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Executive Summary

The *Belle Haven, Dogue Creek, and Four Mile Run Watersheds Management Plan* provides a summary of the current and future conditions of these three watersheds and presents a strategy for restoring and preserving their water resources. The plan was initiated by Fairfax County as part of a multi-year, multi-objective program to preserve and restore the County's natural environment and aquatic resources, and is consistent with the Fairfax County Board of Supervisors' Environmental Agenda adopted in June 2004. It has also been prepared as part of the process of compliance with state and federal laws and mandates, including Virginia's Chesapeake Bay Initiatives and the federal Clean Water Act.

Fairfax County has a long history of planning at the watershed scale. The County's first set of watershed plans were completed in the 1970s. Since that time, land use has changed significantly and there have been many advances in the fields of stormwater management and ecological restoration. These advances have been reflected in the countywide goals for the program, which are consistent across all County watershed plans:

1. Improve and maintain watershed functions in Fairfax County, including hydrology, water quality, and habitat.
2. Protect human health, safety, and property by reducing stormwater impacts.
3. Involve stakeholders in the protection, maintenance and restoration of County watersheds.

This watershed management plan is unique in that it combines an assessment of three non-contiguous watersheds into one document: Belle Haven, Dogue Creek and the Fairfax County portion of the Four Mile Run watershed. These watersheds are located in southeastern and eastern Fairfax County.

To develop the plan, watersheds were subdivided into Watershed Management Areas (WMAs) approximately four square miles in size. As much as possible, WMAs were delineated to encompass the drainage area, and are named after, the major tributaries. They were further divided into subwatersheds, ranging in size from 100 to 300 acres, which represent the smallest assessment unit for the watershed plans.

The Dogue Creek watershed was divided into five WMAs: Barnyard Run, Piney Run, North Fork, Mainstem and Potomac. Due to their smaller size, the Belle Haven and Four Mile Run watersheds were not divided into WMAs and thus the entire watershed for each was treated as a single WMA.

Watershed Planning Process

The watershed management planning process consisted of the following six steps:

1. Review and synthesis of previous studies and data compilation
2. Public involvement to gain input, provide education and build community support
3. Evaluation of current watershed conditions and evaluation of stormwater runoff and other impacts from present and ultimate development conditions
4. Development of non-structural and structural watershed improvement projects
5. Development of preliminary cost estimates, cost/benefit analysis and prioritization of capital projects

6. Adoption of the final watershed management plan by the Board of Supervisors

A set of measurable indicators was used in order to develop a consistent project identification and prioritization process across watersheds. These indicators were used to assess the extent that a reduction of a particular watershed impact, sought by the goals and objectives, was achieved to quantify the presence of potential stresses or pollutant sources and to assess the outcomes from the plan.

The indicators were the key method by which the conditions of the watersheds were assessed -- comparing conditions at the subwatershed level and ranking them from best condition to worst. They provided a quantifiable method to determine why a particular subwatershed was in poor condition, whether from stream impacts, flooding, lack of buffers, forest, or wetlands, or high levels of stormwater pollution. This ranking, in turn, helped to focus the effort of identifying appropriate improvement projects and finally provided a method of measuring and prioritizing which projects would be most effective.

Previous Studies and Data Compilation

The 1970s watershed plans provided useful background information for land use changes, problems identified in the watersheds earlier and proposed projects for solutions. The County's land use and parcel mapping data provided a method of determining the pattern of development and confirming that significant areas were constructed before stormwater management regulations were in place. GIS layers were also used as the basis for developing watershed models. Monitoring results provided much of the data needed for the indicators described above, including information from the County's ongoing bioassessments, the 2005 Stream Physical Assessment and water quality sampling results from the County Health Department and Virginia Department of Environmental Quality.

Public Involvement

The watershed plan was supported by two levels of public involvement. The first level consisted of two meetings open to the public. These were the Issues Scoping Forum that kicked off the public involvement process, held at the Huntley Meadows Nature Center in January 2009, and the Draft Plan Review Workshop, held at Mount Vernon High School in August 2010. The second level of public involvement was provided by the Watershed Advisory Group (WAG), which met five times over the course of the project. The WAG was made up of local stakeholders who advised the planning team about community outreach opportunities, key issues affecting the watersheds and feedback on potential projects.

Watershed Conditions and Runoff Impacts

<u>Belle Haven</u> The Belle Haven watershed is 2.7 square miles in area. Sixty-nine percent of the watershed is developed with the majority, 41 percent, in various residential land uses. Existing imperviousness is 32 percent and is expected to increase by approximately 1.5 percent from future development. The Stream Physical Assessment indicated that the streams in the watershed were unstable and suffered from poor habitat quality. Based on habitat score, the Belle Haven watershed was rated the poorest quality watershed in the County.

The results of the subwatershed ranking analysis showed that all the subwatersheds in the Belle Haven watershed were impaired in some form. All except one were among the lowest ranking for the composite score of impacts and sources. In terms of overall ranking, Belle Haven had the four highest priority subwatersheds for the overall project.

Flooding hazards are a significant issue in the Belle Haven watershed. One road crossing was modeled as overtopping for the 10-year event. Modeled water quality showed high pollutant loads for nitrogen, phosphorus, and sediment, primarily from commercial, transportation, single and multi-family residential land uses that predate stormwater management regulations.

Dogue Creek The Dogue Creek watershed is approximately 19.5 square miles with 6.3 square miles of the watershed located in areas outside of the County jurisdiction in the Fort Belvoir Military Reservation and other U.S. government installations. Approximately 70 percent of the watershed is developed, primarily in the headwaters of Dogue Creek, Barnyard Run and Piney Run, as well as most of the North Fork WMA. Overall, the Dogue Creek watershed is 19 percent impervious and is expected to increase by approximately 1.5 percent due to future development.

There are 888 acres of wetlands in the Dogue Creek watershed, primarily located in Huntley Meadows Park in the Mainstem and Barnyard Run WMAs. The large areas of undeveloped land on Fort Belvoir Military Reservation and Huntley Meadows Park help to protect the overall quality of the mainstem of Dogue Creek.

The Stream Physical Assessment indicated that 50 percent of the stream channels were either unstable or experiencing active bank erosion. Habitat was determined to be primarily in the fair to poor range. In comparison with the rest of the County, the Dogue Creek watershed is in the lower range of quality.

The subwatershed ranking analysis showed that most of the subwatersheds in three of the WMAs were in good condition: Barnyard Run, Piney Run and the Mainstem. This is due, in no small part, to the influence of undeveloped areas of four large parcels: Huntley Meadows Park, Woodlawn Plantation, Greendale Golf Course and Fort Belvoir.

In North Fork, however, all but two of the subwatersheds were impaired in some form. Impairments included low ratings in stream assessment, with many streams channelized with a concrete channel and several ranked poor for aquatic habitat. There were a number of reaches described as unstable and actively eroding. Three road crossings were modeled as overtopping for the 10-year event.

Four Mile Run The Four Mile Run watershed is approximately 20 square miles; however, 17 square miles of the watershed is located in areas outside of Fairfax County. Approximately 95 percent of the watershed study area is developed, with only small portions of open space along the headwaters of Four Mile Run and the mainstem of Upper Long Branch. The Four Mile Run watershed is 36 percent impervious and this is expected to increase by approximately 1.5 percent from future development. The results of the subwatershed ranking analysis showed that all the subwatersheds in Four Mile Run were impaired in some form. All but one were among the lowest ranking for the composite score of impacts and sources. A considerable length of Upper Long Branch (tributary to Four Mile Run) has been channelized with concrete. No road crossings were flooded beyond the design level-of-service. Water quality modeling showed high pollutant loads for nitrogen, phosphorus and sediment throughout Four Mile Run.

Watershed Improvement Projects

Development of watershed restoration strategies involved two elements: first, to determine where to prioritize restoration and preservation efforts, and second, to identify the specific practices and locations where improvements could be made.

The purpose of prioritizing was to focus limited resources in the most effective way, as there were some geographic areas within each watershed where the same improvement could have a greater impact than in others. Once prioritization was complete, specific restoration and preservation sites were identified at a subwatershed scale.

The overall strategy for restoring and protecting the Belle Haven, Dogue Creek and Four Mile Run watersheds was developed with the assistance and input of the Watershed Advisory Group (WAG). The group suggested focusing project recommendations to identify impaired headwater areas and concentrate restoration efforts in these subwatersheds. These improvements will reduce the stress and subsequent damage to downstream channels. This strategy recognized that improvements in headwater areas have the potential to improve conditions throughout the stream network.

Specific restoration practices were in one of two categories: structural or non-structural. Structural practices are physical structures which generally involve budgeting through the Capital Improvement Plan followed by engineering, design and construction. Non-structural practices are programmatic in nature and usually focus on controlling stormwater runoff at the source.

Structural practices included:

- New Stormwater Management Ponds or Stormwater Pond Retrofits
- Stream Restoration
- Area-Wide Drainage Improvements
- Culvert Retrofits
- New BMP/LID or BMP/LID Retrofits
- Flood Protection Mitigation
- Outfall Improvements

Non-structural practices included:

- Buffer restoration
- Rain barrel and impervious disconnection programs
- Dumpsite and obstruction removals
- Community outreach and public education
- Land conservation coordination projects
- Inspection and enforcement programs
- Street sweeping programs
- Studies, surveys, and assessments

To find potential project locations, a desktop assessment was first conducted to identify sites for implementing structural practices in the three watersheds. This initial assessment focused on sites for storage retrofits to reduce or modify peak flows and on-site retrofits primarily to provide water quality. The storage retrofit sites consisted of existing ponds and areas above culverts.

The onsite retrofit sites consisted of parking lots, rooftops, outfalls and inlets. In addition, potential projects for stream restoration, flood mitigation and buffer restoration were identified. In all, over 240 candidate sites were flagged for follow-up.

Non-structural sites were identified from field assessment of potential pollutant sources in a sampling of residential and commercial areas.

Candidate sites for stormwater retrofits and stream restoration were subsequently assessed in the field to identify any site constraints that would prevent improvements from being implemented. The result of the field assessment was either a rough concept for the improvement or a decision that the project was either not feasible or the constraints outweighed the potential benefits. Planning-level cost estimates were developed for the feasible projects and smaller projects were grouped together based on cost and location.

Prioritization, Benefits and Costs of Plan Implementation

The projects were prioritized for implementation using a weighted average of the indicators and other factors to give each a score, as follows: impact indicators (30 percent), source indicators (30 percent), location in a priority subwatershed (10 percent), upstream/downstream sequencing (20 percent) and implementability (10 percent). The final score was used to determine whether the projects fell into a one of two priority phases; high or low. Those projects in the higher priority phase would be constructed in the 0 to 10 year timeframe, and those in a lower priority phase in an 11 to 25 year timeframe

As a result of the prioritization, 60 higher priority (0 – 10 year timeframe) projects were taken forward for concept design and cost estimate. All project information was then summarized in a project fact sheet. These fact sheets provide a description of the project, benefits and considerations, a schematic design and a cost estimate and can be found in Section 5.

In order to assess the benefits of the Belle Haven, Dogue Creek and Four Mile Run Watershed Management Plan, hydrologic, hydraulic and pollutant loading modeling was conducted for future conditions with the proposed projects. All projects were modeled for pollutant loading reductions. Only the 10-year projects were modeled for hydrologic and hydraulic benefits.

The 60 priority projects in the 10-year plan will reduce total suspended solids by 744 tons per year, total nitrogen by 2,076 pounds per year and total phosphorus by 597 pounds per year. The full 25-year plan identifies an additional 29 structural projects for a total of 92, whose overall benefits include eliminating the overtopping of four road crossings and restoring almost five miles of streams and one half-mile of forested buffer. Full plan implementation will reduce pollutant loads by as much as 797 tons per year of total suspended solids, 2,544 pounds per year of total nitrogen and 711 pounds per year of total phosphorus. These benefits will help meet the County's goals for water quality and stream improvements and provide a positive impact on the residents and conditions of the watersheds.

The total estimated cost for the structural projects for the 10-year plan is $26.7 million. This includes all three watersheds; $7.5 million for Belle Haven, $13.7 million for Dogue Creek and $5.5 million for Four Mile Run. Implementation of the 11-25 year structural projects adds $7.5 million for a total of $34.2 million; an additional $7.1 million for Dogue Creek and $0.4 million for Four Mile Run. All proposed projects are presented in the Table ES-1.

Table ES- 1: Master Project List

Priority Structural Projects (Ten Year Implementation Plan)				
Project #	**Project Type**	**WMA**	**Location**	**Cost**
BE9100	Stormwater Pond Retrofit	Belle Haven	West Potomac High School	$174,000
BE9102	New Stormwater Pond	Belle Haven	Belle View Elementary School	$277,000
BE9103	New Stormwater Pond	Belle Haven	Fairchild Property	$750,000
BE9200	Stream Restoration	Belle Haven	Belle Haven Park between Richmond Hwy Foxcroft Rd, and Edgewood Ter	$1,614,000
BE9201	Stream Restoration	Belle Haven	Behind Belle View Dr	$883,000
BE9202	Stream Restoration	Belle Haven	Shields Av	$388,000
BE9203	Stream Restoration	Belle Haven	Downstream of Quander Rd	$1,122,000
BE9500	BMP/LID	Belle Haven	Shops at Huntington Gateway	$105,000
BE9501	BMP/LID	Belle Haven	Wal-Mart and Chuck E. Cheese parking lot	$283,000
BE9502	BMP/LID	Belle Haven	Quander Road School	$69,000
BE9503	BMP/LID	Belle Haven	River Towers	$251,000
BE9504	BMP/LID	Belle Haven	Belle View Shopping Center	$145,000
BE9505	BMP/LID	Belle Haven	14th St	$83,000
BE9506	BMP/LID	Belle Haven	Belle View Blvd	$91,000
BE9507	BMP/LID	Belle Haven	Belle View Shopping Center	$257,000
BE9508	BMP/LID	Belle Haven	Belle View Elementary School	$62,000
BE9509	BMP/LID	Belle Haven	Mount Vernon Recreation Center	$241,000
BE9510	BMP/LID	Belle Haven	West Potomac High School	$85,000
BE9600	Flood Protection/Mitigation	Belle Haven	Culvert under Yale Drive	$593,000
DC9100	New Stormwater Pond	Dogue Creek - North Fork	Mount Vernon High School	$480,000
DC9106	Stormwater Pond Retrofit	Dogue Creek - Barnyard Run	Groveton Woods Condominium	$89,000
DC9201	Stream Restoration	Dogue Creek - North Fork	Between Presidential Dr and Volunteer Dr	$646,000
DC9202	Stream Restoration	Dogue Creek - North Fork	Between Sulgrave Dr and Adrienne Dr	$925,000
DC9203	Stream Restoration	Dogue Creek - North Fork	Upstream of Mount Zephyr Dr near Maryland St	$744,000
DC9204	Stream Restoration	Dogue Creek - North Fork	George Washington Park	$859,000
DC9207	Stream Restoration	Dogue Creek - North Fork	Behind Colony Dr	$646,000

Priority Structural Projects (Ten Year Implementation Plan)				
Project #	**Project Type**	**WMA**	**Location**	**Cost**
DC9210	Stream Restoration	Dogue Creek - Barnyard Run	Between Parsons Ct and Stover Dr	$547,000
DC9211	Stream Restoration	Dogue Creek - Barnyard Run	Between Bedrock Ct and Vantage Drive	$578,000
DC9213	Stream Restoration	Dogue Creek - Mainstem	Greendale Golf Course	$1,228,000
DC9214	Stream Restoration	Dogue Creek - Mainstem	Greendale Golf Course	$1,261,000
DC9215	Stream Restoration	Dogue Creek - Piney Run	Behind Rockcliff La	$1,480,000
DC9217	Stream Restoration	Dogue Creek - Mainstem	Between Old Mill Rd and Richmond Hwy	$707,000
DC9218	Stream Restoration	Dogue Creek - Piney Run	Banks Property	$872,000
DC9400	Culvert Retrofit	Dogue Creek - Mainstem	North side, Telegraph Rd	$27,000
DC9500	BMP/LID	Dogue Creek - North Fork	Smitty's Building Supply	$262,000
DC9501	BMP/LID	Dogue Creek - North Fork	Various	$69,000
DC9503	BMP/LID	Dogue Creek - North Fork	Riverside Elementary School	$74,000
DC9504	BMP/LID	Dogue Creek - North Fork	Mount Vernon High School	$189,000
DC9505	BMP/LID	Dogue Creek - North Fork	Mount Vernon High School	$209,000
DC9506	BMP/LID	Dogue Creek - Piney Run	Alderman Dr	$145,000
DC9507	BMP/LID	Dogue Creek - Piney Run	Parking lots along Westcott Way	$121,000
DC9508	BMP/LID	Dogue Creek - Piney Run	Shoppers parking lot	$240,000
DC9510	BMP/LID	Dogue Creek - Mainstem	Hayfield Secondary School	$223,000
DC9511	BMP/LID	Dogue Creek - Mainstem	Hayfield Plaza	$228,000
DC9512	BMP/LID	Dogue Creek - Barnyard Run	Groveton Gardens	$34,000
DC9513	BMP/LID	Dogue Creek - Barnyard Run	Groveton Elementary School	$45,000
DC9518	BMP/LID	Dogue Creek - Mainstem	Kingstowne Village	$46,000
DC9519	BMP/LID	Dogue Creek - Mainstem	Kingstowne Village	$58,000
DC9520	BMP/LID	Dogue Creek - Mainstem	Church of Jesus Christ of Latter Day Saints	$163,000
DC9522	BMP/LID	Dogue Creek - Mainstem	Along Clames Rd	$21,000
DC9523	BMP/LID	Dogue Creek - Mainstem	Virginia Presbyterian Church	$48,000

Priority Structural Projects (Ten Year Implementation Plan)				
Project #	**Project Type**	**WMA**	**Location**	**Cost**
DC9600	Flood Protection/Mitigation	Dogue Creek - North Fork	Culvert under Ashboro Dr	$488,000
FM9102	New Stormwater Pond	Four Mile Run	Hollybrook II Condos	$2,326,000
FM9104	Stormwater Pond Retrofit	Four Mile Run	Hampton Inn off 14th St and Leesburg Pike	$99,000
FM9105	New Stormwater Pond	Four Mile Run	Off Carlin Springs Rd	$498,000
FM9300	Area-wide Drainage Improvements	Four Mile Run	North of Williamsburg Blvd and Custis Memorial Pkwy and south of Haycock Rd	$1,833,000
FM9500	BMP/LID	Four Mile Run	St. Andrews Parish	$92,000
FM9501	BMP/LID	Four Mile Run	St. Katherine's Greek Orthodox	$52,000
FM9502	BMP/LID	Four Mile Run	Target Greatland	$479,000
FM9503	BMP/LID	Four Mile Run	Korean Cultural Center	$79,000
			Total Cost	**$26,683,000**

Long Term Structural Projects (25 Year Implementation Plan)			
Project #	**Project Type**	**WMA**	**Location**
BE9701	Outfall Improvement	Belle Haven	Quander Road School
DC9101	Stormwater Pond Retrofit	Dogue Creek - North Fork	End of Purks Ct
DC9102	Stormwater Pond Retrofit	Dogue Creek - Piney Run	Kingstowne Fire Station
DC9104	Stormwater Pond Retrofit	Dogue Creek - Piney Run	Kingstowne Village Pkwy at Ashby Ln
DC9105	Stormwater Pond Retrofit	Dogue Creek - Piney Run	Manchester Lake Dr
DC9107	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Devereux West
DC9108	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Crossroads Residential School
DC9109	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Church of Jesus Christ of Latter Day Saints
DC9110	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Virginia Presbyterian Church
DC9200	Stream Restoration	Dogue Creek - North Fork	Robertson Blvd
DC9205	Stream Restoration	Dogue Creek - North Fork	Between Oak Leaf Dr and McNair Dr
DC9206	Stream Restoration	Dogue Creek - North Fork	Rosemont Ave and Rosemont Cir
DC9208	Stream Restoration	Dogue Creek - Mainstem	8822 Richmond Highway (between Old Mill Rd and Sacramento Dr)
DC9209	Stream Restoration	Dogue Creek - Mainstem	Upstream of Old Mill Rd (Close to Pope Leighy House)
DC9212	Stream Restoration	Dogue Creek - Mainstem	Wickford Park

Long Term Structural Projects (25 Year Implementation Plan)			
Project #	**Project Type**	**WMA**	**Location**
DC9216	Stream Restoration	Dogue Creek - Piney Run	Rock Ridge Ln
DC9401	Culvert Retrofit	Dogue Creek - North Fork	Lawrence St between Central Park and Ashboro Dr
DC9502	BMP/LID	Dogue Creek - North Fork	KinderCare Learning Center, Buckman Rd
DC9509	BMP/LID	Dogue Creek - Piney Run	Calvary Baptist Church and Christian School
DC9514	BMP/LID	Dogue Creek - Barnyard Run	Faith United Methodist Church
DC9515	BMP/LID	Dogue Creek - Mainstem	The Shops at Telegraph
DC9516	BMP/LID	Dogue Creek - Mainstem	Crossroads Residential School
DC9517	BMP/LID	Dogue Creek - Mainstem	Kinder Care Learning Center, May Blvd
DC9521	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Franconia Rd at Morning Glory Dr
DC9701	Outfall Improvement	Dogue Creek - Piney Run	Behind 6115 Summer Park Ln
DC9702	Outfall Improvement	Dogue Creek - Piney Run	Rock Ridge Ln
DC9703	Outfall Improvement	Dogue Creek - Barnyard Run	Harrison Ln
FM9100	Stormwater Pond Retrofit	Four Mile Run	Fallswood Glen Ct
FM9101	Stormwater Pond Retrofit	Four Mile Run	Along Arlington Blvd near Kelsey Ct
FM9103	Stormwater Pond Retrofit	Four Mile Run	Commercial center at Arlington Blvd and Wilson Blvd
FM9106	Stormwater Pond Retrofit	Four Mile Run	Diehl Ct
FM9200	Stream Restoration	Four Mile Run	Upstream of Henry Dr and Brook Dr

Non-Structural Projects			
Project #	**Project Type**	**WMA**	**Location**
DC9800	Buffer Restoration	Dogue Creek - Mainstem	Buffer restoration adjacent to commercial / industrial site, Dogue Ct
DC9801	Buffer Restoration	Dogue Creek - Mainstem	Stream adjacent to Huntley Meadows near Sheridonna La. Reach DCPY006
DC9802	Buffer Restoration	Dogue Creek - Piney Run	Hilltop Golf Course
DC9803	Wetland Mitigation	Dogue Creek – North Fork	Riverside Elementary School
DC9901	Rain Barrel Programs – Downspout Disconnection	Multiple	Watershed-wide
DC9902	Rain Barrel Programs – Rain Barrels	Multiple	Watershed-wide
DC9903	Community Outreach/ Public Education – Lawn Care Outreach	Multiple	Watershed-wide

Non-Structural Projects			
Project #	**Project Type**	**WMA**	**Location**
DC9904	Community Outreach /Public Education – Storm Drain Marking	Multiple	Watershed-wide
DC9905	Community Outreach/ Public Education – Tree Planting	Multiple	Watershed-wide
DC9906	Community Outreach/ Public Education – Turf Management	Multiple	Watershed-wide
DC9907	Inspection/Enforcement Enhancement Project – Dumpster Maintenance	Multiple	Watershed-wide
DC9908	Inspection/Enforcement Enhancement Project – Outdoor Mat'l Storage	Multiple	Watershed-wide
DC9909	Inspection/Enforcement Enhancement Project – Vehicle Maintenance	Multiple	Watershed-wide
DC9910	Inspection/Enforcement Enhancement Project – Litter/Trash Enforcement	Multiple	Watershed-wide
DC9911	Dumpsite/Obstruction Removal – Obstruction Removal	Multiple	Watershed-wide
DC9912	Street Sweeping Program	Multiple	Watershed-wide
DC9913	Studies, Surveys and Assessments – Floatables Control	Multiple	Watershed-wide

1 Introduction to Watersheds

A watershed is an area of land that drains all of its water to a specific lake or river. As rainwater and melting snow run downhill, they carry sediment and other materials into our streams, lakes, wetlands and groundwater.

The boundary of a watershed is defined by the watershed divide, which is the ridge of highest elevation surrounding a given stream or network of streams. A drop of rainwater falling outside of this boundary will enter a different watershed and will flow to a different body of water.

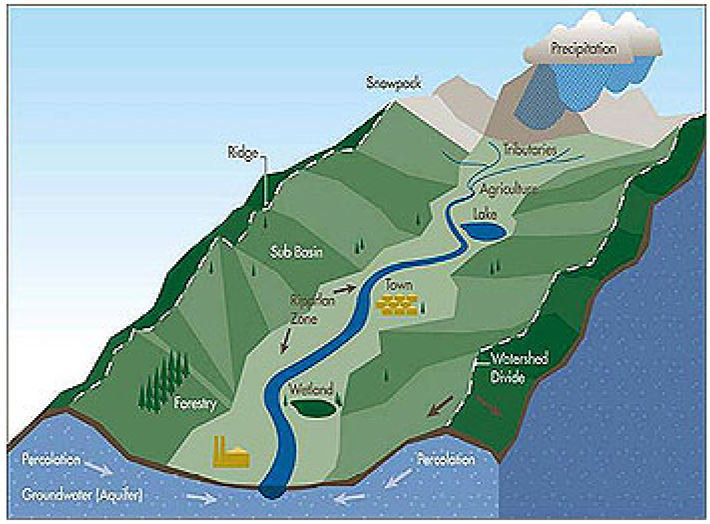

Figure 1-1: Diagram of a watershed

Streams and rivers may flow through many different types of land use in their paths to the ocean. In the above illustration from the U.S. Environmental Protection Agency, water flows from agricultural lands to residential areas to industrial zones as it moves downstream. Each land use presents unique impacts and challenges on water quality.

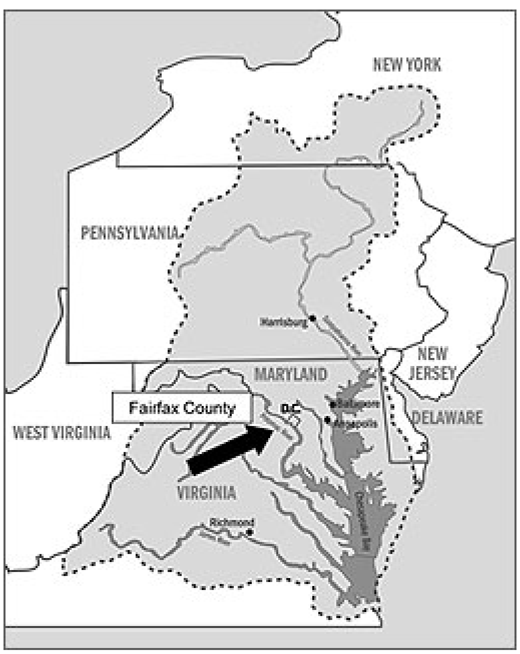

Figure 1-2: The Chesapeake Bay watershed

The size of a watershed can be subjective; it depends on the scale that is being considered.

The image to the left depicts the extent of the Chesapeake Bay watershed, "the big picture" that is linked to our local concerns. This watershed covers 64,000 square miles and crosses into six states: New York, Pennsylvania, Delaware, West Virginia, Maryland, Virginia and the District of Columbia.

One of the watersheds that comprise the Chesapeake Bay watershed is the Potomac River watershed. Fairfax County, as shown on the map, occupies approximately 400 square miles of the Potomac River watershed. This area contains 30 smaller watersheds. Think of watersheds as being "nested" within each successively larger one.

Each watershed in Fairfax County was subdivided to facilitate data management and to promote local awareness of the streams. Watersheds were divided into Watershed Management Areas (WMAs) approximately four square miles in size. WMAs are usually named for the local major tributary. These areas are further divided into subwatersheds, ranging in size from 100 to 300 acres. Subwatersheds represent the smallest modeling unit for watershed planning.

Beginning in the early 1940s, Fairfax County shifted from an agricultural community to an urbanized one whose population exceeds that of several states. While the County continued to develop, the condition of streams and aquatic life declined. In 1999, a Stream Protection Strategy (SPS) was initiated to monitor stream health and establish a baseline of countywide stream conditions. The results of the baseline monitoring effort indicated that only 25 percent of the County's streams were in good to excellent biological health. Stream condition is determined using an Index of Biological Integrity (IBI) that evaluates ecological health based on the community structure of bottom-dwelling aquatic invertebrates.

The baseline study found that roughly 75 percent of streams within the County had areas negatively impacted by impervious conditions within their watersheds. Due to increasing urbanization prior to implementation of modern stormwater controls, impervious land area rapidly increased, contributing to the degradation of the streams.

Introduction to Watershed Planning

The County's comprehensive stormwater management program is currently undergoing a transformation that addresses watershed health using a holistic approach. The mission for the stormwater program is dictated by the need to preserve and restore the natural environment and aquatic resources, which is consistent with the Fairfax County Board of Supervisors' Environmental Agenda adopted in June 2004. The County must also comply with all applicable local, state and federal laws and mandates. These include County ordinances and policies, Virginia's Chesapeake Bay Initiatives and the federal Clean Water Act. Under the Virginia Pollutant Discharge Elimination System (VPDES) the County has an individual Municipal Separate Storm Sewer System (MS4) Permit. This permit requires the creation of watershed management plans to facilitate compliance with the Clean Water Act. In addition, the County is doing its part to fulfill Virginia's commitment to the Chesapeake Bay 2000 Agreement to restore the ecological health of the Chesapeake Bay Watershed.

Fairfax County's first set of watershed plans were completed in the 1970s. Land use has changed significantly since that time. Additionally, there have been many advances in technology and development in the field of stormwater management which have resulted in updates to stormwater policies and regulations. New plans were needed to reflect these changes and to plan for a future in which Fairfax County recognizes that there is a direct link between the vitality of ecological resources and the quality of life for our residents.

The current watershed plans provide more targeted strategies for addressing stream health given current and future land uses and evolving regulations. These plans are one of several tools that enable the County to address program requirements and to improve and maintain watershed health. Each watershed plan includes a prioritized 25-year list of proposed capital improvement projects in addition to non-structural programs and projects. These projects and programs may lead to new and/or revised ordinances, public facilities manual requirements and policies. The plans promote the use of new and innovative practices in stormwater management such as Low Impact Development (LID) techniques and stream restoration using natural channel design. To maximize the effectiveness of these plans, community engagement and involvement from diverse interests were emphasized during the development process.

Watershed management plans were developed by grouping the County's 30 watersheds into 13 planning units (Figure 1-3). Watershed planning began in 2003. By 2007, roughly 50 percent of the County land area had completed watershed plans. This plan is part of the second group of watershed plans, which was initiated in 2007 for the remaining land area.

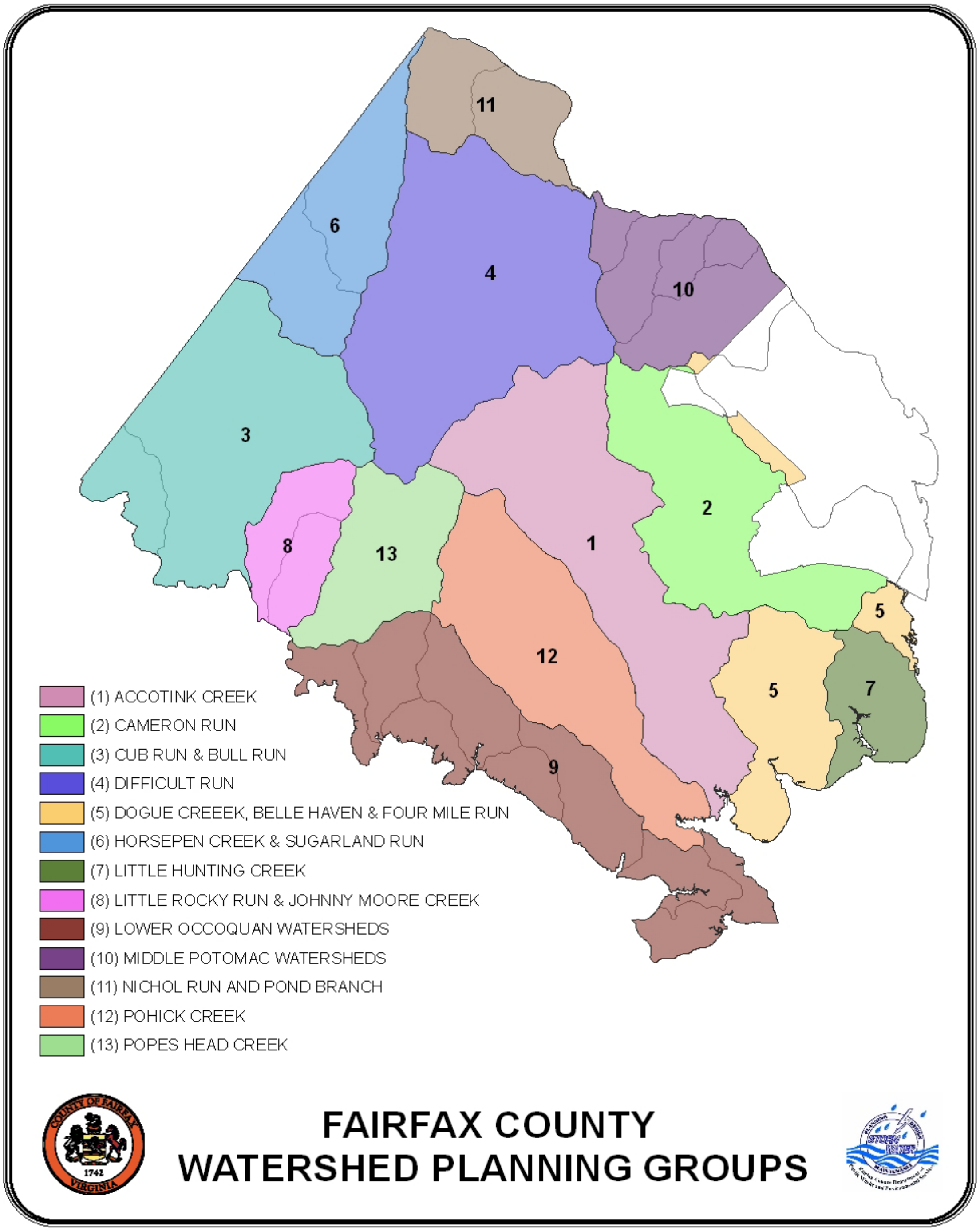

Figure 1-3: Watershed planning groups in Fairfax County

In general, the watershed management planning process consists of the following steps:

1. Review and synthesis of previous studies and data compilation
2. Public involvement to gain input, provide education and build community support
3. Evaluation of current watershed conditions and projection of stormwater runoff from present and ultimate development conditions
4. Development of non-structural and structural watershed improvement projects
5. Development of preliminary cost estimates, cost/benefit analysis and prioritization of capital projects
6. Adoption of the final watershed management plan by the Board of Supervisors

The watershed management planning process has been supported by the Board of Supervisors since its inception in 2003. In fiscal year 2006, the Board of Supervisors dedicated $0.01 per $100 of assessed value from the County's real estate tax revenue towards the overall stormwater management program. This supported the ongoing development and implementation of watershed plans and eventually evolved into the adoption of a stormwater service district starting in fiscal year 2010. The Board recently approved increasing the dedicated amount to a penny and a half for fiscal year 2011.

The following provisions address the funding and implementation of projects and programs in Fairfax County watershed plans. These provisions as recommended by the Board were developed for the Popes Head Creek Watershed Management Plan in February 2006 and have been applied to the Belle Haven, Dogue Creek and Four Mile Run Watershed Management Plan:

> i. Projects and programs (both structural and non-structural) will first undergo appropriate review by County staff and the Board (please see iii below) prior to implementation. Board adoption of the Watershed Management Plan will not set into motion automatic implementation of projects, programs or initiatives that have not first been subject to sufficient scrutiny to ensure that the projects that are funded give the County the greatest environmental benefit for the cost.
>
> ii. Road projects not related to protection of streambeds or banks or water quality will not be funded out of the stormwater and watershed budget.
>
> iii. The Watershed Management Plan provides a conceptual master-list of structural capital projects and a list of potential non-structural projects for the watershed. Staff will, on a fiscal year basis, prepare and submit to the Board a detailed work plan to include a description of proposed projects and an explanation of their ranking, based on specific criteria. Criteria used to assemble this list will include, but are not limited to, cost-effectiveness as compared to alternative projects, a clear public benefit, a need to protect public or private lands from erosion or flooding, a need to meet a specific watershed or water quality goal, and ability to be implemented within the same fiscal year that funding is provided. Staff also intends to track the progress of implementation and report back to the Board periodically.
>
> iv. Each project on the annual list of structural projects will be evaluated using basic value-engineering cost effectiveness principles before implementation and the consideration of alternative structural and non-structural means for accomplishing the purposes of the project will be considered before implementation. This process will ensure the County's commitment to being a fiscally responsible public entity.
>
> v. Obstruction removal projects on private lands will be evaluated on a case-by-case basis for referral to the Zoning Administrator and/or County Attorney for action as public

nuisances; and otherwise to determine appropriate cost-sharing by any parties responsible for the obstructions.

vi. Stream restoration projects on private lands will be evaluated to determine means for cost-sharing by land owners directly responsible for degradation due to their land uses.

2 Watershed Planning Process

2.1 Watershed Goals and Objectives

The County's first six comprehensive watershed management plans outlined intentions for protecting, maintaining or improving streams and the measures that could be taken to meet them. Although the plans conveyed similar aims overall, there were some differences in the way goals and objectives were developed. As a result of these differences, the initial six plans were analyzed the initial six plans to identify common themes in order to create standardized goals and objectives for the remaining watershed management plans. Standardization improved efficiency in the planning process and achieved greater consistency among the plans.

As part of the standardization process, the County selected three overarching goals, or intended outcomes of the watershed management plans:

1. Improve and maintain watershed functions in Fairfax County, including water quality, habitat and hydrology
2. Protect human health, safety and property by reducing stormwater impacts
3. Involve stakeholders in the protection, maintenance and restoration of County watersheds

Ten objectives were developed related to the three goals. Each objective may achieve one or more goals, and each goal may be achieved by one or more objectives. These ten objectives were grouped into five categories based on certain aspects of watershed management the objectives could influence:

1. **Hydrology** - healthy movement and distribution of water through the environment in a way that is protective of streams and human dwellings
2. **Habitat** - suitable environment for sustaining plants and animals
3. **Stream water quality** - general chemical and physical properties of surface waters
4. **Drinking water quality** - quality of water used for human consumption
5. **Stewardship** - the roles the County, other jurisdictions and members of the general public can play in caring for the environment

Under the new approach, County staff and the public had the flexibility to add objectives that were unique and important to a particular watershed, but all plans included the standard goals and objectives as a baseline (Table 2-1).

Table 2-1: Countywide Objectives

Objective	Linked to Goal(s)
CATEGORY 1. HYDROLOGY	
1A. Minimize impacts of stormwater runoff on stream hydrology to promote stable stream morphology, protect habitat, and support biota.	1
1B. Minimize flooding to protect property and human health and safety.	2
CATEGORY 2. HABITAT	
2A. Provide for healthy habitat through protecting, restoring, and maintaining riparian buffers, wetlands, and instream habitat.	1
2B. Improve and maintain diversity of native plants and animals in the County.	1

Objective	Linked to Goal(s)
CATEGORY 3. STREAM WATER QUALITY	
3A. Minimize impacts to stream water quality from pollutants in stormwater runoff.	1, 2
CATEGORY 4. DRINKING WATER QUALITY	
4A. Minimize impacts to drinking water sources from pathogens, nutrients, and toxics in stormwater runoff.	2
4B. Minimize impacts to drinking water storage capacity from sediment in stormwater runoff.	2
CATEGORY 5. STEWARDSHIP	
5A. Encourage the public to participate in watershed stewardship.	3
5B. Coordinate with regional jurisdictions on watershed management and restoration efforts such as Chesapeake Bay initiatives.	3
5C. Improve watershed aesthetics in Fairfax County.	1, 3

Standardizing the goals and objectives made it easier to integrate plan recommendations into a countywide data management system for prioritizing projects, tracking implementation and evaluating the long-term influence of the plans on the health of County streams.

2.2 Indicators

Since accomplishment of objectives cannot be directly measured, indicators that are able to detect changes in the watershed were developed. Indicators are used to assess the condition of the environment, as early-warning signals of changes in the environment, and to diagnose causes of ecological problems. Observed indicators are based upon data and observations collected in the field/area of interest, and are useful in assessing existing watershed conditions. Predictive indicators respond in a predictable manner to ecosystem stressors, and can be used in models of hydrologic and ecosystem processes (such as soil erosion, pollutant loading, etc.) to compare existing and future conditions.

Each indicator was measured by one or more metrics. A metric is an analytical benchmark that responds in a predictable way to increasing human, climatic or other environmental stress. Metrics may be actual numeric values (such as pH or Dissolved Oxygen values) or parameters that have been scored to a numeric scale (such as 1 – 10).

