August 2015

RESTORING OUR WATERSHEDS

Montgomery County's 2010-2015 MS4 Watershed Restoration Achievements

Supplement to the Montgomery County Annual Report
for FY14 NPDES Municipal Separate Storm Sewer System Permit

DEPARTMENT OF
ENVIRONMENTAL
PROTECTION

Working together for a cleaner, greener county.

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List of Acronyms

BI	Business Intelligence
BMP	Best Management Practice
CIP	Capital Improvement Program
CPv	Channel Protection Volume
DEP	Department of Environmental Protection (Montgomery County)
DOT	Department of Transportation (Montgomery County)
DPS	Department of Permitting Services (Montgomery County)
DGS	Department of General Services (Montgomery County)
DSWS	Division of Solid Waste Services (Montgomery County)
EPA	Environmental Protection Agency
ERU	Equivalent Residential Unit
ESD	Environmental Site Design
HB	House Bill
HOA	Homeowners Association
ICC	Intercounty Connector
MCPS	Montgomery County Public Schools
MDE	Maryland Department of the Environment
MEP	Maximum Extent Practicable
M-NCPPC	Maryland-National Capital Park and Planning Commission
MOU	Memorandum of Understanding
MPS	Microsoft Project Server
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
PM	Project Management
SHA	State Highway Administration
SOP	Standard Operating Procedure
SPA	Special Protection Area
SQL	Structured Query Language
TMDL	Total Maximum Daily Load
The County	Montgomery County
The Strategy	The Montgomery County Coordinated Implementation Strategy
USACE	U.S. Army Corps of Engineers
WLA	Wasteload Allocation
WMD	Watershed Management Division, DEP
WQPC	Water Quality Protection Charge
WQv	Water Quality Volume
WRE	Water Resources Engineering
WSSC	Washington Suburban Sanitary Commission

Executive Summary

Stormwater discharges from Montgomery County's storm drain system are regulated under a National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit. The purpose of this document is to be a final summary of Montgomery County's (the County) progress towards meeting the MS4 permit's watershed restoration requirement through the end of the third generation permit term on February 15, 2015. This document is a supplement to the fiscal year 2014 MS4 annual report. Montgomery County Department of Environmental Protection (DEP) has primary responsibility for the majority of the permit requirements, including watershed assessment and restoration managed by DEP's Watershed Management Division (WMD).

In addition to completing implementation of restoration efforts to fulfill the second generation MS4 permit restoration requirement, under the third generation MS4 permit the County was also tasked with restoring an additional 20% of impervious surface area that was not treated to the maximum extent practicable (MEP).

This restoration requirement translated to an additional 3,777 acres of impervious area restoration to be completed by the County. Progress towards meeting this requirement was achieved by tracking impervious acres treated by restoration projects, and impervious acre equivalent credit for alternative urban BMPs, as allowed by Maryland Department of the Environment (MDE). Alternative urban BMPs include practices such as street sweeping, stream restoration, and catch basin cleaning.

Progress Towards the Restoration Requirement

At the end of the third generation MS4 permit term (February 16, 2015), the County had completed restoration treating 1,726 acres of impervious area or its equivalent, with restoration work treating another 197 acres under construction (acres or projects referred to as "in-construction"). Restoration projects to treat an additional 2,431 acres were under contract for design (acres or projects referred to as "in-design"). The County's progress in relationship to the restoration requirement is illustrated in Figure 1.

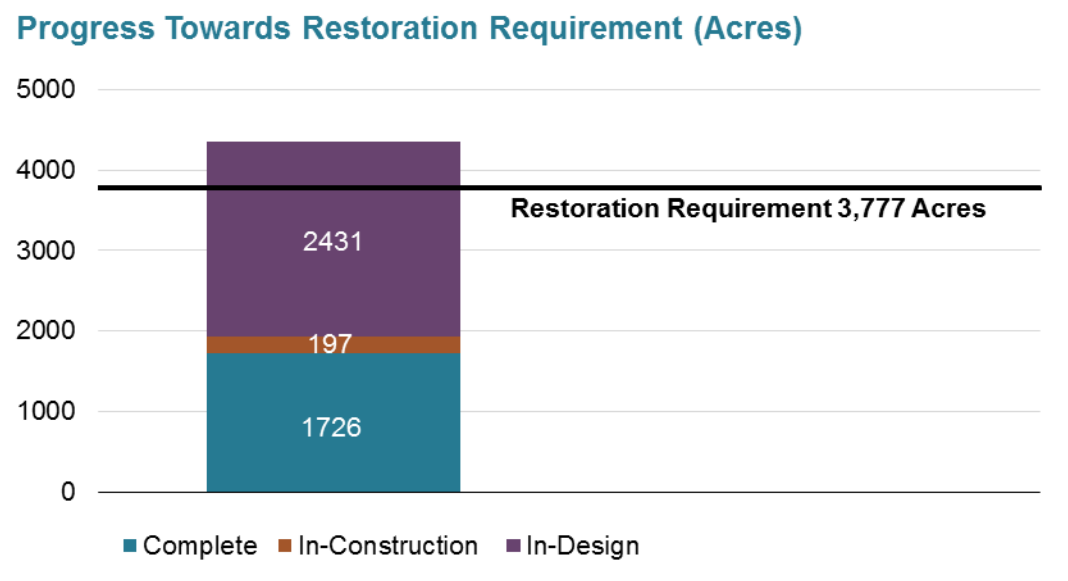


Figure 1 Montgomery County Progress towards the MS4 Permit Watershed Restoration Requirement

DEP's accomplishment of restoring 1,726 acres of impervious area or its equivalent represents completing 46% of the MS4 permit's restoration requirement. Once the in-construction projects are complete this percentage will increase to 51%. Of the projects in-design, 1,854 acres, representing 76% of the 2,431 acres in-design, will need to be realized in order to meet the 20% restoration requirement. The remaining projects will continue to be developed for the next generation MS4 Permit, or can serve as back up inventory for projects in design that may not be feasible to construct.

DEP's progress towards meeting the restoration requirement demonstrates the County's strong commitment to improving water quality and conservation of the environment. The restoration requirement of the third generation MS4 permit represented a significant increase over the second generation MS4 permit requirement. In response, DEP developed a proactive adaptive management approach to take on the intensive and diverse efforts needed for success. The following sections provide context and summarize the efforts undertaken by DEP to progress towards the restoration requirement.

MS4 Permit Background and Accelerating the Watershed Restoration Program

PERMIT BACKGROUND

The County has been subject to an MS4 permit since 1996. The first generation MS4 permit requirements (1996-2001) focused on assessing local watersheds, on identifying locations and extent of stormwater management and receiving stream problems, compiling an inventory of projects to address those problems, and stream physical and biological monitoring. The second generation permit (2001-2006, continued in effect until 2010 due to permit negotiations and legal challenges) included an impervious area restoration requirement to restore 10% of impervious areas not already treated to the MEP. The second generation permit also saw the addition of five municipalities and one special tax district as co-permittees. The third generation MS4 permit (2010-2015)[1] increased the restoration requirement to restore an additional 20% of the impervious areas not already treated to the MEP and added Montgomery County Public Schools (MCPS) as a co-permittee.

In order to comply with the MS4 permit requirements, DEP collaborates with numerous County agencies. These include the Division of Solid Waste Services (DSWS), Department of Permitting Services (DPS), Department of Transportation (DOT), Department of General Services (DGS), and MCPS. DEP also has an established Memorandum of Understanding (MOU) with DGS and is finalizing an MOU with MCPS to increase opportunities for watershed restoration.

STRATEGY DOCUMENTS

DEP had a well-established watershed restoration program in place prior to the third permit cycle; however, the third generation MS4 permit required expansion and acceleration of that existing program. To address the new requirements, the County developed the Implementation Plan Guidance Document that detailed the recommended methods and techniques for preparing individual watershed implementation plans and documented the best available science underlying the technical assumptions used in developing the plans to allow the County

[1] Although it officially expired on February 15, 2015, the permit is administratively continued pending final action, if any, by MDE in response to a decision by the Maryland Court of Special Appeals in Maryland Department of the Environment, et al. v. Anacostia Riverkeeper, et al. to remand the permit to MDE for further proceedings.

to make cost-effective implementation decisions and achieve MDE regulatory approval. The Implementation Plan Guidance Document also prompted the refinement of a BMP coding process, the MS4 permit area, and impervious cover subject to the MS4 permit.

Following the Guidance, watershed implementation plans were developed for most of the County's watersheds where a full range of restoration opportunities were identified and quantified in terms of planning level implementation cost and anticipated pollutant load reduction potential.

DEP then developed the Montgomery County Coordinated Implementation Strategy (the Strategy) in June 2009 that considered implementation across all of the watersheds in an integrated and phased manner. The Strategy laid out a framework for meeting the watershed restoration requirements, Chesapeake Bay Total Maximum Daily Load (TMDL) restoration goals, and setting cost-effective approaches which reflected direct stakeholder input. Finally, the Strategy facilitated project identification and implementation planning by setting priorities among potential projects.

BUDGET, CAPACITY, AND FUNDING

Implementation of the plan laid out in the Strategy required an increased Capital Improvement Program (CIP) budget for funding watershed restoration projects. From 2009 to the latest CIP budget passed for FY15-20, the amount of funding for the watershed restoration program has increased by a factor of ten (Figure 2).

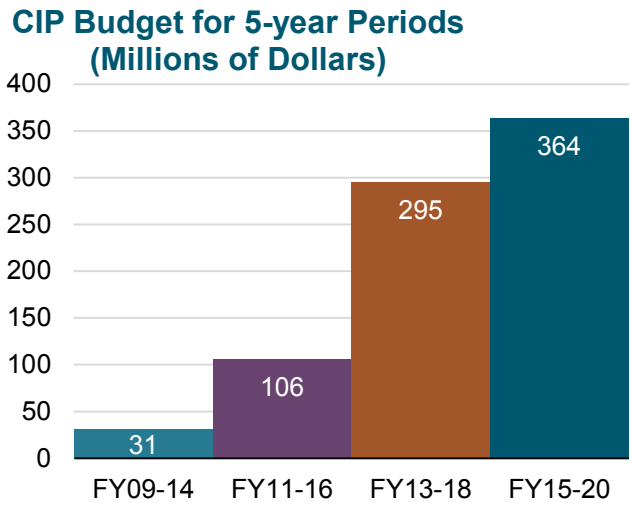


Figure 2 Capital Improvement Program Budgets

The budget increases translated to a direct increase in number of Water Resources Engineering (WRE) vendors and tasks orders issued for design of restoration projects. In addition, DEP also augmented its project management capacity via a consultant contract coupled with doubling internal staff capacity.

The main funding mechanism for the CIP is the Water Quality Protection Charge (WQPC), which went into effect in 2002 and is included as part of the Montgomery County property tax bill. In 2011, the County issued bonds secured by the WQPC to finance the construction and related expenses of watershed restoration projects as approved in the CIP. The issuance of the bonds allowed the capital costs of complying with the increased restoration requirement to be spread over the lifetime of the bonds (and the useful life of the facilities).

Data Management and the Restoration Requirement

DATA MANAGEMENT

The increased restoration requirement of the third generation MS4 permit and increased level of effort to implement watershed restoration projects created a critical need for enhanced data management. In response, DEP has undertaken numerous data management initiatives to specifically support meeting the additional 20% watershed restoration requirement. These efforts include starting a SharePoint site, using Microsoft Project Server (MPS), developing a Business Intelligence System and Dashboard, maintaining and updating the Restoration Sites

Database and developing a new structured query language (SQL database), improving and updating the storm drain layer, and streamlining the drainage areas delineation process.

The County MS4 permit SharePoint site facilitates file hosting and sharing between DEP, project management contractors, WRE contractors, and construction contractors. The SharePoint currently stores content such as task orders, schedules, plans, budgets, designs and reports creating a single repository for restoration project documents. In 2012, DEP began implementing an MPS to monitor CIP project schedule performance. The MPS provides projections of when projects will be ready for construction and completion. Information from the MPS is linked with the Business Intelligence (BI) system and Dashboard. The BI system is designed to analyze data from multiple tables and databases relating to the County's MS4 program to measure and report on specific programmatic performance metrics. The BI system reports six metrics specific to the restoration program including: schedule performance, impervious area restoration progress, program costs, and construction cost estimation accuracy. The metric reports generated by the BI system are easily accessed through an internet-based dashboard interface (the Dashboard).

The Dashboard provides DEP staff and project managers with up-to-date insight into the restoration program's progress towards meeting the 20% restoration requirement (Figure 3). The BI system and the Dashboard have played an important role in continuing adaptive management of the program. The Dashboard can be used to quickly find inefficiencies and identify problems early, serving as a platform for open communication and resource management. Enhanced capabilities are also currently under development by DEP to allow for resource modeling and restoration scenario evaluation using the Dashboard.

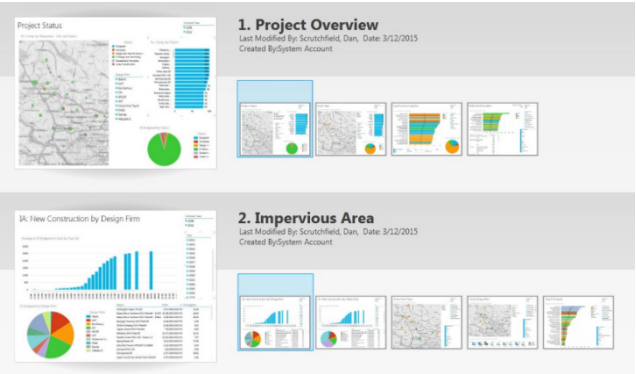


Figure 3 Planning and Compliance Dashboard Screen

DEP also maintains an ESRI ArcGIS Restoration Sites Database that tracks all potential restoration opportunities. In addition to the Restoration Sites Database, the County initiated efforts to create a new SQL database in response to increasing reporting needs and anticipated future permit needs. The purpose of developing the new SQL database is to increase capacity, function, stability and quality of the existing data and improve data organization. The new SQL database represents a significant effort in improving data functionality intended to contribute to the success of the restoration program.

Data management has also involved processing data for storm drain mapping and drainage area delineations. Mapping storm drains is a challenge due to data inconsistency; however, in 2014, DOT began coordinating a large effort to make extensive improvements to the County's storm drain data and to aggregate all the disparate datasets in one central location. DEP maintains open lines of communication with DOT on this effort. On-going construction of new storm drain systems and BMPs requires drainage area delineations to be constantly updated. During the third generation MS4 permit, DEP increased its efforts to delineate drainage areas for newly inventoried BMPs and to perform data quality assurance and control for existing drainage delineations. The number of existing BMP recorded and drainage areas delineated more than doubled from 2011 to 2015.

RESTORATION REQUIREMENT

Determination of the third generation MS4 permit restoration requirement (to restore an additional 20% of uncontrolled impervious areas as of 2009) required the calculation of the impervious cover controlled to the MEP at the end of 2009. As improved information on the area of impervious cover controlled to the MEP became available through new data and more advanced analysis, DEP worked to define the acres represented by the restoration requirement to reflect the most accurate information.

Efforts by DEP to improve the accuracy of the restoration requirement include updating BMP drainage area delineations, verifying existing facilities, incorporating existing roadside swales, and crediting large lot disconnections. Table 1 below illustrates the restoration requirement calculation highlighting how the accuracy of determining the County MS4 impervious area controlled to MEP in 2009 was improved since the Strategy. The restoration requirement of 3,777 acres is 20% of 18,884 acres, which is the County MS4 impervious area under or uncontrolled as of 2009.

Table 1 Restoration Requirement Calculation

	Description	Area (acres)
A.	**Impervious Area Subject to Third Generation MS4 Permit**	**25,119**
B.	**County MS4 Impervious Area Controlled to MEP in 2009**	
	Per The Strategy (2009)	3,661.0
	Updated BMP Tracking and Drainage Area Delineations	691.2
	MEP Verification of Existing Facilities	1,597.3
	Incorporating Existing Roadside Swales	278.3
	Crediting Disconnected Large Lots	7.4
	TOTAL	**6,235.2**
C.	**County MS4 Impervious Area Under/Uncontrolled (2015 Revision) (A-B)**	**18,884**
	Restoration Requirement (2015 Revision) (20% of C)	**3,777***

**See Section C.ii. for comparison of final restoration requirement and original estimate in the Strategy*

Restoration Projects and Accounting for Credit

The County pursued watershed restoration through six unique delivery methods to make progress towards meeting the third generation restoration requirement of 3,777 acres. These methods included CIP projects, RainScapes and Water Quality Protection Charge (WQPC) Credits, complementary restoration projects, management programs, new development and redevelopment, and agency partnerships. The relative contribution of each delivery method is illustrated in Figure 4. The CIP projects form the foundation of the County's restoration program, contributing 70% of the 4,354 acres of imperious credit either completed, in-construction or in-design.

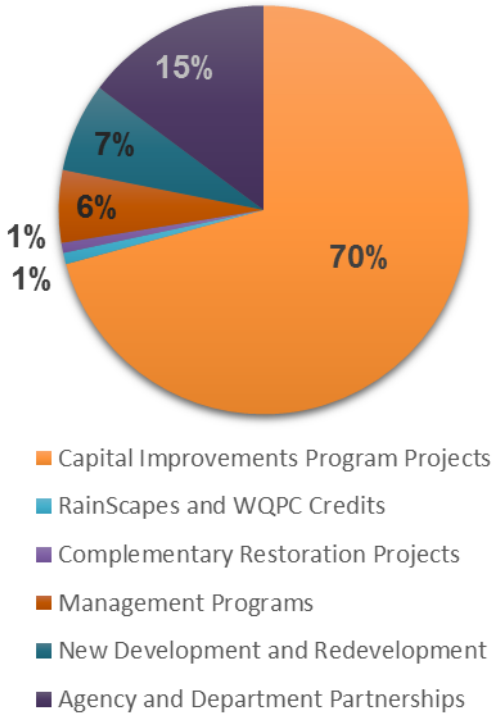


Figure 4 Relative Contribution of Total Impervious Area Credits by Delivery Method

DEP has taken a watershed-based approach to applying green infrastructure at many scales across the County. The U.S. EPA describes green infrastructure as using "*vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water*." (U.S. EPA, 2015)

Most County restoration projects fall within the realm of green infrastructure, as described by EPA. Stream restoration, reforestation and impervious cover removal contribute to the County's network of green corridors and patches that provide habitat, filter pollutants and absorb stormwater runoff. Even stormwater pond retrofits help to improve water quality and enhance habitat.

In addition to its more traditional, larger-scale restoration and retrofit projects, the County has worked to progressively increase its implementation of green infrastructure at the neighborhood and site scale. Environmental Site Design (ESD) practices have been and will continue to be implemented on public and private properties countywide through a variety of delivery methods.

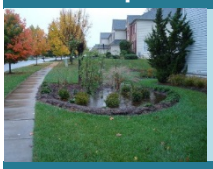
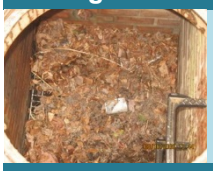
Within the CIP, Green Streets and Government Facilities and Schools focus on implementation of ESD practices along roads and on publicly owned lands. These ESD practices account for 148 acres of the total CIP impervious area credits. RainScapes and WQPC Credits both incentivize installation of ESD practices on residential, institutional, and commercial properties. These programs have contributed 38.8 acres of impervious area credits. Finally, ESD practices that contribute 68.7 acres of impervious area credits have been or are being implemented through Agency Partnerships. The 256 acres treated by ESD practices may comprise only 6% of the 4,354 acres of imperious area credits the County achieved during this permit cycle, but they represent a commitment by DEP to increase ESD implementation in the future.

Impervious area equivalent credits were calculated in accordance with the MDE 2011 Draft Guidance Document, the MDE 2014 Final Guidance Document, and the Maryland Stormwater Design Manual as applicable for each delivery method and project type. Impervious area

equivalent credit for individual trees and conservation landscaping is based on a technical memo developed by the Center for Watershed Protection.

Table 2 provides a summary of impervious acre credits by delivery method and applicable subcategory and also shows a breakdown of complete, in-construction, and in-design acres. The following sections briefly describe the delivery methods.

Table 2 Summary of Impervious Acre Credits by Delivery Method and Status

		Complete	In-Construction	In-Design	Total
Capital Improvement Projects		**663.6**	**152.2**	**2268.8**	**3084.6**
	Stream Restoration	88.7	57.5	510.2	**656.4**
	Green Streets	19.1	0.6	91	**110.7**
	Government Facilities	3.2		34.1	**37.3**
	Stormwater Retrofits	552.6	94.1	1633.5	**2280.2**
RainScapes and WQPC Credits		**38.8**			**38.8**
	RainScapes	15.8			**15.8**
	WQPC	23.0			**23.0**
Complementary		**6.1**	**19.7**	**8.5**	**34.3**
	Reforestation	6.0	19.7	8.5	**34.2**
	Impervious Surface Removal	0.1	0.03		**0.1**
Management Programs		**248.6**			**248.6**
	Street Sweeping	162.6			**162.6**
	Catch Basin Cleaning	86.0			**86.0**
New Development and Redevelopment		**305.2**			**305.2**
	MCPS	12.8			
	M-NCPPC	3.3			
	Private	53.4			
	New BMPs Treating Existing Impervious	235.7			
Agency Partnerships		**463.5**	**25.5**	**153.3**	**642.3**
	ICC	252.7	16.9	58.8	**328.4**
	WSSC	23.2	8.6	94.5	**126.3**
	DGS	0.9			**0.9**
	MCPS	0.7			**0.7**
	DOT	50.0			**50.0**
	USACE	136.0			**136.0**
Total		**1725.8**	**197.4**	**2430.6**	**4353.8**

CAPITAL IMPROVEMENT PROGRAM PROJECTS

There are four types of projects undertaken by DEP through the CIP including stream restoration, green streets, projects at government facilities and County schools, and stormwater retrofits. CIP projects require the largest investment of financial and other resources in comparison to other delivery methods.

Stream restoration involves the rehabilitation of degraded stream channels and is considered green infrastructure. Restoration is intended to reduce streambank erosion and sedimentation, enhance riparian and in-stream habitat conditions, and improve water quality conditions.

Green Streets projects consist of designing and constructing ESD stormwater treatment facilities within existing street rights-of-way and is another green infrastructure method. These projects capture stormwater runoff in neighborhoods with minimal existing stormwater controls and install a combination of rain gardens, swales, permeable pavement, curb extensions with bioretention areas, and tree boxes.

Government Facility and County School projects improve stormwater management and treatment on properties owned by the County government and Montgomery County Public Schools (MCPS) by retrofitting sites with new ESD facilities.

Stormwater retrofits involve upgrading outdated stormwater infrastructure to meet accepted current standards. Third generation MS4 permit retrofit projects focused on stormwater ponds since they are the oldest type of stormwater infrastructure and have the greatest potential for water quality improvements and impervious area treatment.

One important factor contributing to the significant number of acres still in-design is that CIP projects were programmed in the approved FY13-18 budget assuming design and permitting occurring within a 15-month period and construction occurring immediately after final design. As implementation progressed, it became evident that the 15-month design and permitting phase was a challenge with the project design and permitting taking from 18 months for small, simple projects to up to three years or more for larger and more complicated projects. In response, DEP decided on a strategy to issue task orders to design all work necessary to meet the permit requirements before the end of the permit term. This strategy demonstrates DEP's commitment to adaptive management and meeting the restoration requirement.

RAINSCAPES AND WQPC CREDITS

The "RainScapes and WQPC Credits" delivery method is an important component of the watershed restoration program because individual residents, property owners, and community groups become engaged in helping support the County stormwater efforts.

Figure 5 RainScapes Project

DEP's RainScapes program promotes environmentally friendly landscaping and small scale stormwater control and infiltration projects on residential, institutional, and commercial properties by offering technical and financial assistance to property owners (Figure 5). Through RainScapes Rewards, RainScapes Neighborhoods, and RainScapes for Schools, the program has supported implementation of rain gardens, tree plantings, permeable pavement retrofits, dry wells, water harvesting with rain barrels and cisterns, and conservation landscaping.

Impervious area restoration from WQPC credits represent impervious areas treated by stormwater management practices located on private property, not already credited through RainScapes. DEP is made aware of, and is able to track credit for, these stormwater management practices through the property owners' application to receive a WQPC credit reducing the WQPC amount the property owner is required to pay.

COMPLEMENTARY RESTORATION PROGRAMS

Complementary restoration projects include reforestation and impervious surface removal usually completed in combination with larger retrofit or restoration projects in their vicinity. These projects demonstrate the County's commitment to treat additional impervious areas even at small scales as the opportunities present themselves.

Reforestation projects establish the next generation of native trees and understory (smaller trees and shrubs), helping improve the environment and improving stormwater management. Impervious surface removal projects address underutilized impervious surfaces replacing them with pervious surfaces or incorporating them into a new ESD practice.

MANAGEMENT PROGRAMS

Street sweeping and catch basin cleaning are two road maintenance management programs overseen by DOT and DEP that contribute to watershed restoration. Street sweeping removes debris and abrasives from road surfaces, helping to keep drainage systems clean and preventing pollutants from entering the waterways (Figure 6). Catch basins, located along the curb line to allow stormwater to enter the storm drain system, need to be cleaned to remove sediment, debris, and trash. Through these programs 623 tons of debris was collected during FY14.

Figure 6 Street Sweeping

NEW DEVELOPMENT AND REDEVELOPMENT

Throughout the course of the third generation MS4 permit, many areas of impervious cover that were not controlled to the MEP at the end of 2009 have become controlled to the MEP as a result of new development and redevelopment activities. The new development and redevelopment delivery method accounts for these newly controlled areas. DEP carried out four desktop analyses to determine the impervious area that received treatment as a result of new development and redevelopment in four categories including MCPS redevelopment, M-NCPPC property acquisition, private redevelopment, and newly added BMPs.

AGENCY PARTNERSHIPS

DEP actively seeks opportunities to partner with other agencies and departments responsible for completing construction projects throughout the County to optimize watershed restoration. During the third generation MS4 permit, DEP established six specific partnerships that have resulted in significant contributions towards meeting the restoration requirement.

These partnerships include the Maryland State Highway Authority Intercounty Connector, through which 40 restoration projects including stream restorations, green streets and stormwater retrofits were funded and constructed. Partnering with the Washington Suburban Sanitary Commission (WSSC), DEP tracks credits from stream restoration projects throughout the county undertaken by WSSC to improve the sewer infrastructure. DEP works with DGS on County-managed properties undergoing development or redevelopment by DGS to fund some aspects of the construction effort to provide water quality treatment for impervious area in addition to what is required by the new construction on the site. In addition to the MCPS CIP projects, DEP partners with MCPS on MCPS construction projects to contribute funds to pay for the stormwater facilities outside of the project area. In addition to the CIP-funded green streets, DEP collaborated with and supported funding for DOT-led green streets projects and worked with DOT to prioritize outfall stabilizations throughout the County. DEP also partnered with the U.S. Army Corps of Engineers (USACE) in the management/restoration of the Anacostia River watershed, tracking credits from stream restoration projects.

PUBLIC OUTREACH

As the number of watershed restoration projects increased, so did the need for public outreach. Whether they are small scale rain gardens or large scale stream restoration projects, DEP proactively communicates its restoration project intentions to stakeholders and nearby residents throughout the process. On average, throughout a project's design, construction, and completion, six public meetings are held which may include an open forum style meeting with a presentation, a site walk, or attending and presenting at a Homeowners Association Board meeting. DEP developed a watershed restoration outreach standard operating procedure (SOP) to provide staff guidance and consistency on how to effectively reach out to the public. DEP has also developed a public outreach database that tracks outreach efforts for the watershed restoration program as well as outreach supporting other third generation MS4 permit requirements.

The number of public outreach meetings saw a five-fold increase from FY2011 to FY2014 with the total number of people reached through attending meetings increasing four-fold from 200 to over 800. In the future, as restoration projects shift increasingly towards small-scale ESD practices, public outreach efforts will continue to increase as smaller scale practices are more integrated into neighborhoods, have more potential impact on nearby residents, and therefore require increased coordination with the public to produce a project that is accepted by the communities.

Lessons Learned and Next Steps

The additional 20% restoration requirement of the third generation MS4 permit resulted in remarkable growth of DEP's watershed restoration program. The lasting impact of this growth will continue to improve water quality and benefit the environment into the future as lessons learned allow DEP to more efficiently and effectively restore the County's watersheds.

During the third generation MS4 permit term, several of DEP's restoration projects received awards and several grants (Figure 7).

Completing more restoration at a faster rate required increased funding. DEP received the necessary financial support from an increased CIP budget made possible by the County's forward-thinking approach to financing through issuing WQPC bonds. Capacity building was also necessary; so, in addition to increasing internal staff, DEP retained consultants to support the restoration program and to facilitate project progress.

DEP also created improved efficiency within the restoration program by expanding its data management efforts. DEP recognizes the value of investing in on-going data management. Improved knowledge of project performance and programmatic progress leads to better decision making and better restoration outcomes. DEP continues to prioritize improved data management as a critical component of the restoration program and DEP's adaptive management strategy.

Select Program Honors

Awards

- *Stoney Creek Stormwater Management Pond at National Institute of Health*
  National Recreation Award April 2014
  American Council of Engineering Companies (ACEC) Engineering Excellence Awards Competition
  Engineering Excellence Honor Award in Design 2013-2014
  ACEC of Metropolitan Washington
- *Arcola Avenue Green Street Project*
  Achievement Award Winner 2012
  National Association of Counties

Grants

- Department of Natural Resources Chesapeake and Atlantic Coastal Bays Trust Fund
- National Fish and Wildlife Foundation Grant
  Smart integrated stormwater management system demonstration partnership with Washington Council of Governments

Figure 7 DEP Restoration Project Awards and Grants

DEP learned that each restoration delivery method is valuable and poses unique challenges requiring creative solutions. Permitting and public outreach remain the primary drivers of the duration of the design and permitting phase of CIP projects. Smaller-scale implementation will continue to expand as the direct contact with County residents and property owners is extremely valuable in building support for DEP's work. Leveraging partnerships will also continue to be a focus as these efforts proved mutually beneficial in meeting partners' objectives, reducing DEP's costs, and speeding project delivery. Reflecting back, DEP found that project delivery timeframes, on the order of years, were challenged by the restoration requirement timeframe of the five-year permit cycle. This was particularly true for the third generation MS4 permit term where early-phase permit activity required planning and strategic program development prior to project design, permitting, and construction.

The importance of communication with stakeholders and public outreach was magnified during the implementation of restoration projects. DEP greatly values stakeholder input and recognizes that effective communication results in overall improved project outcomes.

Through adaptive management across all project types, DEP is committed to continued improvement of its watershed restoration program to generate efficiencies, develop stakeholder support, and speed project delivery.

A. Introduction

Stormwater discharges from Montgomery County's storm drain system are regulated under a National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit. Under Part IV of the MS4 permit, Montgomery County (the County) Department of Environmental Protection (DEP) is required to submit annual reports to Maryland Department of the Environment (MDE). DEP reports progress towards meeting permit requirements on a fiscal year (FY) basis, from July 1 to June 30 of the following year. On March 13, 2015, DEP submitted the FY14 annual report documenting progress through July 1, 2014. However, the County's third generation MS4 permit term continued until February 15, 2015, leaving seven months of progress unreported. DEP is submitting the following report as the final summary of progress made towards meeting the watershed restoration requirements for the entire third generation MS4 permit term extending from February 16, 2010 through February 15, 2015. DEP has primary responsibility for the majority of the permit requirements, including watershed assessment and restoration.

A.i. Background

The third generation MS4 permit issued to the County, effective February 16, 2010, included a new requirement for watershed restoration. Part III. G. 2, required that, by the end of the MS4 permit term, the County restore an additional twenty percent (20%) of the County's impervious surface area that was not treated to the maximum extent practicable (MEP). Montgomery County is the first county in Maryland to be tasked with a 20% restoration requirement and also the only county in Maryland required to complete the implementation of those restoration efforts that were identified and initiated during the second generation MS4 permit term to restore 10% of the County's impervious surface area. This responsibility presented DEP with the opportunity to develop a large-scale program whose successes have direct benefits both to the environment and other MS4 permit holders who may also face such a requirement.

Faced with an expanded restoration requirement, DEP developed a proactive adaptive management approach. By first completing The Montgomery County Coordinated Implementation Strategy (the Strategy), DEP established a blueprint for meeting the new restoration requirement and laid out a plan for clean water into the future. The larger restoration requirement meant more intensive and more diverse efforts would be needed for success.

This report documents DEP's efforts towards meeting the third generation MS4 permit restoration requirement. Sections B records the process of expanding the restoration program, and Section C summarizes the data management approach and establishment of the restoration requirement. Section D details the status of progress towards meeting the restoration requirement and also describes the implementation strategy for each type of restoration project and includes representative case studies of successful restoration projects. Section E concludes with a summary of improvements and next steps.

A.ii. Evolution of Montgomery County's Restoration Requirement

Montgomery County has been subject to an MS4 permit since the issuance of the first generation MS4 permit in 1996. Table A.1 summarizes the significant components and changes for each permit cycle from the first generation to the third.

Table A.1 Summary of Montgomery County's Permit Requirements

Montgomery County's First Generation MS4 Permit, 1996-2001
Requirements: Set up electronic, geographically referenced databases for storm drains, stormwater best management practices, and other layers of source identification information. The focus was on assessing local watersheds, on identifying locations and extent of stormwater management and receiving stream problems, and compiling an inventory of projects to address those problems. In addition, since the County was the last of the large jurisdictions to successfully complete its application process, the first permit included additional requirements for stream physical and biological monitoring as well as water chemistry monitoring to characterize stormwater runoff. As a result, Montgomery County was the first local jurisdiction to select locations for discharge characterization that could be directly used for evaluating the effectiveness of stormwater retrofits. **Results:** Watershed restoration studies completed for about 40% of the County's total acreage and for the majority of its developed areas. Implemented projects included 26 stormwater retrofit projects covering 4,444 drainage acres and 51 restoration projects on 29.2 miles of impaired streams.
Montgomery County's Second Generation MS4 Permit, 2001-2006 ***continued in effect until 2010, due to permit negotiations and legal challenges***
New Requirements: Six minimum control measures including public education and outreach, public participation and involvement, illicit discharge detection and elimination, construction site and post-construction runoff control, and pollution prevention/good housekeeping. In addition, a specific requirement for watershed restoration and runoff management was added, termed the 10% restoration requirement, for a drainage area or combination of drainage areas equaling 10% of Montgomery County's impervious area that has not been treated to the MEP. Also required monitoring to evaluate the effectiveness of the State's stormwater design criteria for stream channel protection. **Changes:** Five municipalities including the Towns of Chevy Chase, Chevy Chase Village, Kensington, Somerset, and Poolesville, and one special tax district, the Village of Friendship Heights were added as co-permittees. **Results:** Restoration requirement of 2,146 impervious acres representing 10% of Montgomery County's untreated impervious area was met. Initiated the Water Quality Protection Charge (WQPC) as a line item on residential and certain nonresidential property owner tax bills.
Montgomery County's Third Generation MS4 Permit, 2010-2015[2]
New Requirements: Complete the restoration in a watershed or combination of watersheds to restore an additional 20% of the County's impervious surface area that is not treated to the MEP. Also develop, within 12 months of permit issuance, a comprehensive implementation strategy with timelines, public outreach work plan, and estimated costs for projects and programs to meet restoration requirements and local and regional pollutant reduction requirements. **Changes:** MCPS was added as a co-permittee. **Results:** Montgomery County Coordinated Implementation Strategy submitted to MDE in February 2011 and finalized by MDE July 2012. Financial commitment in Capital Improvement Program increased more than tenfold. Completed restoration of 1,726 acres of impervious with another 2,628 acres in-design or in-construction.

[2] Although it officially expired on February 15, 2015, the permit is administratively continued pending final action, if any, by MDE in response to a decision by the Maryland Court of Special Appeals in Maryland Department of the Environment, et al. v. Anacostia Riverkeeper, et al. to remand the permit to MDE for further proceedings.

The second generation MS4 permit restoration requirement of treating 10% of impervious areas not controlled to the MEP represented 2,146 impervious acres. The third generation MS4 permit restoration requirement of treating an additional 20% of impervious areas not controlled to the MEP represents an increased number of 3,777 impervious acres. Table A.2 illustrates the restoration requirement in the context of impervious area within the County MS4 area.

Table A.2 Restoration Requirement Context

Description of Area	Area (Acres)
Total County Area	324,552
County Area Subject to MS4 Permit*	138,649
Impervious Cover Subject to MS4 Permit	25,119
Under or Uncontrolled Impervious Area**	18,884
Restoration Requirement	3,777

**Exclusions include: Certain zoning codes, parklands, forests, municipalities with own stormwater management programs, state and federal properties, and state and federal maintained roads*
***Impervious areas that do not meet MEP standard*

A.II.1 COUNTY AGENCIES AND COLLABORATIONS

The Montgomery County watershed restoration program is run by DEP's Watershed Management Division (WMD). There are several other County agencies that carry out functions required by the MS4 permit that complement the efforts of the watershed restoration program. These include DEP's Division of Solid Waste Services (DSWS) responsible for all solid waste related programs, including programs to reduce litter and increase awareness of waste reduction and recycling. Department of Permitting Services (DPS) is responsible for reviewing and permitting plans for stormwater management and erosion and sediment control, and for ensuring plan compliance. Department of Transportation (DOT) is responsible for storm drains, road, and right of way maintenance. Department of General Services, (DGS), DEP DSWS, and DOT are responsible for property maintenance activities at County-owned facilities covered under the National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Industrial Facilities.

In addition to working with County agencies with operations subject to other permit requirements, DEP actively collaborates with County agencies to specifically optimize watershed restoration efforts. Formal collaborations have been established through two Memorandums of Understanding (MOUs). A MOU between DEP and DGS was established in March 2013 regarding the design and implementation of stormwater/Environmental Site Design (ESD) opportunities on County managed properties. The MOU outlines a process for stormwater/ESD projects initiated by DGS to treat off-site uncontrolled impervious area with funding from the stormwater retrofit Capital Improvement Program (CIP). DEP is also currently working with Montgomery County Public Schools (MCPS), a co-permittee, to finalize a MOU to design and implement ESD retrofit opportunities on MCPS property. The MOU outlines a process for ESD projects initiated by DEP and/or MCPS to treat uncontrolled impervious area. In order to maintain strong collaboration, DEP schedules regular meetings with MCPS representatives regarding ongoing actives and future projects.

A.II.2 WATERSHED MANAGEMENT AND GREEN INFRASTRUCTURE SUPPORT

The third generation MS4 permit restoration requirement was an opportunity for Montgomery County to manifest its broader commitment to environmental stewardship and conservation through natural area protection. The County has approached the watershed restoration requirement as an opportunity to think carefully and broadly about the County's approach to development, green infrastructure, and watershed protection. The Strategy, developed to guide the County toward meeting the restoration requirement, rests on two guiding principles: watershed management and green infrastructure support.

