City of Harrisonburg

Stormwater Improvement Plan

KEEP IT CLEAN, HARRISONBURG
STOP POLLUTED RUNOFF

December 1, 2017

Contents

Acknowledgements

This Stormwater Improvement Plan for the City of Harrisonburg has been prepared by staff of the Department of Public Works; A. Morton Thomas & Associates, Inc.; Tetra Tech; and the Stormwater Advisory Committee. This plan would not have been possible without the dedicated efforts of these participants and the involvement of citizens who participated in public meetings and offered their insight and opinions.

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Introduction

The City of Harrisonburg encompasses 17.4 square miles with a population of approximately 53,000 people. Harrisonburg is home to two university campuses – James Madison University and Eastern Mennonite University – as well as numerous other businesses, non-profit organizations, and a vibrant downtown area.

The overall citywide stormwater program has many functions, including meeting all regulatory requirements, managing equipment and resources, developing a budget, prioritizing and scheduling capital projects, coordinating design, installation, inspection, and maintenance of practices, engaging citizens and businesses, and communicating with decision-makers and stakeholders.

The City of Harrisonburg has two important stormwater programs to consider. The City's MS4 permit program is managed through the Department of Public Works and includes operating and maintaining the City's infrastructure as well as implementing this Stormwater Improvement Plan (SWIP). The Department of Planning & Community Development is responsible for administering the Virginia Stormwater Management Program, which reviews development plans and conducts erosion control and stormwater inspections for new development and redevelopment projects in accordance with city ordinances. There is strong coordination between the various departments involved with stormwater, which also include the departments of Public Utilities, Parks and Recreation, as well as many others described in more detail in Appendix E.

The City initiated this SWIP to improve water quality in local waterways and to chart a strategy for the City to comply with state and federal regulations that require the City to manage stormwater pollution entering Blacks Run and the greater Chesapeake Bay watershed. The main objective of the SWIP is to identify capital improvement (construction) projects, programs, and ways to engage Harrisonburg's citizens to manage stormwater and improve water quality. Another objective of the SWIP is to pursue the above strategies in a cost-effective manner and in coordination with other City initiatives:

Stormwater Alphabet Soup

Stormwater management, like many technical and regulatory topics, is characterized by terms that can be confusing if not defined. Some of the more important terms used in this SWIP are defined below.

Best Management Practice (BMP) refers to a stormwater or water management practice designed to reduce pollution in stormwater runoff. The term is one of several used at local, state, and federal levels to generally describe methods for stormwater treatment. Examples from this SWIP include a bioretention pond and urban stream restoration. BMPs can be *new practices*, meaning that they treat an area that previously had no stormwater treatment or *retrofits* which are upgrades or enhancements to existing BMPs that, due to their age or design, do not maximize treatment benefits by today's standards and can be modified to do so.

Impervious Surface refers to any hard surface that does not let rain water pass through to the ground, resulting in more runoff along with the pollutants carried by that runoff. Examples are streets, rooftops, parking lots, sidewalks, and driveways. Approximately 41% of the City of Harrisonburg is comprised of impervious surfaces. By contrast, yards are considered *pervious surfaces;* they do not create as much runoff, but they still account for pollutants that flow to streams, such as sediment and nutrients in fertilizers.

Municipal Separate Storm Sewer System (MS4) is a municipally-operated system of inlets, pipes, ditches, stormwater practices, and other features that collect and carry stormwater runoff to receiving streams, such as Blacks Run. The Federal Clean Water Act regulates MS4s and requires communities (through a permit) to develop a local stormwater program with certain minimum standards. In Virginia, MS4 permits are issued by the Virginia Department of Environmental Quality (DEQ). Harrisonburg, as well as neighboring jurisdictions – such as Bridgewater, James Madison University, Staunton, and Waynesboro – are regulated MS4s with DEQ permits. Harrisonburg has held a MS4 permit since 2003. The MS4 permit is updated by DEQ in 5-year increments.

Regulated/Unregulated Areas refers to areas of the City that fall inside and outside the jurisdiction of the City's MS4 permit. It is important to note that the entire city limits are not included in the MS4 permit – only sections that are connected to streams via inlets, pipes, and ditches (urban stormwater system) are part of the *regulated area*. Examples include streets, yards, rooftops, and parking lots that feed into the stormwater system. Other parts of the City, such as hillsides or yards that "sheet flow" indirectly to streams are known as *unregulated areas.* Figure 1 illustrates both regulated and unregulated areas within the City. James Madison University holds its own separate MS4 permit, so that land area is not part of the City's MS4. The City's priority is to focus on BMP project implementation in the regulated areas, as that is where pollution reduction efforts will contribute most directly to meeting the permit requirements.

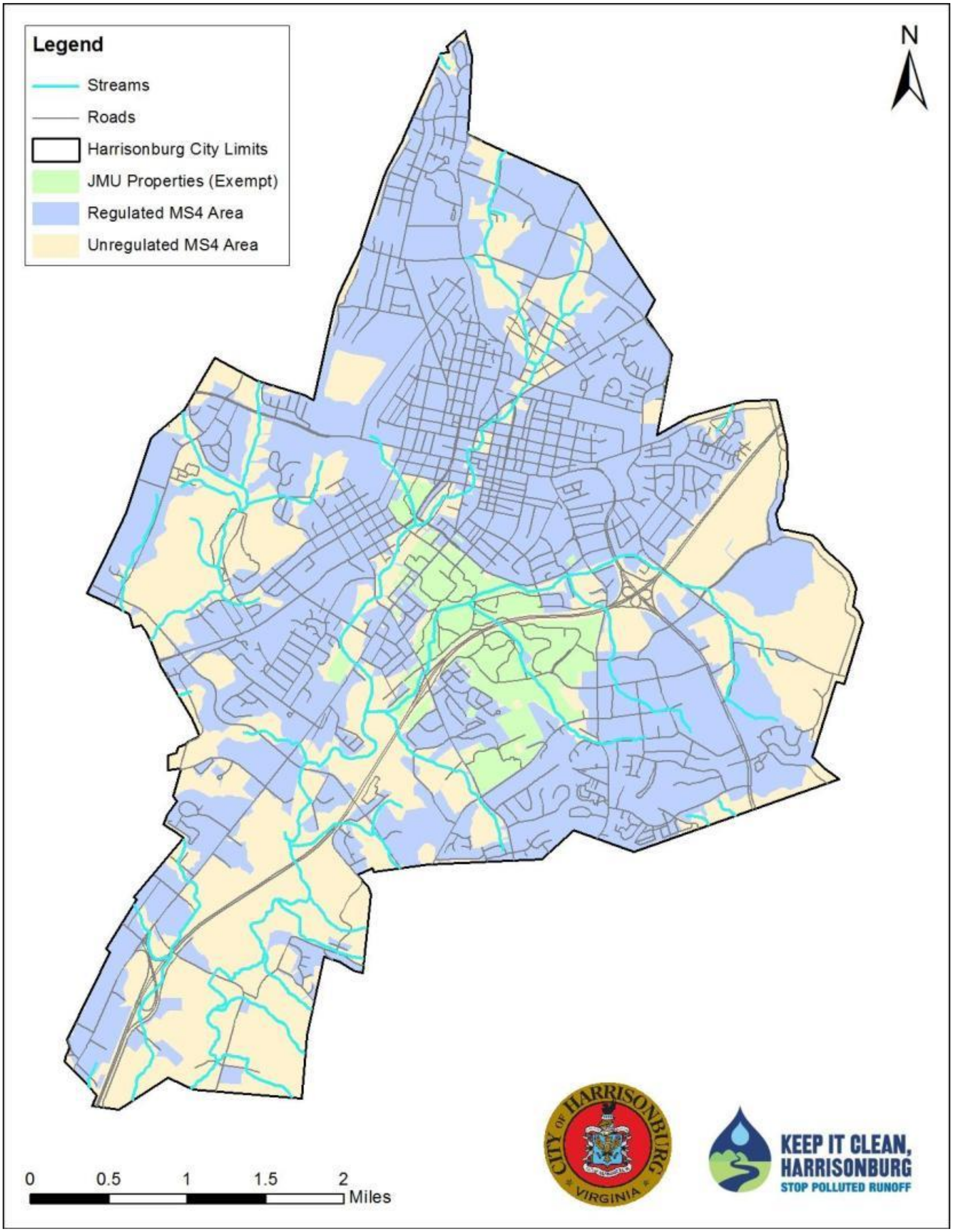
Pollutants are substances that pollute the water by smothering habitats, depleting oxygen, or introducing chemicals that are unhealthy for humans or aquatic life. This SWIP is concerned primarily with three pollutants that are regulated as part of the Chesapeake Bay clean-up and the Blacks Run Cooks Creed clean-up: *Total Phosphorus (TP), Total Nitrogen (TN),* and *Total Suspended Solids (TSS).* TP and TN are *nutrients* that can create excessive algal blooms in waterways and deprive the water of oxygen. TSS is a physical measure of sediment, silt, and other suspended particles that interfere with water clarity, smother aquatic habitats in streams, and can erode or fill stream channels so that drainage and flooding issues are exacerbated. These are not the only three pollutants that affect local waterways, but they are the focus of the regulations and it is believed that reducing these three pollutants will also help reduce other pollutants that impact local waterways.