The indicators used by Fairfax County may be grouped into the following categories:

- **Watershed Impact Indicators** – Measure the extent that reversal or prevention of a particular watershed impact, sought by the goals and objectives, has been achieved ("What's there now, and how is it doing?").
- **Source Indicators** – Quantify the presence of a potential stressor or pollutant source ("Is there a problem, and what's causing it?").
- **Programmatic Indicators** –After the plans are adopted, these will assess outcomes of resource protection and restoration activities ("What's the County doing about the problem, and how is it doing?").

2.2.1 Watershed Impact Indicators

One or more watershed impact indicators for each objective were identified, including predictive and observed indicators. These indicators and the objectives to which they are linked are shown in Table 2-2.

Table 2-2: Watershed Impact Indicators

Objective	**Indicators**
1A Stormwater Runoff	Observed: Benthic Communities, Fish Communities, Aquatic Habitat Predictive: Channel Morphology, Instream Sediment, Hydrology
1B Flooding Hazards	Observed: Flood Complaints Predictive: Number of Road Hazards, Magnitude of Road Hazards, Residential Building Hazards, Non-residential Building Hazards
2A Habitat Health	Observed: Aquatic Habitat Predictive: RPA Riparian Habitat, Headwater Riparian Habitat, Protected Wetland Habitat
2B Habitat Diversity	Observed: Benthic Communities, Fish Communities Predictive: None
3A Stream Water Quality	Observed: *E. coli*, Benthic Communities, Fish Communities Predictive: Upland Sediment, Instream Sediment, Nitrogen, Phosphorus
4A Drinking Water Quality	Observed: *E. coli* Predictive: Nitrogen, Phosphorus, Upland Sediment
4B Storage Capacity	Observed: None Predictive: Upland Sediment, Instream Sediment
5A Public Participation	Programmatic Indicators to be tracked by the County
5B Regional Coordination	Programmatic Indicators to be tracked the County
5C Aesthetics	Programmatic Indicators to be tracked the County

For predictive indicators, three scenarios were considered. Metrics and scores were calculated for:

- Existing Conditions
- Future without project implementation
- Future with project implementation

The future condition metrics and scores reflect the simulated conditions at ultimate build-out based on the County's Comprehensive Plan.

The watershed impact indicator scores were used at multiple stages of watershed planning. First, they were used to assess current and future conditions without project implementation in the watershed. Indicator scores were then used to identify management needs and problem areas during subwatershed ranking (see Section 2.3). Once candidate projects were identified, the indicators were used to prioritize projects alongside cost and feasibility.

2.2.2 Source Indicators

Source indicators were used to evaluate the sources and stressors that impact watershed processes. Examples include:

- Numeric Source Indicators

    - Amount of Channelized/Piped Streams
    - Amount of Directly Connected Impervious Area (DCIA) (predictive)
    - Amount of Impervious Surface (predictive)
    - Number of Stormwater Outfalls
    - Number of Sanitary Sewer Crossings
    - Streambank Buffer Deficiency
    - Total amount of Nitrogen (predictive)
    - Total amount of Phosphorus (predictive)
    - Total Suspended Solids (predictive)
- Field Reconnaissance Observations
    - Hot Spot Investigations
    - Neighborhood Source Assessments
    - All other field reconnaissance observations

The contributions of these indicators to existing and future watershed impacts were evaluated. Metrics and scores were developed for all source indicators under existing conditions. In addition, three scenarios were considered for the predictive indicators, as noted in the list above. Metrics and scores were calculated for these scenarios:

- Existing Conditions
- Future without project implementation
- Future with project implementation

The future condition metrics and scores reflect the simulated conditions at ultimate build-out based on the County's Comprehensive Plan.

Like the watershed impact indicators, source indicator scores were used to rank subwatersheds according to their problems and needs and to assist with candidate project identification.

2.2.3 Programmatic Indicators

Programmatic indicators will be used by the County to help evaluate watershed management needs. These indicators illustrate the extent and location of existing and past management efforts. The following types of management in the watershed were inventoried during plan development:

- Detention Facilities
- Stream Restoration
- Riparian Buffer Restoration
- BMP Facilities
- Low Impact Development
- Inspection and Maintenance of Stormwater Management Facilities
- Inspection and Repair of Stormwater Infrastructure and Outfalls
- Dumpsite Removal
- Regional Ponds
- Volunteer Monitoring
- Subarea Treatment (used in watershed modeling studies)

Information for these indicators will be considered to identify and evaluate watershed management needs for individual watersheds and for the County as a whole.

2.2.4 Composite Scores

After metric values were translated into scores, objective, composite and overall composite scores were calculated for use in subwatershed ranking. Weighting factors were used when calculating composite scores to give more importance to certain indicators and objectives. First, watershed impact indicators were grouped by objective. Each metric score was multiplied by a predetermined weighting factor specific to that indicator, and the products were summed within objectives to generate an objective composite score for each objective. Each objective composite score was then multiplied by a predetermined weighting factor specific to that objective, and the products were summed to generate an overall composite score. A similar process was used for source indicators, but without an objective composite score (since source indicators are not directly linked to objectives).

2.3 Subwatershed Ranking

The composite scores calculated under the methods previously described were used to identify problem areas in the watershed and rank subwatersheds for management priority. Subwatersheds were further categorized based on which management opportunities were most likely to restore functions to the problem areas identified. The resulting data were then utilized to identify key issues and select projects that would achieve the watershed planning goals and objectives.

The subwatershed ranking procedure involved reviewing watershed impact objective, composite, overall composite and source indicator scores. Since some of the indicators are predictive, i.e. based on modeling, it was possible to pose “what if?” questions and test future scenarios with and without management actions. Existing management facilities and programs which were inventoried for programmatic indicators and data collected during field reconnaissance were also considered. The ranking process consisted of the following steps:

1. Used the watershed impact overall composite scores and identified subwatersheds that were potential problem areas under existing and future conditions.
2. Used the watershed impact objective composite scores and identified subwatersheds that were potential problem areas under existing and future conditions for each objective.
3. Reviewed source indicator composite scores and identified additional problem areas.
4. Used individual source indicator scores to identify potential sources of impacts in downstream problem areas.
5. In combination with the above data, used the programmatic indicator data inventory to identify subwatersheds where management was most needed.
6. Consulted available field reconnaissance data throughout the above steps to confirm that results reflected conditions in the field.

All this information was combined to rank subwatersheds in order from the most problematic (higher priority for management actions) to the least problematic (lower priority for management actions). Subwatershed ranking provided guidance as to where management was most needed and could be applied successfully, but the final determination was ultimately based on best professional judgment.

2.4 Stormwater Modeling

Storm events are classified by the amount of rainfall, in inches, that occurs over the duration of a storm. The amount of rainfall depends on how frequently the storm will statistically occur and how long the storm lasts. Based on many years of rainfall data collected, storms of varying strength have been established based on the duration and probability of that event occurring within any given year. In general, smaller storms occur more frequently than larger storms of equal duration. Hence, a 2-year, 24-hr storm (having a 50 percent chance of happening in a given year) has less rainfall than a 10-year, 24-hr storm (having a 10 percent chance of happening in a given year). Stormwater runoff (which is related to the strength of the storm) is surplus rainfall that does not soak into the ground. This surplus rainfall flows (or ‘runs off’) from roof tops, parking lots and other impervious surfaces and is ultimately received by storm drainage systems, culverts and streams.

Modeling is a way to mathematically predict and spatially represent what will occur with a given rainfall event. There are two primary types of models that are used to achieve this goal; hydrologic and hydraulic:

- *Hydrologic models* take into account several factors; the particular rainfall event of interest, the physical nature of the land area where the rainfall occurs and how quickly the resulting stormwater runoff drains this given land area. Hydrologic models can describe both the quantity of stormwater runoff and resulting pollution, such as nutrients (nitrogen and phosphorus) and sediment that are transported by the runoff.
- *Hydraulic models* represent the effect the stormwater runoff from a particular rainfall event has on both man-made and natural systems. These models can both predict the ability man-made culverts/channels have in conveying stormwater runoff and the spatial extent of potential flooding.

Table 2-3 shows three storm events and the rationale for being modeled:

Table 2-3: Modeling Rationale

Storm Event	Modeling Rationale
2-year, 24-hr	Represents the amount of runoff that defines the shape of the receiving streams.
10-year, 24-hr	Used to determine which road culverts will have adequate capacity to convey this storm without overtopping the road.
100-year, 24-hr	Used to define the limits of flood inundation zones

2.4.1 Hydrologic Model (SWMM)

The Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) was first developed in the early 1970s. Over the past 30 years, the model has been updated and refined and is now used throughout the country as a design and planning tool for stormwater runoff. Specifically, SWMM is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas.

The runoff component of SWMM operates on a collection of subwatershed areas where rain falls and runoff is generated. The routing (or hydraulic) portion of SWMM transports this runoff through a conveyance system of pipes, channels and storage/treatment devices. SWMM tracks the quantity and quality of runoff generated within each subwatershed, and the flow rate and depth of water in the conveyance system during a simulation period.

2.4.2 Pollution Model (STEPL)

While the SWMM model can calculate pollutant loads, the Spreadsheet Tool for Estimating Pollutant Load (STEPL) was used to determine pollutant loads for the watershed planning effort. Also developed by EPA, STEPL employs simple algorithms to calculate surface runoff. This includes nutrient loads, such as nitrogen and phosphorus, and sediment loads from various land uses. STEPL also calculates load reductions that would result from the implementation of various Best Management Practices (BMPs). The nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff as influenced by factors such as land use distribution and management practices. Sediment loads are calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using known BMP efficiencies.

2.4.3 Hydraulic Model (HEC-RAS)

The Hydrologic Engineering Centers River Analysis System (HEC-RAS) hydraulic model was initially developed by the U.S. Army Corps of Engineers (USACE) in the early 1990s as a tool to manage the rivers and harbors in their jurisdiction. HEC-RAS has found wide acceptance as the standard for simulating the hydraulics of water flow through natural and/or manmade channels and rivers. HEC-RAS is commonly used for modeling water flowing through a system of open channels with the objective of computing water surface elevations.

The geographic input data for the HEC-RAS model was extracted using HEC-GeoRAS. HEC-GeoRAS is a tool that processes the geospatial data within the County's Geographic Information System, specifically as it pertains to physical features such as stream geometry and flow path so that these features can be represented in the model.

Using available County or Virginia Department of Transportation (VDOT) engineering data, bridge and culvert crossings were coded into the model to simulate the effect these facilities have on the water surface elevations or profile. Where data were not available, field reconnaissance was performed to obtain the crossing elevation data. This crossing data was determined relative to a point where the elevation could be estimated accurately from the County's topographic data. Manning's 'n' values, which represent surface roughness, were assigned to the channel and overbank portions of the studied streams based on field visits and aerial photographs.

The hydrologic flow input data and the locations where the flows change were extracted from SWMM. The 2-yr, 10-yr and 100-yr storm flow outputs were determined at several locations in order to provide a detailed flow profile for input into the HEC-RAS hydraulic model.

As stated previously, the 2-year storm discharge is regarded as the channel-forming or dominant discharge that transports the majority of a stream's sediment load and therefore actively forms and maintains the channel. A comparison of stream dynamics and channel geometry for the 2-year discharge provides insight regarding the relative stability of the system and helps to identify areas in need of restoration.

The 10-year storm discharge was included to analyze the level of service of bridge and culvert stream crossings. Occurring less frequently than the 2-year storm, the flood stage associated with this storm can result in more significant safety hazards to residents. All stream crossings (bridges and culverts) were analyzed against this storm to see if they performed at safe levels.

The 100-year storm discharge is used by the Federal Emergency Management Agency (FEMA) to delineate floodplain inundation zones in order to establish a Flood Insurance Rate Map (FIRM) for a given area. The 100-yr HEC-RAS models were built in compliance with FEMA standards and were included to map the limits of these floodplain inundation zones. This mapping provided a means to assess which properties are at risk to flooding by the 100-yr storm event.

2.5 Public Involvement Plan

A consistent approach for public involvement was important to enable comparisons among planning processes and final watershed management plans. Conversely, as each watershed has unique characteristics, the strategies employed must also address the diverse needs, interests and conditions of the watershed and its community. The principal goals for public involvement were:

- Increase community awareness and understanding of stormwater management
- Provide meaningful participation options for a diversity of stakeholders
- Incorporate community ideas into the scope of the watershed plans
- Strive for community support for the final plans

Recognizing the need for public acceptance of the final plans, County staff created a public involvement process with multiple feedback loops to facilitate informed participation by the public and key stakeholder groups at all development stages. The first step of the public involvement process was to host an Introductory and Issues Scoping forum that was open to all residents. The primary purpose of this forum was to solicit informed input on the development of the watershed management plan. Other objectives were to explain the planning process to the community and develop an initial list of watershed issues and concerns.

After the forum, stakeholder groups were invited to be part of a Watershed Advisory Group (WAG) for each plan. These were comprised of local stakeholders who represented various interests (HOA representatives, environmental groups, etc) and advised County staff about community outreach opportunities and key issues affecting their watershed and potential projects. They also were invited to comment on draft and final versions of the watershed management plan. Each WAG met with County staff five to six times throughout the plan development in order to provide guidance and comments at critical junctures of the process.

The WAG also provided support at the second public forum, the Draft Plan Review Workshop. The workshop provided the extended community with an opportunity to review the first draft of the watershed plan and provide input. Comments were collected at the end of a 30-day period and addressed as appropriate. The final plan was then adopted by the Board of Supervisors.

More information on the public involvement process including WAG meeting minutes, public forum meeting minutes and public comments and responses can be found in Appendix C.

3 Summary of Watershed Conditions

This watershed management plan combines an assessment of three non-contiguous watersheds: Belle Haven, Dogue Creek and the Fairfax County portion of the Four Mile Run watershed, into one document. These watersheds are located in southeastern and eastern Fairfax County as shown on Figure 3-1. The Dogue Creek watershed was divided into five Watershed Management Areas (WMAs). Due to their smaller size, the Belle Haven and Four Mile Run watersheds were not divided into WMAs and thus the entire watershed for each was treated as a single WMA. Watershed Management Area and subwatershed boundaries for these three watersheds are shown on Figures 3-3, 3-6 and 3-9. A summary of each watershed is discussed separately in the sections that follow. Detailed information regarding watershed conditions can be found in the Draft Belle Haven, Dogue Creek and Four Mile Run Watershed Workbook, dated January 2009, located in Appendix A.

Methods and background common to all three watersheds are discussed below.

Land Use and Imperviousness

Existing land use mapping was provided by Fairfax County, and was derived from property mapping and aerial photography. Future land use was also provided by the County and is based on zoning, land use plans and forecasts of expected development and redevelopment.

The acres of impervious surface in each watershed were calculated by WMA from Geographic Information System (GIS) planimetric layers provided by the County. Impervious surfaces include roads, parking lots, buildings, sidewalks and driveways.

Stream Monitoring

In 1999, Fairfax County established the Stream Protection Strategy (SPS) monitoring program, to assess the biological health of the County's streams. A baseline study was completed in 2001. One hundred fourteen sampling sites were established within the County; three were located in Dogue Creek, one in Belle Haven and one in Four Mile Run. The County maintains a continuous monitoring program which assesses the biological, chemical and physical health of the streams. This datum was used by several Watershed Impact Indicators.

In addition to monitoring conducted by County staff, the Northern Virginia Soil and Water Conservation District (NVSWCD) maintains a volunteer monitoring program throughout Fairfax County.

Stream Habitat and Geomorphology

To supplement the biological and habitat data collected by County staff, beginning in the fall of 2002, field crews conducted a detailed Stream Physical Assessment (SPA) on approximately 801 miles of streams throughout Fairfax County, including the Belle Haven, Dogue Creek and Four Mile Run watersheds. As part of the SPA, field crews conducted a physical habitat assessment, a geomorphologic assessment and collected infrastructure information for all streams with a drainage area greater than 50 acres.

303(d) List and TMDLs

The Commonwealth of Virginia is required to monitor Waters of the State and submit a report to EPA and the public every two years. The Virginia Department of Environmental Quality (DEQ) prepares and submits the 305(b)/303(d) Water Quality Assessment Integrated Report, which combines general water quality information required under Section 305(b) of the Clean Water Act with a report on impaired waters that do not meet the water quality standards required in Section 303(d).

The list of impaired waters in the Integrated Report (often referred to as the 303(d) List) specifically describes the locations of the listed water body and the cause and source of pollutants causing the impairment. Once a water body is listed as impaired, a plan is developed to restore the water. This plan takes into account the total amount of pollution a water body can assimilate, or a Total Maximum Daily Load (TMDL). The restoration plan is often referred to as a TMDL and is accompanied by a target year for restoration (referred to as a schedule). Impaired waters for which a TMDL is required are listed under Category 5 in the Impaired Waters Report. For more information on Virginia's monitoring program, visit DEQ's page at www.deq.state.va.us/wqa/homepage.html. For more information on the TMDL program in Virginia, visit DEQ's page at www.deq.virginia.gov/tmdl/homepage.html. Watershed specific information on 303(d) and TMDLs are included in the sections that follow.

HSI/NSA Field Investigations

Field reconnaissance was conducted to update and supplement existing Fairfax County geographic data so current field conditions were accurately represented. This information was used to update watershed GIS data for subsequent analysis. The reconnaissance effort included the identification of current stormwater management facilities, potential restoration opportunities and identification of pollution sources at a representative sample of commercial, industrial, and residential areas using the Center for Watershed Protection's Hotspot Site Investigation (HSI) and Neighborhood Source Assessment (NSA).

<u>Hotspot Site Investigation</u>. The Hotspot Site Investigation was conducted to evaluate the pollution-producing behaviors at commercial hotspots (e.g., gas stations, restaurants, industrial areas, etc.) The goal was to quickly identify areas where stormwater pollution is generated and identify ways to mitigate it. A subsample of potential hotspots within each watershed was assessed. At each site, field crews evaluated various site practices, including vehicle operations, outdoor material storage, waste management, condition of the building, parking and landscaped areas and stormwater infrastructure.

<u>Neighborhood Source Assessment</u>. The Neighborhood Source Assessment is used to evaluate the pollution-producing behaviors in residential areas. A subsample of neighborhoods within each watershed was assessed. Field crews used a windshield survey method to get a sense of general neighborhood characteristics, such as the location of downspouts, turf management, curb and gutter condition and the amount of forest canopy. Where needed, the neighborhood was split into multiple areas when one portion of the neighborhood had significantly different characteristics.

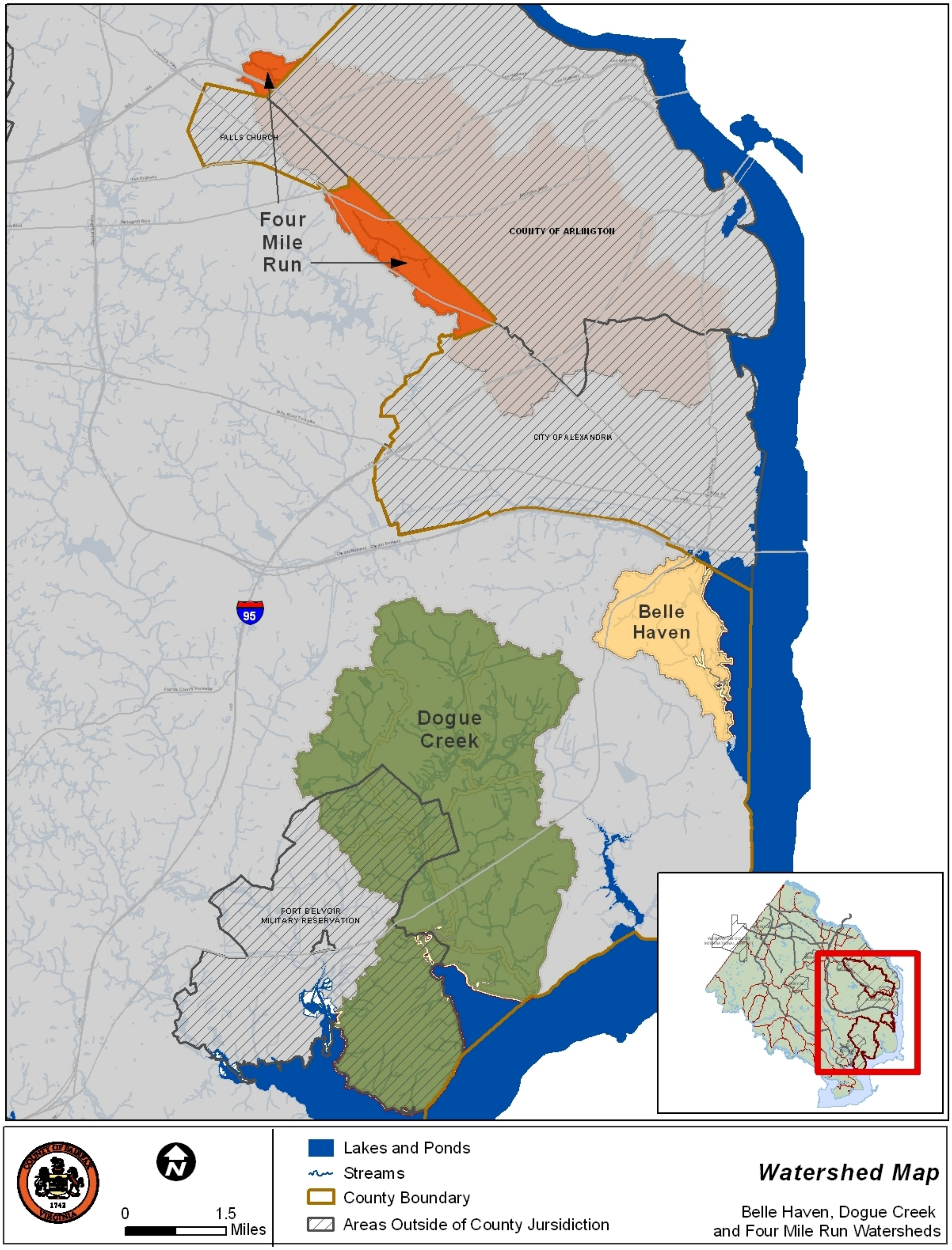

Figure 3-1: Watershed Location Map

3.1 Belle Haven Watershed

The Belle Haven watershed is approximately 2.7 square miles and is part of the Potomac River Basin. As shown in Figure 3-3, the main waterway within the watershed is Hunting Creek (known locally as Quander Brook), which flows for nearly two miles in a northeastern direction from its headwaters near the junction of the Richmond Highway and Beacon Hill Road to its confluence with Cameron Run just upstream of the mouth of Cameron Run where it flows into the Potomac River near the Woodrow Wilson Bridge. The two other principal waterways in the watershed are direct tributaries to the Potomac River, one flowing northeast parallel to and east of Hunting Creek and draining to tidewater, and the other, known as Belle Haven, consisting of three branches flowing southeast to the Potomac River. There are 166 acres of wetlands, the majority of which are freshwater emergent or forested/shrub wetlands.

3.1.1 Land Use and Imperviousness

Approximately 69 percent of the watershed is developed with the majority, 41 percent, in various residential land uses. Current and future land uses are shown on Figure 3-4, Belle Haven Land Use Map. Commercial areas are primarily located along North Kings Highway and Richmond Highway in the northwestern portion of the watershed. Existing imperviousness is 32 percent and is expected to increase by approximately 1.5 percent from future development. Several environmental problems have been accelerated by development, including increased stream erosion and stream sedimentation due to concentrated points of stormwater runoff.

County records indicate that there are 20 stormwater management facilities within the Belle Haven WMA. These facilities provide control for five percent of the WMA. There are no existing or proposed regional ponds for the Belle Haven watershed.

3.1.2 Stream Monitoring

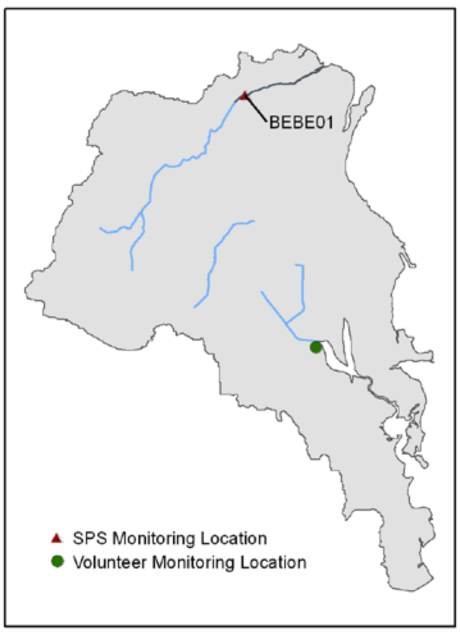

Figure 3-2: SPS baseline and volunteer sampling sites – Belle Haven watershed

There was one site sampled during the SPS Baseline Study. The site, BEBE01, is located on Hunting Creek, as shown on Figure 3-2, and the results are listed in Table 3-1. The composite condition rating for this site was very poor. This site received some of the lowest scores of the entire coastal plain system in Fairfax County. The high level of impervious area and the limited stormwater controls implemented when this watershed was initially developed are likely contributing to poor habitat quality. The most significant problem noted in the SPS Study was the limiting of habitat quality by sediment deposition.

Available County water quality data indicated that water quality fell within acceptable levels for all collected parameters including temperature, dissolved oxygen, specific conductance and pH.

There are no known active monitoring sites in the Belle Haven watershed under the Northern Virginia Soil and Water Conservation District program. There was one site for which no data was available.

Table 3-1: Stream Protection Strategy baseline data summary – Belle Haven

Stream Name (Site Code)	Composite Site Condition Rating	Environmental Variables		
		Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Belle Haven (BEBE01)	Very Poor	Very Poor	Very Poor	Very Low

Source: SPS Baseline Study Report, 2001.

3.1.3 Stream Habitat and Geomorphology

There were two miles of stream assessed in the Belle Haven watershed with all habitat rated as fair to very poor. Physical evaluations of the stream channels resulted in classifying all channels as Channel Evolution Model, Stage III, indicating unstable channels with severe bank erosion. Based on the habitat score, the Belle Haven watershed is the poorest quality watershed in the County.

There were 38 inventory points collected for the infrastructure inventory. The majority of these points were areas of buffer encroachment or locations of storm drain pipes where stormwater enters the stream. The most severe of these points were three buffer points, one obstruction and one erosion point all rated as having a severe impact on the stream system.

In 2008, the US Army Corps of Engineers completed a Flood Damage Reduction Analysis study to examine various alternatives to reduce flooding in the New Alexandria and Belle View subdivisions in the central portion of the Belle Haven watershed. The Corps performed a preliminary investigation and five percent level concept plans but stopped short of conducting a risk and uncertainty analysis required to receive federal funding. As a result of this study, the Corps determined that a floodwall/levee combination with an interior pumping station would be both feasible and cost-effective, with annualized economic benefits outweighing annualized project costs. These costs were estimated to be $12.7 million (escalated to FY 2010 dollars) and would provide a levee/floodwall around the New Alexandria and Belle View communities with a top of protection to elevation 12 feet. The study is available on the Fairfax County Government's website at: www.fairfaxcounty.gov/dpwes/publications/stormwater/bellehavenfinalreport.pdf. For more information, please call the Fairfax County Stormwater Planning Division at 703-324-5500, TTY 711.

3.1.4 Water Quality

Fairfax County Sampling Available County data in the Belle Haven watershed, ranging from August 1999 to March 2006 indicated no sites for which water quality fell outside of acceptable limits. There are no County Health Department sampling sites in the Belle Haven watershed.

303(d) List and TMDLs There were no stream segments in the Belle Haven watershed listed by DEQ as impaired and no TMDLs are scheduled for development or implementation. General information about the TMDL program is presented at the beginning of Section 3.

HSI/NSA Field Investigations In 2009, field crews conducted seven Hotspot Site Investigations and assessed nine neighborhoods to determine potential runoff pollution sources and identify potential treatment practices. Two of sites investigated were determined to be possible hotspots. Of the assessed neighborhoods, overall there was good potential for onsite retrofits of drainage system and only one neighborhood had potential for sediment pollution. Detailed results of the hotspot and neighborhood assessments are discussed in Draft Watershed Workbook found in Appendix A.

Modeling Results The pollutant load model (STEPL) showed that three subwatersheds on the northern end of the WMA had the highest modeled pollutant loads, based primarily on medium and high-density residential development. The best quality subwatershed is on the southeast side of the WMA, containing open space.

The ranking procedure described in Section 2.3 was used to determine the relative condition of the subwatersheds in the Belle Haven watershed. The average existing conditions composite score ranking was 4.37 out of 10, where the worst condition subwatershed scored 3.10 and the best scored 6.03. All the Belle Haven subwatersheds were ranked in the lower half when all three watersheds were considered as a group.

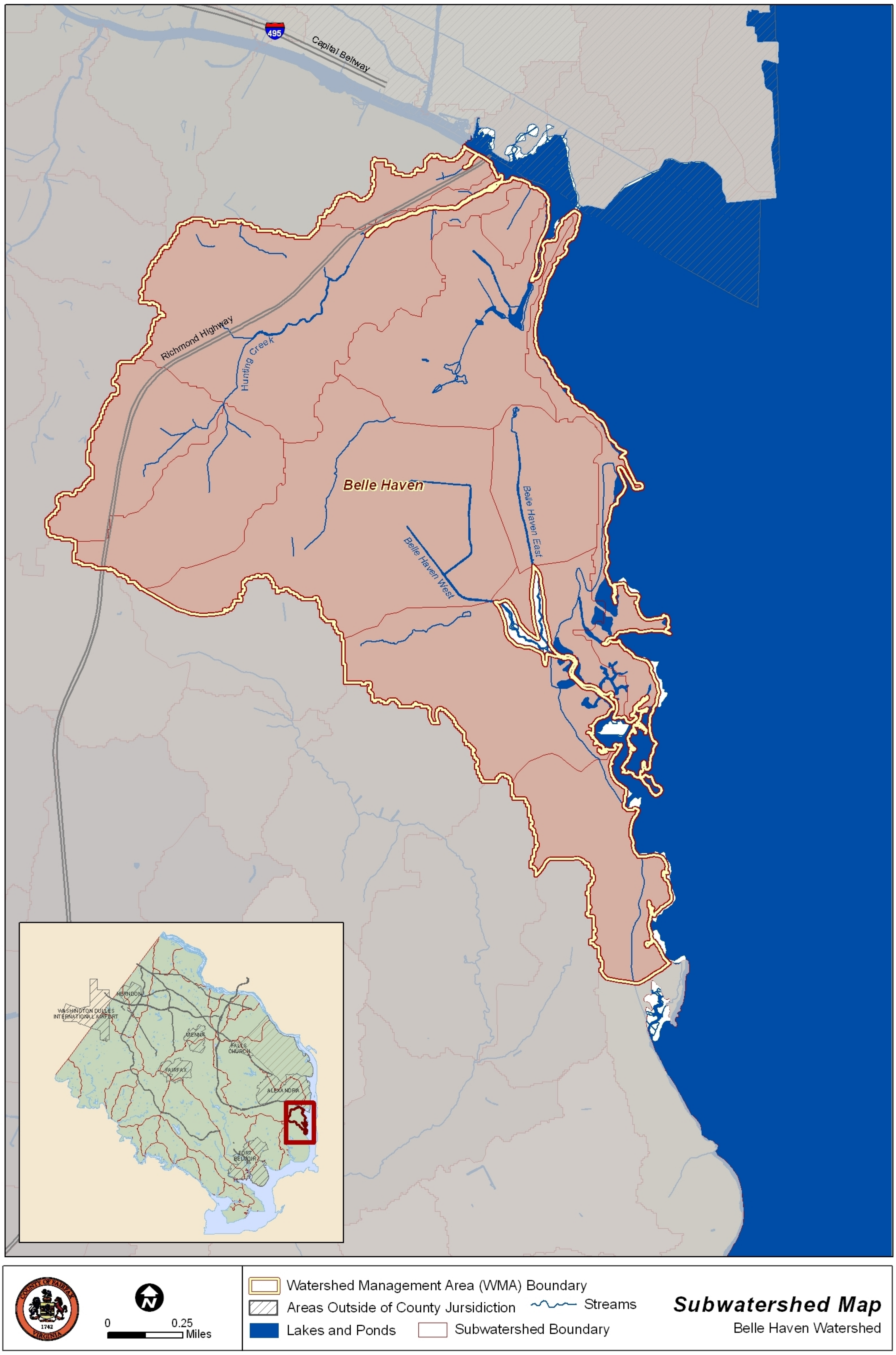

Figure 3-3: Belle Haven Watershed Map

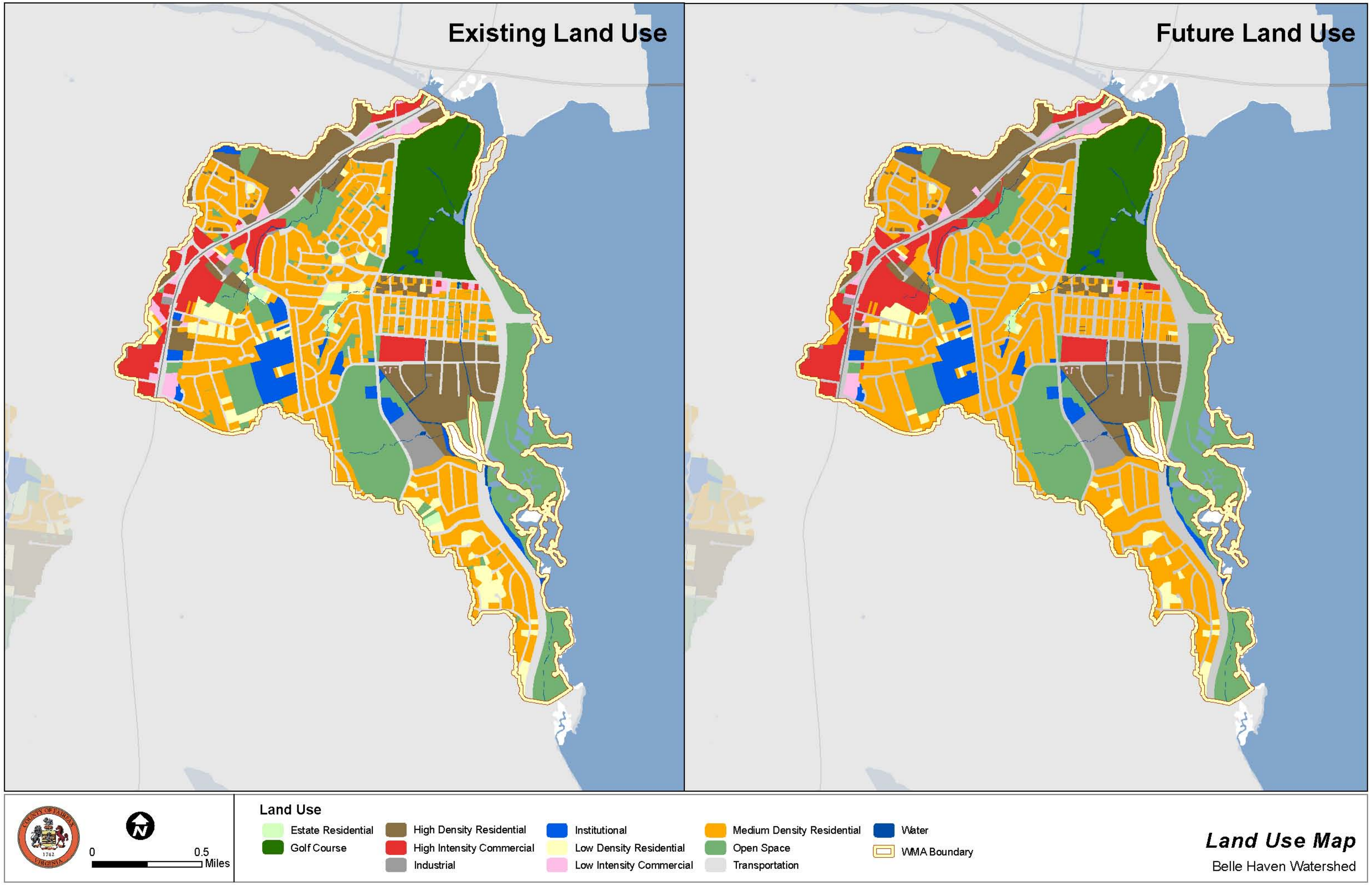

Figure 3-4: Belle Haven Land Use Map

3.2 Dogue Creek Watershed

The Dogue Creek watershed is approximately 19.5 square miles with 6.3 square miles (32 percent) of the watershed located in areas outside of the County jurisdiction in the Fort Belvoir Military Reservation (30 percent) and other US government installations (2 percent), as seen in Figure 3-6. The Dogue Creek watershed is part of the Potomac River Basin and contains about 32 miles of stream divided among five Watershed Management Areas (WMAs): Barnyard Run, Mainstem, North Fork, Piney Run and Potomac, shown in Table 3-2, below. The Potomac WMA is predominantly within the boundaries of Fort Belvoir Military Reservation and is not included in this plan.

Table 3-2: WMAs in the Dogue Creek watershed

WMA	WMA Area (ac)	WMA Area (sq mi)	Stream Length (mi)
Barnyard Run	1,529	2.4	5.3
Mainstem	3,776	5.9	10.2
North Fork	2,806	4.4	9.8
Piney Run	1,736	2.7	6.6
Potomac	2,629	4.1	4.3
Total Watershed	**12,476**	19.5	31.9

The mainstem of Dogue Creek flows for six miles in a southerly direction from its headwaters near the intersection of Franconia Road and South Van Dorn Street to the Dogue Creek Estuary and Potomac River near Fort Belvoir. The principal tributaries to Dogue Creek are Barnyard Run, which drains to the southwest into Dogue Creek within Huntley Meadows Park; Piney Run, which drains southeast into Dogue Creek near Kingman Road within Fort Belvoir; and North Fork, which drains southeast and east into Dogue Creek at Mount Vernon Memorial Highway. There is also direct drainage to the tidal portions of Dogue Creek and the Potomac River in areas of the watershed downstream of the confluence.

3.2.1 Land Use and Imperviousness

Approximately 70 percent of the watershed is developed, primarily in the headwaters of Dogue Creek, Barnyard Run and Piney Run, as well as most of the North Fork subwatershed. Current and future land use for the watershed is shown on Figure 3-7. Most of the development took place after the Flood Plain Ordinance of 1959, which preserved stream valleys and floodplains as open space and limited flooding of habitable buildings. Development west of Telegraph Road is more recent, having primarily been developed since 1980 with high-density residential housing.

There are two significant commercial areas: Kingstowne Towne Center and the Festival at Manchester Lakes Shopping Center in the northwestern portion of the watershed. There are also commercial areas along Route 1 in the southeastern portion of the watershed. The watershed is essentially built out. Only 3.5 percent of the land use is forecast to change.

There are 888 acres of wetlands in the Dogue Creek watershed, according to National Wetland Inventory (NWI) data. Of this, approximately 690 acres are freshwater forested or shrub wetlands, primarily located in Huntley Meadows Park in the Mainstem and Barnyard Run WMAs. The large areas of undeveloped land on Fort Belvoir Military Reservation and Huntley Meadows Park help to protect the overall quality of the mainstem of Dogue Creek. This is in contrast to neighboring watersheds with much higher levels of impervious cover.

The Fairfax County Park Authority, which owns and manages Huntley Meadows Park, is currently restoring the central wetlands of the park to its previous, more water-filled condition. Goals of the project are to preserve the biodiversity of this non-tidal marsh, the only marsh of its type in Fairfax County. The project design will take into account site-specific factors and will be maintainable by park staff and useable by visitors to the park. Currently the area is in the beginning stages of survey, with flagging and stakes marking existing wetland boundaries and areas that will be disturbed by construction. No projects have been proposed within the Park boundaries because of the ongoing restoration.

Overall, the Dogue Creek watershed is 19 percent impervious as shown in Table 3-3. Imperviousness among the WMAs in the watershed ranges from 11 percent in the Potomac WMA to 27 percent impervious in the North Fork WMA. Imperviousness across the watershed is expected to increase by approximately 1.5 percent due to future development.

Table 3-3: Dogue Creek watershed imperviousness

WMA	Total Area (ac)	Impervious Area (ac)	Percent Impervious
Barnyard Run	1,529	194	12.7
Mainstem	3,776	784	20.8
North Fork	2,806	769	27.4
Piney Run	1,736	396	22.8
Potomac	2,629	282	10.7
Total Watershed	**12,476**	**2,425**	**19.4**

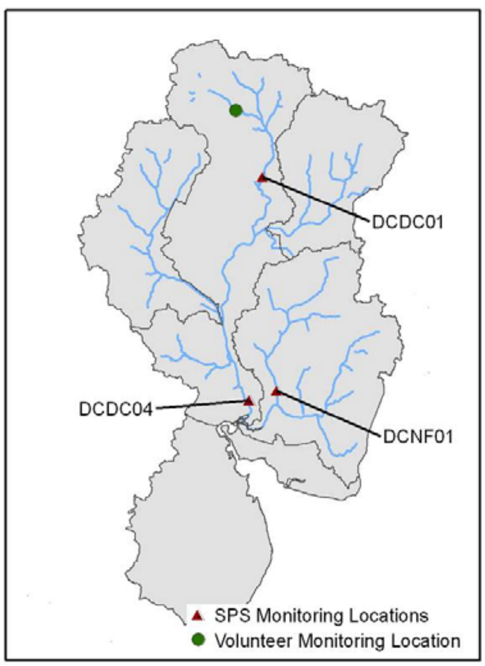

Figure 3-5: SPS baseline and volunteer sampling sites - Dogue Creek watershed

County records indicate that there are 123 stormwater management facilities within the Dogue Creek watershed. These facilities provide control for 12 percent of the area. There are two existing regional ponds in the watershed, one in the North Fork WMA and one in the Mainstem WMA. More information on these ponds can be found in Section 4.3.