The watershed approach is manifested by the comprehensive planning included in the earliest stages of compliance planning. Instead of first seeking opportunities for maximum credits at the lowest cost, DEP assessed its major watersheds and prioritized projects not only for credits and cost, but also for their potential to contribute to the overall health of the watershed.

The green infrastructure support is manifested by the County's commitment to regenerative alternatives to conventional recreational and grey infrastructure (pipes/utilities, structures, facilities, etc.). In addition to small-scale stormwater management facilities commonly recognized as green infrastructure, such as ESD facilities, the County's watershed restoration efforts include numerous projects that demonstrate a broader conception of the term green infrastructure that, in accordance with the U.S. Environmental Protection Agency (EPA), defines green infrastructure as using natural hydrologic features to manage water and provide environmental and community benefits (EPA 2014). Through the diversity of the watershed restoration projects completed and in progress, the County is creating green infrastructure systems that not only address water quality but also provide habitat and enhance the quality of life for its residents. DEP is committed to green infrastructure and is continually working on ways to increase green infrastructure implementation.

B. Accelerating Montgomery County's Watershed Restoration Program

Restoration has both immediate and long-lasting benefits, such as reducing and preventing environmental degradation, and it is therefore at the heart of the County's MS4 program. Over 20 years, DEP's efforts to streamline and enhance its restoration work have resulted in the program that is in place today.

While DEP had a well-established watershed restoration program in place prior to the third permit cycle, the third generation MS4 permit required significant acceleration of that already existing program. This section documents the buildup of the watershed restoration program.

Many changes have taken place within DEP WMD in anticipation and during implementation of the third generation MS4 permit in order to support the increased watershed restoration requirement. Figure B-1 below highlights important milestones representing the acceleration of the restoration program.

Figure B-1 Restoration Program Development Milestones 2010-2012

B.i. The Montgomery County Coordinated Implementation Strategy

In September 2008, MDE published a Tentative Determination for the Montgomery County third generation MS4 permit. This Tentative Determination included a requirement to submit within one year after permit issuance an implementation plan to meet permit requirements. In recognition of the large task ahead, DEP began work on the Strategy in June 2009, eight months prior to the Final Determination of its third generation MS4 permit. Developing the Strategy required assembling and analyzing available data and then generating estimates of impervious area treated and costs of projects. The process for developing the Strategy also included opportunities for public input that factored into the schedule for completion.

The Strategy reflects accelerated progress in adding stormwater management to already developed areas, stream restoration as a primary practice, and documenting progress in meeting water quality standards. The Strategy includes projects already identified through the previously existing watershed assessments conducted under past MS4 permits along with estimated additional retrofit and restoration projects based on land uses and past project experience. Past experience and associated data was also used to set priorities, timelines and estimate costs for implementing restoration and water quality improvement across the County.

Implementation priorities focused on local watersheds with well-defined inventories where the most progress would be achieved toward meeting the restoration requirement while still supporting a comprehensive watershed approach. Nonstructural (e.g. outreach) best management practices (BMPs) were included to address those impairments (bacteria and trash) where behavior change was shown to be the most cost-effective approach for reducing associated pollutants. Pollutant reductions were assigned based on literature values by type of facility and then estimated for each watershed using GIS results and the Watershed Treatment

Model. The Watershed Treatment Model considers multiple factors including land use, imperviousness, and type and coverage by BMP for determining pollutants from uncontrolled runoff. Initial model results are then compared to results of scenarios simulating controlled runoff after addition of various methods of stormwater management.

Chesapeake Bay TMDL

The Chesapeake Bay TMDL restoration goals, established by EPA, set pollution limits for nitrogen and phosphorous in the Chesapeake Bay Watershed. All actions towards meeting MS4 permit requirements are also driven by the Chesapeake Bay TMDL.

The Strategy presented a framework for meeting many MS4 permit requirements, Chesapeake Bay Total Maximum Daily Load (TMDL) restoration goals, and setting cost-effective approaches which reflected direct stakeholder input. There were seven specific priorities considered while developing the Strategy as shown in Figure B-2.

Seven Priorities Guiding Development of the Strategy

1. Provide stormwater runoff management on impervious acres equal to 20% of the impervious area for which runoff is not currently managed to the MEP as well as complete 10% impervious area restoration requirement of second generation MS4 permit.
2. Meet Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) approved by EPA.
3. Make progress toward pollutant reductions that will help meet the State of Maryland's Bay TMDL requirements for 2017 and 2020.
4. Meet commitments in the Trash Free Potomac Watershed Initiative 2006 Action Agreement.
5. Educate and involve residents, businesses, and stakeholder groups in achieving measurable water quality improvements.
6. Establish a tracking framework to be used for annual reporting to meet the County's NPDES MS4 Permit.
7. Identify necessary organizational infrastructure changes needed for successful implementation.

Figure B-2 Priorities that Guided Development of the Strategy

B.I.1 EARLY DIRECTION

Prior to beginning data analysis and modeling for the Strategy, DEP developed an Implementation Plan Guidance Document to plan the priority watershed analyses for the early years of the permit. The Implementation Plan Guidance Document provides the best estimates of reductions in runoff, pollutant loads, and the number of impervious acres treated by cost-effective practices.

There were three specific objectives for the Implementation Plan Guidance Document:

1. Detail the recommended approaches, methods, and techniques used in preparing individual watershed-based implementation plans for the County;
2. Meet the following MS4 Permit requirements:
    a. Watershed restoration via runoff management;
    b. Targeted wasteload allocations for EPA-approved Total Maximum Daily Loads (TMDLs);
    c. Trash and litter management for a trash-free Potomac;
3. Document the best available science underlying the technical assumptions used in developing the plans to allow the County to make cost-effective implementation decisions and achieve MDE regulatory approval.

Crediting BMPs towards Controlling Impervious Cover Treated Coding

The first key element in meeting the objectives of the Implementation Plan Guidance Document was developing a BMP coding and crediting system. Prepared as part of the Implementation Plan Guidance Document in 2010, the BMP classification system was developed based on performance rated by runoff reduction and pollutant removal. Five performance levels from Code 0 to Code 4 were established as shown in Table B.1. These codes were assigned based on literature review. The literature review is available in Table B.19 of Appendix B of the Implementation Plan Guidance Document.

Table B.1 Performance Code Classification of Existing County Stormwater Facilities

Performance Code	
Code 0	Pretreatment Practices
Code 1	Non-performing BMPs: no runoff reduction and no long term pollutant removal
Code 2	Under-performing BMPs: limited runoff reduction and low pollutant removal
Code 3	Effective BMPs: no runoff reduction but moderate to high pollutant removal
Code 4	ESD BMPs: high runoff reduction and moderate to high pollutant removal

Permit approval date (Era Code) ties the type of facility to the level of treatment based on design requirements at the time the permit was approved, and was also considered when assigning reduction and removal rates. Four era codes were established as shown in Table B.2.

Table B.2 Era Code Classification of Existing County Stormwater Facilities

Era Code	
Era 0	Permit approval date is unknown.
Era 1	Pre-1986: Era 1 facilities were among the oldest, with designs that did not meet the Maryland Stormwater Law of 1984 for detention and peak reduction.
Era 2	1986-2002: Facilities from Era 2 had improved water quality requirements than the older facilities.
Era 3	Post-2002 (2003-2009): Facilities from Era 3 were built to more stringent water quality and channel protection requirements in the 2000 edition of the Maryland Stormwater Manual and were considered treated to the MEP.

The result of the performance and era code classification is the matrix shown in Figure B-3. Each BMP was classified by performance and era, and based on those results the drainage area of the BMP was either credited towards controlled impervious cover, or the BMP was considered a possible retrofit opportunity. The most cost-effective retrofit opportunities were identified as Era 1 and Era 2 BMPs with large drainage areas (i.e. dry ponds and extended detention dry ponds). Appendix A.1 provides additional documentation supporting the classification of Code 3 BMPs from Era 2 as meeting the MEP criteria and eligible for credit.

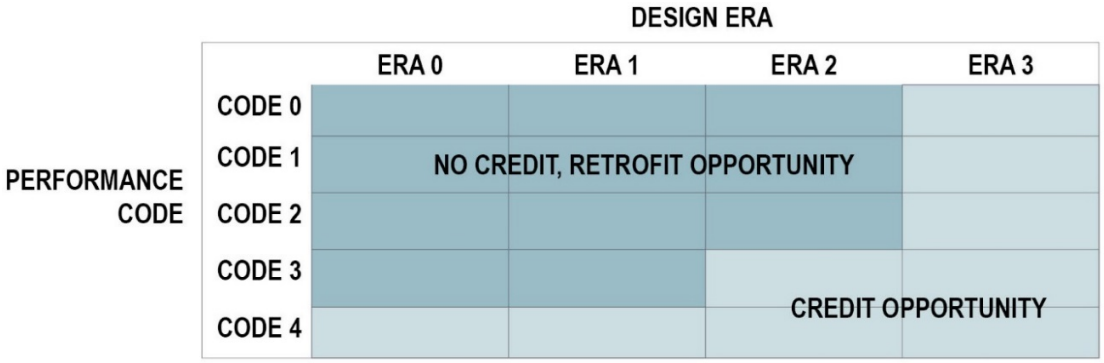


Figure B-3 BMP Classification Coding Matrix

Shortly after the completed Implementation Plan Guidance Document was released in April 2010, MDE published its *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollutant Discharge Elimination System Stormwater Permits, June (Draft) 2011* (the MDE 2011 Draft Guidance Document). In the MDE 2011 Draft Guidance Document, BMPs that provided treatment for the runoff generated by one inch of rainfall and pre-2002 detention facilities that could delay one inch of rainfall over 24 hours could be credited as MEP treatments. The draft also provided credits for non-structural practices such as street sweeping and tree planting and impervious acre credits calculated by per linear foot for stream restoration projects. MDE published its *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollutant Discharge Elimination System Stormwater Permits, August 2014* (the MDE 2014 Final Guidance Document) six months before the end of the County's third generation MS4 permit cycle. The Implementation Plan Guidance Document was not formally revised in response to the MDE changes, but DEP did adapt the appropriate practices in accounting for pollutant reduction and impervious area credits.

Third Generation MS4 Permit Area and Impervious Cover

The second key element in meeting the objectives of the Strategy Guidance Document was establishing the area of impervious cover controlled to the MEP by the end of 2009, which represents the County's starting condition for the third generation MS4 permit watershed restoration requirement.

However, prior to calculating the impervious cover controlled to the MEP by the end of 2009, the County area and total impervious cover, both controlled and uncontrolled, subject to the third generation MS4 permit was established. This step required extensive GIS analysis using the County's land cover, impervious areas, BMP locations and drainage areas, and property ownership (public vs private, County vs non-County agencies). Details of the initial process for establishing total impervious area are available in Appendix C of the Implementation Plan Guidance Document. Section C describes the process of establishing the 2009 controlled impervious cover and the restoration requirement.

Areas excluded from the calculation of the impervious areas included forests, rural and agriculturally zoned areas, and those properties owned by Federal, State, and other non-County agencies such as Maryland National Capital Parks and Planning Commission (M-NCPPC) and Washington Suburban Sanitary Commission. Figure B-4 shown below illustrates the MS4 Permit areas and excluded areas and Table B.3 provides the numerical breakdown.

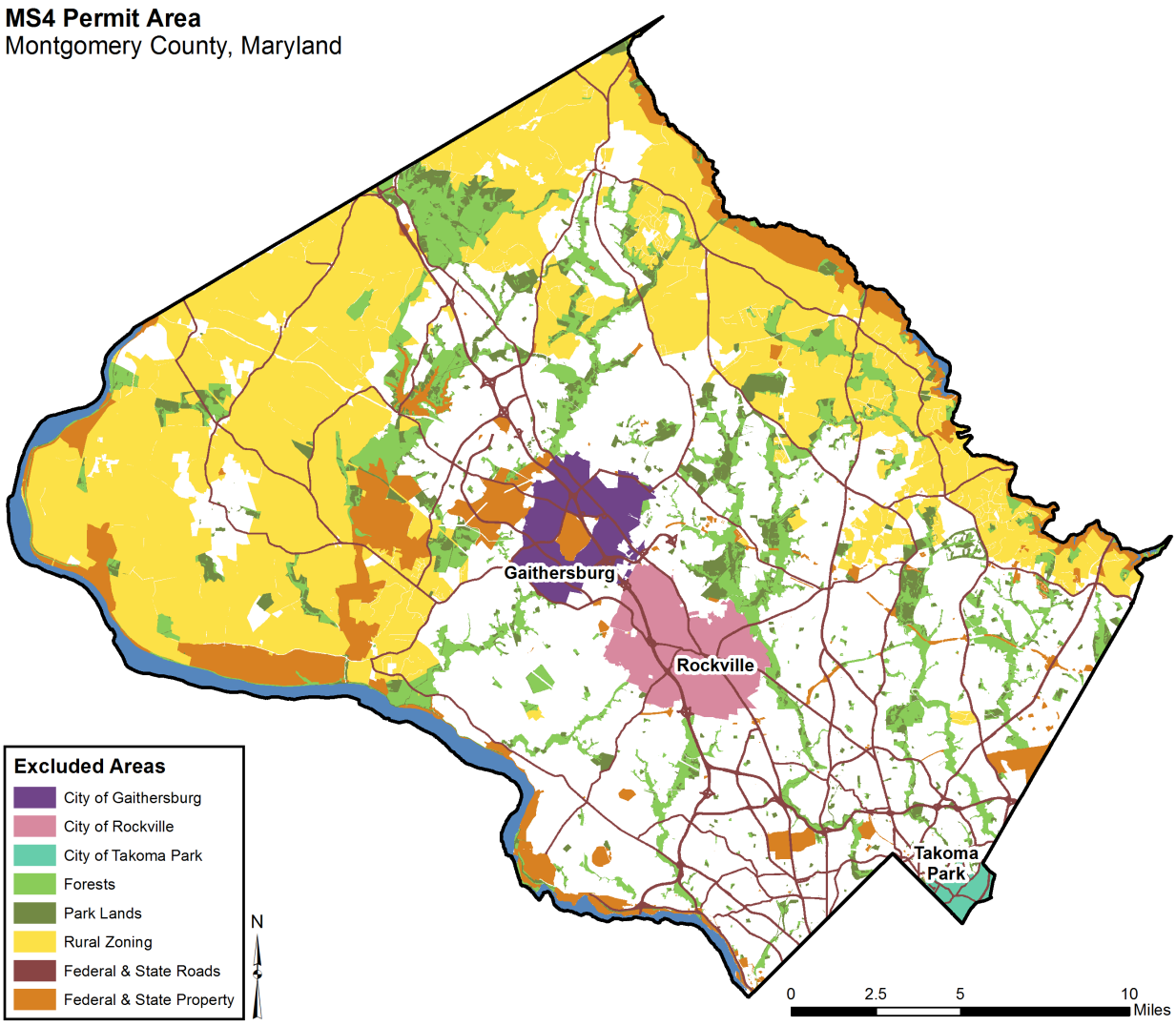


Figure B-4 Montgomery County MS4 Permit Areas

Table B.3 County Area and Impervious Surface Summary per the Strategy

Description	Area in Acres	Percent of Total Area
Total County Area	324,552	100%
County Area Subject to Third Generation MS4 Permit (1)	138,649	43%
Impervious Cover Subject to Third Generation MS4 Permit (2)	25,119	18%

1. *Exclusions include: Certain zoning codes, parklands, forests, municipalities with own stormwater management programs, state and federal properties, and state and federal maintained roads*
2. *Includes impervious areas already treated to MEP and uncontrolled impervious. Percentage relative to County Jurisdictional Area subject to the Stormwater Permit.*

B.I.2 THE STRATEGY

Compliance Targets

Building off of the Implementation Plan Guidance Document, the Strategy identified compliance targets set by the County in order to meet MS4 permit requirement and Chesapeake Bay TMDL restoration goals. Table B.4 identifies the specific compliance targets used in the Strategy and the assumptions for projections beyond the third generation MS4 permit cycle. These future impervious targets assumed that an additional 20% would be required in future permits, however; that was not proposed in the permit or by MDE. Note that the Chesapeake Bay restoration targets shown in this table represent Maryland's original timeline for 100% implementation by 2020, not by 2025 which was the year eventually adopted by all of the bay states for their Phase II Chesapeake Bay Watershed Implementation Plans. In the next permit cycle, the Strategy will be updated to reflect any revisions to the target dates and compliance targets occurring since the development of the Strategy for the third generation MS4 permit.

Table B.4 Compliance Targets from the Strategy

Target Date	Compliance Target	Metric [1]
2015	Meet 20% impervious cover treatment requirement within the MS4 Permit cycle	~4,292 acres of Impervious Cover
2017	Meet the interim dates and targets for the Chesapeake Bay TMDL, which include specific regulated urban area reductions by 2017 for nutrients and sediment (based on MDE's Watershed Implementation Plan)	9%, 12%, and 20% respectively for TN, TP, and TSS reductions from baseline conditions
2020	Meet the full compliance and targets for the Chesapeake Bay TMDL, which include specific regulated urban area reduction by 2020 for nutrients and sediment (based on MDE's Watershed Implementation Plan) Meet additional impervious cover treatment targets associated with next MS4 Permit cycle (assumes another 20% target)	18%, 34%, and 37% respectively for TN, TP, and TSS reductions from baseline conditions ~3,400 acres of Impervious Cover (20% of impervious remaining after 2015)
2025	Meet additional impervious cover treatment targets associated with next MS4 Permit cycle (assumes another 20% target)	~2,750 acres of Impervious Cover (20% of impervious remaining after 2020)
2030	Out year compliance with other watershed TMDLs	100% compliance with MS4 Permit Area WLAs

1. The numbers in this table represent the reductions required from the statewide urban stormwater runoff in the 2010 Maryland Phase I WIP.

In the Strategy, BMP implementation was presented by local watershed to show progress in meeting assigned wasteload allocations in local TMDLs. These results were then summed across the County to show progress toward meeting the 20% restoration requirement and for the Chesapeake Bay nutrient reduction goals.

Project Identification and Implementation Planning

Because of the breadth and scale of the projects under consideration, an important element of the Strategy was its clear guidance for establishing priorities among projects and its inclusion of draft implementation schedules.

To meet compliance targets, the following priorities were generally followed:

- 100% implementation of completed, high, and low priority County projects by 2015.
- Greater ESD focus in urban (as opposed to suburban and rural) watersheds initially. Goal for ESD in these watersheds on public property by 2015 is 10% and on private property is 10%.
- 100% of Public Outreach Potential for all TMDL watersheds by 2015. This was pursued to address trash, nutrient and bacteria loading which rely strongly on effective outreach programs to modify behaviors.
- Generally limited strategies to the top four most cost effective per watershed.

Table B.5 provides the summary countywide implementation schedule, including potential impervious area treated and estimated cost for implementation. According to the Strategy, by 2030 the County will have met its assigned wasteload allocations for all local TMDLs except bacteria and reduced nutrients by a percentage equal to that required to meet the Chesapeake Bay restoration goals. Estimated cost for meeting the 2015 impervious requirement was $305 million; for meeting Bay restoration goals was almost $1 billion; and for achieving assigned wasteload allocations for all local TMDLs was approximately $1.9 billion.

Table B.5 Montgomery County's Watershed Restoration Implementation Schedule

Countywide Watersheds
Summary of Implementation Plan schedule with expected MS4 permit area WLA compliance endpoints

	2015	2017	2020	2025	2030	Permit/ TMDL Target 2017	Permit/ TMDL Target 2020
Impervious Area Treated (acres) (cumulative)	4,292	6,014	7,722	10,518	11,154	6,008	7,723
% of Impervious Area Treated by ESD	18%	34%	47%	60%	635%		
Impervious Area Treatment Cost (Million $) (see assumptions 1&2)	305	622	987	1,687	1,884		
% of Cost for ESD	53%	66%	70%	80%	80%		
Nitrogen (% Reduction)	18%	25%	36%	46%	51%	9%	20%
Phosphorus (% Reduction)	17%	23%	34%	44%	46%	12%	34%
Sediment (% Reduction)	23%	34%	54%	60%	62%	20%	37%
Bacteria (% Reduction)	11%	15%	20%	28%	30%		
Trash (% Reduction)	18%	16%	33%	41%	42%		

Assumptions:
1. Does not include repeated Outreach and Education costs beyond FY2015
2. Does not include an inflation multiplier

B.ii. Budget and Funding Development

A sufficient budget and available funding is critical to the success of the restoration program. In addition to the administrative costs of meeting the MS4 permit requirements, the restoration projects and programs described in detail in Section D require varying levels of financial investment to implement. This section describes the history of funding and details the increase in spending on capital improvement projects from FY08 to FY14.

B.II.1 WATER QUALITY PROTECTION CHARGE

The Water Quality Protection Charge (WQPC) was first established in 2001 by Montgomery County Council Bill 28-00 and went into effect in 2002. The County was authorized to implement the WQPC by Maryland Code Environment Section 4-204 that allows collection of funds to implement stormwater management programs. In Montgomery County, WQPC raises funds to support the County's clean water initiatives to improve stream and water quality and prevent stormwater pollution. Select examples of WQPC funded initiatives are illustrated in Figure B-5 below with example photographs. Additional programs and initiatives not represented in Figure B-5 may also be supported through WQPC funding.

A. Stream Restoration
B. Biological Stream Monitoring
C. BMP Maintenance

Figure B-5 Examples of WQPC Funded Initiatives

The WQPC, considered an excise tax, is included as part of the Montgomery County property tax bill received annually in mid-summer. The WQPC is calculated based on the potential for a property to contribute to stormwater pollution as calculated by property type and impervious area cover. Property types include single family homes, multifamily residences, nonresidential properties, office buildings and religious institutions, agricultural properties, and properties

owned by 501(c)(3) organizations. From 2003-2012, all residential properties and approximately 40% of nonresidential properties including non-profit organizations, places of worship and private schools paid the WQPC. In 2013, to comply with HB 987 discussed below, the WQPC was expanded to all property owners in the County. Applicable state law only exempts property that is owned by a local government, a volunteer fire department, or by the state government. In 2015 Senate Bill (SB) 863 provided alternative funding mechanisms for MS4 jurisdictions, and required financial assurance reporting every two years. SB863 also provided mechanisms for state and county governments to pay for impervious area control in another jurisdiction. SB863 did not change how the WQPC is billed or implemented.

Annually, the County Council sets the rate for an Equivalent Residential Unit (ERU) of 2,406 square feet of impervious surface. Established formulas are then used to determine the actual charge for each property. Property owners may work with the County to appeal their charge assessment or apply for a hardship exemption.

B.II.2 HOUSE BILL 987

In May 2012, the Maryland legislature passed House Bill (HB) 987, Stormwater Management – Watershed Protection and Restoration Bill that was then signed into law. HB 987 established a requirement for a county or municipality subject to a stormwater permit to collect a fee to fund a watershed protection and restoration program. By 2012, Montgomery County had been implementing a similar fee for 10 years. HB 987 made such a fee mandatory for other counties in the state in the Maryland subject to a stormwater permit.

In October 2012, County Council Bill 34-12 made several changes to the WQPC in order to meet HB 987 requirements. These changes included:

- Expanding the types of property that are subject to the Charge to include all nonresidential properties.
- Establishing a 3-year phase-in for any increase in the Charge that is due to application of the HB 987 or any regulations adopted under the bill.
- Authorizing the County to provide credits to property owners that have stormwater management systems on their properties.
- Establishing a hardship exemption for residential property owners who can demonstrate substantial financial hardship.
- Provides a separate billing scale and a hardship exemption for 501(c)3 organizations.
- Authorizing the County to perform maintenance on nonresidential property when the County installs a retrofit on that property

Increases in the ERU rate from $12.75 in 2001 to $88.40 in FY14 reflects the increasing efforts required by the County and DEP to meet the MS4 restoration requirement.

B.II.3 WQPC BONDS

The 20% impervious area restoration requirement of the third generation MS4 permit meant a significant increase in the number of restoration projects DEP would have to undertake. As a result, in 2011, the County Council approved Expedited Bill 11-10 allowing the County to issue bonds secured by the WQPC to finance the construction and related expenses of watershed restoration projects as approved in the CIP. The issuance of the bonds allowed the capital costs of complying with the increased restoration requirement to be spread over the lifetime of the bonds.

B.iii. Ramp up of Capital Improvements Program

B.III.1 BUDGET

The CIP represents the bulk of DEP restoration program spending. Funding of the CIP, tied to the WQPC, has dramatically increased overtime in order to meet the 20% impervious area restoration requirement. Figure B-6 below illustrates the funding increase over time:

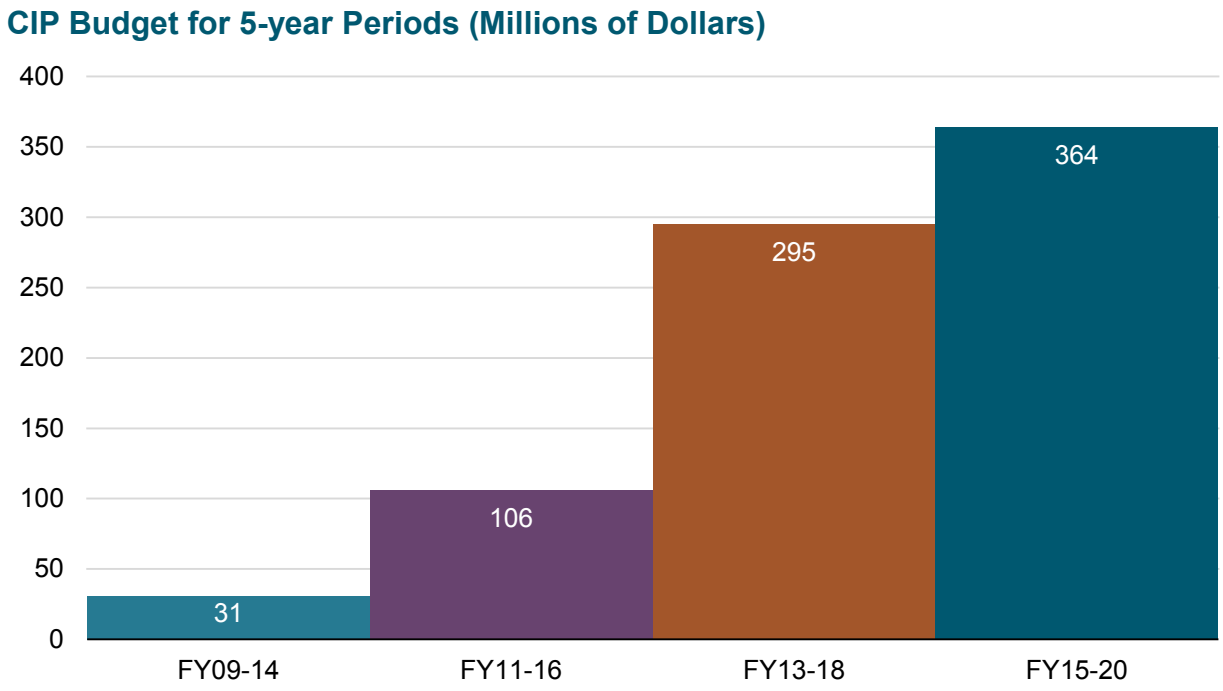


Figure B-6 CIP Budget Increases over Time

The approved FY15-20 CIP budget demonstrates the County's commitment to aggressively implementing projects to meet the third generation MS4 permit watershed restoration requirement.

B.III.2 STAFFING

DEP started increasing internal and external capacity in response to the MS4 permit in 2010 (FY11). In 2010, the water resource engineering and planning staff doubled in capacity from six engineers and planners to a total of twelve. In addition to internal staff managing the design process, DEP expanded program support through the MS4 Program Management (PM) contract. Through the PM contract, DEP increased capacity by adding ten design project managers to assist with the management of Water Resource Engineering (WRE) task orders beginning in January 2013. Prior to the third generation MS4 permit, the 2008 WRE contract had four vendors. A new WRE contract was issued in 2012 that doubled the number of vendors to eight. Starting in FY13, DEP also added a construction section which presently includes one manager, three construction managers, three construction representatives, and two contract employees.

Along with the added staff, the County added management and oversight controls such as a weekly project management meeting to share lessons learned and a more formal approach to communicating design standards.

B.III.3 PROJECTS

Prior to the County receiving the third generation MS4 permit, DEP WMD averaged six to 10 design projects per year. Starting in FY10, the number of design task orders issued annually, and corresponding projects, increased significantly. This increase is illustrated in Figure B-7 below.

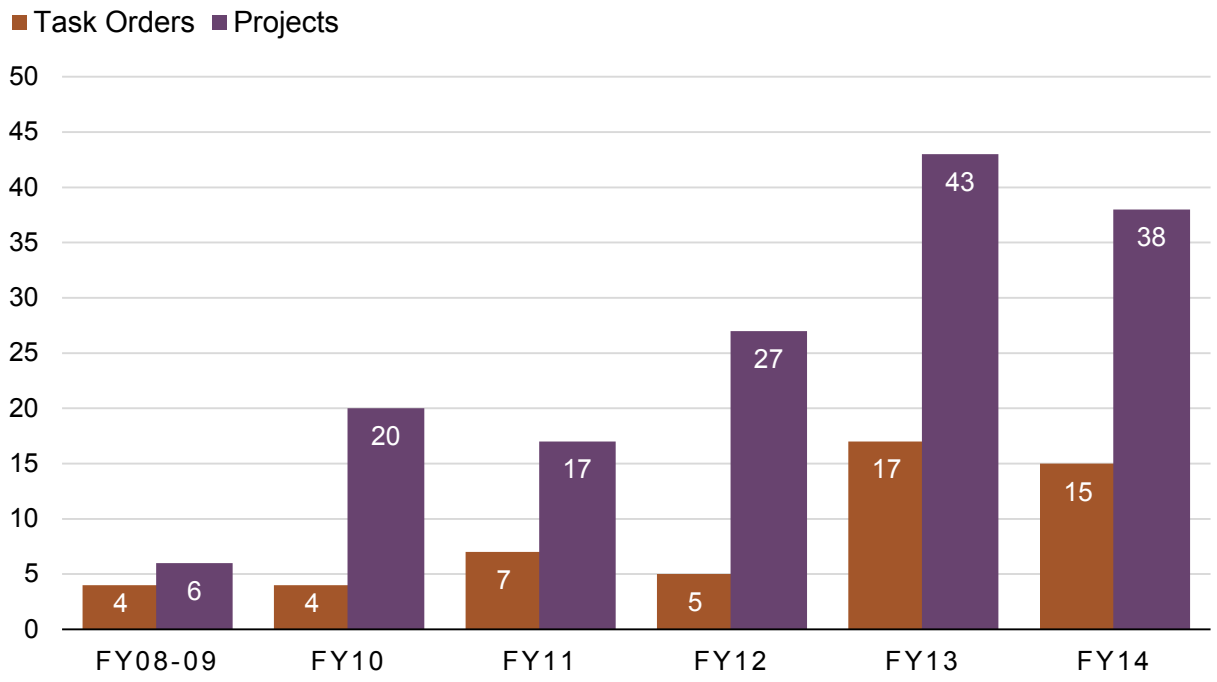


Figure B-7 Number of Design Task Orders and Projects issued per Fiscal Year

Working within the allocated budget to prepare this number of projects for task orders required strong organization and adaptive planning by DEP. Impervious area credit, wasteload allocation impacts, project cost, complexity, size, and feasibility were all factors that were taken into consideration in prioritizing potential projects.

While challenging, DEP has successfully increased its CIP up to an unprecedented level. The increased number of projects has resulted, and will result, in many more acres of impervious area being treated. This treatment has immediate and long-term benefits for the quality of County's waterways and the many people living in and visiting Montgomery County.

B.iv. Public Outreach Component of Watershed Restoration Projects

Whether they are small scale rain gardens or large scale stream restoration projects, DEP proactively communicates its restoration project intentions to stakeholders and nearby residents throughout the process. These projects are located in backyards of residents, within their community, or somewhere they visit such as a school or library. DEP recognizes the need to use multiple ways to communicate using mailings, email, and interactive websites to inform residents about the project as well as invite them to the various public meetings. With continual updates about the projects, DEP helps to promote open dialogue that allows a platform where stakeholders feel their comments and opinions are heard.

On average, throughout the project design, construction, and completion, six public meetings are held which may include an open forum style meeting with a presentation, a site walk, or

attending and presenting at a Homeowners Association Board meeting. The initial meetings serve to inform the public of the general proposed concept of the project while the later meetings present more specific details based upon feedback from stakeholders and regulatory agency comments. Project websites are also designed for residents to obtain information regarding the project as well as learn about the various types of restoration projects that DEP builds (http://www.montgomerycountymd.gov/dep/Restoration/watershed-restoration.html). In addition, there is considerable interaction with individual homeowners that may be affected by a restoration project, especially Green Street projects.

Watershed Planner Standard Operating Procedure

As DEP ramped up its efforts to treat more uncontrolled impervious acres, the level of effort and ability to reach out to residents and stakeholders was reassessed. The increase in the number of staff working on restoration projects meant increased complexity in preparing for and informing stakeholders and residents. As a result, a watershed restoration outreach standard operating procedure (SOP) was developed to provide staff guidance as well as consistency on how to effectively reach out to the public. The Watershed Restoration Outreach SOP is continually improved based upon staff feedback and provides a general stepwise guidance for staff to effectively reach out to the public.

Public Outreach Database

Watershed restoration outreach is only a portion of DEP's outreach efforts under the third generation MS4 permit. Under the Public Outreach and Stewardship Workplan, developed as part of the Strategy, DEP educates the public on stormwater pollution and implement programs to affect behavior change focusing on eight practices, including, for example, pet waste management, lawn stewardship, anti-littering, watershed group capacity building, and innovative stormwater management awareness.

At the start of the third generation MS4 permit, all outreach efforts were tracked using various Microsoft Excel Spreadsheets. Over the last year, DEP developed a new outreach database that allows for collection and tracking of outreach activities across multiple DEP programs, including watershed restoration. The new database increases reporting efficiency by standardizing the required data needed for reporting each outreach effort. Metrics tracked include:

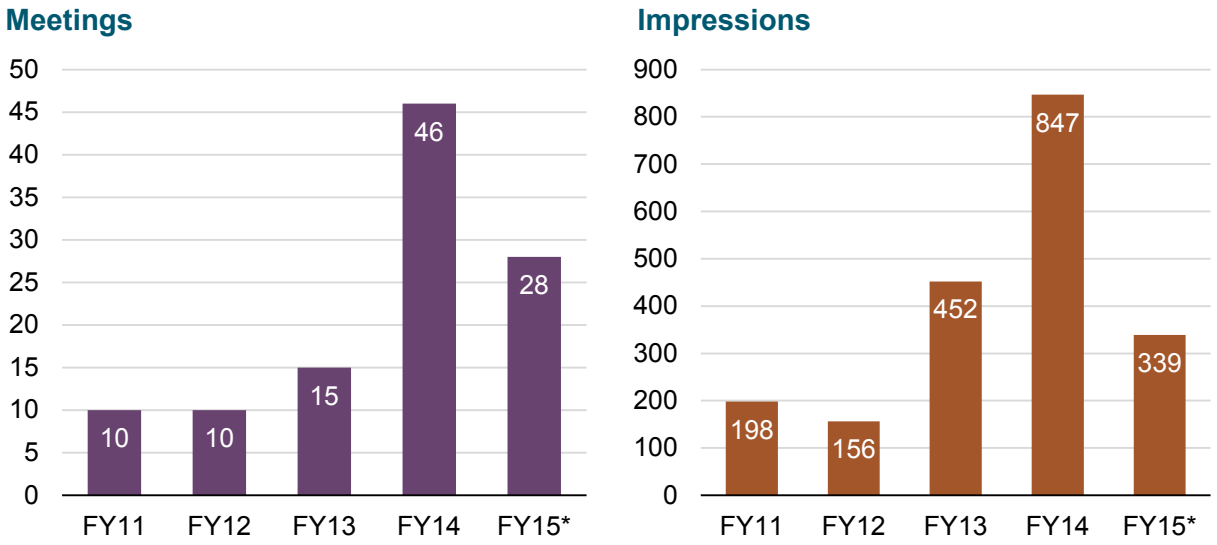
- Date, time, and location where an outreach activity occurred
- Watershed where the event was held
- Number of attendees who participated
- Topics covered at an event (i.e., pet waste, trash, RainScapes, etc.)
- Number of trees planted by volunteers at an event
- Pounds of trash collected by volunteers or watershed groups

The database also informs staff of other DEP activities occurring on the same date or close proximity to their events which allows them to notify their attendees of these other events. The database is also used to query number of events within specific watersheds as well as topics covered.

Increasing Levels of Effort

As the number of restoration projects increased over time, so has the number of public meetings.

Figure B-8 below illustrates the increased public outreach efforts by the watershed restoration program both in number of meetings as well as impressions representing the number of people reached during an event. These restoration outreach efforts are tracked through the new outreach database and also contribute towards the broader third generation MS4 permit public outreach requirements.



**FY15 does not include efforts beyond the end of the permit cycle (February 2015).*

Figure B-8 Number of Public Outreach Meetings and Impressions Over Time

DEP is currently involved in over 120 watershed restoration projects working towards the third generation MS4 permit restoration requirement. As these projects progress, DEP estimates that approximately 720 public meetings (average 6 meetings/project) with residents will be held to facilitate public input and property owner coordination throughout the design, construction and completion phases. Moreover, public outreach efforts in the future are anticipated to increase as the number of stormwater pond facility projects dwindles and the number of more hands-on ESD practices and stream restoration projects increases. Since the smaller scale practices are more integrated into neighborhoods and have more potential impact on nearby residence, the need for increased levels of public outreach to communicate with residents and stakeholders must be considered as these projects involve more coordination with the public to produce a project that is accepted by the communities.

C. Data Management and Establishing the Restoration Requirement

Data management and establishing the restoration requirement are important components of DEP's efforts to comply with the third generation MS4 permit. This section documents the data management practices used to prioritize and manage projects, track and report progress, and improve communication. The section then describes the process employed to establish the restoration requirement with the best accuracy possible.

C.i. Data Management

Data management is a multifaceted and critical component of DEP's MS4 permit program. Managing data is essential to meeting permit requirements and proving permit compliance. Effective data management is particularly essential to the restoration program. As the MS4 permit requirements have evolved, so has DEP's data management strategy.

In addition to implementing the permit-specific requirements for databases and ArcGIS geodatabases, DEP has also undertaken several data management initiatives to specifically support meeting the 20% watershed restoration requirement. These efforts include starting a SharePoint site, using Microsoft Project, developing a Business Intelligence System and Dashboard, maintaining and updating the Restoration Sites Database and developing a new structured query language (SQL) database, continuing to map existing storm drains, and streamlining the drainage areas delineation process. Each of these initiatives is explained in more detail in the following sections.

C.I.1 SHAREPOINT

With the increase in the number of firms and personnel working on restoration projects, it was determined that a SharePoint site was needed to facilitate file hosting and sharing between DEP, the PM contractor, WRE contractors, and construction contractors. The SharePoint was initiated in 2012 with the start of the PM contract. The SharePoint replaced the FTP site previously utilized by DEP.

