future projects and may be eliminated from consideration. The County will take an adaptive management approach and will reevaluate treatment needs as feasibility studies progress. The County will continue to track the overall effectiveness of the various BMP strategies and will adapt the suite of solutions based on the results. In addition, new technologies are continuously evaluated to determine if the new technologies allow more efficient or effective pollution control.

Table 16: Little Patuxent Planning Milestones for Implementation

BMP	Unit	2015 Implemen-tation	2017 Planned	2021 Planned	2025 Planned	Total Implemen tation
Bioretention	acre	8.0				8.0
Bioswale	acre	0.0				0.0
Dry Ponds	acre	582.5				582.5
Extended Detention Dry Ponds	acre	665.2				665.2
Impervious Surface Reduction	acre	2.7				2.7
Infiltration	acre	91.6				192.7
Inlet Cleaning	no. of inlets/yr	202	202	202	202	202

BMP	Unit	2015 Implemen-tation	2017 Planned	2021 Planned	2025 Planned	Total Implemen tation
Outfall Enhancement with SPSC	acre	0.0	211.6		184.8	396.4
Stormwater Retrofits[1]	acre	15.2	77.9		89.9	15.2
Street Sweeping (parking lots)	acre	0.7	0.7	0.7	0.7	0.7
Street Sweeping (roads)[2]	curb-miles	26.0	26.0	26.0	26.0	26.0
SW to the MEP	acre	0.0				
Urban Filtering	acre	0.0				
Urban Tree Plantings	acre	0.0				
Urban Stream Restoration	linear feet	7,210		10,000	1,100	18,310
Vegetated Open Channels	acre	0.4				0.4
Wet Ponds or Wetlands	acre	1,078.6	1,183.2			1,183.2

[1]Includes projects that will convert dry ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds.
[2]Includes curb-miles for arterial, collector, and local streets. Arterial streets swept bi-weekly (26 times a year) and collector and local streets swept monthly (12 times a year)

8.3 Implementation Priorities

To meet the loading allocations and milestones outlined in the previous sections, implementation will be planned based on prioritization analyses presented in the Little Patuxent Watershed Assessment (Anne Arundel, 2014 DRAFT). Little Patuxent subwatersheds were prioritized for restoration/retrofit project selection potential using three separate prioritization models. The models integrated historical environmental data, current stream assessment monitoring data, drainage area characteristics (GIS data), and watershed modeling results into indicators of watershed condition and need. The indicators are combined into the three models:

- Stream Reach Restoration
- Subwatershed Restoration
- Subwatershed Preservation

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

8.3.1 Stream Reach Restoration

The stream restoration prioritization uses a suite of indicators that are weighted and then combined into a final relative rating for each perennial reach as identified in the Physical Habitat Condition Assessment.

The suite of stream restoration indicators used in the Little Patuxent watershed, along with the indicator weight is presented in Table 17.

Table 17: Stream Restoration Assessment Indicators (Anne Arundel, 2014 DRAFT)

Category	Indicator	Weight
Stream Habitat	MPHI score	31.6%
Stream Morphology	Rosgen Level I classifications	5.3%
Land Cover	Percent Imperviousness	5.3%
Infrastructure	Riparian Buffer impacts	5.3%
	Channel erosion impacts	10.5%
	Head cut impacts	5.3%
	Dump site impacts	5.3%
	Other infrastructure impacts (pipes, ditches, crossings, and obstructions)	15.8%
Hydrology and Hydraulics	Road Crossing flooding potential	15.8%

A total of 304 reaches were processed in the stream restoration model. Ten reaches were categorized as "High" priority or worst condition, 62 were "Medium High", 117 were "Medium", and 115 were "Low" priority or best condition (Table 18 and Figure 9). The Towsers Branch subwatershed ranked as a very high priority overall, as six of the ten "High" reaches and 25% of "Medium High" reaches are located in Towsers Branch. The Piney Orchard and Crofton Golf subwatersheds had a combined total of 26 reaches (42%) rated in the "Medium High" category.

Table 18: Stream Restoration Assessment Results (Anne Arundel County, 2014 Draft)

	Number of Reaches with Priority Rating			
Subwatershed	High	Medium High	Medium	Low
LP0		3	1	5
LP1	Not Assessed			
LP2		1	3	4
LP3	2	10	7	4
LP4			3	1
LP5	Not Assessed			
LP6	No Perennial Reaches			
LP7			5	12
LP8		2	4	5
LP9			12	5
LPA		1	10	16
LPB			1	11
LPC	4	6	9	3
LPD		2	14	5

Subwatershed	Number of Reaches with Priority Rating			
	High	Medium High	Medium	Low
LPE	3	12	14	3
LPF			6	10
LPG	1	14	17	13
LPH			1	8
LPI			3	2
LPJ		6	4	7
LPK		5	3	1
Total	**10**	**62**	**117**	**115**

8.3.2 Subwatershed Restoration

Similarly to the stream restoration assessment, the subwatershed assessment used a collection of restoration indicators to assign a rating to each subwatershed. The indicators were weighted and combined into a single restoration rating for each subwatershed. Restoration indicators fell into one of six categories: stream ecology, TMDL impairments, On-site Disposal Systems (OSDS), BMPs, Hydrologic and Hydraulic (H&H) Modeling, Water Quality, and Landscape. Each category contains one to four different indicators. Table 19 provides a summary of the categories, indicators, and relative weighting assigned by the County.

Table 19: Subwatershed Priority Rating Indicators for Restoration (Anne Arundel, 2014 DRAFT)

Category	Indicator	Weight
Stream Ecology	Final habitat score	7.5%
	Bioassessment score	7.5%
303(d) List	Number of TMDL impairments	7.5%
OSDSs (Septics)	Nitrogen Loads from septics (lbs)	9.3%
BMPs	Impervious area treated by BMPs (%)	6.6%
H&H (Land and Soils only)	Peak flow from 1-year storm event (cfs/acre)	4.5%
	Peak flow from 2-year storm event (cfs/acre)	4.5%
	Runoff volume from 1-year storm event (inches/acre)	5.8%
	Runoff volume from 2-year storm event (inches/acre)	5.8%
Water Quality (Land only)	Nitrogen load from runoff (lbs/acre/yr)	6.9%
	Phosphorus load from runoff (lbs/acre/yr)	6.9%
	Total Suspended Solids from runoff (Tons/acre/yr)	0.0%
Landscape	Impervious cover (%)	9.4%
	Forest within the 100 ft stream buffer (%)	10.3%
	% of existing wetlands to potential wetlands	9.4%
	Acres of developable critical area	5.3%

The final ratings range from “Lowest Priority for Restoration” to “Highest Priority for Restoration” where “Lowest Priority” indicates that a subwatershed is a low priority for restoration and therefore in good

condition whereas “Highest Priority” indicates that a subwatershed should be a priority for restoration. The Little Patuxent 2 (LP0) and Jessup (LPK) subwatersheds were rated the highest priority for restoration. Three watersheds, LP7, LP8, and LPH were rated the lowest priorities for restoration (Figure 10). It is also important to focus restoration efforts in subwatershed that ranked highest for existing TSS loads from urban runoff, which include subwatersheds LP4, LP6, LP9, LPG, and LPI (Figure 5).

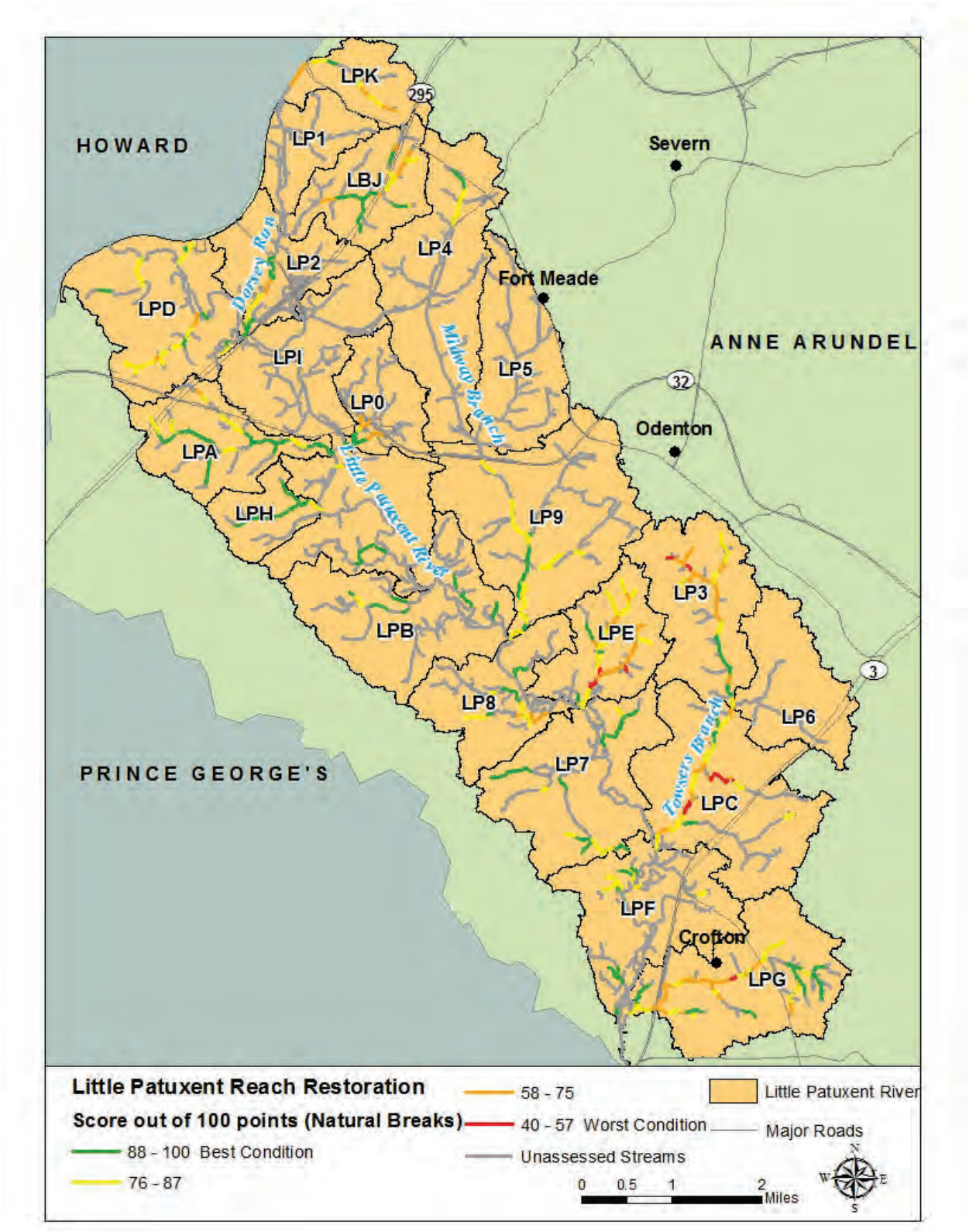


Figure 10: Stream Restoration Assessment Results (Anne Arundel County, 2014 Draft)

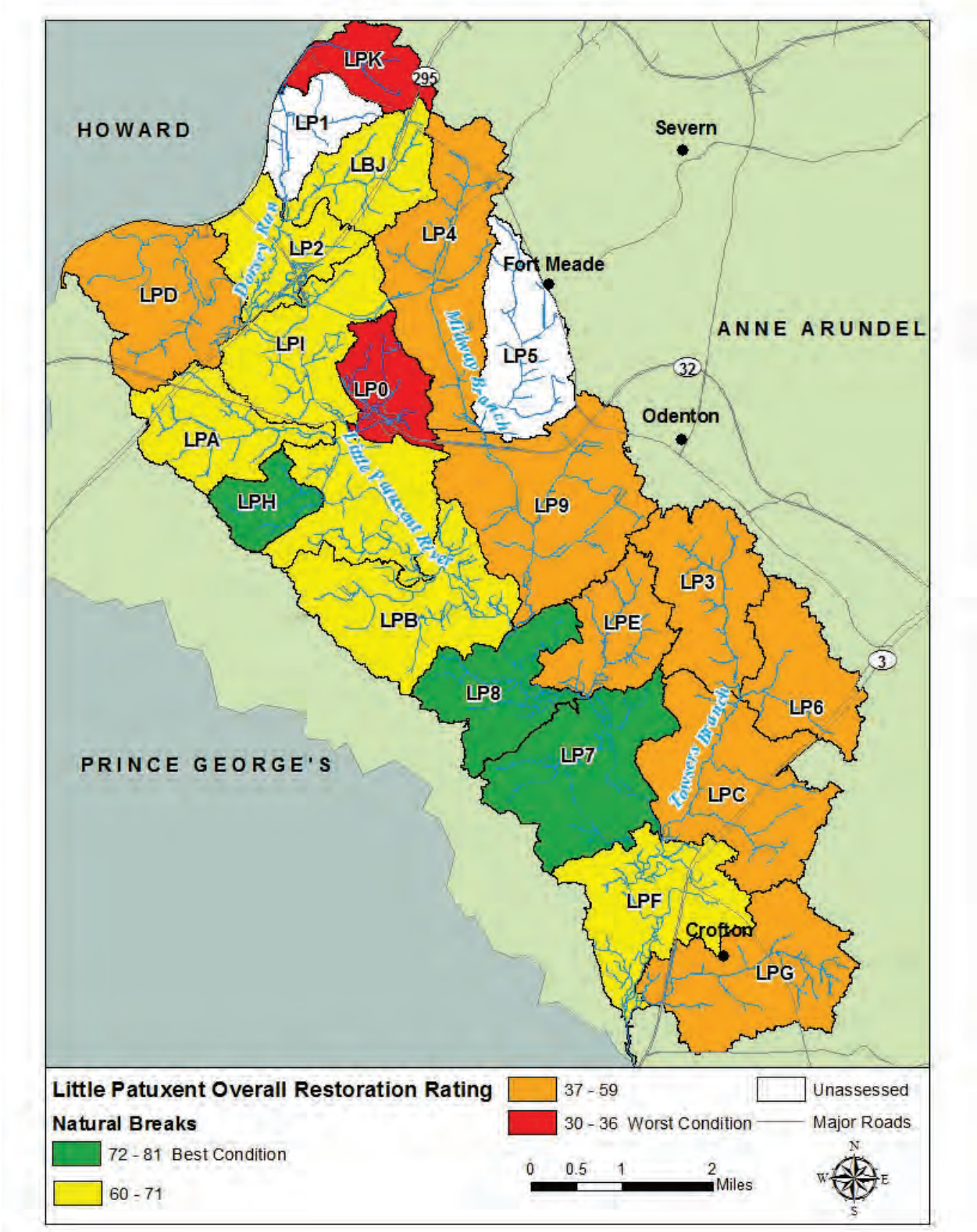


Figure 11: Subwatershed Restoration Assessment Results (Anne Arundel County, 2014 Draft)

8.3.3 Prioritization of Strategy Implementation

As stated in the Anne Arundel County's Phase II WIP, the County uses three major categories to classify urban stormwater strategies: Core Strategy Tier I, Core Strategy Tier II, and Potential Load Reductions Outside the Tier I and Tier II Core Strategy (Anne Arundel County, 2012). BMP planning and implementation will be prioritized based on these three categories with highest priority given to Tier I and Tier II strategies.

Core Urban Stormwater Strategy Tier I includes the following:

- Restoration of ephemeral and perennial streams with a Department of Natural Resources (DNR) Maryland Biological Stream Survey's (MBSS) Maryland Physical Habitat Index (MPHI) score of severely degraded or degraded,
- Implementing stormwater management treatment at currently untreated major pipe outfalls; and,
- Retrofitting stormwater management ponds built prior to 2002 to optimize the pollutant reduction and ecosystem functions for the facilities

Core Urban Stormwater Strategy Tier II includes additional pollutant reduction activities that must be implemented to meet the 2025 allocations; which includes the following:

- Monthly vacuum assisted street sweeping and associated inlet cleaning for all closed section roads,
- Reforestation plan for available public open space land; and,
- SW to the MEP retrofits for County-owned properties including recreation areas

Potential Load Reductions Outside the Tier I and Tier II Core Strategies includes the following:

- Focuses on the work of private citizens and Watershed Master Stewards in implementing SW to the MEP for residential rooftops, in high density areas, and for private commercial and industrial properties.
- These areas have been selected geographically outside the area treated by the WIP core strategy.

8.4 Implementation Strategy

Following the adoption of its Stormwater Remediation Fee in 2013 Anne Arundel County developed a 6-year Capital Improvement Program (CIP) in FY14 that created a Watershed Protection and Restoration Program (WPRP) Class of projects to implement those restoration projects identified in the County's Phase II WIP and applicable individual TMDLs for achieving stormwater WLAs. Funding for this class of projects averages 74 million dollars annually. Project in the WPRP Class were identified and prioritized through a planning level assessment and consist of restoration of ephemeral and perennial streams with a MBSS Maryland Physical Habitat Index (MPHI) score of severely degraded or degraded; implementation of stormwater/water quality treatment at currently untreated stormwater pipe outfalls (greater than 24 inches), and retrofit of stormwater management ponds built prior to 2002, with drainage areas in excess of 10 acres, to optimize pollutant reduction and ecosystem functions for the facilities. As WPRP projects are funded, more detailed feasibility and constructability assessments are conducted. These assessments may result in identifying projects previously thought to be implementable but due to a variety of reasons are not; or identifying additional and new opportunities for load reduction. As these feasibility assessments are completed the County incorporates these findings into its modeling, re-assesses anticipated load reductions and adapts it implementation program to delete or add projects and amends

its CIP accordingly. And, as BMP technologies and efficiencies change, programs mature, credit trading is enacted and new regulations put into place, the County will reassess and modify its restoration strategy in response.

9 Load Reduction Evaluation Criteria (h)

Adaptive management is a critical component of achieving the WLAs required by the *Total Maximum Daily Load of Sediment in the Patuxent River Upper Watershed, Anne Arundel, Howard and Prince George's Counties, Maryland, Approved by EPA September 30, 2011*. This TMDL has clearly established load reduction targets for sediment. 2-Year Implementation Milestones have been established by the County to provide interim planning targets and to serve as a vehicle for assessing progress toward the load reduction targets. Progress will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring. Planning targets will be re-evaluated against progress and revised to ensure that Anne Arundel County is on track to meet established goals. Progress assessments are scheduled for 2017 and 2021, with 2025 set as the final date for achievement of load reductions.

The milestones proposed in Section 8: Implementation Milestones (2015, 2017, and 2021) provide interim planning targets. The planning targets will be used to reevaluate against progress and will be revised, if necessary, to ensure that Anne Arundel County continues to maintain TMDL requirements. Progress evaluation will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring.

9.1 Tracking Implementation of Management Measures

Implementation will be measured by determining whether the targets for implementation shown in Table 16 are maintained according to the milestone schedule presented. Anne Arundel County manages a comprehensive system for adding and tracking projects and accounting for new programs. New BMPs constructed through new development and redevelopment projects are entered into the County's BMP database as they come on line. WPRP is responsible for implementing and tracking Water Quality Improvement Projects (WQIP; i.e., restoration and retrofit projects and programs). Additional internal County groups including Bureau of Highway Road Operation Division who are responsible for maintenance efforts (i.e., street sweeping and inlet cleaning) report back to WPRP. Another way the County is capturing and tracking projects is through the AAWSA. Watershed stewards can enter their own data and implementation projects through the WPRP website (www.aarivers.org). Once these data are reviewed and validated by the County, they are incorporated into the County's master list of environmental restoration projects.

Two-Year Milestone Reporting

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

Milestones are reported in two forms: Programmatic and BMP Implementation. Programmatic milestones identify the anticipated establishment or enhancement of the institutional means that support and enable

implementation. Examples of Programmatic milestones include projected funding, enhancement of existing programs and resources, and the establishment of new programs and studies. The milestone period for Programmatic covers two calendar years – for example, the period for 2014 -2015 is from January 1, 2014 through December 31, 2015. BMP Implementation milestones are a quantitative account of various types of restoration activities (e.g., structural BMPs, stream restoration, maintenance efforts), which have geo-located coordinates. The period for BMP implementation milestones differs from the Programmatic milestones period and covers two state fiscal years – for example, the period for 2014 – 2015 is from July 1, 2013 through June 30, 2015. Planned BMP Implementation milestones reported to MDE include the action (e.g., BMP type), proposed restoration over the 2-year milestone period (e.g., area treated, length restored), actual rate of implementation over 1 year, and percent progress.

The Programmatic and BMP Implementation milestone submittal and reporting process follows an iterative approach and includes three separate submittals to MDE. The first is an initial milestone submittal to MDE by January 31st of the first milestone calendar year (e.g., 2014), followed by an interim milestone progress report submittal by January 31st of the second milestone calendar year (e.g., 2015), and concluding with a final milestone progress submittal by January 31st of the start of the subsequent milestone period (e.g., 2016).

Annual NPDES Reporting

As a requirement of the NPDES permit described in Section 2.4.4, the County must submit on or before the anniversary date of the permit a progress report demonstrating the implementation of the NPDES stormwater program based on the fiscal year. If the County's annual report does not demonstrate compliance with their permit and show progress toward meeting WLAs, the County must implement BMP and program modifications within 12 months.

The annual report includes the following – items in bold font directly relate to elements of the load reduction evaluation criteria:

a. The status of implementing the components of the stormwater management program that are established as permit conditions including:
    i. Source Identification
    ii. Stormwater Management
    iii. Erosion and Sediment Control
    iv. Illicit Discharge Detection and Elimination
    v. Litter and Floatables
    vi. Property Management and Maintenance
    vii. Public Education
    viii. Watershed Assessment
    ix. Restoration Plans
    x. TMDL Compliance
    xi. Assessment of Controls; and,
    xii. Program Funding

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

c. Expenditures for the reporting period and the proposed budget for the upcoming year

d. A summary describing the number and nature of enforcement actions, inspections, and public education programs

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

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

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

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

9.2 Estimating Load Reductions

Progress assessments are scheduled by the Chesapeake Bay Program for 2017 and 2021. At this time, multiple lines of evidence including: several models, monitoring data, and the most recent science on BMP effectiveness and water quality response will be evaluated. The milestones and progress assessments will contribute to constant reassessment of management plans, and adapting responses accordingly as technologies and efficiencies change, programs mature, credit trading is enacted, and regulations are put in place. The County will model load reductions in MAST at the interim (2014, 2016, 2018) and milestone (2015, 2017, 2019) years, which equates to about once a year at minimum.

9.3 Tracking Overall Program Success through Monitoring

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

9.4 Best Management Practices Inspection and Maintenance

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

Background

Both the State and County SWM Codes require maintenance inspections be performed on all SWM practices during the first year of operation and every 3 years thereafter. The first year of operation inspections are performed by the Environmental Control Inspectors before Certificates of Completion is issued for the grading permits under which the practices were constructed. The 3-year maintenance inspections are the responsibility of the WPRP inspection staff.

Phase 1 Inspection and Enforcement

Phase 1 reflects the first time a SWM practice receives a 3-year maintenance inspection and maintenance is required. Using the proper Maintenance Inspection Checklists the Inspector performs the required 3-year maintenance inspection indicating on the Checklist boxes if maintenance is required, not required or the item is non-applicable. The information on the completed Checklist will serve to comply with the inspection requirements of COMAR 26.17.02.11 and be used to complete a Phase 1 Correction Notice issued in the field or mailed to the property owner. The Phase 1 Correction Notices shall be prepared using the I&P standard computerized inspection report software, contain a detailed description of the maintenance required and the compliance date by which the required maintenance is to be completed. If necessary Phase 1 Correction Notices can be completed by hand using the standard Environmental Programs Inspection Report Form. Phase 1 Correction Notices shall contain the proper contact information, be written in a clear and concise fashion with no speculation, editorial comments or superfluous information. The Urban BMP Database shall be updated to show a 3-year Maintenance Inspection was performed. For monthly reporting purposes, all re-inspections shall only be recorded as inspections and not as facilities inspected or as new correction notices issued. Depending on the degree of maintenance required, a Compliance Schedule may be appropriate. All proposed Compliance Schedules must be authorized by the WPRP Supervisor.

Phase 2 Inspection and Enforcement

Phase 2 reflects situations where Phase 1 Enforcement was not successful in obtaining compliance. Phase 2 Enforcement consists of a formal Phase 2 Violation Notice in the form of a certified letter to the property owner or responsible party. The Phase 2 Violation Notice shall be prepared by the WPRP Inspector using the appropriate form letter, reviewed by the WPRP Supervisor/Environmental Code Administrator as appropriate and signed by the WPRP Supervisor. The Phase 2 Notice shall establish final compliance dates for the completion of the required maintenance. The final compliance dates may reflect agreed upon Compliance Schedules as authorized by the WPRP Supervisor.

Phase 3 Inspection and Enforcement

Phase 3 reflects situations where Phase 2 Enforcement was not successful in obtaining compliance. Phase 3 enforcement consists of a legal referral to the Office of Law for the enforcement of the Private Inspection and Maintenance Agreement recorded against the deed for the property in question. The referral shall be prepared by the Environmental Code Administrator using the records associated with the violation.

10 Monitoring (i)

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

To determine the specific parameters to be monitored for tracking progress, one must understand the approach used for the initial listing. The Little Patuxent was originally listed for sediments in 1996 as a suspended sediment listing. This was refined in 2008 to a listing for total suspended solids. In 2002, the State began listing biological impairments on the Integrated Report, at the 8-digit scale, based on a percentage of stream miles degraded and whether they differ significantly from a reference condition watershed (<10% stream miles degraded). The biological listing is based on Benthic and Fish Indices of Biotic Integrity (BIBI/FIBI) results from wadeable streams from assessments conducted by the Maryland Department of Natural Resources (MDNR) Maryland Biological Stream Survey (MBSS). The Little Patuxent was listed for biological community impairment in 2006.

MDE then utilized its Biological Stressor Identification (BSID) process to identify the probable or most likely causes of poor biological conditions. For sediment specifically, the BSID identified 'altered hydrology and increased urban runoff have resulted in degradation to streambed morphology, streambed scouring, and subsequent elevated suspended transport through the watershed.' Overall, the results indicated inorganic pollutants (i.e. chlorides, acute ammonia, sulfate), and flow/sediment related stressors as the primary stressors causing impacts to biological communities.

Based on the results of the BSID, MDE replaced the biological impairment listing with a listing for total suspended solids (TSS). The 2012 final and 2014 draft integrated reports lists 'Habitat Evaluation' as the indicator, and urban runoff/storm sewers as the source. It is noted that the *Decision Methodology for Solids for the April 2002 Water Quality Inventory (updated in February of 2012)*[1], makes a specific distinction between two different, although related 'sediment' impairment types in free flowing streams:

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

With these two sediment impairments in mind the Little Patuxent, which is listed as impaired for TSS, would seem to be water clarity issue; however the methodology used for listing (biological and habitat measures related sediment deposition) seems to point to an in-stream sediment deposition problem. In all likelihood both types of impairment, water clarity and sedimentation, are factors and both should be incorporated into monitoring programs to track changes in the watershed condition over time.

Anne Arundel County's Watershed Protection and Restoration Program (WPRP) has several on-going monitoring programs that target measures of water clarity and sedimentation. These programs are described here.

Countywide Biological Monitoring

In 2004, a Countywide Biological Monitoring and Assessment Program for Anne Arundel County, Maryland was developed to assess the biological condition of the County's streams at multiple scales (i.e., site-specific, primary sampling unit (PSU), and countywide). Under the Countywide Biological Monitoring and Assessment program, biology (i.e., benthic macroinvertebrates) and stream habitat, as well as geomorphological and water quality parameters, are assessed at approximately 240 sites throughout the entire County over a 5-year period using a probabilistic, rotating-basin design. Round One of the County's Biological Monitoring and Assessment Program occurred between 2004 and 2008, and Round Two took place between 2009 and 2013. Round Three is scheduled to be conducted beginning in 2016.

[1] http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/AM_Solids_2012.pdf

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

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

The Little Patuxent watershed is made up of one PSU – Little Patuxent. Ten sampling sites were sampled in each of these PSUs in each round of sampling. Methodologies follow those used by MBSS for the biological sampling (benthic macroinvertebrates only) and habitat evaluations have included both MBSS's Physical Habitat Index (PHI) and the EPA's Rapid Bioassessment Protocol (RBP) metrics. In-situ water quality measures are also collected at each site along with a geomorphic evaluation utilizing cross-sections, particle substrate analysis using pebble counts, and measures of channel slope.

Following these procedures, the County is collecting several parameters related to water clarity and sediment deposition at each site.

- Water Quality Measures and Observations
  - Turbidity (measured), observations of general water clarity and color
- Biological Measures
  - Benthic macroinvertebrates (BIBI)
- Habitat Measures
  - General: bar formation and substrate, presence/absence of substrate type
  - PHI: epibenthic substrate, instream habitat
  - RBP: epifaunal substrate / available cover, pool substrate characterization, sediment deposition, channel alteration
- Geomorphic Measures
  - Particle size analysis using modified Wolman pebble counts at 10 transects proportioned by channel bed features

Results summarized at the PSU scale with mean BIBI and habitat ratings (PHI and RBP) are presented in Table 20.

Table 20: Countywide Biological Monitoring Results for Little Patuxent River

PSU Name	Round	PSU Code	Year Sampled	Drainage Area (acres)	BIBI Rating	PHI Rating	RBP Rating
Little Patuxent	1	17	2007	28,196	P	D	PS
Little Patuxent	2	17	2009	28,196	P	PD	PS

BIBI Ratings: G = Good, F = Fair, P = Poor, VP = Very Poor

PHI Ratings: MD = Minimally Degraded, PD = Partially Degraded, D = Degraded, SD = Severely Degraded

RBP Ratings: C = Comparable, S = Supporting, PS = Partially Supporting, NS = Non-Supporting

Restoration Monitoring

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

Watershed Assessment

In 2001, Anne Arundel County initiated a series of systematic and comprehensive watershed assessments and management plans for restoration and protection across the County. The plans are developed within a regulatory context that includes NPDES MS4 requirements, local TMDLs and Watershed Implementation Plans for the Chesapeake Bay TMDL, Maryland Stormwater Regulations and the Water Resources Element of the County's General Development Plan.

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

The WAP program's stated goals include:

- Characterize subwatersheds;
- Prioritize subwatersheds for preservation and restoration; and
- Inform stressor-response relationships for planning and modeling.

The County continues to reevaluate its monitoring programs as the state of the science progresses, as the understanding of water quality and ecological interactions are improved, and as regulatory programs are added or modified. The WPRP is currently reviewing the Countywide monitoring program to ensure that the methods used are appropriate and meaningful, and that TMDL and NPDES requirements continue to be met.

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Appendix A: Little Patuxent Project List

Status	StormID# or TBD# or Outfall #	Watershed (8-digit Number)	Watershed (8-digit Name)	BMP Type	Drainage Area [acres]	Impervious Drainage Area [acres]	Pervious Drainage Area [acres]	Linear Feet for Stream Restoration	Annual Report Fiscal Year (completed projects only)	Estimated Completion Fiscal Year
Construction Complete	171	02131105	Little Patuxent River	Bioretention	0.05	0.01	0.03		FY2013	
Construction Complete	172	02131105	Little Patuxent River	Bioretention	0.05	0.00	0.05		FY2013	
Construction Complete	175	02131105	Little Patuxent River	Bioretention	0.03	0.03	0.00		FY2013	
Construction Complete	177	02131105	Little Patuxent River	Bioretention	0.04	0.03	0.00		FY2013	
Construction Complete	178	02131105	Little Patuxent River	Bioretention	0.03	0.03	0.00		FY2013	
Construction Complete	180	02131105	Little Patuxent River	Bioretention	0.77	0.53	0.24		FY2013	
Construction Complete	182	02131105	Little Patuxent River	Bioretention	0.39	0.10	0.28		FY2013	
Construction Complete	183	02131105	Little Patuxent River	Bioretention	0.08	0.03	0.05		FY2013	
Construction Complete	184	02131105	Little Patuxent River	Bioretention	1.32	0.97	0.34		FY2013	
Construction Complete	185	02131105	Little Patuxent River	Bioretention	0.67	0.46	0.20		FY2013	
Construction Complete	186	02131105	Little Patuxent River	Bioretention	0.91	0.42	0.49		FY2013	
Construction Complete	187	02131105	Little Patuxent River	Bioretention	0.68	0.26	0.42		FY2013	
Construction Complete	188	02131105	Little Patuxent River	Bioretention	0.42	0.12	0.30		FY2013	
Construction Complete	190	02131105	Little Patuxent River	Bioretention	2.35	0.99	1.37		FY2013	
Construction Complete	189	02131105	Little Patuxent River	Rain Barrel	0.09	0.08	0.01		FY2013	
Construction Complete	343	02131105	Little Patuxent River	Bioretention	0.27	0.09	0.18		FY2013	
Construction Complete	174	02131105	Little Patuxent River	Rain Barrel	0.03	0.03	0.00		FY2013	
Construction Complete	176	02131105	Little Patuxent River	Rain Barrel	0.03	0.03	0.00		FY2013	
Construction Complete	173	02131105	Little Patuxent River	Rain Barrel	0.04	0.03	0.00		FY2013	
In Planning	249	02131105	Little Patuxent River	Rain Barrel	0.05	0.05	0.00		FY2013	
Construction Complete	428	02131105	Little Patuxent River	Rain Barrel	0.02	0.02	0.00		FY2013	
Construction Complete	421	02131105	Little Patuxent River	Rain Barrel	0.04	0.03	0.00		FY2013	
Construction Complete	422	02131105	Little Patuxent River	Rain Barrel	0.01	0.01	0.00		FY2013	
Construction Complete	423	02131105	Little Patuxent River	Rain Barrel	0.03	0.03	0.00		FY2013	

Status	StormID# or TBD# or Outfall #	Watershed (8-digit Number)	Watershed (8-digit Name)	BMP Type	Drainage Area [acres]	Impervious Drainage Area [acres]	Pervious Drainage Area [acres]	Linear Feet for Stream Restoration	Annual Report Fiscal Year (completed projects only)	Estimated Completion Fiscal Year
Construction Complete	486	02131105	Little Patuxent River	Rain Barrel	0.01	0.01	0.00		FY2013	
Construction Complete	181	02131105	Little Patuxent River	Infiltration	0.07	0.07	0.00		FY2013	
Construction Complete	111	02131105	Little Patuxent River	SWM Retrofit	15.24	6.38	8.86		FY2013	
Construction Complete	25	02131105	Little Patuxent River	Stream Restoration				900	FY2013	
Construction Complete	9	02131105	Little Patuxent River	Stream Restoration				2016	FY2013	
Construction Complete	7	02131105	Little Patuxent River	Stream Restoration				1494	FY2013	
Construction Complete	261	02131105	Little Patuxent River	Stream Restoration				1000	FY2013	
Construction Complete	27	02131105	Little Patuxent River	Stream Restoration				1800	FY2013	
Construction Complete	AA29	02131105	Little Patuxent River	Dry Extended Detention Pond	60.95	17.33	43.63		FY2014	
Construction Complete	AA671	02131105	Little Patuxent River	Wet Pond	5.51	2.51	3.00		FY2014	
Construction Complete	AA6045	02131105	Little Patuxent River	Wet Pond	23.08	9.23	13.85		FY2014	
Construction Complete	AA6046	02131105	Little Patuxent River	Wet Pond	6.10	2.44	3.66		FY2014	
In Design	AA6047	02131105	Little Patuxent River	Wet Pond	8.34	3.34	5.00		FY2014	
Construction Complete	AA7131	02131105	Little Patuxent River	Wet Pond	34.48	17.41	17.07		FY2014	
Construction Complete	AA7132	02131105	Little Patuxent River	Wet Pond	1.35	0.41	0.94		FY2014	
Construction Complete	AA7133	02131105	Little Patuxent River	Wet Pond	0.31	0.12	0.18		FY2014	
Construction Complete	AA8627	02131105	Little Patuxent River	Wet Pond	117.60	47.04	70.56		FY2014	
In Design	1326	02131105	Little Patuxent River	Wet Pond	20.9	0.00	20.90			FY2016
In Planning	30	02131105	Little Patuxent River	Wet Pond	6.73	3.19	3.54			FY2016
In Planning	471	02131105	Little Patuxent River	Wet Pond	8.31	1.79	6.52			FY2016
In Design	J18O016	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	no data	no data	no data			FY2016
In Design	2-TBD	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	no data	no data				FY2017
In Planning	TBD	02131105	Little Patuxent River	Outfall Stabilization / Step Pool Stormwater Conveyance	no data	no data				FY2017

Status	StormID# or TBD# or Outfall #	Watershed (8-digit Number)	Watershed (8-digit Name)	BMP Type	Drainage Area [acres]	Impervious Drainage Area [acres]	Pervious Drainage Area [acres]	Linear Feet for Stream Restoration	Annual Report Fiscal Year (completed projects only)	Estimated Completion Fiscal Year
In Design	2527	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	no data	no data				FY2017
In Design	29	02131105	Little Patuxent River	Wet Pond	60.87	18.77	42.10			FY2017
In Design	5705	02131105	Little Patuxent River	Wet Pond	7.71	2.66	5.05			FY2017
In Design	I14O0009	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	114.13	45.5	68.63			FY2017
In Design	I15O0018	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	6.46	3.24	3.22			FY2017
In Design	J18O0015	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	91	43.79	47.21			FY2017
In Planning	I13O0002	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	No Data	No Data	no data			FY2018
In Planning	I13O0006	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	3.7	2.27	1.43			FY2018
In Planning	I13O0008	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	8.43	3.99	4.44			FY2018
In Planning	I13O0018	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	8.54	3.72	4.82			FY2018
In Planning	I13O0020	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	3.55	2.07	1.48			FY2018
In Planning	I13O0037	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	No Data	No Data	No data			FY2018
In Planning	I14O0003	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	74.15	29.14	45.01			FY2018
In Planning	I14O0004	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	2.99	1.26	1.73			FY2018
In Planning	I14O0005	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	4.33	1.97	2.36			FY2018
In Planning	I14O0013	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	48.14	24.97	23.17			FY2018
In Planning	I18O0006	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	6.65	3.04	3.61			FY2018
In Planning	I18O0007	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	5.51	2.26	3.25			FY2018
In Planning	I18O0008	02131105	Little Patuxent River	Step Pool Stormwater Conveyance	18.8	7.91	10.89			FY2018
In Planning	TBD	02131105	Little Patuxent River	Stream Restoration				2300		FY2018
In Design	TBD	02131105	Little Patuxent River	Stream Restoration				8800		FY2018

Appendix B: Anne Arundel County Sediment Local TMDL Restoration Plans – Response to MDE Comments

Anne Arundel County Sediment Local TMDL Restoration Plans
Response to Comments
Maryland Department of the Environment Comments Received May 19, 2015

County comments addressed in **bold blue** text.

Attachment 1

Permit Conditions: Part IV.E Restoration Plans and Total Maximum Daily Loads (TMDLs)
MDE Assessment and Recommendations

- Restoration Plans: MDE's comments on the County's impervious surface assessment and associated restoration effort (Part IV.E.2.a) were attached to the March 31, 2015 letter. As discussed in that letter, comments on the impervious surface area assessment shall be addressed by May 26, 2015. The following are MDE's general comments on the restoration plans for stormwater wasteload allocations (WLAs) required under Part IV.E.2.b of the current permit:
    - Anne Arundel County submitted individual plans to address the sediment total maximum daily loads (TMDLs) for the Upper Patuxent River, Little Patuxent River, and the Lower North Branch of the Patapsco River. The County also submitted a combined plan to address the 19 separate bacteria TMDLs associated with the County's waterways.
    - **COUNTY RESPONSE: no response needed**

    - In their technical comments, MDE's Science Services Administration (SSA) has noted several issues with the pollutant baseline analyses that prevent comparing the County's modeling to MDE's official 2005 Local TMDL Base Scenario. SSA has provided several options for resolving discrepancies between official Maryland Assessment Scenario Tool (MAST) and County generated progress scenarios.
    - **COUNTY RESPONSE: See response below – Attachment 2, Major Comments, Sediment**

    - Any best management practices (BMPs) used in the modeling of baselines or current load analyses shall be maintained according to State regulations. BMPs that are not inspected at least once every three years and maintained may not be included as treatment when modeling loads.
    - **COUNTY RESPONSE: The County included a section on their process for inspection and maintenance with mention of actions taken if a facility is not meeting standards (9.4 Best Management Practices Inspection and Maintenance).**

    - TMDL restoration plans should be consistent with the guidance found in "Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for NPDES Stormwater Permits" (MDE Guidance, MDE 2014) or, if more recent, the appropriate Chesapeake Bay Program (CBP) guidance. The County should use acceptable BMPs and the associated load reductions found in these documents. For example, specific load reductions for each practice are inconsistent (e.g., bioretention is listed as a range of 50% to 80%), and do not reflect the values found in the MDE Guidance and updated CBP efficiencies.

- **COUNTY RESPONSE: The MDE document *Guidance for Using the Maryland Assessment Scenario Tool to Develop Stormwater Wasteload Allocation Implementation Plans for Local Nitrogen, Phosphorus, and Sediment Total Maximum Daily Loads* (June 2014) includes recommendations on how to use MAST to develop SW-WLA plans for nutrient and sediment TMDLs. At this time, MAST CBP Phase 5.3.2 has not been updated to reflect BMP efficiencies published in MDE's guidance *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for NPDES Stormwater Permits* (August 2014). Therefore, BMP efficiencies currently available and programmed in MAST will differ from those published in MDE's guidance. For example, there are two sediment removal efficiencies in MAST for bioretention depending on the type of soil (A/B 80% versus C/D 55%). In MDE's guidance, bioretentions are considered efficiency BMPs with a 70% sediment removal.**

  The efficiencies table for each plan has been edited to show individual removal efficiencies for bioretention A/B soils and bioretention C/D soils rather than presenting a range.

- Information used to develop the individual TMDL restoration plans is not consistent with similar information found in other sections of the County's Annual Report and associated databases. For example, the County's urban BMP database indicates that there are ten Bioretention practices with a total drainage area of 23 acres that could be applied to the baseline for the Little Patuxent River watershed. However, the total drainage treated by these practices for the baseline analysis in the restoration plan (see Table 10) is 70.9 acres.
- **COUNTY RESPONSE: Data used in the sediment restoration plans has been made consistent with the NPPDES geodatabase (Attachment A) with minor updates where needed between the timing of the plan and the latest Attachment A submittal.**

- Each of the restoration plans lacks specificity in how individual TMDLs will be addressed. These plans need to be of sufficient detail to ensure that expected interim milestones can be achieved and the TMDL addressed. Each plan should include a list of specific BMPs that will be implemented during the current permit term to address these TMDLs. This list should include BMP locations, drainage areas, impervious area treated, load reductions, estimated costs, and implementation schedule (e.g., design, construction). This list shall coincide with interim targets identified in the restoration plans.
- **COUNTY RESPONSE: See response below – Attachment 2, Major Comments, General**

- Public Participation:
  - Anne Arundel County has developed a website (www.aarivers.org) and an interactive, online application to provide public access to information on watershed assessments and restoration activities.
  - **COUNTY RESPONSE: no response needed**

- As TMDL implementation plans and new watershed assessments are developed, that information also will be made available on the County's website.
- **COUNTY RESPONSE: no response needed**

- Anne Arundel County must accept public comments on watershed assessments and watershed restoration plans. The County must provide a summary of how comments received were addressed in its next annual report.
- **COUNTY RESPONSE: a summary of comments will be prepared once public notice/review periods are completed**

- TMDL Compliance: Anne Arundel County continues to work with MDE to implement its Chesapeake Bay TMDL WIP. The County has been implementing associated activities since fiscal year 2013. Information concerning these activities and progress toward achieving programmatic and implementation milestones were reported to SSA on January 2015.
- **COUNTY RESPONSE: no response needed**

Attachment 2

Anne Arundel County Stormwater Waste Load Allocation (WLA) Implementation Plan Comments

Major Comments

- General:

  - These plans lack specificity at a site level scale, probably due to planning uncertainties such as, finding sites, purchasing or gaining access to land, obtaining all required permits and designing BMPs. This is understandable, and MDE recognizes that these plans are still works in progress. During subsequent annual reports, and by the time of the next permit issuance, the county should plan on including a much higher level of site-specific detail on planned implementation.
  - **COUNTY RESPONSE: The County has added several items to increase the specificity of the plan. 1. List of completed restoration projects and currently programmed projects. 2. Mapping of street sweeping routes. 3. Details on the County's process for moving projects from the identification stage in the County's watershed assessments through the feasibility process.**

- Sediment:

  - The county uses MAST to develop its sediment TMDL implementation plans. When comparing estimates of current progress loads to the baseline loads for a given sediment TMDL, the county did not use the official 2013 progress scenario in MAST. Instead, they created a new progress scenario by adding all BMPs known to be

implemented in the watershed to a no action scenario. By comparing the loading outputs from the official 2013 progress scenario in MAST and the progress scenario created by the county, it is evident that many BMPs from the county's 2013 progress scenario were not included in the official MAST 2013 progress scenario and the baseline load scenario (2005 Local TMDL Base). Therefore, a comparison between the 2005 Local TMDL Base scenario and the county's 2013 progress scenario is not valid. A revision of this discrepancy should be made immediately. MDE suggests either of the following options for making a valid comparison:

1. Compare the official MAST 2013 progress scenario loads to a target calculated from the 2005 local TMDL base scenario.
2. Use BayFAST to re-establish a 2005 condition baseline load by inputting the impervious and pervious urban land-use conditions and BMPs present at the time, from which a new target can be calculated, and compare this to a re-established 2013 progress scenario.
3. Take the official MAST 2009 progress scenario: add BMPs that were installed between 2009 and 2013, and compare the resulting load to the 2005 Local TMDL Base scenario.