3.2.2 Stream Monitoring

The results of the data collected from the three SPS baseline study sampling sites within the Dogue Creek watershed are shown in Table 3-4 (listed generally upstream to downstream). SPS monitoring locations are shown on Figure 3-5. Composite condition ratings for sites in the watershed ranged from poor (in the North Fork WMA at site DCNF01) to good at the two Dogue Mainstem WMA sites. Habitat was fair at all three sites, but sampling of biological health varied from good at the upstream Dogue Mainstem site, DCDC01 (where fish taxa richness was also high) to very poor at the North Fork site. Goldfish, an exotic species, were noted throughout the Dogue Creek stream system, with naturalized populations present in both the mainstem of Dogue Creek and in the North Fork tributary. The most significant problem noted in the SPS Study was the limiting of habitat quality by sediment deposition.

The large areas of undeveloped land on Fort Belvoir Military Reservation and Huntley Meadows Park help to protect the overall quality of the mainstem of Dogue Creek. This is in contrast to neighboring watersheds with much higher levels of impervious cover. However, future development and redevelopment of Fort Belvoir as part of the Base Realignment and Closure (BRAC) may impact the overall quality of Dogue Creek, especially if forested areas are removed as part of the process.

There is one NVSWCD monitoring site in the Dogue Creek watershed, as shown in Figure 3-5. This site is located on a tributary to the mainstem of Dogue Creek near its headwaters and received a rating of unacceptable. A separate volunteer monitoring program conducted within Huntley Meadows Park indicates good habitat with only a few problem areas.

Table 3-4: Stream Protection Strategy baseline data summary – Dogue Creek

Stream Name (Site Code)	Composite Site Condition Rating	Environmental Variables		
		Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Dogue Creek 1 (DCDC01)	Good	Good	Fair	High
North Fork 1 (DCNF01)	Poor	Very Poor	Fair	Low
Dogue Creek 2 (DCDC04)	Good	Fair	Fair	Moderate

Source: SPS Baseline Study Report, 2001. Sites are generally ordered from upstream to downstream.

3.2.3 Stream Habitat and Geomorphology

In 2002, habitat was assessed on approximately 17 of the 32 miles of stream within the Dogue Creek watershed. Of the assessed reaches, three miles (nine percent) of stream were rated as good, nine miles (28 percent) as fair and five miles (16 percent) as poor for habitat conditions. There were no reaches rated as excellent. In comparison with the rest of the County, the Dogue Creek watershed is in the lower range of quality.

The Channel Evolution Model resulted in classifying approximately 50 percent of the channels in the Dogue Creek watershed as Stage III, indicating unstable stream channels experiencing severe bank erosion. Most of the remainder of the watershed was categorized as Stage IV, indicating the stream channels are beginning to recover after disturbance.

3.2.4 Water Quality

Fairfax County Sampling Available County data within the Dogue Creek watershed, ranging from July 1999 to September 2006, including SPS Baseline and continued DPWES monitoring, indicated one site on Dogue Creek Mainstem and one site along the North Fork each had a pH reading below the acceptable range of 6.0.

For health department data collected between 2000 and 2002 at the single sampling site in the Dogue Creek watershed, there was only one occurrence where pH was outside of criteria limits out of a total of 53 samples. All temperature readings were within required limits. Criteria exceedance for dissolved oxygen was higher, with 13 percent (seven samples) below the allowable dissolved oxygen limit. Fecal coliform samples exceeded the maximum allowable limit of 200 bacteria per 100 ml of water for 89 percent of the samples collected between 2000 and 2002, with the maximum reading in September of 2001 at 3100 colonies per 100 mL of water.

303(d) List and TMDLs DEQ listed portions of the streams in the Dogue Creek watershed as impaired waters, as shown in Table 3-5. General information about the TMDL program is presented at the beginning of Section 3.

Table 3-5: Dogue Creek Watershed impaired water bodies

Impairment Code	**Location**	**Impairment**	**Year Listed**	**TMDL Schedule**
A14E-02-BAC	Segment includes all tidal waters of Dogue Creek, extending from approximately river mile 2.1 until the confluence with the Potomac River.	*Escherichia coli*	2006	2022

HSI/NSA Field Investigations In 2009, field crews conducted 32 Hotspot Site Investigations and assessed 10 neighborhoods in the Dogue Creek watershed to determine potential runoff pollution sources and identify potential treatment practices. As a result of this investigation, there were five confirmed hotspots and 21 potential hotspots identified. Neighborhoods generally lacked stormwater treatment and stenciled storm drains. Table 3-6 provides a summary of the sites investigated for each WMA. Detailed results of the hotspot and neighborhood assessments are discussed in the Draft Watershed Workbook in Appendix A.

Table 3-6: Dogue Creek HSI/NSA results

WMA	**HSI**	**NSA**	**Confirmed Hotspots**	**Potential Hotspots**	**NSA Result**
Barnyard Run*	n/a	n/a	n/a	n/a	
Mainstem	10	2	2	6	Lacked stormwater treatment and stenciled storm drains.
North Fork	19	7	2 (1 severe)	14	Lacked stormwater treatment and stenciled storm drains; rooftops drained to impervious surfaces.
Piney Run	3	1	1	1	Lacked stormwater treatment and stenciled storm drains.
Total	**32**	**10**	**5**	**21**	

* The Barnyard Run WMA is primarily forested. There were no potential hotspots or neighborhoods identified during desktop analysis that required field investigation.

Modeling Results The northern end of the Dogue Creek watershed, specifically the northern end of the Mainstem and Piney Run WMAs and the northern portion of the North Fork WMA, show the highest modeled pollutant loads for total nitrogen, total phosphorus and total suspended solids. The best quality areas based on pollutant load modeling (STEPL) are in the southern portion of the Barnyard Run WMA, associated with Huntley Meadows, and the central and southern portions of Piney Run.

Of the three watersheds evaluated in this Plan (Belle Haven, Dogue Creek and Four Mile Run), Dogue Creek showed to be in the best condition, showing the influence of Huntley Meadows Park and the undeveloped area in Fort Belvoir. The average existing conditions composite score ranking for the subwatershed was 5.51 out of 10, where the worst condition subwatershed scored 3.72 and the best scored 7.51.

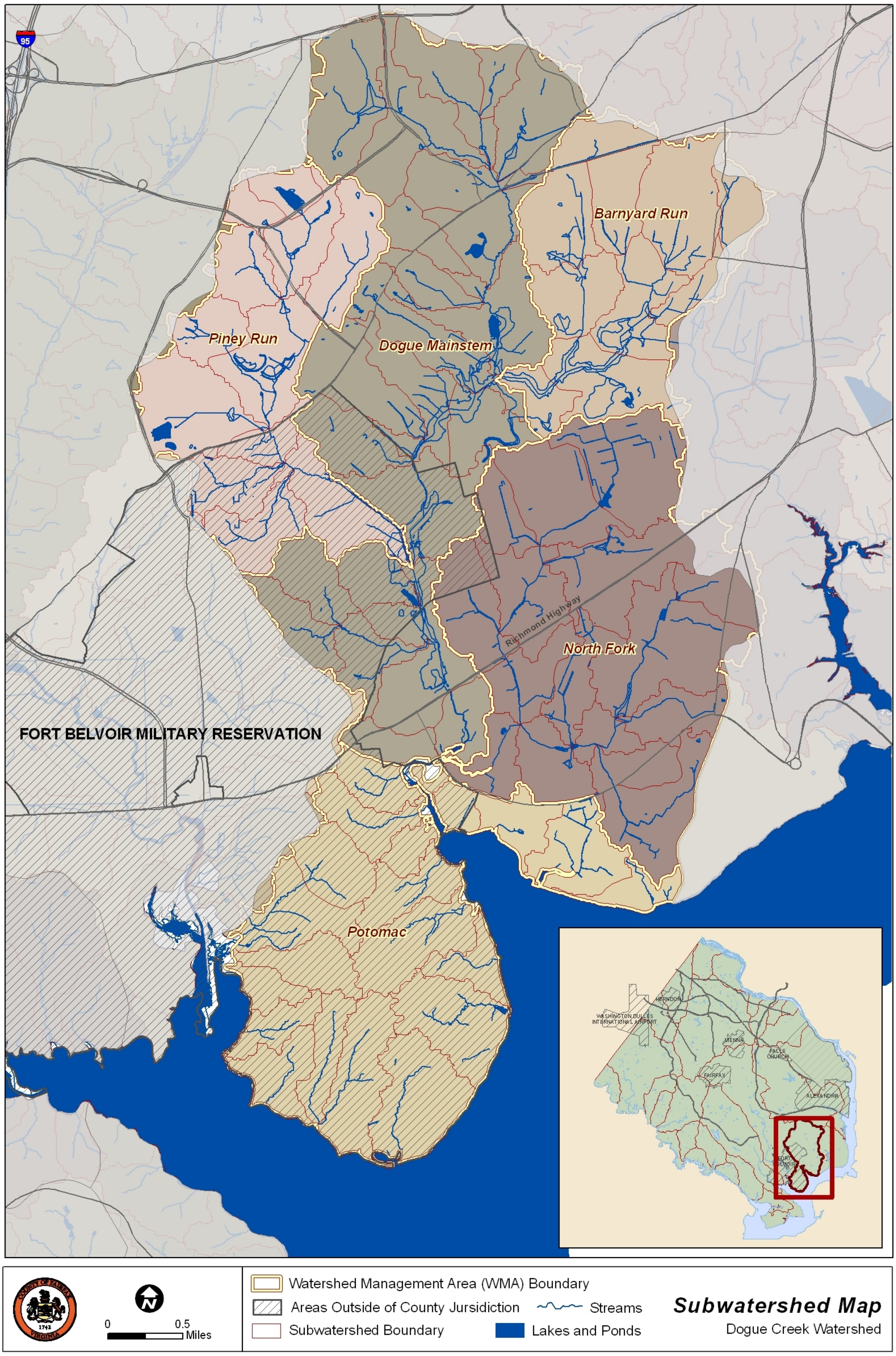

Figure 3-6: Dogue Creek Watershed Map

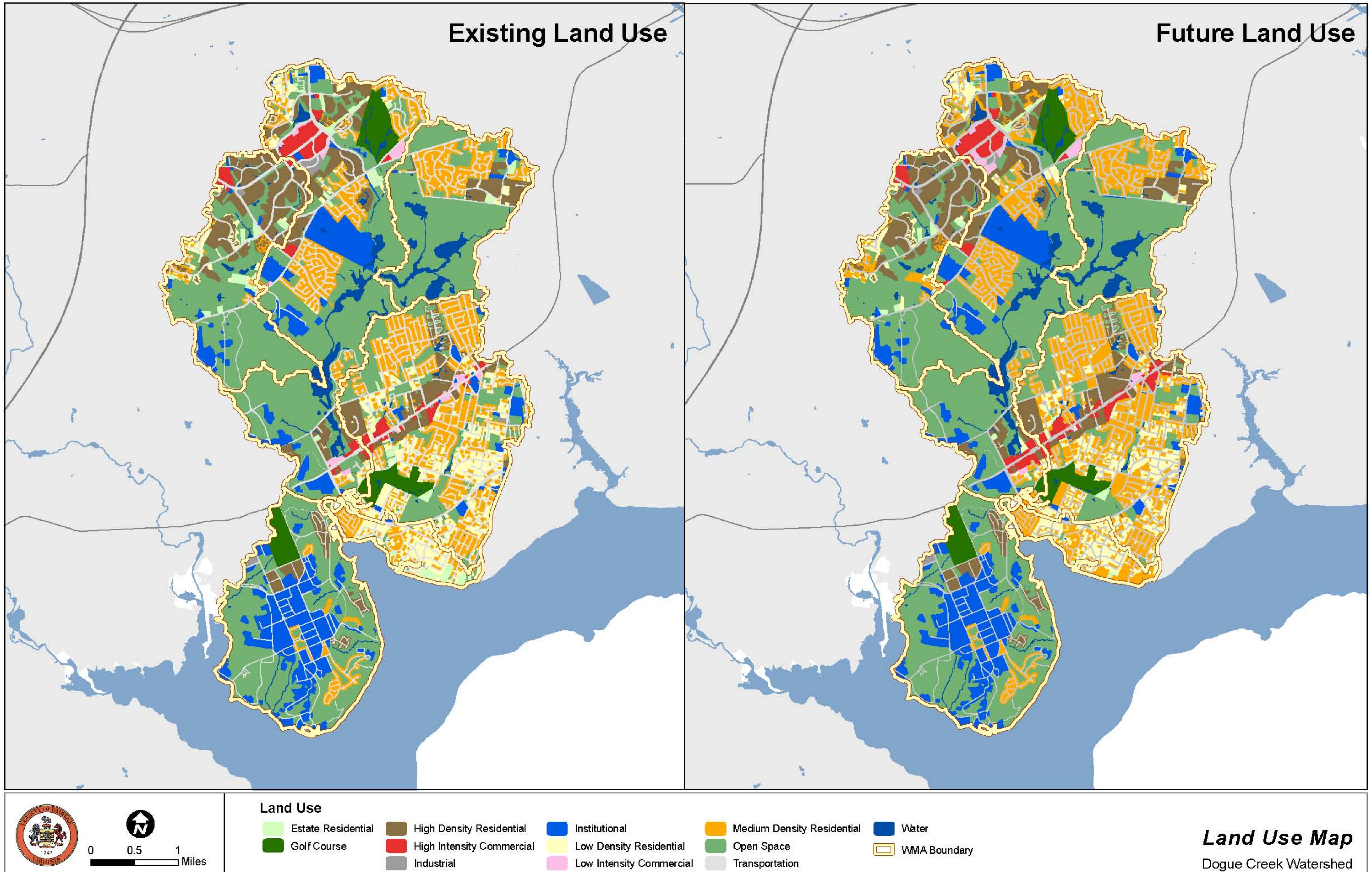

Figure 3-7: Dogue Creek Land Use Map

3.3 Four Mile Run Watershed

The Four Mile Run watershed is approximately 20 square miles with 17 square miles of the watershed located in areas outside of Fairfax County jurisdiction in the City of Falls Church, City of Alexandria and Arlington County, as shown on Figure 3-9. This plan will focus only on the portion of Four Mile Run located within Fairfax County (approximately 3.1 square miles), which includes the headwaters of Four Mile Run and Upper Long Branch which flows into Arlington County. Throughout this report, when the term Four Mile Run watershed is used, it refers to only the portion of Four Mile Run within the study area as described above.

The headwaters of Four Mile Run flow for 0.3 miles in a southeastern direction from its origin near I-66 and Westmoreland Street to the edge of the study area where it leaves Fairfax County jurisdiction. Long Branch flows for 1.5 miles in a southeastern and eastern direction from its headwaters near Leesburg Pike and Arlington Boulevard to the boundary with Arlington County. As with the Belle Haven watershed, the Fairfax County portion of the Four Mile Run watershed was not subdivided into WMAs so that the entire watershed is one WMA.

3.3.1 Land Use and Imperviousness

Approximately 95 percent of the watershed study area is developed, with only small portions of open space along the headwaters of Four Mile Run and the mainstem of Upper Long Branch. Current and future land use for the watershed is shown on Figure 3-10. The Four Mile Run watershed is 36 percent impervious and is expected to increase by approximately 1.5 percent from future development. Several environmental problems have been accelerated by the high level of development including increased stream erosion and stream sedimentation due to concentrated points of stormwater runoff.

Commercial areas in the Four Mile Run watershed are situated in two areas: Seven Corners and Bailey's Crossroads. Significant redevelopment of these areas can be expected as part of the County's revitalization plan. Redevelopment is not expected to change the land use, but it may provide opportunities for stormwater and watershed improvements as part of a coordinated plan.

County records indicate that there are 80 stormwater management facilities within the Fairfax County portion of the Four Mile Run watershed. These facilities provide control for 14 percent of the WMA. There are no existing or proposed regional ponds for this watershed.

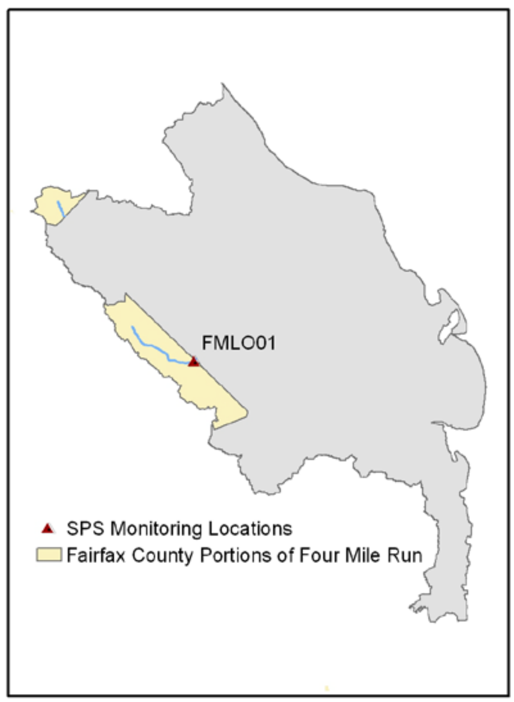

Figure 3-8: SPS baseline and volunteer sampling sites - Four Mile Run watershed

3.3.2 Stream Monitoring

There was one site sampled during the SPS Baseline Study. The site, FMLO01, is located on Upper Long Branch, as shown on Figure 3-8, and the results are listed in Table 3-7. The composite condition rating for the sampling site was very poor. Habitat was very poor and fish taxa richness was very low with the sample dominated by tolerant species. The index of biotic integrity was poor. Stream modification was noted as a significant problem in the Four Mile Run watershed. Many streams have been modified to allow large amounts of stormwater to be quickly conveyed. This results in many streams with banks stabilized by concrete, rip-rap and gabion. Due to the highly urbanized nature of this watershed, in some areas stream reaches are conveyed through a series of pipes and concrete channels.

There are no known volunteer sampling sites in the Fairfax County portion of the Four Mile Run watershed.

Table 3-7: Stream Protection Strategy baseline data summary – Four Mile Run

Stream Name (Site Code)	Composite Site Condition Rating	Environmental Variables		
		Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Four Mile Run (FMLO01)	Very Poor	Poor	Very Poor	Very Low

Source: SPS Baseline Study Report, 2001.

3.3.3 Stream Habitat and Geomorphology

Upper Long Branch extends for approximately 1.5 miles. Of the assessed length, 60 percent was considered to be recovering from disturbance while the remaining 40 percent was actively eroding. The dominant substrate was gravel along the entire assessed reach and habitat ranged from fair to poor. In comparison with the rest of Fairfax County, the Four Mile Run watershed falls in the lower range of quality with issues of poor bank stability and buffer zone width.

3.3.4 Water Quality

Fairfax County Sampling There is one Fairfax County Health Department sampling site in the Four Mile Run watershed. Of the 54 samples collected to test fecal coliform at this site between 2000 and 2002, fecal coliform levels exceeded the allowable criteria limit for 41 samples (76 percent).

303(d) List and TMDLs DEQ listed portions of the streams in the Four Mile Run watershed as impaired waters, as shown in Table 3-8 General information about the TMDL program is presented at the beginning of Section 3.

Table 3-8: Four Mile Run impaired water bodies

Impairment Code	Location	Impairment	Year Listed	TMDL Schedule
A12R-01-BAC	Segment begins at the headwaters of Four Mile Run and continues downstream until river mile 1.46, approximately 0.27 river miles upstream from the Arlington Ridge Road bridge. Segment includes non-tidal waters of Four Mile Run.	*Escherichia coli*	1994	Completed, 2002
A12R-01-BAC	Segment includes the tidal waters of Four Mile Run; from river mile 1.46 downstream until the confluence with the Potomac River,	*Escherichia coli*	1996	2010

Impairment Code	Location	Impairment	Year Listed	TMDL Schedule
	at the state line.			

HSI/NSA Field Investigations In 2008, field crews conducted 19 Hotspot Site Investigations and assessed eight neighborhoods in the Four Mile Run watershed to determine potential runoff pollution sources and identify treatment practices. The Hotspot Site Investigation resulted in two confirmed hotspots, 13 potential hotspots and four sites that were determined not to be a hotspot. Neighborhoods generally lacked stormwater treatment and storm drains were either lacking or not stenciled. Detailed results of the hotspot and neighborhood assessments are discussed in the Draft Watershed Workbook in Appendix A.

Modeling Results The pollutant load model (STEPL) showed that pollutant loads for Four Mile Run were high for total suspended solids, total nitrogen and total phosphorus. The highest modeled loads correspond with heavily developed commercial areas while the lowest correspond with high-density residential areas.

The average existing conditions composite score ranking for Four Mile Run was 4.42 out of 10, where the worst condition subwatershed scored 3.55 and the best scored 5.86. Of the three watersheds in the Plan, Four Mile Run ranked slightly better than Belle Haven but poorer than Dogue Creek.

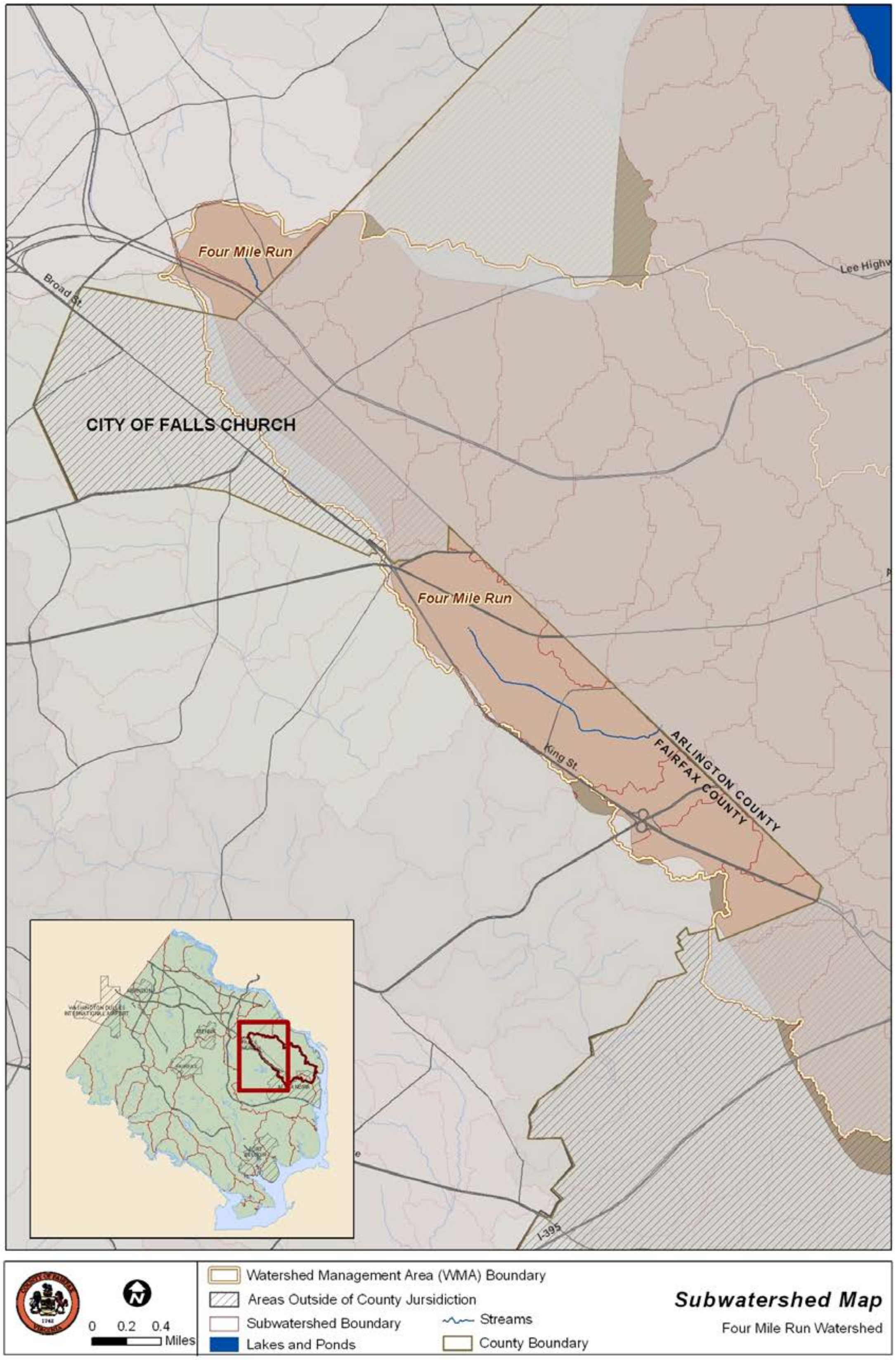

Figure 3-9: Four Mile Run Watershed Map

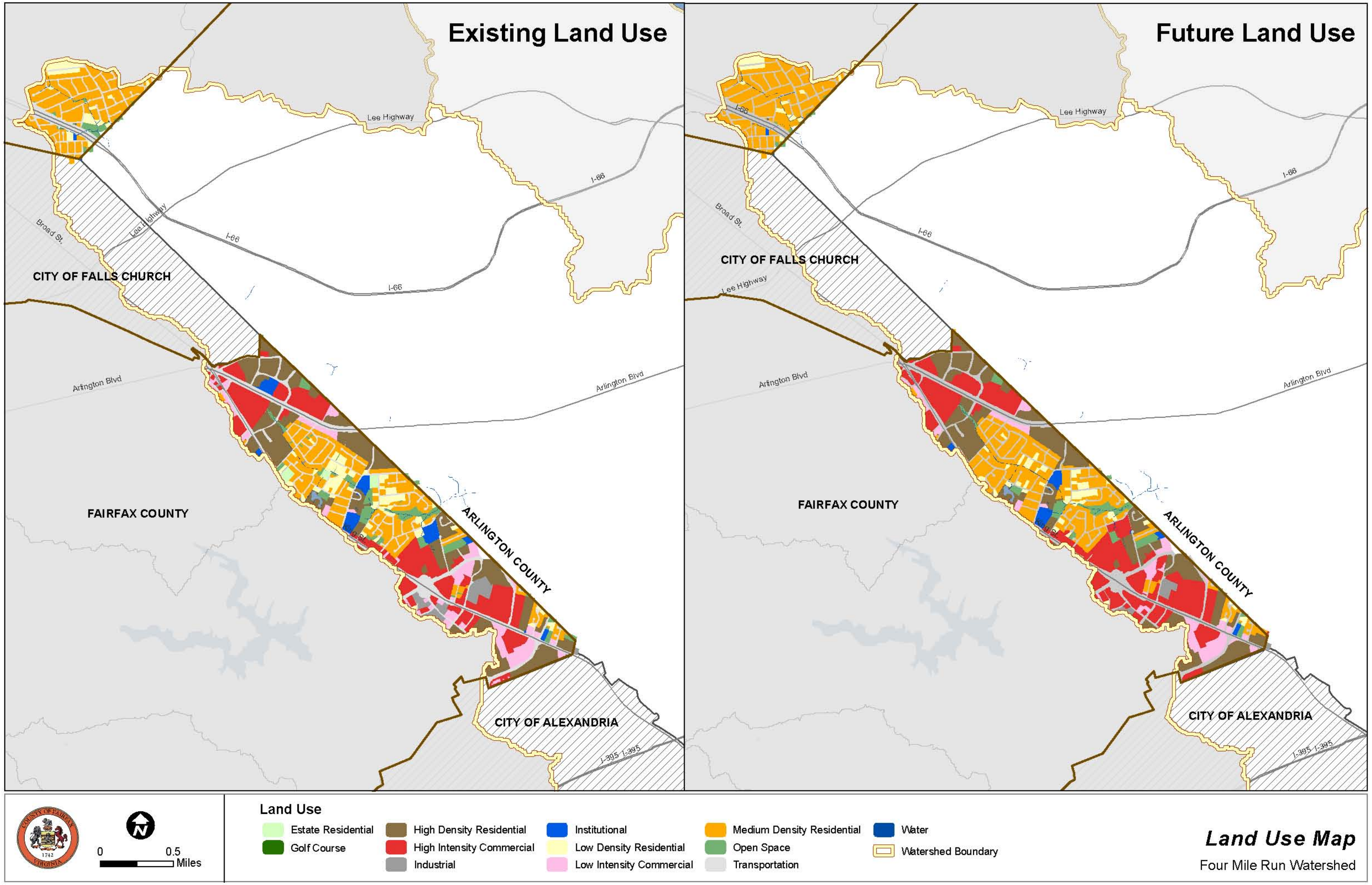

Figure 3-10: Four Mile Run Land Use Map

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3.4 Subwatershed Ranking

The subwatershed ranking procedure described in Section 2.3 was performed on all three watersheds as if they were a single entity. A short description of the subwatershed scores for each of the watersheds is provided in the separate watershed discussions above. Figure 3-11 shows the results of the ranking through color gradation between green (best) to red (worst). Of the three watersheds, Belle Haven's subwatersheds scored the lowest, with an average score of 4.37 out of 10.0. The Four Mile Run subwatersheds ranked slightly better than those in Belle Haven, with an average score of 4.42. Dogue Creek had the highest quality subwatersheds and overall best average score of 5.51. The results of the subwatershed ranking were an integral part of identifying the highest priority projects for restoring the watershed and stream systems.

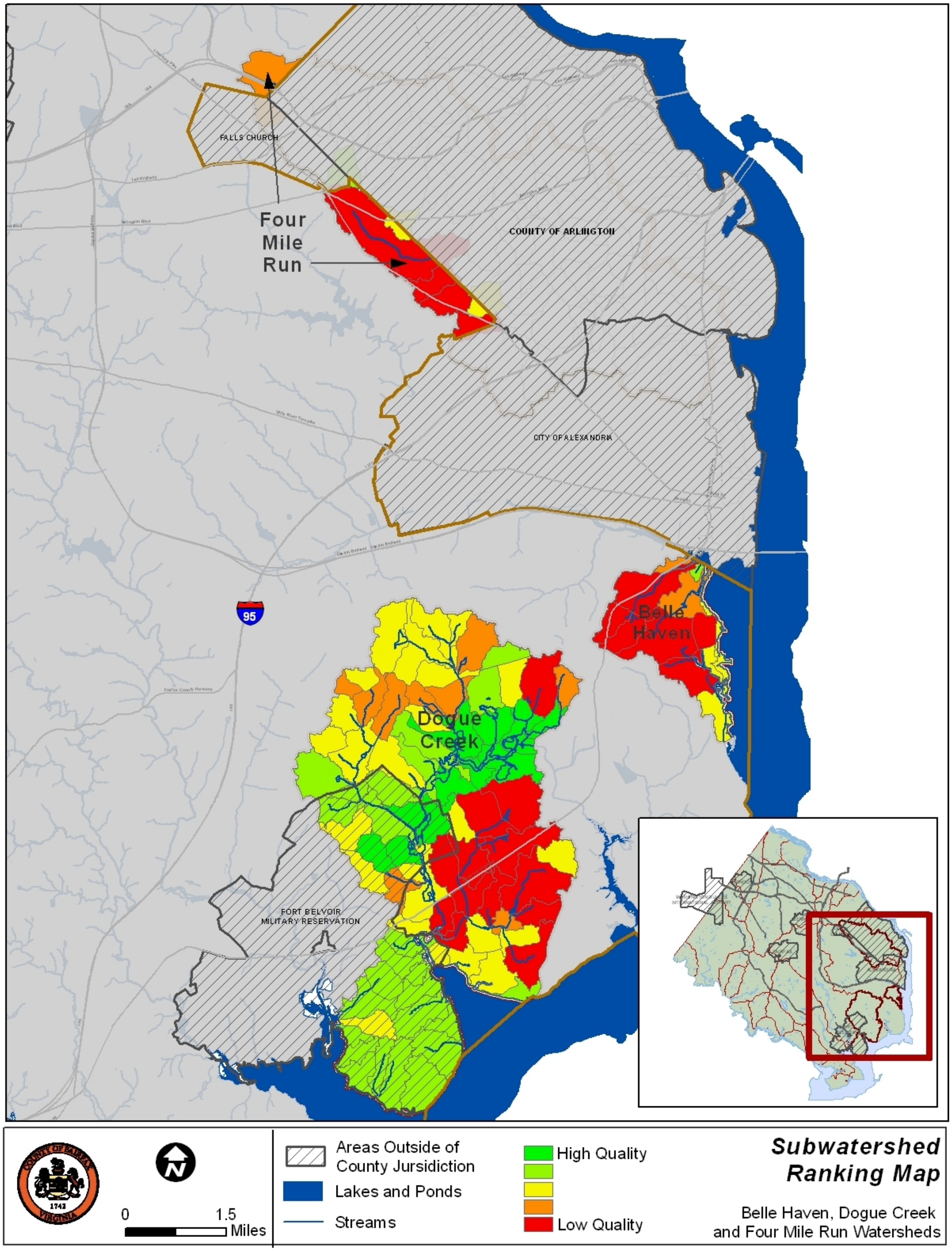


Figure 3-11: Subwatershed Ranking Map

4 Watershed Restoration Strategies

4.1 Subwatershed Strategies

The watershed restoration process follows the assessment of subwatershed conditions summarized in the preceding section. It involves two elements: first, to determine where in the watershed to prioritize restoration efforts, and second, to identify specific practices and locations where improvements can be made.

The purpose of prioritizing was to focus limited resources in the most effective way, as there were some geographic areas within the watershed where the same improvement can have a greater impact than in others. Once prioritization was complete, specific restoration sites were identified at a subwatershed scale. These results are described in Section 5. This section provides an overview of the approach and practices considered.

The overall strategy for restoring the Belle Haven, Dogue Creek and Four Mile Run watersheds was developed with the assistance and input of the Watershed Advisory Group (WAG). The group suggested focusing project recommendations to identify impaired headwater areas and concentrate restoration efforts in these subwatersheds. These improvements will reduce the stress and subsequent damage to downstream channels. This strategy recognized that improvements in headwater areas have the potential to reduce stressors downstream and to improve conditions throughout the stream network. Projects were given a higher priority if they were on publicly maintained land or in areas where project costs could be shared with developers. The full Technical Memorandum detailing the subwatershed strategy process can be found in Appendix B.

Figure 4-1 visually depicts subwatershed prioritization for project selection. Headwater subwatersheds, shown in grey, are subwatersheds where a stream begins, either for the main channel, a tributary, or a small branch draining to a main channel or tributary. Subwatersheds draining directly to tidewater were not included.

Once headwater areas were defined, an approach was needed to determine which areas were impaired. These subwatersheds (identified by the red hatch in Figure 4-1) were defined using the indicator data discussed in Section 2.3. The indicators were divided into four summary groups, and then each subwatershed was ranked based on the score from the four summary groups and the overall ranking. If the subwatershed scored either among the worst 40 percent in the overall ranking, or the worst 20 percent for one of the indicator groups, it was presumed to be impaired. The four groups are as follows:

1. Stormwater Runoff Impacts: This group of indicators summarizes the conditions of the streams within the subwatershed and has been used primarily to assist in locating potential stream restoration sites.

2. Flooding Hazards: The indicators for flooding hazards have been derived from planning-level hydraulic modeling for the project. They include residential or commercial buildings that are shown within the modeled 100-year flood limit and crossings which are modeled as overtopped by the 10-year event.

3. Habitat Health: These indicators describe conditions of the natural resources that contribute to habitat quality such as forest cover, wetlands and riparian buffers.

4. Water Quality: Four indicators were used in this objective score. Three are derived from watershed modeling, which is specific to each subwatershed and integrates GIS data on imperviousness, land use and stormwater treatment. The fourth is based on monitoring data for *E. coli* collected by Virginia Department of Environmental Quality (VDEQ).

There are some features of interest in each watershed that can be seen on Figure 4-1. First, every subwatershed in Belle Haven and Four Mile Run met the criteria for impairment, while in Dogue Creek a majority of the subwatersheds were in better condition. Second, essentially all of the Four Mile Run subwatersheds are headwaters, either to the mainstem or to Upper Long Branch. As a result, investigations of restoration sites were made watershed-wide. While impaired areas of Belle Haven occur throughout the watershed, only two subwatersheds were classified as headwater areas, so the focus on restoration investigations was concentrated to this land area. Dogue Creek has impaired headwater areas in all of its WMAs, although the largest concentration is in the upper Mainstem and North Fork WMAs.

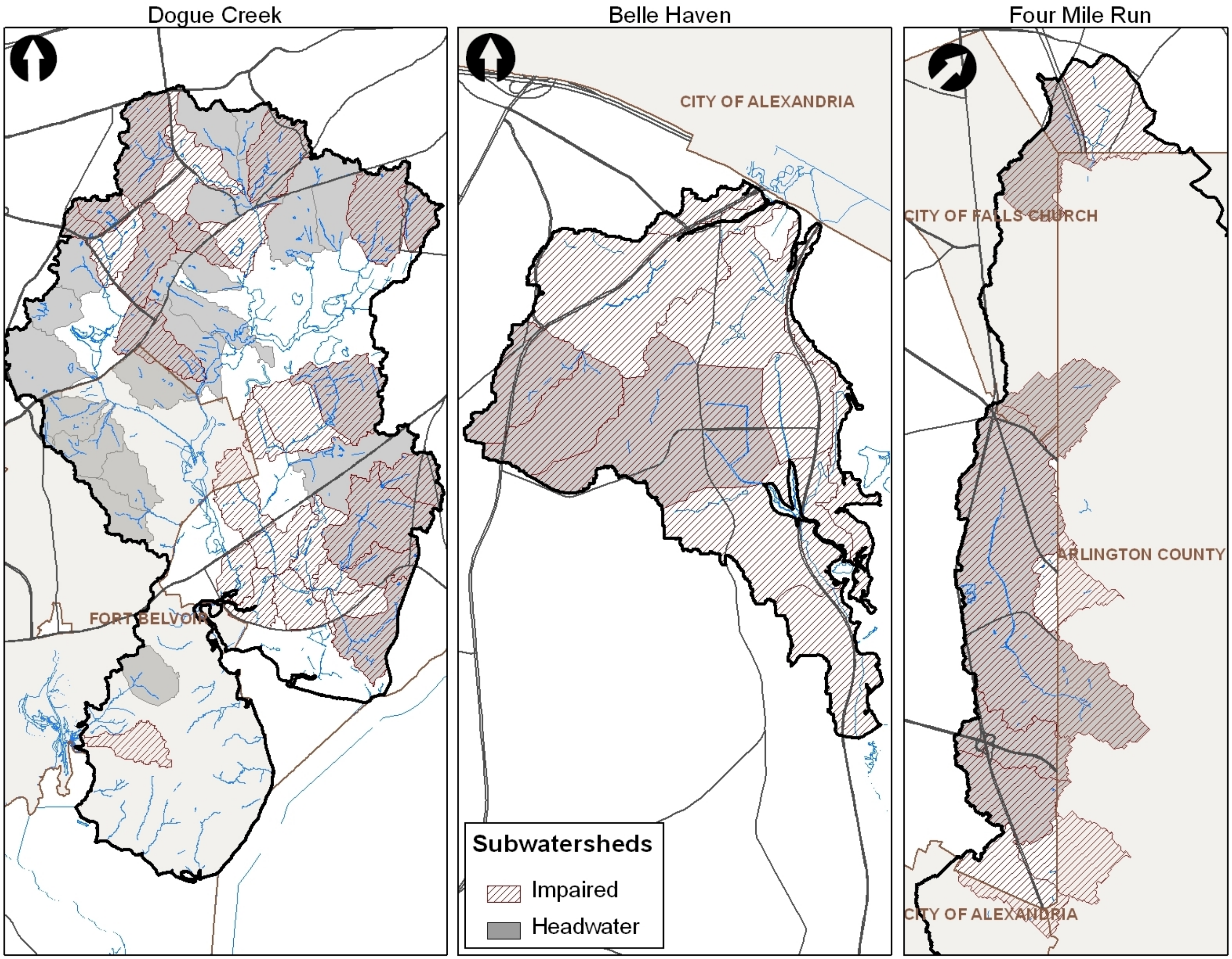


Figure 4-1: Subwatershed Strategy

4.2 Description of Watershed Restoration Practices

Stormwater management techniques are generally described as being in one of two categories: structural or non-structural. Structural practices are physical structures which generally involve budgeting through the Capital Improvement Plan and engineering, design and construction. Non-structural practices are more programmatic in nature and usually focus on controlling stormwater runoff at the source through reducing the amount of runoff and/or reducing the opportunity for stormwater to wash off and transport pollutants downstream.