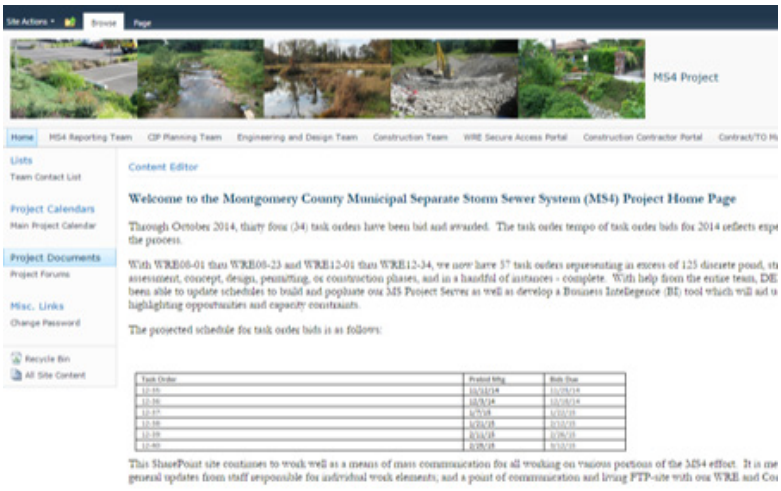


Figure C-1 Sharepoint Homepage

The SharePoint currently stores content such as task orders, schedules, plans, budgets, designs and reports across 25 different pages. This initiative has streamlined communications and file sharing creating a single repository for restoration project documents. The well-organized and securely maintained SharePoint has increased efficiency of contracting and implementation through improving accessibility to important information. Figure C-1 illustrates the homepage of the Sharepoint site.

C.I.2 MICROSOFT PROJECT

Starting in 2012, with the awarding of the WRE contract, the County and PM contractor developed a strategy for monitoring project schedule performance through design and implementation of a Microsoft Project Server (MPS). The MPS is used only for DEP's CIP restoration projects completed by DEP and WRE contractors. The MPS provides projections of when projects will be ready for construction and completion. It also documents when design, permitting, and construction milestones were met for each project. Microsoft project information is linked with the Business Intelligence System and Dashboard described in the next section to provide a project schedule tracking metric for CIP projects.

C.I.3 BUSINESS INTELLIGENCE SYSTEM AND DASHBOARD

The Business Intelligence (BI) system is designed to analyze data from multiple tables and databases relating to the County's MS4 program to measure and report on specific programmatic performance metrics. The BI system reports on 13 unique metrics, six of which are specific to the restoration program. The six restoration program metrics reported by the BI are described in Table C.1.

Table C.1 Business Intelligence (BI) System Metrics for the Restoration Program

Metric	Description
Project Schedule Performance	Specific to CIP projects, this metric provides dates of achieved and scheduled project milestones through integration with the MPS.
Impervious Area Progress Timeline	This metric reports when and how much impervious credit was achieved/gained, by watershed, inclusive of all permit cycles. The metric pulls data from multiple sources including MPS and the Restoration Sites Database to provide a comprehensive report of all restoration efforts by the County.
Impervious Area by Watershed	This metric reports how much impervious credit was achieved/gained over time by watershed for the current permit cycle only. This metric also includes project status. Similar to Impervious Area Progress Timeline, the metric pulls data from multiple sources including MPS and the Restoration Sites Database.
Program Cost Summary	This metric provides a projection of program cost over time by pulling and populating cost information from multiple database and sources.
WRE Estimate Accuracy	This metric compares construction costs as estimated by the WREs with actual construction cost.
Designed Impervious Area Control	This metric provides the design group with a look back at the level of IA reductions designed vs. a specified target.

The metric reports generated by the BI system are easily accessed through an internet-based dashboard interface (the Dashboard) (Figure C-2). The Dashboard provides DEP staff and project managers instant and up-to-date insight into the restoration program's progress towards meeting the 20% restoration requirement. The BI system and the Dashboard have played an important role in continuing adaptive management of the program. The Dashboard can be used to quickly find inefficiencies and identify problems early serving as a platform for open communication and resource management.

Enhanced capabilities are also currently under development by DEP to allow for resource modeling and restoration scenario evaluation using the Dashboard.

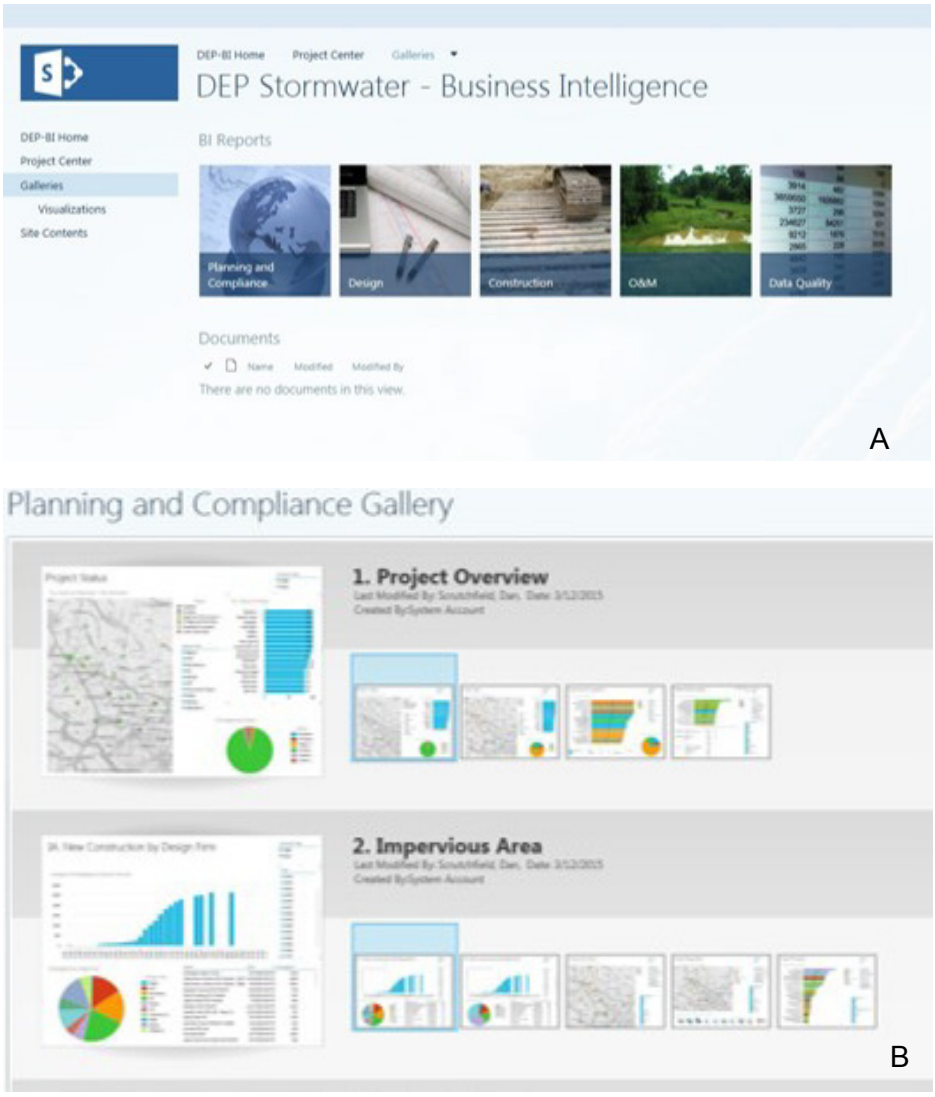


Figure C-2 BI System (A) and Dashboard (B) Example Images

C.I.4 RESTORATION SITES DATABASE AND NEW SQL DATABASE

The Restoration Sites Database tracks all potential restoration opportunities including those in design, under construction, completed, and dropped. The Restoration Sites Database was developed using ESRI ArcGIS in 2003 during the second generation MS4 permit. Throughout the third generation MS4 permit, the Restoration Sites Database has undergone numerous minor updates to accommodate various internal and MS4 permitting requirements.

However, as a result of increasing reporting needs, changing new permit requirements and resulting programmatic expansion, long-term use of only the Restoration Sites Database was determined to be insufficient to meet future permit needs. To begin to address anticipated future permit needs, the County initiated efforts to create a new SQL database. In 2015, data was transferred into the new SQL database still undergoing development. In addition to increasing reporting efficiency, the SQL database will provide an opportunity to document institutional knowledge into the database for historical tracking. The SQL database will also make the data open source allowing other County agencies and departments, as well as DEP internal sections,

such as Stormwater Maintenance, to know where DEP's projects are located and facilitate coordination.

The Restoration Sites Database contains three feature types (point, line, and polygon) with an attribute table of over 90 fields to track all restoration actives including costs, impervious progress, location, etc. The purpose of developing the new SQL database is to increase capacity, function, stability and quality of the existing data and improve data organization. The new SQL database represents a significant effort in improving data functionality intended to contribute to the success of the restoration program.

Anticipated benefits and features of the new SQL database in development are explained in the Table C.2 below.

Table C.2 Benefits and Features of the New SQL Database Currently Under Development

Increase Data Usability
Features:
Incorporate multi-components such as tables and geospatial features
Tracking fields are subdivided into multiple tables for ease in data update and management
Users can view information they need without viewing columns of information that is may not be essential to them
Reports can be customized for specific programmatic reporting
Improve tracking capabilities
Features:
Differentiate impervious tracking: Control Impervious – impervious attributed to the 2009 controlled impervious used to calculate the restoration requirement Credit Impervious – impervious attributed to the County's progress towards meeting the restoration requirement
Improve data integration
Features:
Integration with the BI system
Utilizing inventory of identified opportunities from watershed assessments into project planning and prioritization

C.I.5 STORM DRAIN MAPPING

Storm drain mapping is critical to determining drainage areas. Drainage areas determine the impervious area treated by a potential project and therefore influence project development and prioritization.

Mapping the County's storm drain system is a complex process. Data is provided by multiple entities including DEP, DOT, DPS, State Highway Administration (SHA), Washington Suburban Sanitary Commission (WSSC), and several municipalities. Historically, a lack of cohesion and consistency within the data caused by each entity having a distinct process for inputting new data, attributes, domains, and varying overall quality has made creating a comprehensive storm drain inventory very difficult. Additionally, storm drains are often digitized in the permit-stage of a project, and due to a lack of time and personnel, they are not reviewed once as-built drawings

are available, leaving some systems within the overall network that are different on the ground, and some that were never actually built.

In 2014, DOT began coordinating a large effort to make extensive improvements to the County's storm drain data and to aggregate all the disparate datasets in one central location. Data from all the sources is being continually added, reviewed and updated, with the DOT conducting field surveys as necessary to verify attributes. Additionally, these efforts are working to overcome the problems of topological integrity, including gaps, overlaps, and mismatches and within the network. DEP maintains open lines of communication with DOT on this effort. Benefits of this process are illustrated in Table C.3 below.

Having high-quality and comprehensive storm drain data is of vital importance to DEP, as these structures affect the flow of stormwater, and are necessary to take into account when delineating new drainage areas for a storm water facility, as well as when making decisions about potential restoration projects. In addition, storm drain mapping is also important to supporting identification and resolution of illicit discharges, another requirement of the MS4 permit.

Table C.3 Benefits of Storm Drain Mapping Efforts

New Standardized Data Structure
Attributes and Domains
Applied to all new data
Migrating old data to this new format
Improved Data Entry Process
New methodology
QA/QC chain
Data uploaded to the new centralized location
Defined DPS Permit Process
DEP responsible for reviewing public and private permits that come through DPS with storm drain information
DEP adds these features to the new DOT developed database

C.I.6 DRAINAGE AREA DELINEATIONS

Drainage area delineation for existing BMPs is an on-going process because the built-environment constantly changes. The construction of new storm drain systems and BMPs often alters the drainage of existing BMPs. This data change affects the selection and design of restoration projects as well as factors into the calculation of the restoration requirement as described in Section C.ii.1 and the calculation of watershed restoration progress.

Although the County began delineating drainage areas early in its watershed restoration program and continued efforts through the second generation MS4 permit, a large backlog of missing drainage areas remained at the beginning of the third generation MS4 permit cycle. DEP has increased its efforts to delineate drainage areas for newly inventoried BMPs and to perform data quality assurance and control for existing drainage delineations. DEP has also developed an inventory process that streamlines and standardizes the steps involved with adding new BMPs and delineating drainage areas. In addition to the number of BMP records increasing rapidly with the buildup of the restoration program, the number of drainage areas

inventoried has also increased rapidly. Figure C-3 below illustrates the dramatic increase in records and delineations from 2011 to February 2015.

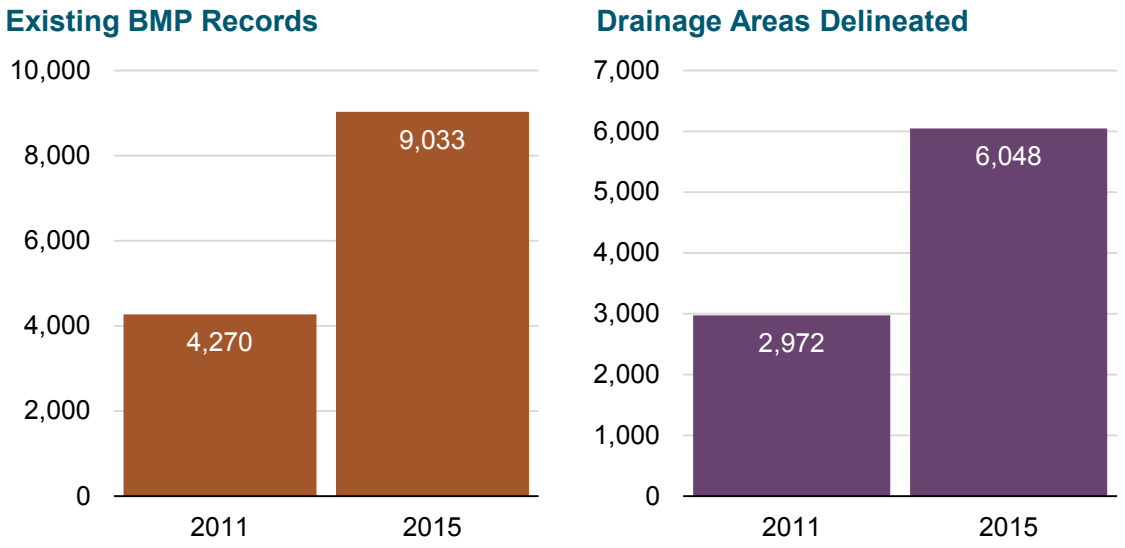


Figure C-3 Increase in BMP Records and Drainage Area Delineations

C.ii. Establishing the Restoration Requirement

While the third generation MS4 permit restoration requirement to restore an additional 20% of uncontrolled impervious cover is fixed number, the number of acres represented by 20% of uncontrolled impervious depends on the calculation of the impervious cover controlled to the MEP at the end of 2009. As improved information on the area of impervious cover controlled to the MEP at the end of 2009 became available through new data and more advanced analysis, DEP has worked to define the acres represented by the restoration requirement to reflect the most accurate information.

The following section explains the efforts that were undertaken to gather improved information to establish the restoration requirement. These efforts include updating BMP drainage area delineations, verifying existing facilities, incorporating existing roadside swales, and crediting large lot disconnections. Improvements in the accuracy of the restoration requirement during the course of the third generation MS4 permit are summarized in Table C.4 and Table C.5 below.

Table C.4 Establishment of the Restoration Requirement

Description	Area (acres)		
Total County Area	324,552		
Total Impervious Area	35,965		
County Area Subject to Third Generation MS4 Permit	138,649		
Impervious Area Subject to Third Generation MS4 Permit	25,119		
	The Strategy (2009)	Annual Report (2013 and 2014)	Revision (2015)
County MS4 Impervious Area Controlled to MEP in 2009	3,661	5,239	6,235
County MS4 Impervious Area Under/Uncontrolled	21,458	19,880	18,884
Restoration Requirement	4,292	3,976	3,777

Table C.5 Establishment of Impervious Area Treated to the MEP in 2009

	Description	Area (acres)
A.	Impervious Area Subject to Third Generation MS4 Permit	**25,119**
	County MS4 Impervious Area Controlled to MEP in 2009	
	Per The Strategy (2009)	3,661.0
	Updated BMP Tracking and Drainage Area Delineations	691.2
	MEP Verification of Existing Facilities	1,597.3
	Incorporating Existing Roadside Swales	278.3
	Crediting Disconnected Large Lots	7.4
B.	TOTAL	**6,235.2**
C. County MS4 Impervious Area Under/Uncontrolled (2015 Revision) (A-B)		**18,884**
	Restoration Requirement (2015 Revision) (20% of C)	**3,777**

C.II.1 UPDATED BMP TRACKING AND DRAINAGE AREA DELINEATIONS

As described in Sections C.i.5-C.i.6, the process of inventorying BMPs and determining drainage areas is an on-going process. This process has immediate impacts on the determination of the impervious area with stormwater treatment to the MEP in 2009 and the restoration requirement. There are many existing impervious areas that had stormwater control to the MEP by the end of 2009, but due to lack of delineated drainage areas for the facilities, the impervious areas treated were not captured in the original Strategy calculation. Likewise, BMPs constructed for redevelopment and new developments prior to the end of 2009 may also provide MEP treatment for previously uncontrolled impervious areas, yet without accompanying drainage areas, these facilities cannot be included in the accounting.

To address this issue, DEP is continuously refining and delineating drainage areas for BMPs that do not already have an associated drainage area. Over the course of the third generation MS4 permit, from FY10 to February 2015, DEP has added over 3,000 drainage areas to its inventory going from 2,972 to 6,048 delineated drainage areas. Updated BMP and drainage area delineations resulted in the determination that 691.2 acres of impervious area were controlled to MEP in 2009.

The process of updating BMP drainage area delineations allows DEP to develop an increasingly accurate and comprehensive picture of the existing BMP inventory, the area of impervious cover controlled to the MEP in 2009, and restoration requirement progress and consequently, develop a better understanding of impervious controls needed throughout the County.

C.II.2 MEP VERIFICATION OF EXISTING FACILITIES

Existing facilities within the County may be eligible for stormwater treatment credit if they treat stormwater to the MEP as determined by MDE guidelines. Certain existing BMP facilities required verification of MEP treatment prior to including their associated drainage areas in the area of impervious cover controlled to the MEP in 2009.

The first step of the verification process involved a GIS desktop exercise to categorize DEP's BMP inventory based on specific attributes including geographic location, type, and permit approval date. This resulted in three categories of BMPs that need verification including wet ponds permitted prior to 1986, wet ponds permitted between 1986 and 2002, and BMPs in the Special Protection Areas (SPA).

Once categorized, additional analysis was completed based on the BMP category. Table C.6 outlines the MEP criteria and summarizes the additional analysis for each category. More detail on the MEP analysis for wet ponds permitted between 1986 and 2002 is provided in Appendix A.1. An example of an approved Water Quality Plan for an SPA requiring treatment of the one-inch water quality volume is provided in Appendix A.2.

The process of MEP verification of existing facilities resulted in the determination that 1,597.3 acres of impervious cover were controlled to MEP in 2009.

Table C.6 Additional Analysis and MEP Criteria by BMP Category

Wet Ponds Permitted Prior to 1986
Based on The Strategy, wet ponds built prior to 1986 are ineligible for credit unless it can be shown that the pond meets the MEP design requirements in the Maryland Stormwater Design Manual to treat the one-inch water quality volume. A combination of GIS desktop analysis, as-built/computation evaluation, and field assessment was conducted to verify if the wet ponds met the MEP requirements.
Wet Ponds Permitted Between 1986 – 2002
Based on The Strategy, wet ponds permitted between 1986 and 2002 are accounted for as part of the area of impervious cover controlled to the MEP in 2009 Desktop analysis, as-built/computation evaluation, and field assessment were conducted for a sampling of these ponds to verify this assumption.
BMPs in the Special Protection Areas
Stringent stormwater management regulations are enforced for new developments within the County's four designated SPAs. Each SPA and date established is listed below: 1994 - Clarksburg 1995 - Piney Branch 1995 - Upper Paint Branch 2004 - Upper Rock Creek BMPs in a SPA watershed, permitted after the establishment of the SPA, are considered eligible due to the one-inch water quality volume requirement. These BMPs mostly consist of treatment trains with a series of pre-treatment practices and built-in redundancy.

C.II.3 INCORPORATING EXISTING ROADSIDE SWALES

Older, open section roads with grass swales are found throughout the County. Although not originally designed as BMPs per the Maryland Stormwater Design Manual, many of these existing swales do meet the design criteria set forth in the Manual, thereby providing treatment of impervious cover stormwater runoff from their contributing drainage areas.

Since roadside swales have the potential to treat stormwater, incorporating existing roadside swales into the area of impervious cover controlled to the MEP in 2009 was an important component of establishing the restoration requirement. Roadside swales are not included in the BMP inventory or in the restoration geodatabase and therefore required a separate process of identification and accounting.

Per the MDE 2014 Final Guidance Document, and drawing upon the Maryland State Highway Administration's (SHA) December 2013 document, *Existing Water Quality Grass Swale Identification Protocol*, DEP developed a protocol to locate existing and previously undocumented roadside grass swales in the County consisting of three major components. While a detailed description of the process is provided in Appendix B, the process is summarized in Table C.7 below.

Table C.7 Process for Identifying and Verifying Existing Roadside Swales

Part 1: Desktop Evaluation Using Geospatial Techniques
ESRI ArcGIS was used to analyze detailed elevation data to locate potential swales. An iterative process narrowed down the initial network of potential drainage swales by setting geometric, slope, and land cover criteria and excluding any areas not covered by the MS4 permit and any swales within existing credit drainage areas. This resulted in 33,225 potential roadside swale sites in the County.
Part 2: Field Campaign to Assess Accuracy of Desktop Methods
Identified roadside swales were grouped into 156 categories based on longitudinal slope category (ideal or adequate), average year built of the properties within the subdivision they fell in, and the majority zoning category for the subdivision. Representative field sites were selected for each group and in total 121 groups were field surveyed. Two-person field survey crews collected data using a GPS enabled iPad and recorded detailed geometric measurements and observations of the site condition.
Part 3: Post-Field Data Finalization
Post-processed field data was then compared to the GIS data. The field data set corresponded well with the GIS data, suggesting the desktop GIS processes effectively characterized the potential grass swales for the defined criteria. The GIS data was refined by adding relevant attributes from the field-surveyed sites to the other swales within the same category. Any groups that had unsatisfactory field-derived results for key criteria were eliminated from the dataset. Swales that passed the filtering process were considered the final dataset.

The area of impervious cover treated by swales determined to meet the grass swale criteria in the Maryland Stormwater Design Manual was conservatively computed to be half of the road width for the length of road running along the swale. Only roads within the County MS4 area and not already within a credited drainage area were included in the final accounting. It was determined that 278.3 acres of previously uncontrolled impervious area were draining to roadside grass swales and could be considered area treated to the MEP in 2009. Figure C-4 shows examples of roadside swales that were field evaluated.

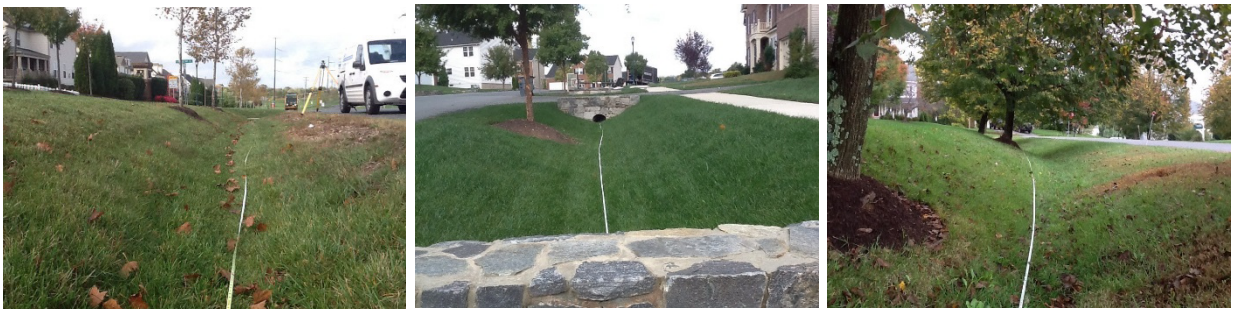


Figure C-4 Examples of Field-Evaluated Roadside Swales

C.II.5 CREDITING DISCONNECTED LARGE LOTS

As with open section roads, large lot residential zoning is found throughout the County. In The Strategy, buildings on large residential lots were considered untreated impervious unless they were within a credited drainage area. However, per the MDE 2014 Final Guidance Document, large residential lots with disconnected rooftops may be considered treated to the MEP, assuming they meet the disconnection or sheet flow criteria in the Maryland Stormwater Design Manual.

A desktop GIS analysis was carried out by DEP to determine the area of impervious cover on disconnected large lots that could be counted in the area of impervious cover controlled to the MEP in 2009. The desktop analysis used an iterative process to create a subset of property parcels that met the following criteria.

- Residential zoning
- Within the MS4 permit area and not in a drainage area already receiving credit
- Three acres or larger with building footprint entirely within the parcel

GIS Spatial Analyst tools were used to create and evaluate flow paths from each corner of the largest building on each parcel, which were then aggregated for each quadrant of the structure. If the flow path met the crediting criteria for a given quadrant, including not crossing any other impervious, and passing through slopes of 5% or less, 25% of the quadrant area was credited. If the flow path failed to meet the criteria, no credit was given. The quadrant credits were summed per building for each qualifying large lot.

The total impervious credits for all qualifying buildings on large lots were then summed resulting in a total large lot disconnection value of 7.4 acres applied to the area of impervious cover controlled to the MEP in 2009.

C.II.6 THE NEED FOR ANNUAL UPDATES

Data sources and tracking methods are can quickly become out of date in the fast-paced and dynamic reality of a populated and changing county. Therefore, running the calculations annually, when possible, is the best path towards ensuring accuracy and continued return on investments in MS4 projects.

D. Implementation of Restoration Projects and Green Infrastructure

This section reports the status of the County's progress towards meeting the third generation MS4 permit restoration requirement. In addition to an overall summary, this section also provides a detailed look at the various types of projects and partnerships that comprise Montgomery County's watershed restoration portfolio through the perspective of the various delivery methods pursued by DEP.

D.i. Restoration Requirement Progress Summary

The third generation MS4 permit watershed restoration requirement to restore 20% of the impervious area not controlled to the MEP by the end of 2009 represents 3,777 acres. Progress towards meeting this requirement is achieved by earning impervious area credits, calculated in equivalent acres, from restoration projects. As of the end of the third generation MS4 permit, the County had completed restoration totaling 1726 acres of impervious acre credit with projects treating an additional 197 acres under constructions (projects or acres referred to as "in-construction") and projects treating another 2431 acres under contract for design (acres or projects referred to as "in-design"). This progress in relationship to the restoration requirement is illustrated in Figure D-1.

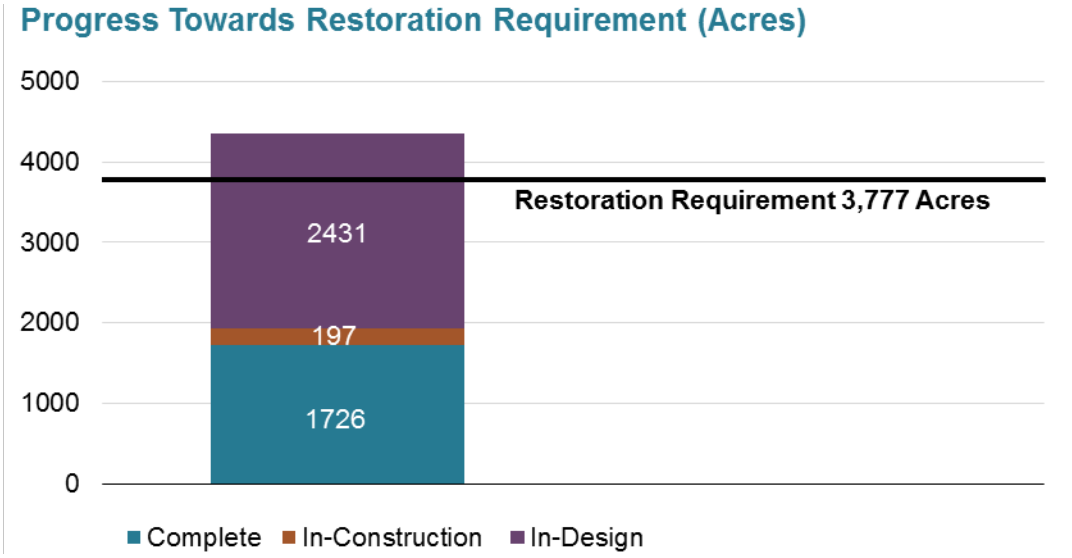


Figure D-1 Montgomery County Progress Towards the Watershed Restoration Requirement

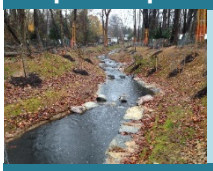
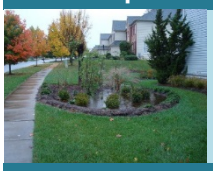
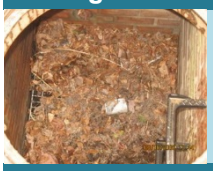
At the end of the third generation MS4 permit term (February 16, 2015), DEP succeeded in restoring 1726 acres of impervious area equivalent credit completing 46% of the restoration requirement. Once the projects in-construction are complete, this percentage will increase to 51%. Of the projects in-design, 1854 acres, representing 76% of the 2431 acres in-design, will need to be constructed in order to meet the restoration requirement.

One important factor contributing to the significant number of acres still is design is that CIP projects were programmed in the approved FY13-18 budget assuming design occurring within a 15-month period and construction occurring immediately after final design. The 15-month design period reflected the need for making the regulatory permitting process as efficient as possible, and recognizing the proposed projects are an environmental benefit once they are constructed. As implementation progressed, it became evident that the 15-month design period was impractical and DEP recognized the challenges of meeting the permit requirements of the

restoration work. In response, DEP decided to issue task orders to design all work necessary to meet the permit requirements before the end of the permit term. By tracking progress throughout the third generation MS4 permit term, DEP became aware of the challenges it faced in meeting the restoration requirement. DEP made strategic changes that led to better outcomes for the environment with the County committing that the restoration requirement will be met once all in-design projects are complete.

The Country pursued restoration credits through six unique delivery methods. These methods included CIP projects, RainScapes and WQPC Credits, complementary restoration projects, management programs, new development and redevelopment, and agency partnerships. The total impervious acre credits from each delivery method including a status breakdown of complete, in-construction and in-design acres are shown in Table D.1.

Table D.1 Summary of Impervious Acre Credit by Delivery Method and Status

	Complete	In-Construction	In-Design	Total
Capital Improvement Projects	**663.6**	**152.2**	**2268.8**	**3084.6**
 Stream Restoration	88.7	57.5	510.2	**656.4**
Green Streets	19.1	0.6	91	**110.7**
Government Facilities	3.2		34.1	**37.3**
Stormwater Retrofits	552.6	94.1	1633.5	**2280.2**
RainScapes and WQPC Credits	**38.8**			**38.8**
 RainScapes	15.8			**15.8**
WQPC	23.0			**23.0**
Complementary	**6.1**	**19.7**	**8.5**	**34.3**
 Reforestation	6.0	19.7	8.5	**34.2**
Impervious Surface Removal	0.1	0.03		**0.1**
Management Programs	**248.6**			**248.6**
 Street Sweeping	162.6			**162.6**
Catch Basin Cleaning	86.0			**86.0**
New Development and Redevelopment	**305.2**			**305.2**
 MCPS	12.8			
M-NCPPC	3.3			
Private	53.4			
New BMPs Treating Existing Impervious	235.7			
Agency Partnerships	**463.5**	**25.5**	**153.3**	**642.3**
 ICC	252.7	16.9	58.8	**328.4**
WSSC	23.2	8.6	94.5	**126.3**
DGS	0.9			**0.9**
MCPS	0.7			**0.7**
DOT	50.0			**50.0**
USACE	136.0			**136.0**
Total	**1725.8**	**197.4**	**2430.6**	**4353.8**

The relative contribution of each delivery method is illustrated in Figure D-2 showing both the contributions divided by status as well as in total. While the number of impervious acre credits earned through the different methods varies greatly, each acre contributes to improving water quality.

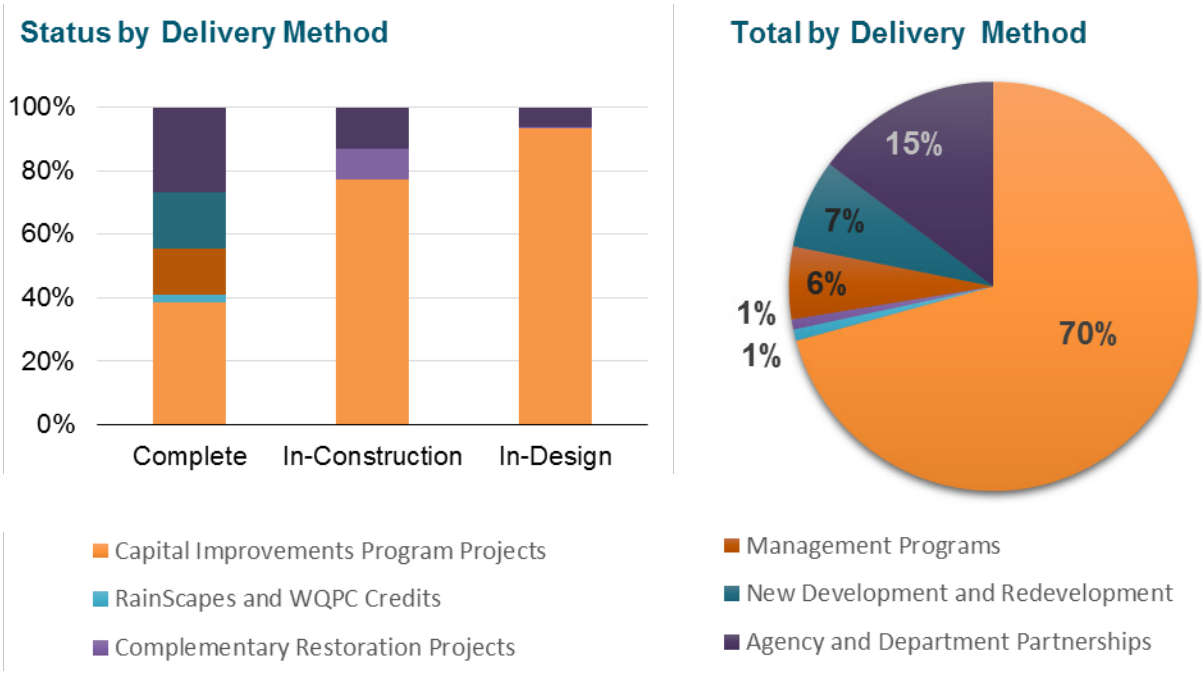


Figure D-2 Contribution of Impervious Area Credits by Delivery Method by Status and Total

As illustrated in Figure D-2, the CIP projects form the foundation of the County's restoration program contributing 70% of total impervious acre credit. Agency partnerships are the next largest contribution followed by new development and redevelopment and then management programs. RainScapes and WQPC credits and complementary restoration projects have the smallest contributions. However, the value of these methods, especially for RainScapes implementation, lies not only in the number of acres, but in the public outreach impact.

The project types and credit accounting approach is described in the following sections for each delivery method. Additional detail is provided for CIP projects including Stream Restoration, Green Streets, Governmental Facilities, and Stormwater Retrofits as these projects represent not only the largest contribution toward the restoration requirement, but also DEP's greatest commitment of financial and personnel resources.

D.I.1 GREEN INFRASTRUCTURE

Most County restoration projects fall within the realm of green infrastructure, as described by EPA. Stream restoration, reforestation and impervious cover removal contribute to the County's network of green corridors and patches that provide habitat, filter pollutants and absorb stormwater runoff. Even stormwater pond retrofits help to improve water quality and enhance habitat.

What is Green Infrastructure?

Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water.

U.S. EPA Office of Water
http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm

In addition to its more traditional, larger-scale restoration and retrofit projects, the County has worked to progressively increase its implementation of green infrastructure at the neighborhood and site scale. ESD practices have been and will continue to be implemented on public and private properties countywide through a variety of delivery methods.

Within the CIP, Green Streets and Government Facilities and Schools focus on implementation of ESD practices along roads and on publicly owned lands. These ESD practices account for 148 acres of the total CIP impervious area credits. RainScapes and WQPC Credits both incentivize installation of ESD practices on residential, institutional, and commercial properties. These programs have contributed 38.8 acres of impervious area credits. Finally, ESD practices that contribute 68.7 acres of impervious area credits have been or are being implemented through Agency Partnerships. The 256 acres treated by ESD practices may comprise only 6% of the 4,354 acres of imperious area credits the County achieved during this permit cycle, but they represent a commitment by DEP to increase ESD implementation in the future.

D.ii. Capital Improvements Program Projects

CIP projects are the primary delivery method for watershed restoration and thus serve as the foundation of the restoration program. The CIP is managed by DEP and funded by the WQPC as described in Section B.iii.1. As illustrated in Figure D-3, CIP projects account for a majority of the impervious acre credits that are treated by restoration. CIP projects contribute 3084.6 acres of impervious area treatment – 70% of the total 4,353.8 acres completed, in-construction or in-design.

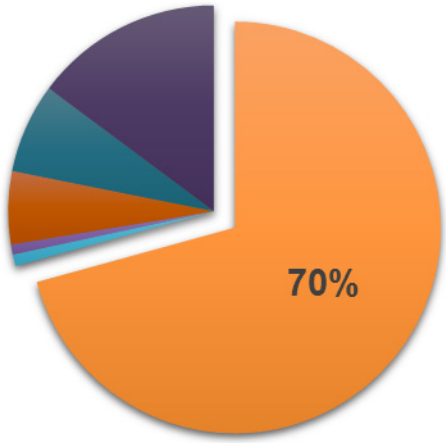


Figure D-3 Percentage of Total Impervious Acre Credits from CIP Projects

There are four types of projects undertaken by the CIP including stream restoration, green streets, projects at government facilities and County schools, and stormwater retrofits. CIP projects require the largest investment of financial and other resources in comparison to other delivery methods.

All projects undertaken by the CIP follow the Watershed Restoration Project developed to help prioritize projects and ensure smooth implementation (Figure D-4). The first step of this process – the Watershed Study Process – is detailed in Figure D-5.

In order to meet the 20% restoration requirement, the number of CIP projects to be carried out increased dramatically during the third generation MS4 permit. Increasing the number of CIP projects meant growing the CIP capacity. The larger number of projects also created an opportunity to identify and implement successful strategies and provide insight on how to avoid the setbacks and challenges faced by DEP in working towards the 20% restoration requirement. Following a description of each project type, project timeframes are discussed and lessons learned compiled to highlight successful strategies for implementing CIP projects.