Total Maximum Daily Load (TMDL) – sometimes referred to as a *pollution diet* – quantifies the maximum amount of pollution a waterway can carry to fulfill the beneficial uses and, importantly, the amount that must be reduced to be within this limit. TMDLs are developed for waterways that do not fulfill their intended beneficial uses (e.g., fishing, swimming, recreation) because of one or more pollutants. The pollution reduction is critical in a regulatory sense, because it becomes a requirement for local and state pollution reduction efforts, including stormwater management programs such as this citywide plan.

The *Chesapeake Bay TMDL* includes the three pollutants noted above: TP, TN, and TSS. The required load reductions are calculated for the entire Chesapeake Bay watershed and each state within the watershed for various "sectors" (e.g., urban, agriculture, forestry). The Chesapeake Bay, through their permitting authority, allocate a proportionate share of the urban load reduction to each MS4 within the Bay watershed under their jurisdiction. Urban load reduction refers to the amount of pollutant needed to be reduced by the City for the waterway to meet water quality standards – or, in the case of a watershed as large as the Chesapeake Bay, – to meet water quality standards for the Shenandoah River and so on and so forth all the way to the Chesapeake Bay. These are often called a Waste Load Allocation (WLA) in the permit requirements. Harrisonburg's MS4 permit requires practices and programs to reduce TP, TN, and TSS loads as the City's contribution to the overall pollutant load reduction for urban areas. Efforts to address the Chesapeake Bay TMDL will also improve local streams and waterways and provide other local benefits tied to this SWIP.

The *Blacks Run & Cooks Creek TMDL* includes the two pollutants noted above: TP and TSS. The required load reductions are calculated for the entire Blacks Run and Cooks Creek watersheds and each contributing entity within the watershed for various "sectors" (e.g., urban, agriculture, industrial). DEQ allocates, through their permitting authority, a proportionate share of the urban load reduction to each sector within the local watershed under their jurisdiction. These are often called a Waste Load Allocation (WLA) in the permit requirements. Harrisonburg's MS4 permit requires practices and programs to reduce TP and TSS loads as the City's contribution to the overall pollutant load reduction for urban areas. Efforts to address the Blacks Run and Cooks Creek TMDL will improve local streams and waterways and provide other local benefits tied to this SWIP.

Figure 1. Harrisonburg Regulated MS4 Areas



Note: JMU properties are exempt from consideration in this plan because the University has its own MS4 permit requirements that are separate from the City's permit requirements.

Goals and Objectives of the SWIP

GOAL 1 – To develop a plan to meet Blacks Run/Cooks Creek and Chesapeake Bay TMDL requirements and associated pollutant reductions in the MS4 permit.

Objective 1.1 – Conduct a citywide assessment of existing watersheds and related city plans.

Objective 1.2 – Identify, evaluate, rank, and prioritize stormwater improvement projects based on their ability to fulfill pollutant reduction requirements in a cost-effective manner.

Objective 1.3 – Identify, evaluate, and prioritize stormwater improvement programs based on their ability to fulfill pollutant reduction requirements in a cost-effective manner.

Objective 1.4 – Coordinate proposed stormwater improvement projects with other city initiatives, programs, and plans.

Objective 1.5 – Tie projects and programs to the Stormwater Utility Fee Credit Program to engage residential and non-residential property owners.

GOAL 2 – To improve local water quality and address drainage issues where feasible by implementing a wide variety of stormwater projects.

Objective 2.1 – Consider local benefits and issues of concern to the community when ranking and prioritizing stormwater improvements and programs.

Objective 2.2 – Identify new programs or program enhancements that may provide public engagement and/or cost savings.

Objective 2.3 – Wherever possible and feasible, address local drainage issues through the implementation of stormwater improvements that are primarily to improve water quality but can also reduce or eliminate drainage concerns.

GOAL 3 - To implement programs and projects in the most cost-effective way.

Objective 3.1 – Utilize the SWIP Excel tool for ranking and preliminary costing purposes.

Objective 3.2 – Create high priority plans for the highest ranked projects that can be used for grant applications.

Objective 3.3 – Implement a Public/Private Partnership program to share the costs and benefits of water quality projects.

Pollutant Load Reductions: How Much & When?