4.2.1 Structural Practices

Structural projects can be designed to meet any of the goals and objectives for a particular watershed through restoring streams, providing mitigation from flooding, removing pollutants from stormwater runoff or improving aquatic and terrestrial habitat. The Belle Haven, Dogue Creek and Four Mile Run Watershed Management Plan includes the following structural practices:

- New Stormwater Management Ponds
- Stormwater Pond Retrofit
- Stream Restoration Projects
- Area-Wide Drainage Improvement
- Culvert Retrofit
- New BMP/LID or BMP/LID Retrofit
- Flood Protection / Mitigation
- Outfall Improvement

When stormwater management began to be implemented, the approach taken was to provide treatment facilities at the point of discharge. These were typically a type of pond or storage facility or outfall improvement and dealt mainly with the excess volume of stormwater runoff. As more knowledge was gained from experience, approaches that treated stormwater closer to its source were developed. These included BMP/LID facilities or area-wide improvements to the drainage system such as water quality filters at inlets. Structural projects can also serve several different functions based on their design: reducing the amount of stormwater, improving water quality, or attenuating high flows.

The following provides a short description of each of the structural practices proposed for the plan.

New Stormwater Management Pond

Description

These projects are newly-constructed dry ponds, wet ponds or stormwater wetlands. They are designed to help reduce the impacts of stormwater runoff by either permanently or temporarily storing the water.

All three types of ponds can be designed for water quality improvements by retaining the water long enough for sediment and pollutants to settle out of the water.

Wet ponds and stormwater wetlands can also provide water quality and habitat benefits through landscaping with aquatic vegetation. Vegetation is added to the pond design to treat dissolved nutrients (nitrogen and phosphorus), which can be difficult to remove through settling and filtering. In the process of growing, aquatic vegetation takes the nutrients up out of the water through its roots and sequesters them.

Figure 4-2: Stormwater Management wet pond (Source: Fairfax County)

Figure 4-3: Engineered stormwater wetland (Source: Fairfax County)

Design Considerations

Ponds can be categorized into three main categories:

1. Dry ponds, which are quantity controls to capture rapidly flowing runoff and release it slowly over a longer time period;
2. Wet ponds, which have a permanent pool that allows for sedimentation along with an level of storage above the pool to provide extended detention like a dry pond; and
3. Stormwater wetlands, which function similarly to a wet pond but are landscaped to provide better treatment of dissolved nutrients and aquatic habitat for a wider variety of species.

All three types may designed to include extended detention. Extended detention basins provide additional temporary storage above the bottom of a dry pond or the permanent pool of a wet pond or wetland. The extra storage area holds stormwater for longer settling times, which allows it to be released more slowly, reducing stress on downstream channels, and gives more time for pollutants to settle out. This improves the pollutant removal efficiency for dry ponds, wet ponds and wetlands.

Stormwater Management Pond Retrofit

Description

A stormwater management pond retrofit consists of changes or improvements made to an existing stormwater pond to provide additional water quality treatment. If the assessment of the watershed indicates that stream protection is necessary, the retrofit may include changes in the outflow controls to provide for peak flow reductions that help to minimize stream degradation.

Design Considerations

The amount of water treated (water quantity) can be improved in two ways. First, by increasing the time the stormwater runoff stays in the pond through making the pond bigger and changing the outflow control to release the extra water more slowly. Second, there may be opportunities to add to the drainage area treated by the pond by redirecting untreated area to the pond.

Retrofits to improve water quality treatment involve adding features or controls that were not part of the original design. These approaches involve changing the way the pond functions, with methods such as the following:

Figure 4-4: Stormwater dry pond retrofit (Source: Fairfax County)

- Changing outflow controls or adding a BMP plate for extended detention
- Changing the flow path within the pond so water travels farther between the inlet and the outlet
- Creating multiple pond cells within a single pond. Reconfiguring the pond and the landscape to capture more stormwater

Other approaches involve adding new features to the pond:

- Creating a shallow subsurface wetland bench around the perimeter which provides an opportunity for aquatic vegetation to take up nutrients
- Creating wetland areas within the pond
- Creating a forebay to capture sediment before it enters the pond, which improves maintainability
- Creating a micropool at the outlet to add an additional location for sedimentation

Stream Restoration

Description

The goal of stream restoration is to return the stream to a stable state in which it neither significantly erodes or fills with sediment, is connected to its floodplain and has an improved habitat condition.

Besides being undertaken to restore stability, stream restoration projects may be proposed to restore natural physical, biological, or ecological function to a stream which has become degraded due to man-made changes in the channel or the watershed, such as channel straightening, armoring with concrete or gabions, or culvert installation.

Figure 4-5: Stream restoration (Source: Fairfax County)

Design Considerations

Several approaches to restoration are available based on the type of impairment and constraints such as availability of adjacent land. For all of these projects, structures based on natural stream bed forms are used. Wood and stone structures can be used to concentrate stream flow to the center of the channel to provide a good flow depth for aquatic life between storm events.

For incised urban channels, there are several options available depending on the severity of the degradation and availability of adjacent land. The most extensive restoration designs may move the stream itself, creating a new channel on a new alignment at the original floodplain elevation. Other alternatives could involve adjusting the cross-section, reducing bank slopes, or creating a new floodplain bench within an over-widened channel. For incised channels with no room to increase meander width, a restoration design could include using grade controls to flatten the slope of the stream and dissipate stream energy.

Less extensive restoration approaches could be undertaken where there is insufficient space or the existing flows make it infeasible to recreate a natural channel. These could involve armoring stream banks with rock or bioengineering materials to prevent further erosion, grading to lay back over-steepened banks and create a more stable cross-section.

Culvert Retrofit

Description

These projects reconfigure and improve existing culverts, which allow streams to flow under roads and trails in the County. They may consist of water quantity (e.g. peak flow reduction, increased storage etc.) and/or water quality (e.g. improved runoff quality through micropools, wetland plantings, etc.) improvements.

Figure 4-6: Culvert retrofit control structure, flow left to right (Source: KCI)

This retrofit option is installed upstream from existing road culverts by constructing a control structure and potentially excavating a micro-pool similar to that seen in Figures 4-6 and 4-7.

Figure 4-7: Culvert retrofit, flow right to left (Source: Center for Watershed Protection)

These projects are usually designed for headwater, intermittent streams. The control structure will detain and reduce stormwater flow; the micropool prevents resuspension of previously settled sediments and also prevents clogging of the low flow orifice and may be able to infiltrate the runoff from smaller storms, improving water quality. Additional water quality treatment can be obtained through sedimentation or vegetative uptake.

Design Considerations

If the upstream area is an open floodplain, it may be possible to construct an off-line wet pond or stormwater wetland to improve water quality treatment. Since roadway embankments are not usually designed to impound water, special design measures are necessary, particularly a new embankment built upstream of the culvert.

Secondary impacts need to be considered as well, including impacts to the 100-year floodplain, fish passage barriers, or impacts to wetlands and forest.

The best situations for culvert retrofits occur when:

- Upstream land is in public ownership
- Channel has intermittent or ephemeral flow
- Upstream channels have a shallow slope, are connected to the floodplain, and have low streambanks
- The retrofit is upstream of a proposed stream restoration project.

Best Management Practice / Low Impact Development

Description

These projects are intended to improve performance or efficiency of existing BMPs (which may or may not incorporate LID practices) or installation of new practices in areas where stormwater is uncontrolled.

BMP/LID systems are a suite of small practices which are installed as close as possible to where stormwater runoff is being generated. Depending on the exact type of project, they are designed to provide water quality treatment, some reduction in stormwater and detention to reduce peak flows. The main objective is to mimic the pre-development runoff characteristics of the site through treating precipitation (or runoff) before it becomes concentrated by designing many smaller systems that work together on the site instead of a larger stormwater management facility downstream.

Design Considerations

A combination of several BMP/LID types and techniques can be used to achieve the best overall treatment. All of them incorporate one or more of the following processes:

<u>Runoff reduction</u>:
- surface ponding
- infiltration
- evapotranspiration

<u>Pollutant removal</u>:
- sedimentation
- filtration
- vegetative uptake

Figure 4-8: Parking lot bioretention (Source: Fairfax County)

Figure 4-9: Vegetated swale (Source: Fairfax County)

Figure 4-10: Tree box filter (Source: Fairfax County)

Individual BMP/LID practices that incorporate these processes include the following:

- Bioretention Filters and Basins
- Vegetated Swale
- Manufactured BMPs (e.g. Tree Box Filter)
- Dry Swale
- Filter Strips
- Sand Filters
- Percolation/Infiltration Trench
- Vegetated Roof
- Rain Garden

Rain gardens are essentially a non-engineered form of bioretention that treats rooftop runoff from individual roof leaders or overland runoff. They consist of small, landscaped depressions with a sand/soil mixture planted with native shrubs, grasses or flowering plants. Runoff is detained in the depression for no more than a day. Rain gardens can replenish groundwater, reduce stormwater volumes downstream and remove pollutants.

Figure 4-11: Green roof on a parking building (Source: Fairfax County)

Figure 4-12: Sand filter along MD355(Source: KCI)

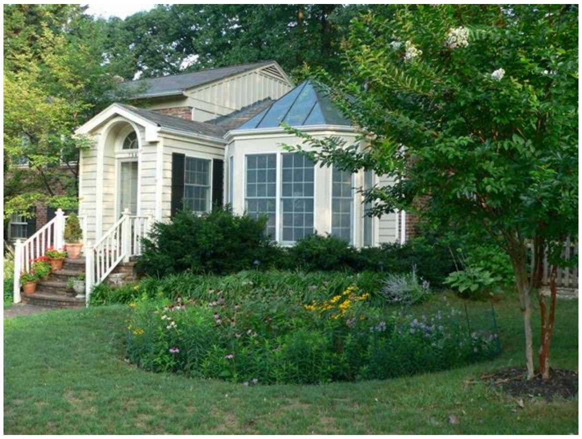


Figure 4-13: Residential rain garden (Source: Fairfax County)

Area-Wide Drainage Improvement

Description

Area-Wide Drainage Improvements are projects (or suites of projects) which improve multiple outfalls and/or other stormwater infrastructure throughout a neighborhood. Controls could be custom-designed swales or bioretention systems (Figure 4-14), proprietary devices such as inlet filters (Figure 4-15) or the tree boxes described earlier (Figure 4-10).

Design Considerations

Area-wide improvements are similar to BMP/LID systems and may use the same practices. In some cases, an area-wide improvement may use more than one type of project type within the project limits.

The design focus on an area-wide improvement is to revise or upgrade the conveyance system area to provide treatment for a community rather than to treat a particular site, as with BMP/LID controls. Conversion of grass channels to vegetated swales, implementation of bioretention or tree boxes at inlets, or conversion of outfall ditches to storage or filtration systems would all be examples.

However, because of the proximity to roads and utilities, infiltration systems and vegetated swales may only be feasible in lower-density residential areas.

Figure 4-14: Vegetated swale for roadside drainage (Source: KCI)

Figure 4-15: Inlet filter (Source: Ultra-Tech Int'l)

Flood Protection / Mitigation

Description

Flood protection projects (or suites of projects) are intended to alleviate potential flooding of roads, buildings, road crossings, or significant property.

Figure 4-16: Obsolete culvert (Source: KCI)

Figure 4-17: New replacement culvert (Source: KCI)

Road crossings (culverts or bridges) that may have been designed to safely pass high flows, such as the 100-year flood, occasionally become obsolete due to changes in upstream land use or other factors that increase storm flow volume or frequency. In such a case, a crossing that might have been designed with a one percent chance of flooding in any given year might now overtop more frequently.

In this case, for primary roads in particular, traffic standards may no longer be met. Flood protection or mitigation projects are intended to bring crossings back to current standards to allow higher stormwater flows to pass safely or adding storage upstream to reduce the peak flow to the under-sized structure.

Design Considerations

These improvements can include raising the roadbed above the flood level, rebuilding culverts so they can pass more water, replacing worn or damaged culverts with newer ones that allow water to flow more quickly. The example shown in Figures 4-16 and 4-17 include all of these techniques, with the roadway height increased and the larger double box culvert replacing the three smaller round metal ones.

In smaller streams, identifying and repairing constrictions in the drainage network may be sufficient. For larger rivers it may be necessary to rebuild bridges with a wider span to allow more space for floodwaters to pass.

For all of these types of projects, a key design consideration is to avoid potential flooding downstream. By removing constrictions, streamflows will increase, and conditions must be analyzed to make sure that flood mitigation at one site does not move the problem downstream to another.

Outfall Improvement

Description

Outfall projects improve existing stormwater outlet structures and address problems associated with inadequate outfalls (e.g. erosion, scour, head cuts etc.).

These projects are designed to protect the natural stream channels in the watershed from fast flowing stormwater runoff discharging from the storm drainage system. These high flows can cause erosion of the ditches and headwaters at the outfall; to the extent that stormwater infrastructure can be undermined and fail. They can also be a cause for further erosion or deposition downstream.

Design Considerations

There are several types of improvements that could be made depending on site constraints. If there is sufficient space, an off-line pond can be created to treat the first flush of stormwater, with higher flows bypassed into the existing stream channel.

Outfall improvements can be designed to provide water quality treatment along with energy dissipation. In an area with more constraints, a more common approach is to improve the conveyance immediately below the outfall structure to provide additional energy dissipation and reduce scour and erosion. Methods include the use of rip rap, plunge pools to break the flow of water and energy dissipation structures which adds turbulence to reduce the velocity of the outfall discharge.

Stream restoration design approaches can also be considered if the site is suitable, particularly step pool systems which can reduce the stormwater runoff velocity.

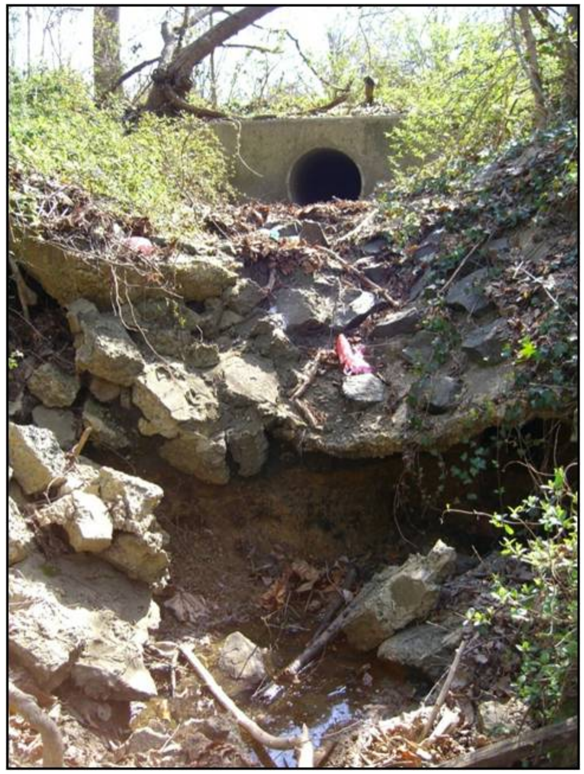


Figure 4-18: Outfall improvement (Source: Fairfax County)

Non-Structural Practices

Non-structural projects are a group of projects that do not require traditional construction measures to be implemented and may be programmatic in nature. These projects include but are not limited to the following practices:

- Stream buffer restorations
- Rain barrel programs
- Dumpsite and obstruction removals
- Community outreach and public education
- Land conservation coordination projects
- Inspection and enforcement projects
- Street sweeping programs
- Recommendation of additional studies, surveys and assessments

These projects, in concert with the structural projects, represent a holistic approach to watershed management. Since much of the land area in Fairfax County is privately owned, there is a strong need to work with local communities to promote environmental awareness and recommend projects that can be implemented by residents and other groups.

The fundamental difference between structural and non-structural projects is the ability to predict the result of the project implementation through models. For example, the nitrogen removal of a wet pond may be calculated; however, there is no way to predict the reduction in nitrogen from an outreach campaign on proper fertilizer use. Additionally, these projects and programs should not be confined to any single watershed but could be implemented throughout the County as opportunities occur. Because of these differences, non-structural projects were evaluated and will be implemented using a different process than the structural projects.

There are many advantages of non-structural projects. Some of the key advantages to this projects type are:

- Less costly
- Less disruptive
- Promotes public and community awareness

In general, non-structural projects represent opportunities to proactively pursue stormwater issues that more traditional structural practices cannot address. The use of non-structural practices fulfills Fairfax County’s MS4 permit requirements and environmental initiatives. The full potential of these projects will be realized through partnerships with County agencies, residents and other interested parties.

Stream Buffer Restoration

Description

The vegetated land area on either side of a stream is referred to as the riparian buffer. Buffers can be comprised of grasses, shrubs, trees, or a combination of the three. Forested buffers provide streambank stability, food for aquatic life and shading of the stream. Stream buffers also provide important wildlife habitat. In many urban areas, stream buffers have been impacted through development. Restoring vegetation to these areas can improve the quality of the stream. Buffer restoration projects can be incorporated into stream banks stabilization and stream restoration projects to encourage multiple water quality and habitat benefits.

Design Considerations

There are several design guidelines that can have an effect on the efficiency of a stream buffer. The first is the buffer width. Whenever possible, a minimum width of 100 feet on each side of the stream should be maintained to provide adequate stream protection.

Figure 4-19: Buffer restoration project in Fairfax County (Source: Fairfax County)

The ideal buffer vegetation is a mature forest, for a number of reasons. Shade will help keep the stream cooler, roots will help stabilize the banks, and leaf litter will provide a food source for macroinvertebrates and other organisms in the stream.

Buffers are effective as a stormwater filter in areas of low density development. Where there are frequent storm drain outfalls bypassing the buffer and discharging directly in the stream, the filtration benefit is lost.

Dumpsite/Obstruction Removal

Description

Stream valleys, particularly those in isolated areas, are occasionally sites where unwanted trash or materials are dumped. This can consist of yard waste in residential neighborhoods, bulk trash where the owner does not wish to pay a disposal fee, or hazardous materials where a permit may not have been obtained. Obstructions refer to items in the streambed that impede flow sufficiently to accelerate streambank erosion or increase the risk of flooding.

Design Considerations

Dumpsite cleanup is typically a maintenance-level activity, which may require trucks, loaders, or other light equipment for removal.

Obstructions are removed in a similar fashion. Review of the site conditions should be performed by a stream ecologist because in some cases woody debris and a buildup of sediment can improve stream habitat conditions.

Impervious Disconnection and Rain Barrel Programs

Description

Impervious disconnection refers to practices that reduce the effect of impervious cover by small-scale storage, infiltration, or redirection to pervious areas. It differs from BMP/LID systems primarily because these practices can be installed easily without the need for engineering and design.

Design Considerations

Rain barrels are used to capture, store and reuse residential rooftop runoff. They consist of a simple collection device to store rainwater from individual downspouts, after which it can be reused for non-potable purposes such as irrigation or car washing. Capacity is typically 50 to 100 gallons, which is sufficient to store the runoff from 0.1" to 0.2" of rainfall from the area drained by a single downspout.

Figure 4-20: Rain barrel (Source: Project Clean Water)

Figure 4-21: Disconnecting a downspout (Source: City of Toronto)

Figure 4-22: Permeable pavement blocks in a parking lot (Source: Fairfax County)

Downspout disconnection consists of adding piping or gutter systems on the ground to turn the flow from a downspout away from driveways or sidewalks to lawns or landscaped areas. Rooftop runoff redirected in this fashion is treated by surface filtration through the vegetated area and infiltration into the soil. Directing runoff onto vegetation allows the biological processes to reduce pollutants. This is also an effective method of preventing temperature increases in runoff.

The use of pervious pavement systems can provide a form of disconnection for parking lots, driveways, walkways and other hard surfaces. These systems may consist of a special asphaltic paving material (porous pavement), a special concrete material (porous concrete) or open jointed concrete blocks (permeable pavement blocks). They allow stormwater to infiltrate directly through the surface instead of flowing to a collection system. The most significant constraint is the requirement for an underdrain if the soils below the surface are not permeable and will not allow the runoff to infiltrate. Maintenance is also required to prevent sediment from clogging the surface and preventing the water from infiltrating through the surface.

Community Outreach/Public Education

Description

Outreach and education programs are intended to educate the public on how to reduce the potential for pollutants to reach our waterways. Pollutants can range from nitrogen and phosphorus in improperly applied fertilizer, to bacteria found in dog waste left on the ground. These programs are intended to change pollutant-causing behaviors by providing information on how behavior affects water quality and to recommend types of changes that can be made to reduce impacts.

Design Considerations

Proper lawn and turf care practices can reduce excess nitrogen, phosphorus, insecticides and herbicides from getting into local streams. Education on soil testing, fertilizer application and pesticide use is intended to reduce the amount of these materials and educate on the appropriate application time. Encouraging conversion of lawn to native landscaping is another option for outreach programs.

Pet waste contributes harmful bacteria and excess nutrients to stormwater. Programs for control include adoption and enforcement of pooper scooper laws, education regarding its effects on streams and lakes, signs and publicly-available disposal containers.

Storm drain stenciling or labeling is a relatively easy method of outreach that involves labeling storm drain inlets with painted or prefabricated signs that indicate that materials thrown into the storm drain are not treated and go directly to a water body, which is typically named on the sign.

Figure 4-23: High and medium maintenance lawns (Source: KCI)

Figure 4-24: Pet waste sign in common area (Source: KCI)

Figure 4-25: Fairfax County storm drain label (Source: Fairfax County, label produced by Das Manufacturing, Inc.)

Programs to promote tree planting in residential yards, commercial open space, and in the open grassy area between sidewalks and streets can increase the tree canopy, increasing evapotranspiration and interception, slowing runoff and allowing more infiltration as it is absorbed into the ground. Trees also reduce erosion by holding soil and by reducing the impact of rain to bare ground. The program is a good opportunity to involve park and neighborhood supporting groups.

Inspection/Enforcement Enhancement Project

Description

Inspection and enforcement activities include identifying staff to routinely inspect commercial sites for potential runoff polluting activities. Depending on local ordinances, citations can be written for improper disposal of materials. In other cases, a targeted education and outreach program to the landowner and the employees may be effective in reducing the activities.

Figure 4-26: Improperly stored outdoor materials (Source: Center for Watershed Protection)

Figure 4-27: Improper dumpster maintenance (Source: Center for Watershed Protection)

Design Considerations

Vehicle maintenance and repair operations can exert a significant impact on water quality by generating toxins such as solvents, waste oil, antifreeze and other fluids. Often, vehicles that are wrecked or awaiting repair can be a stormwater hotspot if leaking fluids may be picked up by stormwater runoff.

Protecting outdoor material storage areas is a simple and effective pollution prevention practice for many commercial, industrial, institutional, municipal and transport-related operations. The underlying concept is to prevent runoff contamination by avoiding contact between outdoor materials and rainfall (or runoff). Examples include salt storage areas for highways, manure storage on farms, or excavated soil from construction sites.

Dumpsters provide temporary storage of solid waste at many businesses and can be a significant pollution source if improperly maintained. Many dumpsters are open, which allows rainfall to mix with the wastes, generating a source of trash, oil and grease, metals, bacteria, organic material, excess nutrients and sediments. Good dumpster management is particularly important to reduce trash loadings to a stream.

Litter and trash enforcement is carried out through the enforcement of regulations for illegal dumping, litter laws or unsecure truck loads. Education can also be an element to positively change the behavior. Community outreach programs for beautifying neighborhoods, including health and safety information can be used effectively in the implementation of the programs.

Street Sweeping Program

Description

Street sweeping refers to sweeping of roads, gutters, and parking lots in order to remove street dust and dirt before it is washed into storm drains and streams. Street sweeping can be used as primary treatment or pre-treatment for pollutants that cannot be entirely removed from the environment through other source control methods.

Figure 4-28: Street sweeper (Source: Tymco, Inc.)

Figure 4-29: Catch basin (Source: Fairfax County)

Design Considerations

There is a wide range of variability and efficiency among street sweeping equipment. Mechanical sweepers are effective for larger particles and cleanup of winter deicing materials. Much of the pollutants picked up by stormwater runoff consist of smaller particles in the micrometer range. A regenerative air sweeper can be effective at removing this material. Frequency of sweeping activities is also a key factor in pollutant removal efficiency.

An alternative to street sweeping is catch basin cleaning, which consists of periodically opening storm drain inlets and removing the material that has accumulated at the bottom. However, resident outreach and education is needed to stop the practice of disposing of materials into storm drain inlets.

4.2.2 Structural Project Prioritization

Projects were prioritized using a procedure that was applied similarly across all watersheds in order to develop an implementation plan for the design and construction of the proposed structural projects. This procedure is described in detail in Appendix B. The purpose was to identify the most effective projects in each watershed with a method that was quantifiable and based on a set of measurable indicators. The procedure was conducted using the indicator metrics from Section 2.3 to identify subwatersheds most in need of restoration. Five factors were considered, as follows:

1. Impact Indicators: Measure the extent that a particular watershed impact can be reduced by a proposed project.

2. Source Indicators: Quantify the reduction of potential stressor or pollution sources.

3. Location within Priority Subwatersheds: Projects were prioritized based on the quality of the subwatershed in which they were located. Projects received a higher score if they were located in a lower quality subwatershed.

4. Sequencing: Projects were scored based on their location in each WMA. Projects in headwater subwatersheds were given highest priority.

5. Implementability: Implementability was a measure of which projects would be easier to implement, defined by whether or not they were on County-owned or maintained property, and whether or not upstream quantity controls were required for them to be successfully implemented.

Final project prioritization was calculated based on a weighted average of the five factors:

• Effect on Impact Indicators	30%
• Effect on Source Indicators	30%
• Location within Priority Subwatersheds	10%
• Sequencing	20%
• Implementability	10%

After the scores were calculated, they were reviewed and adjustments were made for some of the more qualitative factors, such as forecasts of changes in stream condition, flooding hazards and riparian buffer based on implementation of each project.

Once the initial prioritization was completed, a simplified cost benefit analysis (CBA) was made for the highest priority 10-year projects in order to provide additional information on cost-effectiveness. The analysis was made by dividing the composite score (a measure of benefits) with the cost, to allow a comparison among projects. This information was used to adjust final ranking of projects.

Of the 60 projects analyzed, approximately half stayed in the same relative rank for both methods. In general, the projects that were ranked high but scored low using CBA were project types with significantly higher costs, primarily new stormwater ponds, stream restoration and flood mitigation projects. A review of the problems identified in the watershed suggests that the need for additional stormwater storage in untreated areas justified the additional cost, as did restoration of degraded streams and flood mitigation improvements.

The opposite conclusion was found for projects that ranked low but scored high in the CBA analysis. For the most part, these projects were smaller BMP/LID retrofits that provided good benefits for their low cost. However, the area they treated was generally very small, leading to lower overall benefits.

4.2.3 Non-Structural Project Prioritization

Non-structural projects were derived from two sources. First, pollution prevention measures were identified during the upland reconnaissance of residential and commercial areas which assessed potential pollutant sources. As part of the assessment, several possible programs were identified for specific areas which had the potential to reduce or control sources of pollution or stormwater runoff. The second approach included indentifying site specific areas for buffer restoration and land conservation measures through the use and analysis of GIS mapping.

One hundred forty non-structural project sites were recommended for consideration through these assessments. Many of the pollution prevention measures could be carried out more efficiently if they were done on a watershed-wide or countywide basis. With this in mind, the proposed projects were grouped by project type. The resulting list of non-structural projects is shown in the end of Table 4-3. Projects that spanned across several watersheds were given project numbers related to Dogue Creek, the largest watershed in the plan grouping.

The non-structural projects were prioritized similarly to the structural projects, with the goal of identifying five high priority projects. Two factors were used in the prioritization:

Impact Indicators Projects were scored using best professional judgment based on the effectiveness at improvements in runoff impacts on streams, flood mitigation, habitat enhancement and water quality.

Implementability Best professional judgment was used to determine ease of implementation, based on cost and time commitment required by Fairfax County staff.

Scores were calculated based on a weighted average of these two factors:

- Effect on Impact Indicators 60%
- Implementability 40%

The highest priority watershed-wide project was Downspout Disconnection, followed by Obstruction Removal and Litter/Trash Enforcement. Tree Planting projects were next in priority. These four projects, along with Buffer Restoration DC9801, prioritized with the structural projects, were the five highest priority non-structural projects.

Table 4-1 summarizes the prioritization for the non-structural projects.

Table 4-1: Non-structural project prioritization

Project ID	Non-Structural Measure	Detailed Action	Priority
DC9801	Buffer Restoration	Buffer Restoration	High
DC9803	Wetland Mitigation	Wetland Mitigation	High
DC9901	Rain Barrel Programs	Downspout Disconnection	High
DC9905	Outreach / Education	Tree Planting	High
DC9910	Inspection / Enforcement	Litter/Trash Enforcement	High
DC9911	Dumpsite / Obstruction Removal	Obstruction Removal	High
DC9800	Buffer Restoration	Buffer Restoration	Low
DC9802	Buffer Restoration	Buffer Restoration	Low
DC9902	Rain Barrel Programs	Rain Barrels	Low
DC9903	Outreach / Education	Lawn Care Outreach	Low
DC9904	Outreach / Education	Storm Drain Marking	Low
DC9906	Outreach / Education	Turf Management	Low
DC9907	Inspection / Enforcement	Dumpster Maintenance	Low
DC9908	Inspection / Enforcement	Outdoor Materials	Low
DC9909	Inspection / Enforcement	Vehicle Maintenance	Low
DC9912	Street Sweeping	Street Sweeping	Low
DC9913	Studies, Surveys and Assessments	Floatables Control	High

4.3 *Status of Regional Ponds*

Fairfax County records show that there are no regional ponds in the Belle Haven and Four Mile Run watersheds and two regional ponds proposed in the Dogue Creek watershed. Table 4-2 shows the status of these ponds according to the County records, followed by a short description of the results of the site investigation conducted as part of this watershed plan.

Table 4-2: Regional ponds in the Dogue Creek watershed

Project Name	WMA	Status	Time frame	Facility ID Number	Drainage Area (ac)	WMP Status
Mt. Vernon High School Outfall Project (MV-1A)	North Fork	C	EX	WP0389	139	No action
South Van Dorn Street, Phase 3, Regional Pond (DC-106)	Dogue Creek Mainstem	C	EX	1480DP	50	No action

C=complete; I=Inactive, not funded; EX=Existing

Pond MV-1A There are no retrofits proposed for this regional pond. However, there are seven projects proposed in the drainage area of the pond: one stormwater management pond, five BMP/LIDs and one stream restoration site.

Pond DC-106 There are no retrofits recommended for this pond nor were there any projects proposed within the pond drainage area.

4.4 *Summary of Proposed Projects*

Table 4-3 is the Master List of Projects, which shows all the projects proposed in the plan, organized by implementation priority, then by watershed and project number. The 10-year implementation projects have project fact sheets associated with them which are located in Section 5.

Map 4-1 shows all structural project locations throughout the three watersheds as they are distributed within the Dranesville, Mason, Lee, and Mount Vernon supervisor districts. Non-structural projects, which are intended to be implemented watershed-wide, are listed in a table on the map.

Table 4-3: Master list of projects

Priority Structural Projects (10-Year Implementation Plan)[1]						
Project #	**Project Type**	**WMA**	**Location**	**Watershed Benefit**	**Land Owner**	**Cost**
BE9100	Stormwater Pond Retrofit	Belle Haven	West Potomac High School	Water Quality and Quantity	County – FCPS	$174,000
BE9102	New Stormwater Pond	Belle Haven	Belle View Elementary School	Water Quality and Quantity	County – FCPS	$277,000
BE9103	New Stormwater Pond	Belle Haven	Fairchild Property	Water Quality and Quantity	County	$750,000
BE9200	Stream Restoration	Belle Haven	Belle Haven Park between Richmond Hwy Foxcroft Rd, and Edgewood Ter	Water Quality	County – FCPA	$1,614,000
BE9201	Stream Restoration	Belle Haven	Behind Belle View Dr	Water Quality	Private Residential	$883,000
BE9202	Stream Restoration	Belle Haven	Shields Ave	Water Quality	Private Residential	$388,000
BE9203	Stream Restoration	Belle Haven	Downstream of Quander Rd	Water Quality	Private Commercial	$1,122,000
BE9500	BMP/LID	Belle Haven	Shops at Huntington Gateway	Water Quality	Private Commercial	$105,000
BE9501	BMP/LID	Belle Haven	Wal-Mart and Chuck E. Cheese parking lot	Water Quality	Private Commercial	$283,000
BE9502	BMP/LID	Belle Haven	Quander Road School	Water Quality	County - FCPS	$69,000
BE9503	BMP/LID	Belle Haven	River Towers	Water Quality	Private Residential	$251,000
BE9504	BMP/LID	Belle Haven	Belle View Shopping Center	Water Quality	Private Commercial	$145,000
BE9505	BMP/LID	Belle Haven	14th St	Water Quality	State - VDOT	$83,000
BE9506	BMP/LID	Belle Haven	Belle View Blvd	Water Quality	State - VDOT	$91,000
BE9507	BMP/LID	Belle Haven	Belle View Shopping Center	Water Quality	Private Commercial	$257,000
BE9508	BMP/LID	Belle Haven	Belle View Elementary School	Water Quality	County - FCPS	$62,000
BE9509	BMP/LID	Belle Haven	Mount Vernon Recreation Center	Water Quality	County - FCPA	$241,000
BE9510	BMP/LID	Belle Haven	West Potomac High School	Water Quality	County - FCPS	$85,000
BE9600	Flood Protection/Mitigation	Belle Haven	Culvert under Yale Drive	Flood Mitigation	State – VDOT	$593,000

Priority Structural Projects (10-Year Implementation Plan)[1]						
Project #	**Project Type**	**WMA**	**Location**	**Watershed Benefit**	**Land Owner**	**Cost**
DC9100	New Stormwater Pond	Dogue Creek - North Fork	Mount Vernon High School	Water Quality and Quantity	County – FCPS	$480,000
DC9106	Stormwater Pond Retrofit	Dogue Creek - Barnyard Run	Groveton Woods Condominiums	Water Quality and Quantity	Private	$89,000
DC9201	Stream Restoration	Dogue Creek - North Fork	Between Presidential Dr and Volunteer Dr	Water Quality	Private Residential	$646,000
DC9202	Stream Restoration	Dogue Creek - North Fork	Between Sulgrave Dr and Adrienne Dr	Water Quality	Private Residential	$925,000
DC9203	Stream Restoration	Dogue Creek - North Fork	Upstream of Mount Zephyr Dr near Maryland St	Water Quality	Private - Residential	$744,000
DC9204	Stream Restoration	Dogue Creek - North Fork	George Washington Park	Water Quality	County - FCPA	$859,000
DC9207	Stream Restoration	Dogue Creek - North Fork	Behind Colony Dr	Water Quality	Private Residential	$646,000
DC9210	Stream Restoration	Dogue Creek - Barnyard Run	Between Parsons Ct and Stover Dr	Water Quality	Private - Residential	$547,000
DC9211	Stream Restoration	Dogue Creek - Barnyard Run	Between Bedrock Ct and Vantage Drive	Water Quality	Private - Residential	$578,000
DC9213	Stream Restoration	Dogue Creek - Mainstem	Greendale Golf Course	Water Quality	County - FCPA	$1,228,000
DC9214	Stream Restoration	Dogue Creek - Mainstem	Greendale Golf Course	Water Quality	County - FCPA	$1,261,000
DC9215	Stream Restoration	Dogue Creek - Piney Run	Behind Rockcliff Ln	Water Quality	Private - Residential	$1,480,000
DC9217	Stream Restoration	Dogue Creek - Mainstem	Between Old Mill Rd and Richmond Hwy	Water Quality	Private	$707,000
DC9218	Stream Restoration	Dogue Creek - Piney Run	Banks Property	Water Quality	County - FCPA	$872,000
DC9400	Culvert Retrofit	Dogue Creek - Mainstem	North side, Telegraph Rd	Water Quality	Private Residential	$27,000
DC9500	BMP/LID	Dogue Creek - North Fork	Smitty's Building Supply	Water Quality	Private Commercial	$262,000
DC9501	BMP/LID	Dogue Creek - North Fork	Various	Water Quality	County/Private	$69,000
DC9503	BMP/LID	Dogue Creek - North Fork	Riverside Elementary School	Water Quality	County - FCPS	$74,000

Priority Structural Projects (10-Year Implementation Plan)[1]						
Project #	**Project Type**	**WMA**	**Location**	**Watershed Benefit**	**Land Owner**	**Cost**
DC9504	BMP/LID	Dogue Creek - North Fork	Mount Vernon High School	Water Quality	County – FCPS	$189,000
DC9505	BMP/LID	Dogue Creek - North Fork	Mount Vernon High School	Water Quality	County – FCPS	$209,000
DC9506	BMP/LID	Dogue Creek - Piney Run	Alderman Dr	Water Quality	State - VDOT	$145,000
DC9507	BMP/LID	Dogue Creek - Piney Run	Parking lots along Westcott Way	Water Quality	Private - Residential	$121,000
DC9508	BMP/LID	Dogue Creek - Piney Run	Shoppers parking lot	Water Quality	Private Commercial	$240,000
DC9510	BMP/LID	Dogue Creek - Mainstem	Hayfield Secondary School	Water Quality	County – FCPS	$223,000
DC9511	BMP/LID	Dogue Creek - Mainstem	Hayfield Plaza	Water Quality	Private Commercial	$228,000
DC9512	BMP/LID	Dogue Creek - Barnyard Run	Groveton Gardens	Water Quality	Private	$34,000
DC9513	BMP/LID	Dogue Creek - Barnyard Run	Groveton Elementary School	Water Quality	County – FCPS	$45,000
DC9518	BMP/LID	Dogue Creek - Mainstem	Kingstowne Village	Water Quality	Private Commercial	$46,000
DC9519	BMP/LID	Dogue Creek - Mainstem	Kingstowne Village	Water Quality	Private Commercial	$58,000
DC9520	BMP/LID	Dogue Creek - Mainstem	Church of Jesus Christ of Latter Day Saints	Water Quality	Private – Church	$163,000
DC9522	BMP/LID	Dogue Creek - Mainstem	Along Clames Dr	Water Quality	State - VDOT	$21,000
DC9523	BMP/LID	Dogue Creek - Mainstem	Virginia Presbyterian Church	Water Quality	Private – Church	$48,000
DC9600	Flood Protection/Mitigation	Dogue Creek - North Fork	Culvert under Ashboro Drive	Flood Mitigation	State – VDOT	$488,000
FM9102	New Stormwater Pond	Four Mile Run	Hollybrook II Condos	Water Quality and Quantity	Private - Residential	$2,326,000
FM9104	Stormwater Pond Retrofit	Four Mile Run	Hampton Inn off 14th Street and Leesburg Pike	Water Quality and Quantity	Private Commercial	$99,000
FM9105	New Stormwater Pond	Four Mile Run	Off Carlin Springs Rd	Water Quality and Quantity	Private - Commercial	$498,000

Priority Structural Projects (10-Year Implementation Plan)[1]						
Project #	**Project Type**	**WMA**	**Location**	**Watershed Benefit**	**Land Owner**	**Cost**
FM9300	Area-wide Drainage Improvements	Four Mile Run	North of Williamsburg Blvd and Custis Memorial Pkwy and south of Haycock Rd	Water Quality	Private Residential and State - VDOT	$1,833,000
FM9500	BMP/LID	Four Mile Run	St. Andrews Parish	Water Quality	Private - Church	$92,000
FM9501	BMP/LID	Four Mile Run	St. Katherine's Greek Orthodox	Water Quality	Private - Church	$52,000
FM9502	BMP/LID	Four Mile Run	Target Greatland	Water Quality	Private Commercial	$479,000
FM9503	BMP/LID	Four Mile Run	Korean Cultural Center	Water Quality	Private	$79,000
					Total Cost	**$26,683,000**

Long Term Structural Projects (25 Year Implementation Plan)					
Project #	**Project Type**	**WMA**	**Location**	**Watershed Benefit**	**Land Owner**
BE9701	Outfall Improvement	Belle Haven	Quander Road School	Water Quality	Public/Local
DC9101	Stormwater Pond Retrofit	Dogue Creek - North Fork	End of Purks Ct	Water Quality and Quantity	Private
DC9102	Stormwater Pond Retrofit	Dogue Creek - Piney Run	Kingstowne Fire Station	Water Quality and Quantity	Private
DC9104	Stormwater Pond Retrofit	Dogue Creek - Piney Run	Kingstowne Village Pkwy at Ashby Ln	Water Quality and Quantity	Public/Local
DC9105	Stormwater Pond Retrofit	Dogue Creek - Piney Run	Manchester Lake Dr	Water Quality and Quantity	Private
DC9107	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Devereux West	Water Quality and Quantity	Private
DC9108	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Crossroads Residential School	Water Quality and Quantity	Private – School
DC9109	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Church of Jesus Christ of Latter Day Saints	Water Quality and Quantity	Private – Church
DC9110	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Virginia Presbyterian Church	Water Quality and Quantity	Private – Church
DC9200	Stream Restoration	Dogue Creek - North Fork	Robertson Blvd	Water Quality	Private Residential
DC9205	Stream Restoration	Dogue Creek - North Fork	Between Oak Leaf Dr and McNair Dr	Water Quality	Private