Figure D-4 Montgomery County's Watershed Restoration Project Process

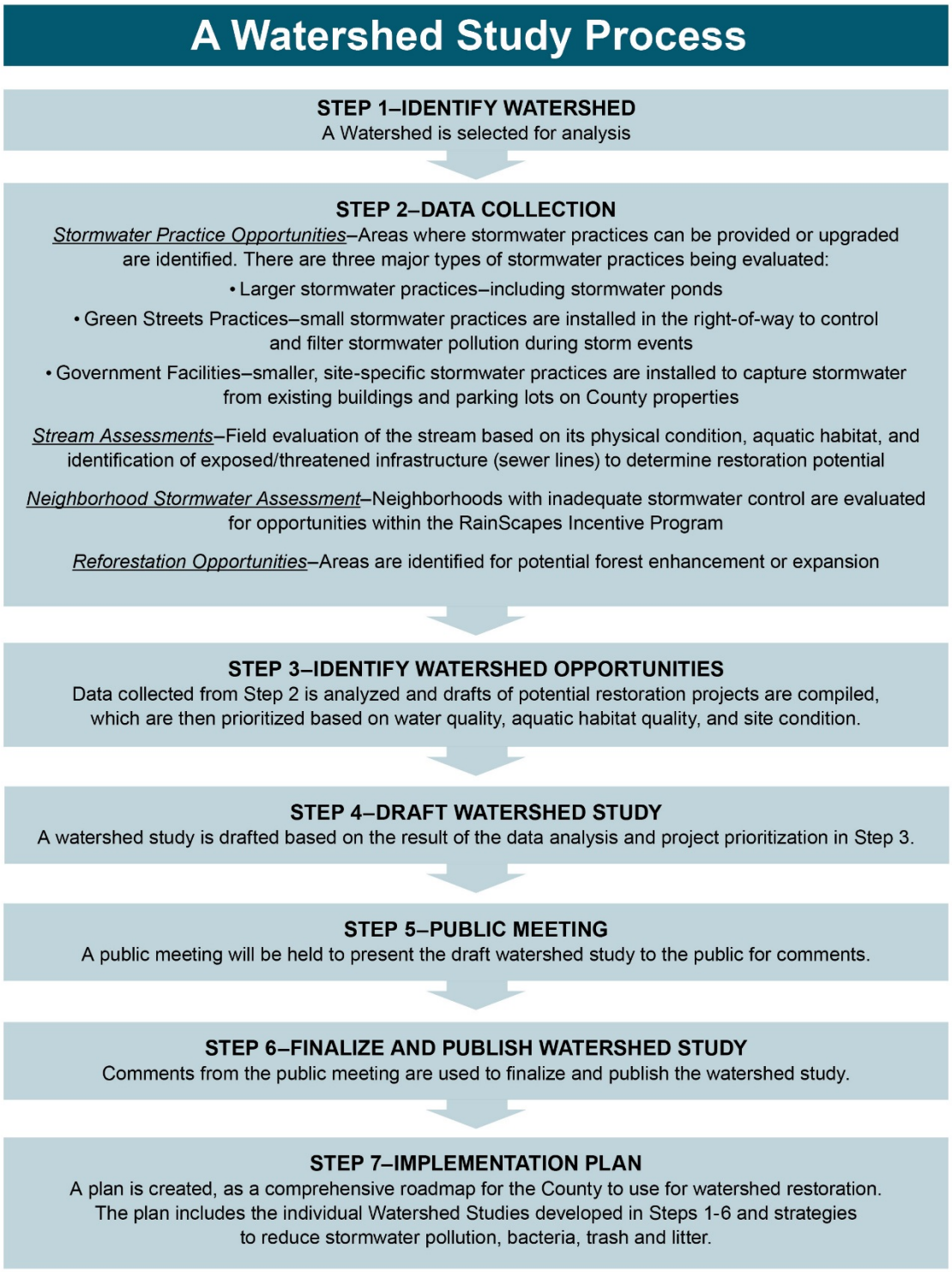


Figure D-5 Montgomery County's Watershed Study Process

D.II.1 STREAM RESTORATION

Stream restoration involves the rehabilitation of degraded stream channels (Figure D-6) and is considered green infrastructure. Restoration is intended to reduce streambank erosion and sedimentation, enhance riparian and in-stream habitat conditions, and improve water quality conditions.

Figure D-6 Completed Stream Restoration on Hollywood Branch

Stream Restoration	
88.7	Impervious Acre Credit - Complete
57.5	Impervious Acre Credit - In-Construction
510.2	Impervious Acre Credit - In-Design

Stream degradation occurs when urbanization results in increases in impervious surface and widespread deforestation that significantly alter the hydrologic dynamics in the local watersheds. These processes cause negative impacts such as sedimentation, excess nutrients, channel entrenchment, loss of forested riparian buffer, and streambank erosion.

Common stream restoration practices include raising the elevation of the existing channel or excavating a floodplain, installing in-stream boulders and large woody debris structures to stabilize the stream bed and adjacent banks and diversify in-stream habitat, installing constructed riffles to increase channel roughness to reduce stream bed scour, and establishing a wooded riparian buffer. Of the total 3,084.6 acres of restoration implemented as part of the CIP program, 656.4 equivalent acres are stream restoration.

Impervious Crediting Approach

The impervious crediting approach for stream restoration is determined by the MDE 2011 Draft Guidance Document and the MDE 2014 Final Guidance Document. Stream restoration is credited at a rate of one equivalent impervious acre per 100 linear foot of restored stream.

Accomplishments

- Each of the County's streams presents a slightly different history of function and impairments, and the restoration opportunities vary by site. In order to maximize the effectiveness of stream restoration implementation, the County developed the Watershed Restoration Project Process to identify the highest priority projects. The process also allowed for the development of site-specific project goals that correspond to the critical issues and causes of stream degradation.
- In addition to thoughtful project selection and execution, the stream restoration projects also include pre- and post-construction monitoring and discharge characterization to evaluate the success of the project. This documentation of the restoration benefits is an asset in building support for the projects. Sites are typically monitored for two consecutive years prior to construction and five consecutive years following construction, with a final monitoring event a decade after construction. Project-specific monitoring protocols are developed to assist in evaluating whether or not a given project has successfully fulfilled its goals.

D.II.2 GREEN STREETS IMPLEMENTATION

Green Streets projects consist of designing and constructing ESD stormwater treatment facilities within existing street rights-of-way and are another green infrastructure method. These projects capture stormwater runoff in neighborhoods with minimal existing stormwater controls and insufficient open space to install large stormwater practices.

Figure D-7 Completed Dennis Avenue Green Streets ESD Facility During Rainfall

Green Streets designs are highly variable, but all include some combination of rain gardens, swales, permeable pavement, curb extensions with bioretention areas, and tree boxes (Figure D-7). In addition to the stormwater management and treatment benefits, Green Streets projects create aesthetically attractive streetscapes, provide improved natural habitat, and calm traffic.

Green Streets	
19.1	Impervious Acre Credit - Complete
0.6	Impervious Acre Credit - In-Construction
91.0	Impervious Acre Credit - In-Design

Green Streets projects follow the Watershed Restoration Project Process with expanded site assessments that consider neighborhood and streetscape characteristics including existing right-of-way feature dimensions, underlying soil characteristics, and area traffic dynamics such as parking, pedestrian, and bicycle facilities.

DEP collaborates closely with DOT to implement Green Streets projects in areas where roadway maintenance or renovation is planned.

Impervious Crediting Approach

Green Streets project credits are calculated as the sum of credits earned for each individual ESD facility implemented to the MEP, per the Maryland Stormwater Design Manual. ESD facility credit is established by MDE and is based on the impervious area removed, rainfall depth treated, and the watershed area draining to the facility.

Accomplishments

- Among CIP projects, Green Streets are usually under the most intense public scrutiny because the work is highly visible and directly affects residents. It is a major accomplishment that each Green Streets project to date has been successful in building a supportive stakeholder coalition.
- The Strategy prioritized a greater focus on implementing ESD in urban watersheds of Rock Creek and Anacostia River watersheds. The increased number of Green Streets projects helps to integrate stormwater treatment along roads, which convey a large proportion of nutrient runoff.
- The partnership between DEP and DOT is being continually strengthened through Green Streets projects collaborations that pave the way for more efficient communication, information transfer and new project partnerships.

D.II.3 GOVERNMENT FACILITIES AND COUNTY SCHOOLS

This section describes projects to improve stormwater management and treatment on properties owned by the County government and Montgomery County Public Schools (MCPS) by retrofitting sites with new ESD facilities. These projects are also considered green infrastructure.

Projects sites include schools, libraries, community recreation centers, and park and ride facilities.

The County approach to retrofitting its government facilities is outlined in the Strategy, with DEP designated to oversee the design, permitting, and construction. Retrofit plans provide treatment of water quality volume or environmental site design volume to the extent practicable by implementing ESD facilities on-site or within the public right-of-way (Figure D-8).

Figure D-8 Completed Bioretention ESD Facility at Aspen Hill Library

Government Facilities and County Schools	
3.2	Impervious Acre Credit - Complete
34.1	Impervious Acre Credit - In-Design

While the project objectives are to manage the largest volume of runoff possible, the availability of green space can be at a premium at these sites, making space-efficient design an important priority. Government facilities projects implement ESD facilities such as rain gardens, swales, curb extensions, and permeable pavement. Inlet retrofits or non-structural practices such as disconnecting runoff conveyances from local water bodies are also considered on a case-by-case basis.

While modifying or retrofitting existing stormwater ponds at the sites are generally beyond the scope of these projects, the possible contribution from all existing controls and infrastructure is considered in formulating the design plans. DEP also works closely with MCPS on school projects.

Impervious Area Crediting Approach

Similar to Green Streets projects, government projects credits are calculated as the sum of credits earned for each individual ESD facility implemented to the MEP, per the Maryland Stormwater Design Manual. ESD facility credit is established by the MDE guidance document and is based on the impervious area removed, the rainfall depth treated and the watershed area draining to facility.

Accomplishments

- Each completed project successfully balanced the needs of water management with competing demands for the use of the available green space.
- Three retrofit projects were completed including Aspen Hill Library, Kensington Park Library, and Ridgeview Middle School. Sixteen projects are in design including nine school projects, three community/recreation center projects, and three Park & Ride center projects.
- DEP has assessed a total of 131 MCPS and 58 government properties for ESD retrofit opportunities and maintains a retrofit inventory database of possible retrofit projects.

D.II.4 STORMWATER RETROFITS

Stormwater retrofits involve upgrading outdated stormwater infrastructure to meet current standards. Retrofit projects focus on stormwater ponds since they have the greatest potential for improvement. Stormwater ponds were one of the first stormwater management practices to become commonplace, but the design of ponds has changed significantly over the past 40 years, and many older ponds represent missed opportunities for efficient capture and treatment of runoff. Wet ponds and wetland ponds that provide habit and use plants are also considered green infrastructure.

Figure D-9 Completed Stormwater Pond Retrofit at Naples Manor

Stormwater Retrofits	
552.6	Impervious Acre Credit - Complete
94.1	Impervious Acre Credit - In-Construction
1,633.5	Impervious Acre Credit - In-Design

Modifying and updating older existing stormwater ponds in the County improves water quality and quantity control to the MEP (Figure D-9). The project objective for the retrofit designs is to manage the largest volume of runoff possible to meet the current MDE requirements for full Water Quality volume (WQv) and the channel protection volume (CPv) per the MDE Stormwater Design Manual[3]. On sites where both requirements cannot be met, the design must maximize use of the site toward achieving the WQv as a first priority. On sites where WQv cannot be met, channel protection volume is maximized.

Across the County, priority sites were selected through detailed watershed studies and in accordance with the general retrofit guidance provided by MDE.

Impervious Area Crediting Approach

The crediting approach for stormwater pond retrofits is established by MDE guidance documents. Retrofits are credited at 1 acre impervious per 1 acre of impervious drainage area captured if the facility provides treatment for the WQv to the MEP.

Accomplishments

- After a few projects met with early phase design delays, the project team implemented a series of practices that streamlined the permitting for these projects. Implemented practices included scheduling a pre-application meeting with MDE and the U.S. Army Corps of Engineers (USACE) to document commitments as well as proactive communication with DPS and M-NCPPC. These practices reduced but did not eliminate permitting delays.
- Several projects were redesigned in light of community input. While the redesigns were challenging, incorporating input led to projects that resulted in long-term good will and support for the restoration efforts of the County.

[3] The Water Quality Volume (WQv) is the storage needed to capture and treat the runoff from 90% of the average annual rainfall. The Channel Protection Volume (CPv) is the storage needed for 24 hour extended detention of the one-year, 24 hour storm event.

D.II.5 PROJECT TIMEFRAMES

To improve efficiency and speed project delivery DEP developed a consistent set of deliverables and tasks that guide and mark the progress of restoration projects. Figure D-10 illustrates the steps involved during the design/permitting phase and the construction phase.

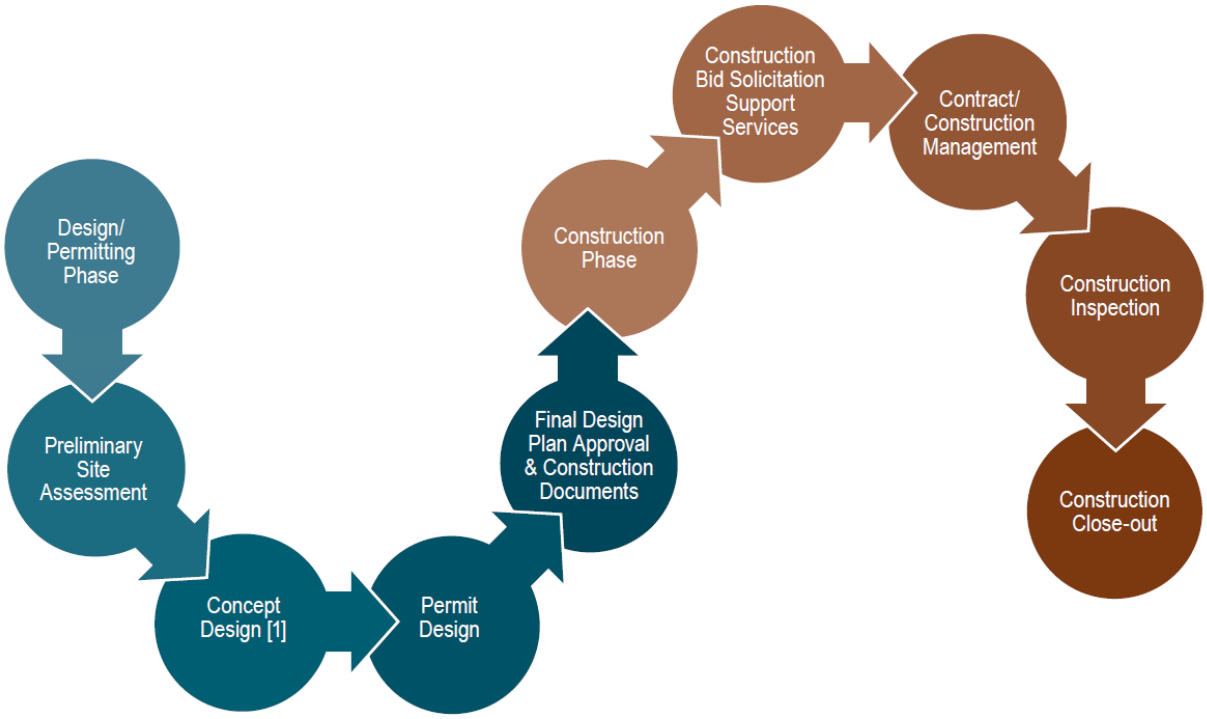


Figure D-10 Deliverables and Tasks for Design/Permitting and Construction Phases for CIP Projects
[1] Green streets projects do not require the concept design deliverable.

The outlined steps of each phase are carried out in collaboration between the WRE contractors, the PM contractor, and DEP. During the course of the third generation MS4 permit, DEP found that the time required for each step is highly variable based on a number of factors. Factors common to all projects are discussed first followed by a discussion of common timeframes and factors specific to project type.

Design and Permitting Phase

Review periods for permitting agencies require a certain amount of time that cannot be shortened, even with increased efficiency and streamlined communication. DEP continually strives for improving the quality of submitted permit applications in order to reduce revisions required later. However, unanticipated concerns can arise that require design revisions and delay permitting. DEP is working with other Phase I jurisdictions and MDE to evaluate how permitting can be streamlined and permitting times reduced.

Stakeholder input and community engagement are additional factors influencing the length of time required for the design and permitting phase. Organizing and carrying out meeting with community groups takes time. In addition, responding to concerns and incorporating input also extends the design phase. DEP recognizes community interaction and support is critical to the success of the projects and the overall watershed restoration program. As such, DEP will continue to take the time necessary to fully engage its project stakeholders.

Construction Phase

Weather can play a significant role in time to complete construction. Since restoration projects are generally located where water is found, excessive wetness from rain is a primary reason preventing construction from proceeding as scheduled. Similarly, snow-covered or frozen land can cause delays in the winter. The last stage of construction in most restoration projects is landscaping. To encourage the survival of new plantings, this stage is often carried out when it would be best for plant establishment. This means that construction can be mostly complete, but close-out is postponed because the planting is scheduled for later in the year. Additionally, following construction close-out, restoration project sites generally require an additional six to 12 months of landscape maintenance. So while construction is considered complete, DEP continues to invest time and resources to ensure the vegetation, critical to the project function, is maintained.

Stream Restoration

Design and permitting for stream restoration projects can take anywhere from 24 to 36 months. The length of the stream restoration project, location, severity of degradation, and complexity of the proposed restoration all factor into the time required to complete the design and permitting phase. Construction is highly dependent on the length of the project. DEP found the pace at which construction progresses to be roughly 250-350 ft/month. Shorter projects (1,500-2,000 ft) can take from six to eight months with longer projects (2,000-5,000 ft) taking from 12 to 15 months to complete. The longest projects (8,000ft) can take up to two year to construct. Construction schedules also have to be sensitive to stream closure periods. In total, DEP found stream restoration projects can take from three to five years to complete design/permitting and construction.

Green Streets

DEP has found design and permitting for Green Streets takes generally between 18 and 24 months to complete, extending to up to three years for particularly complex or large projects. Green Streets projects are integrated into neighborhoods, which means that community outreach and stakeholder input factors strongly in how long design and permitting takes. Time to complete construction depends on the number of stormwater facilities to be built. DEP found Green Streets projects can take from one to three years to complete construction. This timeframe includes completing all facilities for a project. As construction progresses, certain facilities are built and begin to function prior to the close-out of the whole project.

Government Facilities and County Schools

Government facilities and county schools CIP projects have a similar design and permitting time frame as Green Streets lasting generally from 24 to 36 months. This is due to the similarity in the types of facilities implemented, small scale ESD practices, and stakeholder input. During the third generation MS4 permit cycle, completed government facilities and county schools projects were smaller scale, composed of two to three facilities each. As such, the construction timeframe for these projects was much smaller, from three to six months. Another factor driving a shorter and more precisely timed construction schedule for these projects is the need to complete construction at schools during the summer months, when school is not in session.

Stormwater Retrofits

Stormwater retrofits can pose complex engineering challenges resulting in a design and permitting phase lasting from 24 to 36 months. The permitting process tends to be more time consuming because pond designs are often subject to more thorough inspection, due to risks associated with potential dam safety hazard classification. Additionally, community outreach

often involves interfacing with HOAs which requires additional involvement than with individual property owners. While stormwater retrofits involve greater time in permitting and design, the construction phase tends to be shorter with construction generally lasting on the order of four to six months with some projects extending up to a year and beyond depending on complexity. Pond retrofits are particularly subject to wet weather delays due winter conditions and extended wet periods.

D.II.6 CIP PROJECT LESSONS LEARNED

The following section compiles the lessons learned throughout the course of implementing the third generation MS4 permit watershed restoration CIP projects. Lessons learned are organized by phase including Design/Permit and Construction. Lessons learned that apply to all CIP projects are presented first with project type specific lessons following.

Design/Permit Phase

- Compliance with the M-NCPPC Forest Conservation Law requires approval of forest conservation plans and working around existing forest conservation easements within or otherwise affected by project work (e.g. by their proximity to access routes). While this process can extend the permitting timeframe, an exemption for linear projects is currently in process and is intended to streamline the review process.
- Identify and address site constraints and community concerns as early as possible. Changes later in the project are more difficult to incorporate.
- Reconciling landowner disputes and/or preferences for site design in conflict with project goals can extend the design phase while the residents' concerns are integrated with a technical solution. Landowner input is important and proactive communication and outreach to address issues can be an opportunity to educate landowners.
- For ESD facilities, plant selection is important. Be flexible and ready to explain benefits of native plants.
- Effective staffing and ensuring proper oversight by senior staff is critical to maintain high levels of quality in all deliverables and to avoid straining performance capacity.
- Permitting review and community interaction are critical points in the design/permitting phase that have significant influence on the time to project delivery. While measures can be taken to streamline permit review, the time required for developing community support and integrating community input is highly variable and unpredictable.
- Schedule pre-application meetings with MDE and USACE and document commitments. Proactive communicate and check in with MDE, USACE, DPS, and M-NCPPC throughout the permitting process.

<u>Stream Restoration</u>

- MDE/USACE-401/404 permits require obtaining signed floodplain encroachment waivers from all landowners affected when where proposed hydraulic modeling indicates a 0.1' increase or greater than the existing 100-year floodplain elevation. The timeframe for obtaining these waivers is difficult to anticipate.
- It is best to tackle floodplain encroachments issues early in the process, especially before access/maintenance easements are obtained.

- Especially in highly urbanized watersheds, two-dimensional modeling is a valuable design tool to better predict existing and proposed system hydraulic dynamics in order to minimize design failures.
- Regarding easement acquisition:
    - Be as proactive as possible when engaging community where project is proposed. Visual aids and face-to-face are indispensable when discussing projects with the public.
    - Maintain diligence with easements especially with property transfers. If a property owner sells their property before an easement was recorded, the process restarts.
    - DEP is developing a list of frequently asked questions (FAQ) to assist landowners with understanding easements.

Green Streets

- Green Streets projects require frequent, proactive community outreach. Public input improves designs and provides insight into existing drainage issues, parking needs, traffic calming needs, and aesthetic preferences.
- The design approach should be undertaken in a manner that anticipates potential issues/conflicts with property owners. ESD facility designs need to be flexible to adapt to community input.
    - Two precedent Montgomery County Department of Transportation (DOT) green streets projects, Sligo Park Hills and Dennis Avenue, underwent significant design changes on the basis of community outreach and coordination. Perhaps more than other watershed restoration CIP projects, Green Streets are highly sensitive to community perception and acceptance, and thus are susceptible to substantial design modifications prior to construction, potentially resulting in project delays that are difficult to predict.
- Often, community members don't understand where their property ends and the street right-of-way begins. Clarifying this distinction can help to temper project expectations.
- Community support for the project can be facilitated by finding an advocate within the neighborhood's Homeowners Association (HOA) board or civic association. Emphasizing traffic calming as a project benefit can also enhance community support of projects along arterial streets.
- Design for ease of maintenance. Overly intricate designs are difficult to maintain.
- Location of street trees and trees on private property can limit opportunities to treat road runoff.

Government Facilities

- Communicate early and often with stakeholders and allow adequate lead time for scheduling meetings with stakeholders.
- Develop an understanding of traffic patterns and site uses early in the process, as they are critical to developing an acceptable design.
- When selecting facilities, consider the burden of maintenance and whether the party ultimately responsible will be able to maintain the facility.
- Carefully document meetings and decisions to capture the project history to prevent delays from higher turnover of staff at government facilities project sites.

- Initial site concept designs often change, with certain components dropping out due to reasons such as competing green space uses, parking or traffic flow demands, proximity to basements or buildings, safety concerns, cost-effectiveness, and maintenance.
- Access to sites for survey and geotechnical work must be coordinated with school of facility personnel.

Stormwater Retrofits

- Meet with HOAs early and as often as feasible and anticipate a substantial investment of time for HOA outreach.
- Concept design changed or projects were dropped for the following reasons:
  - Concerns with wet ponds including mosquitos, safety, reduction of green space, deer/duck/frog attractant. These were then usually converted to dry CPv facilities during various stages of design.
  - Other HOA concerns such as fences and access.
  - Small pond footprint that could not be expanded to add WQv or CPv.
  - The MEP design did not provide cost effective treatment volume.
  - Retrofit would create a dam hazard according to dam safety hazard classification.

Construction Phase

- Construction-related issues that may result in delays or otherwise derail projects include:
  - Differing site conditions
  - Utility conflicts such as inaccurately located utilities.
  - Weather delays (winter, excessively wet conditions, etc.)
  - Engineering Errors or Omissions
  - Poor contractor performance
- Once construction is complete, landscaping maintenance and permitting closeout typically lasts another 6-12 months. This range is due to a variety of possible situations such as construction finishing outside of planting season, proper vegetation is not established to release permits, or as-built drawings are not approved.
- Continual contact with residents and outreach events such as informal ribbon-cutting ceremonies help build support for watershed restoration CIP projects.

Stream Restoration

- Due to stream closure periods, in-stream work is restricted during certain times of the year. Stream restoration schedules are generally planned around this closure period. However, delays in permitting, easements, etc. may result in construction not finishing work before next stream closure period resulting in delayed project delivery.

Green Streets

- The ESD facility construction should be timed in coordination with DOT street improvements to protect newly-built facilities from potential contamination by activities such as resurfacing. Midway through construction in some portions of Sligo Park Hills, the street was milled to prepare for resurfacing. The milled debris was flushed by rain into recently constructed facilities and clogged permeable parking pads.

Government Facilities

- Due to safety concerns and potential impacts to normal operations, school project construction is recommended to be completed during summer months.

D.iii. RainScapes and WQPC Credits

The RainScapes and WQPC credits delivery method is an important component of the watershed restoration program because individual residents, property owners, and community groups become engaged in helping support the County stormwater efforts. These programs also play a key in educating the public and incentivizing changes in behavior that will have long-term positive effects on water quality and the environment. Both of these programs are considered green infrastructure.

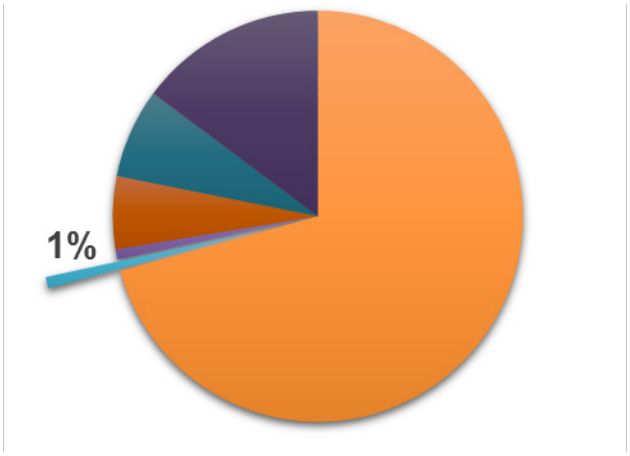


Figure D-11 Percentage of Total Impervious Acre Credits from RainScapes and WQPC Credits

RainScapes	
11.4	Impervious Acre Credit – RainScapes Rewards
1.8	Impervious Acre Credit – RainScapes Neighborhoods
2.6	Impervious Acre Credit – RainScapes Schools
WQPC Credits	
23.0	Impervious Acre Credit - WQPC

As illustrated in Figure D-11, impervious acres treated through RainScapes and WQPC credits represents a small portion of total progress towards the restoration requirement. However, these efforts directly support the goal of maximizing ESD practices in urban areas as set forth in the Strategy. Furthermore, as more of the large-scale projects identified in the watershed implementation studies are completed, the County will have to increasingly rely on small-scale widely distributed stormwater management treatments to meet future restoration requirements. Developing and improving implementation of RainScapes and WQPC credit programs is an investment in present day as well as future restoration efforts.

D.III.1 RAINSCAPES

DEP's RainScapes program promotes environmentally friendly landscaping, small scale stormwater control, and infiltration projects on residential, institutional, and commercial properties by offering technical and financial assistance to property owners for eligible techniques (Figure D-12). RainScapes techniques include rain gardens, tree plantings, permeable pavement retrofits, dry wells, water harvesting with rain barrels and cisterns, and conservation landscaping.

Figure D-12 RainScapes Project

The primary component of the RainScapes program is a rebate program called RainScapes Rewards. Additional efforts have been made through a subdrainage approach called the RainScapes Neighborhoods program, a community-based approach in other neighborhoods that have strong watershed groups and the RainScapes for Schools program for MCPS sites. After a five year pilot, the RainScapes Neighborhoods approach has been significantly redesigned and was re-launched in FY 2014.

RainScapes Rewards

The RainScapes Rewards rebate eligible projects reduce stormwater pollution and achieve measurable water quality benefit by controlling, at a minimum, the first inch of rainfall using runoff reduction techniques.

Projects provide a visible and distributed presence for stormwater management on private lots across the County and are serving to raise both public awareness and action. The RainScapes Rewards program is funded through the Water Quality Protection Charge and the lifetime maximum rebate per residential parcel is $2,500.

Since the program's inception in 2008, 530 RainScapes Rewards rebates have been awarded for projects contributing a total of 11.4 impervious acre credits. In FY13, participants in the program shifted towards more substantial projects, such as permeable paver retrofits rather than smaller water harvesting/rain barrel projects. This appears to be the direct result of the training program that was instituted in FY10, which has provided free training to landscape professionals to educate local professionals about the RainScapes/ESD approach to storm water management, the incentives offered by the County RainScapes program and the support to those professionals provided by the application and review process.

The process for a RainScapes Rewards projects is illustrated in Figure D-13 below. The total time for implementing RainScapes Rewards projects is highly variable because so many steps in the process depend on the homeowner rather than the County.

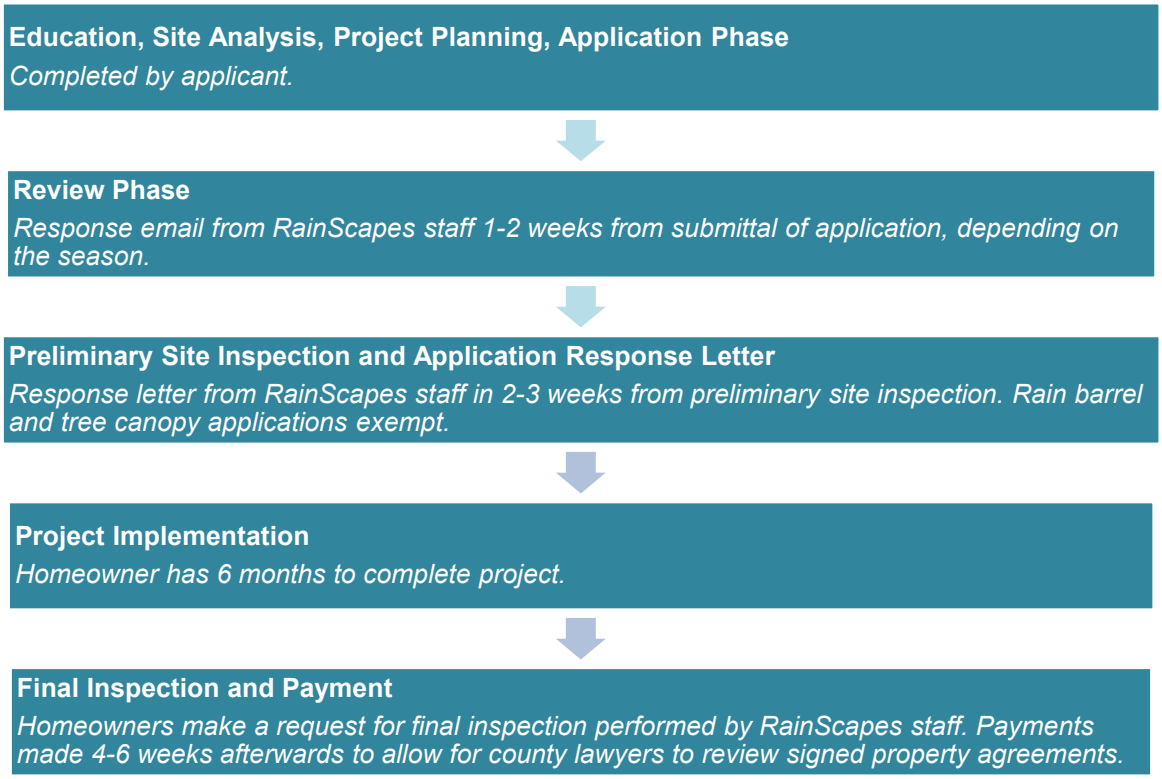


Figure D-13 RainScapes rewards program process

RainScapes Neighborhoods

The RainScapes Neighborhoods Program was developed as a data-based approach which would allow modeling estimates for reduction to be evaluated with actual field results. The intent was to evaluate installation effectiveness within small, targeted neighborhood-scale catchments for on-lot stormwater runoff reduction practices. The approach was to interest property owners into allowing projects to be installed by DEP and affiliated watershed groups. Priority areas for the program efforts in targeted neighborhoods were established in priority watersheds with active citizens' group or watershed organizations to leverage education and outreach efforts. The RainScapes Neighborhoods program implemented 41 projects contributing 0.88 acres of impervious acre credit in the neighborhoods of Breewood, Forest Estates, Garrett Park, Glen Echo Heights, Ken Gar, Sligo Park Hills, the Town of Chevy Chase and Wheaton Woods. These RainScapes Neighborhoods used an approach in which the County paid the full cost of design and installation of RainScapes practices at no cost to the property owner other than an agreement to allow access and then to maintain the project. Figure D-14 shows two completed RainScapes Neighborhood projects.

Figure D-14 Completed RainScapes Neighborhoods Projects at Forest Hills (left) and Glen Echo Heights (right)

Other neighborhoods were selected based on an approach of partnering with local watershed groups. Under this approach, DEP RainScapes matched outside grant funding. Grant funds were used for design and site preparation and DEP RainScapes funds were used for plants and mulch. Volunteers were responsible for providing and coordinating volunteer labor. Additional demonstration projects were installed to train watershed group members and design professionals on the particular details of assessing sites, installing rain gardens, and other RainScapes projects. Overall, these 24 projects added control to another 0.89 impervious acres.

After a review in the summer of 2013, a change to the RainScapes Neighborhoods program was made to shift to a site assessment and education focus, rather than a direct installation focus. Extensive outreach was carried out in targeted towns with workshops, individual site assessments prepared for interested property owners, and follow-up design assistance.

The RainScapes Neighborhoods program goal is now to provide technical support and information so that property owners can better participate in the RainScapes Rewards program to more rapidly expand the extent of RainScapes installations.

This new RainScapes Neighborhoods effort is grouped under the heading of RainScapes Communities. Education and site assessment will be the main tools of this Community based approach, with RainScapes Rewards providing the technical review and cash incentives. The concept of RainScapes Communities provides RainScapes outreach and interaction with communities identified through watershed studies and through other groupings such as HOAs, Congregations and Community Pools.

RainScapes for Schools

Figure D-15 Students Involved with RainScapes for Schools Project at Seven Locks Elementary School

RainScapes for Schools was initiated in 2008, with a goal of providing curriculum storm water management demonstration project at Montgomery County Public Schools (MCPS) as part of our Co-Permittee agreement. 15 projects have been installed at MCPS sites, and add control for 2.61 impervious acres on MCPS sites (Figure D-15). In addition, the RainScapes for Schools Growing program has supported high school horticulture curriculum in MCPS and is now providing about 800 plants per year to DEP to use for demonstrations and outreach events as well as replacement plants for storm water management facilities. This novel approach has provided education to 300-400 high school students and 30-60 elementary or middle school students per year in the MCPS system.

Impervious Area Treated and Crediting Approach

The RainScapes program accomplishments were credited as treating impervious area where possible according to the following considerations.

- Credit for dry wells, green roofs, permeable pavement, pavement removal, rain gardens, rain barrels and cisterns is calculated based on the MDE 2014 Final Guidance Document.
- Impervious cover credit for individual trees and conservation landscaping is based on a technical memo developed by the Center for Watershed Protection (Appendix D).

Accomplishments

- The number of RainScapes Reward projects submitted each year has risen steadily suggesting successful public outreach and increasing interest of County residents to participate in improving stormwater treatment.
- Instituted an online application process and internal database tracking system to improve customer service and reporting times
- DEP staff significantly reduced wait time to receive Rewards payments down to 2 months
- Standardized inspection forms and switched to iPad technology which increased efficiency of site visits and reporting.
- Over 400 landscape professionals have attended our RainScapes training and four courses for LID/ESD maintenance and restoration have been created at Montgomery College.
- Successfully launched the used of social media to educate the public
- Provided direct training to over 1500 residents in hands-on workshop format in addition to the large number of attendees at various other public speaking at invited events.
- Created an educational video which is available online for all who visit the RainScapes website
- RainScapes staff have been invited to speak on EPA webinars, national and regional conferences and have offered training to a large number of surrounding municipalities on how to start an incentive program. Considerable outreach efforts have established RainScapes as a term that the general public is beginning to globally recognize, associating it with all storm water and environmentally supportive landscape practices, whether on private property or on public property.

RainScapes Program Insights

The RainScapes program has worked through a range of approaches to reaching out to the County residents since program inception, going through a few cycles of innovation.

RainScapes Rewards

- Residents indicate that they like RainScapes because the program enables them to reduce their personal negative impact on the environment, the program offers both technical and cash assistance and the installations beautify their home or institutional setting. Two key lessons were that once involved, most indicated that they want to do more and they saw the program as striking the proper balance between the role of property owners and government.
- There are several key components of a successful rebate/incentive program. There must be a well-designed and robust method for tracking data, preferably a database approach. Adequate administrative support is essential. Appropriate technical methodologies, including online inputs of applications, and GIS and tablet technology can help to improve accuracy and efficiency. Informational handouts should be straightforward and easily understood. Finally, marketing should be aggressive.
- Rain barrels are good candidates for a non-rebate approach – either through workshop delivery with contractor installation option or via a utility offering them as an installation. Proper maintenance of rain barrels can be onerous and they capture relative little water for the funds expended. Requiring 200 gallons of capture addressed the capacity issue but eliminated some participation.

RainScapes for Neighborhoods

- Providing free rain gardens, rain barrels and conservation landscapes/ drywells was not a fiscally sustainable model. In addition, the process of finding participants, satisfying County contracting requirements and contractor availability increased project time. The current program provides site assessment services in neighborhoods after extensive outreach, and appears to be a more cost effective way for the County to proceed.

D.III.2 WATER QUALITY PROTECTION CHARGE CREDITS

The Water Quality Protection Charge (WQPC) is the primary method for funding the watershed restoration program. The WQPC is applied to all eligible properties in the County and described in detail in Section B.ii.1. However, property owners have the opportunity to apply for credit to reduce their WQPC if they maintain stormwater management practices on their property. The reporting associated with this application provides the County an additional avenue by which to track restoration activity and calculate the amount of impervious surface that is treated.