- **COUNTY RESPONSE: The official 2013 Progress Scenario in MAST cannot be compared to the watershed specific 2013 MAST scenario created by the County because of fundamental differences in BMP data entry and load calculations. BMPs were entered at the Countywide level for the official 2013 Progress Scenario with loads distributed by 8-digit watersheds based on available County MS4 land use area among other components. BMPs were entered by Local TMDL 8-digit watershed based on actual treatment locations for the County's 2013 MAST scenario. BMP data entry in this approach ensures that land use loads are accurately calculated based on treatment strategies on the ground in a specific watershed.**

  The County cannot follow option 1 or 3 because of the discrepancies described above. However, the County has looked into re-calculating a 2005 Baseline as proposed in option 2 and has moved forward with this approach.

  For the 2005 Baseline, the County has modeled BMPs with a construction built date prior to 7/1/2005 in BayFAST at the local TMDL watershed scale (i.e., delineated facility boundary) using MAST County MS4 Phase I/II 2005 impervious and pervious data pulled from the MAST Compare Scenario tool at the 8-digit, county split scale.

  Based on communication with MDE the reduction accounting procedure for progress and planned scenarios has been modified such that loads from new urban sources since the baseline year are not required to be accounted for. The progress and planned scenario modeling now is keeping the 2005 land use static and calculating the

gross reduction from the additional restoration BMPs added with each progress and planned scenario.

Sediment Plans

- Editorial Comments:
  - Little Patuxent Plans, Section 1.1 (p. 4): The dates listed for TMDL approval are incorrect. Approval dates are provided in the TMDL Data Center's "TMDL Search" Function. Please correct dates. Also, please indicate that the sediment and nutrient TMDLs are only for Centennial Lake, as appropriate.
  - **COUNTY RESPONSE: Cycle listing date was incorrectly transcribed as TMDL approval date. The following dates were changed in the plan:**
    - **TSS sediment approved in 1996 to 2011**
    - **Sedimentation/siltation approved in 1998 to 2002**
    - **Phosphorus approved in 1998 to 2002**

  - Little Patuxent Plans & Upper Patuxent Plans, Section 1.2 (p. 5): The formula for the 2025 Allocated Load uses the reduction percentage for Patapsco. This formula needs to be corrected in the next revision.
  - **COUNTY RESPONSE: Correct values were used in calculations and analyses. Incorrect values were reported in the description of Table 1. The following values were changed in the plans:**
    - **Little Patuxent: 0.222 to 0.205**
    - **Upper Patuxent: 0.222 to 0.114**

  - Little Patuxent Plans, Table 13 (p. 33): The baseline information in Table 13 is incorrect (copied from Patapsco). Please correct table using information from Table 11 in this report in the next revision.
  - **COUNTY RESPONSE: Updated table with correct baseline information for Little Patuxent.**

  - Upper Patuxent Plans, Section 1.1 (p. 4): The TMDLs mentioned in this section were approved in 2011, not 2001. Please correct the date.
  - **COUNTY RESPONSE: Typo. Updated date to 2011.**

- Specific Comments:
  - Little Patuxent, Patapsco Lower North Branch & Upper Patuxent Plans, Table 1 (p. 6): The "reductions" in Table 1 are all calculated from the 2005 baseline. This is not clear based on the table. Additionally, more information regarding changes in the loads due

to development should be included, such as the number of acres and the loads associated with those acres (with and without BMPs).

- **COUNTY RESPONSE: Subsequent guidance from MDE stated that reductions are from the 2005 Baseline only. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and future "Accounting for Growth" policies will address the remaining 10%. Discussion of loads due to growth appears in text in sections 3.3 – Anticipated Growth, 3.3.1 – Estimates of Future Growth, and 3.3.2 – Offsetting Sediment Loads from Future Growth.**
-
- Little Patuxent Plans & Upper Patuxent Plans, Table 13 (p. 33) & Patapsco Lower North Branch Plans, Table 13 (p. 31): Table 13 could have sub-rows showing the estimated 2025 load change due to growth as well as reductions from implementation actions. MDE suggests including the change in loads due to growth either in a table or text format in the next revision.
- **COUNTY RESPONSE: Subsequent guidance from MDE stated that reductions are from the 2005 Baseline only. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and future "Accounting" for Growth policies will address the remaining 10%. Table 13 only displays planned reduction from the 2005 Baseline Load. Discussion of loads due to growth appears in text in sections 3.3 – Anticipated Growth, 3.3.1 – Estimates of Future Growth, and 3.3.2 – Offsetting Sediment Loads from Future Growth.**

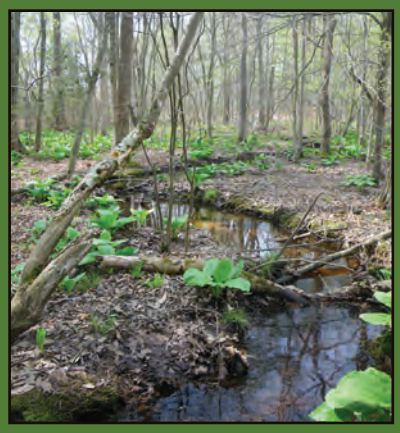
- Little Patuxent Plans, Figure 8 (p. 34), Patapsco Lower North Branch Plans, Figure 8 (p. 32) & Upper Patuxent Plans, Figure 8 (p. 33): Figure 8 is confusing. The grey bars are indicted to be MAST loadings, but the yellow bars are planning loads. It is unclear how they relate. Figure 8 should be clarified, updated or removed. It could be updated in the next revision to incorporate the change in loads, with growth and reductions from the milestone BMPs shown in Table 16.
- **COUNTY RESPONSE: Figure 8 (new Figure 9) has been updated. The figure now only shows progress and planned loads as the reduction from the 2005 Baseline Load to make this clearer.**

- Little Patuxent Plans & Upper Patuxent Plans, Section 5.1 (p. 31), Patapsco Lower North Branch, Section 5.1 (p. 29-30): Section 5.1 describes current BMP implementation through 2013, but does state from when. It is important to know if BMPs prior to the baseline year (2005) are being counted. Since pre-2005 BMPs should not be given credit toward TMDL implementation, BMPs should be divided into two categories: those completed before 2005 and those completed between 2005 and 2013.
- **COUNTY RESPONSE: The 2013 Progress scenario (now updated to 2015 Progress) loads are modeled using all County BMP data from their database ranging in built dates**

from 1978 - June 2005, and only restoration BMPs from July 2005 through 2013 (now updated to 2015).

The difference between 2013 Progress (now updated to 2015 Progress) loads, and the 2005 Baseline loads represents the reduction achieved from restoration BMPs built between 2005 and 2013 (now updated to 2015).

Modeling following this approach does not double count pre-2005 treatment.









Upper Patuxent River Sediment TMDL Restoration Plan

Anne Arundel County, Maryland
February 2016

Anne Arundel County WATERSHED Protection & Restoration PROGRAM

Upper Patuxent River
Sediment TMDL Restoration Plan

February 2016

Prepared for:

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Appendices

Appendix A	Upper Patuxent Project List
Appendix B	Response to MDE Comments on Draft Plan

List of Acronyms

AAWSA	Anne Arundel Watershed Stewards Academy
BayFAST	Chesapeake Bay Facility Assessment Scenario Tool
BMP	Best Management Practices
BSID	Biological Stressor Identification
CBP	Chesapeake Bay Program
CIP	Capital Improvement Program
EOS	Edge of Stream
H&H	Hydrologic and Hydraulic
LULC	Land use / Land cover
MAST	Maryland Assessment Scenario Tool
MDE	Maryland Department of the Environment
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
OSDS	On-site Disposal Systems
SPSC	Step Pool Storm Conveyance
SW to MEP	Stormwater to the Maximum Extent Practicable
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
WIP	Watershed Implementation Plan
WPRP	Watershed Protection and Restoration and Program

1 Introduction

1.1 Background and Purpose

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

Under the Federal Clean Water Act (CWA), the State of Maryland is required to assess and report on the quality of waters throughout the state. Where Maryland's water quality standards are not fully met, Section 303(d) requires the state to list these water bodies as impaired waters. States are then required to develop a TMDL for pollutants of concern for the listed impaired waters. The Patuxent River Upper (Upper Patuxent) watershed has several impaired waters listings in Maryland's Integrated Report of Surface Water Quality [303(d) list and 305(b) Report] including nutrients, sediment, heavy metals, *Escherichia coli*, sulfates, and chlorides. There are currently three final TMDLs, which were all approved in 2011, within the Upper Patuxent; total suspended solids (TSS; sediment) TMDL, a mercury in fish tissue TMDL, and a bacteria TMDL. These TMDLs apply to several jurisdictions including Howard, Prince George's, and Anne Arundel Counties. This plan will specifically address the Upper Patuxent sediment TMDL under the responsibility of Anne Arundel County. The bacteria TMDL is being addressed by Anne Arundel County in a separate plan. Anne Arundel County does not share responsibility for the mercury in fish tissue TMDL.

Responsibility for Upper Patuxent sediment reduction is divided among the contributing jurisdictions, listed above. The TMDL loading targets, or allocations, are also divided among the pollution source categories, which in this case includes non-point sources (termed load allocation or LA) and point sources (termed waste load allocation or WLA). The WLA consists of loads attributable to regulated process water or wastewater treatment, and to regulated stormwater. For the purposes of the TMDL and consistent with implementation of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Discharge Permit (MS4), stormwater runoff from MS4 areas is considered a point source contribution.

Anne Arundel County's current MS4 permit (11-DP-3316, MD0068306) issued in its final form by the MDE in February of 2014 requires development of restoration plans for each stormwater WLA approved by EPA prior to the effective date of the permit (permit section IV.E.2.b). This plan satisfies this permit requirement and provides the loading target, recommended management measures, load reduction estimates, schedule, milestones, cost estimates and funding sources, and the tracking and monitoring approaches to meet the stormwater WLA (SW-WLA).

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

This plan demonstrates that Anne Arundel County met its sediment SW-WLA for the Upper Patuxent during 2015. The strategies proposed will provide further treatment to reduce current sediment loads from the urban stormwater sector.

1.2 TMDL Allocated and Planned Loads Summary

The following Restoration Plan only addresses loads allocated to Anne Arundel County NPDES regulated stormwater point source sediment. Additional SW-WLAs for the Upper Patuxent Watershed TMDL assigned to Howard and Prince George's counties, Phase II jurisdictions, Maryland State Highway Administration, and other NPDES regulated stormwater are not the responsibility of Anne Arundel County and will not be addressed in this plan.

The Upper Patuxent Watershed TMDL requires an 11.4% reduction of sediment loads from 2005 baseline levels to achieve the target SW-WLA for Anne Arundel County NPDES regulated stormwater. A planning horizon of 2025 was i used as the date to achieve these load reductions with 2017 proposed as a milestone to assess progress.

Based on MDE guidance, growth in the stormwater load since the TMDL baseline year was not accounted for in the analysis conducted in the development of this plan. Local TMDLs are considered met, from a planning perspective, when the load reductions associated with 2015 restoration progress coupled with the planned restoration load reductions exceed the load reduction required.

This section of the plan, including Table 1, provides a concise summary of the loads and reductions at important timeline intervals including the 2005 baseline, 2015 progress, 2017 milestone and 2025 final planning intervals. These terms and dates are used throughout the plan and explained in more detail in the following sections. They are presented here to assist the reader in understanding the definitions of each, how they were derived, and to provide an overall summary demonstrating the percent reduction required and percent reduction achieved through full implementation of this plan. Sediment loads and wasteload allocations are presented as tons/year in the local TMDL but will be discussed as lbs/year in this restoration plan.

- **2005 Baseline Loads**: Baseline levels (i.e., land use loads with baseline BMPs) from 2005 conditions in the Upper Patuxent watershed using the Chesapeake Bay Facility Assessment Scenario Tool (BayFAST) Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) model. Baseline loads were used to calculate the stormwater allocated sediment loads, or SW-WLA.
- **2015 Progress Loads and Reductions**: Progress loads and load reductions achieved from restoration best management practice (BMP) implementation through 2015. The 2015 Progress Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 Baseline – 2015 Progress Reduction.
- **2017 Interim Milestone Goal Loads and Planned Loads and Reductions**: Planned 2017 loads and reductions will result from implementation of strategies through 2017. The 2017 Planned Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 Baseline – 2017 Planned Reduction.
- **2025 Allocated Load**: Allocated loads are calculated from the 2005 baseline levels, calibrated to CBP P5.3.2 as noted above, using the following calculation: 2005 Baseline – (2005 Baseline x 0.114); or, 2005 Baseline x (1 – 0.114)

- **2025 Planned Loads and Planned Reductions**: Loads and reductions that will result from implementation of this plan. The 2025 Planned Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 Baseline – 2025 Planned Reduction.

Table 1: Upper Patuxent River Local TMDL Allocated and Planned Loads

	Sediment (tons/year)	Sediment (lbs/year)
2005 Baseline Loads	243	485,565
2015 Progress Loads	212	423,373
2015 Progress Reductions	31	62,192
2017 Planned Loads*	203	406,299
2017 Planned Reductions	40	79,266
2025 TMDL Allocated Loads	215	430,211
2025 Planned Loads*	176	351,860
2025 Planned Reductions	67	133,705
Required Percent Reduction	11.4%	11.4%
Planned Percent Reduction Achieved	27.5%	27.5%

*2017 and 2025 planned loads are calculated by subtracting planned restoration sediment reductions from the 2005 Baseline Load. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal.

1.3 Restoration Plan Elements and Structure

This plan is developed within the context of on-going watershed management planning, restoration, and resource protection being conducted by Anne Arundel County. The County initiated comprehensive watershed assessment and management plans in 2000 and has currently completed plans for seven of the 12 major watersheds, including the Upper Patuxent which was completed in 2008. The TMDL regulation uses the term 'Patuxent River Upper'; however, it references the same geography included in Anne Arundel County's 2008 Upper Patuxent watershed plan and this restoration plan. The County also prepared a Phase II Watershed Implementation Plan (WIP) in 2012 in response to requirements set forth in the Chesapeake Bay TMDL for nitrogen, phosphorus and sediment. Information synthesized and incorporated into this plan for the Upper Patuxent watershed draws upon these sources with updates and additions where necessary to meet the specific goals of the SW-WLA. The TMDL analyses and reports developed by MDE are also referenced. These primary sources include:

- Upper Patuxent River Watershed Overall Summary Recommendation Report (Anne Arundel County, 2008)
- Chesapeake Bay TMDL, Phase II Watershed Implementation Plan, Final (Anne Arundel County, 2012)
- Total Maximum Daily Load of Sediment in the Patuxent River Upper Watershed, Anne Arundel, Howard, and Prince George's Counties, Maryland (MDE, 2011)

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

- General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan (MDE, May 2014)
- Guidance for Using the Maryland Assessment Scenario Tool to Develop Stormwater Wasteload Allocation Implementation Plans for Local Nitrogen, Phosphorus, and Sediment TMDLs (MDE, June 2014)
- Guidance for Developing Stormwater Wasteload Allocation Implementation Plans for Nutrient and Sediment Total Maximum Daily Loads (MDE, November 2014)
- Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated (MDE, August 2014)

The Upper Patuxent plan has been prepared in accordance with the EPA's nine essential elements for watershed planning. These elements, commonly called the 'a through i criteria' are important for the creation of thorough, robust, and meaningful watershed plans and incorporation of these elements is of particular importance when seeking implementation funding. The EPA has clearly stated that to ensure that Section 319 (the EPA Nonpoint Source Management Program) funded projects make progress towards restoring waters impaired by nonpoint source pollution, watershed-based plans that are developed or implemented with Section 319 funds to address 303(d)-listed waters must include at least the nine elements.

The Upper Patuxent watershed restoration plan is organized based on these elements. A modification to the order has been incorporated such that element c., a description of the management measures, is included before element b., the expected load reductions. We feel this modified approach is easier to follow. The letters (a. through i.) are included in the headers of the plan's major sections to indicate to the reader the elements included in that section. The planning elements are:

a. An identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the plan and to achieve any other watershed goals identified in the plan, as discussed in item (b) immediately below. (Section 3)

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time. (Section 5)

c. A description of the management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above as well as to achieve other watershed goals identified in the plan, and an identification of the critical areas in which those measures will be needed to implement this plan. (Section 4)

d. An estimate of the amount of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. (Section 6)

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the recommended management measures. (Section 7)

f. A schedule for implementing the management measures identified in this plan that is reasonably expeditious. (Section 8)

g. A description of interim, measurable milestones for determining whether management measures or other control actions are being implemented. (Section 8)

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised. (Section 9)

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above. (Section 10)

The outcomes of the planning effort are to provide guidance for the strategic implementation of watershed protection and restoration efforts that will advance progress toward meeting Anne Arundel County's local TMDLs pollutant loading allocations, and ultimately meeting water quality standards. Successful implementation of the plan will lead to improvements in local watershed conditions and aquatic health.

2 Watershed Characteristics

2.1 Watershed Delineation

The Upper Patuxent is one of 12 major watersheds in Anne Arundel County, Maryland, and is situated in the western portion of the County (Figure 1). The watershed shares political boundaries with Prince George's County along the Patuxent River and a smaller portion of the watershed is shared with Howard County. The Upper Patuxent watershed is a part of the Chesapeake Bay watershed with the Patuxent River mainstem discharging directing into the Chesapeake Bay.

2.2 Upper Patuxent

The Upper Patuxent watershed is approximately 22,420 acres (35.0 square miles) in area and contains approximately 90 total perennial miles of stream reaches. The watershed includes several named streams including Stocketts Run, Davidsonville Branch, Ropers Branch, and the mainstem of the Upper Patuxent River. These named streams are distributed among 19 subwatersheds, as shown below in Table 2 and on Figure 2. These subwatersheds were used as planning units for the watershed assessment and management plan completed for this watershed by the County in 2008. Although the average subwatershed size is 1,180 acres, the subwatersheds range in size from 339 acres in UP1 to 2,833 acres in UP7. The channel length in each subwatershed also varies similarly.

The Upper Patuxent watershed is largely undeveloped; however, Davidsonville and the outer suburbs of Crofton are located on the eastern boundary of the watershed. A large portion of the Patuxent Wildlife Refuge, a federal property owned and operated by the Fish and Wildlife Service of the U.S. Department of Interior, is located in the northern section of the watershed (Figure 2).

Table 2: Upper Patuxent River Watershed Drainage Area and Perennial Stream Miles

Subwatershed Code	Subwatershed Name	Drainage Area (Acres)	Drainage Area (Square Miles)	Stream Miles
UP1	Upper Patuxent River Mainstem	339	0.5	0.7
UP2	Upper Patuxent River Mainstem	854	1.3	0.3
UP3	Upper Patuxent River Mainstem	492	0.8	0.0

Subwatershed Code	Subwatershed Name	Drainage Area (Acres)	Drainage Area (Square Miles)	Stream Miles
UP4	Upper Patuxent River Mainstem	674	1.1	0.4
UP5	Upper Patuxent River Mainstem	384	0.6	0.4
UP6	Upper Patuxent River Mainstem	1,548	2.4	4.6
UP7	Upper Patuxent River Mainstem	2,833	4.4	3.3
UP8	Upper Patuxent River Mainstem	1,261	2.0	5.2
UP9	Ropers Branch	638	1.0	3.0
UPA	Upper Patuxent River Mainstem	1,163	1.8	4.8
UPB	Upper Patuxent River Mainstem	2,641	4.1	7.7
UPC	Upper Patuxent River Mainstem	974	1.5	3.5
UPD	King's Branch	1,728	2.7	8.3
UPE	Upper Patuxent River Mainstem	813	1.3	5.1
UPF	Davidsonville Branch	1,428	2.2	9.2
UPG	Stocketts Run 1	917	1.4	5.9
UPH	Stocketts Run 2	1,366	2.1	10.0
UPI	Stocketts Run 3	1,271	2.0	9.4
UPJ	Stocketts Run 4	1,090	1.7	7.9
Upper Patuxent River Total		**22,417**	**35.0**	**89.8**

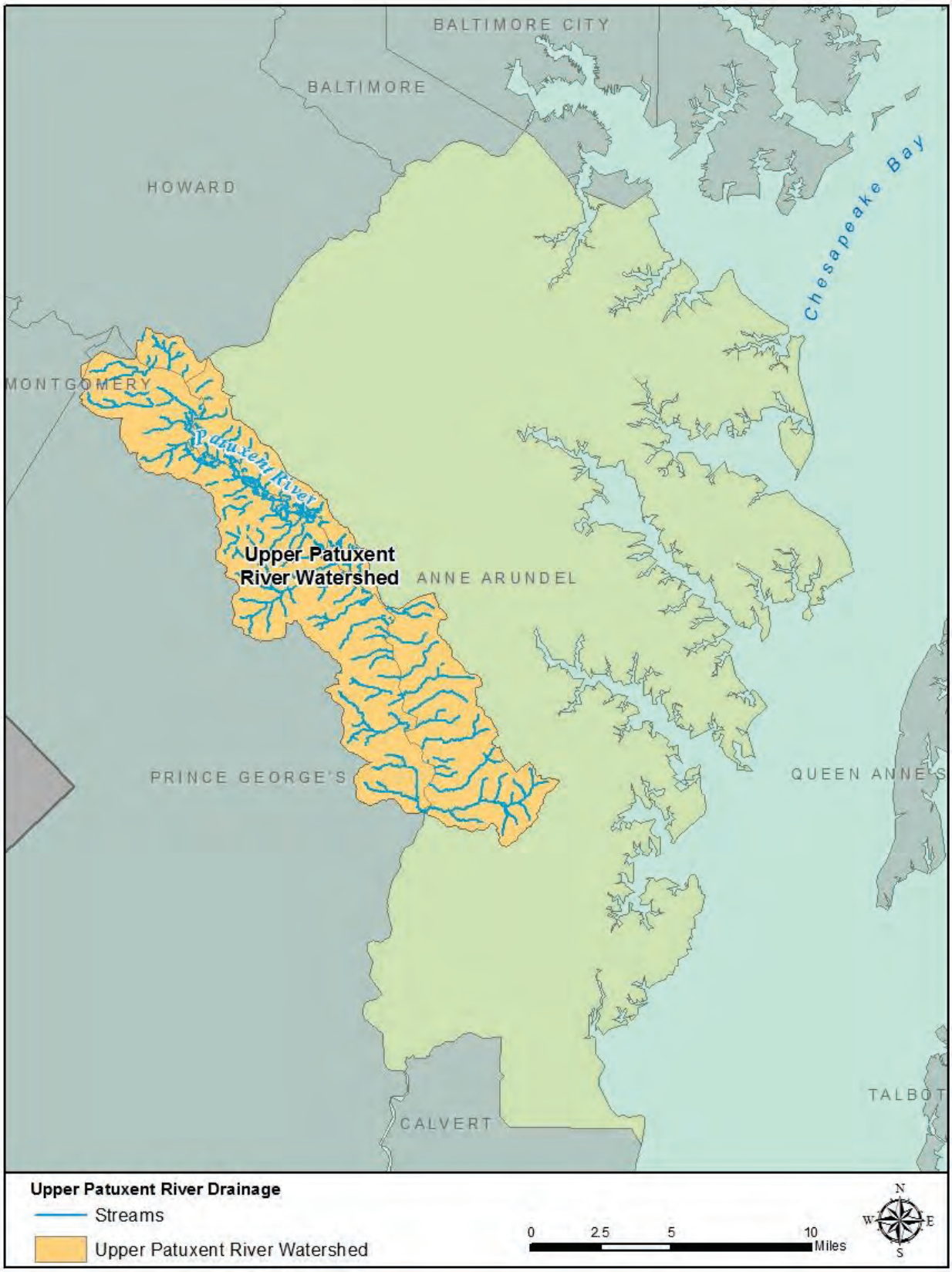
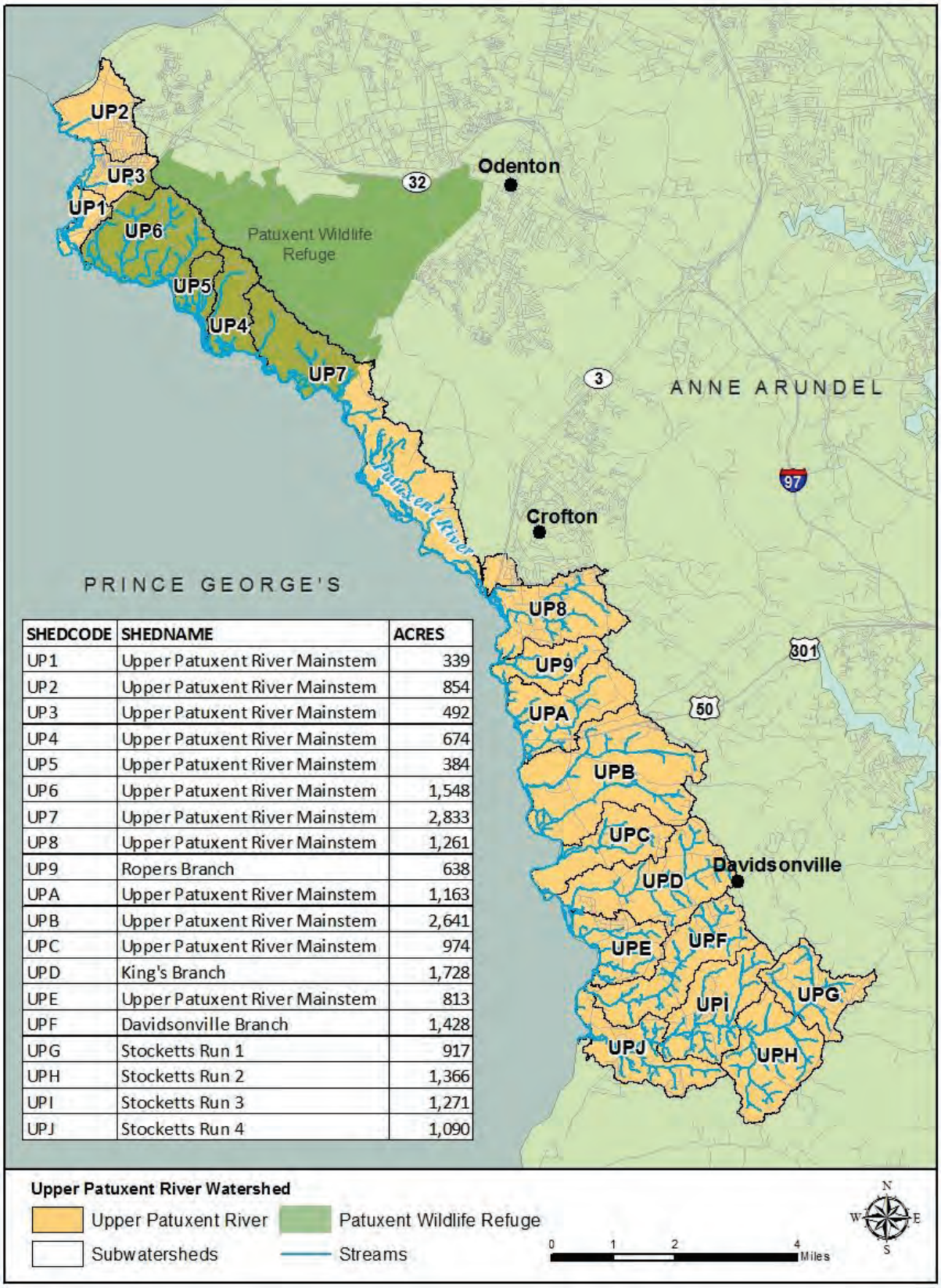


Figure 1: Upper Patuxent River Watershed



SHEDCODE	SHEDNAME	ACRES
UP1	Upper Patuxent River Mainstem	339
UP2	Upper Patuxent River Mainstem	854
UP3	Upper Patuxent River Mainstem	492
UP4	Upper Patuxent River Mainstem	674
UP5	Upper Patuxent River Mainstem	384
UP6	Upper Patuxent River Mainstem	1,548
UP7	Upper Patuxent River Mainstem	2,833
UP8	Upper Patuxent River Mainstem	1,261
UP9	Ropers Branch	638
UPA	Upper Patuxent River Mainstem	1,163
UPB	Upper Patuxent River Mainstem	2,641
UPC	Upper Patuxent River Mainstem	974
UPD	King's Branch	1,728
UPE	Upper Patuxent River Mainstem	813
UPF	Davidsonville Branch	1,428
UPG	Stocketts Run 1	917
UPH	Stocketts Run 2	1,366
UPI	Stocketts Run 3	1,271
UPJ	Stocketts Run 4	1,090

Figure 2: Upper Patuxent River Subwatershed Location

2.3 Land Use/Land Cover

The type and density of various land uses can have a dramatic effect on water quality and stream habitat. Forested areas slow stormwater flow and allow water to gradually seep into soils and drain into streams. Vegetation and soils bind nutrients and pollutants found within stormwater—improving water quality as it infiltrates the ground. Developed areas, with a high percentage of impervious surfaces (buildings, paved roads, parking lots, etc.), do not reduce either the volume or flow of stormwater—increasing the amount of pollutants entering streams. Increased stormflow affects stream habitat negatively by increasing bank erosion and decreasing instream and riparian habitat. Agricultural land, if managed incorrectly, can also impair streams with increases nutrients and bacteria.

See Figure 3 for aerial imagery of the Upper Patuxent watershed. Land use / land cover (LULC) data from the Anne Arundel County Office of Information Technology (2011) is presented in Figure 4. Data presented in the figures below were used to characterize the watershed and show potential pollution sources. These LULC data were not used in the calculations of loads and load reduction, which were based instead on the land-river segment scale from the Chesapeake Bay Program Partnership Watershed Model.

2.3.1 Existing Land Use/Land Cover

According to 2011 LULC data (Table 3), the largest category in the Upper Patuxent is forested land, or woods (51.7%) residential 2-acre (12.5%). Developed land in the watershed accounts for 24.2% and largely consists of residential areas (17.8%), transportation (2.5%), and commercial (2.2%).

Table 3: 2011 Land Use / Land Cover

Land Use / Land Cover	Acres	Percent of Watershed
Airport	14	0.1%
Commercial	503	2.2%
Forested Wetland	110	0.5%
Industrial	76	0.3%
Open Space	2,134	9.5%
Open Wetland	55	0.2%
Pasture/Hay	1,043	4.7%
Residential 1/2-acre	203	0.9%
Residential 1/4-acre	360	1.6%
Residential 1/8-acre	182	0.8%
Residential 1-acre	458	2.0%
Residential 2-acre	2,793	12.5%
Row Crops	1,894	8.4%
Transportation	560	2.5%
Utility	275	1.2%
Water	162	0.7%
Woods	11,595	51.7%
Total	**22,417**	**100.0%**

2.3.2 Impervious Surfaces

Impervious surfaces concentrate stormwater runoff, accelerating flow rates and directing stormwater to the receiving stream. This accelerated, concentrated runoff can cause stream erosion and habitat degradation. Runoff from impervious surfaces picks up and washes off pollutants and is usually more polluted than runoff generated from pervious areas. In general, undeveloped watersheds with small amounts of impervious cover are more likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover. Impervious cover is a primary factor when determining pollutant characteristics and loadings in stormwater runoff.

The degree of imperviousness in a watershed also affects aquatic life. There is a strong relationship between watershed impervious cover and the decline of a suite of stream indicators. As imperviousness increases the potential stream quality decreases with most research suggesting that stream quality begins to decline at or around 10 percent imperviousness (Schueler, 1994; CWP, 2003). However, there is considerable variability in the response of stream indicators to impervious cover observed from 5 to 20 percent imperviousness due to historical effects, watershed management, riparian width and vegetative protection, co-occurrence of stressors, and natural biological variation. Because of this variability, one cannot conclude that streams draining low impervious cover will automatically have good habitat conditions and a high quality aquatic life.

Impervious surfaces make up 5.5% of the overall Upper Patuxent drainage (Table 4; impervious surfaces data obtained from Anne Arundel County Office of Information Technology - 2011). Impervious surface is highest in areas near MD 295 and Laurel Park in addition to residential areas in the outer suburbs of Crofton and Davidsonville.

Table 4: Upper Patuxent River Watershed Percent Impervious Cover

Subwatershed Code	Subwatershed Name	% Impervious Cover
UP1	Upper Patuxent River Mainstem	6.1%
UP2	Upper Patuxent River Mainstem	27.6%
UP3	Upper Patuxent River Mainstem	15.1%
UP4	Upper Patuxent River Mainstem	0.4%
UP5	Upper Patuxent River Mainstem	0.0%
UP6	Upper Patuxent River Mainstem	0.2%
UP7	Upper Patuxent River Mainstem	1.0%
UP8	Upper Patuxent River Mainstem	14.7%
UP9	Ropers Branch	1.1%

Subwatershed Code	Subwatershed Name	% Impervious Cover
UPA	Upper Patuxent River Mainstem	3.4%
UPB	Upper Patuxent River Mainstem	5.5%
UPC	Upper Patuxent River Mainstem	5.3%
UPD	King's Branch	7.3%
UPE	Upper Patuxent River Mainstem	7.5%
UPF	Davidsonville Branch	4.5%
UPG	Stocketts Run 1	6.3%
UPH	Stocketts Run 2	3.0%
UPI	Stocketts Run 3	3.4%
UPJ	Stocketts Run 4	3.6%
Upper Patuxent River Total		**5.5%**



Figure 3: Upper Patuxent River Watershed Aerial Imagery (2014)

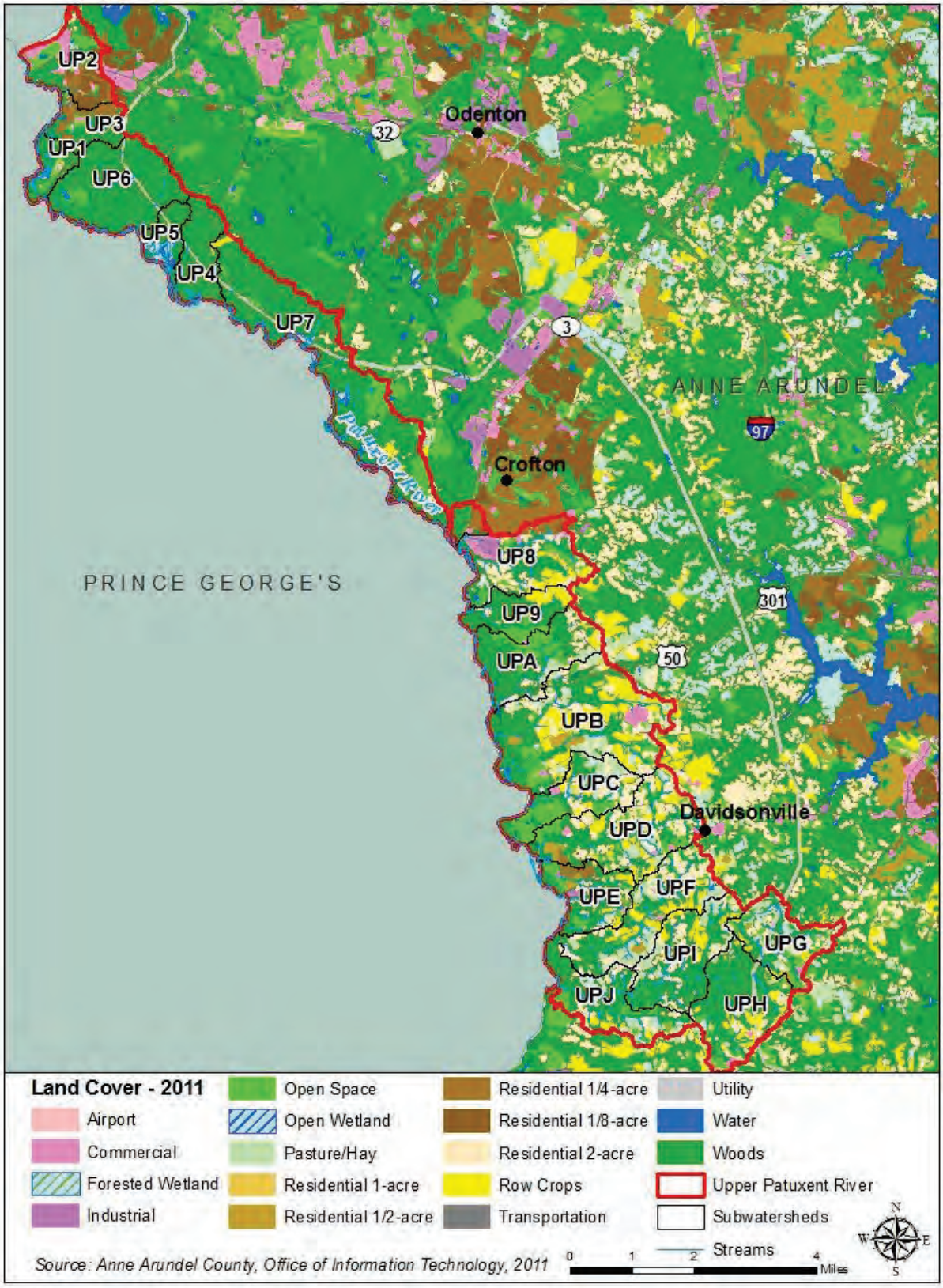


Figure 4: Upper Patuxent River Watershed Land Cover (2011)

2.4 Water Quality

2.4.1 Use Designations

According to water quality standards established by MDE in the Code of Maryland Regulations (COMAR) 26.08.02.03-.03 - Water Quality, Upper Patuxent is classified as Use I waters which are designated to support water contact recreation, and protection of non-tidal warmwater aquatic life. Designations include recreation; industrial and agricultural water supply; and fish, aquatic life, and wildlife (Table 5).

Table 5: Use Designations of the Upper Patuxent River

Designated Uses	Upper Patuxent
Growth and propagation of fish (not trout), other aquatic life and wildlife	X
Water contact sports	X
Leisure activities involving direct contact with surface water	X
Fishing	X
Agricultural water supply	X
Industrial water supply	X
Propagation and harvesting of shellfish	-
Seasonal migratory fish spawning and nursery use	-
Seasonal shallow-water submerged aquatic vegetation use	-
Open-water fish and shellfish use	-
Seasonal deep-water fish and shellfish use	-
Seasonal deep-channel refuge use	-
Growth and propagation of trout	-
Capable of supporting adult trout for a put and take fishery	-
Public water supply	-

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

2.4.2 303(d) Impairments

According to Maryland's final 2012 and draft 2014 303(d) list of impaired waters (MDE, 2012a; MDE, 2014a), several segments within the Upper Patuxent watershed are listed for water quality impairments.

The Upper Patuxent watershed contains three Category 4a stream segments which include those waters that are not meeting their use designation but for which a TMDL has been developed to address the impairments. Category 4a waters include the entire watershed listed for sediment, the lower portion of the watershed listed for fecal bacteria (*Escherichia coli*), and Cash Lake (Prince George's County) listed for mercury in fish tissue.

Category 5 waters for the Upper Patuxent watershed, which include those waters that are not meeting their use designation and require a TMDL, include the entire watershed for chlorides and sulfates. These listings were added in 2014 and replace the 2006 category 5 biological listing for "cause unknown."

2.4.3 TMDLs

Total Maximum Daily Loads (TMDLs) are established for waterbodies on Maryland's 303(d) integrated list of impaired waterbodies to set pollutant limits to achieve attainment of the designated use. For each

combination of waterbody and pollutant, the State must estimate the maximum allowable pollutant load, or TMDL, that the waterbody can receive and still meet water quality standards. TMDLs are required by Clean Water Act.

Category 4a of the 303(d) list describes impaired waters with a TMDL or other reduction measure in place. Category 5 lists impaired waters in need of a TMDL. Listings for chlorides and sulfates in the Upper Patuxent are currently in need of a TMDL.

The Upper Patuxent currently has three final TMDLs completed - one for sediment (approved 2011), a second for *Escherichia coli* (approved 2011), and a third for mercury in fish tissue (approved 2011). This Restoration Plan focuses on implementing strategies to address the sediment TMDL which requires a 11.4% reduction of Anne Arundel County NPDES regulated stormwater point source sediment.

In addition to local TMDLs in the Upper Patuxent, the County must also meet WLAs allocated from the *Chesapeake Bay Total Maximum Daily Loads for Nitrogen, Phosphorus, and Sediment* (USEPA, 2010). The Bay TMDL is a result of requirements under the CWA to meet water quality standards and executive order 13508 signed by President Barack Obama in 2009 that put a renewed emphasis and focus on the Chesapeake Bay. The local sediment TMDL for the Upper Patuxent is more geographically specific than the Bay-wide allocated loads assigned in the Bay TMDL. However, all load reductions achieved from implementation efforts described in this plan will help support the County's Bay TMDL goals.

2.4.4 NPDES

Section 402(p) of the Clean Water Act required the EPA to add Municipal Separate Storm Sewer System (MS4) discharges to the NPDES permit program. In 2002, EPA directed permit writers to include WLA requirements in NPDES permits, including those for MS4 discharges. Anne Arundel County holds a Phase I – Large Jurisdiction (greater than 250,000 population) MS4 permit (11-DP-3316, MD0068306) issued by the MDE. The County's first generation permit was issued in 1993. The current fourth generation permit was issued in February of 2014.

TMDL Permit Requirements

The objective of this plan is to meet the County's MS4 NPDES permit requirement to develop restoration plans for local TMDLs per permit condition IV.E.2.b. Plans must be developed within the first year of permit issuance. Anne Arundel County's final permit was issued on February 12, 2014 therefore the restoration plans must be complete by February 11, 2015.

The permit states the County must submit "…a restoration plan for each stormwater Waste Load Allocation (WLA) approved by EPA prior to the effective date of the permit." For each WLA, the County is required to:

PART IV. Standard Permit Conditions
E. Restoration Plans and Total Maximum Daily Loads
2. Restoration Plans
b. Within one year of permit issuance, Anne Arundel County shall submit to MDE for approval a restoration plan for each stormwater WLA approved by EPA prior to the effective date of the permit. The County shall submit restoration plans for subsequent TMDL WLAs within one year of

EPA approval. Upon approval by MDE, these restoration plans will be enforceable under this permit. As part of the restoration plans, Anne Arundel County 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 restoration plans 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 County's watershed assessments.

Further, the permit requires continual outreach to the public regarding the development of its watershed assessments and restoration plans and requires public participation in the TMDL process (permit section IV.E.3.a-d).