Long Term Structural Projects (25 Year Implementation Plan)					
Project #	**Project Type**	**WMA**	**Location**	**Watershed Benefit**	**Land Owner**
DC9206	Stream Restoration	Dogue Creek - North Fork	Rosemont Ave and Rosemont Cir	Water Quality	Private
DC9208	Stream Restoration	Dogue Creek - Mainstem	8822 Richmond Highway (between Old Mill Rd and Sacramento Dr)	Water Quality	County-FCPA, Private
DC9209	Stream Restoration	Dogue Creek - Mainstem	Upstream of Old Mill Rd (Close to Pope Leighy House)	Water Quality	Private
DC9212	Stream Restoration	Dogue Creek - Mainstem	Wickford Park	Water Quality	Public/Local
DC9216	Stream Restoration	Dogue Creek - Piney Run	Rock Ridge Ln	Water Quality	Private
DC9401	Culvert Retrofit	Dogue Creek - North Fork	Lawrence St between Central Park and Ashboro Dr	Water Quality	State - VDOT
DC9502	BMP/LID	Dogue Creek - North Fork	KinderCare Learning Center, Buckman Rd	Water Quality	Public/Local
DC9509	BMP/LID	Dogue Creek - Piney Run	Calvary Baptist Church and Christian School	Water Quality	Private
DC9514	BMP/LID	Dogue Creek - Barnyard Run	Faith United Methodist Church	Water Quality	Public/Local
DC9515	BMP/LID	Dogue Creek - Mainstem	The Shops at Telegraph	Water Quality	Private – Commercial
DC9516	BMP/LID	Dogue Creek - Mainstem	Crossroads Residential School	Water Quality	Private – School
DC9517	BMP/LID	Dogue Creek - Mainstem	Kinder Care Learning Center, May Blvd	Water Quality	Private - Commercial
DC9521	Stormwater Pond Retrofit	Dogue Creek - Mainstem	Franconia Road at Morning Glory Dr	Water Quality and Quantity	Private
DC9701	Outfall Improvement	Dogue Creek - Piney Run	Behind 6115 Summer Park Ln	Water Quality	Private
DC9702	Outfall Improvement	Dogue Creek - Piney Run	Rock Ridge Ln	Water Quality	Public/Local
DC9703	Outfall Improvement	Dogue Creek - Barnyard Run	Harrison Ln	Water Quality	County-FCPA, Private
FM9100	Stormwater Pond Retrofit	Four Mile Run	Fallswood Glen Ct	Water Quality and Quantity	Unknown

Long Term Structural Projects (25 Year Implementation Plan)					
Project #	**Project Type**	**WMA**	**Location**	**Watershed Benefit**	**Land Owner**
FM9101	Stormwater Pond Retrofit	Four Mile Run	Along Arlington Blvd near Kelsey Ct	Water Quality and Quantity	Unknown
FM9103	Stormwater Pond Retrofit	Four Mile Run	Commercial center at Arlington Blvd and Wilson Blvd	Water Quality and Quantity	Private
FM9106	Stormwater Pond Retrofit	Four Mile Run	Diehl Ct	Water Quality and Quantity	Public/Local
FM9200	Stream Restoration	Four Mile Run	Upstream of Henry Dr and Brook Dr	Water Quality	Private Residential

Non-Structural Projects					
Project #	**Project Type**	**WMA**	**Location**	**Watershed Benefit**	**Land Owner**
DC9800	Buffer Restoration	Dogue Creek - Mainstem	Buffer restoration adjacent to commercial / industrial site, Dogue Ct	Water Quality and Quantity	Private
DC9801	Buffer Restoration	Dogue Creek - Mainstem	Stream adjacent to Huntley Meadows near Sheridonna La. Reach DCPY006	Water Quality and Quantity	Private, FCPA
DC9802	Buffer Restoration	Dogue Creek - Piney Run	Hilltop Golf Course	Water Quality and Quantity	Private
DC9803	Wetland Mitigation	Dogue Creek – North Fork	Riverside Elementary School	Water Quality	Public/Local
DC9901	Rain Barrel Programs – Downspout Disconnection	Multiple	Watershed-wide	Water Quality and Quantity	Various
DC9902	Rain Barrel Programs – Rain Barrels	Multiple	Watershed-wide	Water Quality and Quantity	Various
DC9903	Community Outreach/ Public Education – Lawn Care Outreach	Multiple	Watershed-wide	Water Quality	Various
DC9904	Community Outreach/ Public Education – Storm Drain Marking	Multiple	Watershed-wide	Water Quality	Various
DC9905	Community Outreach/ Public Education – Tree Planting	Multiple	Watershed-wide	Water Quality and Quantity	Various

Non-Structural Projects					
Project #	**Project Type**	**WMA**	**Location**	**Watershed Benefit**	**Land Owner**
DC9906	Community Outreach/Public Education – Turf Management	Multiple	Watershed-wide	Water Quality	Various
DC9907	Inspection/Enforcement Enhancement Project – Dumpster Maintenance	Multiple	Watershed-wide	Water Quality	Various
DC9908	Inspection/Enforcement Enhancement Project – Outdoor Mat'l Storage	Multiple	Watershed-wide	Water Quality	Various
DC9909	Inspection/Enforcement Enhancement Project – Vehicle Maintenance	Multiple	Watershed-wide	Water Quality	Various
DC9910	Inspection/Enforcement Enhancement Project – Litter/Trash Enforcement	Multiple	Watershed-wide	Water Quality	Various
DC9911	Dumpsite/Obstruction Removal – Obstruction Removal	Multiple	Watershed-wide	Water Quality	Various
DC9912	Street Sweeping Program	Multiple	Watershed-wide	Water Quality	Various
DC9913	Studies and Assessments – Floatables Control	Multiple	Watershed-wide	Water Quality	Various

[1]Please note that only priority 10-yr structural projects will have associated project fact sheets at the end of section 5

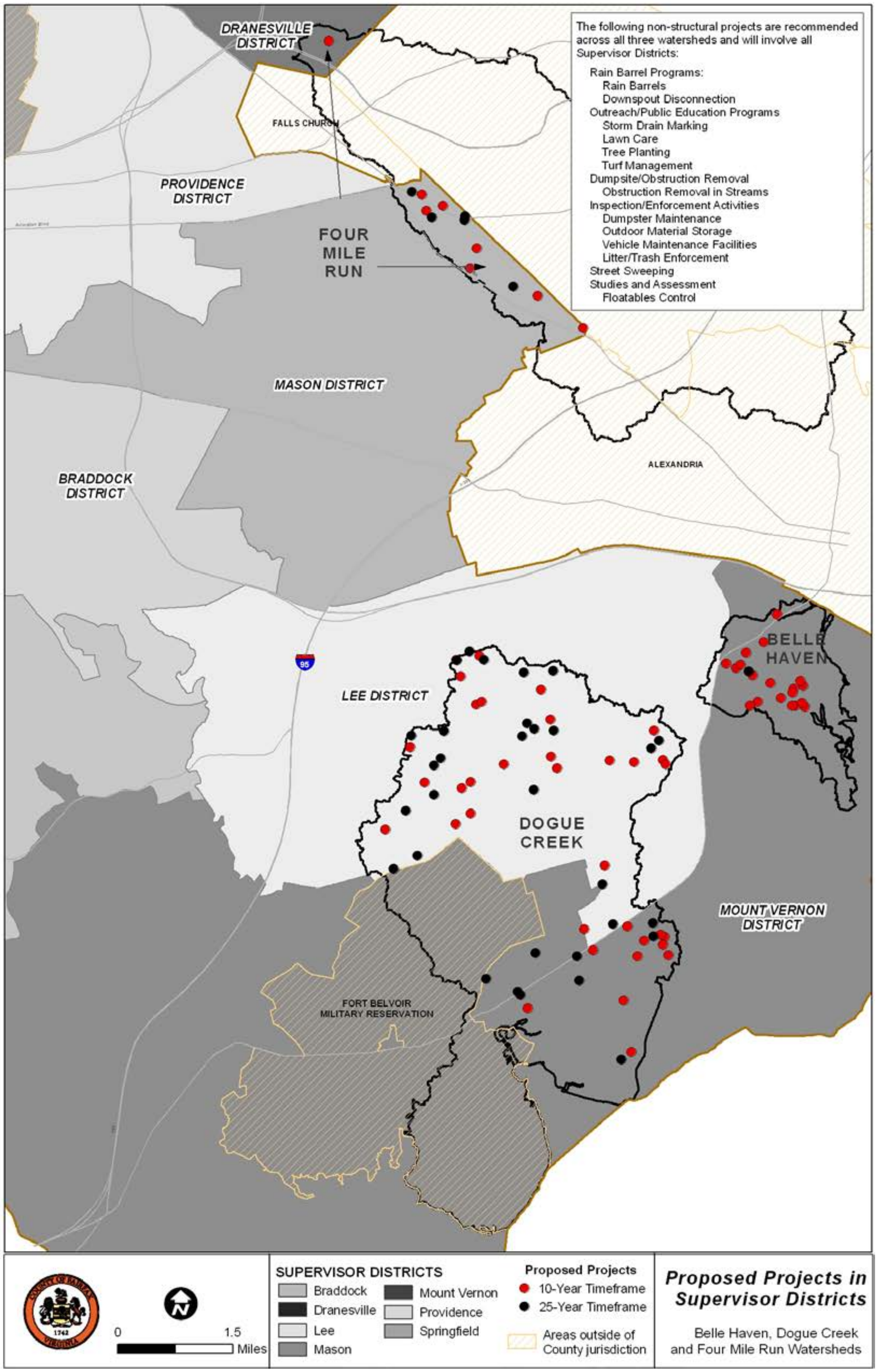


Figure 4-30: Proposed projects in supervisor districts

5 WMA Restoration Strategies

In an area as built-out and diverse as Fairfax County, it is important to understand the specific issues in a watershed in order to determine the best strategy to restore and protect it. To do this, each watershed was divided into Watershed Management Areas, which are generally two to four square miles and are named for the local major tributary. Due to their smaller size, the Belle Haven and Four Mile Run watersheds were not divided into WMAs and thus the entire watershed for each was treated as a single WMA.

5.1 Belle Haven

The results of the subwatershed ranking analysis showed that all the subwatersheds in the Belle Haven watershed were impaired in some form. All except one were among the lowest ranking for the composite score of impacts and sources. In terms of overall ranking, Belle Haven had the four highest priority subwatersheds for the overall project.

Several reaches of Quander Brook, including parts in the headwaters, were incised and unstable, with points of high erosion. Four subwatersheds in this WMA were identified as headwaters and were reviewed for potential stormwater retrofit improvements. The west branch of Belle Haven, in the southeast portion of the watershed, flows partly in a concrete channel through a high-density residential area, but has the potential for restoration. Modeled water quality showed high pollutant loads, primarily from commercial, transportation, single and multi-family residential land uses that predate stormwater management regulations.

Flooding hazards are a significant issue in the Belle Haven watershed, primarily the area draining under the George Washington Memorial Highway, North of Wake Forest Drive. This area is part of a planning process by the US Army Corps of Engineers.

5.1.1 Structural Projects

5.1.1.1 10-Year Projects

<u>BE9100 Stormwater Pond Retrofit</u>

This project is designed to retrofit an existing detention basin adjacent to West Potomac High School by converting it to a shallow wetland. The bottom of the detention basin will be excavated to incorporate wetland planting zones and meandering flow channels. A new control structure will be installed on the existing barrel pipe to increase the pond's detention time.

<u>BE9102 New Stormwater Pond</u>

This project proposes implementation of an extended detention dry pond at Belle View Elementary School. Project BE9102 will treat runoff from Belle View Elementary School rooftops and parking lots.

<u>BE9103 New Stormwater Pond</u>

This project is proposed to create an extended detention dry pond with a sediment forebay at Fairchild Property. The pond is designed for multiple benefits: to provide quantity and quality control for a large untreated impervious area upstream, to reduce erosive flows downstream, to work with the proposed stream restoration projects in Quander Brook and to improve conditions at adjacent storm drain outfalls.

BE9200 Stream Restoration

Most of this project lies within Belle Haven Park property. The channel is currently experiencing severe bank and bed erosion. Restoration of the channel will include regrading and stabilizing the eroded stream banks. Projects BE9103, BE9202 and BE9203 have been proposed upstream of this project and should be completed prior to this project.

BE9201 Stream Restoration

This low gradient reach has been channelized and straightened for its entire length. The potential project consists of removing the concrete channel and restoring natural bed and banks and improving the riparian buffer from Belle View Boulevard downstream to the confluence with the Belle Haven West Channel.

BE9202 Stream Restoration

This 400 linear foot site is located within a moderately forested tract of land and extends from a 72-inch pipe outfall and continues towards Quander Road. Currently this channel is mostly straight, incised, over-widened and contains a riparian buffer that is comprised of many invasive species. Restoration of this channel will include regrading and stabilizing eroded stream banks along with the installation of grade controls, buffer restoration and elimination of invasive species.

BE9203 Stream Restoration

The proposed projects will daylight the culvert adjacent to the car dealership which will help to reduce the back water effect in this area. Restoration of this channel should follow the design and construction of BE9103 and BE9202 to allow for proper stream design and construction between projects.

BE9500 BMP/LID

The proposed project is to create bioretention areas and install tree box filters to treat the roof and parking lot runoff from the Shops at Huntington Gateway. The tree box filters will be installed at the existing storm drain inlets in the parking lot and bioretention areas will be created by grading the existing medians.

BE9501 BMP/LID

Installation of bioretention filters, basins and tree box filters is proposed to treat the runoff from a large commercial strip mall parking lot located along Richmond Highway. A portion of this parking lot in the north is used for a park and ride. This project is located just upstream of project BE9103, which is a proposed stormwater facility.

BE9502 BMP/LID

The proposed project is to install tree box filters to receive parking lot runoff at Quander Road School. The project site is the parking lot east of the school near the entrance. Tree box filters will be installed at three existing inlets in the parking lot.

BE9503 BMP/LID

The project proposes installation of tree box filters at the existing inlets and creation of a bioretention area to treat the runoff from the west side parking lot. Eight existing inlets will be installed with tree box filters and the open area next to the western-most parking lots will be graded and converted to a bioretention area.

BE9504 BMP/LID

The proposed project is designed to install tree box filters and create bioretention areas to receive runoff from the northern section of parking lot at Belle View Shopping Center on Belle View Boulevard. Tree box filters will be installed at four existing inlets and medians will be graded to create bioretention areas.

BE9505 BMP/LID

Installation of a vegetated swale in the median of 14th Street and tree box filters along the roadway will treat road and roof runoff from residences between H Street and Old Towne Road.

BE9506 BMP/LID

Installation of tree box filters along the shoulders and in the medians of Belle View Boulevard is proposed to treat runoff for water quality.

BE9507 BMP/LID

This project would treat runoff from the parking lot and roof of the Belle View Shopping center by implementing bioretention filters and basins in the medians and constructing a tree box filter in the parking lot.

BE9508 BMP/LID

This project would treat runoff from the Belle View Elementary School parking lot by installing bioretention filters and basins in the medians and adjacent grassy areas. This project is located just upstream of project BE9102, which is a proposed stormwater pond.

BE9509 BMP/LID

Tree box filters are proposed at eleven storm drain inlets to treat parking lot runoff from the Mt. Vernon Recreation Center and Sports Complex.

BE9510 BMP/LID

This project consists of implementing bioretention filters and basins along the edges of the parking lot to treat runoff on the west side of West Potomac High School. This project is located just upstream of the stormwater facility retrofit site BE9100.

BE9600 Flood Protection/Mitigation

The storm drain under Princeton Drive is modeled as flooding for the 100-year event, and the road crossing at Yale Drive overtops for the 10-year event. The project would be reconstruction of the road crossing and storm drain.

5.1.1.2 25-Year Projects

BE9701 Outfall Improvement

This project is an outfall retrofit which would repair a failing outfall and eroding channel behind Quander Road School.

5.1.2 Non-Structural Projects

DC9904 Community Outreach/ Public Education – Storm Drain Marking

This project is intended as a watershed-wide outreach program to provide stencils or other markings on storm drain inlets to educate the public, reduce dumping and reduce the amount of litter entering the storm drain system. Several locations were identified in this WMA through the upland reconnaissance assessment, including Belle Haven, Penn Daw MHP, Fordham Village and Belle Haven Towers.

DC9905 Community Outreach/ Public Education – Tree Planting

Restoration of the urban forest has both water quantity and quality benefits. It is one of few methods to reduce temperature impacts of urbanization, and it provides terrestrial habitat as well. This project is intended as a watershed-wide outreach program to encourage tree planting. The upland reconnaissance identified several residential areas that could benefit, including Belle View, Westgrove, New Alexandria, Belle Haven Meadows and Villamay.

DC9906 Community Outreach/ Public Education – Turf Management

This project is intended to reach out to professional turf managers throughout the watershed and help them assess their practices in the context of stormwater runoff quality. In this WMA, Belle Haven Country Club was identified as a project site.

DC9909 Inspection/Enforcement Enhancement Project – Vehicle Maintenance

This project would provide watershed-wide targeted enforcement of spill prevention and pollution prevention regulations for sites where vehicles are maintained. The upland reconnaissance identified a car dealership where materials were stored outside without cover; there was visible staining around the storage area and vehicles were maintained, washed, repaired and stored outside.

DC9911 Dumpsite/Obstruction Removal – Obstruction Removal

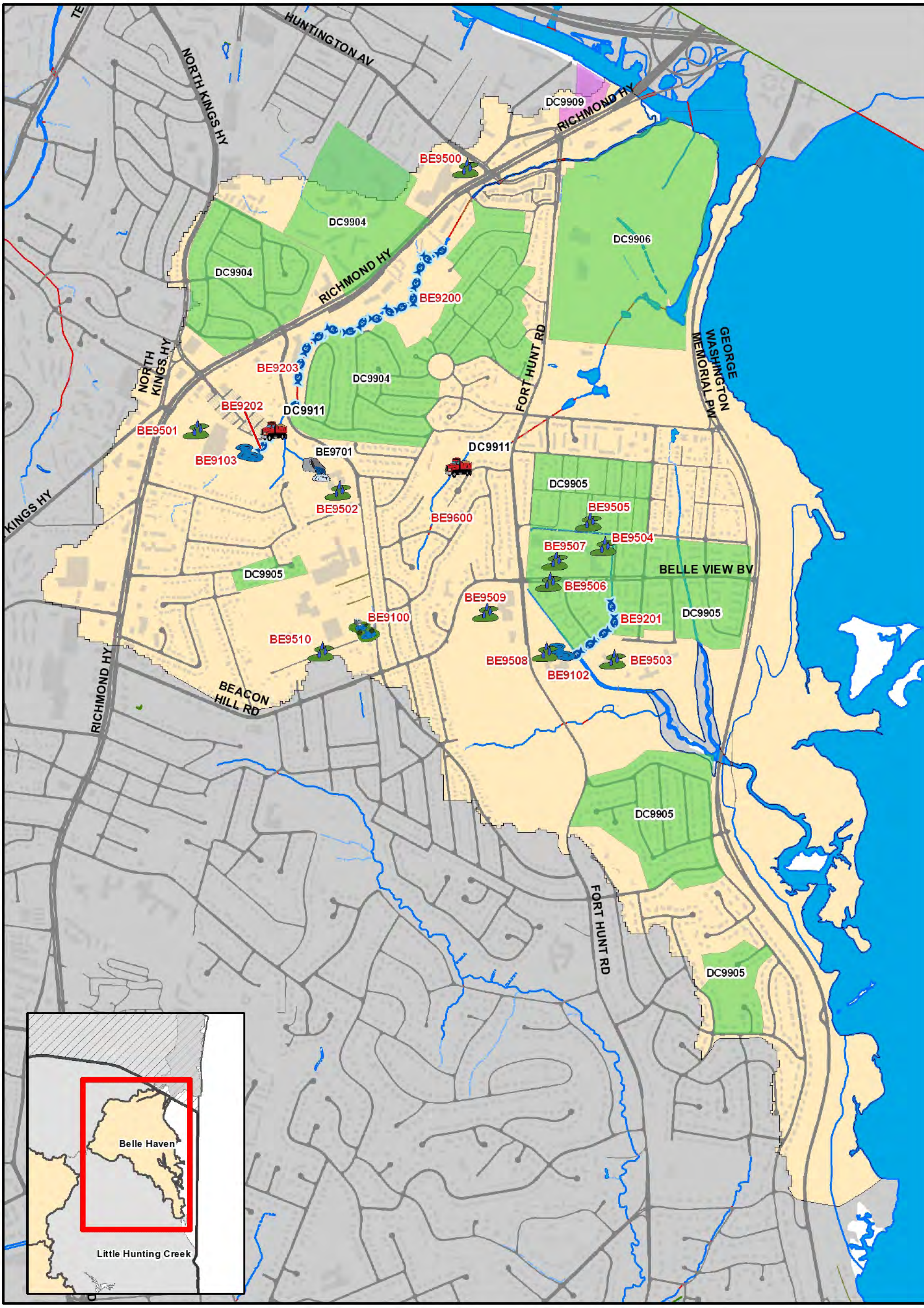
This project is intended as a watershed-wide program to remove obstructions in the stream network. Field assessment identified two stream sites with significant obstructions warranting a removal effort in this WMA. The first is a debris and log jam in the upper reaches of Quander Brook, and the second is debris and downed trees in the channel behind Swan Terrace.

Table 5-1: Belle Haven Projects

Structural Projects[1]						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	**Phase**
BE9100	Stormwater Pond Retrofit	BE-BH-0015	West Potomac High School	Water Quality and Quantity	County - FCPS	1 - 10
BE9102	New Stormwater Pond	BE-BH-0015	Belle View Elementary School	Water Quality and Quantity	County – FCPS	1 - 10
BE9103	New Stormwater Pond	BE-HC-0020	Fairchild Property	Water Quality and Quantity	County	1 - 10
BE9200	Stream Restoration	BE-HC-0010	Belle Haven Park between Richmond Hwy Foxcroft Rd, and Edgewood Ter	Water Quality	County - FCPA	1 - 10
BE9201	Stream Restoration	BE-BH-0015	Belle View Condos	Water Quality	Private - Residential	1 - 10
BE9202	Stream Restoration	BE-HC-0020	Shields Ave	Water Quality	Private - Residential	1 - 10
BE9203	Stream Restoration	BE-HC-0010	Downstream of Quander Rd	Water Quality	Private - Commercial	1 - 10
BE9500	BMP/LID	BE-HC-0025	Shops at Huntington Gateway	Water Quality	Private - Commercial	1 - 10
BE9501	BMP/LID	BE-HC-0020	Wal-Mart and Chuck E. Cheese parking lot	Water Quality	Private - Commercial	1 - 10
BE9502	BMP/LID	BE-HC-0015	Quander Road School	Water Quality	County - FCPS	1 - 10
BE9503	BMP/LID	BE-BH-0015	River Towers	Water Quality	Private – Residential	1 - 10
BE9504	BMP/LID	BE-BH-0015	Belle View Shopping Center	Water Quality	Private - Commercial	1 - 10
BE9505	BMP/LID	BE-BH-0015	14th St between H St and I St	Water Quality	State - VDOT	1 - 10
BE9506	BMP/LID	BE-BH-0015	Belle View Blvd	Water Quality	State - VDOT	1 - 10
BE9507	BMP/LID	BE-BH-0015	Belle View Shopping Center	Water Quality	Private – Commercial	1 - 10
BE9508	BMP/LID	Multiple	Belle View Elementary School	Water Quality	County – FCPS	1 - 10
BE9509	BMP/LID	Multiple	Mt. Vernon Recreation Center	Water Quality	County - FCPA	1 - 10
BE9510	BMP/LID	BE-BH-0015	West Potomac High	Water Quality	County - FCPS	1 - 10

Structural Projects[1]						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	**Phase**
			School			
BE9600	Flood Protection/Mitigation	BE-BH-0015	Culvert under Yale Dr	Flood Mitigation	State - VDOT	1 - 10
BE9701	Outfall Improvement	BE-HC-0015	Quander Road School	Water Quality	Public/Local	11 - 25
Non-Structural Projects						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	
DC9904	Community Outreach/ Public Education – Storm Drain Marking	Multiple	Watershed-wide	Water Quality	Various	
DC9905	Community Outreach/ Public Education – Tree Planting	Multiple	Watershed-wide	Water Quality and Quantity	Private	
DC9906	Community Outreach/ Public Education – Turf Management	BE-HC-0000	Belle Haven Country Club	Water Quality	Private	
DC9909	Inspection/Enforcement Enhancement Project – Vehicle Maintenance	Multiple	Car dealerships	Water Quality	Private	
DC9911	Dumpsite/Obstruction Removal – Obstruction Removal	BE-BH-0015 BE-HC-0020	Upper reach of Quander Brook and behind Swan Ter	Water Quality	Private	

[1]Only the 10-year structural projects will have an associated project fact sheet.



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Buffer Restoration
Stream Restoration
BMP/LID
Culvert Retrofit
Dumpsite/Obstruction Removal
New Stormwater Pond
Outfall Improvement
Stormwater Pond Retrofit
Other
Community Outreach/Public Education
Area-wide Drainage Improvement
Land Conservation Project
Flood Protection/Mitigation
Inspection/Enforcement Enhancement
Rain Barrel Program
Street Sweeping Program
Studies, Surveys and Assessments

Implementation timeframe denoted by project label color. Red = 0-10 years Black = 11-25 years and non-structural projects.

Map 5.1

WMA: Belle Haven Proposed Projects

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5.2 Dogue Creek – Barnyard Run Results

The results of the subwatershed ranking analysis showed that most of the subwatersheds in Barnyard Run were in good condition, primarily due to the influence of Huntley Meadows Park, which made up all or most of the land area in the lower part of the WMA. In addition, Lee District Park makes up part of the headwaters of this tributary. Three subwatersheds were identified as headwaters and were reviewed for potential retrofits and improvements.

None of the subwatersheds in the Barnyard Run WMA were ranked among the highest priority areas for stream problems; however, there are potential projects for restoration of concrete channels in three subwatersheds. No significant flooding issues were identified.

5.2.1 Structural Projects

5.2.1.1 10-Year Projects

<u>DC9106 Stormwater Pond Retrofit</u>

There is an existing detention basin located at Groveton Woods Condominiums, adjacent to Lafayette Village Apartments that may be converted to a shallow wetland by removing the existing concrete low flow channels, excavating the existing bottom to incorporate wetland planting zones and meandering flow channels and modifying the riser.

<u>DC9210 Stream Restoration</u>

This project is located in Woodstone HOA between Parsons Court and Stover Drive and extends from Bedrock Road downstream to an existing tree line just north of the Huntley Meadows Park boundary. Currently, this channel is concrete lined and very straight with a narrow strip of mowed grass on each side of the channel. Restoration efforts should focus on removing the existing 500’ of concrete channel and replacing it with a more natural channel with an improved buffer on each bank.

<u>DC9211 Stream Restoration</u>

This project is located within Woodstone HOA between Vantage Drive and Bedrock Court and extends from Bedrock Road downstream to just north of the Huntley Meadows Park boundary. The channel is straight, concrete lined and has a narrow strip of mowed grass on each side. The downstream portion of this channel is mostly forested. Restoration efforts should focus on replacing the existing concrete channel with a restored natural channel.

<u>DC9512 BMP/LID</u>

This project involves installation of tree box filters and creation of bioretention areas to treat runoff from parking lots at Groveton Gardens. One existing storm drain inlet will be retrofitted with a filter and a low open area adjacent to the parking lot will be graded to create a bioretention area.

<u>DC9513 BMP/LID</u>

A tree box filter and bioretention filters and basins are proposed in the Groveton Elementary School parking lot to treat stormwater runoff. Field assessment showed that this parking lot was currently treated for quantity control; however, quality treatment is lacking at this time.

5.2.1.2 25-Year Projects

DC9514 BMP/LID

This project recommends implementation of tree box filters at the inlets in the Faith United Methodist Church parking lot. This project also provides a good educational opportunity.

DC9703 Outfall Improvement

This project would improve two outfalls along Harrison Lane: a culvert experiencing severe active erosion and a culvert for which the concrete apron is being undermined and has shifted.

5.2.2 Non-Structural Projects

DC9911 Dumpsite/Obstruction Removal – Obstruction Removal

The stream assessment identified trees and debris at two points in stream in Huntley Meadows Park. This project is intended to be part of a watershed-wide program to remove obstructions in the stream network.

Table 5-2: Barnyard Run WMA Projects

Structural Projects[1]						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	**Phase**
DC9106	Stormwater Pond Retrofit	DC-BY-0030	Groveton Woods Condominium	Water Quality and Quantity	Private - Residential	1 - 10
DC9210	Stream Restoration	DC-BY-0035	Between Parsons Ct and Stover Dr	Water Quality	Private - Residential	1 - 10
DC9211	Stream Restoration	DC-BY-0040	Between Bedrock Ct and Vantage Drive	Water Quality	Private - Residential	1 - 10
DC9512	BMP/LID	DC-BY-0030	Groveton Gardens	Water Quality	Private	1 - 10
DC9513	BMP/LID	DC-BY-0030	Groveton Elementary School	Water Quality	County - FCPS	1 - 10
DC9514	BMP/LID	DC-BY-0035	Faith United Methodist Church	Water Quality	Private - Church	11 - 25
DC9703	Outfall Improvement	DC-BY-0030	Harrison Ln	Water Quality	County-FCPA, Private	11 - 25
Non-Structural Projects						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	
DC9911	Dumpsite/Obstruction Removal – Obstruction Removal	DC-BY-0020	Huntley Meadows Park	Water Quality	County -FCPA	

[1]Only the 10-year structural projects will have an associated project fact sheet.

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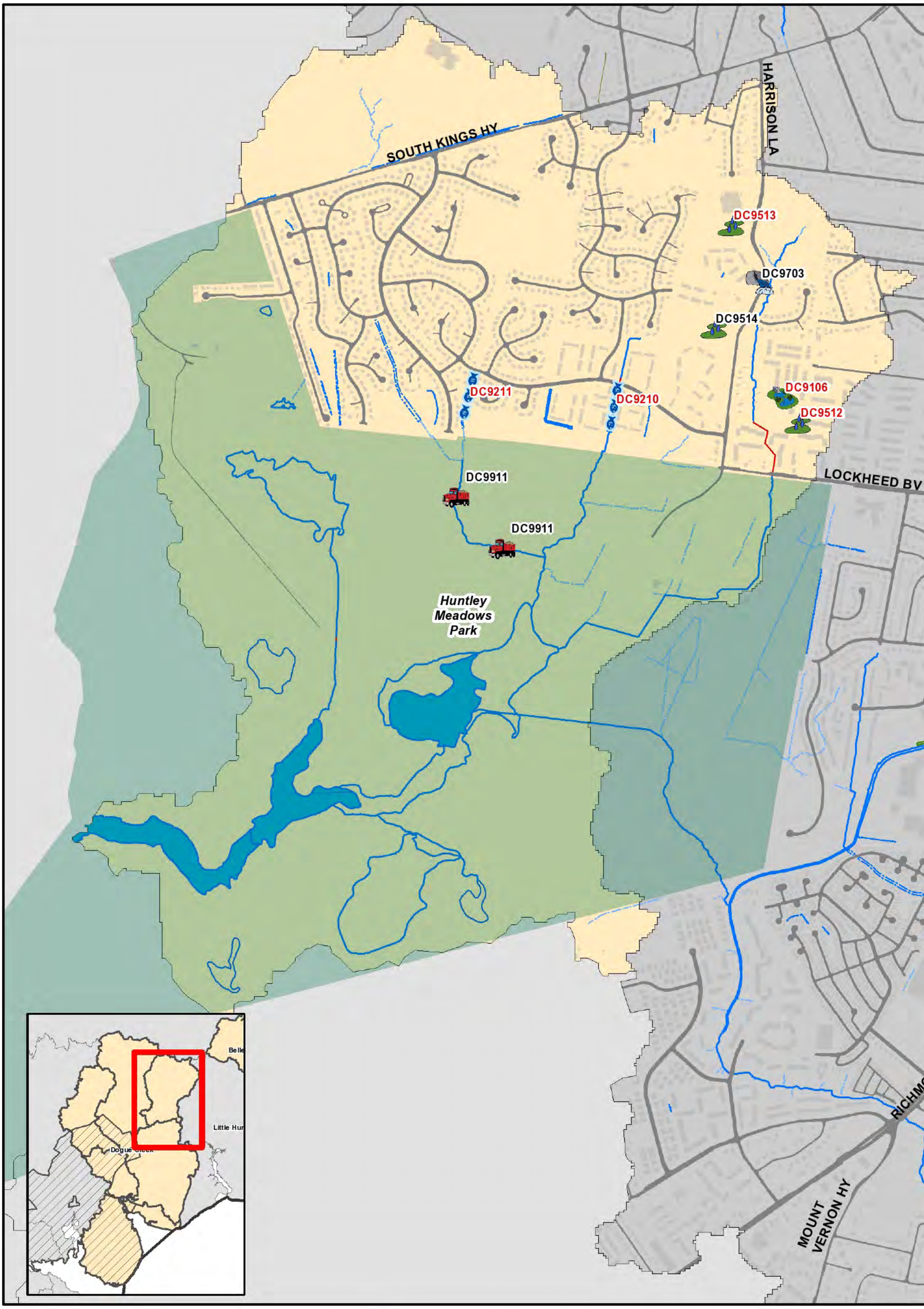

Map 5.2

WMA: Barnyard Run Proposed Projects

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5.3 Dogue Creek – Mainstem Results

The results of the subwatershed ranking analysis showed that a significant number of the subwatersheds in the Mainstem of Dogue Creek were in good condition, primarily due to the influence of undeveloped areas of three large parcels: Huntley Meadows Park, Woodlawn Plantation Greendale Golf Course and Fort Belvoir. Because of its long, narrow shape, many of the subwatersheds in this WMA were identified as headwaters.

Restoration projects were identified in stream reaches with concrete channels or erosion and stability issues. Three sites with impaired buffer were rated with moderate impact and moderate restoration potential.

5.3.1 Structural Projects

5.3.1.1 10-Year projects

DC9213 Stream Restoration

This project is involves restoring three separate concrete lined stream channels within Greendale Golf Course. Restoration efforts should focus on removing the existing concrete channels and replacing them with a more natural channel. Development of a riparian buffer around each natural channel should be incorporated with the restoration if feasible.

DC9214 Stream Restoration

This project is includes restoring two separate natural stream channels that total 2,000 feet, which flow to golf course ponds and have a tree buffer on one bank and a fairway on the other bank. These channels are incised and over-widened. Proposed restoration includes regrading and stabilizing eroded stream and adjusting the profile to reduce active erosion.

DC9217 Stream Restoration

This project would restore three separate sections on Dogue Creek Mainstem between Richmond Highway and Old Mill Road. The areas of severe erosion and deficient buffer included in this project total a restored length of approximately 850 feet.

DC9400 Culvert Retrofit

The project consists of providing an impoundment structure such as a weir wall across the existing stream channel on the upstream (north) side of a culvert under Telegraph Road to provide stormwater management.

DC9510 BMP/LID

Hayfield Secondary School parking lot runoff could be treated by installing bioretention filters and basins in the medians and adjacent grassy areas. The facilities would be installed on the downstream side of each parking lot.

DC9511 BMP/LID

This project would treat runoff from the Hayfield Plaza parking lot by implementing bioretention filters and basins in the grassy areas adjacent to the southern portion of the parking lot. The facilities would most likely be installed on the downstream side of each parking lot.

DC9518 BMP/LID

Installation of tree box filters are proposed to provide water quality treatment for runoff from the parking lot behind the commercial strip mall located along Kingstowne Village Parkway. Currently, the site appears to have quantity treatment in the form of underground storage.

DC9519 BMP/LID

Installation of bioretention filters and basins and tree box filters are proposed to treat runoff from the driveways and parking lots behind the commercial strip mall located between Kingstowne Boulevard and Kingstowne Village Parkway. The open area between the parking lots will be used for bioretention and one existing inlet will be retrofitted with a tree box filter.

DC9520 BMP/LID

Installation of bioretention filters and basins and tree box filters are proposed to treat runoff from the parking lot surrounding the Church of Jesus Christ of Latter Day Saints along Villa Street. Tree box filters can be added near the church building. Parking lot islands as well adjacent grassy areas could be modified for bioretention filters and basins.

DC9522 BMP/LID

Installation of vegetated swales is proposed to treat road and residential runoff along Clames Drive and Higham Drive. The right-of-way along Clames Drive appears to have enough room for placement of the proposed projects. Coordination with existing driveway culverts and property owners will be needed.

DC9523 BMP/LID

Bioretention filters and basins and rooftop disconnection are proposed to treat Virginia Presbyterian Church runoff before entering an existing dry pond located on the east side of the property. In particular, the drains located on the west side of the church could be disconnected and allowed to drain onto open area for filtration and bioretention filters and basins could be placed at the edge of the parking lot to treat water before entering the dry pond.

5.3.1.2 25-Year Projects

DC9107 Stormwater Pond Retrofit

An existing detention basin at Devereux West would be converted to a shallow wetland by removing the existing concrete low flow channels, excavating the pond bottom to incorporate wet storage zones ranging in depth for high and low marshes and installing a new control structure on the barrel pipe.

DC9108 Stormwater Pond Retrofit

This project will reconstruct the existing pond at Crossroads Residential School to enhance water quality treatment and to prevent embankment failure. The inflow for the existing dry pond is currently clogged causing the pond to function as a wet pond or wetland.

DC9109 Stormwater Pond Retrofit

This project would remove the concrete channels in the existing stormwater management pond at the Church of Jesus Christ of Latter Day Saints at Franconia Road and South Van Dorn Street. There would be some excavation to allow water quality, aquatic vegetation would be added and the riser would require debris clearing.

DC9110 Stormwater Pond Retrofit

This is a retrofit of a stormwater management pond treating a parking lot next to Virginia Presbyterian Church. This project would remove the concrete channels in the existing stormwater management pond and plant aquatic vegetation.

DC9208 Stream Restoration

This project is a stream restoration for a reach at 8822 Richmond Highway (between Old Mill Road and Sacramento Drive) with an exposed sewer manhole and vertical banks.

DC9209 Stream Restoration

This stream restoration would repair moderate bank erosion for a 700 foot reach upstream of Old Mill Road assessed with active widening.

DC9212 Stream Restoration

This project would restore the existing 400 foot concrete channel at Wickford Park to a natural channel design.

DC9515 BMP/LID

This project would convert several parking lot islands at The Shops at Telegraph to bioretention areas. This project would treat approximately half of the stormwater runoff from the parking lot and associated buildings.

DC9516 BMP/LID

This project is a retrofit of a parking lot at Crossroads Residential School and includes adding dry swales, bioretention and water quality inlets for water quality treatment. Existing water and electric lines, a storm drain and trees would affect implementation. The pond proposed in project DC9108 located east of the school would add additional water quality treatment along with providing water quantity control for the site.

DC9517 BMP/LID

This project is a retrofit of a parking lot at the KinderCare Learning Center on May Boulevard which currently drains to a yard inlet. The project would create a rain garden at the existing inlet to allow for water quality treatment. Design and implementation would need to take child safety into account.

DC9521 BMP/LID

This would retrofit an existing dry pond at Franconia Road at Morning Glory Drive by converting to a dry swale to add water quality treatment. Debris would also be removed from the existing inlets.

5.3.2 Non-Structural Projects

DC9800 Buffer Restoration

Stream assessment information was used to identify areas of deficient buffer with the potential for restoration. This site is adjacent to a commercial and industrial area. The project would consist of revegetating or reforesting the riparian buffer to enhance streambank stability and provide habitat.

DC9801 Buffer Restoration

This site is near Sheridonna Lane adjacent to Huntley Meadows Park. Stream assessment information was used to identify areas of deficient buffer with the potential for restoration. The project would consist of revegetating or reforesting the riparian buffer to enhance streambank stability and provide habitat.

DC9901 Rain Barrel Programs – Downspout Disconnection

The upland reconnaissance identified several commercial sites where downspouts were directly connected to storm drains and a watershed-wide outreach program could be beneficial in reducing runoff volume or peak flows. In this WMA, two gas stations, and an auto center at the corner of Route 1 and Mt. Vernon Memorial Highway were noted.

DC9903 Community Outreach/ Public Education – Lawn Care

This project would be part of a watershed-wide outreach program to homeowners to provide education and guidance on lawn care practices that could potentially reduce pollutants in stormwater runoff. The upland reconnaissance identified one multifamily residential neighborhood (Gilford) with high-maintenance lawns that could be targeted with this effort.

DC9905 Community Outreach/ Public Education – Tree Planting

This project is intended as a watershed-wide outreach program to encourage tree planting, which has both water quantity and quality benefits and is one of few methods to reduce temperature impacts of urbanization, and it provides terrestrial habitat as well. One multi-family neighborhood (Gilford) was identified as a potential outreach target.