The City's MS4 permit is reauthorized by DEQ in 5-year permit cycles. The total pollutant load reductions are allocated into 3 permit cycles, or a 15-year span. This comprises the current permit cycle (2013 through 2018) as well as the next two cycles (2018 through 2023 and 2023 through 2028). That means that the City has until the year 2028 to provide 100% of required load reductions, divided out through the three permit cycles as follows:

Cycle 1, 2013 – 2018: 5% of the total

Cycle 2, 2018 – 2023: An additional 35% or 40% of the total

Cycle 3, 2023 – 2028: An additional 60% or 100% of the total

The Required Pollutant Load Reductions (Figure 2 and Table 1) lists the actual numerical load reductions required for TN, TP, and TSS for the City. These values are calculated using the regulated MS4 area and methods outlined by the Chesapeake Bay Program and the City's MS4 general permit, along with the *Virginia DEQ Guidance Memo No. 15-2005, Chesapeake Bay TMDL Special Condition Guidance* (DEQ 2015). The values are based on the City of Harrisonburg being within the Potomac River Basin.

Figure 2. Required Pollutant Load Reductions (as a percentage of total required)

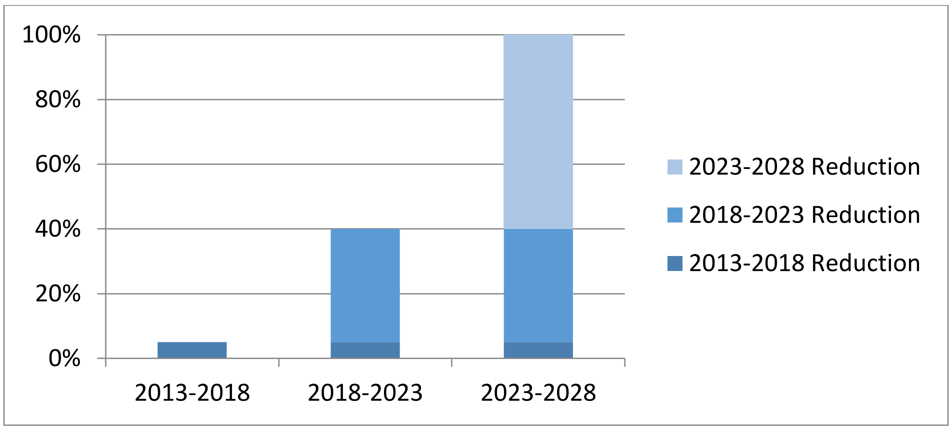


Table 1. Required Pollutant Load Reductions as a Mass Load (Achieved Annually)

Targeted Pollutants	Required Reduction 2013 to 2018: 5% of Total (lbs/yr)	Required Reduction 2018 to 2023: 35% of Total (lbs/yr)	Required Reduction 2023 to 2028: 60% of Total (lbs/yr)	Total Required Reduction: 100% of Total (lbs/yr)
Total Nitrogen (TN)	347	2,337	4,027	6,711
Total Phosphorus (TP)	34	320	531	885
Total Suspended Solids (TSS)	37,978	265,901	455,818	759,697

The take-home points from the sections above:

- The City has a regulatory obligation through the TMDL and MS4 permit to reduce the loads of TP, TN, and TSS in specific amounts by the year 2028 for the Chesapeake Bay TMDL and by an undetermined time for the Blacks Run/Cooks Creek TMDL.
- The selected practices and programs should be cost-effective and provide local benefits.

Practices that Impact Local Water Quality

There are many practices available that can chip away at pollutant loads. The following two sections outline projects and programs as two primary focal points of the SWIP.

The BMP categories addressed in the tables below include Structural BMPs; Urban Stream Restoration; Urban Tree Canopy; Street Sweeping & Catch Basin Cleaning; Septic System to Sanitary Conversions and Homeowner BMPs. To categorize these BMPs further, we have split them into a discussion of projects and programs:

Projects	Structural BMPs (Includes BMP Retrofit), Urban Stream Restoration
Programs	Urban Tree Canopy, Street Sweeping & Catch Basin Cleaning, Septic System to Sanitary System Conversions, Homeowner BMPs

Projects include those practices that will need to go through extensive design, bidding, and construction. Programs include those practices that are imbedded into existing city budgets and are, in most cases, already occurring as a part of regular city operations. The SWIP has identified ways to evaluate and enhance both practices.

When discussing both the local Blacks Run/Cooks Creek TMDL and the Chesapeake Bay TMDL pollution reduction requirements, it is only projects and programs (not nutrient purchasing) that will allow the City to meet both regulations simultaneously.

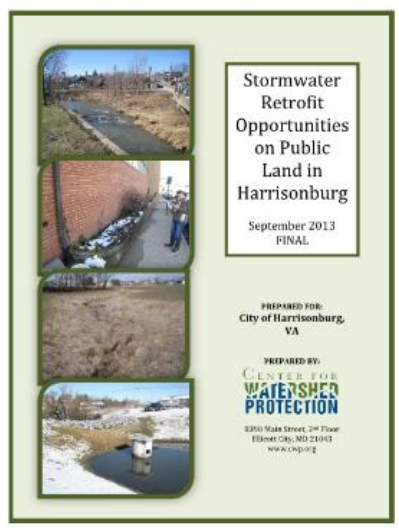
Identifying Water Quality Projects

Building or retrofitting existing stormwater facilities is a cost-efficient practice that also allows for local water quality improvements. The SWIP process evaluated the most promising projects in Harrisonburg and identified, at a planning scale, how widespread the application of each project and program could be across the City, particularly in the MS4 regulated areas.

The City used several sources to identify potential water quality projects. First, the City reviewed the 2013 *Stormwater Retrofit Opportunities on Public Land in Harrisonburg* study by the Center for Watershed Protection (CWP 2013). This review yielded 17 potential BMP locations on public land, some of which are carried over into this plan.

Second, the City used geospatial analysis through an *EPA BMP Siting Tool* to identify the best locations in the City for BMPs to be located based on location, terrain, geology, soils, and other factors. This yielded thousands of potential BMP sites.

Third, the City performed a desktop analysis of the potential BMP sites. After eliminating infeasible BMP locations, the City conducted a field investigation to evaluate the feasibility of each remaining BMP location. Details on the assessment of new BMP sites are in Appendix D, while information on the field investigations are in Appendix E. The City purposely identified more BMPs than necessary to account for BMPs being removed from the plan during implementation for various reasons, such as the inability to secure easements on private land or unexpected site conditions that prevent construction.



Stormwater Retrofit Opportunities on Public Land in Harrisonburg, 2013

Identifying Types of Water Quality Projects (BMP Types)

After undergoing this process, the City had identified BMP locations. The question remained: which BMP types should the City use to meet pollution reduction requirements? The following BMP types were chosen based on their cost efficiency and pollutant removal efficiency as well as their feasibility alongside land development projects. These BMP types are further explained in the tables below.

New Structural BMPs	Bioretention Facilities, Regenerative Stormwater Conveyance, Vegetated Filter Strip, Shallow Marsh/Wet Pond, Enhanced Extended Detention Pond, Public Cisterns
Existing Structural BMPs	BMP Retrofits
Stream Restoration	Urban Stream Restoration

Each table below provides a brief description of the BMP category, the types of BMPs in that category, and example photos. Appendix C provides more detail on the analysis of each BMP category and the process used to analyze that BMP.