The permit requires an annual progress report presenting the assessment of the NPDES stormwater program based on the fiscal year. A TMDL assessment report to include complete descriptions of the analytical methodology used to evaluate the effectiveness of the County's restoration plans and how these plans are working to achieve compliance with EPA approved TMDLs is a component of the annual report. The assessment will include: estimated net change in pollutant load reductions from water quality improvement projects; a comparison of the net change to targets, deadlines, and applicable WLAs; cost data for completed projects; cost estimates for planned projects; and a description of a plan for implementing additional actions if targets, deadlines, and WLAs are not being met (permit section IV.E.4.a-e).

Impervious Surface Permit Requirements

The County's permit requires implementation of restoration efforts for 20% of the County's impervious surface area that has not already been restored to the maximum extent practicable (MEP) (permit section (IV.E.2.a). Though projects and strategies outlined in this plan will certainly add treatment of impervious surfaces, accounting for impervious treatment is not included in this report.

3 Causes and Sources of Impairment (a)

3.1 Impairments

Elevated levels of sediment currently impair the Upper Patuxent watershed as evident through the 303(d) listings and local TMDL requirement. Sediment, both from upland and in-stream sources, can impact in-stream habitat by covering and filling gravelly and rocky substrate, which is a preferred substrate habitat for some aquatic organisms (fish and benthic community) and necessary for some fish species for spawning. Finer clays, silts and sands associated with sediment as a pollutant are more

mobile and transient and provide less liveable space for more sensitive benthic macroinvertebrate species by filling the interstitial spaces between larger substrate particles in the channel bottom. Increases in sediment loads in channels that cannot adequately transport the load can lead to deposition and aggrading streams. These factors often negatively impact channel flow, causing additional erosion and increases in flooding, particularly if road crossing capacity is limited by sediment accumulation. Suspended sediment in the water column may limit light penetration and prohibit healthy propagation of algae and submerged aquatic vegetation. Suspended sediments can cause gill abrasion in fish and can limit clarity which impacts aquatic species that rely on sight for feeding.

3.2 Sources

The majority of sediment loads in the Upper Patuxent originate from urban stormwater runoff from development and in-stream sources related to channel erosion.

3.2.1 Urban Stormwater Runoff

The contribution of urban stormwater to sediment loading was analyzed in the Upper Patuxent River Watershed. Figure 5 presents the annual total suspended solids runoff load as the relative quantity of sediment contributed from each subwatershed (i.e., lowest to highest). The water quality model used for the assessment was based on EPA's Simple Method (Schueler, 1987) and PLOAD models (EPA, 2001) using event mean concentrations (EMCs) for each LULC type. The results presented here are only the sediment associated with runoff, and do not reflect in-stream sources. The most significant contributing LULC categories related to urban stormwater in terms of loading rates include airport, transportation, and commercial and industrial areas. Residential development, while a lower loading rate, makes up the largest portion of developed land in the watershed (17.8%) and is therefore also a significant contributor.

Subwatersheds contributing the lowest amount of existing sediment loads include UP1, UP4, UP5, UP6, and UP9. Subwatersheds contributing the highest amount of existing sediment loads include UP2 and UPB and to a lesser extent, subwatersheds UP7 and UP8. Management measures targeted in subwatersheds with high existing sediment loads will be the priority of this restoration plan to ensure required reductions are achieved and maintained.

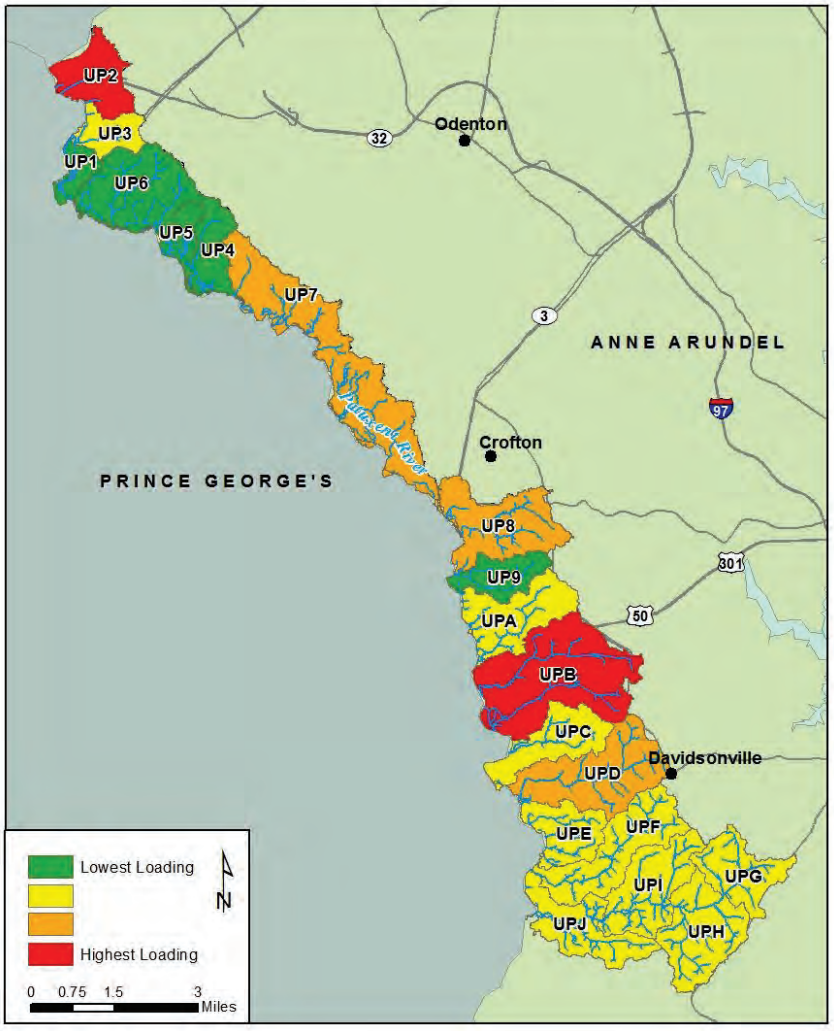


Figure 5: Total Suspended Solids Load from Runoff Based on Existing Conditions - Includes BMP Reductions

3.2.2 In-stream Sources

Although channel bed and bank erosion occurs naturally as streams work to maintain a state of dynamic equilibrium, excessive erosion can occur due to increased stream velocities associated with development activities that increase imperviousness within the watershed. Channel erosion can deliver excessive pollutants, such as sediment and phosphorus, downstream, where water quality can be impacted and important habitat for fish spawning and benthic invertebrates can be smothered. Excessive erosion can also threaten the stability of other nearby built infrastructure. The Biological Stressor Identification Analysis (BSID; MDE, 2010) for the Upper Patuxent has determined that biological communities in this watershed are likely degraded due to flow/sediment related stressors. These stressors often result from altered hydrology and increased runoff from impervious area, specifically from channel erosion and subsequent elevated suspended sediment transport through the watershed. Thus, suspended sediment was identified as a probable cause and confirmed the Category 5 listing for total suspended sediment as an impairing substance in this watershed.

Approximately 90 miles of streams were assessed, and characterized for the Upper Patuxent River Watershed Overall Summary Recommendation Report (Anne Arundel County, 2008). Collected data

included stream classifications, physical habitat condition assessment, inventory of infrastructure and environmental features, habitat scores, channel geomorphology, road crossing flood potential, bioassessments, and aquatic resource indicators. Within each perennial reach, channel erosion was assessed and scored based on severity. A score of 5 was considered Moderate impact, a score of 7 was considered Severe, and a score of 10 was considered an Extreme condition. A total of 100 erosion locations impacting approximately 6,820 linear feet of stream reaches were cataloged in the Upper Patuxent with the majority of points scored as moderate (90%) erosion and the remaining 10% of sites scored as severe erosion (Table 6 and Table 7).

Table 6: Erosion Inventory and Severity per Subwatershed (Anne Arundel County, 2008)

Subwatershed and stream miles		Number of Erosion Impacts			Total
		5	7	10	
UP1	0.7				0
UP2	0.3				0
UP3	0.0				0
UP4	0.4				0
UP5	0.4				0
UP6	4.6	9			9
UP7	3.3	5			5
UP8	5.2	7			7
UP9	3.0	13			13
UPA	4.8	9	1		10
UPB	7.7	12			12
UPC	3.5	3			3
UPD	8.3	13			13
UPE	5.1	2	1		3
UPF	9.2	10	4		14
UPG	5.9	2			2
UPH	10.0				0
UPI	9.4	5	4		9
UPJ	7.9				0
Total number per rating		90	10	0	
Total number per type		100			

Gray =<5 sites Green = 5-10 sites Yellow = 11-20 sites Orange = 21-50 sites

Table 7: Linear Feet of Erosion per Subwatershed

Subwatershed	Erosion Impacts and Linear Feet			Total Linear Feet
	5	7	10	
UP1	0	0	0	0
UP2	0	0	0	0
UP3	0	0	0	0
UP4	0	0	0	0
UP5	0	0	0	0
UP6	460	0	0	460
UP7	120	0	0	120
UP8	525	0	0	525
UP9	1,270	0	0	1,270
UPA	445	40	0	485
UPB	625	0	0	625
UPC	57	0	0	57
UPD	1,110	0	0	1,110
UPE	45	200	0	245
UPF	531	500	0	1,031
UPG	55	0	0	55
UPH	0	0	0	0
UPI	370	470	0	840
UPJ	0	0	0	0
Total	5,613	1,210	0	6,823

An assessment of channel geomorphology utilizing Rosgen Level I geomorphic classifications was also administered for each single-threaded, perennial reach throughout the watershed as part of the Upper Patuxent River Watershed Overall Recommendation Summary (Anne Arundel County, 2008). An assessment of channel geomorphology is useful to better understand the stability of a stream and its associated behaviors including channel entrenchment. The Rosgen classification system has four levels. The Level I classification is a geomorphic characterization that groups streams as Types A through G based on aspects of channel geometry, including water surface slope, entrenchment, width/depth ratio, and sinuosity.

Due to the narrow and long shape and size of the Upper Patuxent River Watershed, the subwatersheds were grouped into two geographic sections, northern and southern, with the sections divided by Route 3 near Crofton. Nearly half (43%) of the assessed perennial streams in the northern and southern sections of the Upper Patuxent River Watershed were Type B channels (43% and 42%, respectively), which are very stable, moderate gradient channels with low sinuosity and low erosion rates. Eighteen percent of streams and 24% of streams in the northern and southern sections, respectively, were Type C channels, which exhibit a well-developed floodplain, higher sinuosity and susceptibility to de-stabilization when flow regimes are altered. The remainder of streams assessed in both the northern and southern sections of Upper Patuxent were Type F and Type G channels, which are generally low gradient, entrenched channels with high erosion rates.

3.3 Anticipated Growth

Future urban sector growth and the anticipated increase in urban loads that may result are expected to be controlled by two elements: stormwater management to the MEP that is required with new development, and anticipated "Accounting for Growth" policies. This CIS is developed to treat the reduction required from the initial baseline year load, calibrated to the current Bay model. Based on coordination with MDE, TMDL restoration planning should focus on the untreated and undertreated areas associated with the urban footprint at the time of the TMDL baseline. Future loads and loads potentially added to the urban sector since the baseline year to present are not accounted for here as they are addressed under other programs. MDE has requested in restoration plan development guidance (MDE, 2014d) that jurisdictions begin estimating potential additional loads, therefore estimates are included in section 3.3.1.

3.3.1 Estimates of Future Growth

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

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

The Anne Arundel County General Development Plan was finalized April 2009 and was adopted in October 2009 (Bill No. 64-09; Anne Arundel County, 2009). The next update of the plan is due by 2019. Anne Arundel County is considered one of the fastest growing counties in the region with 14.6% population growth (427,239 to 489,656 persons) over 1990-2000 compared to 6.9% growth in the Baltimore region and 10.8% growth throughout the State of Maryland (Anne Arundel County, 2009). The population in Anne Arundel County is projected to increase to 564,925 persons by 2025, which is an increase of 15.4% from 2000 data and to 579,137 persons by 2035, an increase of 18.3% from 2000 data.

The primary developed areas located in Upper Patuxent watershed are Davidsonville, the southern extent of Laurel Park, and the outer extents of development associated with Crofton. The Upper Patuxent watershed is not included in the County's Priority Funding Areas which are areas where the County directs new growth. Therefore, expected growth will not be targeted in this area. For development that does occur, Anne Arundel County continues to utilize strategies such as promoting low impact development and implementing stormwater BMPs for water quality treatment. However, increased urban stormwater related loads will inevitably occur as growth continues.

To estimate potential increases in loads over time due to growth, an analysis was completed using a combination of MAST modeled loading estimates, and estimates based on recent growth patterns. Figure 6 shows initial conditions loads without BMPs as modeled in MAST (grey bars) at the Upper Patuxent 8-digit subwatershed scale as well as projected loads with (blue bars) and without (orange bars) the application of stormwater BMPs to the maximum extent practicable (SW to the MEP). Projected loads were calculated by applying the average percent change observed between MAST loading result from 2010 through 2015 (1.9%) to loads of the previous year. In this manner a 1.9%

annual increase in loads would be expected from 2015 to 2025 if development were to occur at the same rate and be implemented without BMPs. Because in actuality new development will follow Maryland's stormwater regulations, the resultant loading increases were reduced by 90% based on the MAST removal rates for sediment treated by stormwater treatment to the maximum extent practicable (SW to the MEP). The results are shown as the blue bars in Figure 6. Additional projected loads without the application of SW to the MEP sediment removal rates are shown as the orange bars in Figure 6.

Projected loading in 2025 with the application of SW to the MEP will be incorporated in TMDL modeling efforts to account for growth in the watershed.

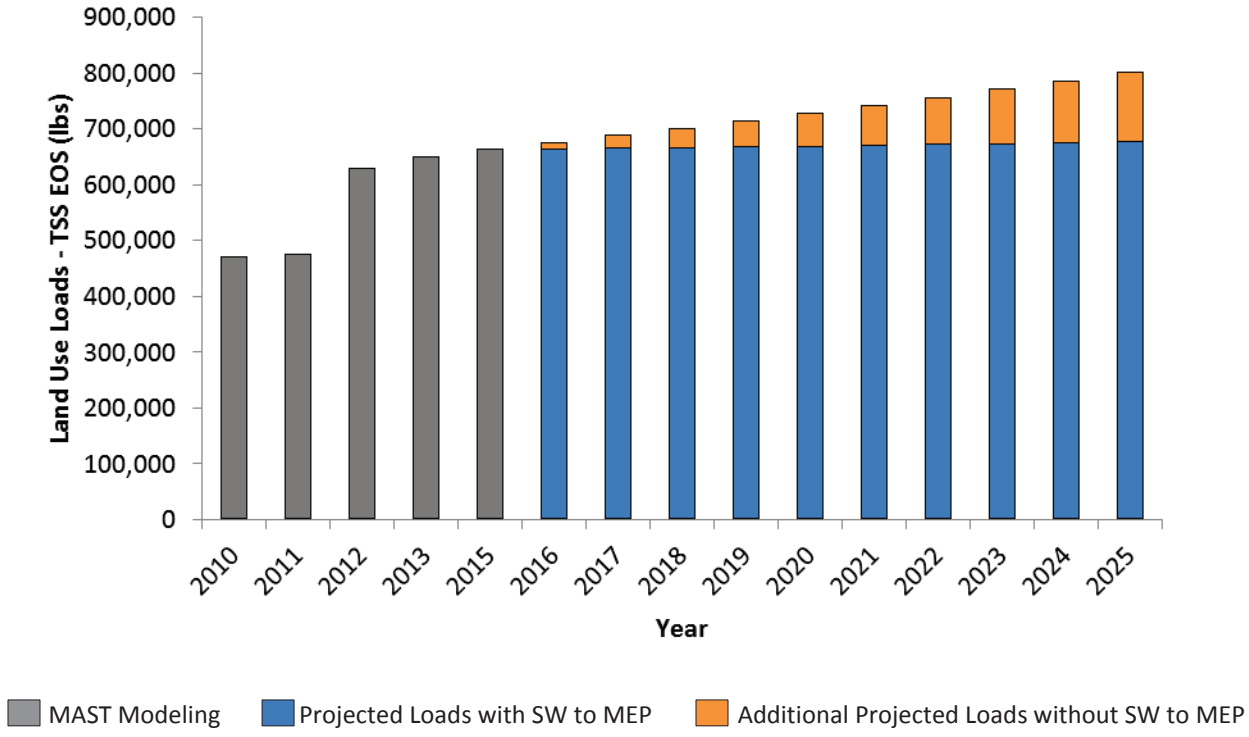


Figure 6: Modeled and Projected Land Use Loads

Figure 7 depicts sediment runoff loading by subwatershed based on a future conditions modeling scenario with the implementation of projects funded in the County's Capital Improvement Program (CIP) as recommended in the Upper Patuxent River Watershed Overall Summary Recommendation Report (Anne Arundel County, 2008) and discussed further in Section 4: Management Measures. In general, future sediment loading is projected to be highest in portions of the Upper Patuxent Mainstem (UP2, UP7, UP8, and UPB) and King's Branch (UPD).

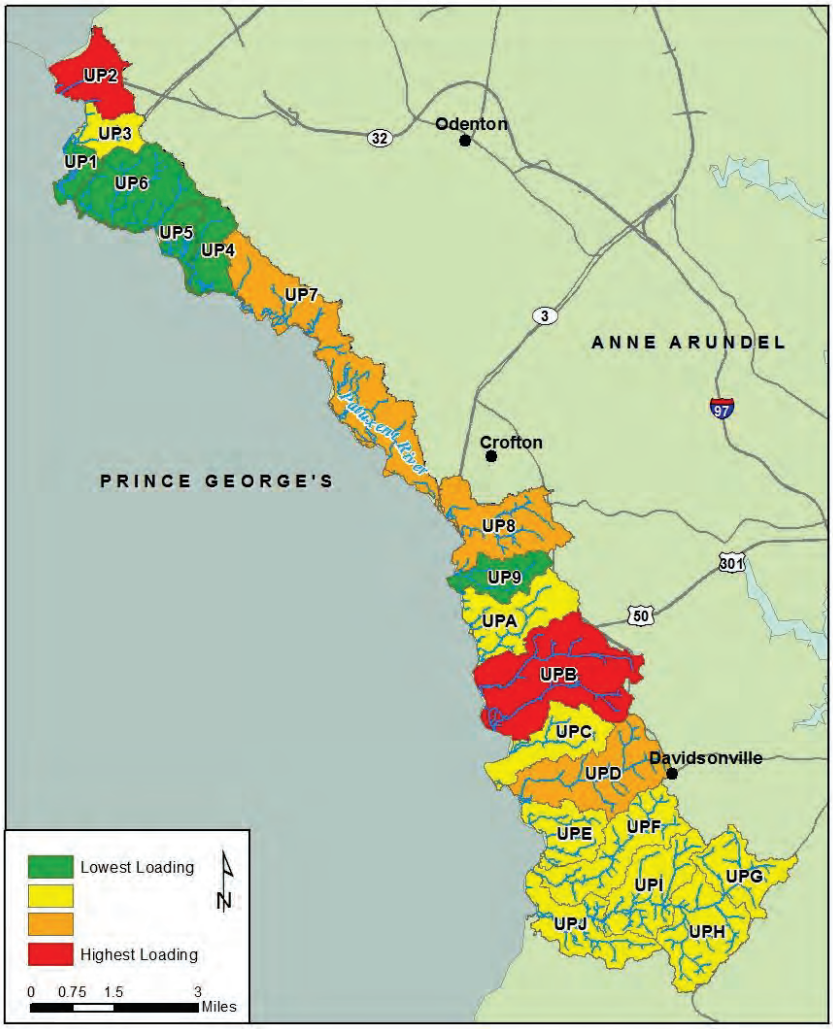


Figure 7: Total Suspended Solids Loads from Runoff Based on Future Conditions - Includes BMP Reductions

3.3.2 Offsetting Sediment Loads from Future Growth

Growth and development is expected to occur throughout Anne Arundel County, and depending on when and where this growth occurs, pollutant loading from urban stormwater sources may also increase. It is anticipated that new development will make use of ESD stormwater treatment according to MDE's Stormwater Regulations.

Maryland's 2007 Stormwater Management Act went into effect in October of 2007, with resulting changes to COMAR and the 2000 Maryland Stormwater Design Manual in May of 2009. The most significant changes relative to watershed planning are in regard to implementation of ESD. The 2007 Act defines ESD as "using small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources." As such Anne Arundel County has updated Articles 16 and 17 of the County Code to incorporate the requirements for ESD. Anne Arundel County finalized the *Anne Arundel County Stormwater Management Practices and Procedures Manual* to incorporate criteria specific to the County that are not addressed within the Maryland Design Manual (Anne Arundel County, 2010).

Figure 6 in Section 3.3: Anticipated Growth shows projected land use loads with and without the application of SW to the MEP. TMDL modeling efforts include the application of SW to the MEP to represent ESD treatment for new development in the watershed. SW to the MEP will control 90% of sediment loads for that new development.

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

4 Management Measures (c)

Best management practices (BMPs) are either already implemented or are planned for implementation to achieve and maintain the Upper Patuxent local TMDL load reductions. This section serves to describe the types of BMPs and management measures being implemented in the watershed. Load reductions that result from these measures are discussed in the following section, Section 5: Expected Load Reductions.

4.1 Modeling Approach

Each BMP provides a reduction for nitrogen, phosphorus, and sediment, along with other pollutants. The pollutant load for the Upper Patuxent watershed was determined using BayFAST, which calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program Partnership Watershed Model. BayFAST, created by Devereux Environmental Consulting for MDE, is a web-based pollutant load estimating tool that streamlines environmental planning. Users specify, delineate facility boundaries (e.g., watershed, parcel, drainage area), and alter land use information within the delineated boundary depending on the model year. Local TMDL baseline loads were calibrated in BayFAST by modeling BMPs installed prior to the TMDL baseline year on top of baseline land use background loads. This ensures that the same set of baseline BMPs are used throughout future progress and planned scenarios.

BayFAST estimates of load reductions for point and nonpoint sources include: agriculture, urban, forest, and septic loading. Load reductions are not tied to any single BMP, but rather to a suite of BMPs working in concert to treat the loads. Both BayFAST and the Chesapeake Bay Program Partnership Watershed Model calculate reductions from all BMPs as a group, much like a treatment train. Reductions are processed in order, with land use change BMPs first, load reduction BMPs next, and BMPs with individual effectiveness values at the end. The overall the load reduction can vary depending on which BMPs are implemented.

Pollutant load reductions achieved by maintenance efforts (e.g., street sweeping and inlet cleaning) are calculated outside of BayFAST. As discussed in the following section 4.2: Best Management Practices, inlet cleaning and street sweeping will be practiced in the Upper Patuxent watershed. Sediment

reduction credit for street sweeping and inlet cleaning is calculated following methods described in MDE (2014b). Vacuum-assisted street sweeping at a rate of 2 times per month reduces the load on the swept area by 25%. Inlet cleaning receives credit based on the mass of material collected, at the rate of 420 lb TSS per ton of wet material.

Both the Chesapeake Bay Program Partnership Watershed Model and BayFAST provide loads at two different scales: Edge-of-Stream (EOS) and Delivered (DEL). Delivered loads show reductions based on in-stream processes, such as nutrient uptake by algae or other aquatic life. This TMDL plan focuses on reducing load on the land, so EOS estimates are more appropriate and were used for all the modeling analysis.

This section presents the level of BMP implementation. Section 9 presents information on how progress toward load reductions will be evaluated and management plans adapted on an on-going basis.

4.2 Best Management Practices

Many stormwater BMPs address both water quantity and quality, however, some BMPs are more effective at reducing sediment than others. The stormwater practices listed below keep the focus on "green technology" to reduce the impacts of stormwater runoff from impervious surfaces. These BMPs were selected specifically for three reasons: 1) effectiveness for water quality improvement, 2) willingness among the public to adopt, and 3) implementable in multiple facility types without limitations by zoning or other controls.

These practices are consistent with those currently being implemented by Anne Arundel County DPW as water quality improvement projects. The County has the technical expertise, operational capacity, and system resources in place to site, design, construct and maintain these practices.

The recommended practices are also consistent with those proposed in the County's Phase II WIP for the Chesapeake Bay TMDL and in the County's comprehensive watershed planning efforts. Exceptions to this are dry ponds which include dry detention ponds and dry extended detention ponds. These practices are no longer considered for future implementation; however, there are many existing facilities that are still actively treating runoff throughout the County so they are described here as well. The practices include:

- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. Rain gardens may be engineered to perform as a bioretention.
- **Bioswales** —An open channel conveyance that functions similarly to bioretention. Unlike other open channel designs, there is additional treatment through filter media and infiltration into the soil.
- **Dry Detention Ponds** – Depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow MAST modeling includes hydrodynamic structures in this category. These devices are designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.

- **Dry Extended Detention Ponds** - Depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. They are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, allowing additional wet sedimentation to improve treatment effectiveness.
- **Impervious Surface Reduction** - Reducing impervious surfaces to promote infiltration and percolation of runoff storm water. Disconnection of rooftop and non-rooftop runoff, rainwater harvesting (e.g., rain barrels), and sheetflow to conservation areas are examples of impervious surface reduction.
- **Infiltration** — A depression or trench to form a shallow basin where sediment is trapped and stormwater infiltrates into the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil; they are not constructed on poor soils, such as C and D soil types. Yearly inspections to determine if the basin or trench is still infiltrating runoff are planned. Dry wells, infiltration basins, infiltration trenches, and landscaped infiltration are all examples of this practice type.
- **Outfall Enhancement with Step Pool Storm Conveyance (SPSC)** – The SPSC is designed to stabilize outfalls and provide water quality treatment through pool, subsurface flow, and vegetative uptake. The retrofits promote infiltration and reduce stormwater velocities. This strategy is modeled in MAST as bioswales.
- **Stream Restoration -** Stream restoration in urban areas is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape of a stream, help improve habitat and water quality conditions in degraded streams.
- **Stormwater Retrofits –** Anne Arundel County plans to construct a variety of retrofits throughout the County. Stormwater retrofits may include converting dry ponds, dry extended detention ponds, or wet extended detention ponds into wet pond structures, wetlands, infiltration basins, or decommissioning the pond entirely to install SPSC (step pool storm conveyance).
- **Urban Filtering** - Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit.
- **Urban Tree Plantings** - Urban tree planting is planting trees on urban pervious areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting
- **Vegetated Open Channels** - Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff then releases it at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached pollutants. Until 2002 in Maryland, these practices were generally designed to meet water quantity, not water quality objectives. There is little or no vegetation within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.

The measured effectiveness for each of these practices may be found in Table 8.

Table 8: Typical Sediment Reduction from Stormwater BMPs

BMP	Sediment Reduction
Bioretention A/B soils	80%
Bioretention C/D soils	55%
Bioswales	80%
Dry Detention Ponds	10%
Dry Extended Detention Ponds	60%
Impervious Surface Reduction*	-
Infiltration	95%
Outfall Enhancement with SPSC**	80%
Stream Restoration	15.13 lbs/linear ft
Urban Filtering	80%
Urban Tree Plantings*	-
Vegetated Open Channels	70%
Wet Ponds or Wetlands	60%

Sources: Simpson and Weammert, 2009; and Maryland Assessment Scenario Tool (MAST) documentation
* Calculated as a land use change to a lower loading land use
**Outfall enhancement with SPSC modeled as bioswales in MAST

Along with the structural BMPs listed above, treatment will also be provided through non-structural measures. These are treatments that rely on programs that continue throughout the year and are repeated annually.

- **Inlet Cleaning -** Storm drain cleanout practice ranks among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with their NPDES stormwater permits. Sediment reduction credit is based on the mass of material collected, at the rate of 420 lb TSS per ton of wet material (MDE, 2014b).
- **Street sweeping** — Starting Fiscal Year 2015, Anne Arundel County has enhanced their street sweeping program which now includes sweeping curb-miles within the Upper Patuxent (Anne Arundel County DPW, 2015; Figure 8). This enhanced program targets impaired watersheds and curbed streets that contribute trash/litter, sediment, and other pollutants. For full credit by MDE, street sweeping should occur twice a month or 26 times a year on urban streets. This frequent sweeping of the same street will reduce nitrogen and phosphorus as well as sediment. Under the enhanced street sweeping program Anne Arundel County is sweeping arterial streets within the Upper Patuxent watershed on a bi-weekly basis (26 times a year) and collector and local streets on a monthly basis (12 times a year). Vacuum-assisted street sweeping at a rate of 2 times per month reduces the load on the swept area by 25%. In order to quantify sediment load reductions from monthly sweeping efforts, the removal rate of 22% for vacuum-assisted monthly sweeping was applied to total sediment collected from collector and local streets (CWP, 2008).



Figure 8 – Street Sweeping Routes in Anne Arundel County, Maryland

5 Expected Load Reductions (b)

WLAs in the sediment TMDL were developed using the Chesapeake Bay Program Phase 5.2 (CBP P5.2) watershed model. Currently, MAST is using a computational framework that is compatible with an updated version of the model: CBP P5.3.2. Because the TMDL was developed under an older version of the model, the TMDL WLA needed to be translated into a MAST-compatible target load. In order to do this, the 2005 baseline sediment load was re-calculated in MAST with the 8-digit county split geography (Upper Patuxent 02131104, Anne Arundel County). The required reduction percent assigned to the Anne Arundel County Phase I MS4 source (11.4%) in the local TMDL regulation was then applied to the new baseline load to calculate required sediment reduction. The required sediment reduction was then subtracted from the new baseline load to calculate the MAST-compatible target TMDL WLA. Sediment loads required for the Upper Patuxent Anne Arundel County Phase I MS4 source are shown in Table 9.

Table 9: Sediment Loads Required for the Upper Patuxent Watershed Local TMDL Anne Arundel County Phase I MS4 Source

2005 Baseline Load (lbs/yr)	Required Reduction %	Required Reductions (lbs/yr)	TMDL Load Allocation (lbs/yr)
485,565	11.4%	55,354	430,211

5.1 2015 Progress – Actual Implementation

Anne Arundel County maintains an extensive geodatabase of stormwater urban BMP facilities and water quality improvement projects (WQIP). Approximately 507 acres of County Phase I MS4 land has been treated through 2015 in addition to 3,750 linear feet of stream restoration and the implementation of other non-structural BMPs (source: 2015 NPDES Annual Report database- Attachment A: Table B and D; and County CIP list of completed projects). Current BMP implementation through 2015 in the Upper Patuxent is shown in Table 10. A list of completed projects is included in Appendix A.

Table 10: Current BMP Implementation through 2015 for Upper Patuxent River

BMP	Unit	2015 Current Implementation
Bioretention	acre	0.06
Bioswale	acre	4.02
Dry Ponds	acre	52.57
Extended Detention Dry Ponds	acre	13.64
Impervious Surface Reduction	acre	0.06
Infiltration	acre	255.00
Inlet Cleaning	no. of inlets	38
SW to the MEP	acre	1.9
Urban Filtering	acre	0.0
Urban Tree Plantings	acre	0.0
Urban Stream Restoration	linear feet	3,750.0
Vegetated Open Channels	acre	0.0

BMP	Unit	2015 Current Implementation
Wet Ponds or Wetlands	acre	182.2

Source: WPRP urban BMP and WQIP database

2015 Progress results are shown in Table 11.

Table 11: 2015 Progress Reductions Achieved

Baseline Load and TMDL WLA	TSS-EOS lbs/yr
2005 Baseline Scenario Load	485,565
Required Percent Reduction	11.4%
Required Reduction	55,354
Local TMDL WLA	430,211
2015 Progress Results	**TSS-EOS lbs/yr**
2015 Progress Reduction Achieved	62,192
2015 Percent Reduction Achieved	12.8%

5.2 Planned Implementation

Table 12 compares implementation of existing BMPs with planned levels of implementation. This increase in implementation will continue to achieve the loads required in the local TMDL and ensure that future growth (through 2025) is treated. These loads meet the TMDL required reductions for the Upper Patuxent (Table 13). A list of completed projects and projects programmed out to FY19 is included in Appendix A.

Figure 9 shows baseline and progress loads (green bars) and planned loads (yellow bars) compared to milestone goal loads (red bars and red line). As discussed in Section 3.3: Anticipated Growth, initial conditions loads (2011 – 2015) without BMPs were modeled in MAST at the Upper Patuxent 8-digit subwatershed scale. This comparison shows that all background loads will be treated to the required TMDL allocated load with current and future BMP implementation.

Table 12: BMP Implementation - Current 2015 and Planned 2025 Levels for the Upper Patuxent River

BMP	Units	2015 Current Implementation	2025 Planned Implementation
Bioretention	acre	0.1	0.1
Bioswale	acre	4.0	4.0
Dry Ponds	acre	52.6	52.6
Extended Detention Dry Ponds	acre	13.6	13.6
Impervious Surface Reduction	acre	0.1	0.1
Infiltration	acre	255.0	255.0
Inlet Cleaning	no. of inlets	38	38
Outfall Enhancement with SPSC	acre	0.0	201.7

Stormwater Retrofits[1]	acre	0.0	37.2
Street Sweeping[2]	curb-miles	4.9	4.9
SW to the MEP	acre	0.0	0.0
Urban Filtering	acre	0.0	10.0
Urban Tree Plantings	acre	0.0	0.0
Urban Stream Restoration	linear feet	3,750.0	5,000
Vegetated Open Channels	acre	0.0	0.0
Wet Ponds or Wetlands	acre	182.2	204.4

[1]Includes projects that will convert dry ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds.
[2]Includes curb-miles for arterial, collector, and local streets. Arterial streets swept bi-weekly (26 times a year) and collector and local streets swept monthly (12 times a year)

Table 13: 2025 Planned Reductions

Baseline Load and TMDL WLA	**TSS-EOS lbs/yr**
2005 Baseline Scenario Load	485,565
Required Percent Reduction	11.4%
Required Reduction	55,354
Local TMDL WLA	430,211
2025 Planned Results	**TSS-EOS lbs/yr**
2025 Planned Load[1]	351,860
2025 Planned Reduction Achieved	133,705
2025 Percent Reduction Achieved	27.5%

[1]2025 Planned load is the 2025 Planned Reduction Achieved subtracted from the 2005 Baseline Loads. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and Accounting for Growth policies will address the remaining 10%.

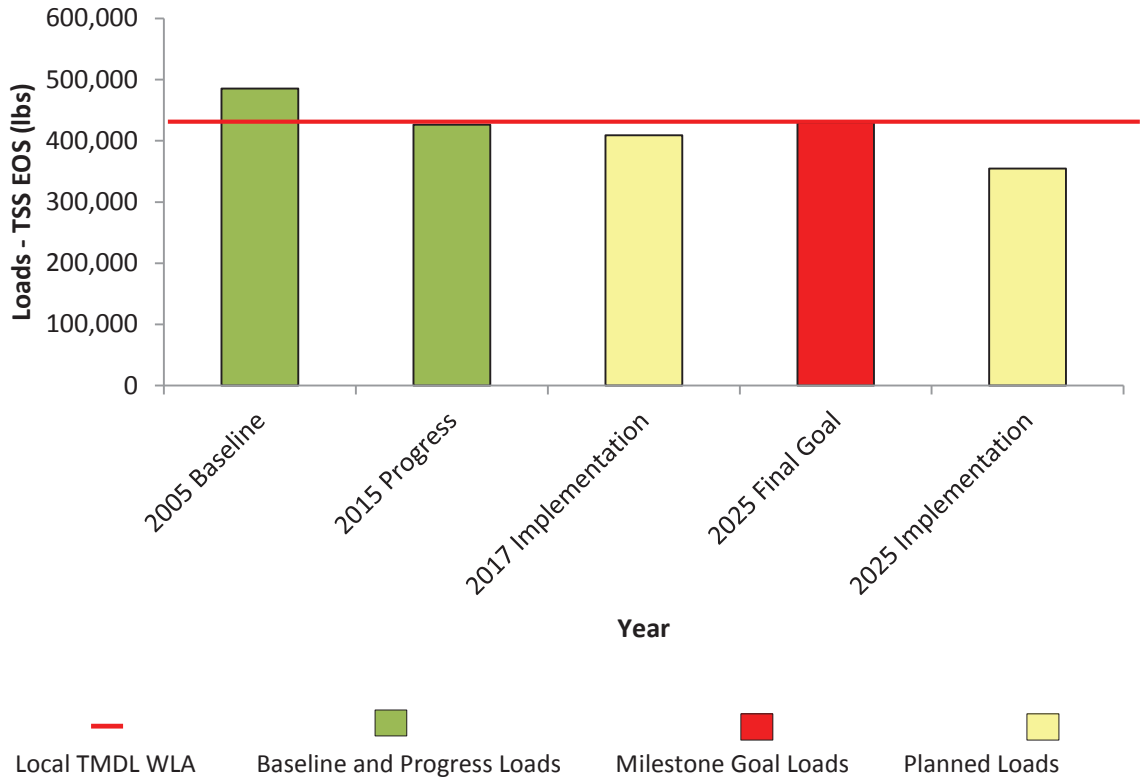


Figure 9: Progress and Planned Reductions in the Upper Patuxent River Watershed

6 Technical and Financial Assistance Needs (d)

Technical Needs

Technical assistance to meet the reductions and goals of a TMDL takes on many forms including MDE assistance to local governments, state and local partner assistance to both MDE and municipalities, and technical consultants contracted to provide support across a wide variety of service areas related to BMP planning and implementation.

MDE has and will provide technical assistance to local governments through training, outreach and tools, including recommendations on ordinance improvements, technical review and assistance for implementation of BMPs at the local level, and identification of potential financial resources for implementation (MDE, 2014b).

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

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

Technical assistance for Public Participation and Education and for Monitoring will also be necessary to fully implement and track progress towards meeting the goals of the local TMDL. These elements are discussed in sections 7 and 10 of this plan.

Financial Needs

The total projected cost to implement the County's CIP projects described in this plan for the Upper Patuxent watershed is $11,437,861 including $6,019,950 towards outfall enhancements with SPSC, $2,648,207 towards stream restorations, $879,687 towards stormwater pond retrofits, $76,000 for inlet cleaning, and $1,814,017 for street sweeping. Structural BMP project costs are estimated based on the average cost per pound of nitrogen removed based on a group of completed projects consisting of various BMP types. Since these practices reduce nitrogen and phosphorus as well as sediment, costs derived from this method translate for sediment removal. This approach was used to calculate structural BMP costs in the County's Phase II WIP. Non-structural BMP costs for inlet cleaning were derived from historic County data and include equipment, operations, and maintenance costs.

Table 14 includes a summary of funding need per CIP project BMP type and project phase. Project cost is split throughout the implementation timeframe with design and land ROW estimated costs to occur the first year of the project, construction costs to occur in the second year, and overhead costs split between the first and second year.

Table 14: Upper Patuxent River Cost Over Milestone Periods

BMP	2014-2015	2016-2017	2018-2019	2020-2021	2022-2025	Total Cost
Outfall Enhancement	**$390,005**	**$2,132,473**	**$1,469,179**	**$2,028,293**		**$6,019,950**
Design	$256,245		$219,690	$206,044		$681,979
Land ROW	$51,249		$54,923	$41,209		$147,380
Construction		$2,049,962	$1,098,452	$1,648,349		$4,796,762
Overhead	$82,511	$82,511	$96,115	$132,692		$393,829
Stream Restoration			**$2,648,207**			**$2,648,207**
Design			$395,994			$395,994
Land ROW			$98,998			$98,998
Construction			$1,979,968			$1,979,968
Overhead			$173,247			$173,247
SWM Pond Retrofit	**$235,730**	**$643,957**				**$879,687**
Design	$24,479	$65,416				$89,895
Land ROW	$0	$13,083				$13,083
Construction	$195,830	$523,330				$719,159
Overhead	$15,422	$42,128				$57,550
Inlet Cleaning	**$15,200**	**$15,200**	**$15,200**	**$15,200**	**$15,200**	**$76,000**
Street Sweeping	**$362,803**	**$362,803**	**$362,803**	**$362,803**	**$362,803**	**$1,814,017**

6.1 Funding Sources

Prior to the passage of Maryland House Bill 987 and, as stated in the Anne Arundel County Phase II WIP (Anne Arundel County, 2012), the County's funding capacity to implement urban stormwater restoration/retrofit projects was limited by the County's Capital Improvement Program (CIP) budget for environmental restoration and water quality improvement projects. To comply with forthcoming requirements of the Phase I NPDES MS4 permit, and to support restoration efforts towards reducing pollutant loads required for both the Chesapeake Bay TMDL and local TMDLs throughout Maryland, the State Legislature passed a law in 2012 (House Bill 987) mandating that Maryland's 10 largest jurisdictions (those with Phase I MS4 permits), including Anne Arundel County, develop a Watershed Protection and Restoration Program and establish a Stormwater Remediation Fee. To comply with the State legislation, Anne Arundel County passed legislation in 2013, Bill 2-13.

The County's Stormwater Remediation Fee provides a dedicated source of revenue for the implementation of local stormwater management plans through stormwater management practices and stream and wetland restoration activities and is assessed to Anne Arundel County property owners based on the amount of impervious surface on their property. The Stormwater Remediation Fee is structured to provide sufficient funding for projects to meet the pollutant load reduction required by the Chesapeake Bay TMDL, EPA approved individual TMDLs with a stormwater WLA and to meet the impervious surface management requirements as well as other stormwater obligations set forth in the County's NPDES MS 4 Permit. The fee is assessed to Anne Arundel County property owners as a separate line item on the owner's real property tax bill.

In addition to the Stormwater Remediation Fee, Anne Arundel County actively pursues grant funding from Federal, State and non-governmental organizations (NGOs) to leverage funding for its restoration projects. And, with the creation of the Stormwater Remediation Fee, the County has developed a Grant Program to provide funding to local NGOs to facilitate implementation of restoration projects that further the County's ability to meet its regulatory requirements.

7 Public Participation / Education (e)

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

In order to implement an effective strategy to meet water quality standards and achieve pollutant load reduction, an effort to engage a very broad audience of landowners was a necessity. The Anne Arundel Watershed Stewards Academy (AAWSA), a pre-eminent non-profit (501(c)3) environmental organization, was formed through Anne Arundel County Department of Public Works and the County Board of Education's Arlington Echo Outdoor Education Center (Anne Arundel County, 2012). AAWSA's mission is to identify, train, and support citizens to become Master Watershed Stewards who take

action with their neighbors to restore local waterways in Anne Arundel County. This program is a unique way to integrate education as a vital element in its role in preservation, conservation and advocacy. There are currently more than 100 certified Master Watershed Stewards throughout Anne Arundel County and adjacent areas.

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

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

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

These programs and others like them could be more focused on the Upper Patuxent watershed.

In addition to the AAWSA, the following organizations have been identified for possible partnerships and education and outreach for the Upper Patuxent:

- Master Gardeners
- Audubon Society
- Students for the Environment
- Maryland civic associations and service clubs:
    - Maryland Home Builders Assoc.
    - Audubon Naturalist Society of the Central Atlantic States

- Audubon Society of Central Maryland
- Blue Water Baltimore
- Chesapeake Audubon Society
- Chesapeake Bay Program
- Chesapeake Bay Foundation
- Chesapeake Bay Trust
- Chesapeake Ecology Center
- Center for Watershed Protection
- Alliance for the Chesapeake Bay
- Alliance for Sustainable Communities
- Baywise Master Gardeners
- Sierra Club – Maryland Chapter
- Magothy River Association
- Patuxent Riverkeeper
- West/Rhode Riverkeeper
- Nature Conservancy
- Smithsonian Environmental Research Center
- Anne Arundel Community College
- University of Maryland
- University of Maryland Extension
- Volunteer Center for Anne Arundel County

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

Part 4.E.3 of the County's NPDES MS4 permit outlines requirements for public involvement in the development of TMDL restoration plans. The County will fulfill these requirements by providing notice in *The Capital* newspaper which serves all of Anne Arundel County. This notice will outline how the public may obtain information on the restoration plan and provide comments. The County will provide copies of the restoration plan to parties upon request. The County will provide for a minimum 30-day comment period before finalizing the plan and will include a summary in the text of the annual report of how the County addressed or will address any material comments received from the public.