DC9906 Community Outreach/ Public Education – Turf Management

This project is intended to reach out to professional turf managers throughout the watershed and help them assess their practices in the context of stormwater runoff quality. In this WMA, Greendale Golf Course was identified as a project site. It is part of the Fairfax County Parks system.

DC9907 Inspection/Enforcement Enhancement Project – Dumpster Maintenance

Poorly maintained dumpsters and other waste management practices are a source of litter and pollutants in stormwater runoff. This project is a watershed-wide enforcement and outreach approach to properties where problems were identified during the upland reconnaissance. Dumpsters in this WMA with evidence of leakage, lack of cover, and direct connection to storm drain inlets were flagged as hotspots.

DC9909 Inspection/Enforcement Enhancement Project – Vehicle Maintenance

This project would provide watershed-wide targeted enforcement of spill prevention and pollution prevention regulations for sites where vehicles are maintained. The upland reconnaissance identified two gas stations and an auto center at the corner of Route 1 and Mt. Vernon Memorial Highway where vehicles were stored, repaired and maintained outside; there was evidence of spill and leakage from vehicles, and uncovered fueling areas were present and directly connecting to storm drains.

DC9911 Dumpsite/Obstruction Removal – Obstruction Removal

This project is intended as a watershed-wide program to remove obstructions in the stream network. Two sites were identified during field assessment where trees, sediment, and debris had created a blockage.

Table 5-3: Mainstem WMA Projects

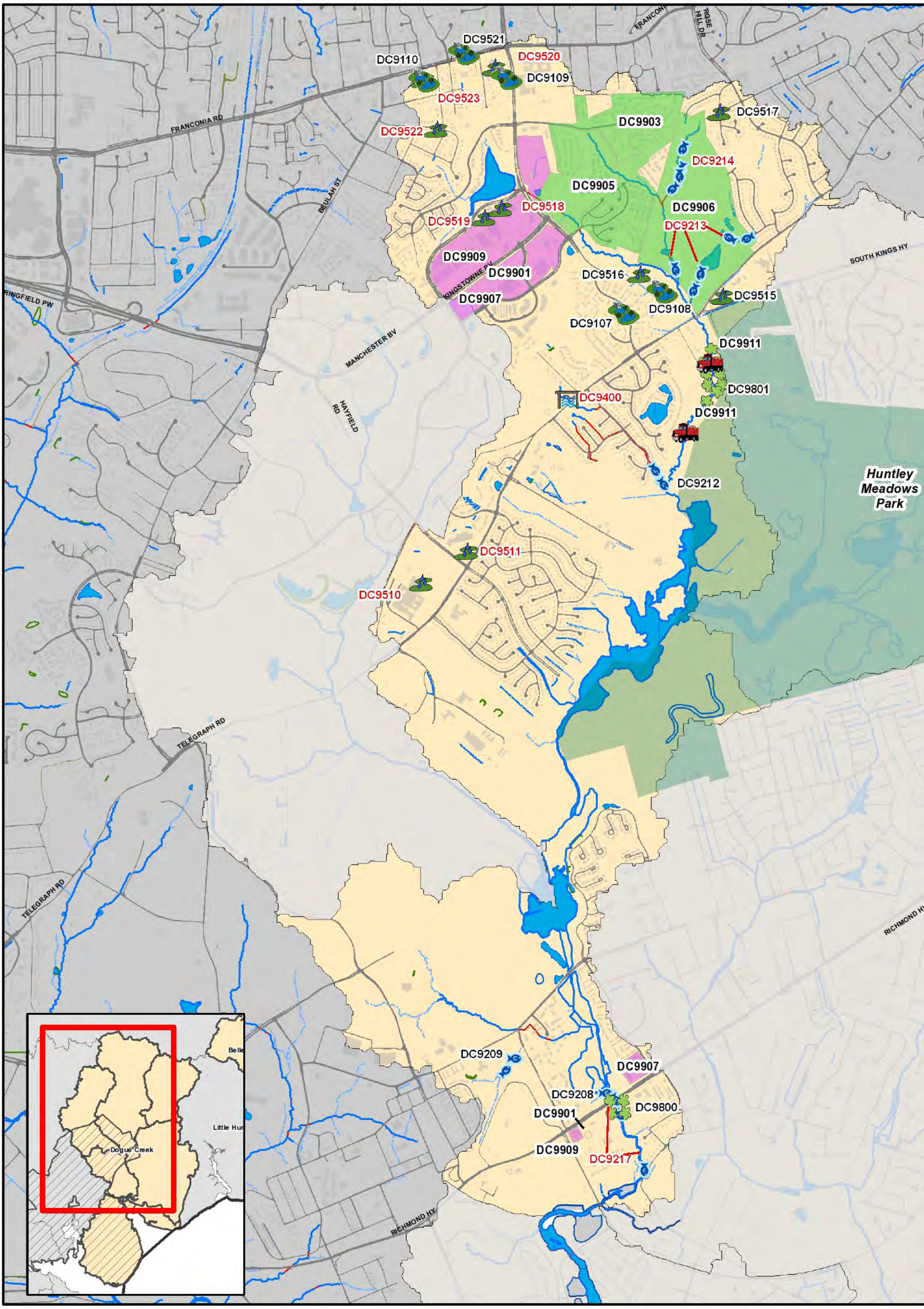
Structural Projects[1]						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	**Phase**
DC9213	Stream Restoration	DC-DC-0090	Greendale Golf Course	Water Quality	County - FCPA	1 - 10
DC9214	Stream Restoration	DC-DC-0100	Greendale Golf Course	Water Quality	County - FCPA	1 - 10
DC9217	Stream Restoration	DC-DC-0000	Between Old Mill Rd and Richmond Hwy	Water Quality	Private	1 - 10
DC9400	Culvert Retrofit	DC-DC-0075	North side, Telegraph Rd	Water Quality	State – VDOT	1 - 10
DC9510	BMP/LID	DC-DC-0050	Hayfield Secondary School	Water Quality	County - FCPS	1 - 10
DC9511	BMP/LID	DC-DC-0050	Hayfield Plaza	Water Quality	Private - Commercial	1 - 10
DC9518	BMP/LID	DC-DC-0110	Kingstowne Village	Water Quality	Private - Commercial	1 - 10
DC9519	BMP/LID	DC-DC-0110	Kingstowne Village	Water Quality	Private - Commercial	1 - 10
DC9520	BMP/LID	DC-DC-0110	Church of Jesus Christ of Latter Day Saints	Water Quality	Private – Church	1 - 10
DC9522	BMP/LID	DC-DC-0110	Clames Dr	Water Quality	State - VDOT	1 - 10
DC9523	BMP/LID	DC-DC-0110	Virginia Presbyterian Church	Water Quality	Private - Church	1 - 10
DC9107	Stormwater Pond Retrofit	DC-DC-0085	Devereux West	Water Quality and Quantity	Private	11 - 25
DC9108	Stormwater Pond Retrofit	DC-DC-0085	Crossroads Residential School	Water Quality and Quantity	Private - School	11 - 25
DC9109	Stormwater Pond Retrofit	DC-DC-0110	Church of Jesus Christ of Latter Day Saints	Water Quality and Quantity	Private - Church	11 - 25
DC9110	Stormwater Pond Retrofit	DC-DC-0110	Virginia Presbyterian Church	Water Quality and Quantity	Private - Church	11 - 25
DC9208	Stream Restoration	DC-DC-0010	8822 Richmond Hwy (between Old Mill Rd and Sacramento Dr)	Water Quality	County- FCPA, Private	11 - 25
DC9209	Stream Restoration	DC-DC-0015	Upstream of Old Mill Rd (Close to Pope Leighy House)	Water Quality	Private	11 - 25
DC9212	Stream Restoration	DC-DC-0065	Wickford Park	Water Quality	Public/Local	11 - 25

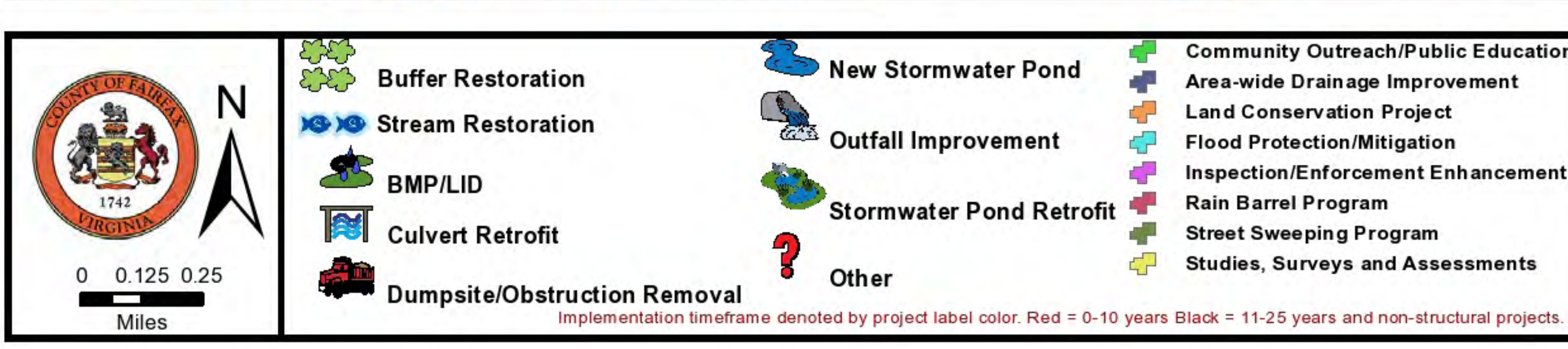
Structural Projects[1]						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	**Phase**
DC9515	BMP/LID	DC-DC-0085	The Shops at Telegraph	Water Quality	Private - Commercial	11 - 25
DC9516	BMP/LID	DC-DC-0085	Crossroads Residential School	Water Quality	Private - School	11 - 25
DC9517	BMP/LID	DC-DC-0100	KinderCare Learning Center, May Blvd	Water Quality	Private - Commercial	11 - 25
DC9521	BMP/LID	DC-DC-0110	Franconia Rd at Morning Glory Dr	Water Quality and Quantity	Private - Residential	11 - 25

Non-Structural Projects					
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**
DC9800	Buffer Restoration	DC-DC-0000	Buffer restoration adjacent to commercial / industrial site, Dogue Ct	Water Quality and Quantity	Private
DC9801	Buffer Restoration	DC-DC-0080	Stream adjacent to Huntley Meadows near Sheridonna Ln	Water Quality and Quantity	Private, FCPA
DC9901	Rain Barrel Programs – Downspout Disconnection	Multiple	Watershed-wide	Water Quality and Quantity	Private
DC9903	Community Outreach/ Public Education – Lawn Care	Multiple	Watershed-wide	Water Quality	Private
DC9905	Community Outreach/ Public Education – Tree Planting	Multiple	Watershed-wide	Water Quality and Quantity	Private
DC9906	Community Outreach/ Public Education – Turf Management	DC-DC-0090	Greendale Golf Course	Water Quality	County - FCPA
DC9907	Inspection/Enforcement Enhancement Project – Dumpster Maintenance	Multiple	Watershed-wide	Water Quality	Private
DC9909	Inspection/Enforcement Enhancement Project – Vehicle Maintenance	Multiple	Gas stations and auto centers	Water Quality	Private

Non-Structural Projects					
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**
DC9911	Dumpsite/Obstruction Removal – Obstruction Removal	DC-DC-0080	Trees and debris in mainstem in Huntley Meadows Park	Water Quality	County - FCPA

[1]Only the 10-year structural projects will have an associated project fact sheet.





Map 5.3

WMA: Mainstem Proposed Projects

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5.4 Dogue Creek – North Fork Results

The subwatershed ranking analysis showed that all but two of the subwatersheds in North Fork were impaired in some form. Most of the subwatersheds were among the lowest ranking. Nine subwatersheds were identified as headwaters and were reviewed for potential stormwater retrofit improvements.

Analysis showed low ratings in stream quality. Many streams have been channelized with a concrete channel but have potential for restoration to a more natural condition. Several of the streams were ranked poor for aquatic habitat. There were a number of reaches described as unstable and actively eroding, with either good or moderate restoration potential.

5.4.1 Structural Projects

5.4.1.1 10-Year Projects

DC9100 New Stormwater Pond

The project proposes creation of an extended detention dry pond with a sediment forebay at Mount Vernon High School. Runoff from the roofs and parking lots will be treated for water quantity control and water quality. The proposed pond will be implemented in open space adjacent to the track and field.

DC9201 Stream Restoration

This site is characterized by severe erosion and has a high restoration potential. The site runs through a wooded residential area between Presidential Drive and Volunteer Drive and extends from just upstream of Cherrytree Drive to Robertson Boulevard. Several other items, including utility line stabilization, a head cut and obstructions could be remedied at this site as part of the stream restoration project.

DC9202 Stream Restoration

This 1350 LF site is located within a moderately forested tract of land and sits between Sulgrave Drive and Adrienne Drive. Based on existing conditions, this project would consist of spot stabilization treatments, using both hard and soft engineering techniques. Minor changes in channel dimensions would be required.

DC9203 Stream Restoration

This project is a stream restoration upstream of Mount Zephyr Drive near Maryland Street. This reach is currently experiencing moderate to severe erosion along both banks. Restoration will include reconnecting this channel back to the original floodplain and installing grade controls to help prevent future downcutting and overwidening.

DC9204 Stream Restoration

This site is located within George Washington Park between Quisenberry Drive and Old Mount Vernon Road. The existing conditions within the reach include several head cuts, incision areas and destabilized banks. Restoration efforts should focus on reconnecting this channel to the floodplain by reducing channel dimensions and raising bed elevations through profile adjustments, regrading and stabilizing stream banks.

DC9207 Stream Restoration

Most of this channel is over-widened, unstable and incised with eroded banks on straight reaches of the stream. Restoration of this channel will focus on creating a nested channel, where the floodplain and banks of the current channel will be regraded to allow for a new floodplain at an elevation lower than the original floodplain.

DC9500 BMP/LID

Installation of bioretention filters and basins and tree box filters are proposed to treat runoff from the parking lot surrounding Smitty's Building Supply and adjacent areas along Richmond Highway.

DC9501 BMP/LID

Bioretention filters and basins are proposed for construction at low points of the parking lots in this area to capture and treat the runoff. The sites at Maury Place located between the street and the lot would require construction of a depressed berm. Removal of either play area or parking and curb cuts might be required for the site at the foot of Mohawk Lane.

DC9503 BMP/LID

This project would treat runoff from the parking lots at Riverside Elementary School and George Washington Recreational area by implementing bioretention filters and basins and tree box filters in the medians and in adjacent grassy areas in the parking lots.

DC9504 BMP/LID

Mount Vernon High School south parking lot runoff would be treated by installing bioretention filters and basins and tree box filters in and along the edges of the parking lot. Tree box filters will be suitable in the parking lot and bioretention filters are possible at the south edge of the parking lot.

DC9505 BMP/LID

Mount Vernon High School north parking lot runoff would be treated by installing bioretention filters and basins and tree box filters in and along the edges of the parking lot. All but one of these sites are located just upstream of a proposed stormwater project (DC9100) and could be designed as a system to maximize pre-treatment, water quality benefits and water quantity storage.

DC9600 Flood Protection/Mitigation

The crossing at Ashboro Drive overtops. Culvert reconstruction could reduce backwater effects.

5.4.1.2 25-Year Projects

DC9101 Stormwater Pond Retrofit

This project would convert the existing stormwater management pond at the end of Purks Court to a shallow marsh to allow for additional water quality treatment.

DC9200 Stream Restoration

This 700 linear foot site is characterized by a concrete channel. The intention of this project would be to remove the concrete channel and develop a natural stream channel. The proposed restoration site runs from Robertson Boulevard to Craig Avenue and should be completed after project DC9201, located upstream.

DC9205 Stream Restoration

The concrete channel for the reach between Oak Leaf Drive and McNair Drive would be partially or completely removed as part of this stream restoration project. This would restore the channel to more natural conditions.

DC9206 Stream Restoration

This stream restoration project would restore the stream reach at Rosemont Avenue and Rosemont Circle to a more natural condition by removing the concrete channel and should be completed after project DC9205, located upstream. The riparian buffer would be replanted as well.

DC9401 Culvert Retrofit

This culvert retrofit would regrade and revegetate an existing grass swale along Lawrence Street between Central Park and Ashboro Drive.

DC9502 BMP/LID

This project would place tree box filters or bioretention filters at all curb inlets at the KinderCare Learning Center on Buckman Road.

5.4.2 Non-Structural Projects

DC9803 Wetland Mitigation

This project would expand the existing wetland adjacent to Riverside Elementary School and could include an educational component with boardwalk and signage. Additionally, the existing wetland would benefit from the removal of several invasive species.

DC9901 Rain Barrel Programs – Downspout Disconnection

This project is intended as a watershed-wide outreach program that could reduce the runoff volume or peak flows. The upland reconnaissance identified several commercial sites where downspouts were directly connected to storm drains. In this WMA, several gas stations and other businesses on Richmond Highway were flagged for potential downspout disconnection.

DC9902 Rain Barrel Programs – Rain Barrels

Rain barrels are the residential solution and a first step to downspout disconnection. This project would be a watershed-wide outreach program to encourage their use. Six neighborhoods were identified during the upland reconnaissance with roof drainage that would be suitable for this approach.

DC9904 Community Outreach/ Public Education – Storm Drain Marking

This project is intended as a watershed-wide outreach program to provide stencils or other markings on storm drain inlets to educate the public, reduce dumping and reduce the amount of litter entering the storm drain system. Most of the residential neighborhoods in this WMA which were assessed during the upland reconnaissance assessment were found to be lacking storm drain markings.

DC9905 Community Outreach/ Public Education – Tree Planting

Several of the communities assessed during the upland reconnaissance could be sites for a watershed-wide outreach program to encourage tree planting and urban reforestation. These included Timothy Park, Fairfield, Mt Vernon Park, Pinewood Lawn, Mt Vernon on Potomac, Oxford and Mt Vernon Valley.

DC9906 Community Outreach/ Public Education – Turf Management

Outreach to turf managers is similar to residential lawn care outreach, but it is more focused on data gathering to assess current practices, with subsequent education for managers about runoff pollution. In this WMA, Mt Vernon Country Club was identified as a potential outreach site.

DC9907 Inspection/Enforcement Enhancement Project – Dumpster Maintenance

This project is a watershed-wide enforcement and outreach approach to properties where problems were identified with waste management practices during the upland reconnaissance. These included uncovered dumpsters and dumpsters located near storm drain inlets without runoff diversion methods.

DC9908 Inspection/Enforcement Enhancement Project – Outdoor Material Storage

Materials stored outdoors and exposed to precipitation are a potential source of stormwater runoff pollution. Two sites in this WMA had materials stored without cover or uncovered loading/unloading operations which drained towards the storm drain. This project would be a watershed-wide enforcement and outreach approach to check for stormwater pollution prevention plans and educate property owners.

DC9909 Inspection/Enforcement Enhancement Project – Vehicle Maintenance

In this WMA, eight of the sites assessed during the upland reconnaissance showed evidence of vehicles stored, repaired, or maintained outdoors, or with uncovered fueling areas. This project would provide watershed-wide targeted enforcement of spill prevention and pollution prevention regulations for sites where vehicles are maintained

DC9911 Dumpsite/Obstruction Removal – Obstruction Removal

Ten sites were identified with significant obstructions during the stream assessment. These included a beaver dam, concrete, trash and downed trees. This project is intended as a watershed-wide program to remove obstructions in the stream network.

DC9912 Street Sweeping Program

Three residential areas and two large shopping centers were found to have trash, litter, or organic debris in the curb and gutter flowing to storm drain inlets. This project consists of developing or extending a street sweeping program to remove potential pollutants from the street before they can wash off in a storm.

Table 5-4: North Fork WMA Projects

Structural Projects[1]						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	**Phase**
DC9100	New Stormwater Pond	DC-NE-0035	Mount Vernon High School	Water Quality and Quantity	County - FCPS	1 - 10
DC9201	Stream Restoration	DC-NE-0020	Between Presidential Dr and Volunteer Dr	Water Quality	Private - Residential	1 - 10
DC9202	Stream Restoration	DC-NE-0025	Between Sulgrave Dr and Adrienne Dr	Water Quality	Private - Residential	1 - 10
DC9203	Stream Restoration	DC-NE-0030	Upstream of Mount Zephyr Dr near Maryland St	Water Quality	Private - Residential	1 - 10
DC9204	Stream Restoration	DC-NE-0035	George Washington Park	Water Quality	County – FCPA	1 - 10
DC9207	Stream Restoration	DC-NW-0015	Behind Colony Dr	Water Quality	Private - Residential	1 - 10
DC9500	BMP/LID	DC-NW-0015	Smitty's Building Supply	Water Quality	Private - Commercial	1 - 10
DC9501	BMP/LID	DC-NW-0015	Various	Water Quality	County/Private	1 - 10
DC9503	BMP/LID	DC-NE-0035	Riverside Elementary School	Water Quality	County - FCPS	1 - 10
DC9504	BMP/LID	DC-NE-0035	Mount Vernon High School	Water Quality	County - FCPS	1 - 10
DC9505	BMP/LID	DC-NE-0035	Mount Vernon High School	Water Quality	County - FCPS	1 - 10
DC9600	Flood Protection/ Mitigation	DC-NW-0030	Culvert under Ashboro Dr	Flood Mitigation	Private - Commercial	1 - 10
DC9101	Stormwater Pond Retrofit	DC-NE-0035	End of Purks Ct	Water Quality	Private	11 - 25
DC9200	Stream Restoration	DC-NE-0020	Robertson Blvd	Water Quality	Private - Residential	11 - 25
DC9205	Stream Restoration	DC-NE-0005	Between Oak Leaf Dr and McNair Dr	Water Quality	Private	11 - 25
DC9206	Stream Restoration	DC-NW-0005	Rosemont Ave and Rosemont Cir	Water Quality	Private	11 - 25
DC9401	Culvert Retrofit	DC-NW-0030	Lawrence St between Central Park and Ashboro Dr	Water Quality	State - VDOT	11 - 25

Structural Projects[1]						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	**Phase**
DC9502	BMP/LID	DC-NW-0015	KinderCare Learning Center, Buckman Rd	Water Quality	Public/Local	11 - 25

Non-Structural Projects					
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**
DC9803	Wetland Mitigation	DC-NE-0035	Riverside Elementary School	Water Quality	Public/Local
DC9901	Rain Barrel Programs – Downspout Disconnection	Multiple	Watershed-wide	Water Quality and Quantity	Private
DC9902	Rain Barrel Programs – Rain Barrels	Multiple	Watershed-wide	Water Quality and Quantity	Private
DC9904	Community Outreach/ Public Education – Storm Drain Marking	Multiple	Watershed-wide	Water Quality	Private
DC9905	Community Outreach/ Public Education – Tree Planting	Multiple	Watershed-wide	Water Quality and Quantity	Private
DC9906	Community Outreach/ Public Education – Turf Management	DC-NE-0000	Mount Vernon Country Club	Water Quality	Private
DC9907	Inspection/Enforcement Enhancement Project – Dumpster Maintenance	Multiple	Watershed-wide	Water Quality	Various
DC9908	Inspection/Enforcement Enhancement Project – Outdoor Material Storage	Multiple	Watershed-wide	Water Quality	Various
DC9909	Inspection/Enforcement Enhancement Project – Vehicle Maintenance	Multiple	Gas stations, body shops, and repair shops,	Water Quality	Various

Non-Structural Projects					
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**
DC9911	Dumpsite/Obstruction Removal – Obstruction Removal	Multiple	Watershed-wide	Water Quality	Various
DC9912	Street Sweeping Program	Multiple	Watershed-wide	Water Quality	Various

[1]Only the 10-year structural projects will have an associated project fact sheet.

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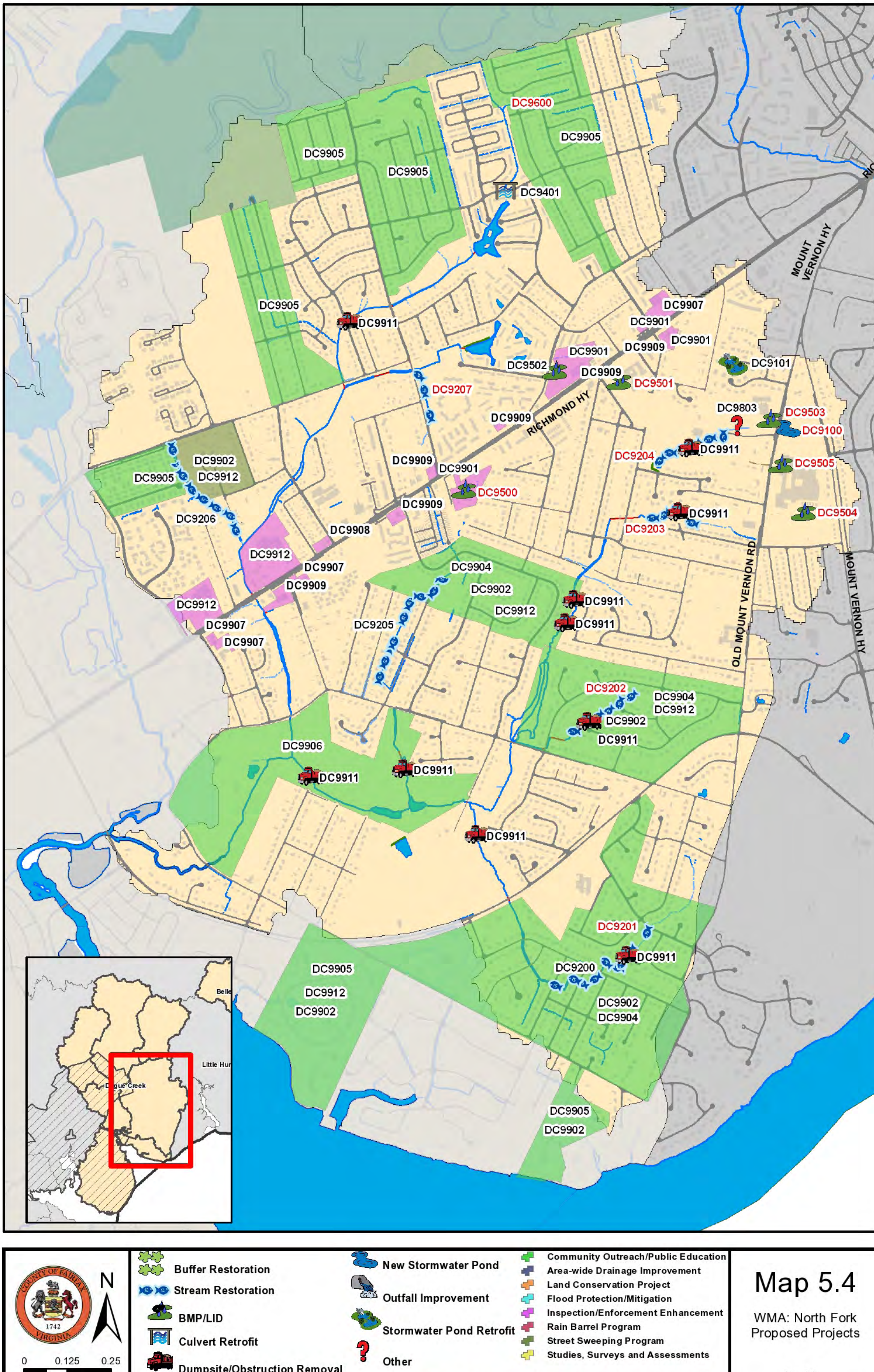
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Buffer Restoration
Stream Restoration
BMP/LID
Culvert Retrofit
Dumpsite/Obstruction Removal
New Stormwater Pond
Outfall Improvement
Stormwater Pond Retrofit
Other
Community Outreach/Public Education
Area-wide Drainage Improvement
Land Conservation Project
Flood Protection/Mitigation
Inspection/Enforcement Enhancement
Rain Barrel Program
Street Sweeping Program
Studies, Surveys and Assessments
Implementation timeframe denoted by project label color. Red = 0-10 years Black = 11-25 years and non-structural projects.
Map 5.4
WMA: North Fork
Proposed Projects

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5.5 Dogue Creek – Piney Run Results

The lower reaches and subwatersheds of Piney Run are within the boundaries of Ft. Belvoir and were not assessed for this plan. The majority of the remaining subwatersheds met the definition of headwater areas and the assessment was focused on these areas.

While Piney Run was not ranked among the high priority areas for stream problems, there were a few localized areas where potential projects were identified from the stream assessment data. None of the subwatersheds within Piney Run were a high priority for flood mitigation. No road crossings were overtopped beyond the level of service frequency.

None of the subwatersheds in the Piney Run WMA were among the highest priority for water quality problems. There is a diversity of land use, primarily high-density residential and commercial areas, along with open space.

5.5.1 Structural Projects

5.5.1.1 10-Year Projects

DC9215 Stream Restoration

This site is experiencing bank erosion on outside meanders and channel bed incision, with an exposed sanitary sewer pipe. Restoration of the channel will include reconnecting the stream to the floodplain by reducing the existing channel dimensions, raising the bed elevation of the channel to correct the slope and installing grade controls to prevent future bed incision.

DC9218 Stream Restoration

This project will daylight a stream located on the Banks Property. The upstream portion of the reach is currently piped for several hundred feet. This project would restore this section of stream to a natural channel. The project would also repair eroded portions downstream of the property itself.

DC9506 BMP/LID

Installation of a vegetated swale and several tree box filters are proposed to treat roof as well as driveway runoff at the end of Alderman Drive.

DC9507 BMP/LID

Installation of bioretention filters and basins and tree box filters are proposed to treat runoff from the residential parking lots along Wescott Hills Way. This project includes retrofitting four existing inlets that drain the entire parking lot.

DC9508 BMP/LID

Bioretention filters and basins are proposed in the medians of the Shoppers' parking lot to treat the runoff from the parking lot before it enters into the storm drain system. Most of this parking lot drains to single inlets along medians.

5.5.1.2 25-Year Projects

DC9102 Stormwater Pond Retrofit

Concrete channels would be removed, the pond bottom flattened and aquatic plants would be planted at the existing pond at the Kingstowne Fire Station. The bottom of the existing pond is currently kept mowed. This maintenance would no longer be required.

DC9104 Stormwater Pond Retrofit

This is a retrofit of an existing pond at Kingstowne Village Parkway at Ashby Lane in which a low flow channel and wetland has already developed. Additional vegetation would be added and maintained and a micropool would be added at the riser.

DC9105 Stormwater Pond Retrofit

The retrofit of the existing pond at Manchester Lake Drive would include minor regrading, removing the concrete channel and creating landscaping around the edge of the pond.

DC9216 Stream Restoration

This stream restoration project at Rock Ridge Lane would repair severe bank erosion and heavy sediment deposition in the channel.

DC9509 BMP/LID

This project is a retrofit of a parking lot at Calvary Baptist Church and Christian School. Medians would be replanted with plants providing bioretention. Rain gardens would also be added to treat the rooftop runoff.

DC9701 Outfall Improvement

This outfall retrofit would repair the eroding channel and undercut banks at this outfall behind 6115 Summer Park Lane.

DC9702 Outfall Improvement

This project would replace the concrete pipe at this outfall under Rock Ridge Lane.

5.5.2 Non-Structural Projects

DC9802 Buffer Restoration

Field assessment identified a section of stream downstream of Hilltop Golf Club with a deficient buffer which had the potential for restoration. This project would consist of outreach to educate and encourage the property owners to restore the buffer.

DC9902 Rain Barrel Programs – Rain Barrels

Rain barrels are a residential approach to downspout disconnection. This project would be a watershed-wide outreach program to encourage their use, perhaps by subsidizing the cost. One neighborhood, Windsor Gable, was identified as suitable during the upland reconnaissance. Outreach to this area would be coordinated with other efforts throughout the watershed or the County.

DC9905 Community Outreach/ Public Education – Tree Planting

This project is intended as a watershed-wide outreach program to encourage tree planting. The upland reconnaissance identified three residential areas in this WMA that could benefit, including Manchester Lakes, Windsor Gable, and Victoria Cross.

DC9907 Inspection/Enforcement Enhancement Project – Dumpster Maintenance

This project is a watershed-wide enforcement and outreach approach to properties where problems were identified during the upland reconnaissance. Dumpsters at one site in this WMA were flagged as hotspots for poor condition and direct connection to storm drain inlets.

DC9909 Inspection/Enforcement Enhancement Project – Vehicle Maintenance

One site in the WMA was seen with vehicles maintained repaired, washed outside; evidence of leaks from at least one vehicle; and materials stored outside with the storage area directly connected to the storm drain. This project would provide watershed-wide targeted enforcement of spill prevention and pollution prevention regulations.

DC9911 Dumpsite/Obstruction Removal – Obstruction Removal

Six beaver dams were identified in Piney Run during the stream assessment. This project is intended as a watershed-wide program to remove obstructions in the stream network, including beaver dams if they are found to be contributing to erosion or flooding. The beaver dams in the Piney Run WMA will be removed because they are contributing to erosion or flooding.

Table 5-5: Piney Run WMA Projects

Structural Projects[1]						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	**Phase**
DC9215	Stream Restoration	DC-PY-0035	Behind Rockcliff Ln	Water Quality	Private - Residential	1 - 10
DC9218	Stream Restoration	DC-PY-0040	Banks Property	Water Quality	County – FCPA	1 - 10
DC9506	BMP/LID	DC-PY-0020	Alderman Dr	Water Quality	State - VDOT	1 - 10
DC9507	BMP/LID	DC-PY-0040	Parking lots along Westcott Way	Water Quality	Private - Residential	1 - 10
DC9508	BMP/LID	DC-PY-0050	Shopper's parking lot	Water Quality	Private - Commercial	1 - 10
DC9102	Stormwater Pond Retrofit	DC-PY-0020	Kingstowne Fire Station	Water Quality and Quantity	Private	11 - 25
DC9104	Stormwater Pond Retrofit	DC-PY-0025	Kingstowne Village Pkwy at Ashby Ln	Water Quality and Quantity	Public/Local	11 - 25
DC9105	Stormwater Pond Retrofit	DC-PY-0055	Manchester Lake Dr	Water Quality and Quantity	Private	11 - 25
DC9216	Stream Restoration	DC-PY-0045	Rock Ridge Ln	Water Quality	Private	11 - 25
DC9509	BMP/LID	DC-PY-0050	Calvary Baptist Church and Christian School	Water Quality	Private - Church	11 - 25
DC9701	Outfall Improvement	DC-PY-0030	Behind 6115 Summer Park Ln	Water Quality	Private	11 - 25
DC9702	Outfall Improvement	DC-PY-0045	Rock Ridge Ln	Water Quality	Public/Local	11 - 25

Non-Structural Projects					
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**
DC9802	Buffer Restoration	DC-PY-0020	Hilltop Golf Course	Water Quality and Quantity	Private
DC9902	Rain Barrel Programs – Rain Barrels	Multiple	Watershed-wide	Water Quality and Quantity	Private
DC9905	Community Outreach/ Public Education – Tree Planting	Multiple	Watershed-wide	Water Quality and Quantity	Private
DC9907	Inspection/Enforcement Enhancement Project – Dumpster Maintenance	Multiple	Watershed-wide	Water Quality	Private

Non-Structural Projects					
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**
DC9909	Inspection/Enforcement Enhancement Project – Vehicle Maintenance	Multiple	Gas stations and auto repair shops	Water Quality	Private
DC9911	Dumpsite/Obstruction Removal – Obstruction Removal	DC-PY-0025	Beaver dams at two sites in mainstem of Piney Run	Water Quality	Private

[1]Only the 10-year structural projects will have an associated project fact sheet.

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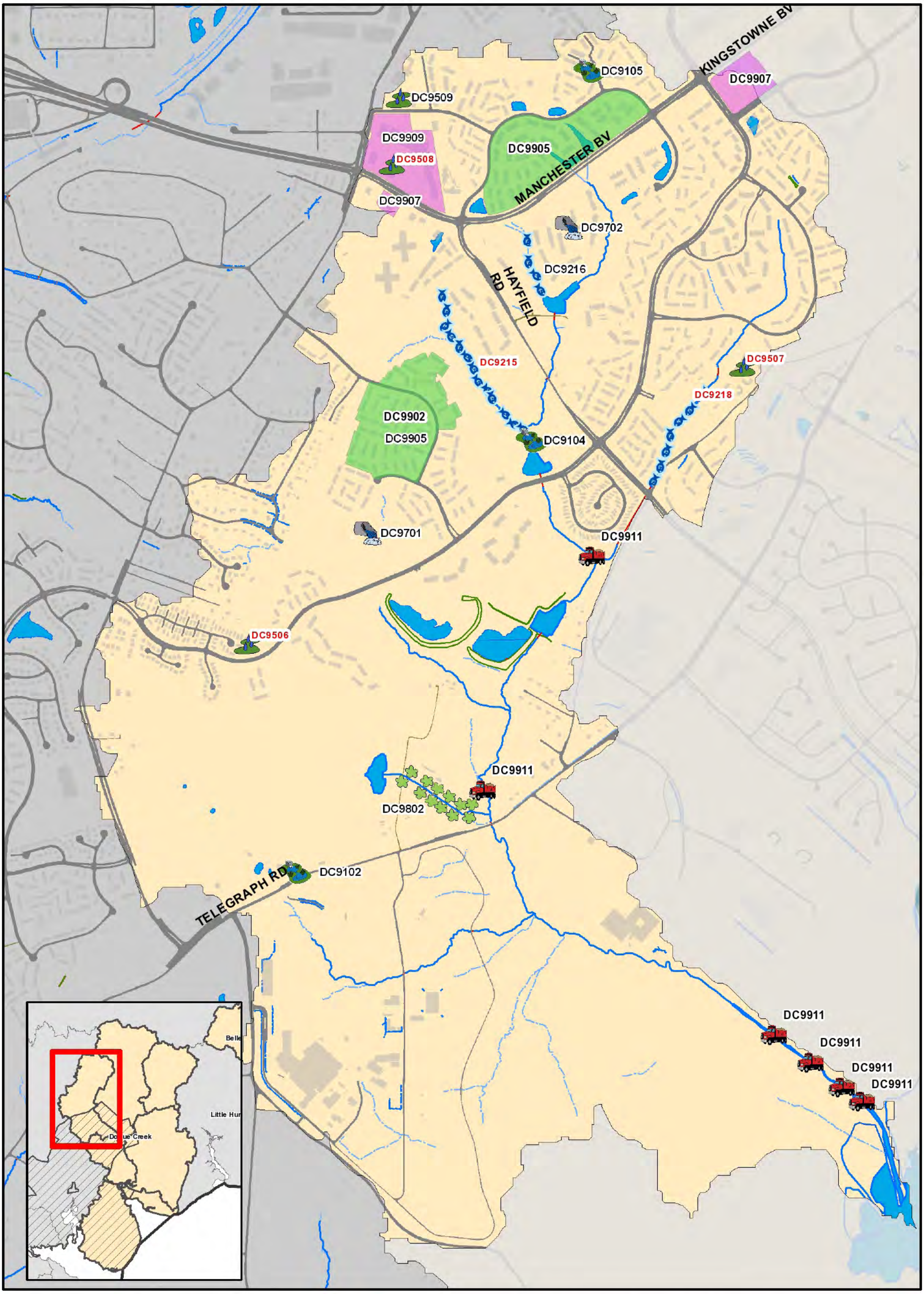

Map 5.5

WMA: Piney Run
Proposed Projects

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5.6 Four Mile Run Results

The results of the subwatershed ranking analysis showed that all the subwatersheds in Four Mile Run were impaired in some form. All but one were among the lowest ranking for the composite score of impacts and sources. All the subwatersheds in this WMA are headwaters and all were reviewed for potential improvements.

A considerable length of Upper Long Branch (tributary to Four Mile Run) has been channelized with concrete. Because of the channelization, most of the streambanks are stable; however, there were a few severely eroded stream areas upstream of the concrete channel. Several residential structures along the channel are within the modeled 100-year flood limits. No crossings were flooded beyond the design level-of-service.

Water quality modeling showed high loads of total suspended solids, total nitrogen and total phosphorus. Much of the WMA is completely developed prior to regulations requiring stormwater management facilities with commercial, transportation, and medium or high-density residential land uses.

5.6.1 Structural Projects

5.6.1.1 10-Year Projects

FM9102 New Stormwater Pond

This project would create a stormwater management facility at Hollybrook II Condominiums upstream of the culvert on Patrick Henry Drive immediately downstream of a 66” outfall. Stream banks both upstream and downstream of the proposed facility are eroded. The proposed project will treat runoff from a large drainage area consisting of commercial and high density residential areas.

FM9104 Stormwater Pond Retrofit

An existing detention basin located adjacent to Hampton Inn hotel parking lot would be converted to an extended detention basin by removing the existing concrete low flow channels, excavating the existing bottom to incorporate wetland planting zones and meandering flow channels and installing a new control structure on the existing barrel pipe.