Stormwater management practices that landowners present in their applications include rain gardens, green roofs, swales, conservation landscaping, dry wells, infiltration trenches, porous pavement, wet ponds, sand filters, rain barrels, dry ponds and underground storage.

To receive the credit, the property owners must submit an application to DEP by the annual deadline (September 30). The amount of the credit earned by each stormwater management practice is based on the type of practice and the volume of water treated. The maximum credit a property owner can receive is 80% of their charge using ESD and 50% using traditional stormwater approaches. There are some baseline expenses such as the inspection of stormwater facilities and storm drain maintenance that all property owners are expected to contribute to.

The WQPC credit is related to the RainScapes Rewards program in that the RainScapes Rewards program supports the implementation of new practices whereas the WQPC credit is an

ongoing credit for having such practices in place. Property owners participating in the RainScapes Rewards program may apply for WQPC credit once the new practice is in place.

Impervious Area Treated and Crediting Approach

The WQPC credit program allows DEP to track and claim impervious acre treatment credits for the stormwater practices reported by landowners seeking the credit.

Only the properties within the MS4 permit area and outside of a drainage area that is already receiving credit are incorporated. While projects credited through the RainScapes program are eligible for a WQPC credit, the County does not include those projects in the WQPC impervious area accounting since the credit is claimed through the RainScapes delivery method.

Qualifying nonresidential credit applications are researched and the treated amount of impervious surface is recorded. Qualifying residential credit applications are researched and the total water quality volume needed to receive full credit and the actual water quality volume being treated are recorded. The resulting percentage is applied to the total impervious on the property, which yields the amount of impervious being treated. Impervious area treated from all eligible applications is added to arrive at a total sum for the County. The total impervious area treated and captured by the Water Quality Protection Charge credit program is 23 acres.

D.iv. Complementary Restoration Projects

Complementary restoration projects include reforestation and impervious surface removal. These project opportunities are identified through a variety of methods, including watershed assessments and BMP retrofit evaluations. To streamline implementation, they are often combined with larger retrofit or restoration projects in their vicinity.

Complementary restoration projects represent a small fraction of the total watershed restoration progress (Figure D-16). However, these projects are important because they demonstrate the County's commitment to treat additional impervious areas even at small scales as the opportunities present themselves.

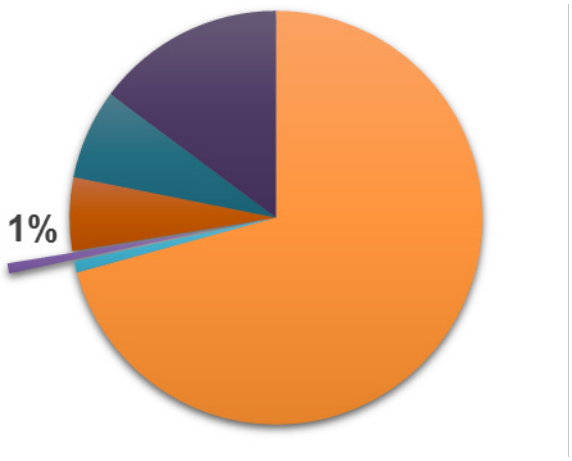


Figure D-16 Percentage of Total Impervious Acre Credits from Complementary Projects

Reforestation	
6.0	Impervious Acre Credit - Complete
19.7	Impervious Acre Credit - In-Construction
8.5	Impervious Acre Credit - In-Design
Impervious Removal	
0.1	Impervious Acre Credit - Complete
0.03	Impervious Acre Credit - In-Construction

D.IV.1 REFORESTATION

Montgomery County understands and recognizes the importance of establishing the next generation of native trees and understory (smaller trees and shrubs) to help improve our environment. Reforestation also contributes to improved stormwater management. To this end, watershed studies across the County identified specific areas as having potential for reforestation. As restoration projects are funded, adjacent reforestation opportunities are integrated into the restoration design and construction plans and then monitored long term by DEP (Figure D-17).

Figure D-17 Gum Springs Farm Botanical Reforestation Before (left), After (right)

The reforestation site locations are protected by various safeguards. Some are located on County property, within an easement area, or within a stream buffer protected from potential deforestation. In addition to these safeguards, a botanical monitoring assessment is conducted throughout the reforestation period, and stressors such as invasive species, deer browse/rub, and vandalism are documented and reduced if possible. One of the most valuable lessons learned by the County is to avoid planting small plant material due to low survival rates.

Impervious Area Treated and Crediting Approach

Crediting reforestation efforts requires field evaluations to determine whether a site would meet the criteria for impervious equivalent credit. These site visits were also used to gather information on how to improve the sites so that they would qualify for future reforestation credit.

The County identified and field evaluated 62 reforestation sites. Of those sites, 38 sites were determined to meet MDE's reforestation criteria as defined in the MDE 2011 Draft Guidance Document to receive impervious credit. MDE criteria require a survival rate of 100 trees per acre or greater with at least 50% of trees having two-inch diameter or greater at 4.5 feet above ground.

The reforestation monitoring protocol and detailed impervious area calculations are documented in Appendix C. In total, reforestation has contributed impervious areas treatment credit for 34.2 acres.

D.IV.2 IMPERVIOUS SURFACE REMOVAL

During the design phase of each restoration project, the County examines and identifies opportunities where underutilized impervious surfaces can be removed. In cases where the locations of the impervious surfaces are not incorporated into a new BMP, the County removes the impervious surface and provides a minimum of four inches of topsoil where either seed or sod is placed to establish an urban pervious surface. The majority of the impervious surfaces removed are either converted to urban pervious or are part of a new ESD practice such as a rain garden, bioretention practice or swale. Figure D-18 illustrates a completed impervious surface removal project where the impervious was replaced with pervious cover.

Figure D-18 Example of Impervious Surface Removal Before (left), After (right)

Impervious Area Treated and Crediting Approach

To receive credit for impervious area removal, the sites must meet criteria in the MDE 2011 Draft Guidance Document, which requires vegetative cover for 95% of the area. Credit is awarded at a rate of 0.62 credit acres per 1 acre of eligible impervious surface removed. In total, 0.1 acres of credit were accomplished via this delivery method.

D.v. Management Programs

DEP oversees the implementation of numerous management programs to meet the MS4 permit requirements. These include illicit discharge detection and elimination, anti-litter programs, outreach and education, and road maintenance pollution prevention programs. Certain road maintenance procedures (street sweeping and catch basin cleaning) can also earn impervious acre credit towards the watershed restoration requirement. The management programs delivery method contribute 6% of the total restoration acres through street sweeping and catch basin cleaning efforts (Figure D-19).

Street sweeping and catch basin cleaning are described in the following sections. These activities are completed working in close partnership with the DOT.

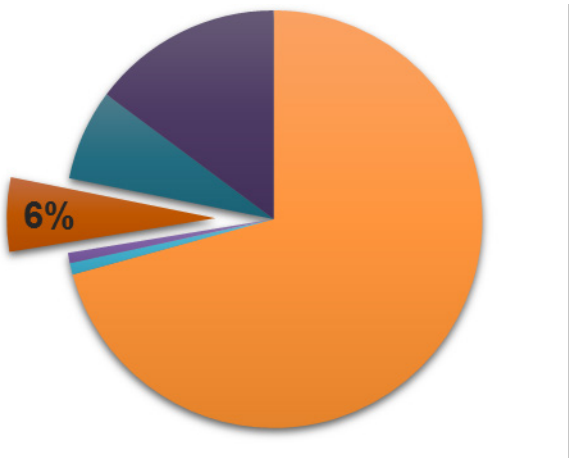


Figure D-19 Percentage of Total Impervious Acre Credits from Management Programs

Street Sweeping	
162.6	Total Impervious Acre Credit FY14
Catch Basin Cleaning	
86	Total Impervious Acre Credit FY14

D.V.1 STREET SWEEPING

Street sweeping removes debris and abrasives from road surfaces, helping to keep drainage systems clean and preventing pollutants from entering the waterways (Figure D-20). Street sweeping was required by the MS4 permit and was initially conducted by DOT using both DOT and DEP funding. Sweeping efforts generally concentrated on two types of roadways: residential neighborhoods and selected arterial routes that had more commercial activity, traffic and observed trash.

Figure D-20 Street Sweeping

In FY12, DEP increased the frequency of sweeping the arterial routes from once to twice each month. According to the MDE 2014 Final Guidance Document, this frequency allowed the County to earn equivalent impervious acre treatment credit and stormwater pollutant load reductions toward TMDL goals. In FY14, DEP assumed all oversight and inspection of the arterial sweeping program. To maximize the efficiency of the program, DEP is currently identifying new arterial routes that are concentrated in areas with watershed TMDLs such as Anacostia and Rock Creek for twice monthly sweeping.

DOT sweeps many additional miles of residential roads, with DEP helping to prioritize the routes that can recover material in sensitive areas. While these additional efforts contribute to meeting the general goals of the road maintenance program and benefit water quality, they are not eligible for equivalent acre credit. As of FY15, funding for all street sweeping comes from the WQPC.

Impervious Area Treated and Crediting Approach

Impervious area credit is calculated based on the MDE 2014 Final Guidance Document that credits 0.40 impervious acres per ton of material removed on roads that are swept twice monthly.

For FY14, the County collected 406.4 tons of material controlling an impervious acreage equivalent of 162.6 acres.

D.V.2 CATCH BASIN CLEANING AND STORM DRAIN VACUUMING

Catch basins located along the curb line allow stormwater to enter the storm drain system. They also catch sediment, debris, and trash below the inlet in order to prevent the materials from clogging the storm drain pipes and polluting receiving waters. As catch basins fill, they need to be cleaned out in order to continue performing their important function.

Cleaning is carried out by DOT using a vacuum truck to remove material that has accumulated in the catch basin. The vacuum is also used to remove material along the length of the storm drains via manhole access points.

DEP works with DOT to track the amount of material removed from catch basins and storm drains during the cleaning process. DEP is then able to claim impervious acre equivalent credit for the removal of sediment, debris, and trash and to claim stormwater pollutant load reductions toward TMDL goals.

Impervious Area Treated and Crediting Approach

Impervious area credit is calculated based on the MDE 2014 Final Guidance Document that credits 0.40 impervious acres per ton of material removed from catch basin. In FY14, 217 tons of material was removed from the system resulting in credit for 86 acres of treated impervious area.

D.vi. New Development and Redevelopment

Throughout the course of the third generation MS4 permit, many areas of impervious cover that were not controlled to the MEP at the end of 2009 have become controlled to the MEP as a result of new development and redevelopment activities. The new development and redevelopment delivery method accounts for these newly controlled areas (Figure D-21).

While the new development and redevelopment efforts are carried out by entities other than DEP, DEP performs the necessary analysis in order to determine impervious acre credit towards the restoration requirement.

New development and redevelopments credits are calculated from four categories of activities: MCPS redevelopment, M-NCPPC property acquisition, private redevelopment, and newly added BMPs.

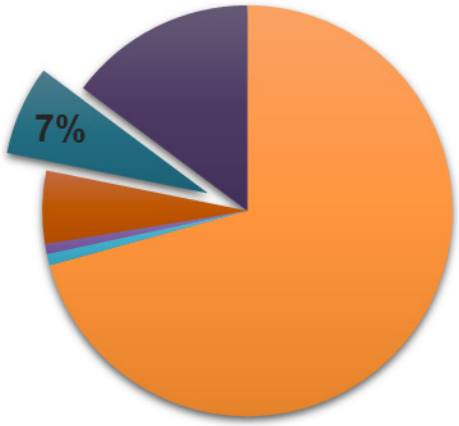


Figure D-21 Percentage of Total Impervious Acre Credits from New Development and Redevelopment

MCPS Redevelopment	
12.8	Total Impervious Acre Credit
Properties Purchased by MNCCPC	
3.3	Total Impervious Acre Credit
Private Redevelopment	
53.4	Total Impervious Acre Credit
New BMPs Treating Existing Impervious Cover	
235.7	Total Impervious Acre Credit

D.VI.1 MONTGOMERY COUNTY PUBLIC SCHOOLS REDEVELOPMENT

MCPS routinely completes modernization projects in which schools are torn down and rebuilt, often with implications for the impervious areas located at these sites that were considered uncontrolled in 2009. The redeveloped or modernized schools adhere to the County's requirement for on-site stormwater management for redevelopments.

Impervious Area Treated and Crediting Approach

During the third generation MS4 permit cycle, DEP analyzed 12 school modernization projects by reviewing available plans and documents, examining the site's GIS data, and reviewing aerial imagery. The methodology and analysis are detailed in Appendix E. The analysis only considered impervious areas within the County's MS4 area and impervious areas outside of already credited BMP drainage areas.

The areas that were impervious according to the Strategy but altered during modernization were reclassified as pervious, per the MDE 2011 Draft Guidance Document at the rate of one impervious acre equals 0.62 pervious acres.

For the 12 school redevelopment projects analyzed, 20.7 acres of impervious area was removed, resulting in 12.8 acres of impervious area credit.

D.VI.2 PROPERTIES PURCHASED BY MNCCPC

Property owned by Maryland National Capital Parks and Planning Commission (M-NCPPC) is a Phase II jurisdiction covered by a separate MS4 permit issued to M-NCPPC and is therefore excluded from the Montgomery County MS4 permit.

Throughout the County's third generation MS4 permit cycle, M-NCPPC has purchased additional properties whose area then becomes subject to M-NCPPC's MS4 permit rather than the County's permit. On these properties, uncontrolled impervious area represents a reduction in the County's impervious area. DEP completed the required analysis to determine the amount of eligible impervious area to credit from each transfer.

Impervious Area Treated and Crediting Approach

Calculating the impervious area credit from M-NCPPC property purchases involved a GIS analysis of property and impervious area data layers. Properties acquired by M-NCPPC after 2009 were flagged, and the acres of uncontrolled impervious area within each property were determined. M-NCPPC also provided DEP with data regarding impervious areas within parks covered by the County MS4 permit that had been demolished. This information was incorporated into the property purchase accounting.

Per the MDE 2011 Draft Guidance Document, impervious area transferred to M-NCPPC's MS4 permit area or removed from parks within the County's MS4 permit area from the County's MS4 area was credited at the rate of one impervious acre equals 0.62 pervious acres. As a result of the analysis, 55 qualifying properties were transferred to M-NCPPC and a total of 5.3 impervious acres were removed from the County's MS4 permit area, resulting in 3.3 acres of impervious area credit.

D.VI.3 PRIVATE REDEVELOPMENT

Private redevelopment occurring after 2009 also yielded newly controlled or removed impervious areas as developers conformed to current stormwater standards for the updated site design. Previously uncontrolled impervious area that becomes controlled as a result of redevelopment can be credited towards the restoration requirement.

While the redevelopment is carried out by private entities, DEP completes the analysis required to determine the impervious acre credit contributed by each project.

Impervious Area Treated and Crediting Approach

DEP analyzed redevelopment projects through a review of stormwater concept letters provided by the DPS and by investigating known redevelopment sites using aerial imagery. DEP then analyzed each project to determine eligibility for restoration credit.

Analysis included reviewing available permit and engineering documents as well as GIS evaluations of aerial images obtained at different times. The methodology and analysis are detailed in Appendix E. Impervious acreage was tabulated and summed for each of the 28 projects site referred to DEP by stormwater concept letters; only nine sites met all the criteria for the 2009 impervious areas on-site to be considered controlled. Investigating additional known sites resulted in 40 redevelopment projects that met all the criteria for the 2009 impervious areas on-site to be considered controlled. To be eligible for credit, redeveloped impervious area also had to be within the MS4 coverage area and outside already-credited BMP drainage areas.

The areas that were impervious according to the Strategy but altered during redevelopment, were reclassified as pervious, per the MDE 2011 Draft Guidance Document at the rate of one impervious acre equals 0.62 pervious acres. In total, the analysis of redevelopment sites results in of 53.4 acres of newly controlled impervious area.

D.VI.4 NEW BMPS TREATING EXISTING IMPERVIOUS COVER

Another source of restoration credits are stormwater Best Management Practices (BMPs) constructed after 2009 that control impervious area that was not controlled in 2009.

While DEP is not involved in the installation of the new BMPs, DEP completes the analysis necessary to calculate the impervious area credit from each BMP constructed after 2009 that treats area classified as impervious in 2009.

Impervious Area Treated and Crediting Approach

The BMP database maintained and continually updated by DEP formed the basis of the new BMP analysis. The database contains records of all the known BMPs within the MS4 permit area. Each record contains the available information on the type of BMP, or BMP Code, Approval date, or Era Code, and the Final Date.

Only BMPs built after 2009 were considered eligible newly-added facilities, providing control to previously uncontrolled impervious areas, according to the Strategy.

Each eligible BMP was evaluated looking at the BMP Code and Era Code to determine if the facility meets the criteria for MEP and qualified for credit. Credit was then tabulated for the qualifying BMPs according to the delineated drainage area that demonstrated treatment of impervious area that was uncontrolled in 2009 and according to the MDE guidance for each type of BMP.

The analysis yielded 235.7 acres of impervious acre credit from new BMPs treating existing impervious cover.

D.vii. Agency and Department Partnerships

Another important aspect of the County's approach to restoration is to seek out opportunities to partner with other agencies and departments responsible for completing construction projects throughout the County (Figure D-22). DEP does not directly oversee the construction of these projects but is involved at the planning level to optimize possible stormwater runoff treatment and restoration from the already planned efforts.

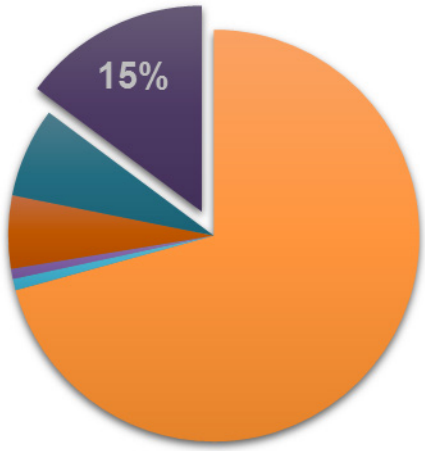


Figure D-22 Percentage of Total Impervious Acre Credits from Agency Partnerships

There are six specific partnerships undertaken by DEP that have resulted in significant contributions towards meeting the restoration requirement. These include the Intercounty Connector, Washington Suburban Sanitary Commission, DGS, MCPS, and DOT. The following sections summarize these partnership efforts.

ICC Stewardship Projects	
252.7	Impervious Acre Credit - Complete
16.9	Impervious Acre Credit - In-Construction
58.8	Impervious Acre Credit - In-Design
WSSC Projects	
23.2	Impervious Acre Credit - Complete
8.6	Impervious Acre Credit - In-Construction
94.5	Impervious Acre Credit - In-Design
DGS Partnership Projects	
0.9	Total Impervious Acre Credit
MCPS Partnership Projects	
0.7	Total Impervious Acre Credit
DTO Partnership Projects	
50	Total Impervious Acre Credit
United States Army Corps of Engineers	
136	Total Impervious Acre Credit

D.VII.1 INTERCOUNTY CONNECTOR

The Intercounty Connector (ICC) is a newly constructed highway connecting I-95 and I-370 through Montgomery County. The ICC was constructed during the third generation MS4 permit cycle and completed in 2014.

As part of the ICC construction, the Maryland State Highway Authority (SHA) was required to complete Environmental Stewardship projects. DEP partnered with SHA by recommending projects from DEP's project inventory.

The ICC provided a valuable opportunity to have over 40 restoration projects funded and constructed as part of the ICC Environmental Stewardship efforts. Credits were available to the County only for those mitigation requirements that were not specified as necessary for building the road. Projects included stream restoration, construction of new stormwater facilities, and retrofits of existing stormwater facilities. The majority of the projects are located within Rock Creek and the Anacostia watersheds.

DEP completed the necessary tracking and analysis to claim restoration credit from new construction and retrofits of stormwater projects. SHA took credit for stream restoration projects constructed to bring the ICC into compliance. In order to determine the number of credits, information such as as-built drawings and computation reports for the stormwater practices was downloaded from ICC's Projectwise SharePoint site and added to DEP's inventory.

ICC Environmental Stewardship projects contribute 328.4 acres of impervious area credit.

D.VII.2 WASHINGTON SUBURBAN SANITARY COMMISSION

The WSSC is currently under a consent decree with the EPA to address sanitary sewer overflows. As part of the consent decree, WSSC is designing and constructing stream restoration projects throughout the County to improve the sewer infrastructure. These projects vary in size and range from 23 linear feet to over 2,000 linear feet. DEP partnered with WSSC to track credits associated with these stream restoration efforts. There are currently 15 projects in DEP's inventory. These efforts contribute 126.3 acres of impervious area credit.

D.VII.3 MONTGOMERY COUNTY DEPARTMENT OF GENERAL SERVICES

The DGS is responsible for construction or reconstruction of County buildings. DEP signed an MOU with DGS in March of 2013 to establish a formal partnership to maximize stormwater/ESD opportunities on County-managed properties undergoing development or redevelopment by DGS. The MOU outlines a process by which DEP works with DGS in the planning phases and funds some aspects of the construction effort if they provide water quality treatment for impervious area in addition to what is required by the new construction on the site. This additional impervious area treatment is tracked by DEP and the impervious credit is calculated according to the MDE guidance.

One collaboration between DGS and DEP was the Scotland Community Recreation Center. DGS removed the existing building and built a new recreation center. In addition to providing all required stormwater management for the new building, DGS installed an underground sand filter to provide water quality treatment for approximately 37,686 SF, equivalent to 0.9 acres, of pre-existing impervious area that was outside of the regulatory requirements for this project. DEP provided half of the funding to install the filter. Figure D-23 shows the Scotland Community Recreation Center underground sand filter under construction in August 2014.

Figure D-23 Underground Sand Filter at the Scotland Community Recreation Center

D.VII.4 MONTGOMERY COUNTY PUBLIC SCHOOLS

MCPS often undertakes construction projects to renovate and improve existing schools. DEP is developing an MOU with MCPS to establish a formal partnership. DEP and MCPS partner during the planning phase of certain projects to implement stormwater management practices to treat impervious areas above and beyond what is required for the project site. MCPS completes the construction with DEP contributing funds to pay for the stormwater facilities outside of the project area. This partnership helps reduce construction costs by combining efforts versus starting a new and separate effort. To date, this approach has only been applied at Cold Spring Elementary School, where 0.7 acres were treated, but the MOU is intended to guide similar collaborations in the future.

D.VII.5 MONTGOMERY COUNTY DEPARTMENT OF TRANSPORTATION

DEP partners closely with DOT on several fronts. DEP funded and collaborated with DOT on the design and construction of three Green Streets projects. The collaboration resulted in the construction of 140 ESD facilities which contributes to 35.6 acres of impervious area restoration credit.

In addition to the projects relating to Green Streets, DEP and DOT collaborate to increase the effectiveness of the DOT's outfall stabilization efforts. The DOT's rehabilitation program provides maintenance on county storm drain structures. While DOT internally prioritizes outfalls stabilization projects, DEP helps by identifying and prioritizing outfalls in need of repair as a part of the watershed studies. DEP then collaborates with DOT on selected stabilization projects. As of FY14, DOT has stabilized approximately 18 reaches covering a sum of 1,438 linear feet contributing 14.4 acres of impervious area restoration credit towards meeting the restoration requirement.

The images shown in Figure D-24 are before and after pictures of a successful outfall stabilization on Schuylkill Road. The 30" diameter RCP with a 2 foot drop to the receiving stream was replaces with a drop manhole with an 18" sump for energy dissipation and receiving stream reach stabilized.

Figure D-24 Outfall Stabilization on Schuylkill Road Before (left), After (right)

D.VII.6 UNITED STATES ARMY CORPS OF ENGINEERS

The USACE work closely with several jurisdictions including DEP and environmental groups on the management/restoration of the Anacostia River watershed. Watershed assessments and feasibility studies were conducted by USACE in collaboration with DEP to comprehensively evaluate and identify restoration projects in the Anacostia River watershed. As of FY14, six stream restoration projects covering a sum of 13,612 linear feet of streams were restored, contributing 136 acres impervious credit towards meeting the restoration requirement.

D.viii. Case Studies

Stream Restoration Case Study: Hollywood Branch Tributary

Project Quick Facts

Location: Silver Spring, MD

Watershed: Paint Branch

Drainage Area: 844 acres, 18% impervious cover

Impervious Area Treatment Credits: 44.7 Acres

Total Cost: $1.58M

Partners: Maryland National Capital Parks & Planning Commission, Chesapeake & Atlantic Coastal Bays Trust Fund

Timeline

Design and Permitting Start: September 2009

Construction Start: May 2014

Estimated Completion of Construction: August 2015 with planting to follow

Summary

In 2006, the Hollywood Branch Tributary, a Designated Use III cold water stream system, was identified as a high priority candidate for stream restoration due to severe streambank erosion, high sedimentation, channel enlargement, and degraded instream habitat conditions for aquatic biota. Restoration strategies included stabilizing and reconstructing streambanks, shifting the channel, creating log/boulder step pools, creating new wetland areas, and raising and stabilizing stream channel with construction of instream features to manage flows.

Highlights

Large-scale stream restoration addressed severely degraded conditions reducing erosion, re-connecting the floodplain, protecting utilities, improving water quality, and enhancing aquatic habitat.

Canon Road Green Streets improvement projects completed in surrounding neighborhoods will also contribute to the long-term success of the stream restoration.

A. (Before) Eroded conditions along bend in stream with overly steep exposed banks and exposed tree roots

B. (After) Banks and channel stabilized with added boulder toe protection

C. (Before) Incised channel and eroded conditions

D. (After) Channel geometry restored and stabilized with step pool structures. Banks stabilized and riparian plantings added

Green Streets Case Study: Sligo Park Hills

Project Quick Facts

Location: Silver Spring, MD

Watershed: Sligo Creek

Impervious area treatment credits: 15.8 Acres

Total Cost: $3.5M

Partners: DOT, Chesapeake & Atlantic Coastal Bays Trust Fund

Timeline

Design and Permitting Start:
August 2012

Construction Start:
July 2013

Completion of Construction:
November 2014

Summary

The original Sligo Park Hills neighborhood design, with homes built between the 1920s and 1950s, did not include any stormwater management. The goal of this Green Streets project was to integrate stormwater management to encourage infiltration of runoff from the roadways and other impervious surfaces. Runoff control would improve water quality, ultimately contributing to improved stream conditions in Sligo Creek. This was accomplished by implementing rain gardens, bioretention gardens, tree box filters, and permeable pavement in the DOT right-of-ways. The project was divided into two phases to accommodate the large size of the neighborhood.

Highlights

Installed 79 structures throughout neighborhood: 33 Bioretention, 3 Micro Infiltration, 35 Porous Parking Pads, and 8 Filterra Tree Boxes.

Partnership with DOT facilitated right-of-way permitting issues, expediting design and construction.

A. (Before) Intersection with no stormwater management

B. (After) Intersection with bioswales and curb inlets

C. (Before) End of street with no stormwater management

D. (After) End of street with bioswales and curb inlets

Green Streets Case Study: Dennis Avenue

Project Quick Facts

Location: Silver Spring, MD

Watershed: Sligo Creek

Impervious area treatment credits: 17.32 Acres

Total Cost: $3.4M

Partners: DOT, Chesapeake & Atlantic Coastal Bays Trust Fund

Timeline

Design and Permitting Start:
October 2012

Construction Start:
June - November 2013 (Two phases)

Completion of Construction:
August 2014

Summary

The Dennis Avenue Green Streets project treats runoff from impervious surfaces within medium to high density residential areas that would be otherwise untreated through conventional stormwater management facilities. The project, which was identified as high priority in early watershed assessments, used rain gardens, bioretention gardens, curbside extension swales, Filterra tree boxes, and a regenerative step-pool conveyance swale along Dennis Avenue. The elements were designed to provide water quality treatment that approached ESD volumes as defined in MDE guidelines. The project was divided into two phases. Phase 1 addressed Dennis Avenue West (3.57 acres) and Phase 2 addressed Dennis Avenue East (20 acres).

Highlights

Installed 23 new green streets facilities.

Template/design-build approach minimized permitting and expedited implementation.

Partnership with DOT facilitated right-of-way permitting and expedited project design and construction.

A. (Before) Path entrance with no stormwater management

B. (After) Path entrance with adjacent bioswales

C. Permeable pavement parking pad

D. Bioretention in action located in median

Government Facilities Case Study: Aspen Hill Library

Project Quick Facts

Location: Rockville, MD

Watershed: Rock Creek

Impervious area treatment credits: 0.7

Total Cost: $340K

Partners/Stakeholders: Library, Friends of the Library, Local Gardening Club

Timeline

Design and Permitting Start:
July 2008

Construction Start:
October 2011

Completion of Construction:
April 2012

Summary

During the 2009 inventory of libraries, schools and government facilities, Aspen Hill Library was identified as having high treatment potential and no plans for redevelopment of the site. The project objectives were to reduce the overall volume and peak flow rate of stormwater runoff from the library property and increase groundwater recharge, leading to a decrease in pollutant loads to Rock Creek. The design included a bioretention cell, a grass swale, and a curb extension in the right of way to treat a portion of Aspen Hill Road. These practices reduce pollutant loads to Rock Creek and filter pollutants such as such as oil, grease, metals, nitrogen, phosphorus and sediments. The key cost drivers during construction included the trench drain, which clogged early in the design life, trench media that had to be replaced due to slow drainage rates, and the use of an electronic sign for right of way construction.

Highlights

The location of the project allowed for a high visibility demonstration project of the ESD approach to stormwater management.

The final design was adjusted to accommodate stakeholders concerns. In this case, a bioswale was eliminated due to concerns of infiltration near a wet basement.

A. (Before) Side yard prior to construction

B. (After) Bioretention facility in side yard at Aspen Hill Library

C. (Before) Curb along Aspen Hill Road near entrance to Aspen Hill Library

D. (After) Curb extension with bioretention along Aspen Hill Road near entrance to Aspen Hill Library

Government Facilities Case Study: Ridgeview Middle School

Project Quick Facts

Location: Gaithersburg, MD

Watershed: Seneca Creek

Impervious area treatment credits: 1.8 acres

Partners/Stakeholders: School personnel and parents

Total Cost: $285K

Permitting/Review: DOT, M-NCPPC, DPS, DGS

Timeline

Design and Permitting Start:
November 2010

Construction Start:
June 2012

Completion of Construction:
August 2012, planting continued into the school year

Summary

During the 2009 inventory of libraries, schools and government facilities, Ridgeway Middle School was identified as having high treatment potential, high level of imperviousness, and no plans for redevelopment of the site. The project objective was to encourage infiltration of runoff from impervious surfaces and thus improve water quality. The design included 2 bioretention cells and 3 rain gardens.

Highlights

Partnership with the school resulted in an improved design and possible future cost savings because the design benefited from thoughtful comments and insights into the anticipated needs for areas for portable classrooms and building expansions.

The location of the project at a school provides educational opportunities for science classes.

Safety concerns were given highest priority and addressed at each stage of the project. For example, plant selection for the design considered possible toxicity and the construction contractors underwent background screening.

A. (Before) Grassy area adjacent to parking lot

B. (After) Bioretention area adjacent to parking lot

C. (Before) Grassy median

D. (After) Median with bioretention area and curb cuts

Stormwater Retrofit Case Study: Naples Manor Pond Retrofit

Project Quick Facts

Location: Silver Spring, MD

Watershed: Anacostia

Impervious area treatment credits: 10.6 Acres

Total Cost: $321K

Partners/Stakeholders: Homeowners Association

Timeline

Design and Permitting Start:
April 2010

Construction Start:
January 2014

Completion of Construction:
July 2014

Summary

The pond at Naples Manor was identified as a potential pond retrofit because of its deteriorated condition and because it was built before the current state and local stormwater management regulations were in place. Prior to the retrofit, the pond provided only partial stormwater management for the upland drainage area and did not meet current MDE stormwater requirements. The pond had an outdated concrete riser, minimally protected or unprotected storm drain outfalls entering the pond, internal earth berms, and collected sediment that reduced its stormwater treatment capacity. Modifications were made to the facility to meet current MDE stormwater requirements for CPv. The retrofit included replacement of the existing concrete riser a new concrete riser designed to better control stormwater and an expansion of the dry basin designed to extend detention of flows, thus reducing downstream erosion and enhancing water quality. Native plantings in the basin help filter pollutants and support a diverse community of insects and birds. In order to accommodate safety requirements, the dam was raised by approximately one foot. Storm drain inflow pipes near the dam were protected with rock to reduce the velocity and erosive nature of discharged flows.

Highlights

Full channel protection volume was provided in what was previously a flood control basin only.

The pond was improved by the addition of vegetation, the updating of a deteriorating riser and outfall structure and by updating the dam to current safety standards.

The project was exempt from forest conservation due to minimal vegetation impact.

A. Original stormwater pond pre-construction

B. Area during construction

C. Retrofitted pond post-construction

RainScapes Case Study: Harn Aqueduct Rain Garden & Conservation Landscaping

Project Quick Facts

Location: Bethesda, MD

Watershed: Cabin John Creek

Drainage area: 3,500 square feet

Impervious area treated: 1,000 square feet

Impervious area treatment credits: 0.0268

Designer: Encore Garden Design

Timeline

Design and Permitting Start:
May 2012

Construction Start:
June 2010

Completion of Construction:
October 2012

Summary

This innovative RainScapes project was motivated by the problem of reoccurring patio flooding. In order to address the flooding at this low-elevation walk-out basement patio, an aqueduct was designed to intercept rainwater at the rooftop and convey it towards a newly designed rain garden uphill and away from the patio. The rain garden effectively treats a substantial portion of the runoff from the property through infiltration. It also enhanced the aesthetic of the landscape and solves the patio flooding problem. The homeowners received RainScapes reward rebates as a result of the improved stormwater management provided by the project.

Highlights

The project was awarded 2014 Best Residential BMP from the Chesapeake Stormwater Network

Use of an aqueduct made it possible to create a rain garden where elevations would have otherwise made it impossible to use such a practice.

Design successfully conveyed 6.6 inches of rainfall from Hurricane Sandy with no patio flooding

Private projects completed and eligible for the RainScapes rewards rebate program can improve stormwater management and ultimately improve water quality in surrounding streams.

A. Yard before start of project

B. Aqueduct under construction

C. Rain garden during planting

D. Completed aqueduct and rain garden

E. Lessons Learned and Next Steps

The 20% restoration requirement of the third generation MS4 permit resulted in remarkable growth of DEP's watershed restoration program. The lasting impact of this growth will continue to improve water quality and benefit the environment into the future as lessons learned allow DEP to more efficiently and effectively restore the County's watersheds.

During the third generation MS4 permit term, several of DEP's restoration projects received awards and several grants (Figure E-1).

Completing more restoration at a faster rate required increased funding. DEP received the necessary financial support from an increased CIP budget made possible by the County's forward-thinking approach to financing through issuing WQPC bonds. Capacity building was also necessary, so in addition to increasing internal staff, DEP retained consultants to support the restoration program and help move many of the projects forward faster than would have otherwise been possible.

DEP also created improved efficiency within the restoration program by expanding its data management efforts. DEP recognizes the value of investing in on-going data management. Improved knowledge of project performance and programmatic progress leads to better decision making and better restoration outcomes. DEP continues to prioritize improved data management as a critical component of the restoration program and DEP's adaptive management strategy.

Select Program Honors

Awards

- *Stoney Creek Stormwater Management Pond at National Institute of Health*
  National Recreation Award April 2014
  American Council of Engineering Companies (ACEC) Engineering Excellence Awards Competition
  Engineering Excellence Honor Award in Design 2013-2014
  ACEC of Metropolitan Washington
- *Arcola Avenue Green Street Project*
  Achievement Award Winner 2012
  National Association of Counties

Grants

- Department of Natural Resources Chesapeake and Atlantic Coastal Bays Trust Fund
- National Fish and Wildlife Foundation Grant
  Smart integrated stormwater management system demonstration partnership with Washington Council of Governments

Figure E-1 DEP Restoration Project Awards and Grants

DEP learned that each restoration delivery method is valuable and poses unique challenges requiring creative solutions. Permitting and public outreach remain the primary drivers of the duration of the design and permitting phase of CIP projects. Smaller-scale implementation will continue to expand as the direct contact with County residents and property owners is extremely valuable in building support for DEP's work. Leveraging partnerships will also continue to be a focus as these efforts proved mutually beneficial in meeting partners' objectives, reducing DEP's costs, and speeding project delivery. Reflecting back, DEP found that project delivery timeframes, on the order of years, were challenged by the restoration requirement timeframe of the five-year permit cycle. This was particularly true for the third generation MS4 permit term where early-phase permit activity required planning and strategic program development prior to project design, permitting, and construction.

The importance of communication with stakeholders and public outreach was magnified during the implementation of restoration projects. DEP greatly values stakeholder input and recognizes that effective communication results in overall improved project outcomes and delivery timeframes.

Through adaptive management across all project types, DEP is committed to continued improvement of its watershed restoration program to generate efficiencies, develop stakeholder support, and speed project delivery.

References

U.S. Environmental Protection Agency (EPA), Green Infrastructure Basics, *What is Green Infrastructure?*, <http://water.epa.gov/infrastructure/greeninfrastructure/>, Accessed 06/15/2015.

Maryland Department of the Environment, *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollutant Discharge Elimination System Stormwater Permits,* June (Draft) 2011.

Maryland Department of the Environment, *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollutant Discharge Elimination System Stormwater Permits,* August 2014.

Maryland State Highway Administration, *Existing Water Quality Grass Swale Identification Protocol*, December 2013.

Appendices

Appendix A.1 Stormwater Ponds 1986-2002 MEP Review

Appendix A.2 Approved Water Quality Plan for an SPA

Appendix B Evaluation of Existing Roadside Swales

Appendix C Reforestation Monitoring Protocol and Impervious Area Crediting

Appendix D.1 Impervious Cover Credit for Conservation Landscaping

Appendix D.2 Impervious Cover Credit for Individual Trees

Appendix E Analysis Approach for MCPS and Private Redevelopment

Appendix A.1 Stormwater Ponds 1986-2002 MEP Review

MEMORANDUM

Date: May 14, 2015

To: Montgomery County Department of Environmental Protection

From: Brown and Caldwell/ Biohabitats, a Joint Venture

Subject: Stormwater Ponds 1986-2002 Maximum Extent Practicable Review

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Introduction

Under the MS4 permit, Montgomery County is required to restore twenty percent of the County's impervious surface area that is not treated to the Maximum Extent Practicable (MEP). As part of determining impervious surfaces that are already treated to the MEP, the County assumed that wet stormwater facilities coded "3" (Effective BMPs) and developed within Era 2 (1986 to 2002) met MEP[1]. In order to verify this assumption, the DEP requested that the Joint Venture (JV) analyze a sample of Code 3, Era 2 facilities. The purpose of this memorandum is to describe the pond selection process and methodology for this analysis.