8 Implementation Schedule and Milestones (f & g)

This section presents the target loads and the activities required to achieve those targets based on the 2017 interim and 2025 final loads and implementation targets. The following schedule and milestones follows the Chesapeake Bay TMDL milestone date framework (60% progress by 2017) and end date (2025; USEPA, 2010). This schedule has previously been approved by the CBP for the applicable Bay TMDLs and is believed to be a good option for tracking progress towards reduction goals of the Upper Patuxent local TMDL.

8.1 Loading Allocations and Milestone Targets

Planning loads for 2017 and final loads for 2025 for the Upper Patuxent watershed are presented in Table 15 below. As mentioned in Section 5: Expected Load Reductions (b) (see Tables 10 and 11), progress is already underway with the implementation of strategies throughout the watershed. As a result of current implementation efforts, the 2015 Progress sediment load is less than the 2025 TMDL Allocated load.

Table 15: Upper Patuxent Planning and Target Loads (edge-of-stream loads)

Load	Sediment Load (lbs/year)
2005 Baseline Load	485,565
2015 Progress Load	423,373
2025 TMDL Allocated Load	430,211
Percent Reduction between 2005 Baseline and 2025 Loads	11.4%

8.2 Implementation Milestones

To meet the loading allocations and milestones outlined in the previous section, implementation of programs and BMPs must keep pace and meet planned implementation targets. Table 16 details the implementation for each tracked BMP with the associated unit of measure. The 2015 data reflects existing BMPs while the 2017, 2021, and 2025 values reflect the planned implementation for those years. A list of completed projects and projects programmed out to FY19 is included in Appendix A.

Table 16: Upper Patuxent River Planning Milestones for Implementation

BMP	Unit	2015 Implemen-tation	2017 Planned	2021 Planned	2025 Planned	Total Impleme ntation
Bioretention	acre	0.1				0.1
Bioswale	acre	4.0				4.0
Dry Ponds	acre	52.6				52.6
Extended Detention Dry Ponds	acre	13.6				13.6
Impervious Surface Reduction	acre	0.1				0.1
Infiltration	acre	255.0				255.0
Inlet Cleaning	no. of inlets/yr	38	38	38	38	38
Outfall Enhancement with SPSC	acre	0.0	26.6	87.55	87.55	201.7
Stormwater Retrofits[1]	acre	0.0	37.2			37.2
Street Sweeping[2]	acre	4.9	4.9	4.9	4.9	4.9
SW to the MEP	acre	0.0				0.0
Urban Filtering	acre	0.0	10.0			10.0

BMP	Unit	2015 Implemen-tation	2017 Planned	2021 Planned	2025 Planned	Total Impleme ntation
Urban Tree Plantings	acre	0.0				0.0
Urban Stream Restoration	linear feet	3,750.0	450	400	400	5,000
Vegetated Open Channels	acre	0				0.0
Wet Ponds or Wetlands	acre	182.2	22.2			204.4

[1]Includes projects that will convert dry ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds.
[2]Includes curb-miles for arterial, collector, and local streets. Arterial streets swept bi-weekly (26 times a year) and collector and local streets swept monthly (12 times a year)

8.3 Implementation Priorities

To meet the loading allocations and milestones outlined in the previous sections, implementation will be planned based on prioritization analyses presented in the Upper Patuxent River Watershed Overall Summary Recommendation Report (Anne Arundel, 2008). Upper Patuxent subwatersheds were prioritized for restoration/retrofit project selection potential using three separate prioritization models. The models integrated historical environmental data, current stream assessment monitoring data, drainage area characteristics (GIS data), and watershed modeling results into indicators of watershed condition and need. The indicators are combined into the four models:

- Stream Reach Restoration
- Subwatershed Restoration
- Subwatershed Preservation

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

8.3.1 Stream Reach Restoration

The stream restoration prioritization uses a suite of indicators that are weighted and then combined into a final relative rating for each perennial reach as identified in the Physical Habitat Condition Assessment. The suite of stream restoration indicators used in the Upper Patuxent watershed, along with the indicator weight is presented in Table 17.

Table 17: Stream Priority Rating Indicators for Restoration (Anne Arundel, 2008)

Category	Indicator	Weight
Stream Habitat	MPHI score	31.6%
Stream Morphology	Rosgen Level I Classification	5.3%
Land Cover	Percent Imperviousness	5.3%
Infrastructure	Riparian buffer impacts	5.3%
	Channel erosion impacts	10.5%

Category	Indicator	Weight
	Head cut impacts	5.3%
	Dumpsite impacts	5.3%
	Other infrastructure impacts (pipes, ditches, stream crossings, obstructions)	15.8%
Hydrology and Hydraulics	Road Crossing Flooding Potential	15.8%

A total of 372 reaches were processed in the stream restoration model. The stream reaches in the Upper Patuxent River Watershed were predominantly Good to Fair on the rating scale and are not considered high priority for restoration. Twenty-five reaches were categorized as "Very Poor" and were considered "High" priority or worst condition, 69 were "Poor" or "Medium High" priority, 126 were "Fair" or "Medium" priority, and 152 were "Good" and were considered "Low" priority or best condition (Table 18, Figure 10, and Figure 11). The Stocketts Run subwatershed (UPG, UPH, UPI, UPJ) ranked as a very high priority overall, as 11 of the 25 "Very Poor" reaches are located in Stocketts Run.

Table 18: Stream Restoration Assessment Results (Anne Arundel County, 2008)

Subwatershed	Number of Reaches with Rating			
	Very Poor	Poor	Fair	Good
UP1	No perennial reaches			
UP2	0	2	1	0
UP3	No perennial reaches			
UP4	0	0	0	1
UP5	0	0	1	2
UP6	1	1	1	18
UP7	1	3	4	10
UP8	1	8	7	6
UP9	0	1	3	5
UPA	1	7	9	13
UPB	2	5	13	10
UPC	0	5	6	5
UPD	2	6	9	3
UPE	1	3	5	17
UPF	5	8	21	12
UPG	1	5	10	12
UPH	2	1	7	23
UPI	5	8	14	10
UPJ	3	6	15	5
Total	**25**	**69**	**126**	**152**

8.3.2 Subwatershed Restoration

Similarly to the stream restoration assessment, the subwatershed assessment used a collection of restoration indicators to assign a rating to each subwatershed. The indicators were weighted and

combined into a single restoration rating for each subwatershed. Restoration indicators fell into one of six categories: stream ecology, TMDL impairments, On-site Disposal Systems (OSDS), BMPs, Hydrologic and Hydraulic (H&H) Modeling, Water Quality, and Landscape. Each category contains one to four different indicators. Table 19 provides a summary of the categories, indicators, and relative weighting assigned by the County.

Table 19: Subwatershed Priority Rating Indicators for Restoration (Anne Arundel, 2008)

Category	Indicator	Weight
Stream Ecology	Final habitat score	7.5%
	Bioassessment score	7.5%
303(d) List	Number of TMDL impairments	7.5%
OSDSs (Septics)	Nitrogen Loads from septics (lbs)	9.3%
BMPs	Impervious area treated by BMPs (%)	6.6%
Water Quantity)	Peak flow from 1-year storm event (cfs/acre)	4.5%
	Peak flow from 2-year storm event (cfs/acre)	4.5%
	Runoff volume from 1-year storm event (inches/acre)	5.8%
	Runoff volume from 2-year storm event (inches/acre)	5.8%
Water Quality (Land only)	Nitrogen load from runoff (lbs/acre/yr)	6.9%
	Phosphorus load from runoff (lbs/acre/yr)	6.9%
	Total Suspended Solids from runoff (Tons/acre/yr)	0.0%
Landscape	Impervious cover (%)	9.4%
	Forest within the 100 ft stream buffer (%)	10.3%
	% of existing wetlands to potential wetlands	9.4%
	Acres of developable critical area	5.3%

The results of the subwatershed restoration assessment revealed that the subwatersheds in the Upper Patuxent received a reasonable mix of Good, Fair, Poor, and Very Poor ratings. Three of the nineteen subwatersheds received a “Good” rating or best condition and two subwatersheds received a “Very Poor” rating or worst condition (Table 20, Figure 12, and Figure 13). It is also important to focus restoration efforts in subwatershed that ranked highest for existing TSS loads from urban runoff, which include subwatersheds UP2, UP7, UP8, UPB, and UPD (Figure 5).

Table 20: Subwatershed Restoration Assessment Results (Anne Arundel County, 2008)

Rating	Subwatershed
Good	UP1, UP6, UP9
Fair	UP3, UP4, UP5, UP7, UP8, UPA, UPE, UPH, UPI, UPJ
Poor	UPC, UPD, UPF, UPG
Very Poor	UP2, UPB



Figure 10: Stream Restoration Assessment Results - Upper Patuxent River Northern Section

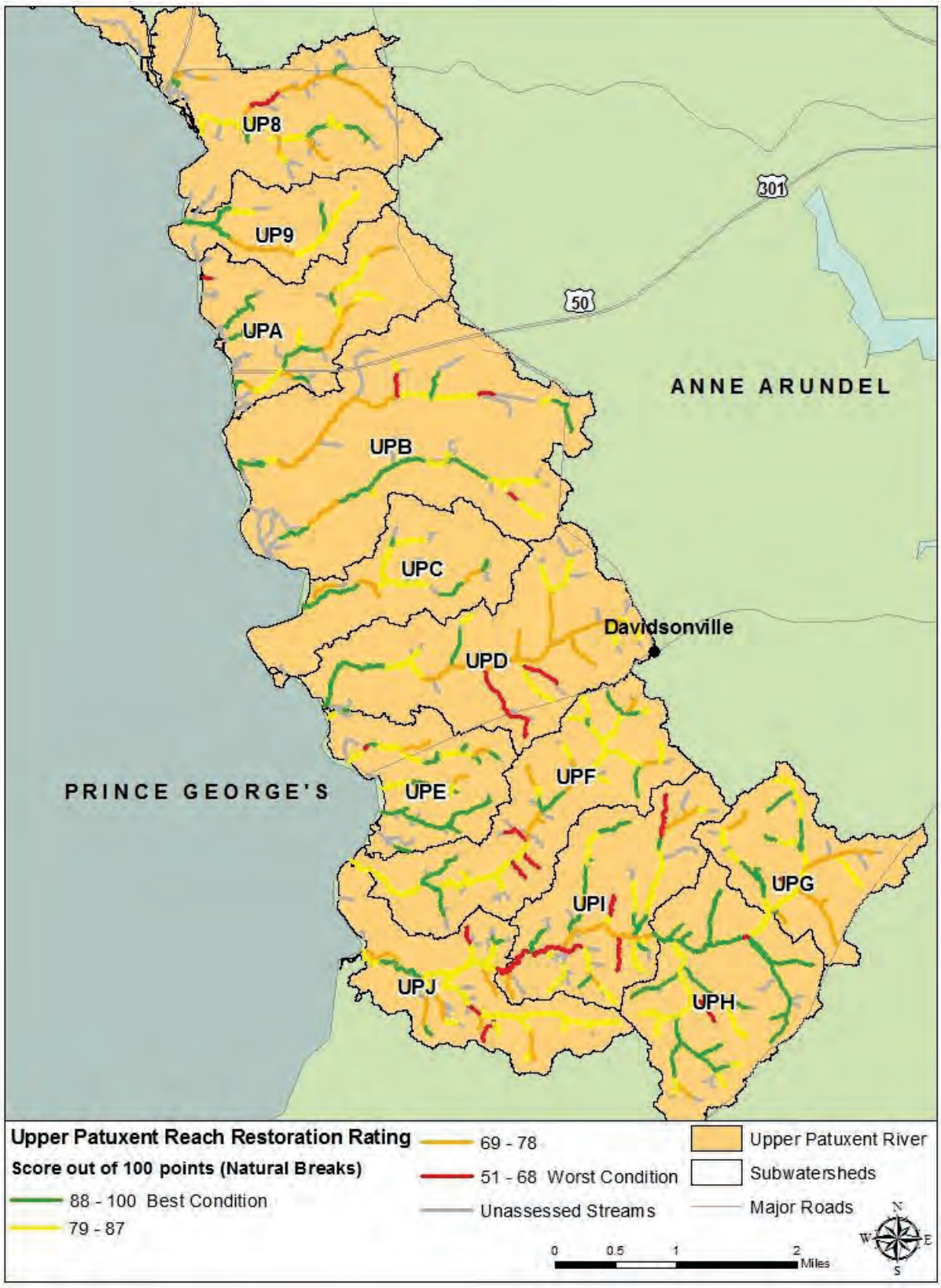


Figure 11: Stream Restoration Assessment Results - Upper Patuxent River Southern Section

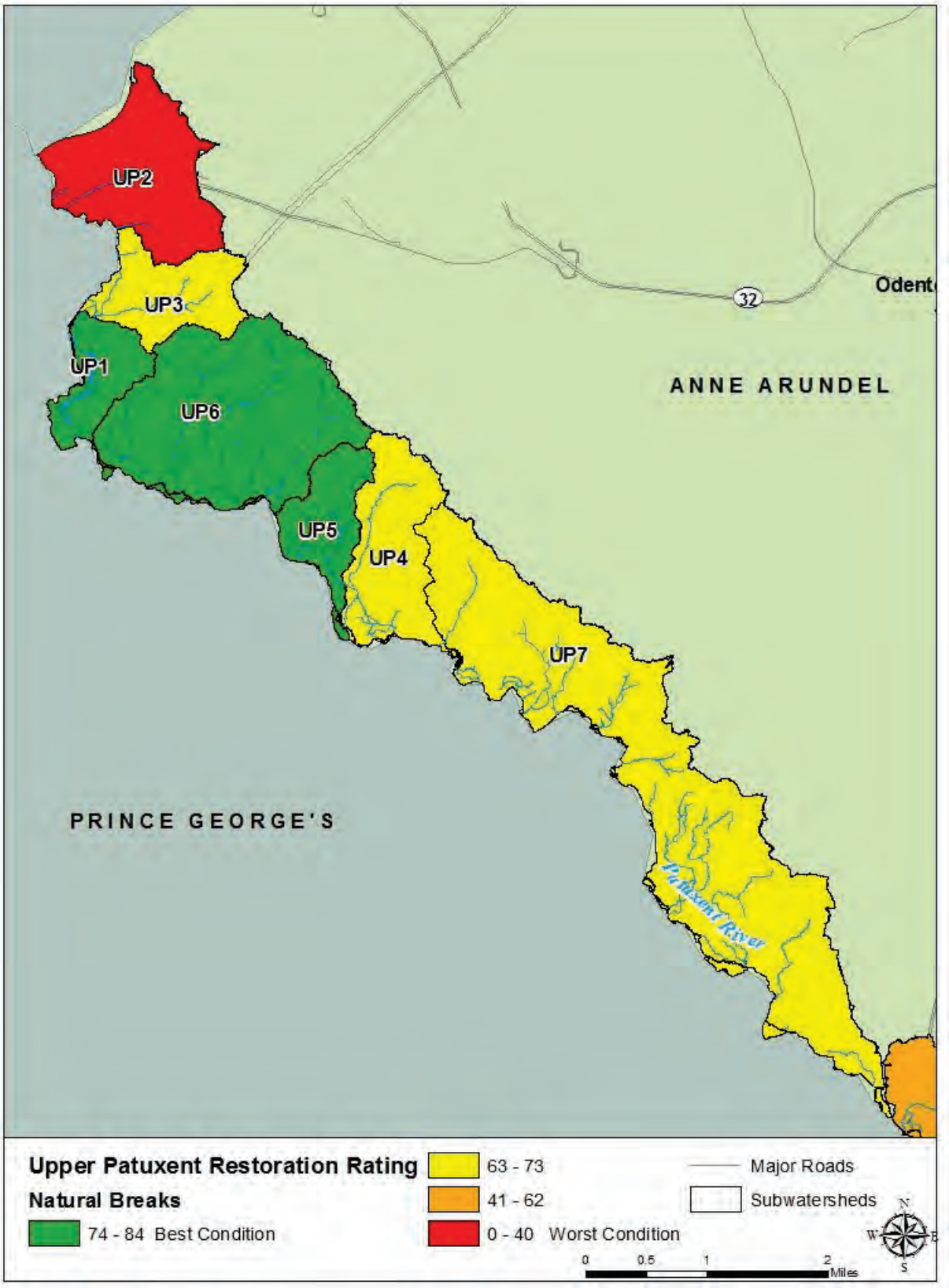


Figure 12: Subwatershed Restoration Assessment Results for the Upper Patuxent River Northern Section



Figure 13: Subwatershed Restoration Assessment Results for the Upper Patuxent River Southern Section

8.3.3 Prioritization of Strategy Implementation

As stated in the Anne Arundel County's Phase II WIP, the County uses three major categories to classify urban stormwater strategies: Core Strategy Tier I, Core Strategy Tier II, and Potential Load Reductions Outside the Tier I and Tier II Core Strategy (Anne Arundel County, 2012). BMP planning and implementation will be prioritized based on these three categories with highest priority given to Tier I and Tier II strategies.

Core Urban Stormwater Strategy Tier I includes the following:

- Restoration of ephemeral and perennial streams with a Department of Natural Resources (DNR) Maryland Biological Stream Survey's (MBSS) Maryland Physical Habitat Index (MPHI) score of severely degraded or degraded,
- Implementing stormwater management treatment at currently untreated major pipe outfalls; and,
- Retrofitting stormwater management ponds built prior to 2002 to optimize the pollutant reduction and ecosystem functions for the facilities

Core Urban Stormwater Strategy Tier II includes additional pollutant reduction activities that must be implemented to meet the 2025 allocations; which includes the following:

- Monthly vacuum assisted street sweeping and associated inlet cleaning for all closed section roads,
- Reforestation plan for available public open space land; and,
- SW to the MEP retrofits for County-owned properties including recreation areas

Potential Load Reductions Outside the Tier I and Tier II Core Strategies includes the following:

- Focuses on the work of private citizens and Watershed Master Stewards in implementing SW to the MEP for residential rooftops, in high density areas, and for private commercial and industrial properties.
- These areas have been selected geographically outside the area treated by the WIP core strategy.

8.4 Implementation Strategy

Following the adoption of its Stormwater Remediation Fee in 2013 Anne Arundel County developed a 6-year Capital Improvement Program (CIP) in FY14 that created a Watershed Protection and Restoration Program (WPRP) Class of projects to implement those restoration projects identified in the County's Phase II WIP and applicable individual TMDLs for achieving stormwater WLAs. Funding for this class of projects averages 74 million dollars annually. Project in the WPRP Class were identified and prioritized through a planning level assessment and consist of restoration of ephemeral and perennial streams with a MBSS Maryland Physical Habitat Index (MPHI) score of severely degraded or degraded; implementation of stormwater/water quality treatment at currently untreated stormwater pipe outfalls (greater than 24 inches), and retrofit of stormwater management ponds built prior to 2002, with drainage areas in excess of 10 acres, to optimize pollutant reduction and ecosystem functions for the facilities. As WPRP projects are funded, more detailed feasibility and constructability assessments are conducted. These assessments may result in identifying projects previously thought to be implementable but due to a variety of reasons are not; or identifying additional and new opportunities for load reduction. As these feasibility assessments are completed the County incorporates these findings into its modeling, re-assesses anticipated load reductions and adapts it implementation

program to delete or add projects and amends its CIP accordingly. And, as BMP technologies and efficiencies change, programs mature, credit trading is enacted and new regulations put into place, the County will reassess and modify its restoration strategy in response.

9 Load Reduction Evaluation Criteria (h)

Adaptive management is a critical component of achieving the WLAs required by the *Total Maximum Daily Load of Sediment in the Patuxent River Upper Watershed, Anne Arundel, Howard and Prince George's Counties, Maryland, Approved by EPA September 30, 2011*. This TMDL has clearly established load reduction targets for sediment. 2-Year Implementation Milestones have been established by the County to provide interim planning targets and to serve as a vehicle for assessing progress toward the load reduction targets. Progress will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring. Planning targets will be re-evaluated against progress and revised to ensure that Anne Arundel County is on track to meet established goals. Progress assessments are scheduled for 2017 and 2021, with 2025 set as the final date for achievement of load reductions.

The milestones proposed in Section 8: Implementation Milestones (2015, 2017, and 2021) provide interim planning targets. The planning targets will be used to reevaluate against progress and will be revised, if necessary, to ensure that Anne Arundel County continues to maintain TMDL requirements. Progress evaluation will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring.

9.1 Tracking Implementation of Management Measures

Implementation will be measured by determining whether the targets for implementation shown in Table 16 are maintained according to the milestone schedule presented. Anne Arundel County manages a comprehensive system for adding and tracking projects and accounting for new programs. New BMPs constructed through new development and redevelopment projects are entered into the County's BMP database as they come on line. WPRP is responsible for implementing and tracking Water Quality Improvement Projects (WQIP; i.e., restoration and retrofit projects and programs). Additional internal County groups including Bureau of Highway Road Operation Division who are responsible for maintenance efforts (i.e., street sweeping and inlet cleaning) report back to WPRP. Another way the County is capturing and tracking projects is through the AAWSA. Watershed stewards can enter their own data and implementation projects through the WPRP website (www.aarivers.org). Once these data are reviewed and validated by the County, they are incorporated into the County's master list of environmental restoration projects.

Two-Year Milestone Reporting

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

Milestones are reported in two forms: Programmatic and BMP Implementation. Programmatic milestones identify the anticipated establishment or enhancement of the institutional means that

support and enable implementation. Examples of Programmatic milestones include projected funding, enhancement of existing programs and resources, and the establishment of new programs and studies. The milestone period for Programmatic covers two calendar years – for example, the period for 2014 - 2015 is from January 1, 2014 through December 31, 2015. BMP Implementation milestones are a quantitative account of various types of restoration activities (e.g., structural BMPs, stream restoration, maintenance efforts), which have geo-located coordinates. The period for BMP implementation milestones differs from the Programmatic milestones period and covers two state fiscal years – for example, the period for 2014 – 2015 is from July 1, 2013 through June 30, 2015. Planned BMP Implementation milestones reported to MDE include the action (e.g., BMP type), proposed restoration over the 2-year milestone period (e.g., area treated, length restored), actual rate of implementation over 1 year, and percent progress.

The Programmatic and BMP Implementation milestone submittal and reporting process follows an iterative approach and includes three separate submittals to MDE. The first is an initial milestone submittal to MDE by January 31st of the first milestone calendar year (e.g., 2014), followed by an interim milestone progress report submittal by January 31st of the second milestone calendar year (e.g., 2015), and concluding with a final milestone progress submittal by January 31st of the start of the subsequent milestone period (e.g., 2016).

Annual NPDES Reporting

As a requirement of the NPDES permit described in Section 2.4.4, the County must submit on or before the anniversary date of the permit a progress report demonstrating the implementation of the NPDES stormwater program based on the fiscal year. If the County's annual report does not demonstrate compliance with their permit and show progress toward meeting WLAs, the County must implement BMP and program modifications within 12 months.

The annual report includes the following – items in bold font directly relate to elements of the load reduction evaluation criteria:

a. The status of implementing the components of the stormwater management program that are established as permit conditions including:
    i. Source Identification
    ii. Stormwater Management
    iii. Erosion and Sediment Control
    iv. Illicit Discharge Detection and Elimination
    v. Litter and Floatables
    vi. Property Management and Maintenance
    vii. Public Education
    viii. Watershed Assessment
    ix. Restoration Plans
    x. TMDL Compliance
    xi. Assessment of Controls; and,
    xii. Program Funding
b. A narrative summary describing the results and analyses of data, including monitoring data that is accumulated throughout the reporting year
c. Expenditures for the reporting period and the proposed budget for the upcoming year

d. A summary describing the number and nature of enforcement actions, inspections, and public education programs
e. The identification of water quality improvements and documentation of attainment and/or progress toward attainment of benchmarks and applicable WLAs developed under EPA approved TMDLs; and,
f. The identification of any proposed changes to the County's program when WLAs are not being met
g. Attachment A – The County is required to complete a database containing the following information:
    i. Storm drain system mapping
    ii. Urban BMP locations
    iii. Impervious surfaces
    iv. Water quality improvement project locations
    v. Monitoring site locations
    vi. Chemical monitoring results
    vii. Pollutant load reductions
    viii. Biological and habitat monitoring
    ix. Illicit discharge detection and elimination activities
    x. Erosion and sediment control, and **stormwater program information**
    xi. Grading permit information
    xii. Fiscal analyses – cost of NPDES related implementation

9.2 Estimating Load Reductions

Progress assessments are scheduled by the Chesapeake Bay Program for 2017 and 2021. At this time, multiple lines of evidence including: several models, monitoring data, and the most recent science on BMP effectiveness and water quality response will be evaluated. The milestones and progress assessments will contribute to constant reassessment of management plans, and adapting responses accordingly as technologies and efficiencies change, programs mature, credit trading is enacted, and regulations are put in place. The County will model load reductions in MAST at the interim (2014, 2016, 2018) and milestone (2015, 2017, 2019) years, which equates to about once a year at minimum.

9.3 Tracking Overall Program Success through Monitoring

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

9.4 Best Management Practices Inspection and Maintenance

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

Background

Both the State and County SWM Codes require maintenance inspections be performed on all SWM practices during the first year of operation and every 3 years thereafter. The first year of operation

inspections are performed by the Environmental Control Inspectors before Certificates of Completion is issued for the grading permits under which the practices were constructed. The 3-year maintenance inspections are the responsibility of the WPRP inspection staff.

Phase 1 Inspection and Enforcement

Phase 1 reflects the first time a SWM practice receives a 3-year maintenance inspection and maintenance is required. Using the proper Maintenance Inspection Checklists the Inspector performs the required 3-year maintenance inspection indicating on the Checklist boxes if maintenance is required, not required or the item is non-applicable. The information on the completed Checklist will serve to comply with the inspection requirements of COMAR 26.17.02.11 and be used to complete a Phase 1 Correction Notice issued in the field or mailed to the property owner. The Phase 1 Correction Notices shall be prepared using the I&P standard computerized inspection report software, contain a detailed description of the maintenance required and the compliance date by which the required maintenance is to be completed. If necessary Phase 1 Correction Notices can be completed by hand using the standard Environmental Programs Inspection Report Form. Phase 1 Correction Notices shall contain the proper contact information, be written in a clear and concise fashion with no speculation, editorial comments or superfluous information. The Urban BMP Database shall be updated to show a 3-year Maintenance Inspection was performed. For monthly reporting purposes, all re-inspections shall only be recorded as inspections and not as facilities inspected or as new correction notices issued. Depending on the degree of maintenance required, a Compliance Schedule may be appropriate. All proposed Compliance Schedules must be authorized by the WPRP Supervisor.

Phase 2 Inspection and Enforcement

Phase 2 reflects situations where Phase 1 Enforcement was not successful in obtaining compliance. Phase 2 Enforcement consists of a formal Phase 2 Violation Notice in the form of a certified letter to the property owner or responsible party. The Phase 2 Violation Notice shall be prepared by the WPRP Inspector using the appropriate form letter, reviewed by the WPRP Supervisor/Environmental Code Administrator as appropriate and signed by the WPRP Supervisor. The Phase 2 Notice shall establish final compliance dates for the completion of the required maintenance. The final compliance dates may reflect agreed upon Compliance Schedules as authorized by the WPRP Supervisor.

Phase 3 Inspection and Enforcement

Phase 3 reflects situations where Phase 2 Enforcement was not successful in obtaining compliance. Phase 3 enforcement consists of a legal referral to the Office of Law for the enforcement of the Private Inspection and Maintenance Agreement recorded against the deed for the property in question. The referral shall be prepared by the Environmental Code Administrator using the records associated with the violation.

10 Monitoring (i)

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

To determine the specific parameters to be monitored for tracking progress, one must understand the approach used for the initial listing. The Upper Patuxent was originally listed for sediments in 1996 as a total suspended solids/sediment listing. In 2002, the State began listing biological impairments on the Integrated Report, at the 8-digit scale, based on a percentage of stream miles degraded and whether

they differ significantly from a reference condition watershed (<10% stream miles degraded). The biological listing is based on Benthic and Fish Indices of Biotic Integrity (BIBI/FIBI) results from wadeable streams from assessments conducted by the Maryland Department of Natural Resources (MDNR) Maryland Biological Stream Survey (MBSS). The Upper Patuxent was listed for biological community impairment in 2006.

MDE then utilized its Biological Stressor Identification (BSID) process to identify the probable or most likely causes of poor biological conditions. For sediment specifically, the BSID identified 'altered hydrology and increased urban runoff have resulted in degradation to streambed morphology, streambed scouring, and subsequent elevated suspended sediment transport through the watershed.' Overall, the results indicated inorganic pollutants (i.e. chlorides, acute ammonia, sulfate), and flow/sediment related stressors as the primary stressors causing impacts to biological communities.

Based on the results of the BSID, MDE replaced the biological impairment listing with a listing for total suspended solids (TSS). The 2012 final and 2014 draft integrated reports lists 'Habitat Evaluation' as the indicator, and urban runoff/storm sewers as the source. It is noted that the *Decision Methodology for Solids for the April 2002 Water Quality Inventory (updated in February of 2012)*[1], makes a specific distinction between two different, although related 'sediment' impairment types in free flowing streams:

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

With these two sediment impairments in mind the Upper Patuxent, which is listed as impaired for TSS, would seem to be water clarity issue; however the methodology used for listing (biological and habitat measures related sediment deposition) seems to point to an in-stream sediment deposition problem. In all likelihood both types of impairment, water clarify and sedimentation, are factors and both should be incorporated into monitoring programs to track changes in the watershed condition over time.

Anne Arundel County's Watershed Protection and Restoration Program (WPRP) has several on-going monitoring programs that target measures of water clarity and sedimentation. These programs are described here.

Countywide Biological Monitoring

In 2004, a Countywide Biological Monitoring and Assessment Program for Anne Arundel County, Maryland was developed to assess the biological condition of the County's streams at multiple scales

[1] http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/AM_Solids_2012.pdf

(i.e., site-specific, primary sampling unit (PSU), and countywide). Under the Countywide Biological Monitoring and Assessment program, biology (i.e., benthic macroinvertebrates) and stream habitat, as well as geomorphological and water quality parameters, are assessed at approximately 240 sites throughout the entire County over a 5-year period using a probabilistic, rotating-basin design. Round One of the County's Biological Monitoring and Assessment Program occurred between 2004 and 2008, and Round Two took place between 2009 and 2013. Round Three is scheduled to be conducted beginning in 2016.

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

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

The Upper Patuxent watershed is made up of three PSUs: Upper Patuxent, Middle Patuxent, and Stocketts Run. Ten sampling sites were sampled in each of these PSUs in each round of sampling. Methodologies follow those used by MBSS for the biological sampling (benthic macroinvertebrates only) and habitat evaluations have included both MBSS's Physical Habitat Index (PHI) and the EPA's Rapid Bioassessment Protocol (RBP) metrics. In-situ water quality measures are also collected at each site along with a geomorphic evaluation utilizing cross-sections, particle substrate analysis using pebble counts, and measures of channel slope.

Following these procedures, the County is collecting several parameters related to water clarity and sediment deposition at each site.

- Water Quality Measures and Observations
  - Turbidity (measured), observations of general water clarity and color
- Biological Measures
  - Benthic macroinvertebrates (BIBI)
- Habitat Measures
  - General: bar formation and substrate, presence/absence of substrate type
  - PHI: epibenthic substrate, instream habitat
  - RBP: epifaunal substrate / available cover, pool substrate characterization, sediment deposition, channel alteration
- Geomorphic Measures
  - Particle size analysis using modified Wolman pebble counts at 10 transects proportioned by channel bed features

Results summarized at the PSU scale with mean BIBI and habitat ratings (PHI and RBP) are presented in Table 21.

Table 21: Countywide Biological Monitoring Results for Upper Patuxent River

PSU Name	Round	PSU Code	Year Sampled	Drainage Area (acres)	BIBI Rating	PHI Rating	RBP Rating
Upper Patuxent	1	16	2007	6,957	P	PD	PS
Middle Patuxent	1	18	2004	6,332	P	PD	S
Stocketts Run	1	19	2005	8,714	F	PD	PS
Upper Patuxent	2	16	2011	6,957	P	MD	S
Middle Patuxent	2	18	2010	6,332	F	PD	PS
Stocketts Run	2	19	2013	8,714	P	PD	PS

BIBI Ratings: G = Good, F = Fair, P = Poor, VP = Very Poor
PHI Ratings: MD = Minimally Degraded, PD = Partially Degraded, D = Degraded, SD = Severely Degraded
RBP Ratings: C = Comparable, S = Supporting, PS = Partially Supporting, NS = Non-Supporting

Restoration Monitoring

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

Watershed Assessment

In 2001, Anne Arundel County initiated a series of systematic and comprehensive watershed assessments and management plans for restoration and protection across the County. The plans are developed within a regulatory context that includes NPDES MS4 requirements, local TMDLs and Watershed Implementation Plans for the Chesapeake Bay TMDL, Maryland Stormwater Regulations and the Water Resources Element of the County's General Development Plan.

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

The WAP program's stated goals include:

- Characterize subwatersheds;
- Prioritize subwatersheds for preservation and restoration; and

- Inform stressor-response relationships for planning and modeling.

The County continues to reevaluate its monitoring programs as the state of the science progresses, as the understanding of water quality and ecological interactions are improved, and as regulatory programs are added or modified. The WPRP is currently reviewing the Countywide monitoring program to ensure that the methods used are appropriate and meaningful, and that TMDL and NPDES requirements continue to be met.

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Appendix A: Upper Patuxent Project List

Appendix A - Upper Patuxent Project List

Status	StormID# or TBD# or Outfall #	Watershed (8-digit Number)	Watershed (8-digit Name)	BMP Type	Drainage Area [acres]	Impervious Drainage Area [acres]	Pervious Drainage Area [acres]	Linear Feet for Stream Restoration	Annual Report Fiscal Year (completed projects only)	Estimated Completion Fiscal Year
Construction Complete	179	02131104	Patuxent River Upper	Bioretention	0.06	0.06	0.00		FY2013	
Construction Complete	164	02131104	Patuxent River Upper	Rain Barrel	0.02	0.02	0.00		FY2013	
Construction Complete	411	02131104	Patuxent River Upper	Rain Barrel	0.02	0.01	0.00		FY2013	
Construction Complete	415	02131104	Patuxent River Upper	Rain Barrel	0.01	0.01	0.00		FY2013	
Construction Complete	562	02131104	Patuxent River Upper	Rain Barrel	0.01	0.01	0.00		FY2013	
Construction Complete	563	02131104	Patuxent River Upper	Rain Barrel	0.01	0.01	0.00		FY2013	
Construction Complete	4	02131104	Patuxent River Upper	Stream Stabilization				950	FY2013	
Construction Complete	337	02131104	Patuxent River Upper	Stream Stabilization				1000	FY2013	
Construction Complete	27	02131104	Patuxent River Upper	Stream Restoration				1800	FY2013	
In Planning	32	02131104	Patuxent River Upper	Step Pool Stormwater Conveyance & Stream Restoration				450		FY2017
Under Construction	816	02131104	Patuxent River Upper	Wet Pond	22.16	5.42	16.74			FY2017
In Design	471	02131104	Patuxent River Upper	Sand Filter	10.02	1.96	8.06			FY2018
In Planning	B12O007	02131104	Patuxent River Upper	Step Pool Stormwater Conveyance	20.46	8.36	12.10			FY2018
In Planning	B12O006	02131104	Patuxent River Upper	Step Pool Stormwater Conveyance	6.29	2.94	3.35			FY2018
In Planning	19	02131104	Patuxent River Upper	Stream Restoration				800		FY2019
In Planning	AA000816	02131104	Patuxent River Upper	Micropool Extended Detention Pond	22.30	4.70	17.60			TBD

Appendix B: Anne Arundel County Sediment Local TMDL Restoration Plans – Response to MDE Comments

Anne Arundel County Sediment Local TMDL Restoration Plans
Response to Comments
Maryland Department of the Environment Comments Received May 19, 2015

County comments addressed in **bold blue** text.

Attachment 1

Permit Conditions: Part IV.E Restoration Plans and Total Maximum Daily Loads (TMDLs)
MDE Assessment and Recommendations

- Restoration Plans: MDE's comments on the County's impervious surface assessment and associated restoration effort (Part IV.E.2.a) were attached to the March 31, 2015 letter. As discussed in that letter, comments on the impervious surface area assessment shall be addressed by May 26, 2015. The following are MDE's general comments on the restoration plans for stormwater wasteload allocations (WLAs) required under Part IV.E.2.b of the current permit:
    - Anne Arundel County submitted individual plans to address the sediment total maximum daily loads (TMDLs) for the Upper Patuxent River, Little Patuxent River, and the Lower North Branch of the Patapsco River. The County also submitted a combined plan to address the 19 separate bacteria TMDLs associated with the County's waterways.
    - **COUNTY RESPONSE: no response needed**

    - In their technical comments, MDE's Science Services Administration (SSA) has noted several issues with the pollutant baseline analyses that prevent comparing the County's modeling to MDE's official 2005 Local TMDL Base Scenario. SSA has provided several options for resolving discrepancies between official Maryland Assessment Scenario Tool (MAST) and County generated progress scenarios.
    - **COUNTY RESPONSE: See response below – Attachment 2, Major Comments, Sediment**

    - Any best management practices (BMPs) used in the modeling of baselines or current load analyses shall be maintained according to State regulations. BMPs that are not inspected at least once every three years and maintained may not be included as treatment when modeling loads.
    - **COUNTY RESPONSE: The County included a section on their process for inspection and maintenance with mention of actions taken if a facility is not meeting standards (9.4 Best Management Practices Inspection and Maintenance).**

    - TMDL restoration plans should be consistent with the guidance found in "Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for NPDES Stormwater Permits" (MDE Guidance, MDE 2014) or, if more recent, the appropriate Chesapeake Bay Program (CBP) guidance. The County should use acceptable BMPs and the associated load reductions found in these documents. For example, specific load reductions for each practice are inconsistent (e.g., bioretention is listed as a range of 50% to 80%), and do not reflect the values found in the MDE Guidance and updated CBP efficiencies.

- **COUNTY RESPONSE: The MDE document *Guidance for Using the Maryland Assessment Scenario Tool to Develop Stormwater Wasteload Allocation Implementation Plans for Local Nitrogen, Phosphorus, and Sediment Total Maximum Daily Loads* (June 2014) includes recommendations on how to use MAST to develop SW-WLA plans for nutrient and sediment TMDLs. At this time, MAST CBP Phase 5.3.2 has not been updated to reflect BMP efficiencies published in MDE's guidance *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for NPDES Stormwater Permits* (August 2014). Therefore, BMP efficiencies currently available and programmed in MAST will differ from those published in MDE's guidance. For example, there are two sediment removal efficiencies in MAST for bioretention depending on the type of soil (A/B 80% versus C/D 55%). In MDE's guidance, bioretentions are considered efficiency BMPs with a 70% sediment removal.**

  The efficiencies table for each plan has been edited to show individual removal efficiencies for bioretention A/B soils and bioretention C/D soils rather than presenting a range.

- Information used to develop the individual TMDL restoration plans is not consistent with similar information found in other sections of the County's Annual Report and associated databases. For example, the County's urban BMP database indicates that there are ten Bioretention practices with a total drainage area of 23 acres that could be applied to the baseline for the Little Patuxent River watershed. However, the total drainage treated by these practices for the baseline analysis in the restoration plan (see Table 10) is 70.9 acres.
- **COUNTY RESPONSE: Data used in the sediment restoration plans has been made consistent with the NPPDES geodatabase (Attachment A) with minor updates where needed between the timing of the plan and the latest Attachment A submittal.**

- Each of the restoration plans lacks specificity in how individual TMDLs will be addressed. These plans need to be of sufficient detail to ensure that expected interim milestones can be achieved and the TMDL addressed. Each plan should include a list of specific BMPs that will be implemented during the current permit term to address these TMDLs. This list should include BMP locations, drainage areas, impervious area treated, load reductions, estimated costs, and implementation schedule (e.g., design, construction). This list shall coincide with interim targets identified in the restoration plans.
- **COUNTY RESPONSE: See response below – Attachment 2, Major Comments, General**

- Public Participation:
  - Anne Arundel County has developed a website (www.aarivers.org) and an interactive, online application to provide public access to information on watershed assessments and restoration activities.
  - **COUNTY RESPONSE: no response needed**

- As TMDL implementation plans and new watershed assessments are developed, that information also will be made available on the County's website.
- **COUNTY RESPONSE: no response needed**

- Anne Arundel County must accept public comments on watershed assessments and watershed restoration plans. The County must provide a summary of how comments received were addressed in its next annual report.
- **COUNTY RESPONSE: a summary of comments will be prepared once public notice/review periods are completed**

- TMDL Compliance: Anne Arundel County continues to work with MDE to implement its Chesapeake Bay TMDL WIP. The County has been implementing associated activities since fiscal year 2013. Information concerning these activities and progress toward achieving programmatic and implementation milestones were reported to SSA on January 2015.
- **COUNTY RESPONSE: no response needed**

Attachment 2

Anne Arundel County Stormwater Waste Load Allocation (WLA) Implementation Plan Comments

Major Comments

- General:

  - These plans lack specificity at a site level scale, probably due to planning uncertainties such as, finding sites, purchasing or gaining access to land, obtaining all required permits and designing BMPs. This is understandable, and MDE recognizes that these plans are still works in progress. During subsequent annual reports, and by the time of the next permit issuance, the county should plan on including a much higher level of site-specific detail on planned implementation.
  - **COUNTY RESPONSE: The County has added several items to increase the specificity of the plan. 1. List of completed restoration projects and currently programmed projects. 2. Mapping of street sweeping routes. 3. Details on the County's process for moving projects from the identification stage in the County's watershed assessments through the feasibility process.**

- Sediment:

  - The county uses MAST to develop its sediment TMDL implementation plans. When comparing estimates of current progress loads to the baseline loads for a given sediment TMDL, the county did not use the official 2013 progress scenario in MAST. Instead, they created a new progress scenario by adding all BMPs known to be

implemented in the watershed to a no action scenario. By comparing the loading outputs from the official 2013 progress scenario in MAST and the progress scenario created by the county, it is evident that many BMPs from the county's 2013 progress scenario were not included in the official MAST 2013 progress scenario and the baseline load scenario (2005 Local TMDL Base). Therefore, a comparison between the 2005 Local TMDL Base scenario and the county's 2013 progress scenario is not valid. A revision of this discrepancy should be made immediately. MDE suggests either of the following options for making a valid comparison:

1. Compare the official MAST 2013 progress scenario loads to a target calculated from the 2005 local TMDL base scenario.
2. Use BayFAST to re-establish a 2005 condition baseline load by inputting the impervious and pervious urban land-use conditions and BMPs present at the time, from which a new target can be calculated, and compare this to a re-established 2013 progress scenario.
3. Take the official MAST 2009 progress scenario: add BMPs that were installed between 2009 and 2013, and compare the resulting load to the 2005 Local TMDL Base scenario.

- **COUNTY RESPONSE: The official 2013 Progress Scenario in MAST cannot be compared to the watershed specific 2013 MAST scenario created by the County because of fundamental differences in BMP data entry and load calculations. BMPs were entered at the Countywide level for the official 2013 Progress Scenario with loads distributed by 8-digit watersheds based on available County MS4 land use area among other components. BMPs were entered by Local TMDL 8-digit watershed based on actual treatment locations for the County's 2013 MAST scenario. BMP data entry in this approach ensures that land use loads are accurately calculated based on treatment strategies on the ground in a specific watershed.**

  The County cannot follow option 1 or 3 because of the discrepancies described above. However, the County has looked into re-calculating a 2005 Baseline as proposed in option 2 and has moved forward with this approach.

  For the 2005 Baseline, the County has modeled BMPs with a construction built date prior to 7/1/2005 in BayFAST at the local TMDL watershed scale (i.e., delineated facility boundary) using MAST County MS4 Phase I/II 2005 impervious and pervious data pulled from the MAST Compare Scenario tool at the 8-digit, county split scale.