The heading of each table also includes a "polluted raindrop" symbol. The number of raindrops is reflective of each BMP's ability to reduce required pollutant loads in Harrisonburg based on the BMP's pollutant removal capabilities. This is provided simply to give a relative sense of how important each BMP may be towards meeting the load reductions. The symbols represent the following:

	BMP or BMP category can reduce 5% or less of the required reduction for TN[1]. The BMP has low pollutant reduction capability and/or can only treat a small amount of land area.
	BMP or BMP category can reduce 5 – 15% of the required reduction for TN[1]. The BMP has moderate pollutant reduction capability and/or can treat a moderate amount of land area.
	BMP or BMP category can reduce up to 30% of the required reduction for TN. The BMP has relatively high pollutant reduction capability and/or can treat a larger amount of land area.

1Total nitrogen (TN) is used here because, based on analysis, it is the most challenging of the three pollutants for Harrisonburg to reduce, and therefore a key selection criteria for BMPs.

Table 2: Structural BMPs

"Structural BMPs" are engineered and constructed practices designed specifically to remove pollutants and provide other community benefits, such as adding green space and habitat, and, in some instances, addressing drainage issues. Many of these practices rely on plants, soil, mulch, and other materials to filter and treat stormwater runoff.

Bioretention Facilities 	Bioretention facilities are landscaped practices that use an engineered soil mix as well as plants and mulch to filter stormwater runoff. Most have underdrain pipes to ensure water only ponds temporarily. They are common in parking lot islands, along pavement edges, and as part of commercial site plans. The City owns and maintains a few bioretention facilities, including this facility pictured at City Hall.
Regenerative Stormwater Conveyance (RSC) 	Designed to look like a dry stream bed, RSCs are linear open channels that convey and treat stormwater runoff in a stable manner. A series of riffles and shallow pools, along with an underlying sand bed and native vegetation, provide a stable flow path for stormwater. The City has not yet constructed a BMP of this type.
Vegetated Filter Strip 	Vegetated filter strips are planted areas, often with amended soils, placed at the edge of parking lots, roadways, or other areas of impervious cover. Runoff flows evenly across the filter strip as sheet flow, allowing plants, mulch, and soil to absorb the runoff. The City owns and maintains a vegetated filter strip on a Harrisonburg Electric Commission property.

Shallow Marsh / Wet Pond 	Wet ponds are typically used to treat larger drainage areas and have a permanent wet pool surrounded by aquatic vegetation. They often provide extended holding capacity of larger storms and have sediment trapping forebays. Shallow marshes serve a similar function as wet ponds. They differ in that shallow marshes typically have water depths of less than 6 inches to 18 inches and are planted with emergent vegetation.
Enhanced Extended Detention Pond 	An enhanced extended detention basin captures stormwater runoff, detains it after each rain event, and then filters and treats the water before it is discharged. Enhanced extended detention ponds include a pond area to settle out pollutants, and then a shallow marsh with vegetation that further filters and treats stormwater. The City maintains two enhanced extended detention ponds, one is pictured here at the corner of Erickson Avenue and Stone Spring Road.
Public Cisterns 	Cisterns collect roof water and store it temporarily to be used later to water landscaping, as indoor non-potable water (e.g., toilets), or for vehicle washing. This helps to reduce the amount of runoff sent downstream. This plan includes consideration of public cisterns which tend to be larger and homeowner cisterns which are for individual use. This image shows two cisterns in place at the Department of Public Works. This water is used to supply the flusher trucks for daily operations.

Table 3. BMP Retrofits

 *"BMP Retrofits" are upgrades or enhancements to existing BMPs that, due to their age or design, do not maximize treatment benefits by today's standards and can be modified to do so.*	
BMP Retrofits 	Some older stormwater ponds and basins have been on the landscape for many years, but do not provide much benefit for water quality treatment because they were built using old standards that only required flood (water quantity) control. Also, some do not provide aesthetic benefits to the surrounding neighborhood and are difficult to maintain. Retrofitting these old basins means converting them to incorporate more vegetation, improved habitat, and water quality treatment to meet today's BMP standards.

Table 4. Urban Stream Restoration

 ***Many existing streams in Harrisonburg have been impacted by years of urban runoff. These streams are characterized by erosion along the streambanks, cutting into adjacent property, and destroying natural habitat for aquatic life.***	
	Eroding streams impact adjacent properties and add sediment and silt into waterways. Stream restoration projects stabilize the stream banks. These projects provide water quality benefits because not as much sediment and silt is created within the stream corridor, and more stable stream functions handle pollutants that wash in from the contributing watershed. Restoration projects can be designed to preserve existing trees and to add ecological benefits for habitat. A prominent stream restoration project occurred in Purcell Park.

Urban Stream Restoration is the only BMP category with three "polluted raindrop" symbols for pollutant reduction capabilities. Structural Practices have two, and the remaining categories have one. It should be noted that Urban Stream Restoration reductions are an order of magnitude higher than the other categories, so that figured prominently in the 'Pounds TN Removed' ranking factor, further explained in Table 5.

Ranking Project Opportunities

Certain BMPs are easier to implement, have more benefits (or less constraints), are lower in cost, or help address drainage concerns in the same area. To give priority to the best BMP opportunities, the plan includes the ranking of all potential BMPs. The City ranked three categories of BMPs: new BMPs, BMP retrofits, and urban stream restoration projects. To do this, the City developed ranking factors and scoring guidelines for each BMP. Each ranking factor was given a scoring range and scoring guidelines as to what criteria the BMP had to meet to receive a given score. For example, one of the ranking factors was *land acquisition*. To receive the maximum score of 10 points, the BMP footprint needed to be entirely on city-owned lands. Conversely, if the BMP requires significant easements or property acquisition, it would receive a score of 0.

BMPs, such as bioretention facilities, help reduce excess nutrients and sediment in stormwater runoff.

The ranking factors contain 3 categories: (1) cost and cost-effectiveness, (2) site and schedule constraints, and (3) addressing other city needs. The full list of the 10 ranking factors and details on the scoring guidelines for each factor are presented in Table 5 and further explained in Appendix G.

BMPs were scored using geospatial data (e.g., known drainage problem areas, city properties) and information collected during the field investigation (e.g., photographs, field data forms). As part of the ranking process, the City also estimated the cost of each BMP using a schedule of generalized unit costs with potential additional costs to implement each BMP added based upon site data (e.g., required diversions of flow, utility conflicts, etc.). The final ranking criteria selected is listed in Table 5. The final list of ranked projects is presented in Appendix H.

What about Flooding and Drainage Issues?

The BMPs in this plan were identified and ranked primarily for their benefits to local water quality and to achieve regulatory compliance for the City's MS4 permit; however, this plan does include careful consideration of water quantity issues related to flooding and drainage concerns throughout the City.

Locations throughout the City experience a range of flooding and drainage concerns. This site shows an interconnection of Blacks Run between the City of Harrisonburg and James Madison University.

A project to eliminate flooding and drainage issues without improving water quality would not meet the basic selection criteria for a BMP, and is not included in the plan; however, all projects in this plan that help to reduce or eliminate flooding and drainage issues received additional points in the ranking.