Stormwater Pond Selection

More than 200 of DEP's ponds are classified as Code 3, Era 2. As much as possible, ponds were selected in order to represent a diverse range of conditions including:

- 8-digit HUC
- Impervious cover treated
- BMP Type; included the following:
    - PDWD: pond-wetland
    - PDWDED: pond-wetland with extended detention
    - PDWT: pond-wet quality and quantity control
    - PDWTED: pond-wet quantity control and extended detention

Ponds were eliminated from analysis for a number of reasons, including:

- Pond was recently retrofitted to improve water quality treatment
- Inadequate records available to conduct analysis

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[1] Montgomery County Department of Environmental Protection. 2010. Implementation Plan Guidance Document. Prepared by Chesapeake Stormwater Network and Biohabitats, Inc.

MEP Process

The goal of the evaluation was to identify whether a pond is treating the tributary drainage area to the MEP. The general process for the evaluation of the existing stormwater ponds was to calculate the provided versus required Water Quality Volume (WQv) as described below. If the WQv provided by a pond is greater than the WQv required, then the pond is considered MEP.

As part of the analysis, a spreadsheet was developed to complete the calculations and document the results. Spreadsheets were completed for each site analyzed. Ultimately, the results were entered into a Microsoft Access database. The steps for determining MEP for each pond were generally as follows:

- Step 1: Review existing data
    - Available GIS data: aerial photography, 2-foot contours, previously-prepared impervious area delineations, and storm sewer mapping.
    - County-provided pond data: design or as-built construction drawings, stormwater management plans, inspection logs, and/or site photos.
    - Permanent pool status: The above data were reviewed to confirm the presence of a permanent pool.
- Step 2: Calculate Required WQv
    - The County-provided drainage area delineation was reviewed and updated, as needed.
    - The existing impervious areas within the drainage area were reviewed and updated, as needed.
    - The impervious area was calculated by clipping it to the drainage area.
    - The required WQv was calculated using the drainage area and impervious area[2].
- Step 3: Calculate Provided WQv
    - Based on the available data for the site, one of the following methodologies, listed in order of preference, was used to calculate the WQv provided by the pond.
        - Storage Volume or Stage-Area Data Provided: Where information for the storage volume was provided on the construction drawings or within the stormwater management plan for a pond, the data was entered into the spreadsheet manually. If stage-area data was provided, the data was used in the spreadsheet to calculate a stage-volume relationship. From the stage-volume relationship, the cumulative volume (WQv provided) was calculated.
        - As-Built Contours: If the construction drawings contained as-built contours, the area of each contour within the pond was measured to develop a stage-area relationship. Measurements were made using AutoCAD, BlueBeam (pdf editing software), or other software available to the reviewer. This data was entered into the spreadsheet to calculate the stage-volume relationship for the pond, and from the stage-volume relationship, the cumulative WQv was calculated. If as-built contours were not provided, design contours were used.
        - Side Slope Data Provided: If available data did not include contours, but provided a constant side slope, the slope was used to calculate the provided WQv.
            - Circular Pond: The surface area of the pond was measured, using either the construction drawings or GIS. The surface area was then used to calculate a

[2] Maryland Department of the Environment. 2000. Maryland Stormwater Design Manual. Baltimore, MD.

radius. Next, the radius of the pond bottom was calculated using the side slope information and depth of the pond. From there, the area of the pond bottom was calculated. Finally, the volume was calculated by multiplying the pond depth by the average of the surface and bottom areas. Figure 1 provides a schematic of this method.

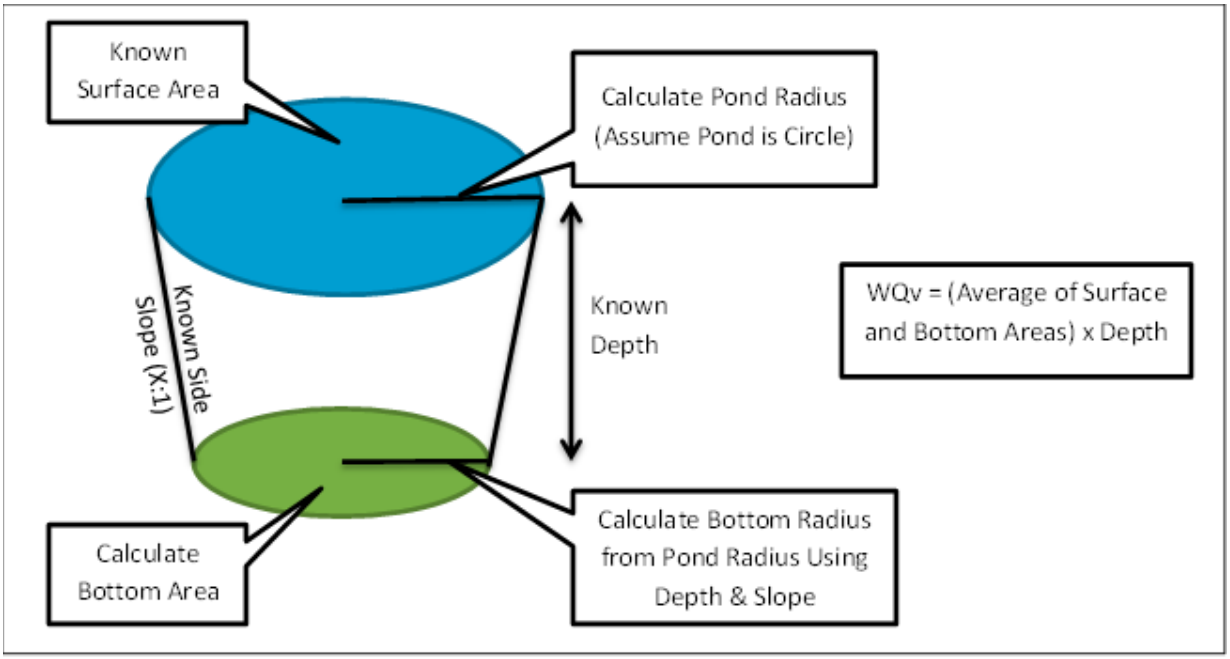


Figure 1. Side Slope Method: Circular Pond

- Trapezoidal Method: This method was determined to be more accurate than the circular method for ponds that are irregularly shaped. The volume of a triangle surrounding the pond below the permanent pool was calculated by multiplying the known side-slope and pond depth by the perimeter of the pond. Next, the volume of the pond was calculated by first multiplying the pond surface area by the depth and then subtracting the volume of the triangle surrounding the outside of the pond. Figure 2 below provides a schematic of this method.

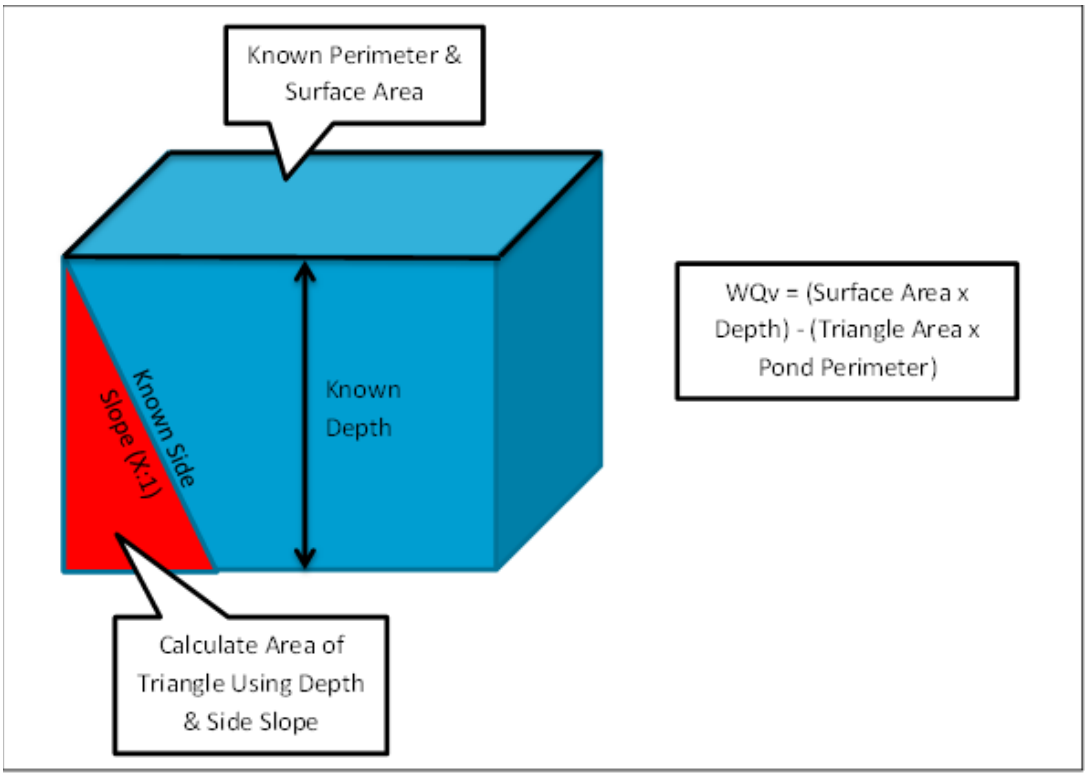


Figure 2. Side Slope Method: Trapezoidal (Irregularly-Shaped) Pond

- Surface Area Decrease Method (Permanent Pool Elevation and Bottom Elevation Known): The surface area of the pond and of a known contour above the permanent pool were both measured. The rate of area decrease (percentage) between the elevations was calculated, along with the percent decrease per foot of elevation change. The percent of decrease was assumed to remain constant beneath the normal water level of the pond. The cumulative permanent pool volume was calculated at one foot increments below the permanent pool using the percent area decrease that was calculated from the known elevations. At the bottom elevation of the pond, the total cumulative WQv was calculated. Figure 3 provides a schematic of this method.

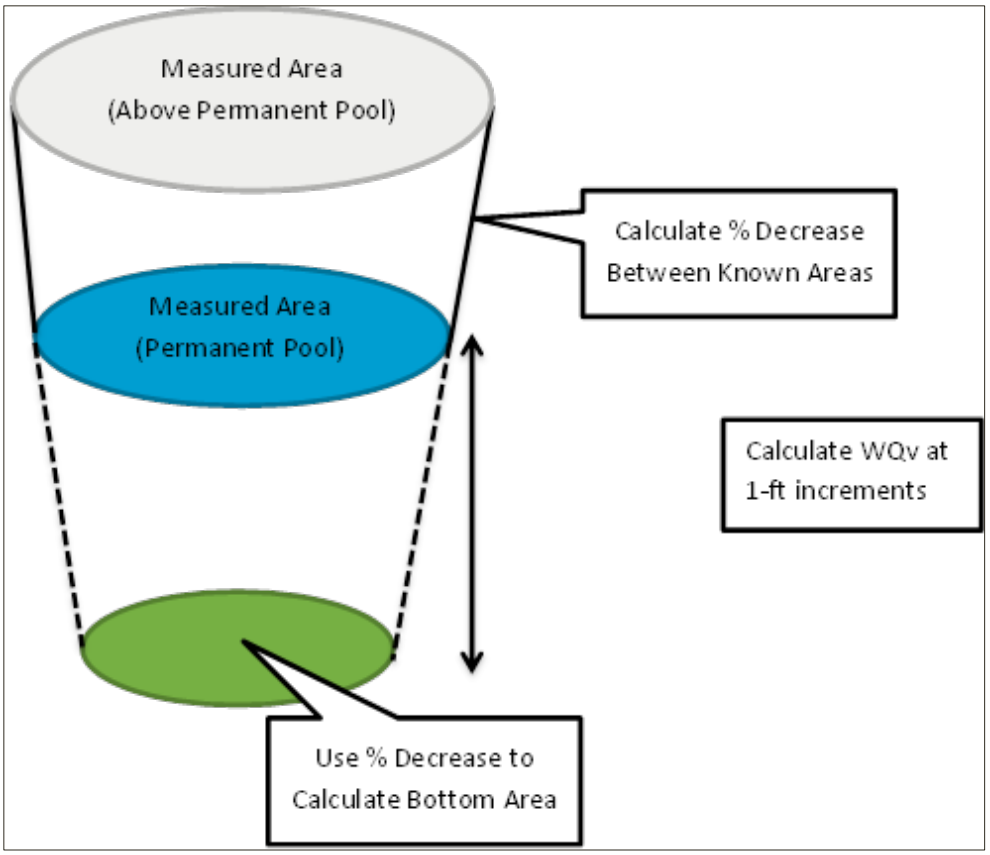


Figure 3. Surface Area Decrease Method: Bottom Elevation Known

- Step 4: If sufficient data were not available to calculate the WQv provided by the pond using one of the methods described under Step 3, then the permanent pool volume was estimated using the following:
    - Surface Area Decrease Method (Bottom Elevation Unknown): The area between two known contours was measured in GIS. The rate of area decrease (percentage) between the elevations was calculated, along with the percent decrease per foot of elevation change. This decrease was assumed to remain constant beneath the normal water level of the pond. The cumulative permanent pool volume was calculated at one foot increments below the permanent pool using the percent decrease in area that was calculated from the known elevations. The depth required to achieve the WQv was identified as the depth when the calculated cumulative WQv was greater than the required WQv. The pond could then be surveyed to determine whether the depth is sufficient to provide the required WQv and be classified as MEP. Figure 4 provides a schematic of this method.

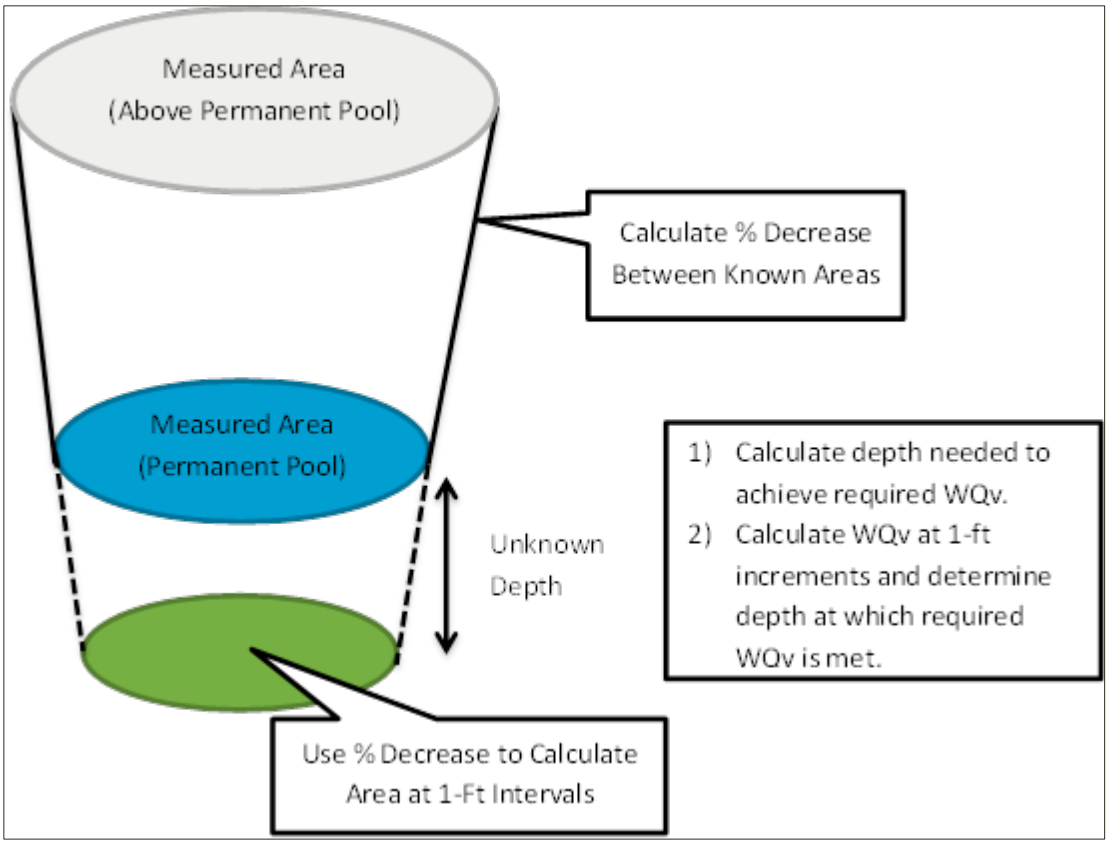


Figure 4. Surface Area Decrease Method: Bottom Elevation Unknown

- Step 5: Categorize Pond.
    - The provided WQv, as calculated under Step 3, was compared to the required WQv calculated under Step 2. The pond was then categorized into one of the following categories.
        - MEP = provided WQv equal to or larger than the required WQv
        - 80% - 99% WQv Achieved
        - 50% - 80% WQv Achieved
        - <50% WQv Achieved
    - If Step 4 was used to estimate the depth needed to meet WQv, the pond was categorized into one of the following categories.
        - Likely MEP – Proceed to Survey: The pond is likely providing the WQv and survey should be conducted to verify the depth and volume of the pond.
        - Unlikely MEP – Send to Task Order: The pond should be reviewed as part of a consultant Task Order to assess the feasibility for a retrofit project to enhance the WQv of the pond.

Appendix A.2 Approved Water Quality Plan for an SPA

DEPARTMENT OF PERMITTING SERVICES

Douglas M. Duncan
County Executive

December 27, 1999

Robert C. Hubbard
Director

Mr. Michael E. Wagner, P.E.
Loiederman Associates, Inc.
1390 Piccard Drive
Rockville, Maryland 20850

Re: **Preliminary/Final** Water Quality Plan for
Snider Property
Preliminary Plan #: 1-99084
SM File #: 200007
Tract Size/Zone: 21.9 acres/RE-1C
Total Concept Area: 21.9 acres
Tax Plate: FQ 343
Lots/Block: 1, 14-20/A & 2-13/B
Parcels: 411, 416 & 419
Montg. Co. Grid: 2810C&D
Watershed: Watts Branch / Piney Branch

SPECIAL PROTECTION AREA

Dear Mr. Wagner:

Based on a review by the Department of Permitting Services Review Staff, the Preliminary/Final Water Quality Plan for the above mentioned site is **acceptable.**

Site Description: The site consists of 21.9 acres located on the east side of Glen Mill Road opposite Unity Lane. The proposed development will consist of one existing single family lot and 20 additional single-family lots with the associated infrastructure. The property is located within the Piney Branch Watershed, which is a designated Special Protection Area (SPA).

Stormwater Management: Water quantity control will be provided via a dry pond that will replace the existing farm pond, and in an off-site (Glen Meadows) dry pond which is currently under construction. These structures will provide detention of the two-year storm with a predeveloped release rate. Quality control will be provided via a treatment train that consists of vegetated conveyance swales which outfall to a forebay, before passing through a surface sand filter. The surface sand filters will be sized to treat one inch of runoff over the proposed impervious area.

Sediment Control: Forebays are to be used along with sediment traps to provide a redundant trapping device. The earth dikes that feed the traps are to be constructed using trapezoidal channels to reduce flow velocities. The site is to be graded in two phases, allowing for rough grading and overall stabilization prior to house construction. Small areas that do not drain to a sediment trap must use super silt fence for sediment control. Silt fence alone will not be allowed as a perimeter control.

Performance Goals: The following is the list of performance goals that were established at the pre-application meeting, and how these goals will be met:

1. Maintain base flow and provide groundwater recharge by minimizing impervious area and providing a recharge area below the surface sand filter.

2. Minimize storm flow runoff via the redundant stormwater management controls and the groundwater recharge area.

3. Minimize increases to ambient water temperature by providing open section roads, using a groundwater recharge system, removing a existing permanent pool farm pond, and by providing shading for the proposed dry pond outfall.

4. Minimize sediment loading by providing redundant sediment controls.

5. Minimize the use of insecticides and fertilizers via a residential Integrated Pest Management Plan as part of the Homeowners Association (HOA) documents. A draft of this plan/document is to be submitted at the detailed sediment control plan stage, and the final document is to be submitted prior to bond release.

Monitoring: The monitoring requirements must be in accordance with the BMP monitoring protocols which have been established by the Department of Permitting Services (DPS) and Department of Environmental Protection (DEP). The required monitoring is as follows:

1. Flow samples of the small tributary (Sheep Run) need to be obtained and tested for nitrogen (nitrate, nitrite and TKN), phosphorous (total and ortho), and total suspended solids. Samples are to be taken three times prior to the start of construction, three times per year during construction, and three times per year after construction is complete for a three-year period. The samples will be obtained during the May through October monitoring period.

2. Provide a photo monitoring station at the proposed dry pond outfall. Photographic documentation reports are to be submitted quarterly during construction and for a three-year period after construction has been completed.

Conditions of Approval: The following conditions must be addressed in the initial submission of the detailed sediment control/stormwater management plan. This list may not be all inclusive and may change based on available information at the time of the review:

1. The surface sand filter must be pre-treated with a forebay.

2. At a minimum, one foot of dead storage is to be provided below the outlet pipe of the surface sand filter.

3. Bioretention structures are to be used for lots that do not drain to the surface sand filter. These structures are to be located in common HOA areas and not on private lots. Also, a stormwater management easement must be provided for these structures that allows for vehicular access.

4. The joint use agreement for grading and to share in the use of the off-site (Glen Meadows) pond must be submitted at the time of plat recordation.

This letter must appear on the original sediment control/stormwater management plan at its initial submittal. Any divergence from the information provided to this office; or additional information received during the development process; or a change in an applicable Executive Regulation may constitute grounds to rescind or amend any approval actions taken, and to reevaluate the site for additional or amended stormwater management requirements.

If you have any questions regarding these actions, please feel free to contact Leo Galanko at (240) 777-6242.

Sincerely,

Richard R. Brush, Manager
Water Resources Section
Division of Land Development Services

RRB.enm:CN200007.LMG

cc: M. Shaneman
S. Federline
SM File # 200007
SM Log # 99-203

QN – On-site; Acres: 21.9
QL – On-site ; Acres: 21.9

Appendix B Evaluation of Existing Roadside Swales

Appendix B

Evaluation of Existing Roadside Swales

Background & Overview

In order to accurately calculate the restoration goal, the County considered other potential sources of existing impervious cover control including roadside swales. This appendix outline the process undertaken by DEP to evaluate roadside swales to determine potential impervious areas control provided by these features. Roadside swale control of impervious cover contributes to the total impervious area controlled to the MEP as of 2009.

Drawing upon the Maryland State Highway Administration (SHA) document, "Existing Water Quality Grass Swale Identification Protocol," the County completed a comprehensive analysis of existing roadside swales that may be treating impervious area that was initially considered uncontrolled. The underlying principle of this effort is that when the proper conditions and criteria are met, roadside grass ditches (swales) may approximate ESD designs that filter and treat stormwater runoff, thus providing water quality treatment that was not previously accounted for in our stormwater infrastructure dataset. To further expand, "Swales are channels that provide conveyance, water quality treatment, and flow attenuation of stormwater runoff. Swales provide pollutant removal through vegetative filtering, sedimentation, biological uptake, and infiltration into the underlying soil media." (SHA 2013). Table Appendix-B.1 below lists the criteria that are critical for a roadside ditch to qualify as a functional grass swale (SHA 2013).

Table Appendix-B.1: Criteria for Functional Grass Gwales

Parameter	**Acceptable Value(s)**
Bottom Width	2 feet (ft) minimum, 8ft maximum
Swale Length	Greater than 35ft
Channel Slope	Less than or equal to 4.0%, or between 4-6% with check dams provided to meet flow depth and velocity criteria
Maximum Flow	Less than or equal to 1.0 feet per second (fps) for runoff from the one-inch rainfall (water quality storm) Less than 5 fps (non-erosive) for runoff from the ten-year design event
Side Slopes	3:1 or flatter
Thick Vegetative Cover	Present
Surface Area of the Channel	Greater than 2% of the contributing drainage area
Maximum Flow Depth	4" and manning's n=0.15 for 1 inch water quality storm

Process

The process to locate existing and previously undocumented roadside grass swales in the County was divided into 3-parts, 1) Desktop evaluation using GIS and remote sensing techniques to find swales that meet the qualifying criteria, 2) Field campaign to assess the accuracy and efficacy of the desktop procedures, 3) Post-processing and finalization of the dataset, taking the field surveys and additional hydrologic information into account.

Part 1: Desktop Evaluation Using Geospatial Techniques

The backbone of this analysis is the 2014 LiDAR elevation data, processed into a 4ft x4ft cell bare-earth digital elevation map (DEM), from which flow direction and accumulation can be used to delineate an initial linear drainage network of potential swales. This network consisted of cells that drain at least 0.1216 acres (or at least 332 other cells, where each cell is ~0.00037 acres), based on the SHA protocols. The initial drainage network was then converted to a vector polyline file representing the potential swales. This vector polyline layer was then used for all subsequent geospatial analyses. The linear network was first filtered to remove any swale lines where 50% of their length did not fall within a 25ft buffer of the roads, as well as lines that ran over the road surface itself, and those that did not meet the minimum length requirement of 35ft or greater.

Several parameters were then computed to determine whether each swale line met the pertinent geometric criteria, or fell within an adequate threshold of doing so. Longitudinal slope was calculated for each distinct line segment, with the results categorized, such that slopes 0-4% were considered ideal, 4-6% adequate, and anything greater than 6% was considered unsatisfactory, and removed from the dataset.

Land cover was analyzed using MNCPPC raster data from 2009 (3ft cell size), with the goal of ensuring each potential swale line, plus an 8ft buffer on either side, had a thick vegetative cover. Any swales where the total area of grass/shrub and tree canopy combined was not at least 50% of the overall land cover were removed from the dataset.

Side slopes were calculated for both sides of each swale line segment. This was done using 16ft long cutlines that were perpendicular to and bisected the swale lines, spaced at 25ft increments, with slope from the endpoint of the cutlines to the center of the swale calculated, and values averaged for each side of each swale. Results were categorized, but no swale lines were eliminated based on this data.

Finally, swale lines were compared against the MS4 excluded area, as well as any existing credit drainage areas, and only lines that fell outside of these 2 datasets were retained.

Part 2: Field Campaign to Assess Accuracy of Desktop Methods

Although many swale lines were removed during various stages of the desktop evaluation process, the dataset was still extremely large at 33,225 sites countywide, making a comprehensive field campaign of all sites impractical. In order to create a relevant and methodical sampling of sites that could be feasibly surveyed, the swales were clustered into groups based on their longitudinal slope category (ideal or adequate), average year built for the properties in the subdivisions where the swales line were located, and the majority zoning category for the subdivision. This clustering yielded 156 'categories', such as "Ideal / 1970s / R-150". The subdivision with the maximum total swale length in a given category was selected as the initial 'representative' neighborhood for that category. A potential field site was then determined for each category, with the initial choice being the swale line in each category's representative neighborhood whose length is closest to the average length per category in that neighborhood. A desktop review was then conducted of the potential 156 category sites. Changes made during the desktop review and absences of viable swales to survey in the field resulted in 35 categories being excluded from the dataset. Of the initial 156 category sites planned, 121 category sites were field surveyed.

The field surveying campaign was completed between 10/13/2014 and 11/05/2014. A two-person survey crew used a 4G LTE Apple iPad and Fulcrum, a GPS enabled data collection application to record data. Each swale to be surveyed was assigned a unique ID. In the event that the survey crew encountered a site that was not a swale and/or was not able to be surveyed, the procedure followed was call DEP and receive direction for a new swale ID to survey. The field crew also carried an "Access Letter" provided by the County that was presented to any local citizens that inquired about the scope of the field verification process. While creating a field sketch of the swale was not originally part of the process, a field sketch was included for all sites surveyed.

The survey crew recorded the following parameters within the electronic field survey forms during the site visits to each surveyed swale. All field data was collected using a relative datum for each site and were not tied to existing benchmarks.

- General:
    - GPS location
    - Date (mm/dd/yyyy)
    - Team/Crew Members
    - Unique Swale ID
- Drainage Area:
    - Land Use (Road, Parking Lot, Rooftop, Lawn, Other)
    - Runoff Obstructions (Overgrown grass/vegetation, Sediment Accumulation, Curb, Other)
    - Additional Features (Sidewalk, Other)
- Channel Geometry:
    - Offset/Elevations at two cross-sections along the swale, including:
        - Edge of road
        - Top and Bottom of Slope for each side of swale
        - Swale Centerline
    - Station/Elevation at swale start
    - Station/Elevation at swale end
- Land Cover :
    - Land Cover(Grass/Herbaceous, Brush, Stone, Concrete/Pavement, Trees, Other)
    - Vegetation Height
    - Vegetation Condition (Good [>80% coverage], Fair [40%-80%], Poor [<40%])
    - Presence of Erosion (Yes, No)
    - Presence of standing water (Yes, No)
- Site Photos (Minimum of 2):
    - Photo standing upstream looking downstream (GPS tagged photo)
    - Photo standing downstream looking upstream (GPS tagged photo)
    - Additional photos showing areas of concern or importance

Once the field survey was complete, the following geometric parameters were calculated based on the field data collected.

- Average Bottom Width: Average channel bottom width of cross-sections taken during survey. Cross-section channel bottoms were calculated as the addition of the bottom of slope offsets for each side of the swale.

- Average Side Slopes (Side A and Side B): Average side slope of cross-sections taken during survey for each side of the swale. Side slopes were calculated from the channel offset/elevations from the bottom of slope to top of slope for each side of the swale.
- Channel Min Depth: Minimum value for each of the following calculations:
    - Cross-section 1 maximum value from one of the following (equals the Side A Depth):
        - Elevation difference between Edge of Road and Bottom of Slope
        - Elevation difference between Top of Slope and Bottom of Slope
    - Cross-section 2 maximum value from one of the following (equals the Side A Depth):
        - Elevation difference between Edge of Road and Bottom of Slope
        - Elevation difference between Top of Slope and Bottom of Slope
    - Cross-section 1 Side B Difference between Top of Slope and Bottom of Slope
    - Cross-section 2 Side B Difference between Top of Slope and Bottom of Slope
- Longitudinal Slope: Slope from Station/Elevation at swale start to Station/Elevation at swale end

Part 3: Post-Field Data Finalization

After completion of the field campaign, the post-processed field data was compared to the GIS-generated data for attributes that had information derived from both sources. Overall, the results were positive, in that there were similar averages and ranges for the field and GIS data, thus suggesting the GIS processes effectively characterized the potential grass swales for the defined criteria. Relevant attributes from the field-surveyed sites (each site representing a category) were distributed to the 'member' swales for each category. However, any category and corresponding member swales that had unsatisfactory field-derived results for key criteria, including longitudinal slope, side slopes, vegetative coverage, bottom width, curbs, or other negative stormwater characteristics were eliminated from the dataset. As a note, for bottom width, field-measured values between 2-8' were ideal and considered full-credit, width 1-2' were given half-credit, and any swales with bottom widths <1' failed and were removed from the dataset. The swales that passed this filtering process were considered the final dataset.

Calculating Contribution to Impervious Area Controlled to the MEP as of 2009

The area of roadway impervious cover treated by each swale was calculated as the swale length times the adjacent roadway divided by two as shown in the equation below.

$$Impervious\ Area\ Treated = Swale\ Line\ Length \times \frac{Road\ Width}{2}$$

A final check was made to ensure that the adjacent roadways to be credited were within the area covered by the County MS4 permit and not within an already credited drainage area.

The completed analysis determined 278.3 acres of previously considered uncontrolled impervious area were draining to roadside grass swales and could be considered area treated to the MEP as of 2009. Based on MDE crediting guidelines, DEP could then count 20% of this total, computed to be 55.7 acres, to the area of impervious cover controlled to the MEP as of 2009. As a result of DEP efforts to evaluate and incorporate existing roadside swales, the calculated restoration goal is more accurate.

References:

Maryland State Highway Administration (SHA), "Existing Water Quality Grass Swale Identification Protocol", December 2013.

Appendix C Reforestation Monitoring Protocol and Impervious Area Crediting

Appendix C

Reforestation Monitoring Protocol and Impervious Area Crediting

Background & Overview

Field work was required to determine whether a reforestation site met the required criteria to qualify for controlled impervious area credit. According to MDE guidance, in order to qualify for controlled impervious area credit, the reforestation areas must have a survival rate of 100 trees per acre or greater with at least 50% of the trees having a diameter of two inches or greater at 4.5 feet above ground level.

This appendix details the monitoring protocol used in the field for evaluating reforestation sites across the County. Additionally, the appendix describes the impervious area crediting approach for reforestation areas.

Reforestation Field Protocol

The DEP identified 14 restoration projects containing reforestation sites. The 14 restoration projects included 62 unique reforestation site planting areas. Each of the 62 unique reforestation sites was field evaluated by a two-person survey crew with field visits taking place between 10/27/2014-11/06/2014. There were 4 restoration projects for which detailed data was not collected during the field evaluation due to the majority of trees being less than 2 inches diameter at breast height (DBH), the planting being a supplemental planting to an existing forest rather than reforestation, or planting areas not observed in the field. These projects were excluded from further crediting analysis.

For the remaining projects and reforestation sites, the following data was collected in the field:

- Count of the number of trees less than 2 inches DBH
- Count of the number of trees greater than 2 inches DBH
- Tree species present
- Other notes as appropriate including:
    1. Presence of invasive species,
    2. Presence of existing trees,
    3. Planting area adjustments based on area planted in the field, etc.
- Photos documenting characteristic site conditions

Impervious Area Treated Crediting Approach

The credit analysis was completed by combining all remaining reforestation projects into one group. The total trees per acre was calculated based on the total number of trees in all the restoration projects divided by the total planting area in acres. This value was used to determine if the survival rate of 100 trees per acre was achieved. This step yielded a value of 180 trees/acre indicating the survival rate was achieved.

The total planting area in acres was used to determine the number of trees needed to meet the qualification that at least 50% of the trees have a diameter of two inches or greater at 4.5 feet above ground level in a planting area with 100 trees per acre. This involved multiply the planting area by 50 to calculate the minimum number of trees needed greater than 2 inches DBH. This step yielded a minimum value of 786 trees needed greater than 2 inches DBH. The total number trees greater than 2

inches DBH recorded was 1,350 indicating the requirement for percentage of trees above 2 inches DBH was also met.

The qualifying restoration sites make up 15.73 acres. Based on MDE guidance, 20% of this value is eligible for credit resulting in 5.98 acres of impervious area treatment credit.

Photographs documenting field evaluations are provided below for each of the projects. Sites within the same project are presented together. There was no photos taken of project Alta Vista Below 355.

The calculations documentation spreadsheet follows the photographs.