  Based on communication with MDE the reduction accounting procedure for progress and planned scenarios has been modified such that loads from new urban sources since the baseline year are not required to be accounted for. The progress and planned scenario modeling now is keeping the 2005 land use static and calculating the

gross reduction from the additional restoration BMPs added with each progress and planned scenario.

Sediment Plans

- Editorial Comments:
  - Little Patuxent Plans, Section 1.1 (p. 4): The dates listed for TMDL approval are incorrect. Approval dates are provided in the TMDL Data Center's "TMDL Search" Function. Please correct dates. Also, please indicate that the sediment and nutrient TMDLs are only for Centennial Lake, as appropriate.
  - **COUNTY RESPONSE: Cycle listing date was incorrectly transcribed as TMDL approval date. The following dates were changed in the plan:**
    - **TSS sediment approved in 1996 to 2011**
    - **Sedimentation/siltation approved in 1998 to 2002**
    - **Phosphorus approved in 1998 to 2002**

  - Little Patuxent Plans & Upper Patuxent Plans, Section 1.2 (p. 5): The formula for the 2025 Allocated Load uses the reduction percentage for Patapsco. This formula needs to be corrected in the next revision.
  - **COUNTY RESPONSE: Correct values were used in calculations and analyses. Incorrect values were reported in the description of Table 1. The following values were changed in the plans:**
    - **Little Patuxent: 0.222 to 0.205**
    - **Upper Patuxent: 0.222 to 0.114**

  - Little Patuxent Plans, Table 13 (p. 33): The baseline information in Table 13 is incorrect (copied from Patapsco). Please correct table using information from Table 11 in this report in the next revision.
  - **COUNTY RESPONSE: Updated table with correct baseline information for Little Patuxent.**

  - Upper Patuxent Plans, Section 1.1 (p. 4): The TMDLs mentioned in this section were approved in 2011, not 2001. Please correct the date.
  - **COUNTY RESPONSE: Typo. Updated date to 2011.**

- Specific Comments:
  - Little Patuxent, Patapsco Lower North Branch & Upper Patuxent Plans, Table 1 (p. 6): The "reductions" in Table 1 are all calculated from the 2005 baseline. This is not clear based on the table. Additionally, more information regarding changes in the loads due

to development should be included, such as the number of acres and the loads associated with those acres (with and without BMPs).

- **COUNTY RESPONSE: Subsequent guidance from MDE stated that reductions are from the 2005 Baseline only. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and future "Accounting for Growth" policies will address the remaining 10%. Discussion of loads due to growth appears in text in sections 3.3 – Anticipated Growth, 3.3.1 – Estimates of Future Growth, and 3.3.2 – Offsetting Sediment Loads from Future Growth.**
-
- Little Patuxent Plans & Upper Patuxent Plans, Table 13 (p. 33) & Patapsco Lower North Branch Plans, Table 13 (p. 31): Table 13 could have sub-rows showing the estimated 2025 load change due to growth as well as reductions from implementation actions. MDE suggests including the change in loads due to growth either in a table or text format in the next revision.
- **COUNTY RESPONSE: Subsequent guidance from MDE stated that reductions are from the 2005 Baseline only. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and future "Accounting" for Growth policies will address the remaining 10%. Table 13 only displays planned reduction from the 2005 Baseline Load. Discussion of loads due to growth appears in text in sections 3.3 – Anticipated Growth, 3.3.1 – Estimates of Future Growth, and 3.3.2 – Offsetting Sediment Loads from Future Growth.**

- Little Patuxent Plans, Figure 8 (p. 34), Patapsco Lower North Branch Plans, Figure 8 (p. 32) & Upper Patuxent Plans, Figure 8 (p. 33): Figure 8 is confusing. The grey bars are indicted to be MAST loadings, but the yellow bars are planning loads. It is unclear how they relate. Figure 8 should be clarified, updated or removed. It could be updated in the next revision to incorporate the change in loads, with growth and reductions from the milestone BMPs shown in Table 16.
- **COUNTY RESPONSE: Figure 8 (new Figure 9) has been updated. The figure now only shows progress and planned loads as the reduction from the 2005 Baseline Load to make this clearer.**

- Little Patuxent Plans & Upper Patuxent Plans, Section 5.1 (p. 31), Patapsco Lower North Branch, Section 5.1 (p. 29-30): Section 5.1 describes current BMP implementation through 2013, but does state from when. It is important to know if BMPs prior to the baseline year (2005) are being counted. Since pre-2005 BMPs should not be given credit toward TMDL implementation, BMPs should be divided into two categories: those completed before 2005 and those completed between 2005 and 2013.
- **COUNTY RESPONSE: The 2013 Progress scenario (now updated to 2015 Progress) loads are modeled using all County BMP data from their database ranging in built dates**

from 1978 - June 2005, and only restoration BMPs from July 2005 through 2013 (now updated to 2015).

The difference between 2013 Progress (now updated to 2015 Progress) loads, and the 2005 Baseline loads represents the reduction achieved from restoration BMPs built between 2005 and 2013 (now updated to 2015).

Modeling following this approach does not double count pre-2005 treatment.











Patapsco River Lower North Branch Sediment TMDL Restoration Plan

Anne Arundel County, Maryland
February 2016

Anne Arundel County WATERSHED Protection & Restoration PROGRAM



Patapsco River Lower North Branch Sediment TMDL Restoration Plan

February 2016

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Appendices

Appendix A Patapsco Lower North Branch Project List
Appendix B Response to MDE Comments on Draft Plan

List of Acronyms

AAWSA	Anne Arundel Watershed Stewards Academy
BayFAST	Chesapeake Bay Facility Assessment Scenario Tool
BMP	Best Management Practices
BSID	Biological Stressor Identification
CBP	Chesapeake Bay Program
CIP	Capital Improvement Program
EOS	Edge of Stream
H&H	Hydrologic and Hydraulic
LULC	Land use / Land cover
MAST	Maryland Assessment Scenario Tool
MDE	Maryland Department of the Environment
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
OSDS	On-site Disposal Systems
SPSC	Step Pool Storm Conveyance
SW to MEP	Stormwater to the Maximum Extent Practicable
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
WIP	Watershed Implementation Plan
WPRP	Watershed Protection and Restoration and Program

1 Introduction

1.1 Background and Purpose

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

Under the Federal Clean Water Act (CWA), the State of Maryland is required to assess and report on the quality of waters throughout the state. Where Maryland's water quality standards are not fully met, Section 303(d) requires the state to list these water bodies as impaired waters. States are then required to develop a TMDL for pollutants of concern for the listed impaired waters. The Patapsco River Lower North Branch (Patapsco LNB) watershed has several impaired waters listings in Maryland's Integrated Report of Surface Water Quality [(303(d) list) and 305(b) Report] including nutrients, sediment, heavy metals, *Escherichia coli*, and polychlorinated biphenyls (PCBs). There are currently two final approved TMDLs within the Patapsco LNB; a bacteria TMDL approved in 2009, and a sediment TMDL approved in 2011. These TMDLs apply to several jurisdictions including Baltimore City and Baltimore, Carroll, Howard, and Anne Arundel Counties. This plan will specifically address the Patapsco LNB sediment TMDL under the responsibility of Anne Arundel County. The bacteria TMDL is being addressed by Anne Arundel County in a separate plan.

Responsibility for Patapsco LNB sediment reduction is divided among the contributing jurisdictions, listed above. The TMDL loading targets, or allocations, are also divided among the pollution source categories, which in this case includes non-point sources (termed load allocation or LA) and point sources (termed waste load allocation or WLA). The WLA consists of loads attributable to regulated process water or wastewater treatment, and to regulated stormwater. For the purposes of the TMDL and consistent with implementation of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Discharge Permit (MS4), stormwater runoff from MS4 areas is considered a point source contribution.

Anne Arundel County's current MS4 permit (11-DP-3316, MD0068306) issued in its final form by the MDE in February of 2014 requires development of restoration plans for each stormwater WLA approved by EPA prior to the effective date of the permit (permit section IV.E.2.b). This plan satisfies this permit requirement and provides the loading target, recommended management measures, load reduction estimates, schedule, milestones, cost estimates and funding sources, and the tracking and monitoring approaches to meet the stormwater WLA (SW-WLA).

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

This plan demonstrates that Anne Arundel County will meet its sediment SW-WLA for the Patapsco LNB by 2017. The strategies proposed will provide further treatment to reduce current sediment loads from the urban stormwater sector.

1.2 TMDL Allocated and Planned Loads Summary

The following Restoration Plan only addresses loads allocated to Anne Arundel County NPDES regulated stormwater point source sediment. Additional SW-WLAs for the Patapsco LNB watershed TMDL assigned to Baltimore, Carroll, and Howard counties, Baltimore City, Maryland State Highway Administration, and other NPDES regulated stormwater are not the responsibility of Anne Arundel County and will not be addressed in this plan. A large section of Baltimore-Washington International Thurgood Marshall Airport (BWI) is located in the western portion of the watershed. Pollutant loads from BWI are the responsibility of Maryland Aviation Association and are not addressed in this plan.

The Patapsco LNB Watershed TMDL requires a 22.2% reduction of sediment loads from 2005 baseline levels to achieve the target SW-WLA for Anne Arundel County NPDES regulated stormwater. A planning horizon of 2025 was initially used as the date to achieve these load reductions with 2017 a proposed milestone to assess progress.

Based on MDE guidance, growth in the stormwater load since the TMDL baseline year was not accounted for in the analysis conducted in the development of this plan. Local TMDLs are considered met, from a planning perspective, when the load reductions associated with 2015 restoration progress coupled with the planned restoration load reductions exceed the load reduction required.

This section of the plan, including Table 1, provides a concise summary of the loads and reductions at important timeline intervals including the 2005 baseline, 2015 progress, 2017 milestone and 2025 final planning intervals. These terms and dates are used throughout the plan and explained in more detail in the following sections. They are presented here to assist the reader in understanding the definitions of each, how they were derived, and to provide an overall summary demonstrating the percent reduction required and percent reduction achieved through full implementation of this plan. Sediment loads and wasteload allocations are presented as tons/year in the local TMDL but will be discussed as lbs/year in this restoration plan.

- **2005 Baseline Loads**: Baseline levels (i.e., land use loads with baseline BMPs) from 2005 conditions in the Patapsco LNB watershed using the Chesapeake Bay Facility Assessment Scenario Tool (BayFAST) Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) model. Baseline loads were used to calculate the stormwater allocated sediment loads, or SW-WLA.
- **2015 Progress Loads and Reductions**: Progress loads and load reductions achieved from restoration best management practice (BMP) implementation through 2015. The 2015 Progress Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 Baseline – 2015 Progress Reduction.
- **2017 Interim Milestone Goal Loads and Planned Loads and Reductions**:
- Planned 2017 loads and reductions will result from implementation of strategies through 2017. The 2017 Planned Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 Baseline – 2017 Planned Reduction.
- **2025 Allocated Load**: Allocated loads are calculated from the 2005 baseline levels, calibrated to CBP P5.3.2 as noted above, using the following calculation: 2005 Baseline – (2005 Baseline x 0.222); or, 2005 Baseline x (1 – 0.222)

- **2025 Planned Loads and Planned Reductions**: Loads and reductions that will result from implementation of this plan. The 2025 Planned Loads are calculated from the 2005 Baseline Loads by the following calculation: 2005 Baseline – 2025 Planned Reduction.

Table 1: Patapsco River Lower North Branch Local TMDL Allocated and Planned Loads

	Sediment (tons/year)	Sediment (lbs/year)
2005 Baseline Loads	711	1,422,388
2015 Progress Loads	631	1,261,366
2015 Progress Reductions	81	161,022
2017 Planned Loads*	457	913,920
2017 Planned Reductions	254	508,469
2025 TMDL Allocated Loads	553	1,106,618
2025 Planned Loads*	381	762,790
2025 Planned Reductions	330	659,523
Required Percent Reduction	22.2%	22.2%
Planned Percent Reduction Achieved	46.4%	46.4%

*2017 and 2025 planned loads are calculated by subtracting planned restoration sediment reductions from the 2005 Baseline Load. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal.

1.3 Restoration Plan Elements and Structure

This plan is developed within the context of on-going watershed management planning, restoration, and resource protection being conducted by Anne Arundel County. The County initiated comprehensive watershed assessment and management plans in 2000 and has currently completed plans for seven of the 12 major watersheds, including the Patapsco LNB which was completed in 2011. The 2011 plan used the term 'Patapsco Non-Tidal' for the watershed, however it references the same geography included in Anne Arundel County's portion of the Patapsco LNB. The County also prepared a Phase II Watershed Implementation Plan (WIP) in 2012 in response to requirements set forth in the Chesapeake Bay TMDL for nitrogen, phosphorus and sediment. Information synthesized and incorporated into this plan for the Patapsco LNB watershed draws upon these sources with updates and additions where necessary to meet the specific goals of the SW-WLA. The TMDL analyses and reports developed by MDE are also referenced. These primary sources include:

- Patapsco Non-Tidal Watershed Assessment Comprehensive Summary Report (Anne Arundel County, 2011)
- Chesapeake Bay TMDL, Phase II Watershed Implementation Plan, Final (Anne Arundel County, 2012)
- Total Maximum Daily Load of Sediment in the Patapsco River Lower North Branch Watershed, Baltimore City and Baltimore, Howard, Carroll, and Anne Arundel Counties, Maryland (MDE, 2011)

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

- General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan (MDE, May 2014)
- Guidance for Using the Maryland Assessment Scenario Tool to Develop Stormwater Wasteload Allocation Implementation Plans for Local Nitrogen, Phosphorus, and Sediment TMDLs (MDE, June 2014)
- Guidance for Developing Stormwater Wasteload Allocation Implementation Plans for Nutrient and Sediment Total Maximum Daily Loads (MDE, November 2014)
- Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated (MDE, August 2014)

The Patapsco LNB plan has been prepared in accordance with the EPA's nine essential elements for watershed planning. These elements, commonly called the 'a through i criteria' are important for the creation of thorough, robust, and meaningful watershed plans and incorporation of these elements is of particular importance when seeking implementation funding. The EPA has clearly stated that to ensure that Section 319 (the EPA Nonpoint Source Management Program) funded projects make progress towards restoring waters impaired by nonpoint source pollution, watershed-based plans that are developed or implemented with Section 319 funds to address 303(d)-listed waters must include at least the nine elements.

The Patapsco LNB Restoration Plan is organized based on these elements. A modification to the order has been incorporated such that element c., a description of the management measures, is included before element b., the expected load reductions. We feel this modified approach is easier to follow. The letters (a. through i.) are included in the headers of the plan's major sections to indicate to the reader the elements included in that section. The planning elements are:

a. An identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the plan and to achieve any other watershed goals identified in the plan, as discussed in item (b) immediately below. (Section 3)

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time. (Section 5)

c. A description of the management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above as well as to achieve other watershed goals identified in the plan, and an identification of the critical areas in which those measures will be needed to implement this plan. (Section 4)

d. An estimate of the amount of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. (Section 6)

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the recommended management measures. (Section 7)

f. A schedule for implementing the management measures identified in this plan that is reasonably expeditious. (Section 8)

g. A description of interim, measurable milestones for determining whether management measures or other control actions are being implemented. (Section 8)

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised. (Section 9)

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above. (Section 10)

The outcomes of the planning effort are to provide guidance for the strategic implementation of watershed protection and restoration efforts that will advance progress toward meeting Anne Arundel County's local TMDLs pollutant loading allocations, and ultimately meeting water quality standards. Successful implementation of the plan will lead to improvements in local watershed conditions and aquatic health.

2 Watershed Characteristics

2.1 Watershed Delineation

The Patapsco LNB is one of 12 major watersheds in Anne Arundel County, Maryland, and is situated in the northwestern portion of the County (Figure 1). The watershed shares political boundaries with Howard County along Deep Run and Baltimore County along the mainstem of the Patapsco River. The most downstream extent of the watershed borders Baltimore City. The Patapsco LNB watershed is a part of the Chesapeake Bay watershed with the Patapsco River mainstem discharging to the tidal portions of the Patapsco River in Baltimore City before entering the Chesapeake Bay.

2.2 Patapsco River Lower North Branch

The Patapsco LNB watershed is approximately 15,270 acres (23.9 square miles) in area and contains approximately 96 miles of streams. The watershed includes several named streams including Stoney Run, Piney Run, Deep Run, Holly Creek, and the mainstem of the Patapsco River. These named streams are distributed among 12 subwatersheds, as shown below in Table 2 and on Figure 2. These subwatersheds were used as planning units for the watershed assessment and management plan completed in 2011. Although the average subwatershed size is 1,272 acres, the subwatersheds range in size from 431 in PN6 to 2,646 in PNB. The channel length in each subwatershed also varies similarly.

Communities within the Patapsco LNB include Linthicum Heights, Hanover, and Severn. A large section of Baltimore-Washington International Thurgood Marshall Airport (BWI) is located in the western portion of the watershed (Figure 2).

Table 2: Patapsco River Lower North Branch Watershed Drainage Area and Perennial Stream Miles

Subwatershed Code	Subwatershed Name	Drainage Area (Acres)	Drainage Area (Square Miles)	Stream Miles
PN1	Patapsco Mainstem	1,030	1.6	6.5
PN2	Holly Creek	856	1.3	4.5
PN3	Patapsco Mainstem	526	0.8	4.3
PN4	Unnamed Tributary	1,175	1.8	6.3
PN5	Patapsco Mainstem	575	0.9	5.4

Subwatershed Code	Subwatershed Name	Drainage Area (Acres)	Drainage Area (Square Miles)	Stream Miles
PN6	Stoney Run 1	429	0.7	4
PN7	Stoney Run 2	2,078	3.2	10.6
PN8	Stoney Run 3	1,421	2.2	6
PN9	Stoney Run 4	2,252	3.5	12.2
PNA	Deep Run	709	1.1	7.4
PNB	Piney Run	2,646	4.1	17.5
PNC	Deep Run	1,571	2.5	11.4
Patapsco River Lower North Branch Total		**15,268**	**23.9**	**96.1**

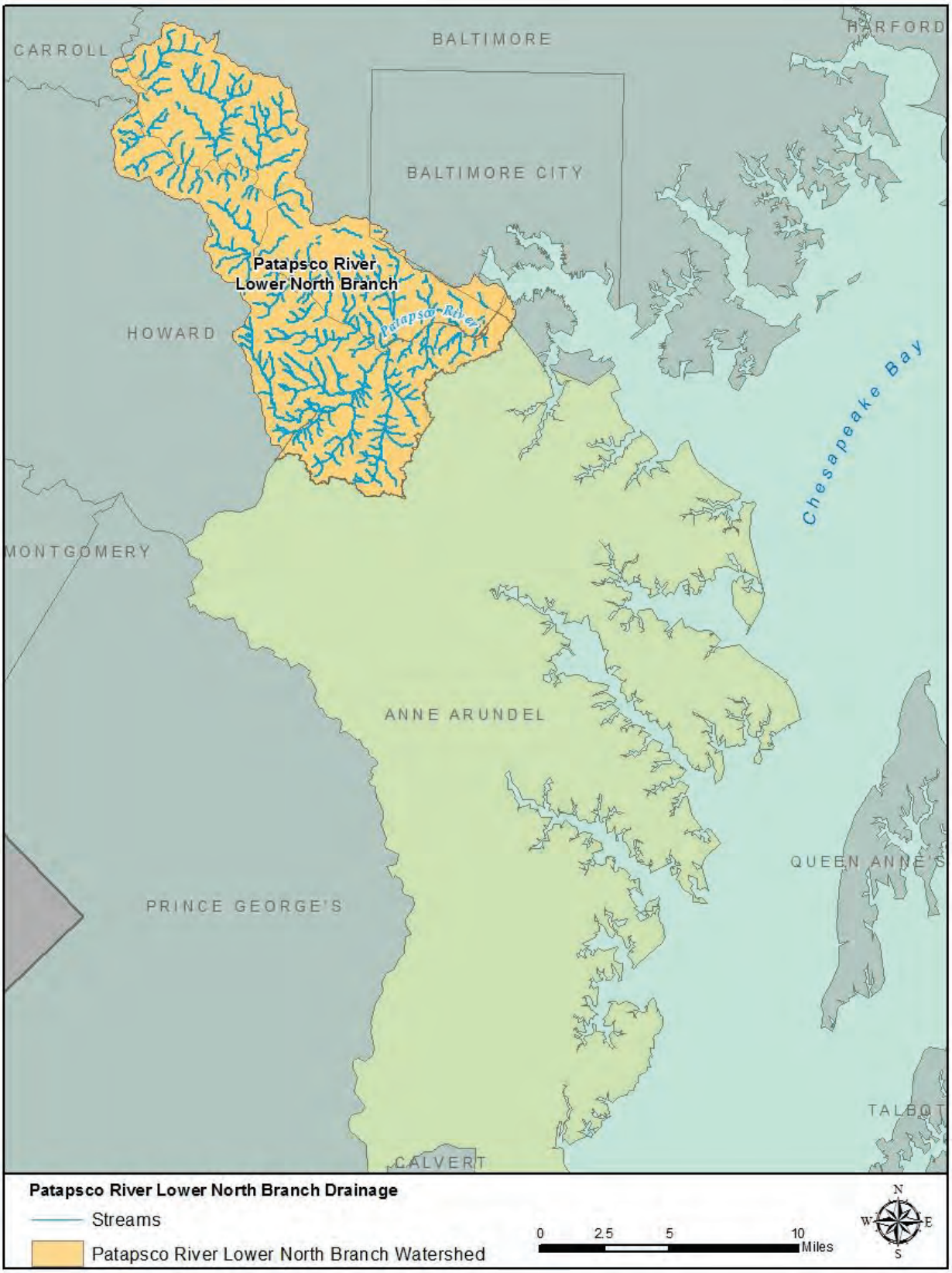
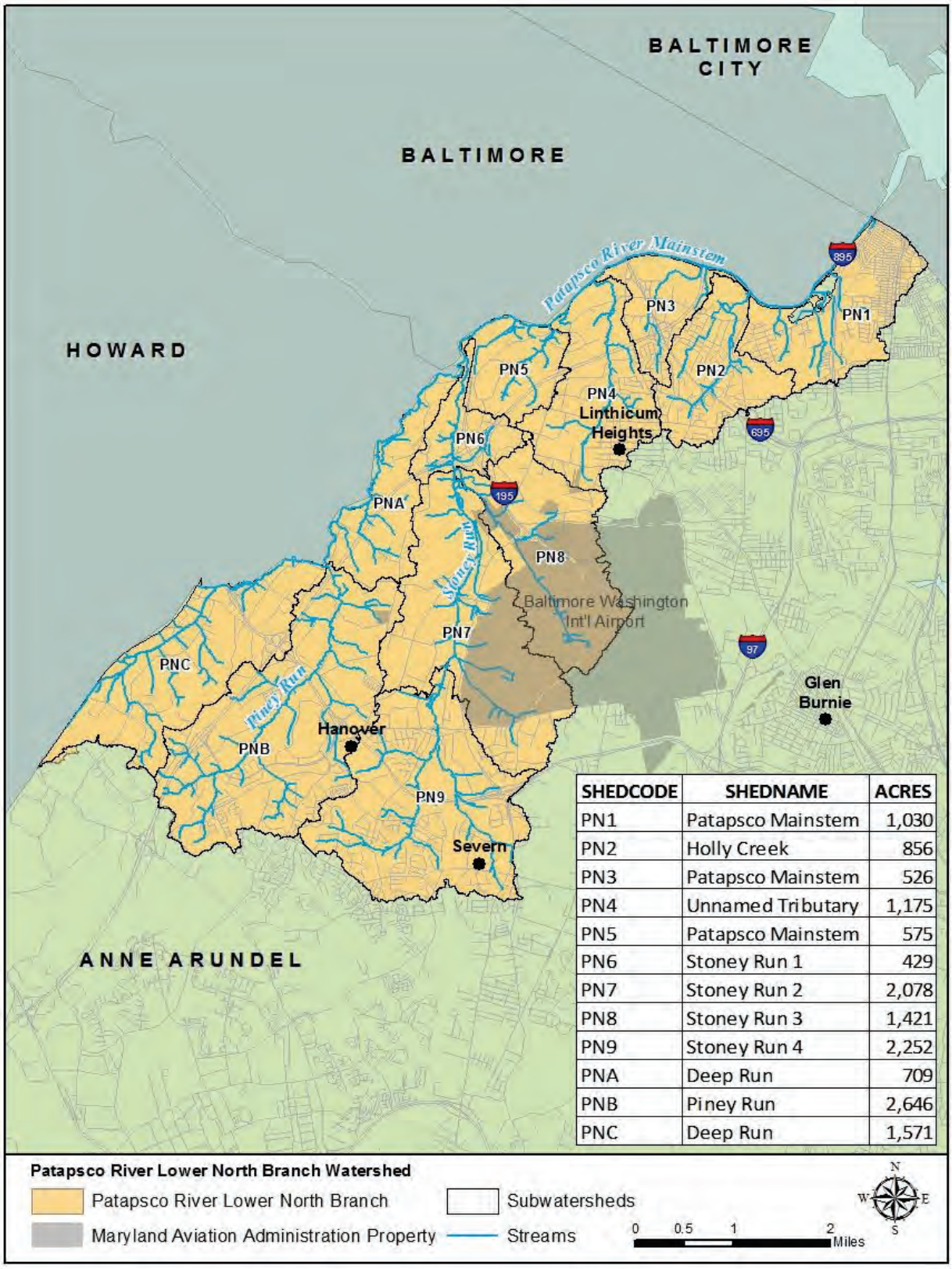


Figure 1: Patapsco River Lower North Branch Watershed



SHEDCODE	SHEDNAME	ACRES
PN1	Patapsco Mainstem	1,030
PN2	Holly Creek	856
PN3	Patapsco Mainstem	526
PN4	Unnamed Tributary	1,175
PN5	Patapsco Mainstem	575
PN6	Stoney Run 1	429
PN7	Stoney Run 2	2,078
PN8	Stoney Run 3	1,421
PN9	Stoney Run 4	2,252
PNA	Deep Run	709
PNB	Piney Run	2,646
PNC	Deep Run	1,571

Figure 2: Patapsco River Lower North Branch Subwatershed Location

2.3 Land Use/Land Cover

The type and density of various land uses can have a dramatic effect on water quality and stream habitat. Forested areas slow stormwater flow and allow water to gradually seep into soils and drain into streams. Vegetation and soils bind nutrients and pollutants found within stormwater—improving water quality as it infiltrates the ground. Developed areas, with a high percentage of impervious surfaces (buildings, paved roads, parking lots, etc.), do not reduce either the volume or flow of stormwater—increasing the amount of pollutants entering streams. Increased stormflow affects stream habitat negatively by increasing bank erosion and decreasing instream and riparian habitat. Agricultural land, if managed incorrectly, can also impair streams with increases nutrients and bacteria.

See Figure 3 for aerial imagery of the Patapsco LNB watershed. Land use / land cover (LULC) data from the Anne Arundel County Office of Information Technology (2011) is presented in Figure 4. Data presented in the figures below were used to characterize the watershed and show potential pollution sources. These LULC data were not used in the calculations of loads and load reduction, which were based instead on the land-river segment scale from the Chesapeake Bay Program Partnership Watershed Model.

2.3.1 Existing Land Use/Land Cover

According to 2011 LULC data (Table 3), the largest category in the Patapsco LNB is forested land, or woods (33.1%) followed by open space (11.5%). Developed land in the watershed largely consists of industrial (9.5%), residential (1/8-acre 9.0%, 1/4-acre 7.9%), commercial (6.9%), and transportation (6.8%). Residential areas as a total make up 26.5% of the watershed.

Table 3: 2011 Land Use / Land Cover

Land Use / Land Cover	Acres	Percent of Watershed
Airport	627	4.1%
Commercial	1,052	6.9%
Forested Wetland	33	0.2%
Industrial	1,450	9.5%
Open Space	1,759	11.5%
Open Wetland	76	0.5%
Pasture/Hay	2	0.0%
Residential 1/2-acre	335	2.2%
Residential 1/4-acre	1,213	7.9%
Residential 1/8-acre	1,367	9.0%
Residential 1-acre	424	2.8%
Residential 2-acre	637	4.2%
Row Crops	33	0.2%
Transportation	1,033	6.8%
Utility	43	0.3%
Water	133	0.9%
Woods	5,050	33.1%
Total	**15,268**	**100.0%**

2.3.2 Impervious Surfaces

Impervious surfaces concentrate stormwater runoff, accelerating flow rates and directing stormwater to the receiving stream. This accelerated, concentrated runoff can cause stream erosion and habitat degradation. Runoff from impervious surfaces picks up and washes off pollutants and is usually more polluted than runoff generated from pervious areas. In general, undeveloped watersheds with small amounts of impervious cover are more likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover. Impervious cover is a primary factor when determining pollutant characteristics and loadings in stormwater runoff.

The degree of imperviousness in a watershed also affects aquatic life. There is a strong relationship between watershed impervious cover and the decline of a suite of stream indicators. As imperviousness increases the potential stream quality decreases with most research suggesting that stream quality begins to decline at or around 10 percent imperviousness (Schueler, 1994; CWP, 2003). However, there is considerable variability in the response of stream indicators to impervious cover observed from 5 to 20 percent imperviousness due to historical effects, watershed management, riparian width and vegetative protection, co-occurrence of stressors, and natural biological variation. Because of this variability, one cannot conclude that streams draining low impervious cover will automatically have good habitat conditions and a high quality aquatic life.

Impervious surfaces make up 27.3% of the overall Patapsco LNP drainage (Table 4; impervious surfaces data obtained from Anne Arundel County Office of Information Technology - 2011). Impervious surface is highest in areas surrounding the Arundel Mills Mall in Hanover and Baltimore-Washington International Airport.

Table 4: Patapsco River Lower North Branch Watershed Percent Impervious Cover

Subwatershed Code	Subwatershed Name	% Impervious Cover
PN1	Patapsco Mainstem	34.6%
PN2	Holly Creek	27.0%
PN3	Patapsco Mainstem	37.7%
PN4	Unnamed Tributary	31.6%
PN5	Patapsco Mainstem	14.1%
PN6	Stoney Run 1	21.4%
PN7	Stoney Run 2	25.0%
PN8	Stoney Run 3	46.9%
PN9	Stoney Run 4	25.5%
PNA	Deep Run	6.7%
PNB	Piney Run	28.2%
PNC	Deep Run	18.1%
Patapsco River Lower North Branch Total		**27.3%**

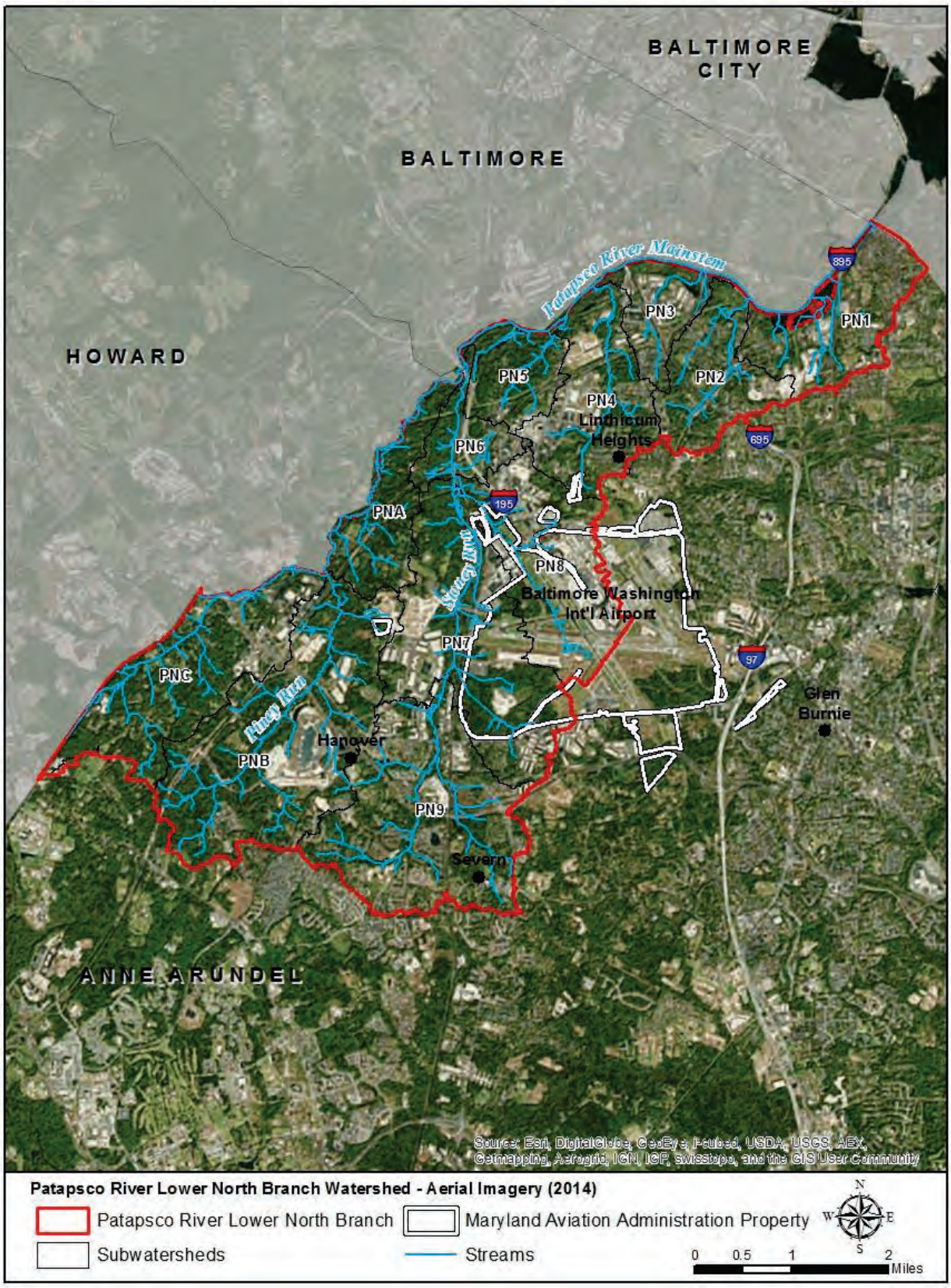


Figure 3: Patapsco River Lower North Branch Watershed Aerial Imagery (2014)

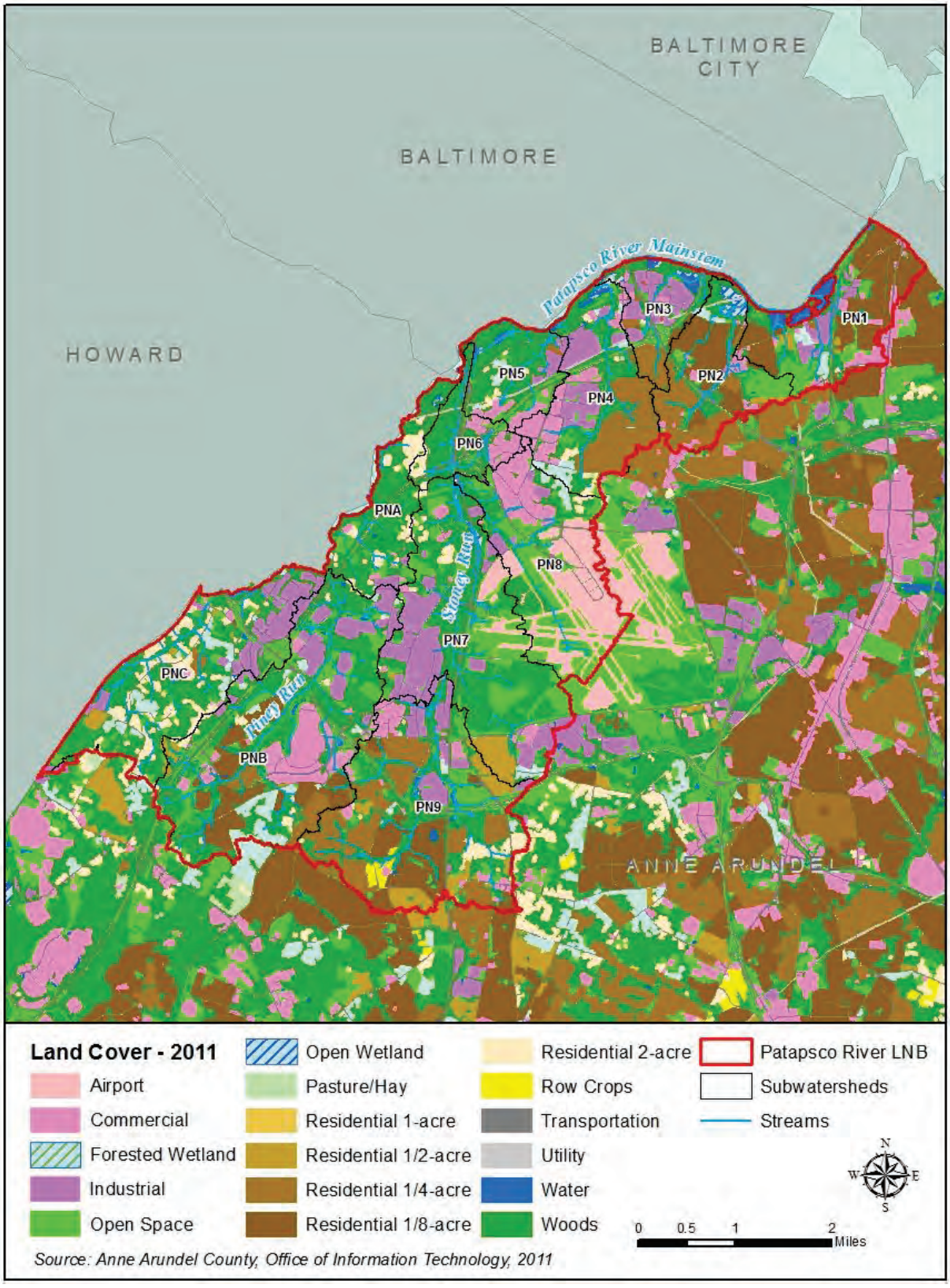


Figure 4: Patapsco River Lower North Branch Watershed Land Cover (2011)

2.4 Water Quality

2.4.1 Use Designations

According to water quality standards established by MDE in the Code of Maryland Regulations (COMAR) 26.08.02.03-.03 - Water Quality, Patapsco LNB is classified as Use I waters which are designated to support water contact recreation, and protection of non-tidal warmwater aquatic life. Designations include recreation; industrial and agricultural water supply; and fish, aquatic life, and wildlife (Table 5).

Table 5: Use Designations of the Patapsco River Lower North Branch River

Designated Uses	Patapsco LNB
Growth and propagation of fish (not trout), other aquatic life and wildlife	X
Water contact sports	X
Leisure activities involving direct contact with surface water	X
Fishing	X
Agricultural water supply	X
Industrial water supply	X
Propagation and harvesting of shellfish	-
Seasonal migratory fish spawning and nursery use	-
Seasonal shallow-water submerged aquatic vegetation use	-
Open-water fish and shellfish use	-
Seasonal deep-water fish and shellfish use	-
Seasonal deep-channel refuge use	-
Growth and propagation of trout	-
Capable of supporting adult trout for a put and take fishery	-
Public water supply	-

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

2.4.2 303(d) Impairments

According to Maryland's final 2012 and draft 2014 303(d) list of impaired waters (MDE, 2012a; MDE, 2014a), several segments within the Patapsco LNB watershed are listed for water quality impairments.

The Patapsco LNB watershed contains two Category 4a stream segments which include those waters that are not meeting their use designation but for which a TMDL has been developed to address the impairments. Category 4a waters include the entire watershed listed for sediment; and multiple segments in the lower portion and upper portion of the watershed listed for fecal bacteria (*Escherichia coli*).

Category 5 waters for the Patapsco LNB watershed, which include those waters that are not meeting their use designation and require a TMDL, include the entire watershed for chlorides and sulfates. These listings were added in 2014 and replace the 2006 category 5 biological listing for "cause unknown." In addition to category 4a and 5 listings, the Patapsco LNB watershed is also listed as a Category 4c, which includes those waters that are listed as impaired but are not impaired by a conventional pollutant. The Category 4c listing for the Patapsco LNB is for stream channelization due to urban development in all 1st through 4th order streams. This listing is significant due to the Category 5 listing for sediment.

2.4.3 TMDLs

Total Maximum Daily Loads (TMDLs) are established for waterbodies on Maryland's 303(d) integrated list of impaired waterbodies to set pollutant limits to achieve attainment of the designated use. For each combination of waterbody and pollutant, the State must estimate the maximum allowable pollutant load, or TMDL, that the waterbody can receive and still meet water quality standards. TMDLs are required by Clean Water Act.

Category 4a of the 303(d) list describes impaired waters with a TMDL or other reduction measure in place. Category 5 lists impaired waters in need of a TMDL. Listings for chlorides and sulfates in the Patapsco LNB are currently in need of a TMDL. In addition, a Water Quality Analysis was completed in 2004 for heavy metals and in 2009 for eutrophication within the Patapsco LNB. EPA concurrence determining that a TMDL was not required was received in 2005 for heavy metals and in 2009 for eutrophication.

The Patapsco LNB currently has two final TMDLs completed - one for sediment (approved 2011) and another for *Escherichia coli* (approved 2009). This Restoration Plan focuses on implementing strategies to address the sediment TMDL which requires a 22.2% reduction of Anne Arundel County NPDES regulated stormwater point source sediment.

In addition to local TMDLs in the Patapsco LNB, the County must also meet WLAs allocated from the *Chesapeake Bay Total Maximum Daily Loads for Nitrogen, Phosphorus, and Sediment* (USEPA, 2010). The Bay TMDL is a result of requirements under the CWA to meet water quality standards and executive order 13508 signed by President Barack Obama in 2009 that put a renewed emphasis and focus on the Chesapeake Bay. The local sediment TMDL for the Patapsco LNB is more geographically specific than the Bay-wide allocated loads assigned in the Bay TMDL. However, all load reductions achieved from implementation efforts described in this plan will help support the County's Bay TMDL goals.

2.4.4 NPDES

Section 402(p) of the Clean Water Act required the EPA to add Municipal Separate Storm Sewer System (MS4) discharges to the NPDES permit program. In 2002, EPA directed permit writers to include WLA requirements in NPDES permits, including those for MS4 discharges. Anne Arundel County holds a Phase I – Large Jurisdiction (greater than 250,000 population) MS4 permit (11-DP-3316, MD0068306) issued by the MDE. The County's first generation permit was issued in 1993. The current fourth generation permit was issued in February of 2014.

TMDL Permit Requirements

The objective of this plan is to meet the County's MS4 NPDES permit requirement to develop restoration plans for local TMDLs per permit condition IV.E.2.b. Plans must be developed within the first year of permit issuance. Anne Arundel County's final permit was issued on February 12, 2014 therefore the restoration plans must be complete by February 11, 2015.

The permit states the County must submit "…a restoration plan for each stormwater Waste Load Allocation (WLA) approved by EPA prior to the effective date of the permit." For each WLA, the County is required to:

PART IV. Standard Permit Conditions

E. Restoration Plans and Total Maximum Daily Loads
2. Restoration Plans
b. Within one year of permit issuance, Anne Arundel County shall submit to MDE for approval a restoration plan for each stormwater WLA approved by EPA prior to the effective date of the permit. The County shall submit restoration plans for subsequent TMDL WLAs within one year of EPA approval. Upon approval by MDE, these restoration plans will be enforceable under this permit. As part of the restoration plans, Anne Arundel County 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 restoration plans 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 County's watershed assessments.

Further, the permit requires continual outreach to the public regarding the development of its watershed assessments and restoration plans and requires public participation in the TMDL process (permit section IV.E.3.a-d).

The permit requires an annual progress report presenting the assessment of the NPDES stormwater program based on the fiscal year. A TMDL assessment report to include complete descriptions of the analytical methodology used to evaluate the effectiveness of the County's restoration plans and how these plans are working to achieve compliance with EPA approved TMDLs is a component of the annual report. The assessment will include: estimated net change in pollutant load reductions from water quality improvement projects; a comparison of the net change to targets, deadlines, and applicable WLAs; cost data for completed projects; cost estimates for planned projects; and a description of a plan for implementing additional actions if targets, deadlines, and WLAs are not being met (permit section IV.E.4.a-e).