The development of this plan also included reference to the 1999 Storm Water Action Plan which catalogued citywide drainage and erosion concerns, updating city databases of known drainage concerns, and the addition of flooding and drainage concerns identified during the first public meeting. The resulting list of 167 flooding and drainage issues were then mapped in the city GIS databases with short descriptions of the identified concern, as described in more detail in Appendix B.

The City hopes that there will be dual and ancillary benefits to many of the proposed projects, thus reducing resources needed for addressing flooding and drainage issues through separate funding in the future. See how the ranking factors played a role in project identification in Table 5.

Table 5. Project Ranking Factors

Ranking Factor	Scoring Technique	Scoring Range	Max Score
Pounds TN Removed	The project with the highest TN pollutant removal receives the highest score. Projects are scored as a percent of the best pollutant removal, multiplied by 20, so the score can range from 0 to 20.	0-20	20
Cost Effectiveness	Cost effectiveness is calculated by dividing the total project cost by the pounds of TN removed. Projects are scored as a percent of most cost effective project multiplied by 20, so the score can range from 0 to 20.	0-20	20
Project Cost	Project cost includes projected cost for design and construction. The lowest project cost receives the highest score, so the score can range from 0 to 10.	0-10	10
Land Acquisition	Projects located on city-owned land earn the highest score as there will be no land acquisition needed.	10	10
	Projects located on private property where minimal easement acquisitions will be needed earn a mid-range score.	5	
	If a project crosses multiple private properties and significant easement or property acquisition will be needed, the project will earn the lowest score.	0	
Drainage Issues	A project that addresses flooding or infrastructure risk in areas with known drainage issues earns the highest score. Drainage issues have been mapped based on staff knowledge and public involvement.	10	10
	Projects that provide detention or conveyance benefits but are not in area with known drainage issues earn a mid-range score.	5	
	Projects that are purely water quality projects and do not provide additional detention or conveyance benefits earn the lowest score.	0	
Maintenance Burden (Long-term)	Projects that require little maintenance earn the highest score.	10	10
	Projects with a medium maintenance burden will earn a mid-range score.	5	
	When extensive staff time and money is needed to maintain the project, it will earn the lowest score.	0	
Site Constraints & Potential Utility Constraints	If there are no constraints such as large trees or underground utilities that would need to be relocated, then the project will earn the highest score.	7	7
	If there are utilities or vegetation present that would be easy to avoid, such overhead electric or phone lines, then projects will earn this score.	5	
	If access is somewhat constrained, making it difficult for construction or maintenance vehicles to access the site, the project will earn a mid-range score.	3.5	
	If vegetation or utilities are present but relatively easy to avoid and access is only somewhat constrained, then projects will earn this score.	2.5	
	If there is poor access, major grading required, karst topography, or major utilities like a sewer line that must be moved, then a project will earn this score.	1	
	If there is poor access, major grading is required, major utilities must be moved, or karst topography is present, a project will earn the lowest score.	0	
Implementation Schedule	If a project can be implemented in under 12 months, with no permitting requirements, it will earn the highest score.	6	6
	If a project can be implemented in under 12 months with permitting requirements or a project can be implemented in 12 to 24 months with no permitting requirements, it will earn this score.	4	
	If a project can be implemented in 12 to 24 months with permitting requirements or a project cannot be implemented in under 2 years with no permitting requirements, it will earn this score.	2	
	If a project cannot be implemented in under 2 years with permitting requirements, it will earn the lowest score.	0	
Synergy	If a project can be incorporated within other city infrastructure plans and projects and it also provides environmental benefits beyond water quality benefits, then the project will earn the highest score.	5	5
	If a project can be incorporated within other city infrastructure plans and projects (including other potential BMPs) but does not provide additional environmental benefits, then it will earn this score.	4	
	If a project provides multi-purpose or environmental benefits beyond water quality benefits, then the project will earn a mid-range score.	2.5	
	A project will earn the lowest score if it provides only water quality benefits.	0	
Aesthetics / Visual Appeal	If a project adds landscaping or would enhance aesthetics at the site, it will earn the highest score.	2	2
	If the project neither detracts from aesthetics nor adds much in the way of value, or the project is out of general public view, it will earn a mid-range score.	1	
	If a project provides only water quality benefits and does not enhance aesthetics of a site, it will earn the lowest score.	0	

The take-home points from the sections above:

- A document developed in 2013 for BMP analysis on publicly-owned land served as a valuable reference and basis for this SWIP, but public and private properties were analyzed for BMP projects in this SWIP process.
- The City has developed ranking criteria to identify feasible and cost-efficient BMPs. The tool analyzed new BMPs, stream stretches for restoration, and existing BMPs that may be suitable for retrofit. The result is a prioritized list of 145 projects spanning all the aforementioned BMP types.

Identifying Water Quality Programs

There are many programs that can reduce pollutant loads. The SWIP process evaluated the most promising programs feasible in Harrisonburg and identified improvements to those programs that already exist. Each table below provides a brief description of the program category, the different components of that program, and example photos.

The heading of each table also includes a "polluted raindrop" symbol. The number of raindrops is reflective of each BMP's ability to reduce required pollutant loads in Harrisonburg based on the BMP's pollutant removal capabilities. This is provided simply to give a relative sense of how important each BMP may be towards meeting the load reductions. The symbols represent the following:

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	BMP or BMP category can reduce up to 30% of the required reduction for TN. The BMP has relatively high pollutant reduction capability and/or can treat a larger amount of land area.

1Total nitrogen (TN) is used here because, based on analysis, it is the most challenging of the three pollutants for Harrisonburg to reduce, and therefore a key selection criteria for BMPs.

Table 6. Urban Tree Canopy

"Urban Tree Canopy" has numerous benefits that include, and expand far beyond, stormwater management. Unfortunately, tree planting does not yield high pollutant removal in comparison to other practices. That being said, maintaining and improving the City's urban tree canopy is still highly encouraged.

	Planting trees in urban landscapes can help reduce runoff and absorb pollutants. The City of Harrisonburg is undergoing development of an urban tree canopy report from the Green Infrastructure Center that identifies how to use trees for stormwater management. Tree planting and maintenance of existing trees is currently a component of the Residential Stormwater Utility Fee Credit Program (see section below).

Table 7. Street Sweeping and Catch Basin Cleaning

Many pollutants accumulate on streets, in gutters, and in catch basins. Cleaning the streets and catch basins can remove these pollutants before they wash down into streams through the storm sewer system.

Street Sweeping 	People are familiar with street sweeping as a way to keep cities clean. The grit, sediment, organic material (e.g., leaves), and other debris collected by sweepers are also a pollutant source when they are allowed to wash off into storm drains which convey runoff to streams and waterways. Collecting this material in street sweepers, when done on a regular basis during the right times of year, reduces downstream pollution. The City of Harrisonburg has a robust street sweeping program. Two street sweepers (purchased with Stormwater Utility Fee funds) circulate the entire City one time each month.
Catch Basin Cleaning 	Like street sweeping, cleaning catch basins and storm drain inlets can remove pollutants before they are allowed to wash downstream into the pipes and eventually into waterways. The City of Harrisonburg has an ongoing catch basin cleaning program. Crews have a goal of reaching every city-owned storm drain inlet once a year.