FM9105 New Stormwater Pond

This project proposes creation of an extended detention dry pond with a sediment forebay at Leesburg Pike Plaza. The project will be sited in the open area adjacent to a parking lot.

FM9300 Area Wide Drainage Improvement

The entire subwatershed FM-FM-0035 has medium density residential area land use and there are no existing stormwater management facilities. The project is distributed throughout the subwatershed and involves replacing the existing inlets with tree box filters or other inlet filters and adding other types of localized facilities to treat the runoff for water quality.

FM9500 BMP/LID

This project proposes creation of bioretention areas to receive the runoff from roof top and parking lot at the St. Andrew Parish. The open area in front of the church and grassy area adjacent to the parking lots will be graded and used for the implementation of bioretention.

FM9501 BMP/LID

Installation of bioretention filters and basins are proposed to treat runoff from St. Katherine's Greek Orthodox Church parking lot. The southern portion of the parking lot presents the best opportunity for retrofit.

FM9502 BMP/LID

This project would treat runoff from the Target Greatland parking lot by implementing bioretention filters and basins in the southern portion of the parking lot where parking islands are located. Tree box filters are proposed on the edges of the strip mall parking lot. Portions of this site may already be treated by underground storage for quantity control.

FM9503 BMP/LID

Runoff characteristics can be improved by removing concrete immediately adjacent to the Korean Cultural Center. The storm inlet next to playground could also be replaced with a rain garden. Bioretention filters and basins would be installed in the median and edges of the parking lot.

5.6.1.2 25-Year Projects

FM9100 Stormwater Pond Retrofit

The existing concrete channel would be removed as part of this stormwater pond retrofit at Fallswood Glen Court. The channel is currently filled with weedy vegetation and would be removed to excavate and allow for water quality treatment.

FM9101 Stormwater Pond Retrofit

This retrofit of a stormwater pond retrofit along Arlington Boulevard near Kelsey Court would remove the concrete and excavate to allow for water quality treatment. The site would be kept for a grassy swale receiving water from rooftops and parking areas.

FM9103 Stormwater Pond Retrofit

This project is a retrofit of a stormwater pond at the commercial center at Arlington Boulevard and Wilson Boulevard. The project would remove the concrete channel and excavate to create an area for water quality treatment. Plants would be added as well as a forebay.

FM9106 Stormwater Pond Retrofit

This is a retrofit of a stormwater management pond at Diehl Court. The project would remove existing concrete channels and excavate the bottom to allow for water quality treatment.

FM9200 Stream Restoration

This stream restoration project at Henry Drive and Brook Drive would stabilize unstable banks by grading and either natural or hard-armoring. There would be only minor changes in channel dimensions. Additionally, a narrow riparian buffer would be established on the left bank.

5.6.2 Non-Structural Projects

DC9901 Rain Barrel Programs – Downspout Disconnection

The upland reconnaissance identified several commercial sites where downspouts were directly connected to storm drains and a watershed-wide outreach program could be beneficial in reducing runoff volume or peak flows. In this WMA, they included a strip mall, gas station, fast food restaurant, and the church / school complex at Columbia Crossroads Church, Corpus Christi School and St. Anthony Parish.

DC9902 Rain Barrel Programs – Rain Barrels

This project would be a watershed-wide outreach program to encourage the use of rain barrels in a medium-density residential area with no stormwater treatment. The area, Brilyn Park, Westmore Gardens and Westmoreland Park, was identified as suitable during the upland reconnaissance.

DC9904 Community Outreach/ Public Education – Storm Drain Marking

This project is intended as a watershed-wide outreach program to provide stencils or other markings on storm drain inlets to educate the public, reduce dumping and reduce the amount of litter entering the storm drain system. Several locations were identified in this WMA through the upland reconnaissance assessment, including Brilyn Park, Westmoreland Park, Lee Boulevard Heights and Glen Forest.

DC9905 Community Outreach/ Public Education – Tree Planting

This project is intended as a watershed-wide outreach program to encourage tree planting and restoration of the urban forest. The upland reconnaissance identified several residential areas that could benefit, including Hollybrook Condominiums, Munson Hill, Glen Acres and Westmore Gardens.

DC9907 Inspection/Enforcement Enhancement Project – Dumpster Maintenance

This project is a watershed-wide enforcement and outreach approach to properties where problems with dumpsters were identified during the upland reconnaissance. Dumpsters in this WMA were identified with evidence of leakage and direct connection to storm drain inlets.

DC9909 Inspection/Enforcement Enhancement Project – Vehicle Maintenance

This project would provide watershed-wide targeted enforcement of spill prevention and pollution prevention regulations for sites where vehicles are maintained. The upland reconnaissance identified five sites, primarily along Leesburg Pike and Arlington Blvd with uncovered fueling areas, vehicles were maintained, washed, repaired and stored outside where materials were stored outside without cover and where discharges were directly connected to the storm drains.

DC9912 Street Sweeping Program

Two neighborhoods and a church site were identified during the upland reconnaissance with a buildup of trash, litter, organic matter, leaves, or lawn clippings in curb and gutter. This project consists of developing or extending a street sweeping program to remove potential pollutants from the street before they can wash off in a storm.

Table 5-6: Four Mile Run Projects

Structural Projects[1]						
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**	**Phase**
FM9102	New Stormwater Pond	FM-LO-0000	Hollybrook II Condos	Water Quality and Quantity	Private - Residential	1 - 10
FM9104	Stormwater Pond Retrofit	FM-FM-0000	Hampton Inn off 14th St and Leesburg Pike	Water Quality and Quantity	Private - Commercial	1 - 10
FM9105	New Stormwater Pond	FM-FM-0010	Off Carlin Springs Rd	Water Quality and Quantity	Private - Commercial	1 - 10
FM9300	Area-wide Drainage Improvements	FM-FM-0035	North of Williamsburg Blvd and Custis Memorial Pkwy and south of Haycock Rd	Water Quality	Private – Residential, State - VDOT	1 - 10
FM9500	BMP/LID	FM-LO-0000	St. Andrews Parish	Water Quality	Private - Church	1 - 10
FM9501	BMP/LID	FM-LO-0000	St. Katherine's Greek Orthodox	Water Quality	Private - Church	1 - 10
FM9502	BMP/LID	FM-LO-0000	Target Greatland	Water Quality	Private - Commercial	1 - 10
FM9503	BMP/LID	FM-LO-0000	Korean Cultural Center	Water Quality	Private	1 - 10
FM9100	Stormwater Pond Retrofit	FM-FM-0020	Fallswood Glen Ct	Water Quality and Quantity	Private	11 - 25
FM9101	Stormwater Pond Retrofit	FM-FM-0020	Along Arlington Blvd near Kelsey Ct	Water Quality and Quantity	Private	11 - 25
FM9103	Stormwater Pond Retrofit	FM-LO-0000	Commercial center at Arlington Blvd and Wilson Blvd	Water Quality and Quantity	Private	11 - 25
FM9106	Stormwater Pond Retrofit	FM-FM-0015	Diehl Ct	Water Quality and Quantity	Public/Local	11 - 25
FM9200	Stream Restoration	FM-LO-0000	Upstream of Henry Dr and Brook Dr	Water Quality	Private - Residential	11 - 25

Non-Structural Projects					
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**
DC9901	Rain Barrel Programs – Downspout Disconnection	Multiple	Watershed-wide	Water Quality and Quantity	Private
DC9902	Rain Barrel Programs – Rain Barrels	Multiple	Watershed-wide	Water Quality and Quantity	Private

Non-Structural Projects					
Project #	**Project Type**	**Subshed**	**Location**	**Watershed Benefit**	**Land Owner**
DC9904	Community Outreach/ Public Education – Storm Drain Marking	Multiple	Watershed-wide	Water Quality	Private
DC9905	Community Outreach/ Public Education – Tree Planting	Multiple	Watershed-wide	Water Quality and Quantity	Private
DC9907	Inspection/Enforcement Enhancement Project – Dumpster Maintenance	Multiple	Watershed-wide	Water Quality	Private
DC9909	Inspection/Enforcement Enhancement Project – Vehicle Maintenance	Multiple	Gas stations and auto repair shops	Water Quality	Private
DC9912	Street Sweeping Program	Multiple	Watershed-wide	Water Quality	Private

[1]Only the 10-year structural projects will have an associated project fact sheet.

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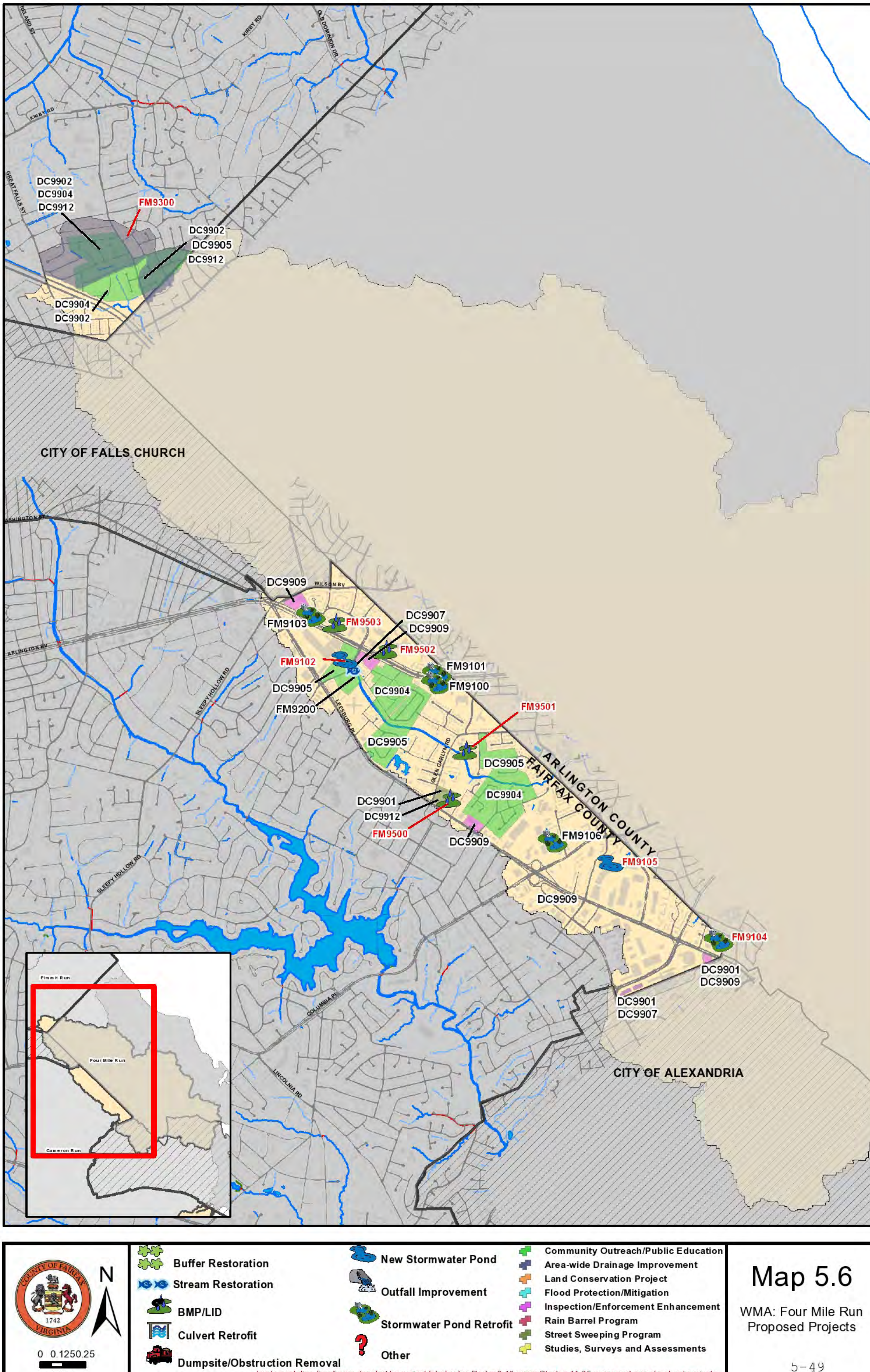
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OLD DOMINION DR
GREAT FALLS ST
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CITY OF FALLS CHURCH
WILSON BV
ARLINGTON BV
SLEEPY HOLLOW RD
LEESBURG PI
GLEN CARLYN RD
COLUMBIA PI
LINCOLNIA RD
DC9909
FM9103
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ARLINGTON COUNTY
FAIRFAX COUNTY
CITY OF ALEXANDRIA
Pimmit Run
Four Mile Run
Cameron Run
COUNTY OF FAIRFAX VIRGINIA 1742
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Miles
Buffer Restoration
Stream Restoration
BMP/LID
Culvert Retrofit
Dumpsite/Obstruction Removal
New Stormwater Pond
Outfall Improvement
Stormwater Pond Retrofit
Other
Community Outreach/Public Education
Area-wide Drainage Improvement
Land Conservation Project
Flood Protection/Mitigation
Inspection/Enforcement Enhancement
Rain Barrel Program
Street Sweeping Program
Studies, Surveys and Assessments
Implementation timeframe denoted by project label color. Red = 0-10 years Black = 11-25 years and non-structural projects.
Map 5.6
WMA: Four Mile Run
Proposed Projects

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5.7 Project Fact Sheets

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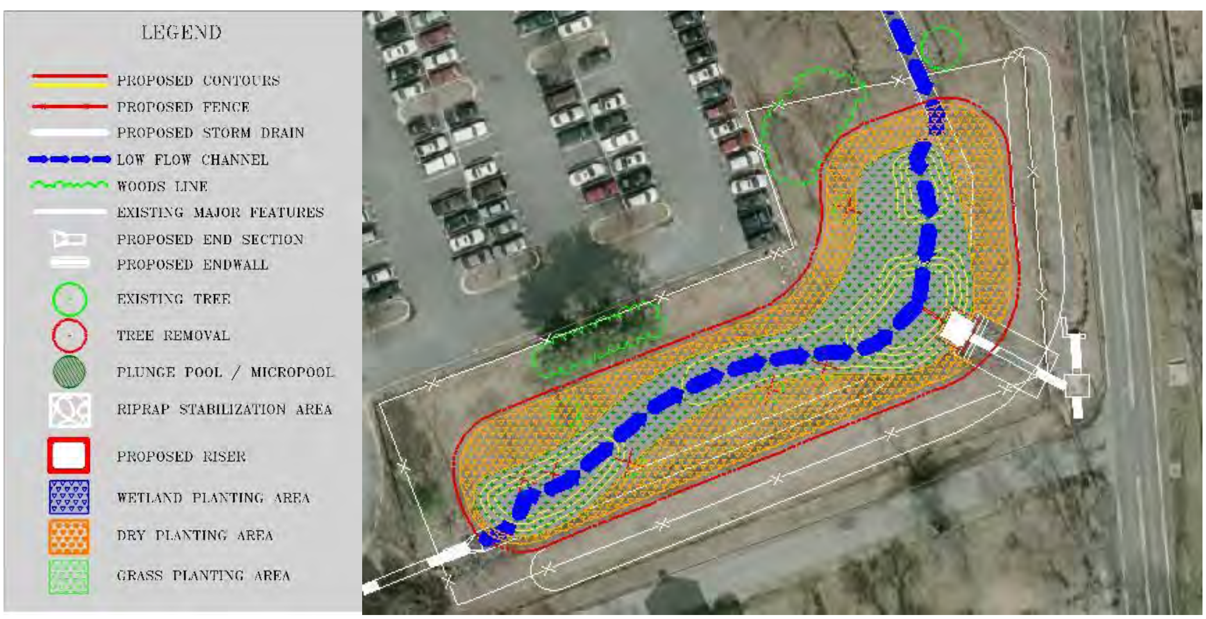
BE9100 Stormwater Pond Retrofit

Vicinity Map

Address:	6500 Quander Road
Location:	West Potomac High School
Land Owner:	County - FCPS
PIN:	0931 01 0054
Control Type	Water Quality and Quantity
Drainage Area	42.28 acres
Receiving Waters	Quander Brook

Description: This project is designed to retrofit an existing detention basin adjacent to West Potomac High School by converting it to a shallow wetland. The pond collects runoff from a part of the High School and medium density residential area west of the site through an existing storm drain network. The bottom of the detention basin will be excavated to incorporate wetland planting zones and meandering flow channels. A new control structure will be installed on the existing barrel pipe to increase the pond's detention time.



Project Area Map

Project Benefits: This facility has the potential to meet the water quality treatment requirement for the contributing drainage area by incorporating a wetland component into this facility. The permanent wet storage will promote uptake of nutrients, removal of pollutants to downstream channels, and suspension of floatables. It is estimated that a total over 3,360 lbs of sediment, 1.2 lbs of total nitrogen and 5.6 lbs of total phosphorus would be reduced by this project. Peak flow management of the 2-year storm can be provided by installing a new riser structure. This action will reduce erosive velocities exiting the facility and preserve downstream channel conditions. The proposed location of this facility is on the West Potomac High School grounds, which will eliminate or reduce the need for land purchase or acquisition and provides an environmental education/stewardship opportunity for students and parents within the Belle Haven community.

Project Design Considerations: The maximum storage volume in this facility is not capable of reducing 10-year discharge volumes to pre-development conditions. Signs promoting safety and environmental education/stewardship can be used at this site to educate students and parents in the community. Minimal tree removal is required for this retrofit. Environmental permitting issues are expected due to the presence of stream baseflow and wetlands in the facility. Access to the proposed facility is good. Existing utilities conflicts are not anticipated.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	0.59	AC	$8,500.00	$5,015
Excavate to create low-flow channel	381	LF	$25.00	$9,525
Curb Opening	1	EA	$2,000.00	$2,000
Tree Removal	6	EA	$2,000.00	$12,000
New Riser	1	LS	$8,000.00	$8,000
Embedded Dewatering Pipe	1	EA	$500.00	$500
Grading and Excavation	876	CY	$35.00	$30,660
Remove Existing Headwall	1	LS	$1,200.00	$1,200
Soil Borings	1	LS	$7,500.00	$7,500
			Initial Project Costs	**$76,400**
Plantings	1	LS	5% of Project	$3,820
Ancillary Items	1	LS	5% of Project	$3,820
Erosion and Sediment Control	1	LS	10% of Project	$7,640
			Base Construction Cost	**$91,680**
			Mobilization (5%)	$4,584
			Subtotal 1	$96,264
			Contingency (25%)	$24,066
			Subtotal 2	$120,330
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$54,149
			Estimated Project Cost	**$174,000**

BE9100_1.jpg: View of pond inflow

BE9100_2.jpg: View of existing pond

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BE9102 New Stormwater Pond

Vicinity Map

Address:	6701 Fort Hunt Road
Location:	Belle View Elementary School
Land Owner:	County – FCPS
PIN:	0932 01 0005
Control Type	Water Quality and Quantity
Drainage Area	4.12 acres
Receiving Waters	Belle Haven West Channel

Description: This project proposes implementation of an extended detention dry pond at Belle View Elementary School. Project BE9102 will treat runoff from Belle View Elementary School rooftops and parking lots. Implementation of the project will increase the detention time and improve the water quality of runoff from the project sites.

Project Area Map

Project Benefits: This facility has the potential to provide water quality via extended detention of the one-half inch, 48 hour storm, and provide 2-year and 10-year peak flow management for the drainage area. This facility will promote removal of suspended solids and floatables to downstream channels, reduce future erosion of downstream channels, and improve overall water quality and habitat. It is estimated that a total of 840 lbs of sediment, 8.4 lbs of total nitrogen and 1.9 lbs of total phosphorus would be reduced by this project. The proposed location of this facility can provide an environmental education/stewardship opportunity for residents of the Belle Haven community.

Project Design Considerations: A potential loss of recreation area at the school will result from construction of this facility. A fence around proposed facility is recommended to promote public safety. No environmental permitting issues are anticipated for this project. Access to the proposed facility is good. Existing utility conflicts are not anticipated. Modifications of existing storm drain systems are necessary to convey runoff from impervious surfaces to the proposed facility.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	0.2	AC	$8,500.00	$1,700
New Inlet	1	EA	$2,500.00	$2,500
New Endwall	1	EA	$2,500.00	$2,500
New Riser	1	LS	$8,000.00	$8,000
Drainage Pipe	50	LF	$125.00	$6,250
Rip Rap Stabilization	71	SY	$100.00	$7,100
Excavate to create low-flow channel	184	LF	$25.00	$4,600
Grading and Excavation	1705	CY	$35.00	$59,675
Embankment	426	CY	$50.00	$21,300
Soil Borings	1	LS	$7,500.00	$7,500
			Initial Project Costs	**$121,125**
Plantings	1	LS	5% of Project	$6,056
Ancillary Items	1	LS	5% of Project	$6,056
Erosion and Sediment Control	1	LS	10% of Project	$12,113
			Base Construction Cost	**$145,350**
			Mobilization (5%)	$7,268
			Subtotal 1	$152,618
			Contingency (25%)	$38,155
			Subtotal 2	$190,773
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$85,848
			Estimated Project Cost	**$277,000**

BE9102_1.jpg: Open area for proposed pond at Belle View ES

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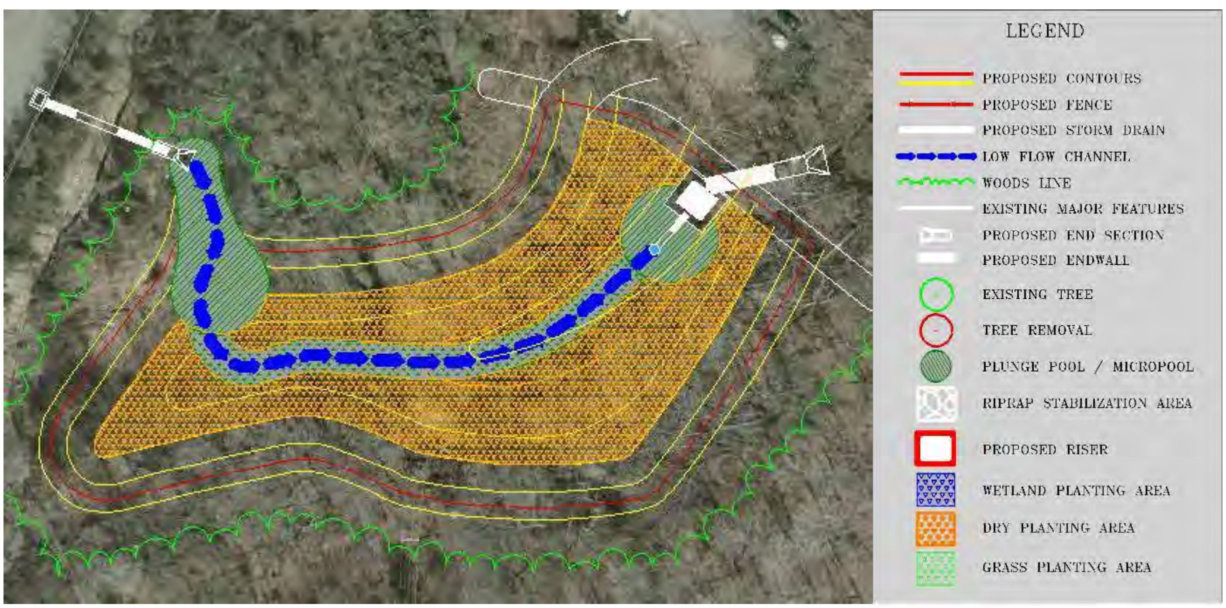
BE9103 New Stormwater Pond

Vicinity Map

Address:	Richmond Hwy and Fairview Dr
Location:	Fairchild Property
Land Owner:	County
PIN:	0833 01 0024
Control Type	Water Quality and Quantity
Drainage Area	97.93 acres
Receiving Waters	Quander Brook

Description: This project is proposed to create an extended detention dry pond with a sediment forebay at Fairchild Property. The pond is designed for multiple benefits: to provide quantity and quality control for a large untreated impervious area upstream, to reduce erosive flows downstream, to work with the proposed stream restoration projects in Quander Brook and to improve conditions at adjacent storm drain outfalls. Runoff from commercial, industrial and residential area along Richmond Highway will be treated by this pond for pollutants including nitrogen, phosphorus and total suspended solids.



Project Area Map

Project Benefits: This facility can meet the water quality treatment requirement for the contributing drainage area via extended detention of the one-half inch, 48 hour storm, as well as peak flow management of the 2-year and 10-year peak runoff volumes. This facility will promote uptake of nutrients, removal of pollutants to downstream channels, suspension of floatables, promote a healthier habitat, and help prevent future erosion of downstream channels. It is estimated that a total over 15,000 lbs of sediment, 158.0 lbs of total nitrogen and 24.4 lbs of total phosphorus would be reduced by this project. Peak flow rates, erosive velocities, and channel sediment loads will also be reduced.

Project Design Considerations: The proposed facility would require a significant amount of forest/tree removal and existing stream channel removal. Environmental permitting issues are expected due to the in-stream location. Access to the proposed facility could be achieved behind the commercial property along Richmond Highway (Rte. 1); however modification of steep slopes, modification of incised channel banks, and significant amounts of tree removal would be necessary for construction equipment. Construction of this facility will require a large amount of excavation and grading to achieve the required volume and the proposed embankment may warrant an elevated hazard classification and/or dam breach analysis. In-stream construction will require base flow diversion.

As the land may be conveyed to the Fairfax County Park Authority in the future, project design and implmentation should be coordinated closely with the FCPA and should allow for park amenities such as trails and planting. The parcel contains two significant sites located on archaeological surveys, and testing or data recovery/avoidance may be required.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub (heavy)	3.32	AC	$12,750.00	$42,330
Drain Pipe	125	LF	$125.00	$15,625
Plungepool / Micropool	2	EA	$500.00	$1,000
New Inlet	1	EA	$2,500.00	$2,500
New Endwall	2	EA	$2,500.00	$5,000
New Riser	1	LS	$8,000.00	$8,000
Embedded Dewatering Pipe	1	EA	$500.00	$500
Excavate to create low-flow channel	368	LF	$25.00	$9,200
Rip Rap Stabilization	73	SY	$100.00	$7,300
Grading and Excavation	6484	CY	$35.00	$226,940
Soil Borings	1	LS	$10,000.00	$10,000
			Initial Project Costs	**$328,395**
Plantings	1	LS	5% of Project	$16,420
Ancillary Items	1	LS	5% of Project	$16,420
Erosion and Sediment Control	1	LS	10% of Project	$32,840
			Base Construction Cost	**$394,075**
			Mobilization (5%)	$19,704
			Subtotal 1	$413,779
			Contingency (25%)	$103,445
			Subtotal 2	$517,224
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$232,751
			Estimated Project Cost	**$750,000**


BE9103_1.jpg: View of proposed pond site

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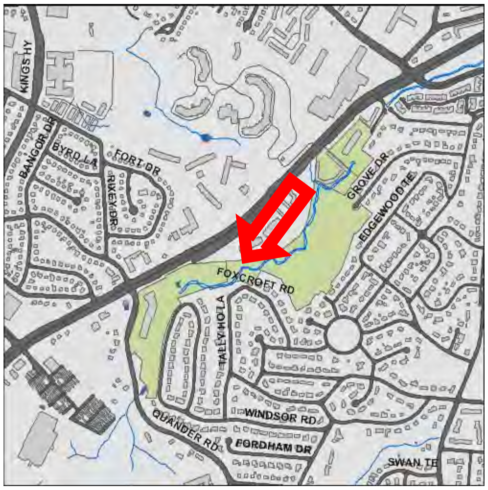
BE9200 Stream Restoration



Vicinity Map

Address:	Between Richmond Hwy, Foxcroft Rd, and Edgewood Terrace
Location:	Belle Haven Park
Land Owner:	County - FCPA
PIN:	0833 01 0053F, 0833 01 0052B, 0833 01 0059
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Quander Brook

Description: This project proposes to restore an eroded section of Quander Brook located between Richmond Highway, Foxcroft Road, and Edgewood Terrace. Most of this project is within Belle Haven Park property; however, the upstream and downstream portions are within privately-owned commercial properties. Currently, this channel is experiencing severe bank and bed erosion. At this time, stormwater controls are not present upstream of this proposed restoration. However, projects BE9103, BE9202, and BE9601 have been proposed upstream and restoration of this channel should follow the design and construction of these projects to allow for proper sequencing. Restoration of this channel will include regrading and stabilizing eroded stream banks with armor-in-place and bioengineering techniques, and installation of grade controls to dissipate energy. All stormdrain outfalls and tributary channel connections to this project should also be stabilized if necessary.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of this project will provide a reduction in sediment supply to receiving stream channels by reducing bank scour and stream bed incision. Benefits from implementing BE9103, BE9202, and BE9601 will also help to provide water quality and quantity benefits to this restored channel. Overall, stream habitat and water quality may be improved due to stable habitat creation and reductions in available sediment supply. It is estimated that a total of over 622,000 lbs of sediment, 498.0 lbs of total nitrogen and 193.0 lbs of total phosphorus would be reduced by this project. This project is mostly contained within park property, which alleviates some of the need for land purchase or acquisition.

Project Design Considerations: Since the upstream and downstream most portions of this project are contained within private commercial properties, significant coordination with these property owners will be necessary for access and construction. Access to the upstream portion of this project could occur from the car dealership parking lot adjacent to Richmond Highway, at the end of Foxcroft Lane, or at the end of Windsor Road. Access from any of these points along the proposed restoration will require significant tree removal and manipulation of steep slopes. Access to the downstream portion of this project could occur at the end of Grove Drive. Significant tree loss is expected with this restoration; however, restoration benefits will outweigh overall construction impacts. This project will require environmental permitting due to construction and modifications to a perennial stream channel and forest impacts. Existing utility impacts are not anticipated with this restoration.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	4.5	Ac	$10,000.00	$45,000
Plantings	4.5	Ac	$25,000.00	$112,500
Construct New Channel	2400	LF	$200.00	$480,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$737,500**
Ancillary Items	1	LS	5% of Project	$36,875
Erosion and Sediment Control	1	LS	10% of Project	$73,750
			Base Construction Cost	**$848,125**
			Mobilization (5%)	$42,406
			Subtotal 1	$890,531
			Contingency (25%)	$222,633
			Subtotal 2	$1,113,164
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$500,924
			Estimated Project Cost	**$1,614,000**


BE9200_1.jpg: View of stream section


BE9200_2.jpg: View of erosion along the banks

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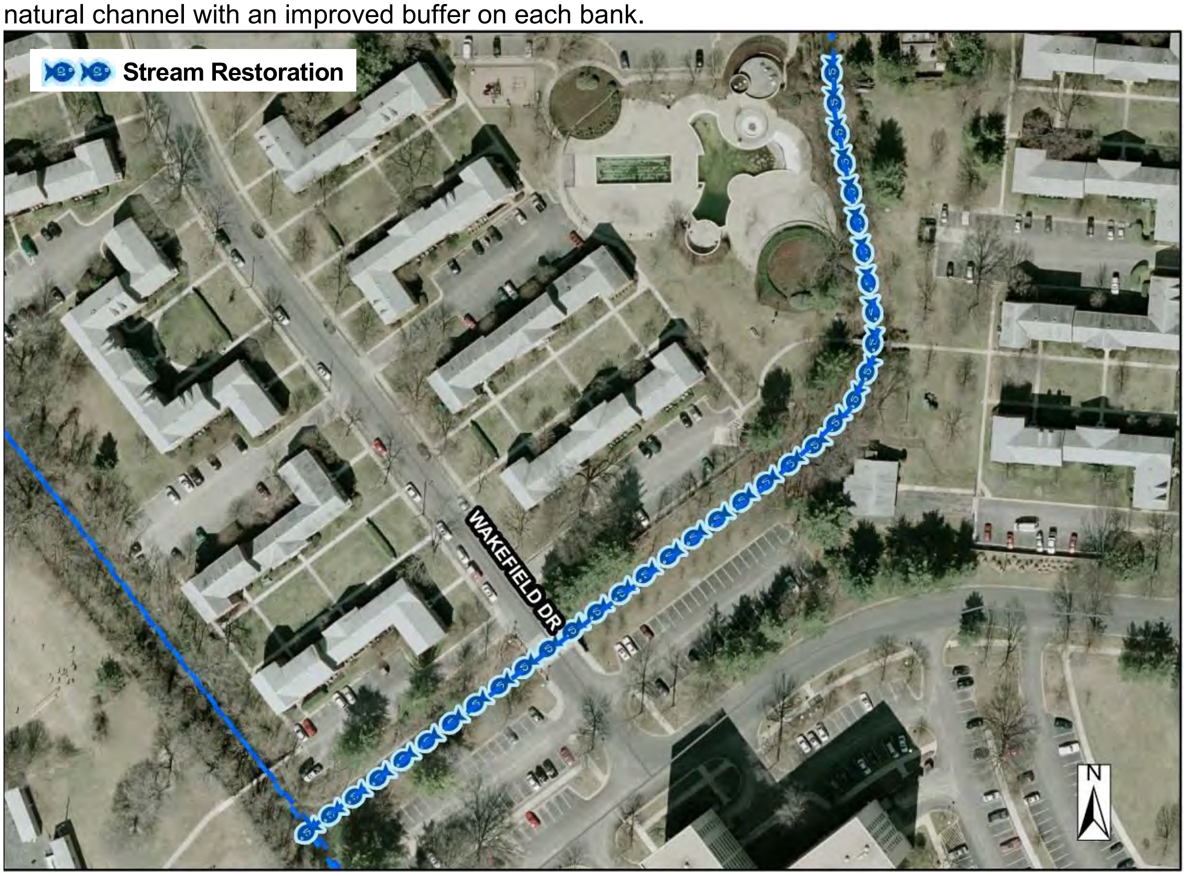
BE9201 Stream Restoration

Vicinity Map

Address:	W Wakefield Dr and Wakefield Dr
Location:	Belle View Condos
Land Owner:	Private - Residential
PIN:	Various
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Belle Haven West Channel

Description: This project is located between Potomac Avenue and Wakefield Drive and extends from Belle View Boulevard downstream to the confluence with the Belle Haven West Channel. Currently, this channel is concrete lined and very straight with mowed grass or trees on each side of the channel. Restoration efforts should focus on removing the existing 1130 feet of concrete channel and replacing it with a more natural channel with an improved buffer on each bank.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Removal of the concrete channel will create instream habitat and riparian plantings along the channel where feasible, will shade the stream and provide some additional bank protection and habitat. A natural channel would help to slow erosive velocities, reduce water temperatures, and allow for nutrient uptake from plantings. Note that removing the concrete will allow for the creation of a natural channel that will be connected to reaches above and below the restoration area that are currently stable.
Property owners along this project might welcome the aesthetic changes of the current channel to a natural, restored channel.

Project Design Considerations: This project is entirely contained within private property and will require significant coordination with property owners for access and construction. This project will require environmental permitting due to construction and modifications to a stream channel. Adequate area for construction and development of a true natural channel may be lacking at this site. Site is very accessible. No major design or construction issues anticipated. Minimal tree loss can be expected with this project. Both upstream and downstream reaches have been assessed as good condition. Restoring this area will connect the reaches with better habitat conditions.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Concrete channel removal	1130	LF	$30.00	$33,900
Clear and Grub	1.25	Ac	$10,000.00	$12,500
Plantings	1.25	Ac	$25,000.00	$31,250
Construct New Channel	1130	LF	$200.00	$226,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$403,650**
Ancillary Items	1	LS	5% of Project	$20,183
Erosion and Sediment Control	1	LS	10% of Project	$40,365
			Base Construction Cost	**$464,198**
			Mobilization (5%)	$23,210
			Subtotal 1	$487,408
			Contingency (25%)	$121,852
			Subtotal 2	$609,260
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$274,167
			Estimated Project Cost	**$883,000**


BE9201_1.jpg: View of concrete channel section

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BE9202 Stream Restoration

Vicinity Map

Address:	6240 Shields Ave
Location:	Upstream of Quander Rd
Land Owner:	Private - Residential
PIN:	0833 01 0025
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Quander Brook

Description: This project is located along Vanport Street and extends from the outlet of the proposed stormwater facility BE9103 to just upstream of the culvert under Quander Road. Currently this channel is mostly straight, incised, over-widened, and contains a riparian buffer that is comprised of many invasive species. At this time, stormwater controls are not present upstream of this proposed restoration. Restoration of this channel should follow the design and construction of project BE9103 to allow for proper sequencing of stream design for appropriate flows and velocities. Restoration of this channel will include regrading and stabilizing eroded stream banks with armor-in-place and bioengineering techniques. Restoration will also include the installation of grade controls to dissipate energy and some stone toe protection to ensure future bank stability. Buffer restoration along regraded areas and where extensive amounts of invasive vegetation are present will be necessary to promote future stability and to restore ecological function. Since this restoration is entirely contained within private residential property and the floodplain is confined due to topography, raising the bed elevation of this channel to reconnect higher flows to the floodplain or regrading the floodplain to create a new bench is not desirable. Most of the current floodplain is forested on both sides of the existing channel.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of this project will provide a reduction in sediment supply to receiving stream channels by reducing bank scour and stream bed incision. Benefits from implementing BE9103 will also help to provide water quality and quantity benefits to this restored channel. It is estimated that a total of over 340,000 lbs of sediment, 271.8 lbs of total nitrogen and 105.3 lbs of total phosphorus would be reduced by this project. Overall, stream habitat and water quality may be improved due to stable habitat creation and reductions in available sediment supply. Restoring the existing riparian buffer along this reach will also provide future channel stability and ecological benefits.

Project Design Considerations: This project is entirely contained within private residential land and will require significant coordination with property owners for access and construction. Access to this project will need to occur from either Vanport Street or off of Quander Road. Access from either of these points along the proposed restoration will require tree removal and manipulation of some steep slopes. Significant tree loss is expected with this restoration; however, restoration benefits and proposed buffer enhancements will outweigh overall construction impacts. This project will require environmental permitting due to construction and modifications to a perennial stream channel and forest impacts. Existing utility impacts are not anticipated with this restoration.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	0.5	Ac	$10,000.00	$5,000
Plantings	0.5	Ac	$25,000.00	$12,500
Construct New Channel	400	LF	$200.00	$80,000
Additional Cost, First 500 LF	400	LF	$200.00	$80,000
			Initial Project Costs	**$177,500**
Ancillary Items	1	LS	5% of Project	$8,875
Erosion and Sediment Control	1	LS	10% of Project	$17,750
			Base Construction Cost	**$204,125**
			Mobilization (5%)	$10,206
			Subtotal 1	$214,331
			Contingency (25%)	$53,583
			Subtotal 2	$267,914
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$120,561
			Estimated Project Cost	**$388,000**


BE9202_1.jpg: View of stream section

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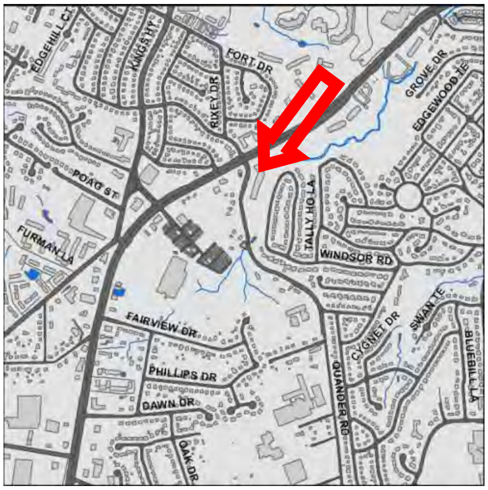
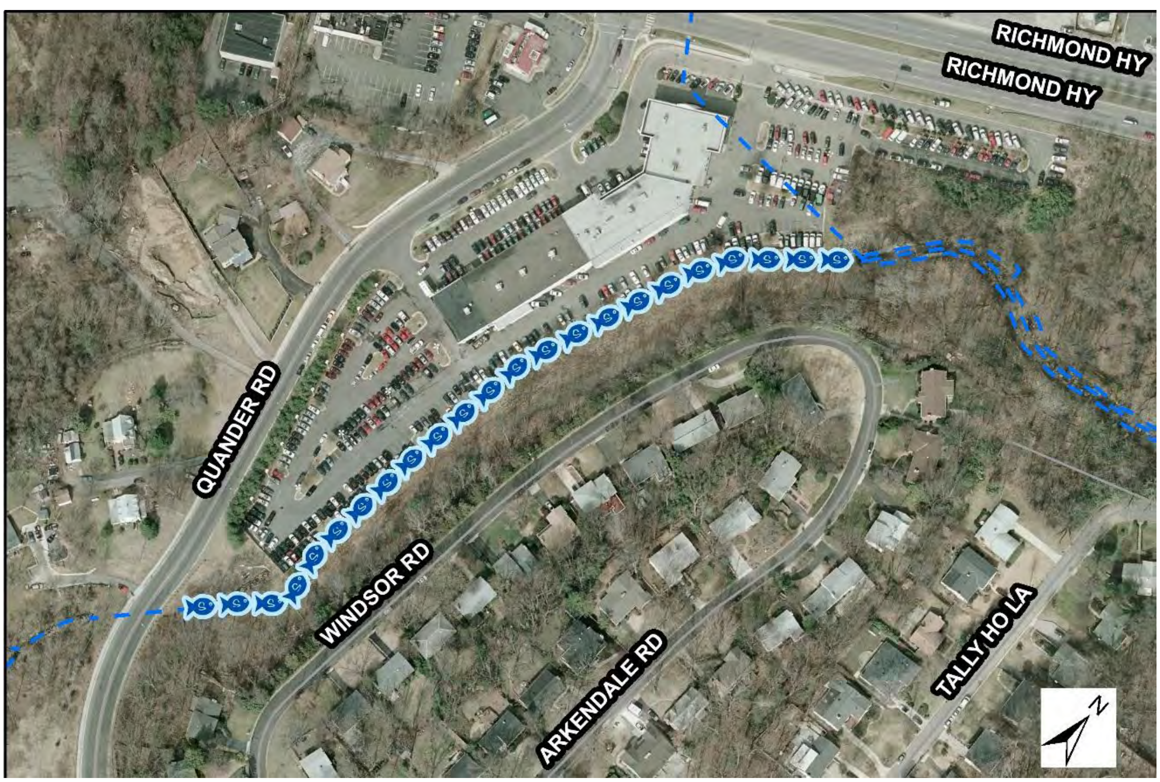
BE9203 Stream Restoration



Vicinity Map

Address:	Behind 6129 Richmond Hwy
Location:	Downstream of Quander Rd
Land Owner:	Private - Commercial
PIN:	0833 01 0052
Control Type	Peak flow control
Drainage Area	
Receiving Waters	Quander Brook

Description: Based on the modeled 100-year flow, buildings that are currently on the upstream and downstream sides of Quander Road appear to be affected due to two culverts under Quander Road and just downstream which may not be sufficient for this large flow. The proposed projects will daylight the culvert adjacent to the car dealership which will help to reduce the back water effect in this area. Restoration of this channel should follow the design and construction of BE9103 and BE9202 to allow for proper stream design and construction between projects. It should also be noted that BE9200 is located just downstream of this project and should be considered when designing the new channel for this project.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Daylighting Quander Brook will produce a stable, natural channel that may provide instream habitat, flood relief, and water quality benefits. Additional benefits from implementing BE9103 and BE9202 will help to provide water quality and quantity benefits to the proposed channel. It would also be a benefit to the community by providing recreational opportunities and potential educational benefits by demonstrating stream restoration techniques.