Album: Northwest Branch South of Randolph Rd

Date: Oct 27, 2014

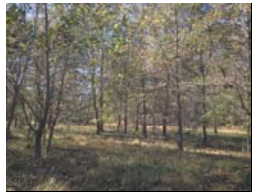
NW Branch S Randolph Rd (1)

NW Branch S Randolph Rd (2)

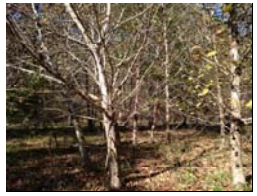
NW Branch S Randolph Rd (3)

NW Branch S Randolph Rd (4)

NW Branch S Randolph Rd (5)



NW Branch S Randolph Rd (6)



NW Branch S Randolph Rd (7)

NW Branch S Randolph Rd (8)

Album: Aspen Hill Library

Date: Oct 27, 2014

Aspen Hill Library (1)

Aspen Hill Library (2)

Aspen Hill Library (3)

Aspen Hill Library (4)

Aspen Hill Library (5)

Aspen Hill Library (6)

Album: Alta Vista Above 355 Date: Oct 27, 2014

Alta Vista Above 355 (1)

Alta Vista Above 355 (2)

Alta Vista Above 355 (3)

Alta Vista Above 355 (4)

Album: Josephs Branch 3b - Spruell Drive

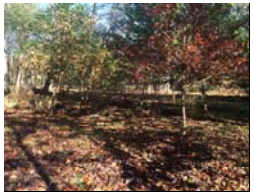
Date: Oct 27, 2014

Josephs Branch (1)

Josephs Branch (2)

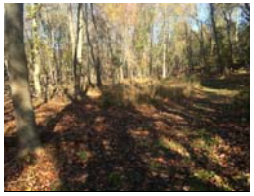
Album: Gum Springs Farm

Date: Oct 30, 2014

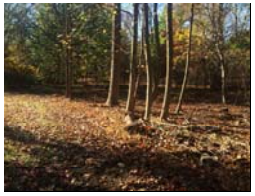


Gum Springs Farm A (1)

Gum Springs Farm A (2)



Gum Springs Farm A (3)



Gum Springs Farm A (4)

Gum Springs Farm A (5)

Gum Springs Farm A (6)

Gum Springs Farm B (1)

Gum Springs Farm B (2)

Gum Springs Farm B (3)

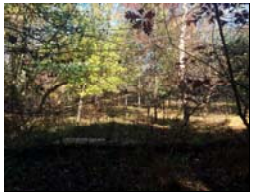
Gum Springs Farm C (1)

Gum Springs Farm C (2)

Gum Springs Farm C (3)

Gum Springs Farm C (4)

Gum Springs Farm D (1)



Gum Springs Farm D (2)

Gum Springs Farm D (3)

Gum Springs Farm E (1)

Gum Springs Farm E (2)

Gum Springs Farm E (3)

Gum Springs Farm F (1)

Gum Springs Farm F (2)

Gum Springs Farm F (3)

Album: Bryant's Nursery Run

Date: Oct 30, 2014

Bryant's Nursery Run Area 1 (1)

Bryant's Nursery Run Area 1 (2)

Bryant's Nursery Run Area 1 (3)

Bryant's Nursery Run Area 1 (4)

Bryant's Nursery 0.06AC 1st (1)

Bryant's Nursery 0.06AC 1st (2)

Bryant's Nursery 0.06AC 1st (3)

Bryant's Nursery Run 0.13AC (1)

Bryant's Nursery Run 0.13AC (2)

Bryant's Nursery Run 0.13AC (3)

Bryant's Nursery Run 0.13AC (4)

Bryant's Nursery 0.06AC 2nd (1)

Bryant's Nursery 0.06AC 2nd (2)

Bryant's Nursery 0.06AC 2nd (3)

Album: Upper Northwest Branch-Mainstem Date: Oct 30, 2014


Upper NW Branch 0.07AC (1)


Upper NW Branch 0.07AC (2)


Upper NW Branch 0.02AC (1)


Upper NW Branch 0.02AC (2)


Upper NW Branch 0.02AC (3)


Upper NW Branch 0.22AC (1)


Upper NW Branch 0.22AC (2)


Upper NW Branch 0.22AC (3)


Upper NW Branch 0.22AC (4)


Upper NW Branch 0.03AC


Upper NW Branch 0.054AC (1)

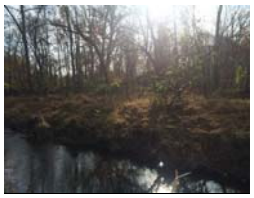

Upper NW Branch 0.054AC (2)


Upper NW Branch 0.052AC (1)


Upper NW Branch 0.052AC (2)


Upper NW Branch 0.04 AC (1)


Upper NW Branch 0.04 AC (2)


Upper NW Branch 0.04 AC (3)


Upper NW Branch 0.097AC (1)


Upper NW Branch 0.097AC (2)


Upper NW Branch 0.097AC (3)


Upper NW Branch 0.13AC (1)


Upper NW Branch 0.13AC (2)


Upper NW Branch 0.098AC (1)


Upper NW Branch 0.098AC (2)


Upper NW Branch 0.046AC (1)


Upper NW Branch 0.046AC (2)


Upper NW Branch 0.181AC (1)


Upper NW Branch 0.181AC (2)


Upper NW Branch 0.027AC


Upper NW Branch 0.032AC


Upper NW Branch 0.057AC (1)


Upper NW Branch 0.057AC (2)


Upper NW Branch 0.039AC (1)


Upper NW Branch 0.039AC (2)

Album: Batchelors Run East

Date: Nov 4, 2014

Batchelors Run East Zone 1 (1)

Batchelors Run East Zone 1 (2)

Batchelors Run East Zone 1 (3)

Batchelors Run East Zone 2 (1)

Batchelors Run East Zone 2 (2)

Batchelors Run East Zone 3 (1)

Batchelors Run East Zone 3 (2)

Batchelors Run East Zone 4 (1)

Batchelors Run East Zone 4 (2)

Batchelors Run East Zone 5 (1)

Batchelors Run East Zone 5 (2)

Batchelors Run East Zone 6 (1)

Batchelors Run East Zone 6 (2)

Batchelors Run East Zone 6 (3)

Batchelors Run East Zone 7 (1)

Batchelors Run East Zone 7 (2)

Batchelors Run East Zone 8 (1)

Batchelors Run East Zone 8 (2)

Batchelors Run East Zone 8 (3)

Batchelors Run East Zone 9 (1)

Batchelors Run East Zone 9 (2)

Batchelors Run East Zone 9 (3)

Batchelors Run East Zone 10 (1)

Batchelors Run East Zone 10 (2)

Batchelors Run East Zone 10 (3)

Batchelors Run East Zone 10 (4)

Batchelors Run East Zone 11

Batchelors Run East Zone 12 (1)

Batchelors Run East Zone 12 (2)

Batchelors Run East Zone 13 (1)

Batchelors Run East Zone 13 (2)

Batchelors Run East Zone 14 (1)

Batchelors Run East Zone 14 (2)

Batchelors Run East Zone 14 (3)

Album: Lower Sycamore Creek

Date: Nov 4, 2014

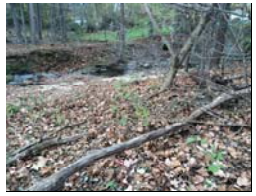
Lower Sycamore Creek 25.3 (1)

Lower Sycamore Creek 25.3 (2)

Lower Sycamore Creek 25.3 (3)

Lower Sycamore Creek 25.3 (4)

Lower Sycamore Creek 25.3 (5)



Lower Sycamore Creek 25.2 (1)

Lower Sycamore Creek 25.2 (2)

Lower Sycamore Creek 25.2 (3)

Lower Sycamore Creek 25.8 (1)

Lower Sycamore Creek 25.8 (2)

Lower Sycamore Creek 25.8 (3)

Lower Sycamore Creek 25.8 (4)

Lower Sycamore Creek 25.8 (5)

Lower Sycamore Creek 25.8 (6)

Lower Sycamore Creek 25.8 (7)

Lower Sycamore Creek 25.7

Lower Sycamore Creek 25.9

Sycamore 25.4 & 25.5 (1)

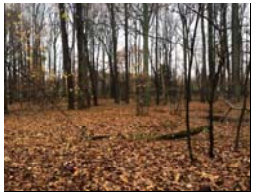
Sycamore 25.4 & 25.5 (2)

Sycamore 25.4 & 25.5 (3)

Sycamore 25.4 & 25.5 (4)

Album: Stream Valley Drive Date: Nov 6, 2014

Stream Valley 0.327AC



Stream Valley Area 1

Stream Valley Area 2 (1)

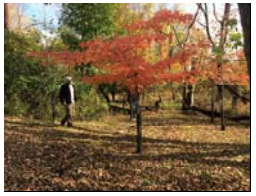
Stream Valley Area 2 (2)

Stream Valley Area 2 (3)

Album: Turkey Branch

Date: Nov 6, 2014

Turkey Branch 0.14AC



Turkey Branch 0.32AC (1)

Turkey Branch 0.32AC (2)

Turkey Branch 0.32AC (3)

Turkey Branch 0.21AC (1)

Turkey Branch 0.21AC (2)

Turkey Branch 0.10AC (1)

Turkey Branch 0.10AC (2)

Turkey Branch 0.41AC (1)

Turkey Branch 0.41AC (2)

Turkey Branch 0.41AC (3)

Turkey Branch 0.15AC (1)

Turkey Branch 0.15AC (2)

Album: Matt Henson Pond 1 Date: Nov 6, 2014

Matt Henson Pond 1 (1)

Matt Henson Pond 1 (2)

Matt Henson Pond 1 (3)

Album: Little Falls Area 1 Date: Nov 6, 2014

Little Falls Area 1

Montgomery County TO9
Reforestation Field Verification
December 2014

SITE ID		SITE DATA									CREDIT ANALYSIS - ACCOUNTING COUNTYWIDE								
Project Name	**Planting Zone/Area**	**Assessed**	**Site Visit**	**Field Crew**	**Acreage**	**Number <2" DBH**	**Number >2" DBH**	**Total Trees**	**Tree Species Present**	**Proceed with Credit Analysis**	**Notes**	**Planting Area (acres)**	**Total # Trees**	**Trees/Acre**	**Meets requirement for 100 trees/acre (Yes/No)**	**# Trees >2" DBH**	**# Trees needed for 50% trees >2" DBH**	**Meets requirement 50% trees >2" DBH**	**Meets All Credit Requirements**	**Impervious Credit (acres)**
Northwest Branch South of Randolph Road	**Area 1**	Yes	October 27, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	2.212	49	283	332	SY, RB, PP, WO, PO, GA, RD	Yes	No existing GIS provided by County; area generated by Biohabitats. Species <2" DBH are most RD and PP. Appears invasive species are being controlled and cages are being maintained.	2.21	332			283				
Aspen Hill Library	**Aspen Hill Library**	No (trees too small)	October 27, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey				0		No	Some RM and W >2" DBH but majority <2" DBH. Spacing >20FT in some areas that would not allow it to meet 100 trees/AC. Deer damage to trees. Most MA broken as base and growing back. Actively mowing around trees.	0.00	0			0				
Alta Vista Above 355	**Area 1**	Yes	October 27, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.076	39	26	65	TP, RB, WH, CE, SY, SD	Yes	Acreage measured in the field (111FTx30FT). No existing GIS provided by County; area generated by Biohabitats. 1 Mimosa tree present.	0.08	65			26				
Alta Vista Below 355	**Alta Vista Below 355**	No (trees too small)	October 27, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey				0		No	Majority of tree <2" DBH. Some planted material washed away.	0.00	0			0				
Josephs Branch 3b - Spruell Drive	**Josephs Branch 3b - Spruell Drive**	No (supplemental planting to existing forest)	October 27, 2014	Bryon Salladin, Sarah Roberts				0		No	Several planted tree found throughout site. One area (~1/10AC) had several trees, but majority were <2" DBH and spacing wouldn't meet 100 trees/AC criteria. The site was already forested, so this planting was considered to be a supplemental planting rather than reforestation.	0.00	0			0				
Gum Springs Farm SWM	**A**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.343	4	52	56	TP, SY, WO, RB, RM	Yes	Didn't include existing trees along stream bank.	0.34	56			52				
Gum Springs Farm SWM	**B**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.237	4	24	28	SY, RB, RO, RM, CH	Yes	Didn't include existing trees along stream bank (6 trees at >2"DBH) and along edge of plot (3 trees at >2" DBH). Appear to be mowing around trees.	0.24	28			24				
Gum Springs Farm SWM	**C**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.235	7	27	34	SY, WO, RM, RB	Yes	Didn't include existing trees along stream bank (6 trees at >2"DBH).	0.24	34			27				
Gum Springs Farm SWM	**D**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.98	17	136	153	SY, WO, RM, RO, RB	Yes		0.98	153			136				
Gum Springs Farm SWM	**E**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.156	3	18	21	SY, PO, W, RM, TP	Yes		0.16	21			18				
Gum Springs Farm SWM	**F**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.745	12	4	16	SY, W, RM, SWO	No	Excluded due to planting within a stormwater pond.	0.00	0			0				
Bryant's Nursery Run	**Area 1**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.085	20	2	22	SA, SY, RM, RB	Yes	Area adjusted by Biohabitats because stream was included in the original delineation. Renamed as Area 1.	0.09	22			2				
Bryant's Nursery Run	**0.06AC**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.06	13	1	14	SA, SY, AB, TP	Yes	Several dead trees. Included volunteer SY in count.	0.06	14			1				
Bryant's Nursery Run	**0.13AC**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.13	20	4	24	SY, SA, RB, RM	Yes	Included volunteer SY in count.	0.13	24			4				
Bryant's Nursery Run	**0.06AC**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.06	7	1	8	SY, SA, AB, RB, RM	Yes		0.06	8			1				

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SITE ID		SITE DATA									CREDIT ANALYSIS - ACCOUNTING COUNTYWIDE								
Project Name	**Planting Zone/Area**	**Assessed**	**Site Visit**	**Field Crew**	**Acreage**	**Number <2" DBH**	**Number >2" DBH**	**Total Trees**	**Tree Species Present**	**Proceed with Credit Analysis**	**Notes**	**Planting Area (acres)**	**Total # Trees**	**Trees/Acre**	**Meets requirement for 100 trees/acre (Yes/No)**	**# Trees >2" DBH**	**# Trees needed for 50% trees >2" DBH**	**Meets requirement 50% trees >2" DBH**	**Meets All Credit Requirements**	**Impervious Credit (acres)**
Upper Northwest Branch - Mainstem	**0.07AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.068	11	6	17	SY, RM, BG, SB, PP	Yes		0.07	17			6				
Upper Northwest Branch - Mainstem	**0.02AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.02	4	0	4	SY, BG, SB	No	Supplemental Planting	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.22AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.216	24	12	36	BG, SB, SY	No	Supplemental Planting. Planted trees were mostly <2"DBH. Existing trees were >2"DBH.	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.03AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.026	7	1	8	PP, SB, RM	No	Supplemental Planting. Area located downstream of GIS location, but AC appears correct. All planted material <2" DBH.	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.054AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.054	5	4	9	SY, TP, PP	No	Supplemental Planting. Existing trees made up all >2" DBH trees. Japanese knotweed present.	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.052AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.052	6	2	8	SY, RM, TP, PP, RD	No	Supplemental Planting	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.04AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.04	9	1	10	PP. SY, RD	No	Supplemental Planting	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.097AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.097	3	2	5	RB, BG, SY	No	Supplemental Planting	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.13AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.127	10	5	15	RM, BG, SY, PP, RD	No	Supplemental Planting	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.098AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.098	6	4	10	WA, SY, BG	No	Supplemental Planting	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.046AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.046	3	3	6	SY, SM, PP	No	Supplemental Planting. SY and SM are existing trees.	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.181AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.181	5	4	9	SY, PP	No	Supplemental Planting	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.027AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.027	3	3	6	TP, BG, PP, GA	No	Supplemental Planting. GA is existing.	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.032AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.032	1	1	2	SY, SM	No	Supplemental Planting. SM is existing. Potentially lost planting to bank erosion.	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.057AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.057	5	11	16	SY, WA, GA, PP, PS	No	Supplemental Planting. WA, GA and PS are existing.	0.00	0			0				
Upper Northwest Branch - Mainstem	**0.039AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.039	3	3	6	SY, SB	Yes	Area located upstream of GIS location, but AC appears correct.	0.04	6			3				
Batchelors Run East	**1**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.702	137	35	172	SY, RB, CE, RM, PP, BG, SG	Yes	Mostly SY, RM & SG >2" DBH	0.70	172			35				
Batchelors Run East	**2**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.428	66	9	75	RM, SY, RB, PP, BG, CE	Yes	Mostly SY and RM >2" DBH	0.43	75			9				
Batchelors Run East	**3**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.447	66	3	69	RB, BG, SY, CE, PP, RM	Yes	Mostly SY and existing mulberry >2" DBH	0.45	69			3				
Batchelors Run East	**4**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.502	119	41	160	PP, CE, RB, RM, SY	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 4 & 1. Mostly RM, SY, BG & existing cedar >2" DBH. Mowing along edge appears to have owed over trees (i.e. large holes remain).	0.50	160			41				
Batchelors Run East	**5**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	1.287	160	69	229	PP, RB, SY, CE, RM, BG	Yes	Mostly RM, SY and existing CE >2" DBH	1.29	229			69				
Batchelors Run East	**6**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.182	19	18	37	SY, RM, SM, RB, PP, BG, CE	Yes	Mostly SY and existing CE >2" DBH	0.18	37			18				
Batchelors Run East	**7**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.704	108	48	156	SY, RM, BG, CE	Yes	Mostly SY and RM >2" DBH	0.70	156			48				
Batchelors Run East	**8**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.38	76	28	104	CE, SY, RM, PP, BG	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 8 & 14.	0.38	104			28				
Batchelors Run East	**9**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.329	44	19	63	RM, CE, RB, SY	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 9 & 13. Mostly SY, RM & existing CE >2" DBH	0.33	63			19				
Batchelors Run East	**10**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.639	137	17	154	RB, RM, BG, SY, CE	Yes	Mostly SY and existing W >2" DBH	0.64	154			17				
Batchelors Run East	**11**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.423	49	17	66	SY, RM, RB, PP, BG, W	Yes	Mostly SY, RM & W >2" DBH	0.42	66			17				
Batchelors Run East	**12**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.28	53	21	74	SY, RM, SM, BG, RB, CE, W	Yes	Mostly SY, RM & W >2" DBH	0.28	74			21				
Batchelors Run East	**13**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.429	24	31	55	SY, RB, RM, CE	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 9 & 13. Mostly SY, RM, existing WA & existing GA >2" DBH	0.43	55			31				
Batchelors Run East	**14**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.699	27	58	85	SY, RM. RB, PP, BG, CE	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 4 & 14 and 8 & 14. Mostly SY and RB >2" DBH	0.70	85			58				

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SITE ID		SITE DATA										CREDIT ANALYSIS - ACCOUNTING COUNTYWIDE								
Project Name	Planting Zone/Area	Assessed	Site Visit	Field Crew	Acreage	Number <2" DBH	Number >2" DBH	Total Trees	Tree Species Present	Proceed with Credit Analysis	Notes	Planting Area (acres)	Total # Trees	Trees/Acre	Meets requirement for 100 trees/acre (Yes/No)	# Trees >2" DBH	# Trees needed for 50% trees >2" DBH	Meets requirement 50% trees >2" DBH	Meets All Credit Requirements	Impervious Credit (acres)
Lower Sycamore Creek	25.3	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.011			0		No	Bank eroded back and plantings are gone.	0.00	0			0				
Lower Sycamore Creek	25.2	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.013			0		No	No plantings observed. Assume nothing survived.	0.00	0			0				
Lower Sycamore Creek	25.8	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.566			0		No	Few planting appear to have survived and are part of the understory.	0.00	0			0				
Lower Sycamore Creek	25.7	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.031			0		No	No plantings observed. Assume nothing survived.	0.00	0			0				
Lower Sycamore Creek	25.9	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.044			0		No	No plantings observed. Assume nothing survived.	0.00	0			0				
Lower Sycamore Creek	25.5 & 25.4	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.038			0		No	No plantings observed. Assume nothing survived.	0.00	0			0				
Stream Valley Drive	0.327AC	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.327	5	51	56	SG, TP, SY, RD, SD, RM, WO, RO	Yes	Planting adjacent to existing forest and adjacent to street. Area adjusted by Biohabitats to represent only areas where planted occurred.	0.33	56			51				
Stream Valley Drive	Area 1	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.632	25	16	41	SY, RM	Yes	Original area=1.188AC was the LOD. Area recalculated by Biohabitats to include only the area planted.	0.63	41			16				
Stream Valley Drive	Area 2	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.914	6	107	113	PO, SY, CE, TP, RB, HO	Yes	Original area=2.217AC was the LOD. Area recalculated by Biohabitats to include only the area planted.	0.91	113			107				
Turkey Branch	LRTB101 Area=0.14AC	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.136	3	15	18	WI, RM, SY, SD, SO	Yes		0.14	18			15				
Turkey Branch	LRTB101 Area=0.32AC	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.321	14	30	44	RM, WI, SY, SM, TP, WA, MU	Yes	Area includes a patch of existing trees. WA and MU are existing.	0.32	44			30				
Turkey Branch	LRTB101 Area=0.21AC	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.208	4	29	33	SY, RM, EL, CH, BE, GA	Yes	Tree count of >2" DBH includes 17 existing trees from an existing patch that makes up ~1/4 of the total area (~0.05AC). Need to include existing trees in order to meet 100 trees/AC. EL, CH, BE, and GA are existing.	0.21	33			29				
Turkey Branch	LRTB203A Area=0.10AC	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.104	0	15	15	SM, SY	Yes		0.10	15			15				
Turkey Branch	Area 1 (LRTB203B Area=0.41AC)	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.204	6	24	30	RM,WO, SY, RO, HO, SHO	Yes	Original area (LRTB203B Area=0.41AC) size adjusted by Biohabitats based on area planted.	0.20	30			24				
Turkey Branch	Area 2 (LRTB203C Area=0.15AC)	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.144	8	14	22	TP, SY, IR, CO, PO	Yes	Original area size (LRTB203C Area=0.15AC) adjusted by Biohabitats based on area planted. Volunteer SY and planted IR.	0.14	22			14				
Matt Henson Pond 1	Area 1	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.472	76	40	116	SY, RB, W, SO, BL, WO	Yes	No existing GIS provided by County; area generated by Biohabitats. Area calculated based on area with trees Matt Henson Pond 1. Opportunity to increase forested patch by decreasing the path width and planting in unmowed area on opposite side of path from pond.	0.47	116			40				
Little Falls	Area 1	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts	0.154	50	12	62	WP, RB, BE	Yes	Lots of volunteers at <2" DBH. Area adjusted by Biohabitats based on area planted.	0.15	62			12				
TOTAL					15.73	1,479	1,350	2,829				15.73	2,829	180	YES	1,350	786	YES	YES	5.98

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SITE ID		SITE DATA									CREDIT ANALYSIS - ACCOUNTING BY PLANTING AREA								
Project Name	**Planting Zone/Area**	**Assessed**	**Site Visit**	**Field Crew**	**Acreage**	**Number <2" DBH**	**Number >2" DBH**	**Total Trees**	**Tree Species Present**	**Proceed with Credit Analysis**	**Notes**	**Planting Area (acres)**	**Total # Trees**	**Trees/Acre**	**Meets requirement for 100 trees/acre (Yes/No)**	**# Trees >2" DBH**	**# Trees needed for 50% trees >2" DBH**	**Meets requirement 50% trees >2" DBH**	**Meets All Credit Requirements**	**Impervious Credit (acres)**
Northwest Branch South of Randolph Road	**Area 1**	Yes	October 27, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	2.212	49	283	332	SY, RB, PP, WO, PO, GA, RD	Yes	No existing GIS provided by County; area generated by Biohabitats. Species <2" DBH are most RD and PP. Appears invasive species are being controlled and cages are being maintained.									
	SUBTOTAL				**2.212**	**49**	**283**	**332**				**2.21**	**332**	**150**	**Yes**	**283**	**111**	**Yes**	**Yes**	**0.84**
Aspen Hill Library	**Aspen Hill Library**	No (trees too small)	October 27, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey				0		No	Some RM and W >2" DBH but majority <2" DBH. Spacing >20FT in some areas that would not allow it to meet 100 trees/AC. Deer damage to trees. Most MA broken as base and growing back. Actively mowing around trees.									
	SUBTOTAL				**0**	**0**	**0**	**0**				**0.00**	**0**	**0**	**No**	**0**	**0**	**No**	**No**	**0.00**
Alta Vista Above 355	**Area 1**	Yes	October 27, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.076	39	26	65	TP, RB, WH, CE, SY, SD	Yes	Acreage measured in the field (111FTx30FT). No existing GIS provided by County; area generated by Biohabitats. 1 Mimosa tree present.									
	SUBTOTAL				**0.076**	**39**	**26**	**65**				**0.08**	**65**	**855**	**Yes**	**26**	**4**	**Yes**	**Yes**	**0.03**
Alta Vista Below 355	**Alta Vista Below 355**	No (trees too small)	October 27, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey				0		No	Majority of tree <2" DBH. Some planted material washed away.									
	SUBTOTAL				**0**	**0**	**0**	**0**				**0.00**	**0**	**0**	**No**	**0**	**0**	**No**	**No**	**0.00**
Josephs Branch 3b - Spruell Drive	**Josephs Branch 3b - Spruell Drive**	No (supplemental planting to existing forest)	October 27, 2014	Bryon Salladin, Sarah Roberts				0		No	Several planted tree found throughout site. One area (~1/10AC) had several trees, but majority were <2" DBH and spacing wouldn't meet 100 trees/AC criteria. The site was already forested, so this planting was considered to be a supplemental planting rather than reforestation.									
	SUBTOTAL				**0**	**0**	**0**	**0**				**0.00**	**0**	**0**	**No**	**0**	**0**	**No**	**No**	**0.00**
Gum Springs Farm SWM	**A**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.343	4	52	56	TP, SY, WO, RB, RM	Yes	Didn't include existing trees along stream bank.									
Gum Springs Farm SWM	**B**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.237	4	24	28	SY, RB, RO, RM, CH	Yes	Didn't include existing trees along stream bank (6 trees at >2"DBH) and along edge of plot (3 trees at >2" DBH). Appear to be mowing around trees.									
Gum Springs Farm SWM	**C**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.235	7	27	34	SY, WO, RM, RB	Yes	Didn't include existing trees along stream bank (6 trees at >2"DBH).									
Gum Springs Farm SWM	**D**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.98	17	136	153	SY, WO, RM, RO, RB	Yes										
Gum Springs Farm SWM	**E**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.156	3	18	21	SY, PO, W, RM, TP	Yes										
Gum Springs Farm SWM	**F**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.745	12	4	16	SY, W, RM, SWO	No	Excluded due to planting within a stormwater pond.									
	SUBTOTAL				**1.951**	**35**	**257**	**292**				**1.95**	**292**	**150**	**Yes**	**257**	**98**	**Yes**	**Yes**	**0.74**
Bryant's Nursery Run	**Area 1**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.085	20	2	22	SA, SY, RM, RB	Yes	Area adjusted by Biohabitats because stream was included in the original delineation. Renamed as Area 1.									
Bryant's Nursery Run	**0.06AC**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.06	13	1	14	SA, SY, AB, TP	Yes	Several dead trees. Included volunteer SY in count.									
Bryant's Nursery Run	**0.13AC**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.13	20	4	24	SY, SA, RB, RM	Yes	Included volunteer SY in count.									
Bryant's Nursery Run	**0.06AC**	Yes	October 30, 2014	Bryon Salladin, Sarah Roberts	0.06	7	1	8	SY, SA, AB, RB, RM	Yes										
	SUBTOTAL				**0.335**	**60**	**8**	**68**				**0.34**	**68**	**203**	**Yes**	**8**	**17**	**No**	**No**	**0.00**

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SITE ID		SITE DATA									CREDIT ANALYSIS - ACCOUNTING BY PLANTING AREA								
Project Name	**Planting Zone/Area**	**Assessed**	**Site Visit**	**Field Crew**	**Acreage**	**Number <2" DBH**	**Number >2" DBH**	**Total Trees**	**Tree Species Present**	**Proceed with Credit Analysis**	**Notes**	**Planting Area (acres)**	**Total # Trees**	**Trees/Acre**	**Meets requirement for 100 trees/acre (Yes/No)**	**# Trees >2" DBH**	**# Trees needed for 50% trees >2" DBH**	**Meets requirement 50% trees >2" DBH**	**Meets All Credit Requirements**	**Impervious Credit (acres)**
Upper Northwest Branch - Mainstem	**0.07AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.068	11	6	17	SY, RM, BG, SB, PP	Yes										
Upper Northwest Branch - Mainstem	**0.02AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.02	4	0	4	SY, BG, SB	No	Supplemental Planting									
Upper Northwest Branch - Mainstem	**0.22AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.216	24	12	36	BG, SB, SY	No	Supplemental Planting. Planted trees were mostly <2"DBH. Existing trees were >2"DBH.									
Upper Northwest Branch - Mainstem	**0.03AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.026	7	1	8	PP, SB, RM	No	Supplemental Planting. Area located downstream of GIS location, but AC appears correct. All planted material <2" DBH.									
Upper Northwest Branch - Mainstem	**0.054AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.054	5	4	9	SY, TP, PP	No	Supplemental Planting. Existing trees made up all >2" DBH trees. Japanese knotweed present.									
Upper Northwest Branch - Mainstem	**0.052AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.052	6	2	8	SY, RM, TP, PP, RD	No	Supplemental Planting									
Upper Northwest Branch - Mainstem	**0.04AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.04	9	1	10	PP. SY, RD	No	Supplemental Planting									
Upper Northwest Branch - Mainstem	**0.097AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.097	3	2	5	RB, BG, SY	No	Supplemental Planting									
Upper Northwest Branch - Mainstem	**0.13AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.127	10	5	15	RM, BG, SY, PP, RD	No	Supplemental Planting									
Upper Northwest Branch - Mainstem	**0.098AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.098	6	4	10	WA, SY, BG	No	Supplemental Planting									
Upper Northwest Branch - Mainstem	**0.046AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.046	3	3	6	SY, SM, PP	No	Supplemental Planting. SY and SM are existing trees.									
Upper Northwest Branch - Mainstem	**0.181AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.181	5	4	9	SY, PP	No	Supplemental Planting									
Upper Northwest Branch - Mainstem	**0.027AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.027	3	3	6	TP, BG, PP, GA	No	Supplemental Planting. GA is existing.									
Upper Northwest Branch - Mainstem	**0.032AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.032	1	1	2	SY, SM	No	Supplemental Planting. SM is existing. Potentially lost planting to bank erosion.									
Upper Northwest Branch - Mainstem	**0.057AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.057	5	11	16	SY, WA, GA, PP, PS	No	Supplemental Planting. WA, GA and PS are existing.									
Upper Northwest Branch - Mainstem	**0.039AC**	Yes	October 30, 2014 & November 4, 2014	Bryon Salladin, Sarah Roberts	0.039	3	3	6	SY, SB	Yes	Area located upstream of GIS location, but AC appears correct.									
	SUBTOTAL				**0.107**	**14**	**9**	**23**				**0.11**	**23**	**215**	**Yes**	**9**	**5**	**Yes**	**Yes**	**0.04**
Batchelors Run East	**1**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.702	137	35	172	SY, RB, CE, RM, PP, BG, SG	Yes	Mostly SY, RM & SG >2" DBH									
Batchelors Run East	**2**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.428	66	9	75	RM, SY, RB, PP, BG, CE	Yes	Mostly SY and RM >2" DBH									
Batchelors Run East	**3**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.447	66	3	69	RB, BG, SY, CE, PP, RM	Yes	Mostly SY and existing mulberry >2" DBH									
Batchelors Run East	**4**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.502	119	41	160	PP, CE, RB, RM, SY	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 4 & 1. Mostly RM, SY, BG & existing cedar >2" DBH. Mowing along edge appears to have owed over trees (i.e. large holes remain).									
Batchelors Run East	**5**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	1.287	160	69	229	PP, RB, SY, CE, RM, BG	Yes	Mostly RM, SY and existing CE >2" DBH									
Batchelors Run East	**6**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.182	19	18	37	SY, RM, SM, RB, PP, BG, CE	Yes	Mostly SY and existing CE >2" DBH									
Batchelors Run East	**7**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.704	108	48	156	SY, RM, BG, CE	Yes	Mostly SY and RM >2" DBH									
Batchelors Run East	**8**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.38	76	28	104	CE, SY, RM, PP, BG	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 8 & 14.									
Batchelors Run East	**9**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.329	44	19	63	RM, CE, RB, SY	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 9 & 13. Mostly SY, RM & existing CE >2" DBH									
Batchelors Run East	**10**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.639	137	17	154	RB, RM, BG, SY, CE	Yes	Mostly SY and existing W >2" DBH									
Batchelors Run East	**11**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.423	49	17	66	SY, RM, RB, PP, BG, W	Yes	Mostly SY, RM & W >2" DBH									
Batchelors Run East	**12**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.28	53	21	74	SY, RM, SM, BG, RB, CE, W	Yes	Mostly SY, RM & W >2" DBH									
Batchelors Run East	**13**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.429	24	31	55	SY, RB, RM, CE	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 9 & 13. Mostly SY, RM, existing WA & existing GA >2" DBH									
Batchelors Run East	**14**	Yes	November 4, 2014	Bryon Salladin, Sarah Roberts	0.699	27	58	85	SY, RM. RB, PP, BG, CE	Yes	The number of existing Eastern Red Cedars were divided evenly between planting zones 4 & 14 and 8 & 14. Mostly SY and RB >2" DBH									
	SUBTOTAL				**7.431**	**1085**	**414**	**1499**				**7.43**	**1,499**	**202**	**Yes**	**414**	**372**	**Yes**	**Yes**	**2.82**

Montgomery County TO9
Reforestation Field Verification
December 2014

SITE ID		SITE DATA									CREDIT ANALYSIS - ACCOUNTING BY PLANTING AREA								
Project Name	**Planting Zone/Area**	**Assessed**	**Site Visit**	**Field Crew**	**Acreage**	**Number <2" DBH**	**Number >2" DBH**	**Total Trees**	**Tree Species Present**	**Proceed with Credit Analysis**	**Notes**	**Planting Area (acres)**	**Total # Trees**	**Trees/Acre**	**Meets requirement for 100 trees/acre (Yes/No)**	**# Trees >2" DBH**	**# Trees needed for 50% trees >2" DBH**	**Meets requirement 50% trees >2" DBH**	**Meets All Credit Requirements**	**Impervious Credit (acres)**
Lower Sycamore Creek	**25.3**	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.011			0		No	Bank eroded back and plantings are gone.									
Lower Sycamore Creek	**25.2**	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.013			0		No	No plantings observed. Assume nothing survived.									
Lower Sycamore Creek	**25.8**	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.566			0		No	Few planting appear to have survived and are part of the understory.									
Lower Sycamore Creek	**25.7**	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.031			0		No	No plantings observed. Assume nothing survived.									
Lower Sycamore Creek	**25.9**	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.044			0		No	No plantings observed. Assume nothing survived.									
Lower Sycamore Creek	**25.5 & 25.4**	No (majority of plantings not found)	November 4, 2014	Bryon Salladin, Sarah Roberts	0.038			0		No	No plantings observed. Assume nothing survived.									
	SUBTOTAL				**0**	**0**	**0**	**0**				**0.00**	**0**	**0**	**No**	**0**	**0**	**No**	**No**	**0.00**
Stream Valley Drive	**0.327AC**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.327	5	51	56	SG, TP, SY, RD, SD, RM, WO, RO	Yes	Planting adjacent to existing forest and adjacent to street. Area adjusted by Biohabitats to represent only areas where planted occurred.									
Stream Valley Drive	**Area 1**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.632	25	16	41	SY, RM	Yes	Original area=1.188AC was the LOD. Area recalculated by Biohabitats to include only the area planted.									
Stream Valley Drive	**Area 2**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.914	6	107	113	PO, SY, CE, TP, RB, HO	Yes	Original area=2.217AC was the LOD. Area recalculated by Biohabitats to include only the area planted.									
	SUBTOTAL				**1.873**	**36**	**174**	**210**				**1.87**	**210**	**112**	**Yes**	**174**	**94**	**Yes**	**Yes**	**0.71**
Turkey Branch	**LRTB101 Area=0.14AC**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.136	3	15	18	WI, RM, SY, SD, SO	Yes										
Turkey Branch	**LRTB101 Area=0.32AC**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.321	14	30	44	RM, WI, SY, SM, TP, WA, MU	Yes	Area includes a patch of existing trees. WA and MU are existing.									
Turkey Branch	**LRTB101 Area=0.21AC**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.208	4	29	33	SY, RM, EL, CH, BE, GA	Yes	Tree count of >2" DBH includes 17 existing trees from an existing patch that makes up ~1/4 of the total area (~0.05AC). Need to include existing trees in order to meet 100 trees/AC. EL, CH, BE, and GA are existing.									
Turkey Branch	**LRTB203A Area=0.10AC**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.104	0	15	15	SM, SY	Yes										
Turkey Branch	**Area 1 (LRTB203B Area=0.41AC)**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.204	6	24	30	RM,WO, SY, RO, HO, SHO	Yes	Original area (LRTB203B Area=0.41AC) size adjusted by Biohabitats based on area planted.									
Turkey Branch	**Area 2 (LRTB203C Area=0.15AC)**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.144	8	14	22	TP, SY, IR, CO, PO	Yes	Original area size (LRTB203C Area=0.15AC) adjusted by Biohabitats based on area planted. Volunteer SY and planted IR.									
	SUBTOTAL				**1.117**	**35**	**127**	**162**				**1.12**	**162**	**145**	**Yes**	**127**	**56**	**Yes**	**Yes**	**0.42**
Matt Henson Pond 1	**Area 1**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts, Don Dorsey	0.472	76	40	116	SY, RB, W, SO, BL, WO	Yes	No existing GIS provided by County; area generated by Biohabitats. Area calculated based on area with trees Matt Henson Pond 1. Opportunity to increase forested patch by decreasing the path width and planting in unmowed area on opposite side of path from pond.									
	SUBTOTAL				**0.472**	**76**	**40**	**116**				**0.47**	**116**	**246**	**Yes**	**40**	**24**	**Yes**	**Yes**	**0.18**
Little Falls	**Area 1**	Yes	November 6, 2014	Bryon Salladin, Sarah Roberts	0.154	50	12	62	WP, RB, BE	Yes	Lots of volunteers at <2" DBH. Area adjusted by Biohabitats based on area planted.									
	SUBTOTAL				**0.154**	**50**	**12**	**62**				**0.15**	**62**	**403**	**Yes**	**12**	**8**	**Yes**	**Yes**	**0.06**
TOTAL					**15.73**	**1,479**	**1,350**	**2,829**												**5.85**

Appendix D.1 Impervious Cover Credit for Conservation Landscaping

memo

Center for Watershed Protection

To: Jennifer Zielinski, Biohabitats

From: Deb Caraco, Center for Watershed Protection

CC: Bill Stack, Ari Daniels, Karen Cappiella

Date: 3/20/2015

Re: Impervious Cover Credit for Conservation Landscaping (CLS)

Background and Introduction

The Montgomery County Department of Environmental Protection (MCDEP) maintains a database of CLS practices implemented under the RainScapes program, but these do not receive credit toward meeting the County's MS4 requirement. Although MDE's guidance does not explicitly credit this practice (MDE, 2014), the practice, when it incorporates a ponding berm, is very similar to a Rain Garden. When CLS does not include a berm, it is more similar to a land conversion from urban pervious cover to forest. This document describes the credits for both the ponding and non-ponding options of this practice, and describes the technical justification for these credits.

Credit and Criteria

For a system that includes ponding, the credit (in acres) is equal to:

$$C_{ponding} = Minimum\ (I_{DA}, 5.9 \times SA)/43,560$$

Where:

C = Credit (in acres of impervious cover)
I_{DA} = Impervious Cover in the Drainage Area (acres)
SA = Surface Area (sf)
43,560 = sf/acre

$$C_{no\ ponding} = 0.38 \times SA/43,560$$

Where:

C = Credit (in acres of impervious cover)
SA = Surface Area (sf)

In order to receive these credits, a CLS area needs to meet certain design criteria (Table 1), which are consistent with the criteria of the RainScapes program.

Table 1. Recommended Design Specifications for Rain Garden and CLS (Adapted from MCDEP, 2014)	
Soil Media Depth	9”
Soil Media Specifications	Decompact to 9” and enhance with 2” of compost.
Ponding Depth (for practices with ponding)[1]	2-3”
Mulch Layer	3”
Landscaping	Submit landscaping plan. At least 75% native, 25% may be non-native. All non-invasive.
Surface Area	Minimum 250 sf
1: Current guidance is 2”, but design is 2-3” in practice.	

Reporting Requirements:
When the practice is implemented, design data including depth of ponding, impervious cover in the drainage area, and practice surface area. These data are recorded in a database maintained by the MCDEP.

The RainScapes program is implemented on private property, so that inspecting every location may not be practical. In order to conform to the MDE’s 3-year verification standard, the MCDEP will design a study to inspect a representative sample of the CLS practices installed in the County. The study will include a tiered approach that utilizes a combination of aerial photography and windshield survey data to verify that the CLS areas are still in place and to estimate surface area, as well as a subsample of on-site inspections to verify more detailed practice features such as ponding depth, flow path and soil condition.

Technical Support for CLS Credits

The technical justification for CLS credits with and without ponding are different, and are as follows:

<u>CLS with Ponding</u>
According to MDE (2014), practices included in the Maryland Stormwater Management Design Manual (the Design Manual; MDE, 2000), considered acceptable water quality treatment BMPs for addressing restoration requirements in MS4 Permits. With some specific exceptions, CLS is very similar to the Rain Garden included in the Design Manual (See Table 2). On important distinction is the ponding depth, which is significantly smaller than the 6” depth allowed for Rain Gardens. Although the CLS ponding depth is between 2” and 3” in practice, this credit includes a 2” ponding depth as a conservative assumption.

Another difference is that the Design Manual has much more rigorous testing requirements for the soils of Rain Gardens. However, the very shallow ponding depth of CLS practices results in a much larger surface area than MDE’s Rain Garden. As a result of this oversizing, combined with soil enhancements put in place at the time of construction, it is assumed that CLS will perform at least as well as the Rain Garden specified in the Design Manual.

Table 2. Design Specifications for Rain Garden and Conservation Landscaping		
	Rain Garden MDE (2000)	CLS MC DEP (2014)
Soil Media Depth	6”-12”	9”
Soil Media Specifications	Soil is tested to meet specific criteria in Appendix B.4 of the Design Manual.	Decompact to 9” and enhance with 2” of compost.
Ponding Depth	<6”	2-3”
Mulch Layer	2-3”	3”
Landscaping	Submit landscaping plan. Locate in full or partial sun. Plants selected for use in a Rain Garden should tolerate both saturated and dry conditions and be native or adapted to Maryland	Submit landscaping plan. At least 75% native, 25% may be non-native. All non-invasive.

The storage volume in the CLS area is equal to the volume stored in the soil medium and mulch, as well as the ponding area (Equation 1):

Equation 1:

$$\boldsymbol{V_{CLS} = V_{Soil+Mulch} + V_{Ponding}}$$

Where:

V_{CLS} = Volume stored in the CLS area (cf)
$V_{Soil+Mulch}$ = Volume stored in the soil and mulch (cf)
$V_{Ponding}$ = Volume stored in the ponding area above the soil bed.