Table 8: Septic System to Sanitary Sewer Conversion

Septic systems have the potential to leak and leach nitrogen into the water table. This excess nitrogen can make its way into local streams and other waterbodies. Connecting a septic system to a sanitary sewer system removes this potential source of excess nitrogen.

	Connecting old septic systems to the City's sanitary sewer system can remove nutrients that may be leaching into the ground and streams. The City has a small number of these older systems, some of which have already been switched over to the sanitary system. Encouraging or requiring property owners to convert from septic to sanitary is a means to meet pollution reduction requirements. This proposed program enhancement is outlined in the Stormwater Utility Fee Program section below.

Table 9: Homeowner BMPs

The City's Stormwater Utility Fee Credit Program allows residential and non-residential property owners to receive a credit on their utility fee if certain BMPs are implemented on their property. For residential properties, there are multiple practices that can receive a credit; the ones noted below are the most widely-used. To receive a fee credit, practices must meet standards outlined in the credit manual: https://www.harrisonburgva.gov/stormwater-utility.

Roof Drain Disconnection 	This practice involves simply routing roof downspouts onto areas of grass or landscaping instead of connecting directly to driveways, streets, or the storm sewer system.
Rain Barrel or Cistern 	Rain barrels collect roof water and store it temporarily to be used later to water gardens, landscaping, and yards. This helps to reduce the amount of runoff sent downstream.
Homeowner Nutrient Management 	The homeowner signs a pledge agreeing to certain lawn care practices involving managing the use of pesticides and fertilizers. These chemicals can end up in stormwater runoff if not applied properly.

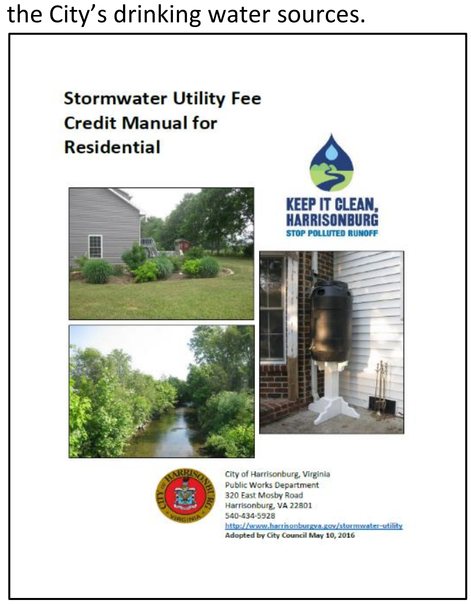
Table 10: Potential Program Enhancement

Program Name	Program Description
Urban Tree Canopy	Review findings and implement recommendations found in the Green Infrastructure Center's 'Utilizing Urban Tree Canopy for Stormwater Management' deliverable package. This document and its findings will be posted here upon completion: https://www.harrisonburgva.gov/stormwater-projects.
Street Sweeping	Maintain current level of service.
Catch Basin Cleaning	Maintain current level of service. Prioritize storm drain cleaning efforts by identifying high priority (poor condition) storm drains to reach at the beginning of each year.
Septic to Sanitary Conversion	1. Include as credit opportunity in the Stormwater Utility Fee Credit Program. 2. Develop a grant program to financially assist with connection fees. Partner with the Shenandoah Valley Soil & Water Conservation District to utilize their grant management expertise. 3. Require regular cleanout of septic systems to ensure system is functioning properly and to track where septic systems are in the City of Harrisonburg.
Homeowner BMPs	See Stormwater Utility Fee Credit Program recommendations (below).

Stormwater Utility Fee Program

The City of Harrisonburg's Stormwater Utility Fee Program became effective on July 1, 2015. The Utility Fee was adopted largely to provide a revenue source for the City to meet the regulatory mandates with the MS4 permits. Revenue collected from the stormwater utility fees is used for the following primary activities:

- Compliance with the Blacks Run/Cooks Creek and Chesapeake Bay TMDL pollution reduction requirements.
- Development of the citywide SWIP (this document) to identify, select, and prioritize capital projects and programs to reduce pollution, manage stormwater, and protect the City's drinking water sources.
- Planning, design and construction of stormwater capital projects, including stormwater management retrofits and community greening projects to reduce pollution and improve water quality. These include projects on city-owned properties and projects in cooperation with other property owners, as identified in this SWIP.
- Coordination of pollution reduction efforts including staff training, pollution prevention and good housekeeping practices for municipal operations, a pollution detection and elimination program, and a public education and outreach program.
- Inspection, maintenance, and operation of City-owned storm sewer systems, natural waterways, and stormwater management practices.



The Stormwater Utility includes a Credit Program whereby residential and non-residential property owners can reduce their fee by implementing one or more practices that help control their site's stormwater runoff. There are two manuals available for residential and non-residential applications that outline the practices and how to calculate the fee reduction. The fee credit is intended to act as an incentive program to engage property owners in stewardship and actions that will assist the City with its pollution reduction responsibilities. The City also can also count these practices submitted by residential property owners (and those voluntary practices by non-residential property owners) towards Blacks Run/Cooks Creek and Chesapeake Bay TMDL pollution reduction requirements. In reviewing SWIP programs, this is an area that could be enhanced to better serve the public as well as the City's reduction requirements.

Table 11. Existing Stormwater Utility Fee Credit Program

Program Name	Program Description
Stormwater Utility Fee Credit Program	The credit program is a mechanism by which property owners can lower their Stormwater Utility Fee. It is available for residential & non-residential property owners, and is a voluntary process that offers a maximum 50% credit. Up to this point, participants have been mostly in the residential category. Available residential practices include: • Roof Drain Disconnection • Rain Barrel/Cistern • Rain Garden • Urban Tree Planting/Maintaining Existing Tree Canopy Cover • Conservation Landscaping • Homeowner Nutrient Management & Lawncare Agreement • Impervious Surface Removal

Table 12. Potential Stormwater Utility Fee Program Enhancement

Program Name	Program Description
Increase Max Credit Offered	Currently the maximum credit is set at 50% for both residential and non-residential credits. An increase in the credit amount would provide extra incentive for property owners to implement practices.
Add Septic to Sanitary Connection	Septic to sanitary sewer connections are creditable under the Chesapeake Bay TMDL program. Adding this as an option to the credit program would allow an extra mechanism for tracking connections and provide property owners with an incentive to connect to the sanitary sewer system.
Streamline Application Process/ other City Initiatives	There are potential water quality incentive programs housed in other departments that could be added to the Stormwater Utility Fee Credit application. Including other city initiatives that improve water quality on the application would mean the credit application process would be streamlined (one application for multiple departments, as opposed to an application for every department's initiatives) and other departments would be able to assist with outreach. An example of this may be an I&I program initiative in correlation with the Public Utilities Department.
Simplify Application Process	The current application process requires a property owner to fill out a .pdf document and then mail/email/or hand in the application. Creating an online application would simplify the process for those applications who wish to fill out a digital application, although paper applications would still be available.