Impervious Surface Permit Requirements

The County's permit requires implementation of restoration efforts for 20% of the County's impervious surface area that has not already been restored to the maximum extent practicable (MEP) (permit section (IV.E.2.a). Though projects and strategies outlined in this plan will certainly add treatment of impervious surfaces, accounting for impervious treatment is not included in this report.

3 Causes and Sources of Impairment (a)

3.1 Impairments

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

3.2 Sources

The majority of sediment loads in the Patapsco LNB originate from urban stormwater runoff from development and in-stream sources related to channel erosion.

3.2.1 Urban Stormwater Runoff

The contribution of urban stormwater to sediment loading was analyzed in the Patapsco Non-Tidal Watershed Assessment (Anne Arundel County, 2011). Figure 5 presents the annual total suspended solids runoff load as the relative quantity of sediment contributed from each subwatershed (i.e., lowest to highest). The water quality model used for the assessment was based on EPA's Simple Method (Schueler, 1987) and PLOAD models (EPA, 2001) using event mean concentrations (EMCs) for each LULC type. The results presented here are only the sediment associated with runoff, and do not reflect in-stream sources. The most significant contributing LULC categories related to urban stormwater in terms of loading rates include airport, transportation, and commercial and industrial areas. Residential development, while a lower loading rate, makes up a large portion of the watershed (26.1%) and is therefore also a significant contributor.

Subwatersheds contributing the lowest amount of existing sediment loads include PN5, PN6, and PNA followed by PN2 and PN7. Subwatersheds contributing the highest amount of existing sediment loads include PN1, PN8, and PN9 and to a lesser extent, subwatersheds PN3, PN4, PNB, and PNC. Management measures targeted in subwatersheds with high existing sediment loads will be the priority of this restoration plan to ensure required reductions are achieved and maintained.

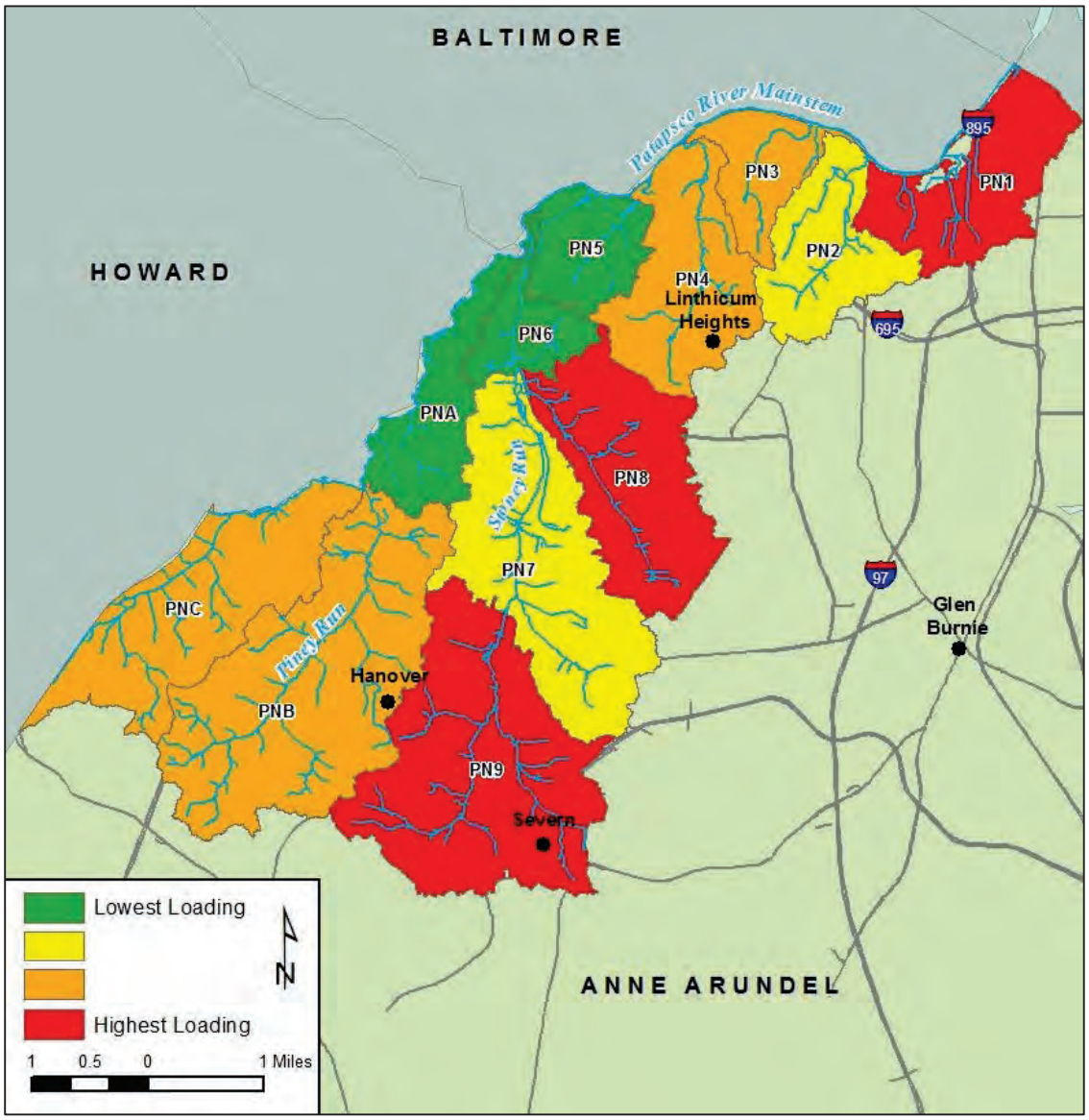


Figure 5: Total Suspended Solids Load from Runoff Based on Existing Conditions - Includes BMP Reductions

3.2.2 In-stream Sources

Although channel bed and bank erosion occurs naturally as streams work to maintain a state of dynamic equilibrium, excessive erosion can occur due to increased stream velocities associated with development activities that increase imperviousness within the watershed. Channel erosion can deliver excessive pollutants, such as sediment and phosphorus, downstream, where water quality can be impacted and important habitat for fish spawning and benthic invertebrates can be smothered. Excessive erosion can also threaten the stability of other nearby built infrastructure. The Biological Stressor Identification Analysis (BSID; MDE, 2012c) for the Patapsco LNB has determined that biological communities in this watershed are likely degraded due to flow/sediment related stressors. These stressors often result from altered hydrology and increased runoff from impervious area, specifically from channel erosion and subsequent elevated suspended sediment transport through the watershed. Thus, suspended sediment was identified as a probable cause and confirmed the Category 5 listing for total suspended sediment as an impairing substance in this watershed.

Approximately 96 miles of streams were assessed, and characterized for the Patapsco Non-Tidal Watershed Assessment (Anne Arundel County, 2011). Collected data included stream classifications, physical habitat condition assessment, inventory of infrastructure and environmental features, habitat scores, channel geomorphology, road crossing flood potential, bioassessments, and aquatic resource indicators. Within each perennial reach, channel erosion was assessed and scored based on severity. A score of 5 was considered Moderate impact, a score of 7 was considered Severe, and a score of 10 was considered an Extreme condition. A total of 225 erosion locations impacting approximately 22,000 linear feet of stream reaches were cataloged in the Patapsco LNB with the majority of points scored as moderate or severe erosion (Table 6 and Table 7). Over half of the erosion sites were located in Piney Run (PNB), Deep Run (PNC), and portions of the Patapsco Mainstem (PN5).

Table 6: Erosion Inventory and Severity per Subwatershed (Anne Arundel County, 2011)

Subwatershed and stream miles		Number of Erosion Impacts			Total
		5	7	10	
PN1	6.6	3	2		5
PN2	4.6		5		5
PN3	4.3		2		2
PN4	6.2	2	6		8
PN5	5.4	18	17	2	37
PN6	4.0	6	7		13
PN7	10.6	10			10
PN8	6.0	17	4		21
PN9	12.3	21	6		27
PNA	7.4	6	4		10
PNB	17.4	18	27	1	46
PNC	11.4	26	15		41
Total number per rating		**127**	**95**	**3**	
Total number per type		**225**			

Gray =<5 sites | Green = 5-10 sites | Yellow = 11-20 sites | Orange = 21-50 sites

Table 7: Linear Feet of Erosion per Subwatershed (Anne Arundel County, 2011)

Subwatershed	Erosion Impacts and Linear Feet			Total Linear Feet
	5	7	10	
PN1	650	470	0	1,120
PN2	0	225	0	225
PN3	0	130	0	130
PN4	120	290	0	410

Subwatershed	Erosion Impacts and Linear Feet			Total Linear Feet
	5	7	10	
PN5	1,555	1,440	125	3,120
PN6	465	180	0	645
PN7	705	0	0	705
PN8	2,370	180	0	2,550
PN9	1,200	695	0	1,895
PNA	1,580	255	0	1,835
PNB	1,495	4,060	40	5,595
PNC	2,240	1,570	0	3,810
Total	**12,380**	**9,495**	**165**	**22,040**

An assessment of channel geomorphology utilizing Rosgen Level I geomorphic classifications was also administered for each single-threaded, perennial reach throughout the watershed as part of the Patapsco Non-Tidal Watershed Assessment (Anne Arundel County, 2011). An assessment of channel geomorphology is useful to better understand the stability of a stream and its associated behaviors including channel entrenchment. The Rosgen classification system has four levels. The Level I classification is a geomorphic characterization that groups streams as Types A through G based on aspects of channel geometry, including water surface slope, entrenchment, width/depth ratio, and sinuosity.

Over one-third of the perennial reaches assessed were classified as entrenched and incised F and G stream types (23.3% and 12.4%, respectively). "F" stream types can develop very high bank erosion rates, significant bar deposition and accelerated channel aggradation and/or degradation while providing for very high sediment supply and storage capacities (Rosgen, 1996). Similarly, "G" stream types also have very high bank erosion rates and a high sediment supply and generate high bedload and suspended sediment transport rates (Rosgen, 1996).

3.3 Anticipated Growth

Future urban sector growth and the anticipated increase in urban loads that may result are expected to be controlled by two elements: stormwater management to the MEP that is required with new development, and anticipated “Accounting for Growth” policies. This CIS is developed to treat the reduction required from the initial baseline year load, calibrated to the current Bay model. Based on coordination with MDE, TMDL restoration planning should focus on the untreated and undertreated areas associated with the urban footprint at the time of the TMDL baseline. Future loads and loads potentially added to the urban sector since the baseline year to present are not accounted for here as they are addressed under other programs. MDE has requested in restoration plan development guidance (MDE, 2014d) that jurisdictions begin estimating potential additional loads, therefore estimates are included in section 3.3.1.

3.3.1 Estimates of Future Growth

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

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

The Anne Arundel County General Development Plan was finalized April 2009 and was adopted in October 2009 (Bill No. 64-09; Anne Arundel County, 2009). The next update of the plan is due by 2019. Anne Arundel County is considered one of the fastest growing counties in the region with 14.6% population growth (427,239 to 489,656 persons) over 1990-2000 compared to 6.9% growth in the Baltimore region and 10.8% growth throughout the State of Maryland (Anne Arundel County, 2009). The population in Anne Arundel County is projected to increase to 564,925 persons by 2025, which is an increase of 15.4% from 2000 data and to 579,137 persons by 2035, an increase of 18.3% from 2000 data.

The primary developed areas located in Patapsco LNB watershed are Hanover, Severn, and Linthicum Heights which include Baltimore-Washington International Airport and various commercial developments, specifically Arundel Mills Mall. The majority of the Patapsco LNB is a part of the County's Priority Funding Areas which are areas where the County directs new growth. Anne Arundel County continues to utilize strategies such as promoting low impact development and implementing stormwater BMPs for water quality treatment. However, increased urban stormwater related loads will inevitably occur as growth continues.

To estimate potential increases in loads over time due to growth, an analysis was completed using a combination of MAST modeled loading estimates, and estimates based on recent growth patterns. Figure 6 shows initial conditions loads without BMPs as modeled in MAST (grey bars) at the Patapsco LNB 8-digit subwatershed scale as well as projected loads with (blue bars) and without (orange bars) the application of stormwater BMPs to the maximum extent practicable (SW to the MEP). Projected loads were calculated by applying the average percent change observed between MAST loading results from 2010 through 2015 (2.1%) to loads of the previous year. In this manner a 2.1% annual increase in loads would be expected from 2015 to 2025 if development were to occur at the same rate and be implemented without BMPs. Because in actuality new development will follow Maryland's stormwater regulations, the resultant loading increases were reduced by 90% based on the MAST removal rates for sediment treated by stormwater treatment to the maximum extent practicable (SW to the MEP). The results are shown as the blue bars in Figure 6. Additional projected loads without the application of SW to the MEP sediment removal rates are shown as the orange bars in Figure 6.

Projected loading in 2025 with the application of SW to the MEP, will be incorporated in TMDL modeling efforts to account for growth in the watershed.

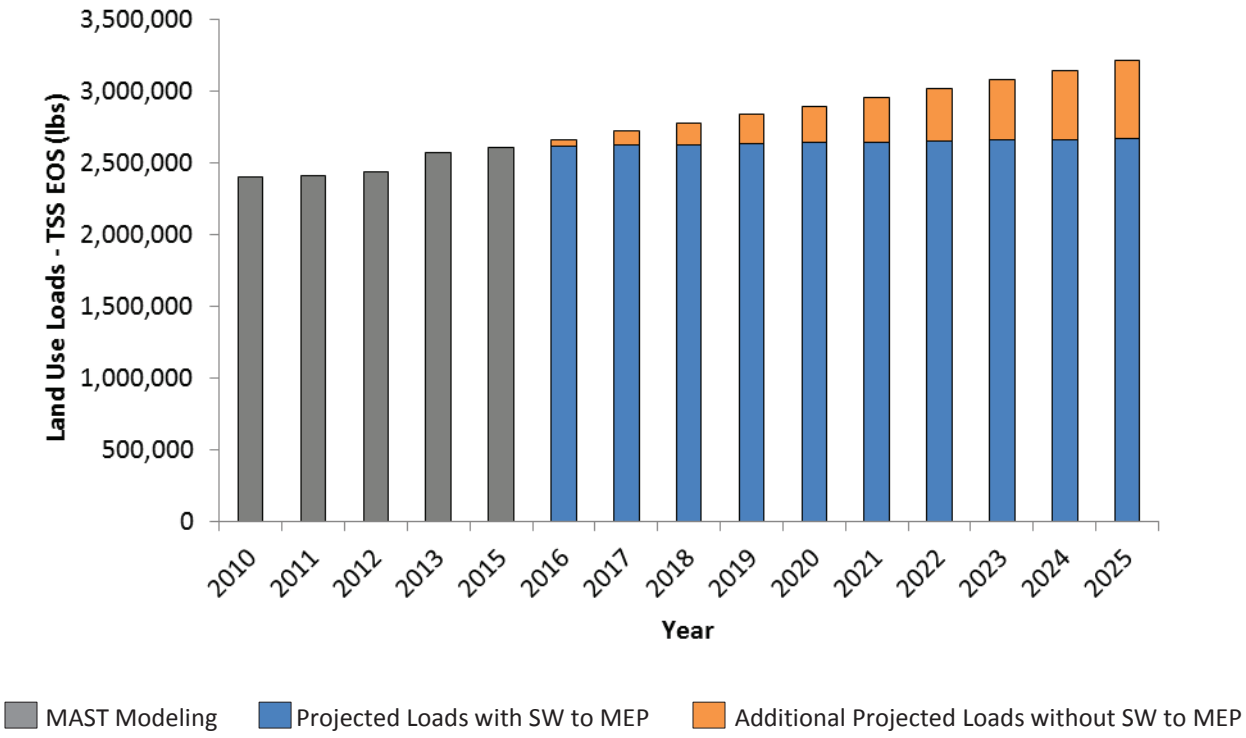


Figure 6: Modeled and Projected Land Use Loads

Figure 7 depicts sediment runoff loading by subwatershed based on a future conditions modeling scenario with the implementation of projects funded in the County's Capital Improvement Program (CIP) as recommended in the Patapsco Non-Tidal Watershed Assessment (Anne Arundel County, 2011) and discussed further in Section 4: Management Measures. In general, future sediment loading is projected to be highest in the headwater systems of Deep Run (PNC), Piney Run (PNB), and Stoney Run (PN7, PN8, PN9) which drain Hanover, Severn, and Baltimore-Washington International Airport.

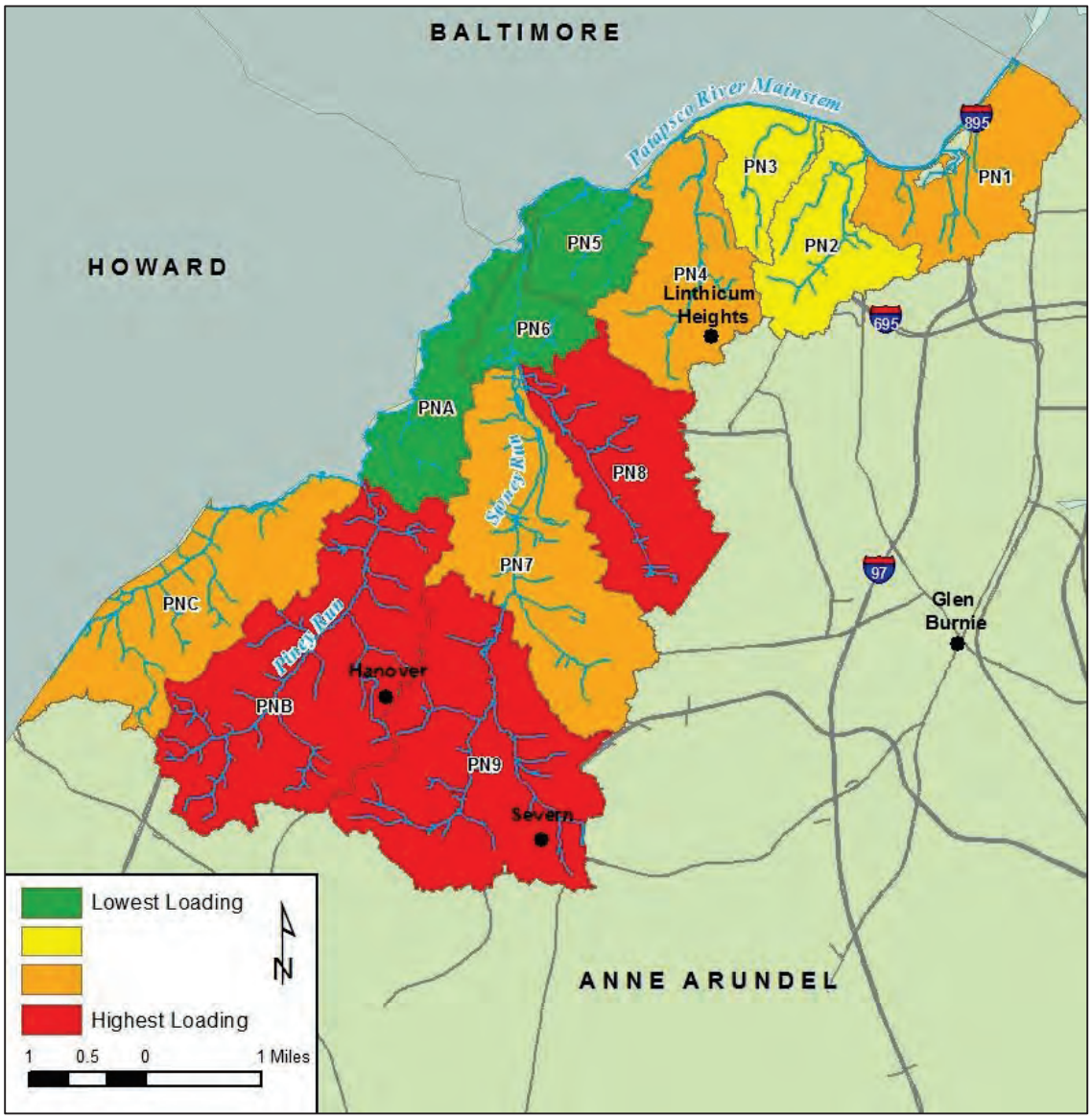


Figure 7: Total Suspended Solids Loads from Runoff Based on Future Conditions - Includes BMP Reductions

3.3.1 Offsetting Sediment Loads from Future Growth

Growth and development is expected to occur throughout Anne Arundel County, and depending on when and where this growth occurs, pollutant loading from urban stormwater sources may also increase. It is anticipated that new development will make use of ESD stormwater treatment according to MDE's Stormwater Regulations.

Maryland's 2007 Stormwater Management Act went into effect in October of 2007, with resulting changes to COMAR and the 2000 Maryland Stormwater Design Manual in May of 2009. The most significant changes relative to watershed planning are in regard to implementation of ESD. The 2007 Act defines ESD as "using small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources." As such Anne Arundel County has updated Articles 16 and 17 of the County Code to incorporate the requirements for ESD. Anne Arundel County finalized the *Anne Arundel County*

Stormwater Management Practices and Procedures Manual to incorporate criteria specific to the County that are not addressed within the Maryland Design Manual (Anne Arundel County, 2010).

Figure 6 in Section 3.3: Anticipated Growth shows projected land use loads with and without the application of SW to the MEP. TMDL modeling efforts include the application of SW to the MEP to represent ESD treatment for new development in the watershed. SW to the MEP will control 90% of sediment loads for that new development.

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

4 Management Measures (c)

Best management practices (BMPs) are either already implemented or are planned for implementation to achieve and maintain the Patapsco LNB local TMDL load reductions. This section serves to describe the types of BMPs and management measures being implemented in the watershed. Load reductions that result from these measures are discussed in the following section, Section 5: Expected Load Reductions.

4.1 Modeling Approach

Each BMP provides a reduction for nitrogen, phosphorus, and sediment, along with other pollutants. The pollutant load for the Patapsco LNB watershed was determined using BayFAST, which calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program Partnership Watershed Model. BayFAST, created by Devereux Environmental Consulting for MDE, is a web-based pollutant load estimating tool that streamlines environmental planning. Users specify, delineate facility boundaries (e.g., watershed, parcel, drainage area), and alter land use information within the delineated boundary depending on the model year. Local TMDL baseline loads were calibrated in BayFAST by modeling BMPs installed prior to the TMDL baseline year on top of baseline land use background loads. This ensures that the same set of baseline BMPs are used throughout future progress and planned scenarios.

BayFAST estimates of load reductions for point and nonpoint sources include: agriculture, urban, forest, and septic loading. Load reductions are not tied to any single BMP, but rather to a suite of BMPs working in concert to treat the loads. Both BayFAST and the Chesapeake Bay Program Partnership Watershed Model calculate reductions from all BMPs as a group, much like a treatment train. Reductions are processed in order, with land use change BMPs first, load reduction BMPs next, and BMPs with individual effectiveness values at the end. The overall the load reduction can vary depending on which BMPs are implemented.

Pollutant load reductions achieved by maintenance efforts (e.g., street sweeping and inlet cleaning) are calculated outside of BayFAST As discussed in the following section 4.2: Best Management Practices,

street sweeping and inlet cleaning will be practiced in the Patapsco LNB watershed. Sediment reduction credit for street sweeping and inlet cleaning is calculated following methods described in MDE (2014b). Vacuum-assisted street sweeping at a rate of 2 times per month reduces the load on the swept area by 25%. Inlet cleaning receives credit based on the mass of material collected, at the rate of 420 lb TSS per ton of wet material.

Both the Watershed Model and MAST provide loads at two different scales: Edge-of-Stream (EOS) and Delivered (DEL). Delivered loads show reductions based on in-stream processes, such as nutrient uptake by algae or other aquatic life. This TMDL plan focuses on reducing load on the land, so EOS estimates are more appropriate and were used for all the modeling analysis.

This section presents the level of BMP implementation. Section 9 presents information on how progress toward load reductions will be evaluated and management plans adapted on an on-going basis.

4.2 Best Management Practices

Many stormwater BMPs address both water quantity and quality, however, some BMPs are more effective at reducing sediment than others. The stormwater practices listed below keep the focus on "green technology" to reduce the impacts of stormwater runoff from impervious surfaces. These BMPs were selected specifically for three reasons: 1) effectiveness for water quality improvement, 2) willingness among the public to adopt, and 3) implementable in multiple facility types without limitations by zoning or other controls.

These practices are consistent with those currently being implemented by Anne Arundel County DPW as water quality improvement projects. The County has the technical expertise, operational capacity, and system resources in place to site, design, construct and maintain these practices.

The recommended practices are also consistent with those proposed in the County's Phase II WIP for the Chesapeake Bay TMDL and in the County's comprehensive watershed planning efforts. Exceptions to this are dry ponds which include dry detention ponds and dry extended detention ponds. These practices are no longer considered for future implementation; however, there are many existing facilities that are still actively treating runoff throughout the County so they are described here as well. The practices include:

- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. Rain gardens may be engineered to perform as a bioretention.
- **Bioswales** —An open channel conveyance that functions similarly to bioretention. Unlike other open channel designs, there is additional treatment through filter media and infiltration into the soil.
- **Dry Detention Ponds** – Depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow MAST modeling includes hydrodynamic structures in this category. These devices are designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.

- **Dry Extended Detention Ponds** - Depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. They are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, allowing additional wet sedimentation to improve treatment effectiveness.
- **Impervious Surface Reduction** - Reducing impervious surfaces to promote infiltration and percolation of runoff storm water. Disconnection of rooftop and non-rooftop runoff, rainwater harvesting (e.g., rain barrels), and sheetflow to conservation areas are examples of impervious surface reduction.
- **Infiltration** — A depression or trench to form a shallow basin where sediment is trapped and stormwater infiltrates into the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil; they are not constructed on poor soils, such as C and D soil types. Yearly inspections to determine if the basin or trench is still infiltrating runoff are planned. Dry wells, infiltration basins, infiltration trenches, and landscaped infiltration are all examples of this practice type.
- **Outfall Enhancement with Step Pool Storm Conveyance (SPSC)** – The SPSC is designed to stabilize outfalls and provide water quality treatment through pool, subsurface flow, and vegetative uptake. The retrofits promote infiltration and reduce stormwater velocities. This strategy is modeled in MAST as bioswales.
- **Permeable Pavement -** Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils or exits via an underdrain.
- **Stream Restoration -** Stream restoration in urban areas is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape of a stream, help improve habitat and water quality conditions in degraded streams.
- **Stormwater Retrofits –** Anne Arundel County plans to construct a variety of retrofits throughout the County. Stormwater retrofits may include converting dry ponds, dry extended detention ponds, or wet extended detention ponds into wet pond structures, wetlands, infiltration basins, or decommissioning the pond entirely to install SPSC (step pool storm conveyance).
- **Urban Filtering** - Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit.
- **Urban Tree Plantings** - Urban tree planting is planting trees on urban pervious areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff then releases it at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached pollutants. Until 2002 in Maryland, these practices were generally designed to meet water quantity, not water quality objectives. There is little or no vegetation within the pooled

area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.

The measured effectiveness for each of these practices may be found in Table 8.

Table 8: Typical Sediment Reduction from Stormwater BMPs

BMP	Sediment Reduction
Bioretention A/B soils	80%
Bioretention C/D soils	55%
Bioswales	80%
Dry Detention Ponds	10%
Dry Extended Detention Ponds	60%
Impervious Surface Reduction*	-
Infiltration	95%
Outfall Enhancement with SPSC**	80%
Permeable Pavement	85%
Stream Restoration	15.13 lbs/linear ft
Urban Filtering	80%
Urban Tree Plantings*	-
Wet Ponds or Wetlands	60%

Sources: Simpson and Weammert, 2009; and Maryland Assessment Scenario Tool (MAST) documentation
* Calculated as a land use change to a lower loading land use
**Outfall enhancement with SPSC modeled as bioswales in MAST

Along with the structural BMPs listed above, treatment will also be provided through non-structural measures. These are treatments that rely on programs that continue throughout the year and are repeated annually.

- **Inlet Cleaning -** Storm drain cleanout practice ranks among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with their NPDES stormwater permits. Sediment reduction credit is based on the mass of material collected, at the rate of 420 lb TSS per ton of wet material (MDE, 2014b).
- **Street sweeping** — Starting Fiscal Year 2015, Anne Arundel County has enhanced their street sweeping program which includes additional sweeping curb-miles within the Patapsco LNB (Anne Arundel County DPW, 2015; Figure 8). This enhanced program targets impaired watersheds and curbed streets that contribute trash/litter, sediment, and other pollutants. For full credit by MDE, street sweeping should occur twice a month or 26 times a year on urban streets. This frequent sweeping of the same street will reduce nitrogen and phosphorus as well as sediment. Under the enhanced street sweeping program, Anne Arundel County is sweeping arterial streets within the Patapsco LNB watershed on a bi-weekly basis (26 times a year) and collector and local streets on a monthly basis (12 times a year). Vacuum-assisted street sweeping at a rate of 2 times per month reduces the load on the swept area by 25%. In order to quantify sediment load reductions from monthly sweeping efforts, the removal rate of 22% for vacuum-assisted monthly sweeping was applied to total sediment collected from collector and local streets (CWP, 2008).



Figure 8: Street Sweeping Routes in Anne Arundel County, Maryland

5 Expected Load Reductions (b)

WLAs in the sediment TMDL were developed using the Chesapeake Bay Program Phase 5 (CBP P5) watershed model. Currently, MAST is using a computational framework that is compatible with an updated version of the model: CBP P5.3.2. Because the TMDL was developed under an older version of the model, the TMDL WLA needed to be translated into a MAST-compatible target load. In order to do this, the 2005 baseline sediment load was re-calculated in MAST with the 8-digit county split geography (Patapsco LNB 02130906, Anne Arundel County). The required reduction percent assigned to the Anne Arundel County Phase I MS4 source (22.2%) in the local TMDL regulation was then applied to the new baseline load to calculate required sediment reduction. The required sediment reduction was then subtracted from the new baseline load to calculate the MAST-compatible target TMDL WLA. Sediment loads required for the Patapsco LNB Anne Arundel County Phase I MS4 source are shown in Table 9.

Table 9: Sediment Loads Required for the Patapsco River Lower North Branch Local TMDL Anne Arundel County Phase I MS4 Source

2005 Baseline Load (lbs/yr)	Required Reduction %	Required Reductions (lbs/yr)	TMDL Load Allocation (lbs/yr)
1,422,388	22.2%	315,770	1,106,618

5.1 2015 Progress – Actual Implementation

Anne Arundel County maintains an extensive geodatabase of urban stormwater BMP facilities and water quality improvement projects (WQIP). Approximately 2,850 acres of County Phase I MS4 land has been treated through 2015 in addition to 650 linear feet of stream restoration and other non-structural BMPs (source: WPRP urban BMP and WQIP database, 2014). Current BMP implementation through 2015 in the Patapsco LNB is shown in Table 10. A list of completed projects is included in Appendix A.

Table 10: Current BMP Implementation through 2015 for Patapsco River Lower North Branch

BMP	Unit	2015 Current Implementation
Bioretention	acre	2.3
Bioswale	acre	0.0
Dry Ponds	acre	314.2
Extended Detention Dry Ponds	acre	548.6
Impervious Surface Reduction	acre	13.0
Infiltration	acre	603.1
Inlet Cleaning	no. of inlets	213
Outfall Enhancement with SPSC	acre	51.4
Permeable Pavement	acre	0.0
Stormwater Retrofits[1]	acre	76.7
Street Sweeping[2]	curb-miles	29.6
SW to the MEP	acre	0.0

BMP	Unit	2015 Current Implementation
Urban Filtering	acre	8.8
Urban Tree Plantings	acre	0.2
Urban Stream Restoration	linear feet	1,150
Wet Ponds or Wetlands	acre	866.3

Source: WPRP urban BMP and WQIP database

[1]Includes projects that will convert dry ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds.

[2]Streets swept monthly in 2013

2015 Progress results are shown in Table 11. The implementation of 2015 Progress BMPs listed in Table 10 have achieved 11.3% reduction of sediment loads.

Table 11: 2015 Progress Reductions Achieved

Baseline Load and TMDL WLA	TSS-EOS lbs/yr
2005 Baseline Scenario Load	1,422,388
Required Percent Reduction	22.2%
Required Reduction	315,770
Local TMDL WLA	1,106,618
2015 Progress Results	**TSS-EOS lbs/yr**
2015 Progress Scenario Load	1,261,366
2015 Progress Reduction Achieved	161,022
2015 Percent Reduction Achieved	11.3%

5.2 Planned Implementation

Table 12 compares implementation of existing BMPs with planned levels of implementation. This increase in implementation will continue to achieve the loads required in the local TMDL and ensure that future growth (through 2025) is treated. These loads meet the TMDL required reductions for the Patapsco LNB (Table 13). A list of completed projects and projects programmed out to FY19 is included in Appendix A.

Figure 9 shows baseline and progress loads (green bars) and planned loads (yellow bars) compared to milestone goal loads (red bars and red line). As discussed in Section 3.3: Anticipated Growth, initial conditions loads (2011 – 2015) without BMPs were modeled in MAST at the Patapsco LNB 8-digit subwatershed scale. This comparison shows that all background loads will be treated to the required TMDL allocated load with current and future BMP implementation.

Table 12: BMP Implementation - Current 2015 and Planned 2025 Levels for the Patapsco River Lower North Branch

BMP	Units	2015 Current Implementation	2025 Planned Implementation
Bioretention	acre	2.3	15.2

BMP	Units	2015 Current Implementation	2025 Planned Implementation
Bioswale	acre	0.0	0.0
Dry Ponds	acre	314.2	314.2
Extended Detention Dry Ponds	acre	548.6	548.6
Impervious Surface Reduction	acre	13.0	13.0
Infiltration	acre	603.1	624.0
Inlet Cleaning	no. of inlets	213	213
Outfall Enhancement with SPSC	acre	51.4	171.0
Permeable Pavement	acre	0.0	0.0
Stormwater Retrofits[1]	acre	76.7	76.7
Street Sweeping[2]	curb-miles	29.6	29.6
SW to the MEP	acre	0.0	0.0
Urban Filtering	acre	8.8	8.8
Urban Tree Plantings	acre	0.2	0.2
Urban Stream Restoration	linear feet	1,150	15,150
Wet Ponds or Wetlands	acre	866.3	1,464.9

[1]Includes projects that will convert dry ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds.
Includes curb-miles for arterial, collector, and local streets. Arterial streets swept bi-weekly (26 times a year) and collector and local streets swept monthly (12 times a year).

Table 13: 2025 Planned Reductions

Baseline Load and TMDL WLA	TSS-EOS lbs/yr
2005 Baseline Scenario Load	1,422,388
Required Percent Reduction	22.2%
Required Reduction	315,770
Local TMDL WLA	1,106,618
2025 Planned Results	**TSS-EOS lbs/yr**
2025 Planned Load[1]	762,790
2025 Planned Reduction Achieved	659,598
2025 Percent Reduction Achieved	46.4%

[1]2025 Planned load is the 2025 Planned Reduction Achieved subtracted from the 2005 Baseline Loads. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and Accounting for Growth policies will address the remaining 10%.

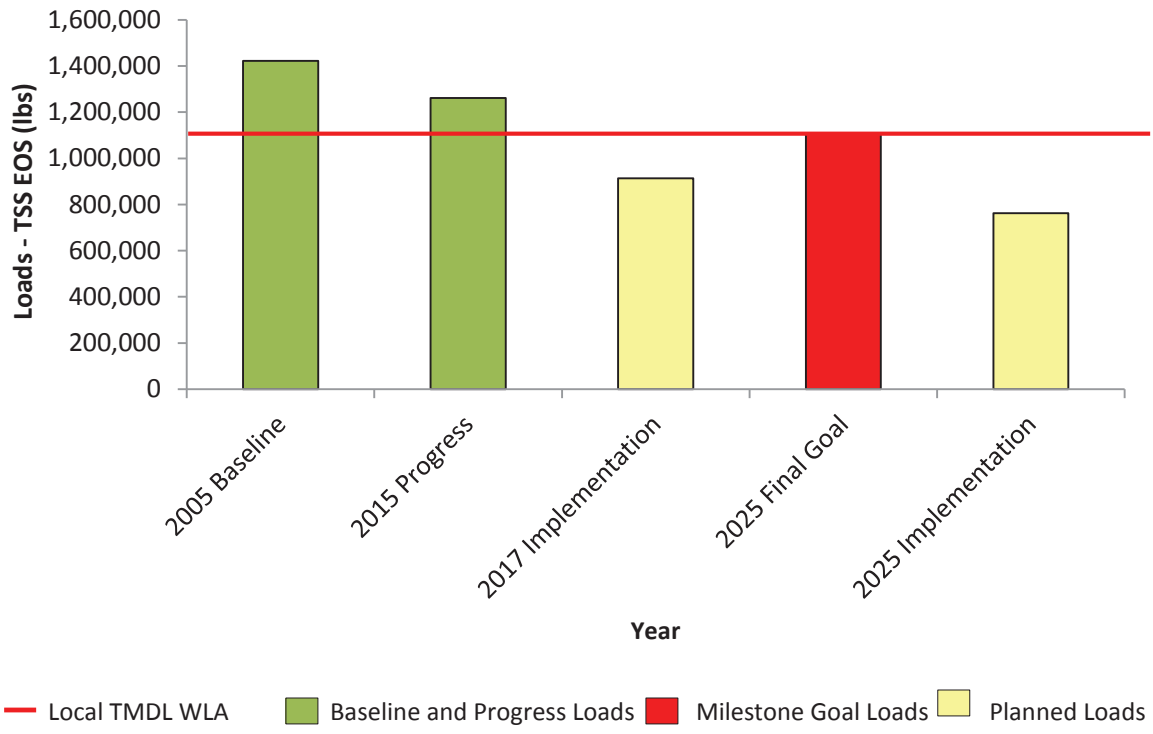


Figure 9: Progress and Planned Reductions in the Patapsco River Lower North Branch

6 Technical and Financial Assistance Needs (d)

Technical Needs

Technical assistance to meet the reductions and goals of a TMDL takes on many forms including MDE assistance to local governments, state and local partner assistance to both MDE and municipalities, and technical consultants contracted to provide support across a wide variety of service areas related to BMP planning and implementation.

MDE has and will provide technical assistance to local governments through training, outreach and tools, including recommendations on ordinance improvements, technical review and assistance for implementation of BMPs at the local level, and identification of potential financial resources for implementation (MDE, 2014b).

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

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

Technical assistance for Public Participation and Education and for Monitoring will also be necessary to fully implement and track progress towards meeting the goals of the local TMDL. These elements are discussed in sections 7 and 10 of this plan.

Financial Needs

The total projected cost to implement the County's CIP projects described in this plan for the Patapsco LNB watershed is $18,192,444 including $14,579,883 towards outfall enhancement with SPSC, $2,010,545 towards stormwater pond retrofits, $426,000 for inlet cleaning, and $1,176,016 for street sweeping. Structural BMP project costs are estimated based on the average cost per pound of nitrogen removed based on a group of completed projects consisting of various BMP types. Since these practices reduce nitrogen and phosphorus as well as sediment, costs derived from this method translate for sediment removal. This approach was used to calculate structural BMP costs in the County's Phase II WIP. Non-structural BMP costs for inlet cleaning and street sweeping were derived from historic County data and include equipment, operations, and maintenance costs.

Table 14 includes a summary of funding need per CIP project BMP type and project phase. Project cost is split throughout the implementation timeframe with design and land ROW estimated costs to occur the first year of the project, construction costs to occur in the second year, and overhead costs split between the first and second year.

Table 14: Patapsco River Lower North Branch Cost Over Milestone Periods

BMP	2014-2015	2016-2017	2018-2019	2020-2021	2022-2025	Total Cost
Outfall Enhancement with SPSC	**$7,884,156**			**$6,695,727**		**$14,579,883**
Design	$800,910			$680,184		$1,481,093
Land ROW	$160,182			$136,037		$296,219
Construction	$6,407,278			$5,441,469		$11,848,747
Overhead	$515,786			$438,038		$953,824
SWM Pond Retrofit	**$1,280,352**	**$730,193**				**$2,010,545**
Design	$204,241					$204,241
Land ROW	$40,848					$40,848
Construction	$931,985	$701,940				$1,633,925
Overhead	$103,278	$28,253				$131,531
Inlet Cleaning	**$85,200**	**$85,200**	**$85,200**	**$85,200**	**$85,200**	**$426,000**
Street Sweeping	**$235,203**	**$235,203**	**$235,203**	**$235,203**	**$235,203**	**$1,176,016**

6.1 Funding Sources

Prior to the passage of Maryland House Bill 987 and, as stated in the Anne Arundel County Phase II WIP (Anne Arundel County, 2012), the County's funding capacity to implement urban stormwater restoration/retrofit projects was limited by the County's Capital Improvement Program (CIP) budget for

environmental restoration and water quality improvement projects. To comply with forthcoming requirements of the Phase I NPDES MS4 permit, and to support restoration efforts towards reducing pollutant loads required for both the Chesapeake Bay TMDL and local TMDLs throughout Maryland, the State Legislature passed a law in 2012 (House Bill 987) mandating that Maryland's 10 largest jurisdictions (those with Phase I MS4 permits), including Anne Arundel County, develop a Watershed Protection and Restoration Program and establish a Stormwater Remediation Fee. To comply with the State legislation, Anne Arundel County passed legislation in 2013, Bill 2-13.

The County's Stormwater Remediation Fee provides a dedicated source of revenue for the implementation of local stormwater management plans through stormwater management practices and stream and wetland restoration activities and is assessed to Anne Arundel County property owners based on the amount of impervious surface on their property. The Stormwater Remediation Fee is structured to provide sufficient funding for projects to meet the pollutant load reduction required by the Chesapeake Bay TMDL, EPA approved individual TMDLs with a stormwater WLA and to meet the impervious surface management requirements as well as other stormwater obligations set forth in the County's NPDES MS 4 Permit. The fee is assessed to Anne Arundel County property owners as a separate line item on the owner's real property tax bill.

In addition to the Stormwater Remediation Fee, Anne Arundel County actively pursues grant funding from Federal, State and non-governmental organizations (NGOs) to leverage funding for its restoration projects. And, with the creation of the Stormwater Remediation Fee, the County has developed a Grant Program to provide funding to local NGOs to facilitate implementation of restoration projects that further the County's ability to meet its regulatory requirements.

7 Public Participation / Education (e)

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

In order to implement an effective strategy to meet water quality standards and achieve pollutant load reduction, an effort to engage a very broad audience of landowners was a necessity. The Anne Arundel Watershed Stewards Academy (AAWSA), a pre-eminent non-profit (501(c)3) environmental organization, was formed through Anne Arundel County Department of Public Works and the County Board of Education's Arlington Echo Outdoor Education Center (Anne Arundel County, 2012). AAWSA's mission is to identify, train, and support citizens to become Master Watershed Stewards who take action with their neighbors to restore local waterways in Anne Arundel County. This program is a unique way to integrate education as a vital element in its role in preservation, conservation and advocacy. There are currently more than 100 certified Master Watershed Stewards throughout Anne Arundel County and adjacent areas.

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

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

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

These programs and others like them could be more focused on the Patapsco LNB watershed.

In addition to the AAWSA, the following organizations have been identified for possible partnerships and education and outreach for the Patapsco LNB:

- Master Gardeners
- Audubon Society
- Students for the Environment
- Maryland civic associations and service clubs:
    - Maryland Home Builders Assoc.
    - Linthicum-Shipley Improvement Association
    - Audubon Naturalist Society of the Central Atlantic States
    - Audubon Society of Central Maryland
    - Blue Water Baltimore
    - Chesapeake Audubon Society
    - Chesapeake Bay Program

- Chesapeake Bay Foundation
- Chesapeake Bay Trust
- Chesapeake Ecology Center
- Center for Watershed Protection
- Alliance for the Chesapeake Bay
- Alliance for Sustainable Communities
- Baywise Master Gardeners
- Sierra Club – Maryland Chapter
- Magothy River Association
- Patuxent Riverkeeper
- West/Rhode Riverkeeper
- Nature Conservancy
- Smithsonian Environmental Research Center
- Anne Arundel Community College
- University of Maryland
- University of Maryland Extension
- Volunteer Center for Anne Arundel County

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

Part 4.E.3 of the County's NPDES MS4 permit outlines requirements for public involvement in the development of TMDL restoration plans. The County will fulfill these requirements by providing notice in *The Capital* newspaper which serves all of Anne Arundel County. This notice will outline how the public may obtain information on the restoration plan and provide comments. The County will provide copies of the restoration plan to parties upon request. The County will provide for a minimum 30-day comment period before finalizing the plan and will include a summary in the text of the annual report of how the County addressed or will address any material comments received from the public.