The following assumptions are used to calculate this volume:

1. The porosity of both the soil and the mulch is 0.3.
2. The depth of mulch is 3”
3. The depth of soil is 9”
4. The shape of the CLS area is an ellipse with a 2:1 major axis to minor axis ratio.
5. The ponding depth (2”) is achieved with 2:1 side slopes

The volume in the soil and mulch us calculated by assuming a 3” depth of mulch and 9” depth of soil (for a total of 12” or 1’) over the area of the CLS and a porosity of 0.3 (Equation 2):

Equation 2:

$$\boldsymbol{V_{Soil+Mulch} = SA \times D_{Media} \times PO}$$

Where:

SA = CLS surface area (sf)
D_{Media} = Mulch and soil depth (feet); assume 1’
PO = Soil and mulch porosity; assume 0.3

The volume in the ponding area is determined by assuming a 2" ponding depth and average ponding area over the CLS (Equation 3). This equation is conservative, since it assumes that the ponding area is equal to the surface area, but the area of ponding is actually slightly larger than the surface area of the media.

Equation 3:

$$\boldsymbol{V_{Ponding} = SA \times \frac{D_{Ponding}}{12}}$$

Where:

$D_{Ponding}$	=	Depth of ponding (ft)
12	=	inches/ft

By combining equations 1, 2 and 3, and assuming a media depth of 12" and porosity of 0.3, the total volume stored in the CLS area is:

Equation 4:

$$\boldsymbol{V_{CLS} = 0.47 \times SA}$$

The credits offered by MDE are equivalent to a 1" design storm. Consequently, the impervious cover treated per practice area is determined by calculating the runoff from each unit area of impervious cover, so that:

Equation 5:

$$\boldsymbol{V_{Target} = I_{DA} \times \frac{1}{12} \times 0.95}$$

Where:

V_{Target}	=	Target treatment volume for a 1" storm
0.95	=	Runoff coefficient for impervious cover

Setting the target volume (Equation 5) less than or equal to the CLS volume (Equation 4) and simplifying results in the following:

Equation 6:

$$\boldsymbol{I_{DA} \leq 5.9 \times SA}$$

Since the impervious cover credit is equal to the impervious area captured, equation 6 can be expressed by the following:

Equation 7:

$$\boldsymbol{C_{ponding} \leq 5.9 \times SA}$$

In addition, the practice can only receive credit for area that it treats, so the practice is limited by the impervious cover in the drainage area, or:

Equation 8:

$$\boldsymbol{C_{ponding} \leq I_{DA}}$$

Combining Equations 7 and 8, and converting from sf to acres, the credit is summarized as:

Equation 9:

$$C_{ponding} = Minimum\ (5.9 \times SA, I_{DA}\ )/43{,}560$$

CLS without Ponding[1]

When these CLS areas are constructed without ponding, they cannot reliably capture stormwater runoff diverted to them, even if they have substantial storage in the soil layer and mulch bed. However, MCDEP guidance encourages applying this practice on compacted turf areas or areas of invasive plants. Consequently, the practice will represent a significant improvement over existing conditions, even if it captures no runoff from adjacent areas. The primary benefit from this practice would be conversion of compacted urban turf to a landscaped area with soil amendments and a mulch layer.

The MDE does not currently recognize soil amendments as an alternative practice, but other Bay States, including Virginia, West Virginia, the District of Columbia, and New York State do allow credits for amending urban soils at the site level, and available research suggests that compost amendments can reduce the annual runoff volume by up to 75% (Battiata et al., 2010). Since the CLS design incorporates a deep (9") depth of soil enhancement, a 3" mulch bed, and native plants, and is targeted to "distressed" urban soils, it is reasonable to assume that the practice will achieve this level of performance.

The approximate benefits of this practice acre calculated using the following assumptions and calculations:

- The runoff coefficient for urban soils targeted for the CLS program is 0.25 (the coefficient for D soils),
- CLS can reduce runoff from the 1" storm by 75%
- The resulting runoff coefficient is approximately 0.06
- This runoff coefficient is very close to the runoff coefficient for forest D soils (0.05), without accounting for the benefits of the plant material in the CLS or benefits achieved by runoff from adjacent landscaped areas.

[1] Conservation Landscaping with ponding may claim this credit as an alternative for cases where the impervious cover in the drainage area are very low (less than 40% of the surface area of the practice)

The proposed credit for CLS is set equal to the credit for converting pervious urban land to forest (MDE, 2014), or:

Equation 10:

$$C_{no\ ponding} = 0.38XSA/43560$$

Where:

$C_{no\ ponding}$	=	Credit for CLSwith no ponding (sf)
0.38	=	Credit for converting urban pervious land to forest (ac/ac)

Conclusion

The impervious area credits proposed in this memorandum for CLS With Ponding and Conservation Landscaping Without Ponding are developed using a different set of assumptions. CLS With Ponding is very similar to a Rain Garden, and consequently can easily be equated with the benefits of this practice. CLS Without Ponding, on the other hand, is different from other practices currently credited by the MDE. Consequently, the approach used to credit this practice relies on a comparison between the hydrologic benefits of this practice and the hydrologic benefits of a land use conversion from urban pervious cover to forest.

References

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Appendix D.2 Impervious Cover Credit for Individual Trees

memo

Center for Watershed Protection

To: Jennifer Zielinski, Biohabitats

From: Deb Caraco, Center for Watershed Protection

CC: Bill Stack, Ari Daniels, Karen Cappiella

Date: 3/20/2015

Re: Impervious Cover Credit for Individual Trees

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1. Background and Introduction

The Montgomery County Department of Environmental Protection (MCDEP) maintains a database of individual trees planted as a part of the Rainscapes program. However, Montgomery County has not reported these individual tree plantings to the MDE and as a result these individual tree plantings have not received any credit toward meeting its MS4 permit impervious cover reduction goals.

Although the Maryland Department of the Environment (MDE) does credit urban tree planting on both pervious and impervious surfaces (MDE, 2014), the language in this guidance implies that the minimum area for aggregating tree planting credits is ¼-acre. In addition, MDE's specific standards for forest stands do not exactly correlate with the standards of the RainScapes program. This memorandum summarizes a strategy for crediting urban tree planting, along with best practices and documentation needed to support it. Finally, a literature survey provides technical support.

2. Credit and Criteria

The individual tree credit is as follows:

$$\boldsymbol{C = 0.0019\ acres\ (82\ sf)\ of\ impervious\ cover\ reduction\ per\ tree}$$

Standards to meet this credit include:

1) The tree is planted within 15' of an impervious surface.
2) Minimum 2" caliper at time of planting.
3) Periodic reporting to MDE to verify the stock of trees implemented as a part of the RainScapes program.
4) Tree planting is accompanied by a documented leaf management program (see "Leaf Litter Management" below)
5) The tree has been alive for at least 3 years, or has a minimum Diameter at Breast Height (DBH) of 6".

This value is an interim credit that is conservative compared with standards adopted in other municipalities of the region. Future monitoring of tree diameter may be used to adjust the credit based on canopy cover provided by the stock of trees in the County.

3. Reporting Requirements:

Currently, MCDEP retains a database of existing trees that records the following information (not all inclusive): number of trees planted, size of trees planted (in some instances), watershed in which property is located, initial inspection date, and in most cases a follow-up verification of project state.

The RainScapes program is implemented on private property, so that inspecting every tree after the initial planting period not be practical. In order to conform to the MDE's 3-year verification standard, the MCDEP will design a study to inspect a representative sample of the trees planted in the County. The study will include a tiered approach that utilizes a combination of aerial photography and windshield survey data to verify that the trees are still alive and in good health (based on a quick visual survey from the road). These data will be supplemented with on-site investigations of some properties that evaluate the Diameter at Breast Height (DBH) and land use under the canopy area. These data will be used both to revise the credit per tree and to adjust the number of trees that are included in the program over time.

The results of this ongoing monitoring will be used for the following purposes:

1) Documenting the long-term survival rate of trees planted as a part of the RainScapes program. If only a fraction of the trees planted continue to survive, then a survival rate factor should be added to the initial credit.
2) Revise Figure 1 (See Section 4 below) to develop a customized relationship between age and DBH for the trees planted as a part of the RainScapes program, and use these data, combined with the canopy interception data in Figure 2 to create a revised relationship between tree age and canopy interception (Figure 3)
3) Develop an inventory of typical tree size among the trees currently in place.
4) Revise the assumption of impervious cover under the tree canopy based on a sample of observations.
5) Using the data in steps 2, 3 and 4, revise the credit after an initial reporting period.

4. Technical Support for the Individual Tree Credits

Overall Approach and Simplifying Assumptions

In developing the individual tree credits, the following overriding assumptions were made. These key assumptions, along with the basis for making them, are highlighted in Table 1.

Table 1. Crediting assumptions and foundation

Assumption	Basis/ Reason for Assumption
1) The maximum possible credit that can be achieved by an urban tree is 1/100th of an acre of forest planted on urban pervious surfaces.	Consistency with MDE guidance. Another option would be to evaluate this credit in terms of conversion of impervious surface to forest, but urban trees to not offer the same benefits as this land conversion since impervious cover under tree canopy remains intact.
2) Individual trees are different from land conversion to forest because the benefits may be confined to interception in the tree canopy and bark, and may not have the benefits of storage within the forest floor.	Backed by fundamental research (see below). Conservative assumption.
3) The credit is based on the runoff and pollutant removal benefits from a 15- to 20- year old tree with a DBH 9" and 15"	Consistency with MDE standards, which allows full credit for conversion to forest if the median DBH is equivalent to 2"provided the performance criteria are met.
4) The benefits of an acre of forest conversion can be scaled down to an individual tree based on the annual runoff reduction provided by the individual and the acre of forest.	Simplicity of approach and data availability.
5) Trees planted in Montgomery County within 15' of impervious cover as a part of the RainScapes program will on average have 1/3 of their canopy over impervious cover and 2/3 over pervious surfaces.	Estimate based on the assumption that each tree shades 150 sf of impervious cover, and has about a 450 sf canopy area. Should be spot checked with a sample of trees in the RainScapes database.
6) In the first three years, the tree offers no benefit, unless the tree has a documented DBH of 6" or greater.	Potential for die-off in the first years, as well as negligible canopy interception during this period. (See "canopy interception" below).
7) Tree credits are based on an "average condition" converted to a typical credit per tree rather than a more refined credit that requires additional documentation.	Simplicity of accounting both for MCDEP and MDE. Sets the stage for a credit that can be used in multiple communities in Maryland. Consistent with MDE's Tree Planting credit, as well as individual tree credits in most communities.

Derivation of Tree Credits

In developing this credit, we assumed that individual trees offer canopy interception, but none of the other hydrologic benefits offered by larger forest stands. This essentially means that the "forest floor" benefits resulting from a thick layer of organic material will not occur as a result of urban tree planting. This is a conservative assumption, since urban trees do offer shade, and homeowners may convert this area to landscaping rather than a traditional lawn. In addition, the RainScapes program guidance does require a mulched area at the time of planting, but this area is quite small.

In order to be consistent with MDE guidance, and to build on analyses previous conducted by the Chesapeake Bay Program, this analysis starts with the assumption that planting a single urban tree can be equated with the practice of converting urban pervious land to forest. As described in MDE (2014), planting an acre of forest at a density of 100 trees per acre on urban land is offered a credit equivalent to treating 0.38 acres of impervious cover. In order to relate the benefits of these two land use changes, the annual runoff reduction provided by each action (planting an acre of forest on urban pervious land and planting a single urban tree) are compared. The ratio between these two annual runoff reduction numbers are then multiplied by the credit offered for an acre of pervious forest planting (in impervious acres) to develop an equivalent single tree credit (Equation 1).

Equation 1:

$$C = \frac{RR_{Tree}}{RR_{UP\ to\ F}} \times 0.38$$

Where:

C	=	Credit (imp. Acres) offered by one tree (acres)
RR_{Tree}	=	Annual Runoff reduction (cf) from canopy interception of one tree
$RR_{UP\ to\ F.}$	=	Annual Runoff reduction (cf) achieved by converting one acre of urban pervious land to forest
0.38	=	Current credit offered by the MDE for converting urban pervious land to forest (impervious acres)

The benefit of canopy interception is calculated on an annual basis, with the assumption that canopy interception effectively reduces the annual runoff volume, as follows:

Equation 2:

$$RR_{Tree} = \frac{I}{7.48} \times Rv_{Tree\ Canopy}$$

Where:

$Rv_{Tree\ Canopy}$	=	Runoff coefficient under the tree canopy. Assuming a weighted value of 2/3 urban pervious (0.25) and 1/3 impervious (0.95), the value is 0.48
I	=	Canopy Interception (gallons; assume 2000 gallons/year; see "Canopy Interception" below)
7.48	=	Units conversion from gallons to cubic feet.

Substituting values into Equation 2, the **annual runoff reduction from one tree is equal to 128 cubic feet per year.**

The runoff from urban pervious and runoff from forest are also determined using the modified simple method (Equation 3):

Equation 3:

$$RR_{UP\ to\ F} = 0.9 \cdot P \cdot (Rv_{Urb\ Perv.} - Rv_{Forest}) \cdot 3{,}630$$

Where:

0.9	=	Conversion factor to account for storms that do not produce runoff

P	=	Annual Precipitation (42”)
$Rv_{Urb\ Perv.}$	=	Runoff coefficient for urban pervious land (0.25)
Rv_{Forest}	=	Runoff coefficient for forest (0.05)
3,630	=	Units conversion from acre-inches to cubic feet.

Substituting the values above values into Equation 3, **the annual runoff reduction for an acre of urban pervious to forest conversion is 27,400 cf.**

Therefore, the ratio of a single tree to an acre of reforestation (in terms of runoff reduction) is 0.005. Substituting back into Equation 1:

$$\boldsymbol{C = 0.0019\ acres\ (82\ sf)\ of\ impervious\ cover\ reduction\ per\ tree}$$

Canopy Interception

The estimated canopy interception was derived using modeling results from the i-Tree tools package and using data from Montgomery County. Figure 1 on the following page shows trunk diameter in inches plotted versus age of the tree in years. Figure 2 shows volume of rainfall intercepted in a year in gallons versus trunk diameter in inches. These data were retrieved from the databases in the i-Tree tools package, specifically from i-Tree STREETS (formerly STRATUM). “Broadleaf Deciduous Large” and “Broadleaf Deciduous Medium” trees are average representations of trees in those categories, found in the Piedmont (South) climate region, in which Montgomery County lies. i-Tree uses a composite model described by Xiao et al (1998) to generate rainfall interception. Trunk size growth rate and rainfall interception potential are Piedmont region-specific.

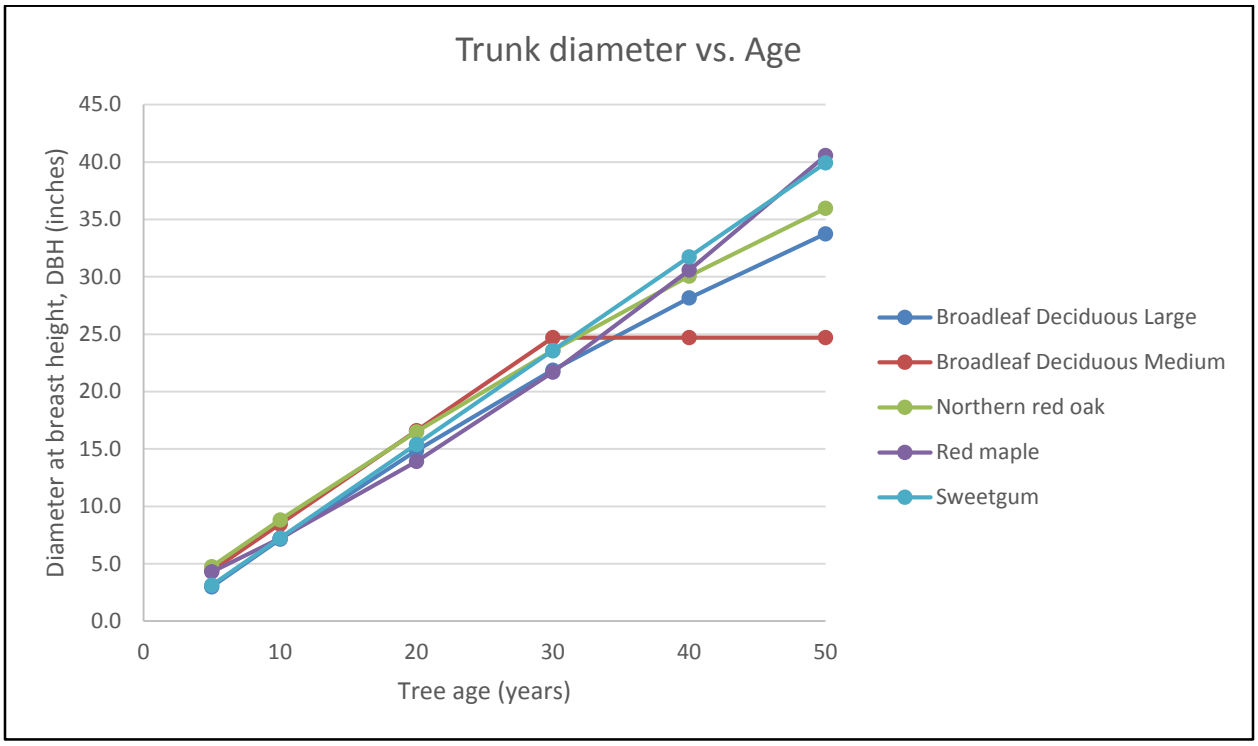

Figure 1. Tree trunk diameter versus age

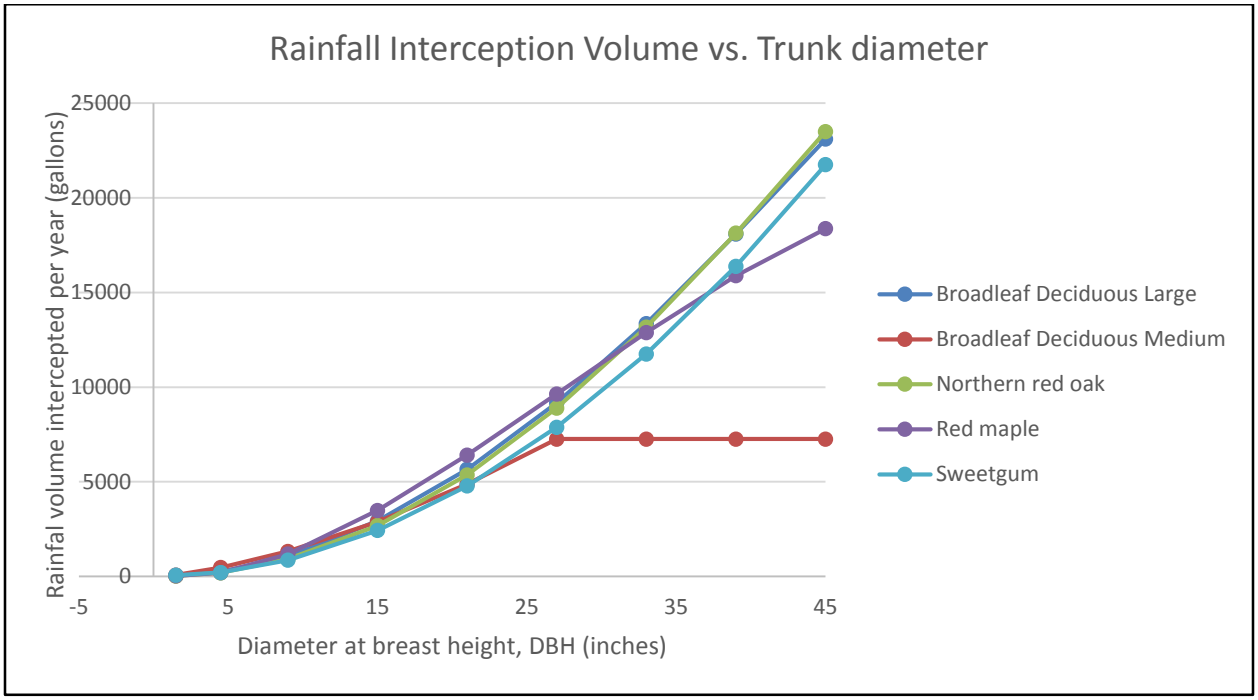

Figure 2. Rainfall interception versus trunk diameter

Using Microsoft Excel's trendline function, polynomial regressions were generated from the plots of trunk diameter vs. age, and volume of rainfall interception vs. trunk diameter. The regression functions all had an R^2 value of at least 0.999. These two functions were tied and plotted in Excel for each of three representative tree species from Montgomery County's RainScapes recommended tree list – Red Maple (*Acer rubrum*), Northern Red Oak (*Quercus rubra*), and Sweetgum (*Liquidambar styraciflua*) – and the one average representation from i-Tree, "Broadleaf Deciduous Large", which includes most of the trees in Montgomery County's list. The other trees in Montgomery County's list fell into the "Broadleaf Deciduous Medium" category, which generally performed similarly to the large trees except that growth and interception plateaued at between 25 and 30 years of age. Because of this plateau, Broadleaf Deciduous Medium was not plotted.

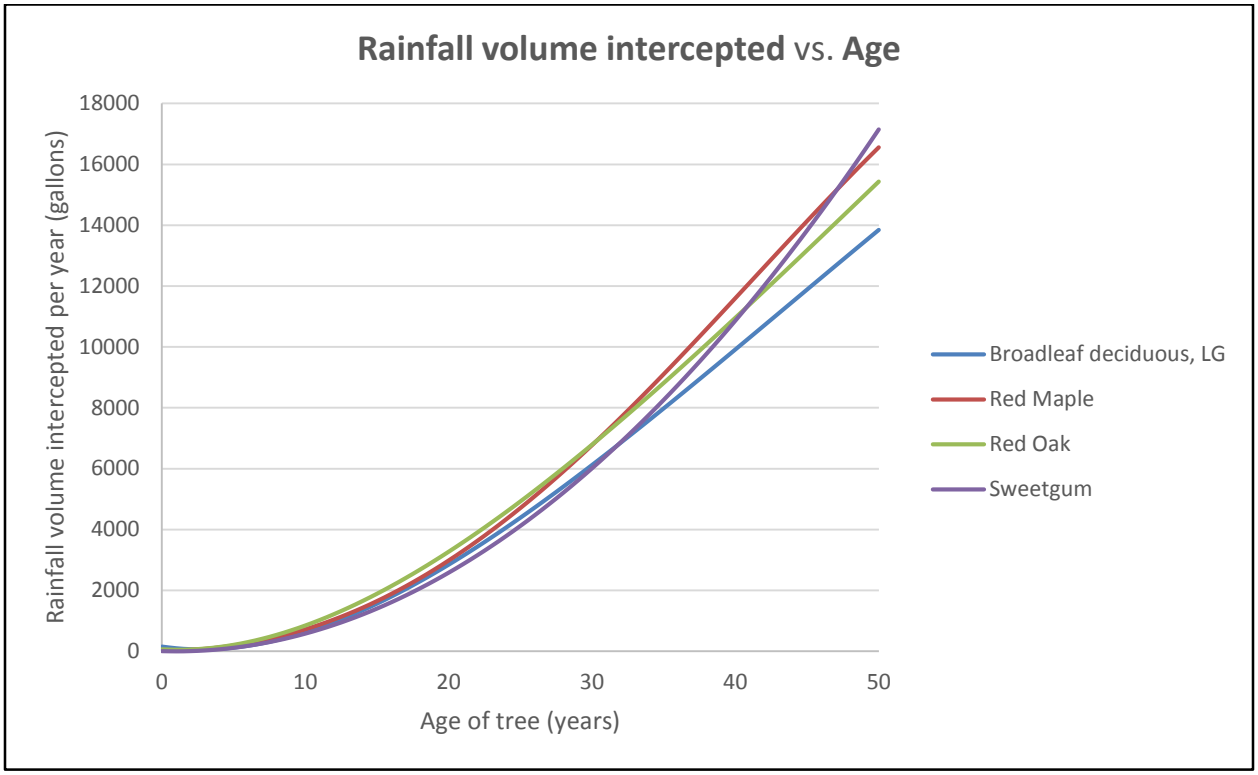

Figure 3. Rainfall interception versus tree age

Two assumptions that acted as the underpinning for these credits were derived from this analysis. First, the average annual interception volume per tree (2,000 gallons/year) was derived from the data in Figure 2 and Figure 3, and represents the runoff reduction associated with a typical tree planted in Montgomery County that is between 15 and 20 years old, and between 9" and 15" DBH. While many trees will be younger than this age at any given time, the trees that survive past this point will accomplish exponential growth in rainfall interception that will offset the trees younger than this age. In addition, the data in Figure 3 suggest that very young and small trees accomplish virtually no interception. Since, unlike a contiguous forest stand, urban trees do not also accomplish a land use change, this credit would not be reported to the MDE until the tree has survived two three-year inspection cycles.

5. Comparison to Credits Offered by Other Communities

Table 2 below shows a breakdown of the impervious surface area or rainfall volume reduction offered by various municipalities across the United States for trees planted or preserved, for the purposes of meeting stormwater management guidelines for development or utility fee reductions. Much of this table was gleaned from Stone Environmental (2014). A typical credit is 100 square feet of impervious reduction for each new tree, which is quite close to the proposed 82 square foot credit. The City of Seattle was an outlier, offering only 20 square feet of impervious cover reduction for each new tree. Some communities, such as Pine Lake, GA and Washington, DC offer a volume credit for an individual storm event, rather than an equivalent impervious reduction. Many municipalities that have stormwater utility fees offer fee credits, including Montgomery County and Baltimore City in Maryland. These fee credit systems typically do not include explanations or calculations for runoff volume or pollutant load reductions.

Table 2. Credits Offered by Other Communities

Community	**Description of credit (for volume or area type)**
Pine Lake, GA	Ordinance passed in 2003 that provides credits for saving trees. Credits help meet site runoff requirements and are determined based on size class of tree: • Trees < 12" DBH = 10 gallons/inch • Trees > 12" DBH = 20 gallons/inch
Sacramento, CA San Jose, CA Santa Clara Valley, CA	2007 Stormwater Quality Design Manual includes credits for new or existing 'interceptor trees.' Credits are accompanied by design criteria and a list of approved interceptor trees. A portion of impervious cover underneath tree canopy may be subtracted from the site impervious cover as follows: • New deciduous trees = 100 s.f. • New evergreen trees = 200 s.f. • Existing trees = ½ the existing canopy
Portland, OR	2004 Stormwater Management Manual includes credits for new or existing trees within 25 feet of impervious surfaces. Credits are accompanied by design criteria and a list of approved species. A portion of impervious cover underneath tree canopy may be subtracted from the site impervious cover as follows: • New deciduous trees = 100 s.f. • New evergreen trees = 200 s.f. • Existing trees = ½ the existing canopy
Indianapolis, IN	2007 Draft Stormwater Green Infrastructure Supplemental Document provides credits for new or existing tree canopy that is within 20 feet of impervious surfaces. Trees must be on approved species list and standards are provided for tree size. An impervious cover reduction credit of 100 s.f. is given for each new tree.
Seattle, WA	2012 online guidance gives the following, confirmed by deeproot.com blog on Green Infrastructure • New deciduous trees = 20 s.f. • New evergreen trees = *50 s.f.* • Existing deciduous trees = 10% canopy, min. 50 s.f. • Existing evergreen trees = 20% canopy, min. 100 s.f.

Table 2. Credits Offered by Other Communities	
Community	**Description of credit (for volume or area type)**
Washington, DC	Trees receive retention value but are not considered total suspended solids (TSS) treatment practices. All credited trees must be preserved/planted/properly maintained until redevelopment occurs. If trees die they must be replaced within 6 months. Volume credits are: • Preserved trees: 20 ft^3 each • Planted trees: 10 ft^3 each Trees planted as part of another BMP, such as a bioretention area, also receive the 10 ft3 retention value.
Philadelphia, PA	Reduction in directly connected impervious area granted when new or existing tree canopy from approved species list extends over or is in close proximity to the impervious cover. New trees (min. 2-inch caliper deciduous or 6 ft. tall evergreen): • 100 ft^2 DCIA reduction per new tree. • New deciduous trees must be at least 2-inch caliper and new evergreen trees must be at least 6 feet tall. Existing trees (at least 4-inch caliper): • Existing trees = ½ the existing canopy • Can only be applied to adjacent DCIA Maximum reduction permitted is 25% of ground level impervious area within limits of disturbance, unless impervious area width is less than 10 feet. Up to 100% of narrow impervious areas may be disconnected.
Baltimore City, MD	Fee credit, without explicit underlying connection to volume or impervious area

6. Leaf Litter Management

An emerging issue in urban stormwater management is the effect of leaf litter on stormwater nutrient loads. Leaf litter is composed of nitrogen, phosphorus, carbon and other elements that provide an important food source in streams. While the benefits of urban tree canopy are well documented, that fate of nutrients from leaf litter that fall on impervious surfaces is less certain, and may have a negative impact on water quality. Recent research demonstrates a significant amount of leaf litter is washed through the storm drain system, with 75% or more of the material collected as organic debris such as leaves, twigs, etc. (Stack et al, 2013; MWCOG, 2009; Rushton, 2006) The potential contribution to the urban nutrient load may also be significant as Kalinosky (2013) estimated 1.5 to 6 lbs. P/curb mile from leaf litter collected by a street sweeper in neighborhoods with less than 5% to 20% tree canopy cover, while other studies find relatively high amounts of phosphorus leaches from leaf litter once wetted but varies depending on the tree species (Wallace et al, 2008).

In urban watersheds, leaf litter collects in curbs and gutters and is flushed through the storm drain system into streams if it is not removed by leaf pick-up programs or street sweeping. This pathway differs greatly from leaf litter falling on forested ground covers, where soil bacteria and other micro-organisms naturally break down the litter returning nutrients to the soil. The nutrient enrichment from leaf litter is most prominent for 'fresh' material or lawn clippings. Leaf litter left unmanaged in urban areas – specifically leaf litter fallen on impervious surfaces – may have a negative impact on local waterways that are generally already impaired for excessive nutrients and biology.

Proper management of leaf litter is effective practice to keep lawns healthy and storm drains free of debris. Leaf litter left on turfgrass blocks sunlight and reduces turf growth due to shading, while the leaf litter also traps moisture

increasing the potential for disease to infest your lawn. While it is a common practice to rake leaf litter curbside for pick-up using vacuum trucks, the timing of this management option is critical to its effectiveness. If leaf litter piles are left curbside, wind and rain may disperse the leaves which then collect in the storm drain and block inlets. Further, emerging research suggests an abundance of leaf litter is washed through the storm drain system into local waterways, with high levels of phosphorus leaching from the leaf litter – however the impact on local waterways is to be determined.

Currently, Montgomery County provides information regarding leaf litter management (Table 3). As more studies are conducted to evaluate the impact of leaf litter, these options may be revisited. In addition, watershed-scale practices such as outfall netting or other capture devices may be recommended in the future.

Table 3. Leaf Litter Management options[1]

1. Recycle leaf litter on the lawn while mowing. While a regular rotary mower may be effective, special mulching blades may be used that are designed to chop the leaf litter and returns them to the turfgrass where they decompose over time. This practice is recommended for dry leaves and broad-leaf, not evergreen needles.
2. Compost leaf litter. Homeowners collect leaf litter in compost containers. The decomposition of leaf litter provides natural organic material to amend soils with nutrient and help build soil structure. Montgomery County provides free composting bins and information on how to compost.
3. Yard waste pick-up Bag in leaf litter bags for curb-side pickup and composting. In Montgomery County, Maryland, weekly curbside yard trim pickups occur year round. Leaf litter material is accepted in paper yard trim bags or in reusable cans labeled with “green yard trim stickers”. Yard waste is not accepted in plastic bags.

7. Conclusion

The above credit for individual tree planting is equivalent to planting 1/200th of an acre of forest on urban pervious land, and applies to trees that have been planted for at least 3 years, or have a minimum DBH of 6”. This is an interim credit that will be evaluated over time based on periodic reporting and a study that documents the survival rate and diameter of trees currently enrolled in the program. In addition, available data suggest that proper leaf litter management will be integral to ensuring that urban trees provide hydrologic benefits without exporting nutrients in the form of leaf litter. The County currently provides information regarding options for leaf litter disposal, and these may be revised over time as more data becomes available.

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[1] Montgomery County “Talking Trash” website provides four options for leaf litter management http://mcrecycles.blogspot.com/2014/10/4-solutions-for-managing-your-autumn.html

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Appendix E Analysis Approach for MCPS and Private Redevelopment

Appendix E

Analysis Approach for MCPS and Private Redevelopment

Background & Overview

During the third generation permit, DEP analyzed areas of impervious cover previously uncontrolled that through redevelopment, became controlled. A total of 12 school properties and 49 private properties were evaluated and credited. This appendix details the analysis approach involving review of available plans and documents, along with GIS assessment of aerial imagery.

Basis of Analysis

Control or removal of impervious cover was based on the 2009 Impervious Layer that delineated impervious areas as of 2009. A visual comparison was made using 2008 orthophotos, 2012-2014 orthophotos, 2009 Impervious Layer (2009 Baseline Impervious), MS4 Excluded Area, and available construction/stormwater plans. Only the modified impervious area within the 2009 Impervious Layer and within the County MS4 Area qualified for credit. It is important to note that although there may be impervious cover shown in the 2008 orthophotos that is now controlled by on site stormwater management practices, credit cannot be taken if the impervious was not digitized/doesn't exist in the 2009 Impervious Layer. No additional impervious was digitized/added to account for impervious area that existed according to the 2008 orthophotos, but wasn't digitized in the 2009 Impervious Layer.

Methodology

The following methodology was used to evaluate each of the redeveloped properties:

1. Research and download available plans and documents for each property.
2. Georeference plans, if available.
3. Using the georeferenced plans, the 2008 orthophotos, the 2012-2014 orthophotos, and the 2009 Baseline Impervious Layer, determine the footprint of 2009 Impervious that was modified or removed.
4. Determine if the impervious is outside of the County's MS4 Area and if it drains to a credited BMP drainage area.
5. Log the data in a GIS polygon shapefile including the name of the property and acreage of impervious removed/modified.

Figure Appendix-E.1 illustrates Step 3 of the above methodology. The image on the left shows the 2008 orthophoto with the 2009 Impervious Layer (shaded pink) overlain. The image on the right shows the same 2009 Impervious Layer, this time overlain on the 2012 orthophoto, showing the modernized facility. The area overlaying the modernized facility is shaded green to indicate the portion of the 2009 impervious cover previously untreated which is now treated. The image also shows that a portion of the 2009 Impervious Layer lies within the MS4 Excluded Area (orange hashed) and is therefore shaded blue, indicating it will not be included in the credit calculations. Impervious area may also be excluded if it drains to a credited BMP drainage area.

Site Condition in 2008

2008 orthophoto and 2009 Baseline Impervious

MS4 Excluded Area

2009 Baseline Impervious

Property Boundary

Site Condition in 2012

2012 orthophoto and 2009 Baseline Impervious

MS4 Excluded Area

2009 Baseline Impervious

Property Boundary

IA Credit

IA Excluded

Figure Appendix-E.1: Illustration of GIS Evaluation of Impervious Credit through Redevelopment

Results

Completing this exercise for the 12 school properties, and 49 private properties yielded the results shown below in Table Appendix-E.1. A total of approximately 106.79 acres of impervious cover was removed or controlled, 20.69 acres from school properties, and 86.10 acres from private properties. This value excludes impervious draining to already credited drainage areas and/or outside of the County's MS4 Area. In accordance with MDE guidance, the credit rate of 1 Acre controlled or Removed = 0.62 Acre Credit was then applied to the impervious total for an adjusted impervious restoration credit total of 66.21 acres.

Table Appendix-E.1 Results of Redevelopment Analysis for All Schools and Private Properties

Property Name	Property Type	Impervious Credit (Acres)	Adjusted Impervious Credit (Acres)
Beverly Farms	School	1.77	1.10
Cabin John	School	3.59	2.23
Cannon Road	School	2.07	1.28
Carderock Springs	School	1.32	0.82
Cresthaven	School	1.78	1.10
Farmland	School	1.59	0.99
Garrett Park	School	1.85	1.15
Glenallan	School	1.79	1.11
Paint Branch	School	1.23	0.76
Seven Locks	School	1.66	1.03
Singer	School	1.44	0.89
Weller Road	School	0.6	0.37
4500 East West Highway Revision	Private	0.07	0.04
Bethesda/Woodmont Lot	Private	2.56	1.59
Brookville Rd	Private	0.16	0.10
Chestnut St	Private	0.03	0.02
Conway Rd Homes	Private	0.03	0.02
Counselman Road Homes	Private	0.11	0.07
Crabbs Branch Depot	Private	17.73	10.99
Culver Street Home	Private	0.04	0.02
Ellsworth Drive	Private	1.03	0.64
Elmore Lane	Private	0.04	0.02
Fairfield Drive	Private	0.02	0.01
Falls Road Homes	Private	0.04	0.03
Frederick Road Apartment	Private	4.01	2.49
Garfield Street Home	Private	0.02	0.01
Georgia Ave parking lot	Private	0.62	0.38
Giant Gas Station	Private	0.27	0.17
Hempstead Ave Homes	Private	0.07	0.04
Landy Lane Site	Private	1.31	0.81
Leland Street	Private	0.04	0.02
Lincoln Street Homes	Private	0.09	0.05
Mango Lane Site	Private	3.57	2.21
Maple Avenue	Private	0.02	0.01
Millwood Road	Private	0.05	0.03
Montgomery County Airpark, Parcels P and 542	Private	0.68	0.42
Montrose Crossing	Private	6.37	3.95
Montrose Crossing Lot	Private	0.17	0.11
Neilwood Home	Private	0.07	0.04
Newport Avenue	Private	0.01	0.01

Property Name	Property Type	Impervious Credit (Acres)	Adjusted Impervious Credit (Acres)
North Bethesda Town Center	Private	1.63	1.01
North Bethesda Town Center	Private	0.49	0.30
North Bethesda Town Center 2	Private	9.87	6.12
Northfield Rd	Private	0.02	0.01
Pike & Rose Plaza	Private	6.10	3.78
Poplar Run Development	Private	11.95	7.41
Quaker Ridge Road	Private	0.16	0.10
Revision to Woodmont Central Phase 1B & 2	Private	0.66	0.41
Rodman Road	Private	0.03	0.02
Roseland Home	Private	0.07	0.04
Silver Spring Depot	Private	3.01	1.87
Silver Spring Transit Center	Private	2.11	1.31
Singleton Drive Homes	Private	0.09	0.05
Strathmore at Bel Pre (Thai Temple)	Private	0.43	0.27
Symphony Park Homes	Private	3.38	2.10
The Galaxy	Private	1.55	0.96
Three Sisters/Glenstone	Private	2.44	1.51
Travilah Property	Private	0.05	0.03
West Virginia Ave Home	Private	0.09	0.06
White Flint Mall	Private	1.43	0.89
Wisconsin Ave Site	Private	1.33	0.83
	TOTALS	**106.79**	**66.21**