The take-home points from the sections above:

- The City has implemented a variety of pollution reduction programs already and has been able to submit those pollution reductions numbers for Blacks Run/Cooks Creek and Chesapeake Bay TMDL compliance.
- There are opportunities to enhance a few of the programs the City has in place to increase pollution reduction.

Are these Projects & Programs Enough?

At the beginning of the SWIP development process, the City analyzed its existing programs in an initial water quality assessment. In this assessment, the City looked at street sweeping, catch basin cleaning, homeowner BMPs and connecting properties on septic to sanitary sewer. These activities are already being conducted in the City (as outlined above) and the City can take credit for these as a part of compliance. In this exercise, the City projected the improvements that these programs could make. Pollution reduction from the existing programs as well as pollution reductions from implementing enhancements was accounted for and outlined below.

Table 13. Summary of Pollutant Loads Reduced from Program Implementation

		TN	TP	TSS
Chesapeake Bay TMDL Total Reduction Required (lbs/yr)		6,711.0	885.0	759,697.0
Implementation Activity (lbs/yr reduced)	Street Sweeping	79.0	26.0	37,153.0
	Catch Basin Cleaning	223.0	50.0	0.0[A]
	Homeowner BMPs	161.0	15.0	0.0[A]
	Septic Connections	291.0	0.0[A]	0.0[A]
Total Reductions (lbs/yr)		754.0	91.0	37,153.0
Load Reduction Gap (lbs/yr)		5,957.0	794.0	722,544.0

[A] This practice does not receive load reduction credit for this pollutant.

As Table 13 shows, there is a remaining load reduction gap from program implementation alone. To fill this gap, the City will install BMP projects throughout the City. Table 14 presents the load reductions from project implementation. The projects listed below have been selected due to their higher rankings from the ten factors outlined in Table 5, expected cost, and other constraints.

Table 14. Summary of Pollutant Loads Reduced from High Priority Project Implementation

	Excel Tool Ranking (out of 100)	TN	TP	TSS
Thomas Harrison Middle School BMP Retrofit Beside Parking Lot	74.9	72.0	5.3	3,775.0
Thomas Harrison Middle School BMP Retrofit Beside Basketball Court and Track	77.0	94.3	6.8	4,766.0
Eastern Mennonite University Detention Pond	58.1	153.3	23.7	22,247.0
Eastern Mennonite University Stream Daylighting and Restoration near Parkwood Drive	40.2	23.2	21	13,855
Virginia Mennonite Retirement Center Enhanced Extended Detention	44.0	252.9	44.1	39,537
Harrisonburg Public Utilities Wet Pond	61.0	235.3	31.5	24,240.0
Heritage Oaks Golf Course Pond	53.3	384.8	60.2	51,112
Keister Elementary School Stream Restoration	45.2	78.9	71.9	47,410.0
Mountain View Drive Stream Restoration	48.8	100.0	101.5	63,260.0
Northend Greenway Trail and Stream Restoration	55.1	595.0	86.0	40,475.0
East Market Street Median Regenerative Stormwater Conveyance	72.2	417.8	54.2	48,010.0

	Excel Tool Ranking (out of 100)	TN	TP	TSS
Project Implementation Total Reductions (lbs/yr)		2407.5	506.2	358,687
Table 13 Program Implementation Total Reductions (lbs/yr)		754.0	91.0	37,153.0
Total Reductions for Project & Program Implementation*		3,161.5	597.2	395,840
Chesapeake Bay TMDL Total Reduction Required (lbs/yr)		6,711.0	885.0	759,697.0
Load Reduction Gap (lbs)		3,549.5	287.8	363,857

* These practices will be revised at the five-year update of the SWIP based on 2nd permit cycle funding opportunities.

The results of this exercise are presented in Table 14. Appendix C contains a detailed look at the water quality assessment, including its technical assumptions and calculations. Based on the assessment, all three pollutants – TN, TP, and TSS –still have a gap (last row in the table) compared to the required pollution reduction for the Chesapeake Bay TMDL. This means that at current project implementation levels, even with an ambitious supporting program, these pollutants cannot be reduced to the levels mandated. This is not an unusual circumstance, as other MS4s in Virginia are wrestling with similar challenges in meeting TN, TP, and TSS reduction requirements by 2023.

The take-home points from the sections above:

- If all program enhancements are implemented and all high-priority projects are implemented the City will still not reach total compliance requirements, *but 60% requirements will be met*. This plan will need to be updated upon entering the third permit cycle to account for the remaining 40%.
- Total reductions required will need to be met by including additional project implementation, additional funding sources, and additional compliance mechanisms to the practices listed above.

Financial Programs

As outlined, even with program enhancement and project implementation the City will still need to incentivize additional project opportunities in the community. Much of this SWIP has focused on BMPs that reduce pollutant loads. However, no BMP can be implemented effectively without a financial program behind it. Table 15 outlines several existing resources that can utilized for pollution reduction ideas. One of the programs, the Virginia Conservation Assistance Program (VCAP), is coordinated by the Shenandoah Valley Soil & Water Conservation District, but is applicable within City limits.

Table 15. Existing City and State Resources

Program Name	Program Description
Stormwater Advisory Committee (SWAC)	• Provides guidance and recommendations on use of stormwater utility fee dollars and guidance in administering the City's stormwater management program
Capital Improvement Plan (CIP) Design-Bid-Build	• Traditional mechanism through CIP to design, publicly bid, and then construct capital improvement projects • Stormwater projects include drainage repairs, stream restoration, and construction of several stormwater BMPs • Subject to project management capacity constraints for the responsible department implementing the CIP

Program Name	Program Description
Virginia Conservation Assistance Program (VCAP)	• Urban cost-share program (to match long-standing cost-share programs for the agricultural sector); Voluntary on the applicant's part • Relatively new as a statewide program • Administered through Soil & Water Conservation Districts • Twelve available BMP practices; large and small • Most popular BMP is conservation landscaping • There are limited funds, statewide

The SWIP has identified several ways to expand and enhance existing program resources to accelerate pollution reduction efforts; Table 16 summarizes some of these. Many involve partnerships with citizens and businesses to achieve higher levels of pollution reduction in a more expedient timeframe. *Public-private partnerships* are being explored across the Chesapeake Bay Watershed and beyond to share responsibility between public and private sectors for local water quality. Many of these partnerships involve innovative financing and contracting mechanisms that are new to the stormwater field, but have been used in other sectors, such as housing, schools and transportation. Appendix E provides more detail on existing and potential future programs and policies for the City's consideration.