8 Implementation Schedule and Milestones (f & g)

This section presents the target loads and the activities required to achieve those targets based on the 2017 interim and 2025 final loads and implementation targets. The following schedule and milestones follows the Chesapeake Bay TMDL milestone date framework (60% progress by 2017) and end date (2025; USEPA, 2010). This schedule has previously been approved by the CBP for the applicable Bay TMDLs and is believed to be a good option for tracking progress towards reduction goals of the Patapsco LNB local TMDL.

8.1 Loading Allocations and Milestone Targets

Planning loads for 2017 and final loads for 2025 for the Patapsco LNB watershed are presented in Table 15 below. As mentioned in Section 5: Expected Load Reductions (b) (see Tables 10 and 11), progress is

already underway with the implementation of strategies throughout the watershed. As a result of current implementation efforts, the 2015 Progress sediment load is less than the 2005 Baseline Load. The 2017 Planned Load is less than theTMDL Allocated load.

Table 15: Patapsco River Lower North Branch Planning and Target Loads (edge-of-stream loads)

Load	Sediment Load (lbs/year)
2005 Baseline Load	1,422,388
2015 Progress Load	1,261,366
2017 Planned Load	913,920
2025 Planned Load	762,790
2025 TMDL Allocated Load	1,106,618
Percent Reduction between 2005 Baseline and 2025 Loads	22.2%

8.2 Implementation Milestones

To meet the loading allocations and milestones outlined in the previous section, implementation of programs and BMPs must keep pace and meet planned implementation targets. Table 16 details the implementation for each tracked BMP with the associated unit of measure. The 2013 data reflects existing BMPs while the 2017, 2021, and 2025 values reflect the planned implementation within these time periods.

Table 16: Patapsco River Lower North Branch Planning Milestones for Implementation

BMP	Unit	2015 Implemen-tation	2017 Planned	2021 Planned	2025 Planned	Total Impleme ntation
Bioretention	acre	2.3	12.9			15.2
Bioswale	acre	0.0				0.0
Dry Ponds	acre	314.2				314.2
Extended Detention Dry Ponds	acre	548.6				548.6
Impervious Surface Reduction	acre	13.0				13.0
Infiltration	acre	603.1	20.9			624.0
Inlet Cleaning	no. of inlets/yr	213	213	213	213	213
Outfall Enhancement with SPSC	acre	51.4	119.6			171.0
Permeable Pavement	acre	0.0				0.0
Stormwater Retrofits[1]	acre	76.7				76.7
Street Sweeping [2]	curb-miles	29.6	29.6	29.6	29.6	29.6

BMP	Unit	2015 Implemen-tation	2017 Planned	2021 Planned	2025 Planned	Total Impleme ntation
SW to the MEP	acre	0.0				0.0
Urban Filtering	acre	8.8				8.8
Urban Tree Plantings	acre	0.2				0.2
Urban Stream Restoration	linear feet	1,150	4,000	10,000		15,150
Wet Ponds or Wetlands	acre	866.3	598.6			1,464.9

[1]Includes projects that will convert dry ponds into wet ponds. Stormwater retrofits are modeled by decreasing acreage for dry ponds and increasing acreage for wet ponds.
[2]Includes curb-miles for arterial, collector, and local streets. Arterial streets swept bi-weekly (26 times a year) and collector and local streets swept monthly (12 times a year)

8.3 Implementation Priorities

To meet the loading allocations and milestones outlined in the previous sections, implementation will be planned based on prioritization analyses presented in the Patapsco Non-Tidal Watershed Assessment (Anne Arundel, 2011). Patapsco LNB subwatersheds were prioritized for restoration/retrofit project selection potential using four separate prioritization models. The models integrated historical environmental data, current stream assessment monitoring data, drainage area characteristics (GIS data), and watershed modeling results into indicators of watershed condition and need. The indicators are combined into the four models:

- Stream Reach Restoration
- Subwatershed Restoration
- Subwatershed Preservation
- Parcel Preservation

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

8.3.1 Stream Reach Restoration

The stream restoration prioritization uses a suite of indicators that are weighted and then combined into a final relative rating for each perennial reach as identified in the Physical Habitat Condition Assessment. The suite of stream restoration indicators used in the Patapsco Non-Tidal watershed, along with the indicator weight is presented in Table 17.

Table 17: Stream Priority Rating Indicators for Restoration (Anne Arundel, 2011)

Category	Indicator	Weight
Stream Habitat	MPHI score	31.6%

Category	Indicator	Weight
Stream Morphology	Rosgen Level I Classification	5.3%
Land Cover	Percent Imperviousness	5.3%
Infrastructure	Riparian buffer impacts	5.3%
	Channel erosion impacts	10.5%
	Head cut impacts	5.3%
	Dumpsite impacts	5.3%
	Other infrastructure impacts (pipes, ditches, stream crossings, obstructions)	15.8%
Hydrology and Hydraulics	Road Crossing Flooding Potential	15.8%

A total of 142 reaches were processed in the stream restoration model. Nine reaches were categorized as "High" priority or worst condition, 31 were "Medium High", 48 were "Medium", and 54 were "Low" priority or best condition (Figure 10). The Deep Run (PNC) subwatershed ranked as a very high priority overall, as seven of the nine "High" reaches are located in Deep Run. The Stoney Run subwatersheds had a combined total of 13 reaches rated in the "Medium High" category (Table 18, Figure 10 and Figure 11).

8.3.2 Subwatershed Restoration

Similarly to the stream restoration assessment, the subwatershed assessment used a collection of restoration indicators to assign a rating to each subwatershed. The indicators were weighted and combined into a single restoration rating for each subwatershed. Restoration indicators fell into one of six categories: stream ecology, TMDL impairments, On-site Disposal Systems (OSDS), BMPs, Hydrologic and Hydraulic (H&H) Modeling, Water Quality, and Landscape. Each category contains one to four different indicators. Table 18 provides a summary of the categories, indicators, and relative weighting assigned by the County.

Table 18: Subwatershed Priority Rating Indicators for Restoration (Anne Arundel, 2011)

Category	Indicator	Weight
Stream Ecology	Final habitat score	7.5%
	Bioassessment score	7.5%
303(d) List	Number of TMDL impairments	7.5%
OSDSs	Nitrogen Loads from septics (lbs)	9.3%
BMPs	Impervious area treated by BMPs (%)	6.6%
H&H (Land and Soils only)	Peak flow from 1-year storm event (cfs/acre)	4.5%
	Peak flow from 2-year storm event (cfs/acre)	4.5%
	Runoff volume from 1-year storm event (inches/acre)	5.8%
	Runoff volume from 2-year storm event (inches/acre)	5.8%
Water Quality (Land only)	Nitrogen load from runoff (lbs/acre/yr)	6.9%
	Phosphorus load from runoff (lbs/acre/yr)	6.9%
	Total Suspended Solids from runoff (Tons/acre/yr)	0.0%
Landscape	Impervious cover (%)	9.4%

Category	Indicator	Weight
	Forest within the 100 ft stream buffer (%)	10.3%
	% of existing wetlands to potential wetlands	9.4%
	Acres of developable critical area	5.3%

The final ratings range from “Lowest Priority for Restoration” to “Highest Priority for Restoration” where “Lowest Priority” indicates that a subwatershed is a low priority for restoration and therefore in good condition whereas “Highest Priority” indicates that a subwatershed should be a priority for restoration. The Patapsco Mainstem Watershed (PN1) was rated the highest priority for restoration. It is also important to focus restoration efforts in subwatersheds that ranked highest for existing TSS loads from urban runoff, which include subwatersheds PN8 and PN9 in addition to PN1 (Figure 5). Four watersheds, PN5, PNA, PN7, and PNC were rated the lowest priorities for restoration (Figure 11).

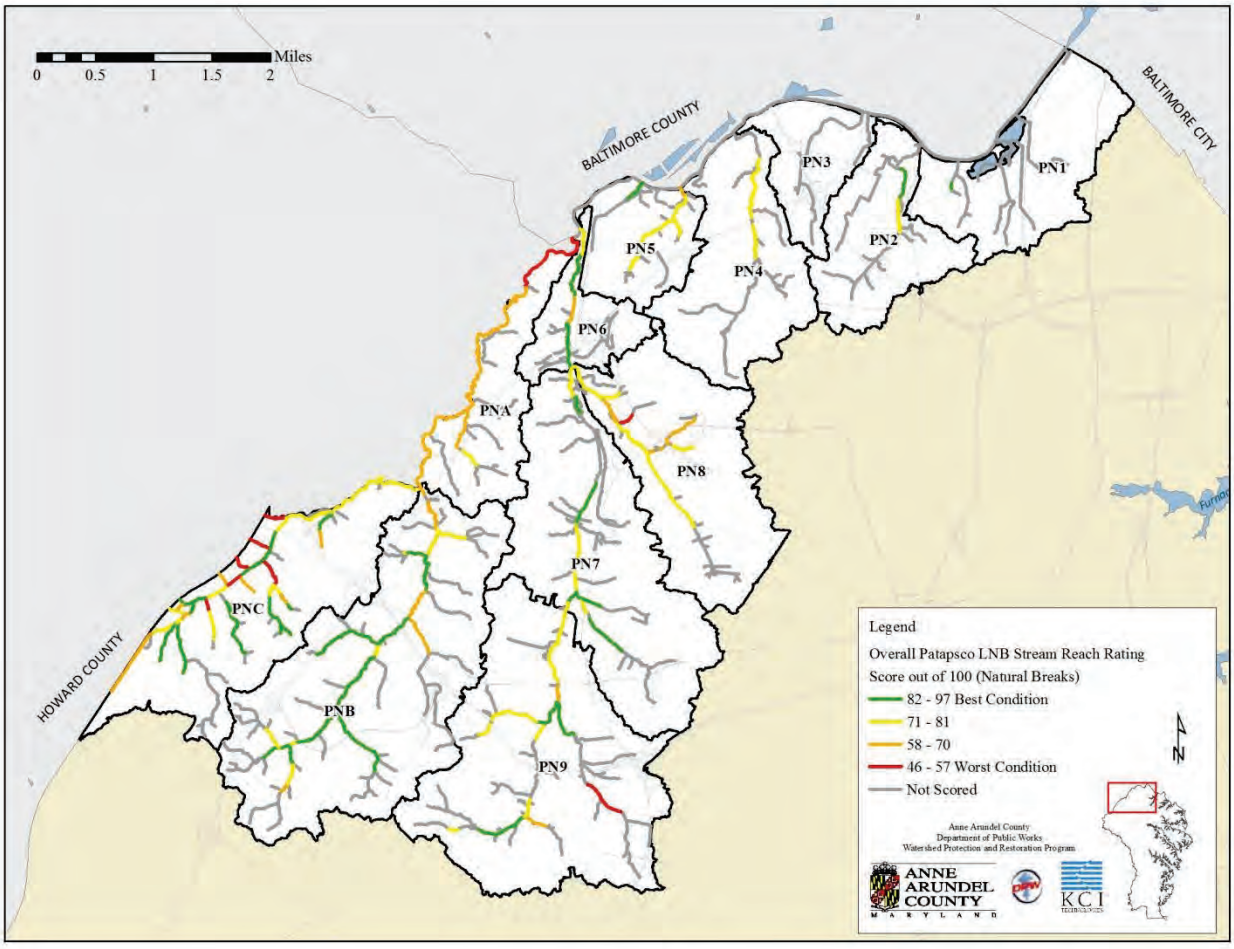


Figure 10: Stream Reach Assessment Results (Anne Arundel County, 2011)

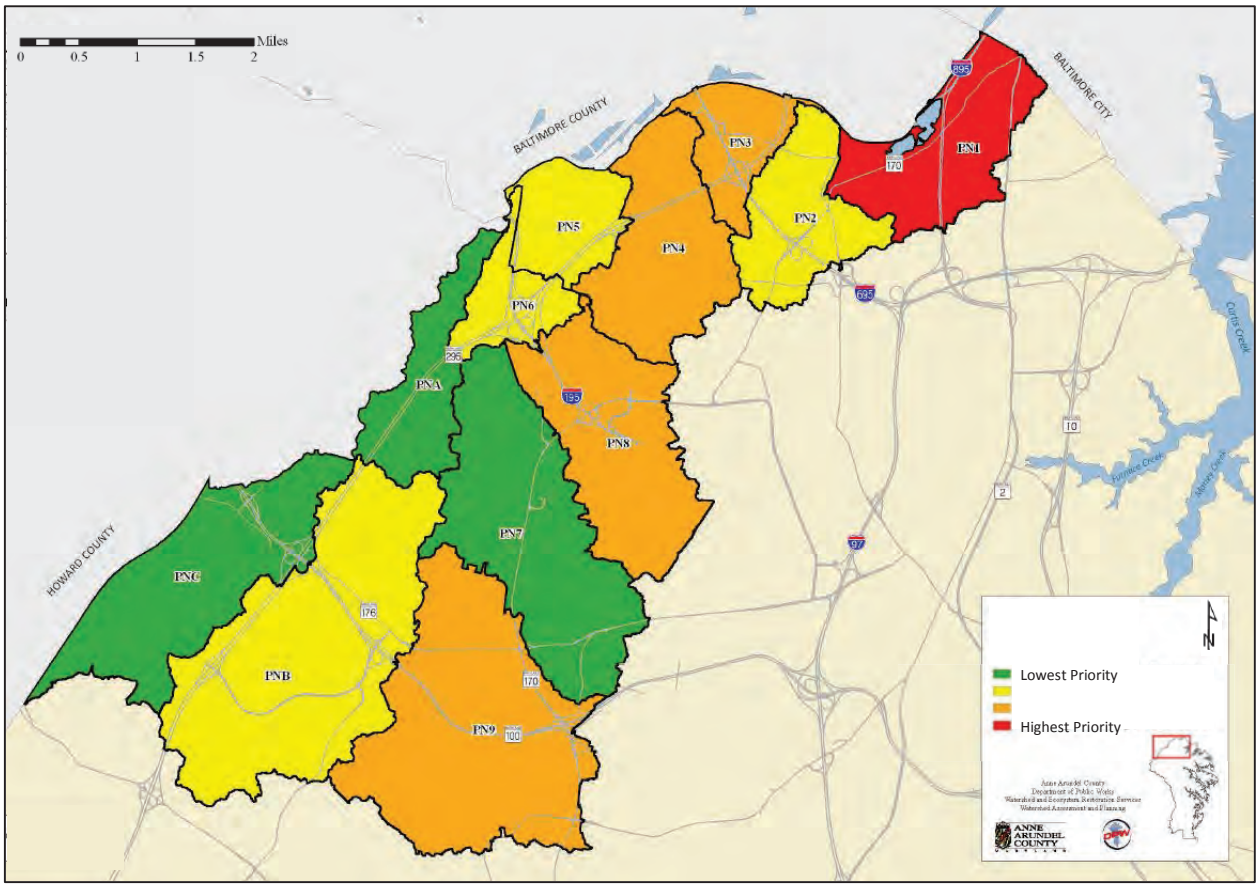


Figure 11: Subwatershed Restoration Assessment Results (Anne Arundel County, 2011)

8.3.3 Prioritization of Strategy Implementation

As stated in the Anne Arundel County's Phase II WIP, the County uses three major categories to classify urban stormwater strategies: Core Strategy Tier I, Core Strategy Tier II, and Potential Load Reductions Outside the Tier I and Tier II Core Strategy (Anne Arundel County, 2012). BMP planning and implementation will be prioritized based on these three categories with highest priority given to Tier I and Tier II strategies.

Core Urban Stormwater Strategy Tier I includes the following:

- Restoration of ephemeral and perennial streams with a Department of Natural Resources (DNR) Maryland Biological Stream Survey's (MBSS) Maryland Physical Habitat Index (MPHI) score of severely degraded or degraded,
- Implementing stormwater management treatment at currently untreated major pipe outfalls; and,
- Retrofitting stormwater management ponds built prior to 2002 to optimize the pollutant reduction and ecosystem functions for the facilities

Core Urban Stormwater Strategy Tier II includes additional pollutant reduction activities that must be implemented to meet the 2025 allocations; which includes the following:

- Monthly vacuum assisted street sweeping and associated inlet cleaning for all closed section roads,
- Reforestation plan for available public open space land; and,
- (SW to the MEP retrofits for County-owned properties including recreation areas

Potential Load Reductions Outside the Tier I and Tier II Core Strategies include the following:

- Focuses on the work of private citizens and Watershed Master Stewards in implementing SW to the MEP for residential rooftops, in high density areas, and for private commercial and industrial properties.
- These areas have been selected geographically outside the area treated by the WIP core strategy.

8.4 Implementation Strategy

Following the adoption of its Stormwater Remediation Fee in 2013 Anne Arundel County developed a 6-year Capital Improvement Program (CIP) in FY14 that created a Watershed Protection and Restoration Program (WPRP) Class of projects to implement those restoration projects identified in the County's Phase II WIP and applicable individual TMDLs for achieving stormwater WLAs. Funding for this class of projects averages 74 million dollars annually. Project in the WPRP Class were identified and prioritized through a planning level assessment and consist of restoration of ephemeral and perennial streams with a MBSS Maryland Physical Habitat Index (MPHI) score of severely degraded or degraded; implementation of stormwater/water quality treatment at currently untreated stormwater pipe outfalls (greater than 24 inches), and retrofit of stormwater management ponds built prior to 2002, with drainage areas in excess of 10 acres, to optimize pollutant reduction and ecosystem functions for the facilities. As WPRP projects are funded, more detailed feasibility and constructability assessments are conducted. These assessments may result in identifying projects previously thought to be implementable but due to a variety of reasons are not; or identifying additional and new opportunities for load reduction. As these feasibility assessments are completed the County incorporates these findings into its modeling, re-assesses anticipated load reductions and adapts it implementation program to delete or add projects and amends its CIP accordingly. And, as BMP technologies and efficiencies change, programs mature, credit trading is enacted and new regulations put into place, the County will reassess and modify its restoration strategy in response.

9 Load Reduction Evaluation Criteria (h)

Adaptive management is a critical component of achieving the WLAs required by the *Total Maximum Daily Load of Sediment in the Patapsco River Lower North Branch Watershed, Baltimore City and Baltimore, Howard, Carroll and Anne Arundel Counties, Maryland, Approved by EPA September 30, 2011*. This TMDL has clearly established load reduction targets for sediment. 2-Year Implementation Milestones have been established by the County to provide interim planning targets and to serve as a vehicle for assessing progress toward the load reduction targets. Progress will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring. Planning targets will be re-evaluated against progress and revised to ensure that Anne Arundel County is on track to meet established goals. Progress assessments are scheduled for 2017 and 2021, with 2025 set as the final date for achievement of load reductions.

The milestones proposed in Section 8: Implementation Milestones (2015, 2017, and 2021) provide interim planning targets. The planning targets will be used to reevaluate against progress and will be revised, if necessary, to ensure that Anne Arundel County continues to maintain TMDL requirements. Progress

evaluation will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring.

9.1 Tracking Implementation of Management Measures

Implementation will be measured by determining whether the targets for implementation shown in Table 16 are maintained according to the milestone schedule presented. Anne Arundel County manages a comprehensive system for adding and tracking projects and accounting for new programs. New BMPs constructed through new development and redevelopment projects are entered into the County's BMP database as they come on line. WPRP is responsible for implementing and tracking Water Quality Improvement Projects (WQIP; i.e., restoration and retrofit projects and programs). Additional internal County groups including Bureau of Highway Road Operation Division who are responsible for maintenance efforts (i.e., street sweeping and inlet cleaning) report back to WPRP. Another way the County is capturing and tracking projects is through the AAWSA. Watershed stewards can enter their own data and implementation projects through the WPRP website (www.aarivers.org). Once these data are reviewed and validated by the County, they are incorporated into the County's master list of environmental restoration projects.

Two-Year Milestone Reporting

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

Milestones are reported in two forms: Programmatic and BMP Implementation. Programmatic milestones identify the anticipated establishment or enhancement of the institutional means that support and enable implementation. Examples of Programmatic milestones include projected funding, enhancement of existing programs and resources, and the establishment of new programs and studies. The milestone period for Programmatic covers two calendar years – for example, the period for 2014 -2015 is from January 1, 2014 through December 31, 2015. BMP Implementation milestones are a quantitative account of various types of restoration activities (e.g., structural BMPs, stream restoration, maintenance efforts), which have geo-located coordinates. The period for BMP implementation milestones differs from the Programmatic milestones period and covers two state fiscal years – for example, the period for 2014 – 2015 is from July 1, 2013 through June 30, 2015. Planned BMP Implementation milestones reported to MDE include the action (e.g., BMP type), proposed restoration over the 2-year milestone period (e.g., area treated, length restored), actual rate of implementation over 1 year, and percent progress.

The Programmatic and BMP Implementation milestone submittal and reporting process follows an iterative approach and includes three separate submittals to MDE. The first is an initial milestone submittal to MDE by January 31st of the first milestone calendar year (e.g., 2014), followed by an interim milestone progress report submittal by January 31st of the second milestone calendar year (e.g., 2015), and concluding with a final milestone progress submittal by January 31st of the start of the subsequent milestone period (e.g., 2016).

Annual NPDES Reporting

As a requirement of the NPDES permit described in Section 2.4.4, the County must submit on or before the anniversary date of the permit a progress report demonstrating the implementation of the NPDES stormwater program based on the fiscal year. If the County's annual report does not demonstrate compliance with their permit and show progress toward meeting WLAs, the County must implement BMP and program modifications within 12 months.

The annual report includes the following – items in bold font directly relate to elements of the load reduction evaluation criteria:

a. The status of implementing the components of the stormwater management program that are established as permit conditions including:
   i. Source Identification
   ii. Stormwater Management
   iii. Erosion and Sediment Control
   iv. Illicit Discharge Detection and Elimination
   v. Litter and Floatables
   vi. Property Management and Maintenance
   vii. Public Education
   viii. Watershed Assessment
   ix. Restoration Plans
   x. TMDL Compliance
   xi. Assessment of Controls; and,
   xii. Program Funding

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

c. Expenditures for the reporting period and the proposed budget for the upcoming year

d. A summary describing the number and nature of enforcement actions, inspections, and public education programs

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

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

g. Attachment A – The County is required to complete a database containing the following information:
   i. Storm drain system mapping
   ii. Urban BMP locations
   iii. Impervious surfaces
   iv. Water quality improvement project locations
   v. Monitoring site locations
   vi. Chemical monitoring results
   vii. Pollutant load reductions
   viii. Biological and habitat monitoring
   ix. Illicit discharge detection and elimination activities
   x. Erosion and sediment control, and **stormwater program information**
   xi. Grading permit information
   xii. Fiscal analyses – cost of NPDES related implementation

9.2 Estimating Load Reductions

Progress assessments are scheduled by the Chesapeake Bay Program for 2017 and 2021. At this time, multiple lines of evidence including: several models, monitoring data, and the most recent science on BMP effectiveness and water quality response will be evaluated. The milestones and progress assessments will contribute to constant reassessment of management plans, and adapting responses accordingly as technologies and efficiencies change, programs mature, credit trading is enacted, and regulations are put in place. The County will model load reductions in MAST at the interim (2014, 2016, 2018) and milestone (2015, 2017, 2019) years, which equates to about once a year at minimum.

9.3 Tracking Overall Program Success through Monitoring

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

9.4 Best Management Practices Inspection and Maintenance

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

Background

Both the State and County SWM Codes require maintenance inspections be performed on all SWM practices during the first year of operation and every 3 years thereafter. The first year of operation inspections are performed by the Environmental Control Inspectors before Certificates of Completion is issued for the grading permits under which the practices were constructed. The 3-year maintenance inspections are the responsibility of the WPRP inspection staff.

Phase 1 Inspection and Enforcement

Phase 1 reflects the first time a SWM practice receives a 3-year maintenance inspection and maintenance is required. Using the proper Maintenance Inspection Checklists the Inspector performs the required 3-year maintenance inspection indicating on the Checklist boxes if maintenance is required, not required or the item is non-applicable. The information on the completed Checklist will serve to comply with the inspection requirements of COMAR 26.17.02.11 and be used to complete a Phase 1 Correction Notice issued in the field or mailed to the property owner. The Phase 1 Correction Notices shall be prepared using the I&P standard computerized inspection report software, contain a detailed description of the maintenance required and the compliance date by which the required maintenance is to be completed. If necessary Phase 1 Correction Notices can be completed by hand using the standard Environmental Programs Inspection Report Form. Phase 1 Correction Notices shall contain the proper contact information, be written in a clear and concise fashion with no speculation, editorial comments or superfluous information. The Urban BMP Database shall be updated to show a 3-year Maintenance Inspection was performed. For monthly reporting purposes, all re-inspections shall only be recorded as inspections and not as facilities inspected or as new correction notices issued. Depending on the degree of maintenance required, a Compliance Schedule may be appropriate. All proposed Compliance Schedules must be authorized by the WPRP Supervisor.

Phase 2 Inspection and Enforcement

Phase 2 reflects situations where Phase 1 Enforcement was not successful in obtaining compliance. Phase 2 Enforcement consists of a formal Phase 2 Violation Notice in the form of a certified letter to the property owner or responsible party. The Phase 2 Violation Notice shall be prepared by the WPRP Inspector using the appropriate form letter, reviewed by the WPRP Supervisor/Environmental Code Administrator as appropriate and signed by the WPRP Supervisor. The Phase 2 Notice shall establish final compliance dates for the completion of the required maintenance. The final compliance dates may reflect agreed upon Compliance Schedules as authorized by the WPRP Supervisor.

Phase 3 Inspection and Enforcement

Phase 3 reflects situations where Phase 2 Enforcement was not successful in obtaining compliance. Phase 3 enforcement consists of a legal referral to the Office of Law for the enforcement of the Private Inspection and Maintenance Agreement recorded against the deed for the property in question. The referral shall be prepared by the Environmental Code Administrator using the records associated with the violation.

10 Monitoring (i)

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

To determine the specific parameters to be monitored for tracking progress, one must understand the approach used for the initial listing. The Patapsco LNB was originally listed for sediments in 1996 as a suspended sediment listing. This was refined in 2008 to a listing for total suspended solids. In 2002, the State began listing biological impairments on the Integrated Report, at the 8-digit scale, based on a percentage of stream miles degraded and whether they differ significantly from a reference condition watershed (<10% stream miles degraded). The biological listing is based on Benthic and Fish Indices of Biotic Integrity (BIBI/FIBI) results from wadeable streams from assessments conducted by the Maryland Department of Natural Resources (MDNR) Maryland Biological Stream Survey (MBSS). The Patapsco LNB was listed for biological community impairment in 2002.

MDE then utilized its Biological Stressor Identification (BSID) process to identify the probable or most likely causes of poor biological conditions. For sediment specifically, the BSID identified 'sediment condition' parameters related to *channel alteration* and *bar formation* with statistically significant associations to biological condition. Likewise, the 'in-stream' habitat measure of *channelization* also had a statistically significant relationship to the biological condition. Overall, the results indicated inorganic pollutants (i.e. chlorides, conductivity, sulfate), and flow/sediment related stressors, and channelization as the primary stressors.

Based on the results of the BSID, MDE replaced the biological impairment listing with a listing for total suspended solids (TSS). The 2012 final and 2014 draft integrated reports lists 'Habitat Evaluation' as the indicator, and urban runoff/storm sewers as the source. It is noted that the *Decision Methodology for Solids for the April 2002 Water Quality Inventory (updated in February of 2012)*[1], makes a specific distinction between two different, although related 'sediment' impairment types in free flowing streams:

1. **TSS**: The first type is an impact to water clarity with impairment due to TSS using turbidity measured in Nephelometer Turbidity Units (NTUs). Although numeric criteria have not been

[1] http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/AM_Solids_2012.pdf

established in Maryland for TSS, MDE uses a threshold for turbidity, a measurement of water clarity, of a maximum of 150 Nephelometer Turbidity Units (NTU's) and maximum monthly average of 50 NTU as stated in Maryland COMAR regulations (26.08.02.03-3). Turbidity also may not exceed levels detrimental to aquatic life in Use I designated waters.

2. **Sedimentation / siltation**: The second type is an impact related to erosional and depositional impacts in wadeable streams. The measures used are biocriteria and the critiera for Use I streams (the protection of aquatic life and growth and propagation of fish (other than trout) and other aquatic life).

With these two sediment impairments in mind the Patapsco LNB, which is listed as impaired for TSS, would seem to be water clarity issue; however the methodology used for listing (biological and habitat measures related sediment deposition) seems to point to an in-stream sediment deposition problem. In all likelihood both types of impairment, water clarity and sedimentation, are factors and both should be incorporated into monitoring programs to track changes in the watershed condition over time.

Anne Arundel County's Watershed Protection and Restoration Program (WPRP) has several on-going monitoring programs that target measures of water clarity and sedimentation. These programs are described here.

Countywide Biological Monitoring

In 2004, a Countywide Biological Monitoring and Assessment Program for Anne Arundel County, Maryland was developed to assess the biological condition of the County's streams at multiple scales (i.e., site-specific, primary sampling unit (PSU), and countywide). Under the Countywide Biological Monitoring and Assessment program, biology (i.e., benthic macroinvertebrates) and stream habitat, as well as geomorphological and water quality parameters, are assessed at approximately 240 sites throughout the entire County over a 5-year period using a probabilistic, rotating-basin design. Round One of the County's Biological Monitoring and Assessment Program occurred between 2004 and 2008, and Round Two took place between 2009 and 2013. Round Three is scheduled to be conducted beginning in 2016.

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

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

The Patapsco LNB watershed is made up of three PSUs, Piney Run, Stony Run and Lower Patapsco. Ten sampling sites were sampled in each of these PSUs in each round of sampling. Methodologies follow those used by MBSS for the biological sampling (benthic macroinvertebrates only) and habitat evaluations have included both MBSS's Physical Habitat Index (PHI) and the EPA's Rapid Bioassessment Protocol (RBP) metrics. In-situ water quality measures are also collected at each site along with a geomorphic evaluation utilizing cross-sections, particle substrate analysis using pebble counts, and measures of channel slope.

Following these procedures, the County is collecting several parameters related to water clarity and sediment deposition at each site.

- Water Quality Measures and Observations
  - Turbidity (measured), observations of general water clarity and color
- Biological Measures
  - Benthic macroinvertebrates (BIBI)
- Habitat Measures
  - General: bar formation and substrate, presence/absence of substrate type
  - PHI: epibenthic substrate, instream habitat
  - RBP: epifaunal substrate / available cover, pool substrate characterization, sediment deposition, channel alteration
- Geomorphic Measures
  - Particle size analysis using modified Wolman pebble counts at 10 transects proportioned by channel bed features

Results summarized at the PSU scale with mean BIBI and habitat ratings (PHI and RBP) are presented in Table 19.

Table 19: Countywide Biological Monitoring Results for Patapsco River Lower North Branch

PSU Name	Round	PSU Code	Year Sampled	Drainage Area (acres)	BIBI Rating	PHI Rating	RBP Rating
Piney Run	1	1	2007	4,868	P	D	PS
Stony Run	1	2	2007	6,203	P	D	PS
Lower Patapsco	1	3	2004	4,040	P	PD	PS
Piney Run	2	1	2012	4,868	P	D	PS
Stony Run	2	2	2010	6,203	P	PD	S
Lower Patapsco	2	3	2012	4,040	P	PD	NS

BIBI Ratings: G = Good, F = Fair, P = Poor, VP = Very Poor

PHI Ratings: MD = Minimally Degraded, PD = Partially Degraded, D = Degraded, SD = Severely Degraded

RBP Ratings: C = Comparable, S = Supporting, PS = Partially Supporting, NS = Non-Supporting

Restoration Monitoring

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

Watershed Assessment

In 2001, Anne Arundel County initiated a series of systematic and comprehensive watershed assessments and management plans for restoration and protection across the County. The plans are developed within a regulatory context that includes NPDES MS4 requirements, local TMDLs and Watershed Implementation Plans for the Chesapeake Bay TMDL, Maryland Stormwater Regulations and the Water Resources Element of the County's General Development Plan.

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

The WAP program's stated goals include:

- Characterize subwatersheds;
- Prioritize subwatersheds for preservation and restoration; and
- Inform stressor-response relationships for planning and modeling.

The County continues to reevaluate its monitoring programs as the state of the science progresses, as the understanding of water quality and ecological interactions are improved, and as regulatory programs are added or modified. The WPRP is currently reviewing the Countywide monitoring program to ensure that the methods used are appropriate and meaningful, and that TMDL and NPDES requirements continue to be met.

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Appendix A: Patapsco River Lower North Branch Project List

Status	StormID# or TBD# or Outfall #	Watershed (8-digit Number)	Watershed (8-digit Name)	BMP Type	Drainage Area [acres]	Impervious Drainage Area [acres]	Pervious Drainage Area [acres]	Linear Feet for Stream Restoration	Annual Report Fiscal Year (completed projects only)	Estimated Completion Fiscal Year
Construction Complete	AA6769	02130906	Patapsco River L N Br	Dry Extended Detention Pond	1.53	1.26	0.27		FY2014	
Construction Complete	AA6954	02130906	Patapsco River L N Br	Dry Extended Detention Pond	13.00	5.20	7.80		FY2014	
Construction Complete	AA7009	02130906	Patapsco River L N Br	Dry Extended Detention Pond	1.96	1.16	0.80		FY2014	
Construction Complete	AA7910	02130906	Patapsco River L N Br	Wet Pond	18.39	4.92	13.47		FY2014	
Construction Complete	AA8953	02130906	Patapsco River L N Br	Infiltration	3.75	1.51	2.24		FY2014	
Construction Complete	AA9236	02130906	Patapsco River L N Br	Wet Pond	3.82	1.42	2.40		FY2014	
Construction Complete	AA9237	02130906	Patapsco River L N Br	Wet Pond	2.15	0.49	1.66		FY2014	
Construction Complete		02130906	Patapsco River L N Br	Stream Restoration				500	FY2015	
Construction Complete	AA000805	02130906	Patapsco River L N Br	Wet Pond	14.40	6.35	8.05		FY2015	
Construction Complete	AA000804	02130906	Patapsco River L N Br	Wet Pond	33.57	7.14	26.43		FY2015	
Construction Complete	AA000803	02130906	Patapsco River L N Br	Wet Pond	30.47	11.81	18.66		FY2015	
Construction Complete	AA001220	02130906	Patapsco River L N Br	Wet Pond	33.22	9.97	23.25		FY2015	
Construction Complete	AA001649	02130906	Patapsco River L N Br	Wet Pond	25.00	15	10.00		FY2015	
Under Construction	149	02130906	Patapsco River L N Br	Wet Pond	47.99	23.01	24.98			FY2016
Under Construction	4455	02130906	Patapsco River L N Br	Wet Pond	10.17	6.38	3.79			FY2016
In Design	803	02130906	Patapsco River L N Br	Wet Pond	36.1	10.65	25.45			FY2016
In Design	805	02130906	Patapsco River L N Br	Wet Pond	13.1	6.05	7.05			FY2016
In Design	1220	02130906	Patapsco River L N Br	Wet Pond	21.46	7.25	14.21			FY2016
In Design	1649	02130906	Patapsco River L N Br	Wet Pond	10.12	3.19	6.93			FY2016
In Design	462	02130906	Patapsco River L N Br	Step Pool Stormwater Conveyance	16.1	7.19	8.91			FY2016
In Design	SWM-06	02130906	Patapsco River L N Br	Step Pool Stormwater Conveyance	14.14	3.51	10.63			FY2017
In Design	SWM-01	02130906	Patapsco River L N Br	Wet Pond	124	25.3	98.70			FY2017
In Design	SWM-04	02130906	Patapsco River L N Br	Infiltration	3.27	0.27	3.00			FY2017

Status	StormID# or TBD# or Outfall #	Watershed (8-digit Number)	Watershed (8-digit Name)	BMP Type	Drainage Area [acres]	Impervious Drainage Area [acres]	Pervious Drainage Area [acres]	Linear Feet for Stream Restoration	Annual Report Fiscal Year (completed projects only)	Estimated Completion Fiscal Year
In Design	SWM-05	02130906	Patapsco River L N Br	Bioretention	3.6	1.59	2.01			FY2017
In Design	SWM-07	02130906	Patapsco River L N Br	Bioretention	9.27	8.15	1.12			FY2017
In Design	SWM-14	02130906	Patapsco River L N Br	Wet Pond	195	66.9	128.10			FY2017
In Planning	SR-04	02130906	Patapsco River L N Br	Stream Restoration				500		FY2017
In Planning	SR-05	02130906	Patapsco River L N Br	Stream Restoration				500		FY2017
In Planning	SR-06	02130906	Patapsco River L N Br	Stream Restoration				500		FY2017
In Planning	SR-07	02130906	Patapsco River L N Br	Stream Restoration				500		FY2017
In Planning	SR-08	02130906	Patapsco River L N Br	Stream Restoration				500		FY2017
In Planning	SR-09	02130906	Patapsco River L N Br	Stream Restoration				500		FY2017
In Design	97	02130906	Patapsco River L N Br	Stream Restoration				500		FY2017
In Design	685	02130906	Patapsco River L N Br	Stream Restoration				500		FY2017
In Design	717	02130906	Patapsco River L N Br	Constructed Wetland	57.79	15.37	42.42			FY2017
In Design	8823	02130906	Patapsco River L N Br	Constructed Wetland	2.87	2.12	0.75			FY2017
Under Construction	42	02130906	Patapsco River L N Br	Infiltration	3.73	1.29	2.44			FY2017
Under Construction	804	02130906	Patapsco River L N Br	Wet Pond	58.02	17.98	40.04			FY2017
Under Construction	822	02130906	Patapsco River L N Br	Infiltration	13.86	3.73	10.13			FY2017
Under Construction	2435	02130906	Patapsco River L N Br	Wet Pond	10.12	4.79	5.33			FY2017
Under Construction	2444	02130906	Patapsco River L N Br	Wet Pond	11.89	4.72	7.17			FY2017
In Design	806	02130906	Patapsco River L N Br	Step Pool Stormwater Conveyance	20.94	8.04	12.90			FY2017
In Design	807	02130906	Patapsco River L N Br	Step Pool Stormwater Conveyance	75.48	19.5	55.98			FY2017
In Planning	TBD	02130906	Patapsco River L N Br	Stream Restoration				10000*		TBD

* estimated value

Appendix B: Anne Arundel County Sediment Local TMDL Restoration Plans – Response to MDE Comments

Anne Arundel County Sediment Local TMDL Restoration Plans
Response to Comments
Maryland Department of the Environment Comments Received May 19, 2015

County comments addressed in **bold blue** text.

Attachment 1

Permit Conditions: Part IV.E Restoration Plans and Total Maximum Daily Loads (TMDLs)
MDE Assessment and Recommendations

- Restoration Plans: MDE's comments on the County's impervious surface assessment and associated restoration effort (Part IV.E.2.a) were attached to the March 31, 2015 letter. As discussed in that letter, comments on the impervious surface area assessment shall be addressed by May 26, 2015. The following are MDE's general comments on the restoration plans for stormwater wasteload allocations (WLAs) required under Part IV.E.2.b of the current permit:
    - Anne Arundel County submitted individual plans to address the sediment total maximum daily loads (TMDLs) for the Upper Patuxent River, Little Patuxent River, and the Lower North Branch of the Patapsco River. The County also submitted a combined plan to address the 19 separate bacteria TMDLs associated with the County's waterways.
    - **COUNTY RESPONSE: no response needed**

    - In their technical comments, MDE's Science Services Administration (SSA) has noted several issues with the pollutant baseline analyses that prevent comparing the County's modeling to MDE's official 2005 Local TMDL Base Scenario. SSA has provided several options for resolving discrepancies between official Maryland Assessment Scenario Tool (MAST) and County generated progress scenarios.
    - **COUNTY RESPONSE: See response below – Attachment 2, Major Comments, Sediment**

    - Any best management practices (BMPs) used in the modeling of baselines or current load analyses shall be maintained according to State regulations. BMPs that are not inspected at least once every three years and maintained may not be included as treatment when modeling loads.
    - **COUNTY RESPONSE: The County included a section on their process for inspection and maintenance with mention of actions taken if a facility is not meeting standards (9.4 Best Management Practices Inspection and Maintenance).**

    - TMDL restoration plans should be consistent with the guidance found in "Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for NPDES Stormwater Permits" (MDE Guidance, MDE 2014) or, if more recent, the appropriate Chesapeake Bay Program (CBP) guidance. The County should use acceptable BMPs and the associated load reductions found in these documents. For example, specific load reductions for each practice are inconsistent (e.g., bioretention is listed as a range of 50% to 80%), and do not reflect the values found in the MDE Guidance and updated CBP efficiencies.

- **COUNTY RESPONSE: The MDE document *Guidance for Using the Maryland Assessment Scenario Tool to Develop Stormwater Wasteload Allocation Implementation Plans for Local Nitrogen, Phosphorus, and Sediment Total Maximum Daily Loads* (June 2014) includes recommendations on how to use MAST to develop SW-WLA plans for nutrient and sediment TMDLs. At this time, MAST CBP Phase 5.3.2 has not been updated to reflect BMP efficiencies published in MDE's guidance *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for NPDES Stormwater Permits* (August 2014). Therefore, BMP efficiencies currently available and programmed in MAST will differ from those published in MDE's guidance. For example, there are two sediment removal efficiencies in MAST for bioretention depending on the type of soil (A/B 80% versus C/D 55%). In MDE's guidance, bioretentions are considered efficiency BMPs with a 70% sediment removal.**

  The efficiencies table for each plan has been edited to show individual removal efficiencies for bioretention A/B soils and bioretention C/D soils rather than presenting a range.