Table 16. Potential New Pollution Reduction and Incentive Programs

Program Name	Program Description
Partner with Non-Profits	• Cooperative program between the City and non-profits to identify and deliver BMPs • Can be structured as a grant program administered by a grant-funding agency; example: Anne Arundel County Restoration Grant Program through the Chesapeake Bay Trust • Can also serve as a workforce development program; examples: READY program, Howard County Eco-Works
City Grant Program	• City administers grants directly to property owners to help pay for initial design and/or construction of BMPs • Could be coupled with VCAP and utility crediting to create multiple incentives • Eligible grantees could be scored based on BMP cost-effectiveness or other factors
Reverse Auction	• Funds are made available to low bidders to install BMPs based solely on pollutant reduction benefits ($ per pound) • Probably most usable for residential program expansion by a third party
Public Private Partnership (P3)	• Municipality contracts with a P3 private partner (likely an environmental consulting firm or contractor) to seek, design, build, and maintain projects • Most of the risk, but also the control, is transferred to the private party • Private party will seek the most profitable approach to reach goals • "Pay for Success" is a related model whereby payment is linked to successful delivery of outcomes (e.g., X pounds of pollutant reduced); See Sokulsky and Alexandrovich (2016) for a detailed description from the western states.

Program Name	Program Description
Community-Based Public Private Partnership (CBP3)	• More of a partnership between the municipality and private partner to establish CBP3 administrative structure • Intent is to add community goals (e.g., workforce, neighborhood investment, community greening) onto the traditional P3 approach

Purchasing Nutrient Credits

The SWIP envisions a significant financial investment on the part of the City. Elected officials and City departments have an obligation to ensure that investments reflect cost-effective options and that the City and its citizens will get their money's worth from the selected projects and programs.

Another option considers off-site compliance, meaning that some pollutant reduction credits are obtained from outside of the jurisdictional limits of Harrisonburg through various credit purchases or contractual arrangements with private pollutant banks or other entities that hold a pollution discharge permit. The MS4 permit authorizes this type of "trading" arrangement.

Using off-site pollutant compliance strategies should not be taken lightly, as it means using stormwater fee dollars for improvements whose chief benefits may accrue elsewhere. Given a choice, the City may prioritize making improvements within its boundaries for the benefit of its own citizens. However, several of the off-site options present very cost-effective solutions, so this will become a very strategic decision about balancing costs and benefits.

The City will strategically plan if there is a need to purchase these credits, as the costs are subject to market influences. For instance, as more MS4s like Harrisonburg become interested in purchasing credits, the cost may go up and the supply may become very constrained. In this regard, there are two types of off-site compliance strategies that need to be considered:

1. Annual Credits

Annual credits mean that they must be purchased every year. This arrangement can be executed through a memorandum of understanding (MOU) or contract with the organization that also has a pollution control permit from the State, but has excess credits that it can make available because pollution reductions are above and beyond currently-permitted limits. For the city, the most likely organization that can offer credits is the Harrisonburg Rockingham Regional Sewer Authority (HRRSA).

There is some risk that annual credits may not be available in future years, so the strategy can be viewed as a "stop-gap" or temporary measure to allow time for local BMPs to be designed and constructed. Given that, annual credits can be very cost-effective and should be included in the overall strategy for compliance.

2. Perpetual Credits

As compared to annual credits, perpetual credits are a one-time purchase. Virginia has an established a "Virginia Nutrient Bank" whereby certain property owners and businesses can establish nutrient banks that generate credits for purchase. The pollution reduction actions that generate these credits are usually on agricultural or larger tracts of land through converting pasture to permanent riparian buffers or restoring degraded streams. These credits are regulated and certified by DEQ. DEQ also requires that credit purchasers be within the same or an adjacent watershed as where the credits are generated. For Harrisonburg, this means the Shenandoah/Potomac watershed, and there are currently about 15 nutrient banks that have available nutrient credits.

While perpetual credits do not have the same level of risk as annual credits, they are much more expensive, and therefore would require a higher commitment of stormwater utility funds. At some point, if these credits are more cost-effective than what can be achieved through local BMP implementation, then they become a viable option. These types of credit purchases will need to be programmed well ahead of the actual need though, because, as stated above, the credit markets are subject to the forces of supply and demand, meaning that costs and availability may fluctuate.

Conclusion

The SWIP provides three options for overall TMDL compliance: programs, capital projects, and nutrient credit purchases. Up to this point, regulatory compliance has been achieved by programs; however, as the pollutant removal requirements increase, the City must diversify its approach towards compliance. The SWIP provides a framework to meet the pollution reduction requirements, which will be used to implement a stormwater improvement strategy that maximizes local benefits while providing a cost-effective solution for citizens and property owners paying the stormwater utility fee.

The SWIP Appendices

The development of this plan involved data collection, review and analyses to assess the City's watersheds, review existing City plans and documents, develop new tools and databases to organize information, modeling through the City's geographic information systems (GIS), calculation of pollution load reductions, identification of BMP sites and priority projects, ranking of those projects for the identification of high priority sites, establishing an MS4 compliance budget, and all associated work.

As a result, this SWIP includes extensive technical appendices and supporting information that provide more details on the topics presented in this document and used in the SWIP development.

Appendix A, Watershed Assessment details the review and assessment of existing City information and plans that are relevant to the SWIP, and how this information was organized using various mapping (geospatial) tools for use as supportive information for this plan.

Appendix B, System Capacity Assessment documents the cataloguing of previous and new flooding and drainage issues as well as floodplains and stream erosion concerns.

Appendix C, Water Quality Assessment contains detailed information on the accounting for pollutant load reductions in the plan, as compared to regulatory requirements for MS4 compliance.

Appendix D, Evaluation of Additional BMP Opportunities discusses additional BMPs needed to close the pollutant load reduction gap for Total Nitrogen (TN) and how locations are types of BMPs were selected.

Appendix E, Citywide Program Assessment outlines existing City programs and policies related to managing a citywide stormwater program, including SWIP implementation strategies.

Appendix F, Field Investigations of BMP Opportunities includes field data forms and site sketches for each BMP included in this plan.

Appendix G, Development of a Prioritization and Ranking Tool details the site analysis for each BMP, ranking criteria developed for this plan, unit cost tables for construction and long-term maintenance estimates, and the approach to ranking BMPs.

Appendix H, List of Recommended BMPs identifies, by category and rank, the new BMP opportunities, existing BMP retrofits, and stream restoration projects included in this SWIP.

Appendix I, High Priority Concept Plans includes a conceptual plan and cost estimate for each BMP opportunity identified as a high priority.

Appendix J, Citywide Program Recommendations includes a more detailed description of the city's programs and policies related to stormwater.

Appendix K, Consensus Building Activities includes supporting information for the two public meetings held during the development of this plan, as well as written comments received during the public comment period.

Appendix A: Watershed Assessment

Appendix B: System Capacity Assessment

Appendix C: Water Quality Assessment

Appendix D: Evaluation of Additional BMP Opportunities

Appendix E: Citywide Program Assessment

Appendix F: Field Investigations of BMP Opportunities

Appendix G: Development of a Prioritization and Ranking Tool

Appendix H: List of Recommended BMPs

Appendix I: High Priority Concept Plans

Appendix J: Citywide Program Recommendations

Appendix K: Additional Consensus Building Activities

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