- Information used to develop the individual TMDL restoration plans is not consistent with similar information found in other sections of the County's Annual Report and associated databases. For example, the County's urban BMP database indicates that there are ten Bioretention practices with a total drainage area of 23 acres that could be applied to the baseline for the Little Patuxent River watershed. However, the total drainage treated by these practices for the baseline analysis in the restoration plan (see Table 10) is 70.9 acres.
- **COUNTY RESPONSE: Data used in the sediment restoration plans has been made consistent with the NPPDES geodatabase (Attachment A) with minor updates where needed between the timing of the plan and the latest Attachment A submittal.**

- Each of the restoration plans lacks specificity in how individual TMDLs will be addressed. These plans need to be of sufficient detail to ensure that expected interim milestones can be achieved and the TMDL addressed. Each plan should include a list of specific BMPs that will be implemented during the current permit term to address these TMDLs. This list should include BMP locations, drainage areas, impervious area treated, load reductions, estimated costs, and implementation schedule (e.g., design, construction). This list shall coincide with interim targets identified in the restoration plans.
- **COUNTY RESPONSE: See response below – Attachment 2, Major Comments, General**

- Public Participation:
  - Anne Arundel County has developed a website (www.aarivers.org) and an interactive, online application to provide public access to information on watershed assessments and restoration activities.
  - **COUNTY RESPONSE: no response needed**

- As TMDL implementation plans and new watershed assessments are developed, that information also will be made available on the County's website.
- **COUNTY RESPONSE: no response needed**

- Anne Arundel County must accept public comments on watershed assessments and watershed restoration plans. The County must provide a summary of how comments received were addressed in its next annual report.
- **COUNTY RESPONSE: a summary of comments will be prepared once public notice/review periods are completed**

- TMDL Compliance: Anne Arundel County continues to work with MDE to implement its Chesapeake Bay TMDL WIP. The County has been implementing associated activities since fiscal year 2013. Information concerning these activities and progress toward achieving programmatic and implementation milestones were reported to SSA on January 2015.
- **COUNTY RESPONSE: no response needed**

Attachment 2

Anne Arundel County Stormwater Waste Load Allocation (WLA) Implementation Plan Comments

Major Comments

- General:

  - These plans lack specificity at a site level scale, probably due to planning uncertainties such as, finding sites, purchasing or gaining access to land, obtaining all required permits and designing BMPs. This is understandable, and MDE recognizes that these plans are still works in progress. During subsequent annual reports, and by the time of the next permit issuance, the county should plan on including a much higher level of site-specific detail on planned implementation.
  - **COUNTY RESPONSE: The County has added several items to increase the specificity of the plan. 1. List of completed restoration projects and currently programmed projects. 2. Mapping of street sweeping routes. 3. Details on the County's process for moving projects from the identification stage in the County's watershed assessments through the feasibility process.**

- Sediment:

  - The county uses MAST to develop its sediment TMDL implementation plans. When comparing estimates of current progress loads to the baseline loads for a given sediment TMDL, the county did not use the official 2013 progress scenario in MAST. Instead, they created a new progress scenario by adding all BMPs known to be

implemented in the watershed to a no action scenario. By comparing the loading outputs from the official 2013 progress scenario in MAST and the progress scenario created by the county, it is evident that many BMPs from the county's 2013 progress scenario were not included in the official MAST 2013 progress scenario and the baseline load scenario (2005 Local TMDL Base). Therefore, a comparison between the 2005 Local TMDL Base scenario and the county's 2013 progress scenario is not valid. A revision of this discrepancy should be made immediately. MDE suggests either of the following options for making a valid comparison:

1. Compare the official MAST 2013 progress scenario loads to a target calculated from the 2005 local TMDL base scenario.
2. Use BayFAST to re-establish a 2005 condition baseline load by inputting the impervious and pervious urban land-use conditions and BMPs present at the time, from which a new target can be calculated, and compare this to a re-established 2013 progress scenario.
3. Take the official MAST 2009 progress scenario: add BMPs that were installed between 2009 and 2013, and compare the resulting load to the 2005 Local TMDL Base scenario.

- **COUNTY RESPONSE: The official 2013 Progress Scenario in MAST cannot be compared to the watershed specific 2013 MAST scenario created by the County because of fundamental differences in BMP data entry and load calculations. BMPs were entered at the Countywide level for the official 2013 Progress Scenario with loads distributed by 8-digit watersheds based on available County MS4 land use area among other components. BMPs were entered by Local TMDL 8-digit watershed based on actual treatment locations for the County's 2013 MAST scenario. BMP data entry in this approach ensures that land use loads are accurately calculated based on treatment strategies on the ground in a specific watershed.**

  The County cannot follow option 1 or 3 because of the discrepancies described above. However, the County has looked into re-calculating a 2005 Baseline as proposed in option 2 and has moved forward with this approach.

  For the 2005 Baseline, the County has modeled BMPs with a construction built date prior to 7/1/2005 in BayFAST at the local TMDL watershed scale (i.e., delineated facility boundary) using MAST County MS4 Phase I/II 2005 impervious and pervious data pulled from the MAST Compare Scenario tool at the 8-digit, county split scale.

  Based on communication with MDE the reduction accounting procedure for progress and planned scenarios has been modified such that loads from new urban sources since the baseline year are not required to be accounted for. The progress and planned scenario modeling now is keeping the 2005 land use static and calculating the

gross reduction from the additional restoration BMPs added with each progress and planned scenario.

Sediment Plans

- Editorial Comments:
  - Little Patuxent Plans, Section 1.1 (p. 4): The dates listed for TMDL approval are incorrect. Approval dates are provided in the TMDL Data Center's "TMDL Search" Function. Please correct dates. Also, please indicate that the sediment and nutrient TMDLs are only for Centennial Lake, as appropriate.
  - **COUNTY RESPONSE: Cycle listing date was incorrectly transcribed as TMDL approval date. The following dates were changed in the plan:**
    - **TSS sediment approved in 1996 to 2011**
    - **Sedimentation/siltation approved in 1998 to 2002**
    - **Phosphorus approved in 1998 to 2002**

  - Little Patuxent Plans & Upper Patuxent Plans, Section 1.2 (p. 5): The formula for the 2025 Allocated Load uses the reduction percentage for Patapsco. This formula needs to be corrected in the next revision.
  - **COUNTY RESPONSE: Correct values were used in calculations and analyses. Incorrect values were reported in the description of Table 1. The following values were changed in the plans:**
    - **Little Patuxent: 0.222 to 0.205**
    - **Upper Patuxent: 0.222 to 0.114**

  - Little Patuxent Plans, Table 13 (p. 33): The baseline information in Table 13 is incorrect (copied from Patapsco). Please correct table using information from Table 11 in this report in the next revision.
  - **COUNTY RESPONSE: Updated table with correct baseline information for Little Patuxent.**

  - Upper Patuxent Plans, Section 1.1 (p. 4): The TMDLs mentioned in this section were approved in 2011, not 2001. Please correct the date.
  - **COUNTY RESPONSE: Typo. Updated date to 2011.**

- Specific Comments:
  - Little Patuxent, Patapsco Lower North Branch & Upper Patuxent Plans, Table 1 (p. 6): The "reductions" in Table 1 are all calculated from the 2005 baseline. This is not clear based on the table. Additionally, more information regarding changes in the loads due

to development should be included, such as the number of acres and the loads associated with those acres (with and without BMPs).

- **COUNTY RESPONSE: Subsequent guidance from MDE stated that reductions are from the 2005 Baseline only. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and future "Accounting for Growth" policies will address the remaining 10%. Discussion of loads due to growth appears in text in sections 3.3 – Anticipated Growth, 3.3.1 – Estimates of Future Growth, and 3.3.2 – Offsetting Sediment Loads from Future Growth.**
-
- Little Patuxent Plans & Upper Patuxent Plans, Table 13 (p. 33) & Patapsco Lower North Branch Plans, Table 13 (p. 31): Table 13 could have sub-rows showing the estimated 2025 load change due to growth as well as reductions from implementation actions. MDE suggests including the change in loads due to growth either in a table or text format in the next revision.
- **COUNTY RESPONSE: Subsequent guidance from MDE stated that reductions are from the 2005 Baseline only. It is assumed that all new development will be treated with SW to the MEP implementation to achieve 90% sediment removal and future "Accounting" for Growth policies will address the remaining 10%. Table 13 only displays planned reduction from the 2005 Baseline Load. Discussion of loads due to growth appears in text in sections 3.3 – Anticipated Growth, 3.3.1 – Estimates of Future Growth, and 3.3.2 – Offsetting Sediment Loads from Future Growth.**

- Little Patuxent Plans, Figure 8 (p. 34), Patapsco Lower North Branch Plans, Figure 8 (p. 32) & Upper Patuxent Plans, Figure 8 (p. 33): Figure 8 is confusing. The grey bars are indicted to be MAST loadings, but the yellow bars are planning loads. It is unclear how they relate. Figure 8 should be clarified, updated or removed. It could be updated in the next revision to incorporate the change in loads, with growth and reductions from the milestone BMPs shown in Table 16.
- **COUNTY RESPONSE: Figure 8 (new Figure 9) has been updated. The figure now only shows progress and planned loads as the reduction from the 2005 Baseline Load to make this clearer.**

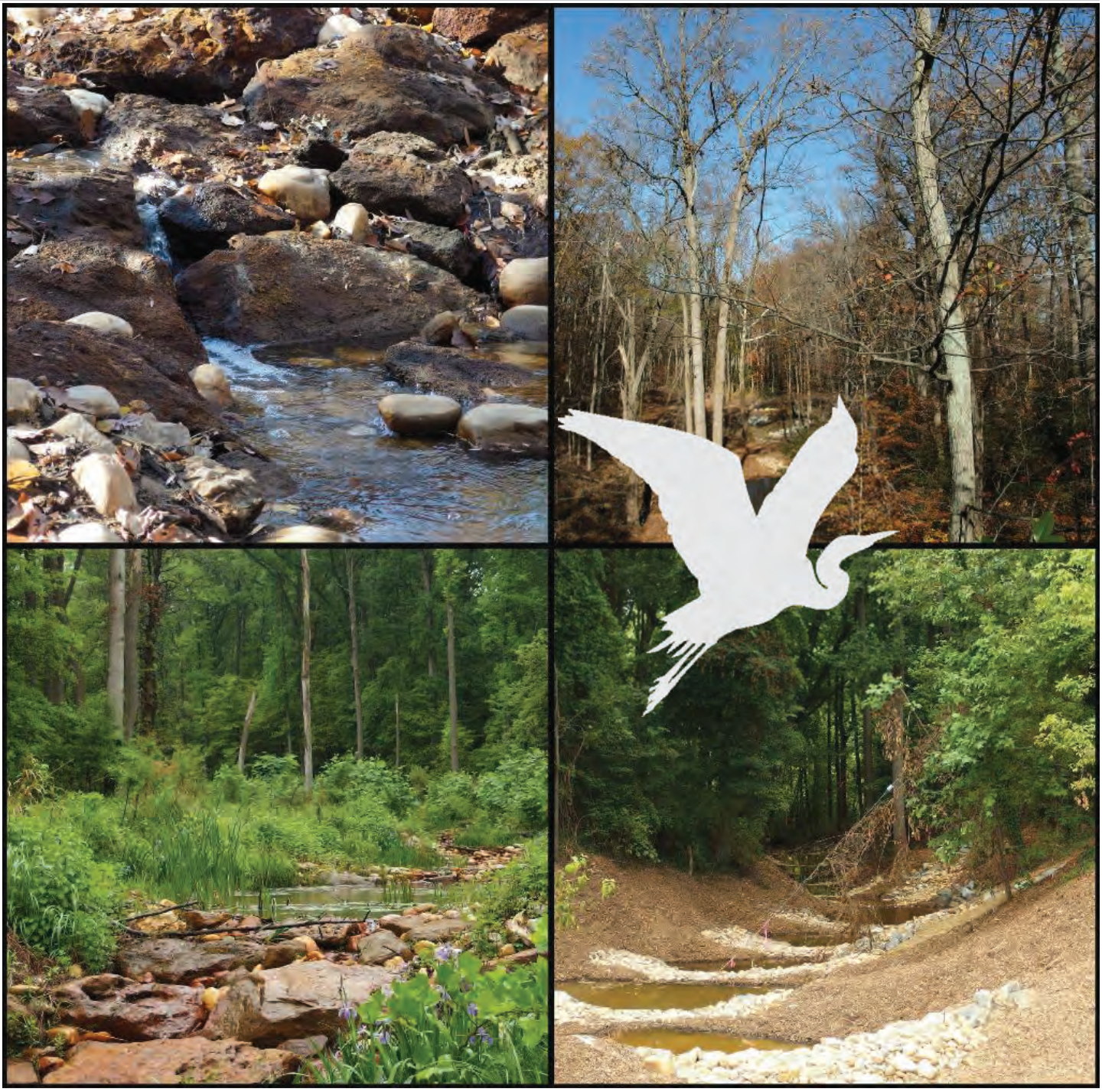
- Little Patuxent Plans & Upper Patuxent Plans, Section 5.1 (p. 31), Patapsco Lower North Branch, Section 5.1 (p. 29-30): Section 5.1 describes current BMP implementation through 2013, but does state from when. It is important to know if BMPs prior to the baseline year (2005) are being counted. Since pre-2005 BMPs should not be given credit toward TMDL implementation, BMPs should be divided into two categories: those completed before 2005 and those completed between 2005 and 2013.
- **COUNTY RESPONSE: The 2013 Progress scenario (now updated to 2015 Progress) loads are modeled using all County BMP data from their database ranging in built dates**

from 1978 - June 2005, and only restoration BMPs from July 2005 through 2013 (now updated to 2015).

The difference between 2013 Progress (now updated to 2015 Progress) loads, and the 2005 Baseline loads represents the reduction achieved from restoration BMPs built between 2005 and 2013 (now updated to 2015).

Modeling following this approach does not double count pre-2005 treatment.

Anne Arundel County
Impervious Area Restoration Plan



Anne Arundel County
WATERSHED
Protection & Restoration
PROGRAM

Department of Public Works
Watershed Protection & Restoration Program
2662 Riva Road
Annapolis, MD 21401
www.aarivers.org

ANNE ARUNDEL COUNTY
MARYLAND

Executive Summary

Anne Arundel County's NPDES MS4 Permit (Permit), issued in February 2014, requires the County to complete implementation of restoration efforts for twenty percent (20%) of the County's impervious surface area that has not already been restored to the maximum extent practicable (MEP).

The Maryland Department of the Environment (MDE) has previously approved[1] the County's impervious surface area assessment and the associated baseline for impervious area restoration. The impervious area assessment identified 1,639 acres as managed to the MEP[2] (i.e., the baseline of managed impervious area) and 29,311 acres as either having no stormwater management or only partial management (i.e., the baseline of unmanaged impervious area). This resulted in 20% restoration acreage of 5,862 acres (restoration goal), to be completed by the County on or before February 2019.

In its approval, MDE has requested the County provide an impervious area restoration plan with the following information:

- Local ID
- Specific BMP type (use the comprehensive list of BMP's from MDE's geodatabase)
- Watershed (8-digit, 12-digit)
- Precise location (lat/long)[3]
- Estimated impervious acres treated (drainage area or equivalent impervious acres)
- Estimated construction completion (FY)
- Estimated cost
- Impervious acres proposed for BMP design
- Impervious acres proposed for BMP construction completion
- BMPs completed with impervious acres treated and cost

The purpose of this impervious area restoration plan is to provide:

- Summary of county's progress towards restoration goal;
- The County's strategy to meet the restoration goal; and
- Specific information requested by MDE, which is provided as appendix 1 to this report.

[1] MDE approval letter dated July 07, 2015.

[2] 238~~,~~ out of the 10,500 existing BMPs were counted as managed, as only these met MDE's triennial inspection requirement.

[3] Precise location for programmed projects is the proposed location at this time. As these projects go through schematic design, and as precise location is available, it will be provided with future reports.

Summary of Progress Towards Restoration Goal

Activity	Acres	Reference
FY15 Water Quality Projects	198	Appendix A of FY2015 MS4 Annual Report
FY15 Septic Connection to WWTP	09	Appendix 1 of this plan
Septic ENR Upgrades	49	Appendix 1 of this plan
FY15 Water Quality Projects [4]	242	Appendix 1 of this plan
FY15 Street Sweeping	246	Section B. (1) of this plan
Total FY15 Acreage	**744**	Sum total of FY15 Activities
Restoration Acres Feb 2014 -June 30 2014	**48**	MS4 Addendum Submittal to MDE, May, 2015.
Total Restoration Acreage (Since Feb 2014) = **792 acres**		

Impervious Area Restoration Goal

The County is committed to improving water quality and its meeting MS4 permit requirements. The County's strategy to meet the restoration goal is based on:

A. Capital Improvement Program (CIP) restoration projects anticipated to be completed by February 2019;
B. Impervious acre equivalent credit for alternative urban BMPs, approved by MDE;
C. Tracking managed impervious area, which was previously counted as unmanaged in the baseline analysis;
D. WPRP Grant Funded projects;
E. Restoration projects implemented in the County by Non-Governmental Organizations (NGOs); and
F. Alternative Strategies.

Figure 1 below provides a summary of the County's restoration strategy. The sections below provide context and summarize these strategies and the County's efforts to meet the restoration goal. The restoration goal tracking will be provided with each annual report and the strategies to meet the goal will be evaluated as well. The County recognizes the need for adaptive management to meet the restoration goal by utilizing all available opportunities and enhancing alternative strategies, including but not limited to, the possibility of County grant expansion, nutrient trading/offset mitigation, and additional CIP projects to close the "gap" (if any) as the restoration goal is tracked annually.

[4] To be consistent with the WIP Final report to MDE, these projects are not being reported in Table D of Appendix A at this time, as the competition of these projects was reported to the County after WIP Final report was sent to MDE.

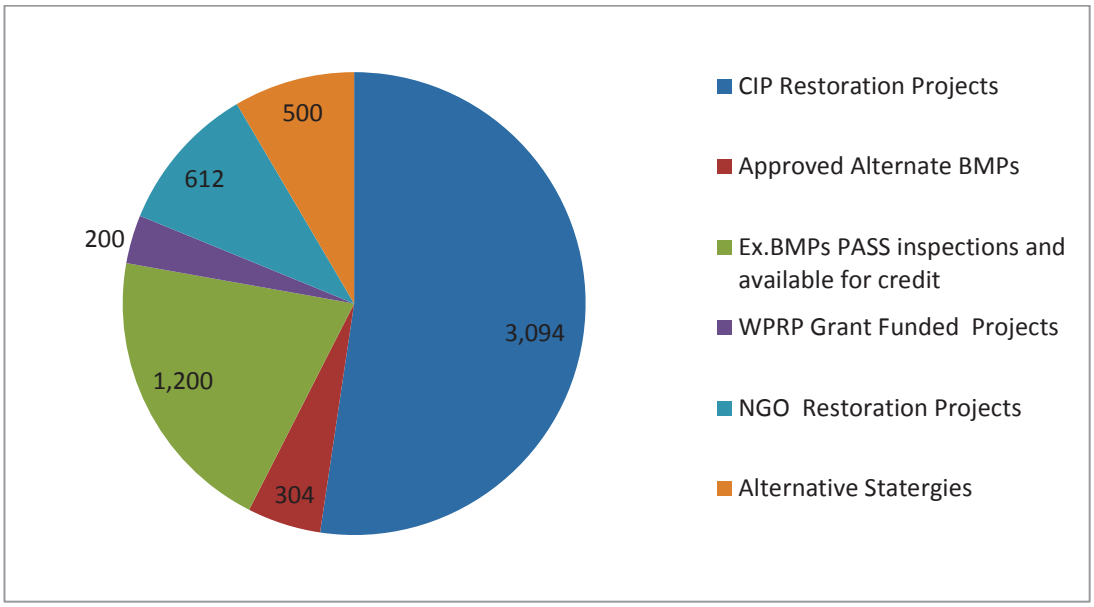


Figure 1 - 20% Restoration Goal Strategy

A. County Capital Improvement Program

Program Background and Funding

Anne Arundel County adopted legislation in June 2013 to create the Watershed Protection and Restoration Program (WPRP), including a Stormwater Remediation Fee (Fee). The Fee is structured to provide sufficient funding for projects to meet the pollutant load reductions required by the Chesapeake Bay TMDL, EPA approved individual TMDLs with a stormwater WLA, and to meet the impervious surface management requirements as well as other stormwater obligations set forth in the County's NPDES MS4 Permit. Given the basis upon which the Fee was established, at this time, funding to achieve applicable stormwater WLAs is considered to be sufficient to satisfy expenses associated with MS4 compliance.

As the restoration goal is a construction standard, the County has identified Capital Improvement Program (CIP) restoration projects from FY14, FY15, and FY16 which are anticipated to be completed by February 2019 to meet a portion of the goal. A list of projects to meet a portion of the goal are included in Appendix 1. These projects provide impervious area restoration through implementation of stream restoration, outfall restoration (e.g., SPSC), and structural stormwater facility retrofits (e.g., BMP retrofit to provide/enhance WQv). Our specific plan is primarily predicated on the County's CIP, which appropriates funding for implementation of infrastructure and environmental restoration projects. The Capital Budget Program Class for Watershed Protection and Restoration Projects identifies and provides cost estimates for those projects specifically identified to meet stormwater WLAs and MS4 restoration requirements. A summary of this funding from FY15 and FY16 is:

FY15: $81,309,300
FY16: $76,582,100

Figure 2 provides a summary of restoration acreage per fiscal year (FY). The restoration acreage is further broken-up into: programmed, under contract, in-design, and completed, to represent the life cycle of restoration projects.

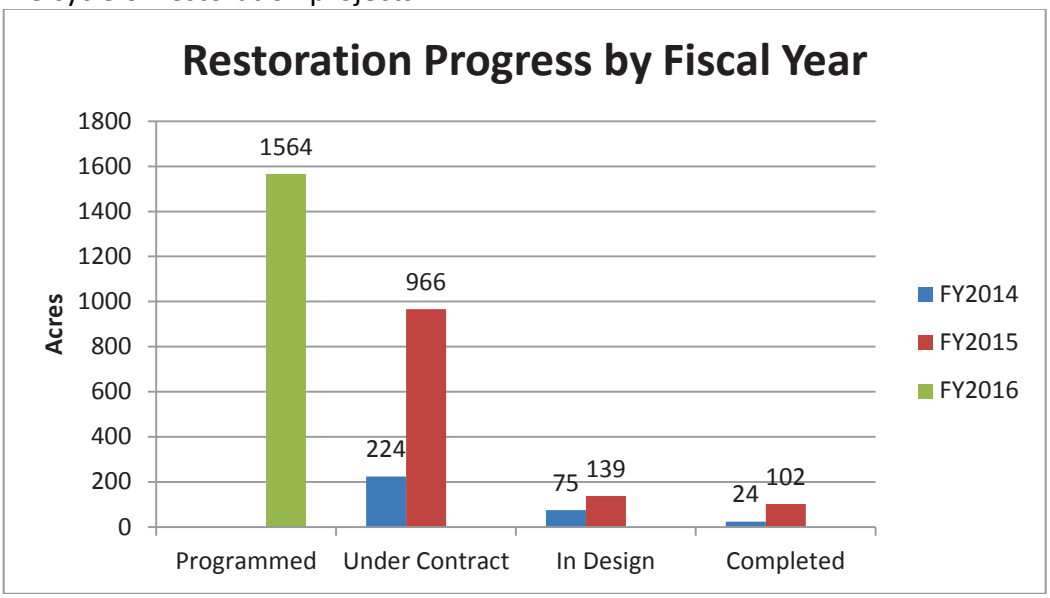


Figure 2 -Summary of CIP projects progress towards restoration requirement.

Most of the programmed projects in FY14 and FY15 are already under contract, in-design, or completed. FY16 projects are programmed at this time. As projects move to next stages of the project cycle (e.g., from programmed to under contract, under contract to in-design, etc.,) the corresponding acreage and changes will be updated with each annual reporting.

Figure 3 provides a breakdown of the restoration acreage per FY by project type (e.g., BMP retrofit, outfall restoration, and stream restoration)

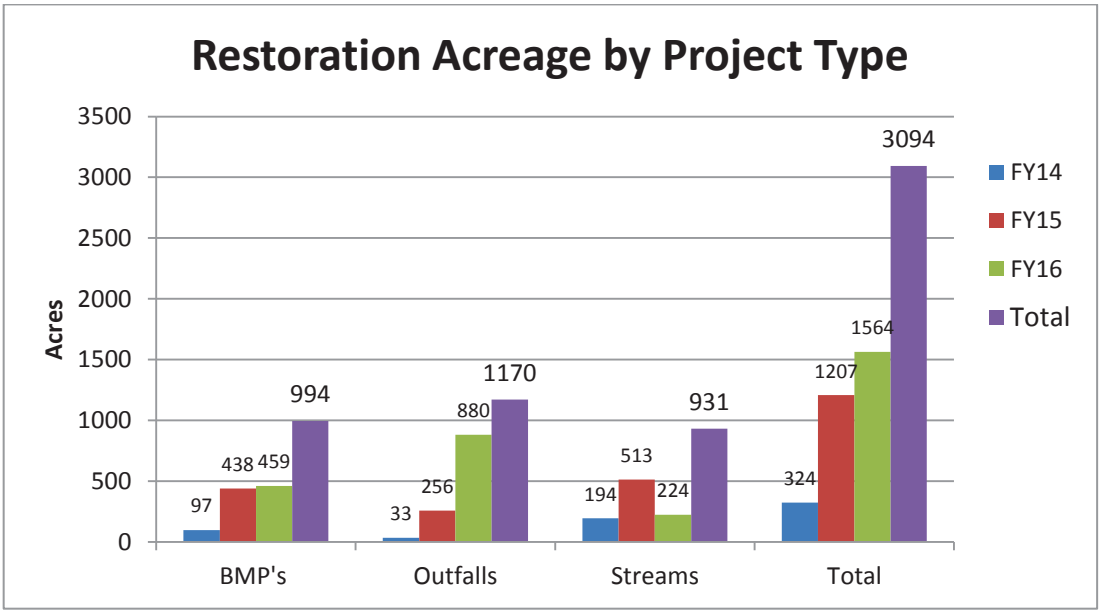


Figure 3- Restoration Acreage by Project Type

Project Identification and Implementation

Using the information obtained from the County's watershed assessments, the County identified and prioritized stream reaches for restoration. These reaches were identified and prioritized based on field–collected data pertaining to the physical characteristics of the stream reach and the adjacent habitat, as well as the position of the stream within the sub watershed and watershed landscape. The watershed assessments also identified and prioritized sub watershed areas for restoration based on both land use characteristics and field-collected data. Within the prioritized sub watershed areas, the County identified structural stormwater facilities whose design predated the 2000 Maryland Stormwater Design Manual, as these structures are likely candidates for water quality improvement. Lastly, for potential restoration purposes, the County identified closed storm drain outfalls having poor ratings, indicating a need for rehabilitation. These outfalls would provide an opportunity for structural facility repair as well as downstream channel rehabilitation, water quality improvement, and possibly opportunities to implement upland retrofits into areas without stormwater management facilities.

It should be recognized that the proposed FY16 restoration projects were identified primarily from existing and/or non-field verified information. Thus, the impervious area restoration plan is, truly, planning level information. As such, the County recognizes the need for continual re-assessment and adaptive management implementation to ensure permit compliance as well as successful implementation of the Phase II WIP strategy for meeting the Chesapeake Bay TMDL.

Restoration Schedule

Appendix 1 includes the information below requested by MDE and is broken in to: BMPs, Outfalls, and Streams. This information is provided in spreadsheet format.

- Local ID
- Specific BMP type (use the comprehensive list of BMP's from MDE's geodatabase)
- Watershed (8-digit, 12-digit)
- Precise location (lat/long)
- Estimated impervious acres treated (drainage area or equivalent impervious acres)
- Estimated construction completion (FY)
- Estimated cost
- Impervious acres proposed for BMP design
- Impervious acres proposed for BMP construction completion
- BMPs completed with impervious acres treated and cost

Utilizing the same data that built the current and future CIP budgets for environmental restoration, the County identified the specific outfalls, stream reaches, and ponds associated with each class of project that was proposed for funding in County Fiscal Year FY16. While the

CIP is projected beyond FY16, our current plan has stopped with the FY16 proposed projects because the Goal is a construction standard and it is anticipated that these projects up to FY16 are expected to meet this standard. CIP projects funded FY14 (i.e., February 2014 thru June 30 2014) and FY15, and implemented after February 2014, are also included in the impervious area restoration plan.

To project the impervious area restoration to be achieved through the end of the permit term, the County used the guidance provided in *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollutant Discharge Elimination System Stormwater Permits (MDE, August 2014*). As better data was available (e.g., as projects go through schematic design submittal, have as-built data), this information was used; but where this data was not available, estimated impervious acres treated was used. The impervious acreage to be restored was determined by project type as follows:

- Stream restoration projects were projected to restore 1 acre of impervious area per every 100 linear feet of stream[5];
- Structural stormwater facility retrofits (i.e., ponds) were projected for retrofit that would achieve 100% of the required WQ_v for the associated drainage area.
- Outfall projects (e.g., SPSC) were projected to achieve 100% of the required WQ_v for the associated drainage area, but the impervious area to be restored was capped at a maximum of 10 acres or the actual impervious area within that drainage area, whichever was less.

Lastly, it should be noted that the impervious area restoration plan is, as noted previously, a plan. As CIP projects have moved forward to feasibility study and then to design, some project components have not moved forward. For example some outfalls identified for retrofit were found to no longer be in need of retrofit and their upland areas were unsuitable for stormwater implementation, or retrofit was deemed not feasible at the current time due to site access issues. Alternatively, some projects (streams) which were in the design/assessment stage have increased in length because reaches previously identified as stable were found to be unstable and associated outfalls in these reaches were also identified which were not previously included in the programmed outfall list. As these projects move to schematic design and further, project specific data will be used to refine the impervious area restored for reporting back to MDE on an annual basis.

For programmed FY16 projects that do not move forward, the County plans to utilize alternative strategies to make-up the "gap." These strategies include, but are not limited to, identifying

[5] As stream restoration projects are in the design submittal phase, credits would be calculated based on the applicable protocols from the approved expert panel report. Linear feet are used as a measure at this time, as this is the best available data for estimated credit calculation purposes and is a conservative estimate of treatment.

retrofit opportunities, documenting credit for recently inspected and maintained BMPs having WQv documentation, adding restoration projects identified by County staff through fieldwork, and working with stakeholders and other NGO groups to implement restoration projects.

B. Alternative Urban BMPs

1. Street Cleaning

The County's street cleaning program is designed to keep debris out of storm drains, our creeks and, rivers, and ultimately the Chesapeake Bay, by reducing the pollutants associated with maintenance activities at County-owned facilities including parks, roadways, and parking lots. This program is administered by the County's Bureau of Highways (BOH).

The County's program covers manual litter collection, street sweeping, cleaning storm drainage pipes and structures, inlet cleaning, and ditch cleaning. During FY15 the County contracted for street sweeping services. Currently the County targets curbed roads with high traffic volumes and/or roads with storm drain outfalls that discharge to and/or touch a tidal or non-tidal water body within the Patapsco River Watershed, a priority area given the Baltimore Harbor Trash TMDL.

Accomplishment data for FY15 is provided below:

- The County swept 2,895 miles of streets during this period using Vactor trucks (Figure 2);
- The County cleaned and removed debris from catch basins, inlets and outlets of pipes to maintain proper drainage for 17,167 structures during this reporting period. This is a 9% increase from the last reporting period in which 15,804 structures were cleaned by hand. In addition, the County inspects catch basins, manholes, and associated pipes to identify structures for cleaning with a sewer vacuum or power rodder. A total of 1,591 structures were cleaned with a sewer vacuum, an increase of 37% from the last reporting period in which 1,165 were cleaned with a sewer vacuum. The County is currently working with different agencies (e.g., Highways and Waste Management Services) to identify a means of calculating the tonnage of debris and material collected, to calculate the impervious area equivalent credit for the catch basin;
- 8,733 bags of litter were manually collected throughout the County;
- A total of 30,220 feet of pipe were cleaned by a power rodder, an increase of 33% from the last reporting period in which 22,648 feet were cleaned. The County is currently working with different agencies (e.g., Highways and Waste Management Services) to identify a means of calculating the tonnage of material collected for purposes of determining the impervious area equivalent credit; and
- The County cleaned 172,763 linear feet of ditch during this period.

In FY15, the County swept 2,895 curb miles, which is 246 acres of equivalent impervious surface credit. The impervious area equivalent is based on the "Street Lane Approach" methodology. As the new *Street Cleaning Bay Expert Panel Report* is approved, beginning FY16 this report will be used to calculate the impervious area equivalent for the street miles swept. Per this new report,

one impervious acre is equivalent to one curb-lane mile swept for streets with curbs and gutters. At this time the County's street cleaning data is not maintained in a GIS format and, thus, is not geographically represented in Appendix 1. The County is currently working on developing GIS coverage for the street cleaning and this information should be provided with future reports.



Figure 4. The County's Vactor Truck Used in Street Cleaning

MDE allows equivalent impervious area credit for catch basin cleaning and stormdrain vacuuming. The County does not collect this data in tons but is working with different agencies (e.g., BOH and Waste Management Services), to calculate the tonnage of street debris collected, to calculate the impervious area equivalent credit for the catch basin cleaning, and to document stormdrain vacuuming activities. This plan assumes that the County continues to clean 2,895 curb miles each year. The actual miles swept would be updated with MS4 report, and this plan would be updated as well.

2. Septic System Connection to Wastewater Treatment Plant Credit (WWTP)

The August 2014 MDE guidance allows an impervious area credit equivalent of 0.39 acres for each septic system that was connected to the County's wastewater treatment system.

- July 1, 2014 through June 30 2015: The County made 23 connections, which translates to 9 acres of equivalent impervious surface credit

Appendix 1 has a listing of these connections.

3. Septic Systems Upgraded to Enhanced Denitrification System Credit

The August 2014 MDE guidance allows an impervious area credit of 0.26 acres for each septic

system upgrade to an enhanced denitrification system.

- July 1, 2014 through June 30, 2015: The County made 187 connections, which translates to 49 acres of equivalent impervious surface credit.

Appendix 1 has a listing of these upgrades.

C. Existing BMPs Managed Impervious Area

MDE has approved the County's evaluation of impervious lands which identified 30,950 impervious acres under the County's MS4 jurisdiction (Establishing Baseline – Impervious Area Assessment; Anne Arundel County, May 2015). Of these acres, 1,639 were identified as managed to the MEP (i.e., the baseline of managed impervious area) and 29,311 acres were identified as either having no stormwater management or only partial management (i.e., the baseline of unmanaged impervious area).

As a part of the baseline analysis, 263 impervious acres from 238 existing BMPs were identified as managed to the MEP. This represents 2.2% of the existing BMPs in the County's Urban BMP database. These BMPs were identified using the criteria outlined in the guidelines, *Section II Establishing Baselines: Impervious Surface Area Assessment*. To accomplish this, BMPs record were queried and selected from the County's Urban BMP database that were found to meet the requirements (i.e., having a documented WQv from either the grading permit application or sealed stormwater report and having an inspection record within the last three years).

To track and gain credit for the managed impervious acreage from existing BMP facilities, which were counted as unmanaged in the baseline analysis, the County is continuing efforts toward:

- BMP inspection and maintenance verification
- Urban BMP database clean-up for the inspected BMPs including documenting WQv.

Table 1 summarizes the BMP inspection verification and database clean-up efforts projected through the end of the permit term, to track managed impervious area.

Fiscal Year	No. of Pass Inspections	Database Clean-Up	No. of Impervious Acres (as managed)	Counted as Managed in Baseline Analysis	Acreage to be Adjusted Towards Baseline
FY15	1,984	Yes[3]	1,500	No	300
FY16	2,820[2]	Yes[1]	1,500	No	300
FY17	2,820[2]	Yes[1]	1,500	No	300
FY18	2,820[2]	Yes[1]	1,500	No	300

Total			6,000		1,200 acres[4]

Table 1- Managed Acreage Tracking

[1] The County is procuring consultant services for the Urban BMP Database clean-up work effort which is anticipated to begin in early summer of 2016. This multi-year work effort will also result in documenting WQv, making these facilities available to be counted as managed to MEP.

[2] A schedule has been put together to inspect BMPs that do not currently have documented triennial inspections. As inspections are performed, the number of facilities that pass inspections would be updated yearly.

[3]. It should be noted that the County has procured consultant services in November, 2015 to clean-up FY15 inspected BMPs. WQv is currently being documented from this work effort, and will be updated with FY16 report.

[4] This acreage is forecasted as a reasonable estimation and will be updated annually as the facilities are inspected and WQv documented (as a part of the bigger database clean-up exercise).

With the Countywide implementation of the WPRP program, 10 FTEs are now dedicated to providing maintenance verification inspections of existing stormwater BMP facilities. As a result, the number of BMPs inspected in FY15 has increased from 238 to 1984. To facilitate these inspections and their concomitant impervious acreage accounting, a schedule for BMP inspections was developed and projected out a minimum of three (3) years. As stormwater BMP facilities are inspected and found to be in good working condition with a documented WQv, the BMP will become available for credit towards the managed impervious area goal and the County will track that managed acreage.

The County is committed to providing accurate data during the BMP inspection through the following:

- Training and certification programs for the inspectors that go out in the field
- GIS/desktop platforms to upload BMP data to local databases
- Quality control checks to validate the uploaded data

Additionally, County staff have attended and participated in BMP maintenance and verification training. Both internal and external training programs have been offered and have been well attended.

As the County further enhances its maintenance inspection program, ramps up field inspection efforts, and increases inspection and maintenance of additional BMPs, the impervious credit associated with these existing BMP practices will be documented toward impervious surface restoration or adjusted baseline. By contracting out the BMP database clean-up effort, it is expected that the County will achieve progress towards documenting water quality volumes for existing BMPs during the FY17 reporting year, and that such efforts will continue in-house into the future years. This effort is tied to the ongoing Urban BMP Database improvements and the required database enhancements associated with the August 2014 guidance, which the County began implementing shortly after receipt of that guidance (MDE 2014).

D. WPRP Grant Funded Projects

The Anne Arundel County Government has partnered with Chesapeake Bay Trust to establish a grant program that supports watershed restoration projects and programs throughout Anne Arundel County: http://www.aacounty.org/DPW/Watershed/Watershed_Grant_Program.cfm. The goal of the Anne Arundel County Watershed Restoration Grant Program is to fund projects that reduce pollutants through the implementation of watershed restoration practices. Projects must be implemented in Anne Arundel County and applications must include at least one partner that represents a stakeholder group based in Anne Arundel County. Projects must accomplish on-the-ground restoration that will help the County meet local water quality and runoff reduction improvement goals. The grant applications are evaluated by a Technical Review Committee and funding is awarded based on the projects' merit (e.g., cost effectiveness, likelihood of project success, long term maintenance requirements, community support).

All proposals provide calculations of nutrient and sediment loads reduced by the project using a nutrient calculator compatible with the MDE 2014 guidance document. Proposals must include an estimate of the total drainage area and total area of impervious surface treated by the project. In addition, other quantifiable outcomes (e.g., square feet of bioretention created, number of trees planted, square feet of buffer planted) must be provided per the MDE 2014 guidance document.

The County's Watershed Restoration Grant Program will support the construction of the following types of watershed restoration implementation projects to achieve reductions of storm flow and pollutants to County waterways:

- Bioretention cells, bioswales, rain gardens, and other low impact development stormwater techniques;
- Stormwater wetland and marsh creation and enhancement;
- Stream and wetland restoration;
- Regenerative conveyance systems (coastal plain outfalls, etc.);
- Green roofs.

In FY15, the County funded 7 grant projects through this program; Appendix 1 includes a listing of these projects. The FY16 grant proposals are currently under review.

E. Other Restoration Projects

The County partners with and works collaboratively with various Non-Governmental Organizations (NGOs) to install restoration projects on the ground. Appendix 1 includes a listing of 31 living shoreline projects to restore 15,302 linear feet of shoreline, which equates to 612 acres of impervious area credit. These include proposed and completed projects. Completed projects were assigned a Unique Storm_ID and have been added to the Urban BMP database.

The County is also working with local partners (e.g., Watershed Stewards Academy) on

restoration and outreach opportunities. Credits for these activities will be provided as a part of the goal updates with future reports. Individual homeowner practices capture a small amount of runoff, however, implementation over a large scale will involve the implementation of numerous practices. For ease of reporting, the County plans to report these small practices over a regional or watershed scale. In this way, the aggregate acres treated by numerous discrete homeowner BMPs can be reported. The impervious area treated is based on 1 inch of treatment over the area reported. The County is continuing to work collaboratively with local partners to maintain records for individual practices and track and verify them over time in order to maintain credit toward Chesapeake Bay and local TMDL requirements.

F. Alternative Strategies

The County anticipates meeting the impervious area restoration goal through a combination of the strategies discussed above, and recognizes the need for adaptive management to meet the restoration goal. Adaptive management would include utilizing all available restoration opportunities and enhancing alternate strategies including, but not limited to, the possibility of County restoration grant program expansion, nutrient trading/offset mitigation, accounting for stormdrain and inlet cleaning equivalent impervious area managed, and identifying additional CIP projects with restoration potential or restoration components. These alternative strategies will help to close any identified “gap” as the restoration goal is tracked annually. The restoration goal tracking will be provided with each annual report and the strategies to meet the goal will be evaluated, and adjustments will be made if necessary.

Summary

The County is committed to improving water quality and meeting its MS4 permit requirements, using all available resources. Based on the strategies outlined above, adaptive management across all restoration project types and a strong commitment to BMP database clean-up, the County is confident it will be able to meet its impervious area restoration goal.

APPENDIX 1

ANNE ARUNDEL COUNTY RECREATION AND PARKS DEPARTMENT

INTEGRATED PEST MANAGEMENT PROGRAM

IPM PROGRAM PRACTICES AND NOTIFICATION PROCEDURES

IPM POLICY STATEMENT

Anne Arundel County Recreation and Parks (AACRP) is committed to providing parks with pest-free environments through the implementation of preventive methods and chemical strategies when necessary.

Beginning in 2013**,** AACRP adopted a pest prevention program known as Integrated Pest Management (IPM) for park grounds and athletic fields. The goal is to provide a safe and healthy recreational environment which is conducive to effective staff productivity, public enjoyment, and progressive resource conservation by managing pests and their environments while balancing costs and benefits with human health and environmental quality.

Since AACRP properties, facilities and programs are often contiguous physically, programmatically, geographically and operationally to Anne Arundel County Public School properties it was deemed imperative that there be a high degree of standardization, commonality and uniformity in pest management philosophy.

IPM PROGRAM OBJECTIVE

Pests and pesticides can pose significant problems and risks to people, property, and the environment. The incorporation of Integrated Pest Management (IPM) procedures for control of landscape pests will:

- Minimize the amount and toxicity of pesticides used in the park facilities;
- Eliminate unnecessary pesticide applications;
- Provide IPM education to the public, park users and park staff;
- Improve landscape and grounds cleanliness;
- Utilize only Licensed, Certified and Registered Technician pesticide applicators;
- Reduce or eliminate exposure of children, vulnerable adults, nursing mothers with infants and pets to pesticide applications;
- Provide universal public and staff notification.

IPM PROGRAM STRATEGIES

Pesticide Applications

AACRP may use pesticides after it is determined that non-toxic options are unreasonable or have been exhausted. The least hazardous pesticide is selected; the method and time of application is based on AACRP's goal to minimize the potential for exposure of park users and staff.

Pesticide applications made in or on park property are conducted by individuals licensed and certified as a pest control applicators or by a registered technician working under the supervision of a certified applicator.

Pesticide applications are made on park grounds only when:

- Weather and wind conditions (<5–10 mph) permit to prevent spray drifting;
- After normal school hours or summer dismissal for park/school conjoined properties;
- During staffed park scheduled closures, on weekends or after reviewing field use schedules.

Universal Notification

AACRP provides universal notifications in all parks, athletic facilities and managed natural areas as appropriate and includes specific information for the public at least twenty-four (24) hours in advance of the application.

Universal notification of planned pesticide spraying is accomplished through:

- The AACRP internet homepage re pesticide application schedules and pesticide product/safety information;
- Individual staffed park facility web sites re pesticide application schedules and pesticide product/safety information;
- Sign posting at all staffed parks, community parks and athletic facilities at least twenty four (24) hours in advance, allowing a 2 week application window, in addition to a rescheduling option in case of weather or circumstance difficulties, whenever a pesticide application is necessary;
- Forty eight hour posted Warning signage and closure of playground areas following pesticide application;
- Warning/closure of vehicular access to areas of community parks during applications;
- Restrict applications to public school conjoined-park properties to periods when children are not present.

Other supporting strategies:

- Inspection and monitoring of property for pests populations;
- Action thresholds to establish the point or the level of pest population at which pest control action will be taken;
- Sanitation and increased tidiness of park and athletic areas to prevent or minimize pest populations;

- Physical, cultural and mechanical controls as initial pest control techniques instead of pesticide applications;
- Biological controls as use of living organisms to control pests;
- Education of park staff and the public regarding potential park pest problems as well as how IPM policies and procedures will be used to achieve the desired pest management;
- Recordkeeping of pest surveys and pesticide use are maintained by Park Administration for 2 years to meet regulatory compliance;
- Material Safety Data Sheets (MSDS) and Product Labels are maintained by the Administration and pesticide applicators, warning information posted on notification signage and records are available for public review upon request;
- Pesticide Sensitive List ...Anne Arundel County residents registered on the Maryland Department of Agriculture Pesticide Sensitive List will receive written and oral notification of a scheduled pesticide application if the registered property abuts that of a park or athletic property that will be undergoing a pesticide application.
- Emergency Applications result in written universal notifications and postings issued within twenty-four (24) hours after the application or the next day.