Project Design Considerations: The existing culvert runs adjacent to and potentially under the car dealership along Quander Road. Due to the proximity of this project, the owners of the car dealership will need to be involved and coordinated with during this project. Residential and commercial structures are close to the project site. Significant tree impacts and environmental permitting can be expected.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Concrete structures/channel removal	1	LS	$50,000.00	$50,000
Clear and Grub	3.5	Ac	$10,000.00	$35,000
Plantings	3.5	Ac	$25,000.00	$87,500
Construct New Channel	1700	LF	$200.00	$340,000
			Initial Project Cost	$512,500
Ancillary Items	1	LS	5% of project	$25,625
Erosion and Sediment Control	1	LS	10% of project	$51,250
			Base Construction Cost	**$589,375**
			Mobilization (5%)	$29,469
			Subtotal 1	**$618,844**
			Contingency (25%)	$154,711
			Subtotal 2	**$773,555**
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$348,100
			Estimated Project Cost	**$1,122,000**

BE9601_1.jpg: View of Pipe downstream of Quander Road

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BE9500 BMP/LID

Vicinity Map

Address:	Richmond Hwy and Huntington Ave
Location:	Shops at Huntington Gateway
Land Owner:	Private - Commercial
PIN:	0833 01 0076
Control Type	Water Quality
Drainage Area	1.64 acres
Receiving Waters	Quander Brook

Description: The proposed project is to create bioretention areas and install tree box filters to treat the roof and parking lot runoff from the Shops at Huntington Gateway. The tree box filters will be installed at the existing storm drain inlets in the parking lot and bioretention areas will be created by grading the existing medians.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of tree box filters and bioretention filters and basins will provide water quality treatment for the commercial parking lot runoff during storm events. These facilities remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total over 990 lbs of sediment, 1.4 lbs of total nitrogen and total phosphorus each would be reduced by this project. The project will also prevent trash and debris from entering the storm drain system and will reduce runoff temperature.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Access to the proposed sites is excellent from the commercial parking lot; however, the property ownership is private and coordination with the owners/management will be necessary. A potential loss of parking spaces may be expected with these sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	2	EA	$10,000.00	$20,000
Bioretention Filters & Basin	173	SY	$150.00	$25,950
			Initial Project Cost	**$45,950**
Plantings	1	LS	5% of project (excluding pervious pavement)	$2,298
Ancillary Items	1	LS	5% of project	$2,298
Erosion and Sediment Control	1	LS	10% of project	$4,595
			Base Construction Cost	**$55,141**
			Mobilization (5%)	$2,757
			Subtotal 1	**$57,898**
			Contingency (25%)	$14,475
			Subtotal 2	**$72,373**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$32,568
			Estimated Project Cost	**$105,000**

BE9500_1.jpg: View of existing storm drain inlet

BE9500_2.jpg: View of existing median to be graded

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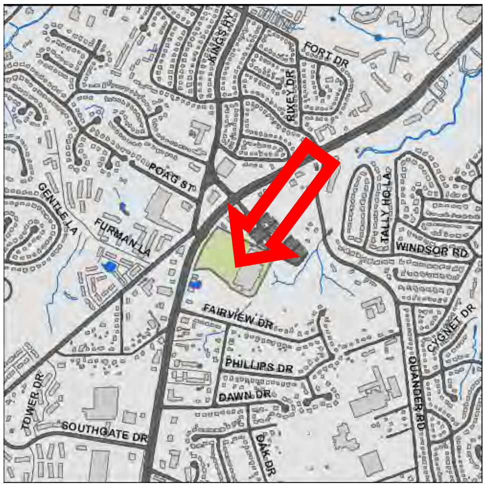
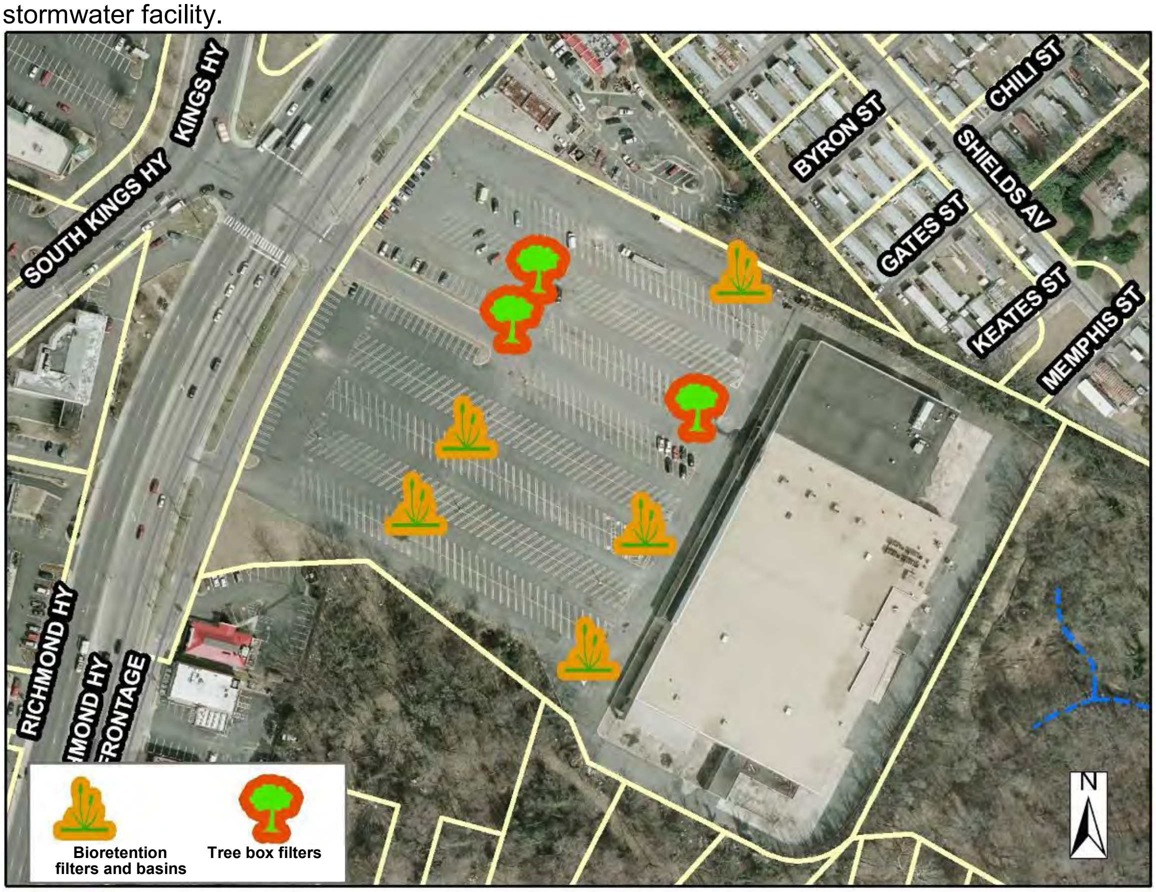
BE9501 BMP/LID



Vicinity Map

Address:	6303 Richmond Hwy
Location:	Wal-Mart and Chuck E. Cheese parking lot
Land Owner:	Private - Commercial
PIN:	0833 01 0024A
Control Type	Water Quality
Drainage Area	5.04 acres
Receiving Waters	Quander Brook

Description: Installation of bioretention filters and basins and tree box filters is proposed to treat the runoff from a large commercial strip mall parking lot located along Richmond Highway. A portion of this parking lot in the north is used for a park and ride. The majority of the south parking lot is not used and little grading would be necessary. This project is located just upstream of project BE9103, which is a proposed stormwater facility.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of the project will provide water quality treatment for this parking lot during storm events. These stormwater facilities remove suspended solids, heavy metals, nutrients and oil and grease from stormwater runoff. It is estimated that a total over 6,010 lbs of sediment, 79.5 lbs of total nitrogen and 12.4 lbs of total phosphorus would be reduced by this project. They also prevent trash and debris from entering the storm drain system and reduce runoff temperature.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Access to the proposed sites is excellent from roads and the commercial parking lot. Property ownership is private and coordination with the shopping center owner/management will be necessary. A loss of parking spaces may be expected with these sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	3	EA	$10,000.00	$30,000
Bioretention Filters & Basin	627	SY	$150.00	$94,050
			Initial Project Cost	**$124,050**
Plantings	1	LS	5% of project (excluding pervious pavement)	$6,203
Ancillary Items	1	LS	5% of project	$6,203
Erosion and Sediment Control	1	LS	10% of project	$12,405
			Base Construction Cost	**$148,861**
			Mobilization (5%)	$7,443
			Subtotal 1	**$156,304**
			Contingency (25%)	$39,076
			Subtotal 2	**$195,380**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$87,921
			Estimated Project Cost	**$283,000**

BE9501_1.jpg: View of existing parking lot

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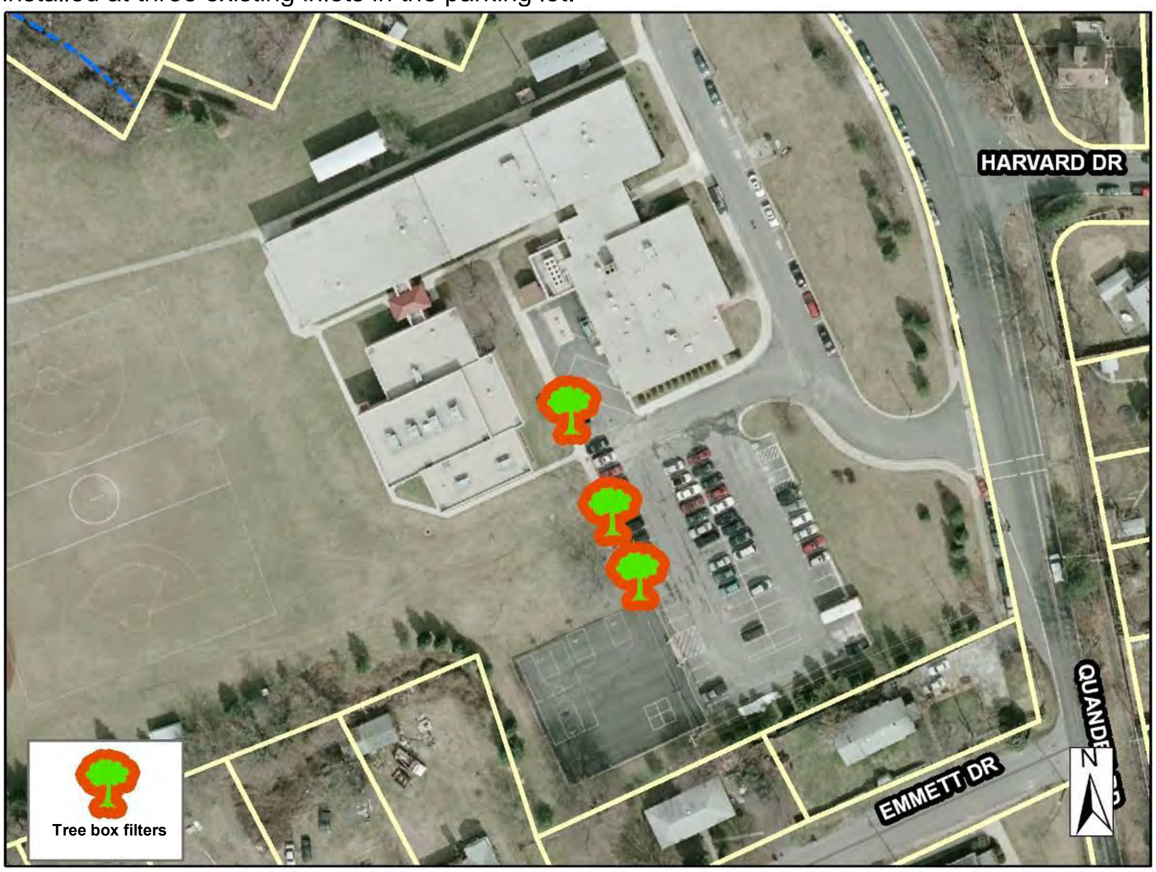
BE9502 BMP/LID

Vicinity Map

Address:	6400 Quander Road
Location:	Quander Road School
Land Owner:	County - FCPS
PIN:	0931 03 0005
Control Type	Water Quality
Drainage Area	0.92 acres
Receiving Waters	Quander Brook

Description: The proposed project is to install tree box filters to receive parking lot runoff at Quander Road School. The project site is the parking lot east of the school near the entrance. Tree box filters will be installed at three existing inlets in the parking lot.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of tree box filters will provide water quality treatment for the Quander Road School parking lot runoff during storm events. Tree box filters remove oil and grease, heavy metals, nutrients including phosphorus and nitrogen, and suspended solids from storm water runoff. It is estimated that a total over 830 lbs of sediment and 1.0 lbs of total phosphorus would be reduced by this project, total nitrogen reduction is negligible. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Access to the proposed sites is excellent from the school parking lot. This site will provide an environmental education/stewardship opportunity for students and parents within the Belle Haven community.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate students and parents in the community. Access to the proposed sites is excellent from the Quander Road School parking lot. Modifications to the existing storm drain system may be necessary to drain the proposed Bioretention Filters and Basins sites. Portions of the school parking lot may be temporarily closed due to construction and could interfere with morning arrival and afternoon dismissal during the school year.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	3	EA	$10,000.00	$30,000
			Initial Project Cost	**$30,000**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,500
Ancillary Items	1	LS	5% of project	$1,500
Erosion and Sediment Control	1	LS	10% of project	$3,000
			Base Construction Cost	**$36,000**
			Mobilization (5%)	$1,800
			Subtotal 1	**$37,800**
			Contingency (25%)	$9,450
			Subtotal 2	**$47,250**
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$21,263
			Estimated Project Cost	**$69,000**

BE9502_1.jpg: View of existing parking lot

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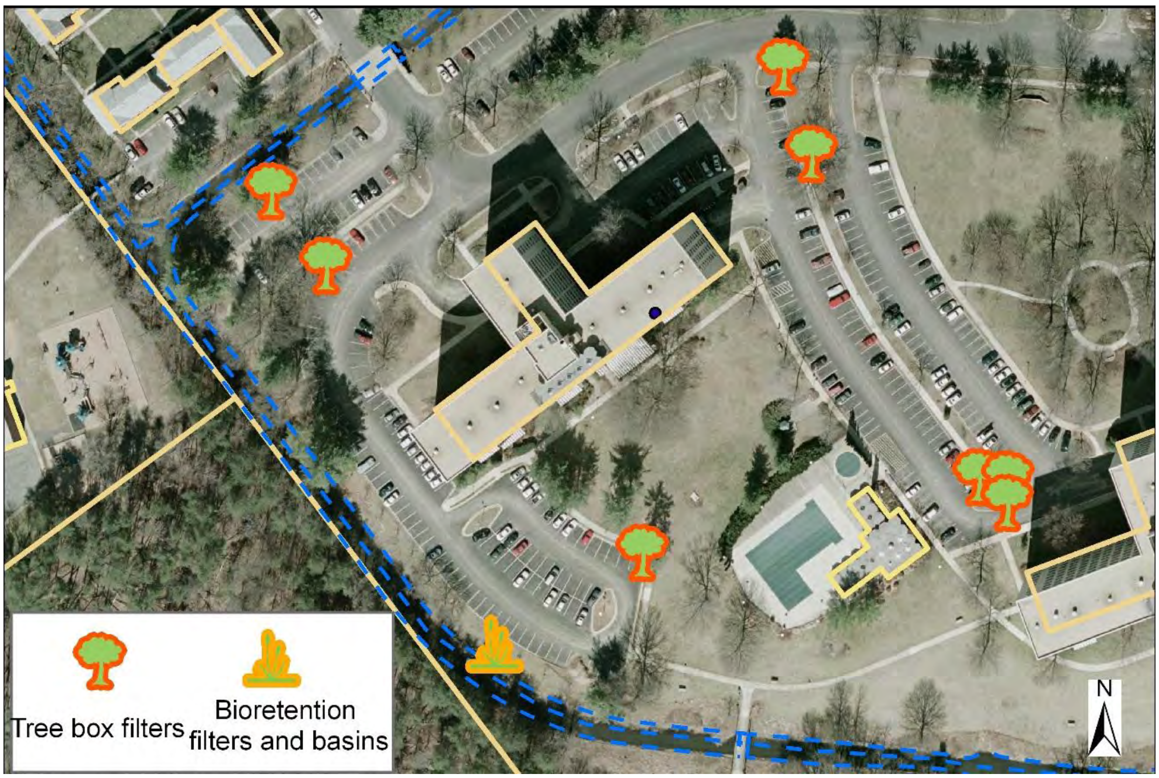
BE9503 BMP/LID

Vicinity Map

Address:	6631 Wakefield Drive,
Location:	River Towers
Land Owner:	Private – Residential
PIN:	Various
Control Type	Water Quality
Drainage Area	3.54 acres
Receiving Waters	Belle Haven West Channel

Description: This project is at River Towers on Wakefield Drive. The project proposes installation of tree box filters at the existing inlets and creation of a bioretention area to treat the runoff from the west side parking lot. Eight existing inlets will be installed with tree box filters and the open area next to the western-most parking lots will be graded and converted to a bioretention area.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of tree box filters and bioretention filters and basins will provide water quality treatment for the River Towers housing development parking lot runoff during storm events. These treatment systems remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total over 1,000 lbs of sediment, 12.4 lbs of total nitrogen and 2.4 lbs of total phosphorus would be reduced by this project. They also prevent trash and debris from entering the storm drain system and have the ability to reduce runoff temperatures.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Minimal tree removal will be required. Construction access to the location is excellent from the River Towers parking lots; however, the property ownership is private and coordination with the River Towers owners/management will be necessary. A temporary or permanent loss of parking spaces can be expected.

Costs:

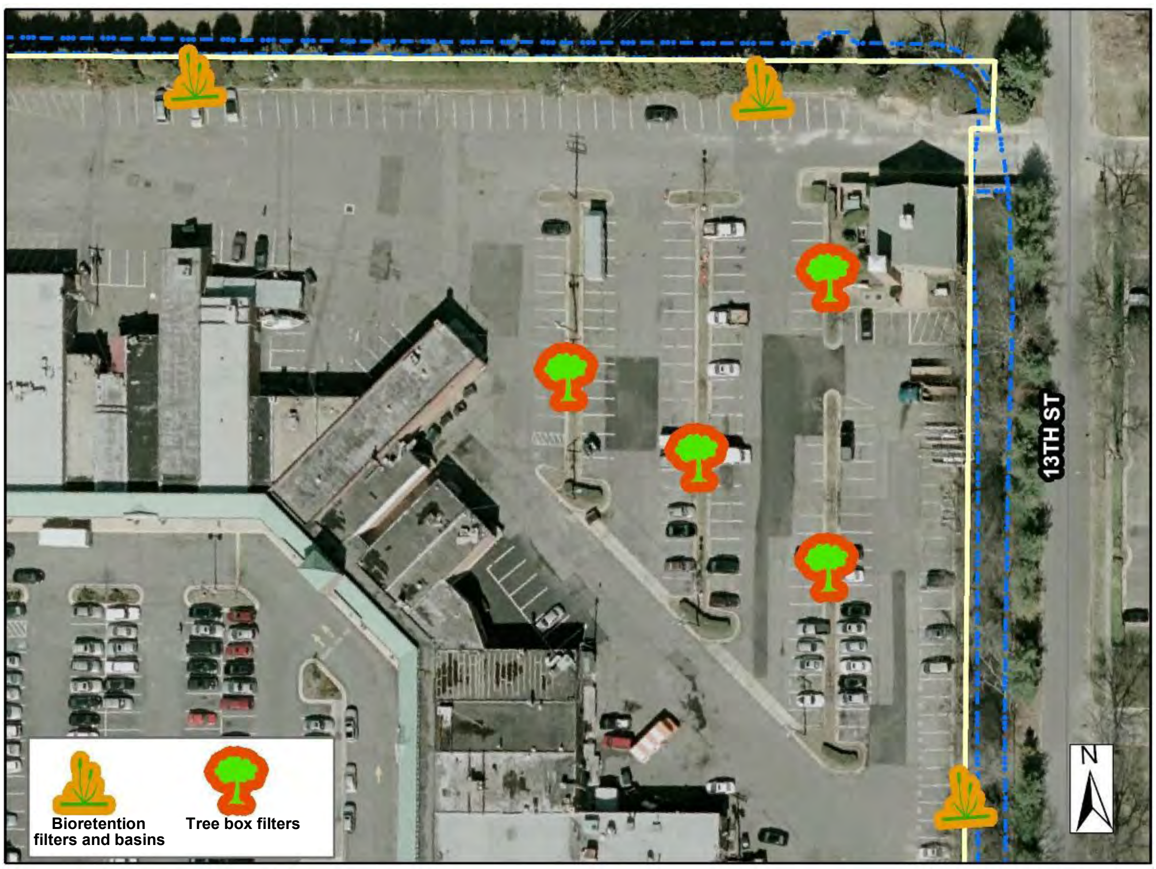
ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	8	EA	$10,000.00	$80,000
Bioretention Filters & Basin	198	SY	$150.00	$29,700
			Initial Project Cost	**$109,700**
Plantings	1	LS	5% of project (excluding pervious pavement)	$5,485
Ancillary Items	1	LS	5% of project	$5,485
Erosion and Sediment Control	1	LS	10% of project	$10,970
			Base Construction Cost	**$131,640**
			Mobilization (5%)	$6,582
			Subtotal 1	**$138,222**
			Contingency (25%)	$34,556
			Subtotal 2	**$172,778**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$77,750
			Estimated Project Cost	**$251,000**

BE9504 BMP/LID

Vicinity Map

Address:	1600 Block, Belle View Blvd
Location:	Belle View Shopping Center
Land Owner:	Private - Commercial
PIN:	0932 01 0002
Control Type	Water Quality
Drainage Area	2.92 acres
Receiving Waters	Belle Haven West Channel

Description: The proposed project is designed to install tree box filters and create bioretention areas to receive runoff from the northern section of parking lot at Belle View Shopping Center on Belle View Blvd. Tree box filters will be installed at four existing inlets and medians will be graded to create bioretention areas.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of tree box filters and bioretention filters and basins will provide water quality treatment for the Belle View Shopping Center runoff during storm events. These facilities remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total over 3,930 lbs of sediment, 52.3 lbs of total nitrogen and 8.1 lbs of total phosphorus would be reduced by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Minimal tree removal may be required for construction. Access to the proposed sites is excellent from roads and the Belle View Shopping Center parking lot. Property ownership is private and coordination with the shopping center owner/management will be necessary. A temporary or permanent loss of parking spaces can be expected.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	4	EA	$10,000.00	$40,000
Bioretention Filters & Basin	156	SY	$150.00	$23,400
			Initial Project Cost	**$63,400**
Plantings	1	LS	5% of project (excluding pervious pavement)	$3,170
Ancillary Items	1	LS	5% of project	$3,170
Erosion and Sediment Control	1	LS	10% of project	$6,340
			Base Construction Cost	**$76,080**
			Mobilization (5%)	$3,804
			Subtotal 1	**$79,884**
			Contingency (25%)	$19,971
			Subtotal 2	**$99,855**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$44,935
			Estimated Project Cost	**$145,000**

BE9504_1.jpg: View of existing inlet and median in parking lot

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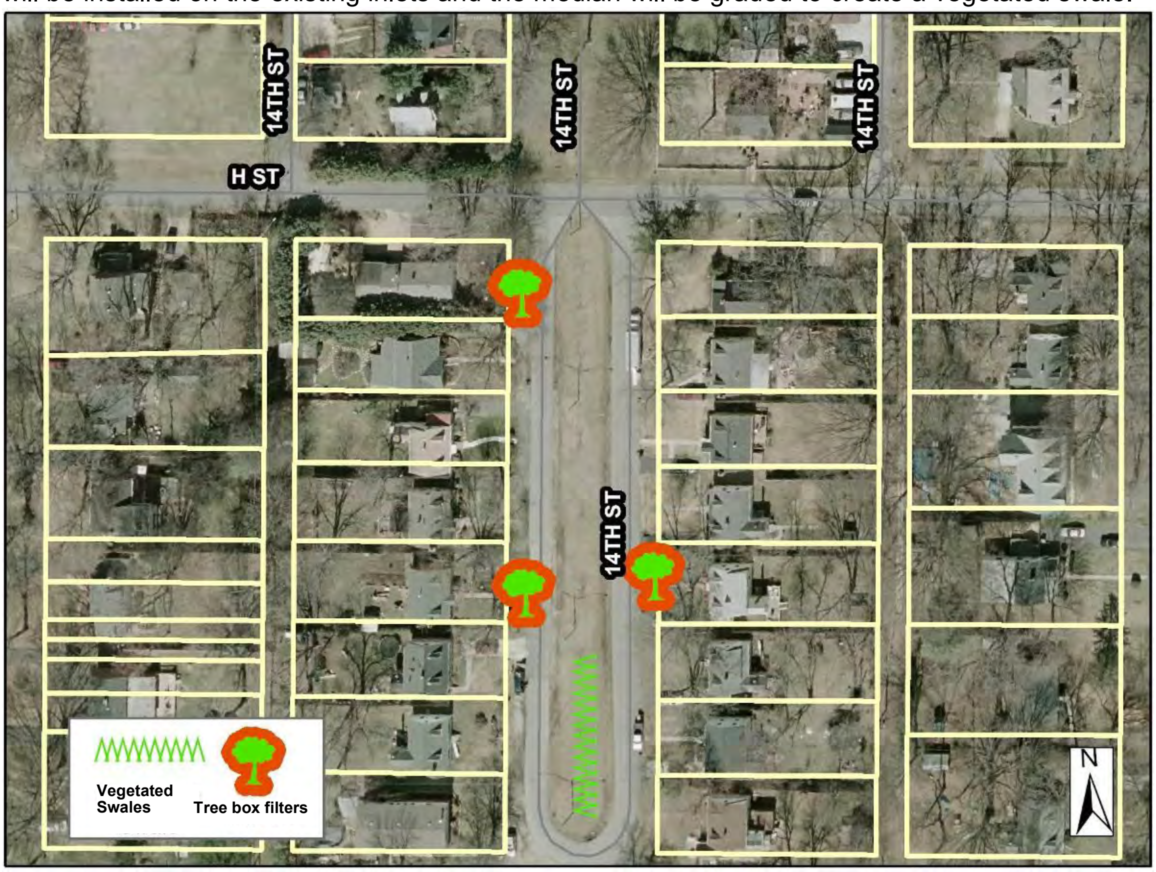
BE9505 BMP/LID

Vicinity Map

Address:	6400 Block, 14th St
Location:	14th St between H St and I St
Land Owner:	State - VDOT
PIN:	NA
Control Type	Water Quality
Drainage Area	1.96 acres
Receiving Waters	Belle Haven West Channel

Description: This project proposes installation of vegetated swale in the median of 14th Street and installation of tree box filters at the inlets along the roadway. The proposed swale will receive the roadway runoff and roof runoff from the medium density residential area north of the project site. Three tree box filters will be installed on the existing inlets and the median will be graded to create a vegetated swale.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of a vegetated swale will provide water quality treatment for residential runoff during storm events, trapping suspended solids, reducing trace metals, and reducing nutrients including phosphorus and nitrogen from storm water runoff. It is estimated that a total over 1,520 lbs of sediment, 20.6 lbs of total nitrogen and 3.8 lbs of total phosphorus would be reduced by this project. The swale can also promote infiltration and can reduce the flow velocity of storm water runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. No tree removal is required for this site. Access to the proposed site is excellent from H Street and 14th Street. Property ownership is most likely private and coordination with the property owners will be necessary for this site.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	3	EA	$10,000.00	$30,000
Vegetated Swale	125	SY	$50.00	$6,250
			Initial Project Cost	**$36,250**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,813
Ancillary Items	1	LS	5% of project	$1,813
Erosion and Sediment Control	1	LS	10% of project	$3,625
			Base Construction Cost	**$43,501**
			Mobilization (5%)	$2,175
			Subtotal 1	**$45,676**
			Contingency (25%)	$11,419
			Subtotal 2	**$57,095**
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$25,693
			Estimated Project Cost	**$83,000**


BE9505_1.jpg: View of median in 14th Street

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BE9506 BMP/LID

Vicinity Map

Address:	1700 Block, Belle View Blvd
Location:	Belle View Blvd
Land Owner:	State - VDOT
PIN:	NA
Control Type	Water Quality
Drainage Area	1.31 acres
Receiving Waters	Belle Haven West Channel

Description: The project proposes installation of tree box filters along the shoulders and in the medians of Belle View Boulevard. Four existing inlets will be retrofitted with tree box filters so that they will treat a portion of roadway runoff.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of tree box filters will provide water quality treatment for portions of the Belle View Shopping Center and Belle View Boulevard runoff during storm events. Tree box filters remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total over 2,170 lbs of sediment, 20.4 lbs of total nitrogen and 4.7 lbs of total phosphorus would be reduced by this project. These filters also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. No tree removal is required for the sites. Access is excellent from Belle View Boulevard and the Belle View Shopping Center parking lot. Maintenance of traffic will be needed along Belle View Boulevard during construction. The construction of new storm drain may be necessary to provide and underdrain for the sites along Belle View Boulevard.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	4	EA	$10,000.00	$40,000
			Initial Project Cost	**$40,000**
Plantings	1	LS	5% of project (excluding pervious pavement)	$2,000
Ancillary Items	1	LS	5% of project	$2,000
Erosion and Sediment Control	1	LS	10% of project	$4,000
			Base Construction Cost	**$48,000**
			Mobilization (5%)	$2,400
			Subtotal 1	**$50,400**
			Contingency (25%)	$12,600
			Subtotal 2	**$63,000**
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$28,350
			Estimated Project Cost	**$91,000**

BE9506_1.jpg: View of median and inlet on Belle View Blvd

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BE9507 BMP/LID

Vicinity Map

Address:	1600 Block, Belle View Blvd
Location:	Belle View Shopping Center
Land Owner:	Private – Commercial
PIN:	0932 01 0001
Control Type	Water Quality
Drainage Area	5.14 acres
Receiving Waters	Belle Haven West Channel

Description: The proposed projects is at the parking lot in front of Belle View Shopping Center on Belle View Blvd. One tree box filter will be installed and the medians between the parking lot will be graded to create bioretention areas. The runoff from the parking lot will be treated for water quality primarily for nitrogen, phosphorus and total suspended solids.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of tree box filters and bioretention filters and basins will provide water quality treatment for the Belle View Shopping Center runoff during storm events. These facilities remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total over 4,000 lbs of sediment, 52.6 lbs of total nitrogen and 8.2 lbs of total phosphorus would be reduced by this project. They also prevent trash and debris from entering the storm drain system and have the ability to reduce runoff temperature.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Minimal tree removal may be required for construction. Access to the proposed sites is excellent from roads and the Belle View Shopping Center parking lot. Property ownership is private and coordination with the shopping center owner/management will be necessary for these sites. A temporary or permanent loss of parking spaces can be expected with these sites. The construction of a new storm drain system to drain the proposed sites to the existing storm drain system may be necessary.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	1	EA	$10,000.00	$10,000
Bioretention Filters & Basin	684	SY	$150.00	$102,600
			Initial Project Cost	**$112,600**
Plantings	1	LS	5% of project (excluding pervious pavement)	$5,630
Ancillary Items	1	LS	5% of project	$5,630
Erosion and Sediment Control	1	LS	10% of project	$11,260
			Base Construction Cost	**$135,120**
			Mobilization (5%)	$6,756
			Subtotal 1	**$141,876**
			Contingency (25%)	$35,469
			Subtotal 2	**$177,345**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$79,805
			Estimated Project Cost	**$257,000**

BE9507_1.jpg: View of medians at Belle View Shopping Center

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BE9508 BMP/LID

Vicinity Map

Address: 6701 Fort Hunt Road
Location: Belle View School
Land Owner: County – FCPS
PIN: 0932 01 0005
Control Type Water Quality
Drainage Area 1.54 acres
Receiving Waters Belle Haven West Branch

Description: Belle View Elementary School parking lot runoff will be treated by installing bioretention filters and basins in the medians and adjacent grassy areas. This project is located just upstream of project BE9102, which is a proposed stormwater pond.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of bioretention filters and basins will provide water quality treatment for the Belle View Elementary School parking lot runoff during storm events. These facilities remove oil and grease, heavy metals, nutrients including phosphorus and nitrogen, and suspended solids from storm water runoff. It is estimated that a total over 1,700 lbs of sediment, 18.6 lbs of total nitrogen and 4.3 lbs of total phosphorus would be reduced by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on school grounds, the need for land purchase or acquisition is eliminated while providing an environmental education/stewardship opportunity for students and parents within the Belle Haven community.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate students and parents in the community. No tree removal is required for installation. Access to the proposed sites is excellent from the Belle View Elementary School parking lot. Modifications to the existing storm drain system may be necessary to drain the proposed sites. Portions of the school parking lot may be temporarily closed due to construction and could interfere with morning arrival and afternoon dismissal if work was undertaken during the school year.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	180	SY	$150.00	$27,000
			Initial Project Cost	**$27,000**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,350
Ancillary Items	1	LS	5% of project	$1,350
Erosion and Sediment Control	1	LS	10% of project	$2,700
			Base Construction Cost	**$32,400**
			Mobilization (5%)	$1,620
			Subtotal 1	**$34,020**
			Contingency (25%)	$8,505
			Subtotal 2	**$42,525**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$19,136
			Estimated Project Cost	**$62,000**


BE9508_1.jpg: View of medians at Belle View School

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BE9509 BMP/LID

Vicinity Map

Address:	2017 Belle View Blvd
Location:	Mt. Vernon Recreation Center
Land Owner:	County – FCPA
PIN:	0931 24090004A
Control Type	Water Quality
Drainage Area	2.83 acres
Receiving Waters	Belle Haven West Channel

Description: The project proposes installation of tree box filters at eleven inlets which receive runoff from the parking lot at Mt. Vernon Recreation Center and Sports Complex.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Tree box filters remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, and oil and grease from storm water runoff. It is estimated that a total of 144 lbs of sediment, less than 0.5 lbs of total nitrogen and total phosphorus each would be reduced by this project. Since this site is located on public land, the need for land purchase or acquisition is eliminated while providing an environmental education/stewardship opportunity for residents within the Belle Haven community.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate residents in the community. Access to the proposed sites is excellent due to multiple parking lots. Modifications to the existing storm drain system may be necessary to provide an underdrain for the proposed facilities.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	11	EA	$10,000.00	$110,000
			Initial Project Cost	**$110,000**
Ancillary Items	1	LS	5% of project	$5,500
Erosion and Sediment Control	1	LS	10% of project	$11,000
			Base Construction Cost	**$126,500**
			Mobilization (5%)	$6,325
			Subtotal 1	**$132,825**
			Contingency (25%)	$33,206
			Subtotal 2	**$166,031**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$74,714
			Estimated Project Cost	**$241,000**


BE9509_1.jpg: View of Parking lot inlet

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BE9510 BMP/LID

Vicinity Map

Address:	6500 Quander Road
Location:	West Potomac High School
Land Owner:	County - FCPS
PIN:	0931 01 0056
Control Type	Water Quality
Drainage Area	2.37 acres
Receiving Waters	Quander Brook

Description: This project consists of installing bioretention filters along the edges of the parking lot to treat runoff on the west side of West Potomac High School. This project is located just upstream of the stormwater facility retrofit site BE9100.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of bioretention filters and basins will provide water quality treatment for the West Potomac High School runoff during storm events. These cells remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total over 210 lbs of sediment, 1.75 lbs of total nitrogen and 0.5 lbs of total phosphorus would be reduced by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on school grounds, the need for land purchase or acquisition is eliminated while providing an environmental education/stewardship opportunity for students and parents within the Belle Haven community.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate students and parents in the community. Minimal tree removal may be required. Access to the proposed sites is excellent from the West Potomac High School parking lot. Modifications to the existing storm drain system may be necessary to drain the proposed sites. Portions of the school parking lot may be temporarily closed due to construction and could interfere with morning arrival and afternoon dismissal if work was undertaken during the school year.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	249	SY	$150.00	$37,350
			Initial Project Cost	**$37,350**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,868
Ancillary Items	1	LS	5% of project	$1,868
Erosion and Sediment Control	1	LS	10% of project	$3,735
			Base Construction Cost	**$44,821**
			Mobilization (5%)	$2,241
			Subtotal 1	**$47,062**
			Contingency (25%)	$11,766
			Subtotal 2	**$58,828**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$26,473
			Estimated Project Cost	**$85,000**

BE9510_1.jpg: View of Parking lot at West Potomac High School

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BE9600 Flood Protection/Mitigation

Vicinity Map

Address:	2100 Block, Yale Drive
Location:	Culvert under Yale Drive
Land Owner:	State - VDOT
PIN:	
Control Type	Peak flow control
Drainage Area	
Receiving Waters	Unknown Tributary of Hunting Creek

Description: The storm drain under Princeton Drive is modeled as flooding for the 100-year event, and the crossing at Yale Drive overtops for the 10-year event. The project would consist of reconstruction of the road crossing and storm drain so that it passes the 100-yr flows without overtopping. The primary indicator is the frequency of flooding of the road crossing.

Project Area Map: Conceptual plan showing potential location of project

Project Benefits: The reconstruction of the structure under Yale Dr. will be able to convey the 10-year storm reducing the modeled overtopping at this location and at the upstream culvert.

Project Design Considerations: New stormwater pond project located on Mount Vernon High School which could have an impact on these crossings. No other projects are located within the immediate vicinity. Coordination and sequencing of these two projects should be considered. There are minimal environmental permitting requirements for this project. The project site can be accessed from Yale Drive. An easement may be required. Homes in the vicinity are located close to the project area, therefore specific care should be taken to reduce impacts to private property.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Excavation	3600	CY	$30.00	$108,000
Stabilization graded base	1080	CY	$50.00	$54,000
Structure (3 x 100 ft 4.5 CMP)	300	LF	$175.00	$52,500
Graded Base	1200	SY	$15.00	$18,000
Curb and gutter	300	LF	$30.00	$9,000
Turfgrass establishment	1400	SY	$3.00	$4,200
Placing topsoil	1400	SY	$5.00	$7,000
Soil Stabilization matting	1400	SY	$5.00	$7,000
			Initial Project Cost	**$259,700**
Plantings	1	LS	5% of project	$12,985
Ancillary Items	1	LS	5% of project	$12,985
Erosion and Sediment Control	1	LS	10% of project	$25,970
			Base Construction Cost	**$311,640**
			Mobilization (5%)	$15,582
			Subtotal 1	$327,222
			Contingency (25%)	$81,806
			Subtotal 2	$409,028
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$184,063
			Estimated Project Cost	**$593,000**

BE9600_1.jpg: Upstream side of culvert on Yale Drive

BE9600_2.jpg: Downstream side of culvert on Yale Drive

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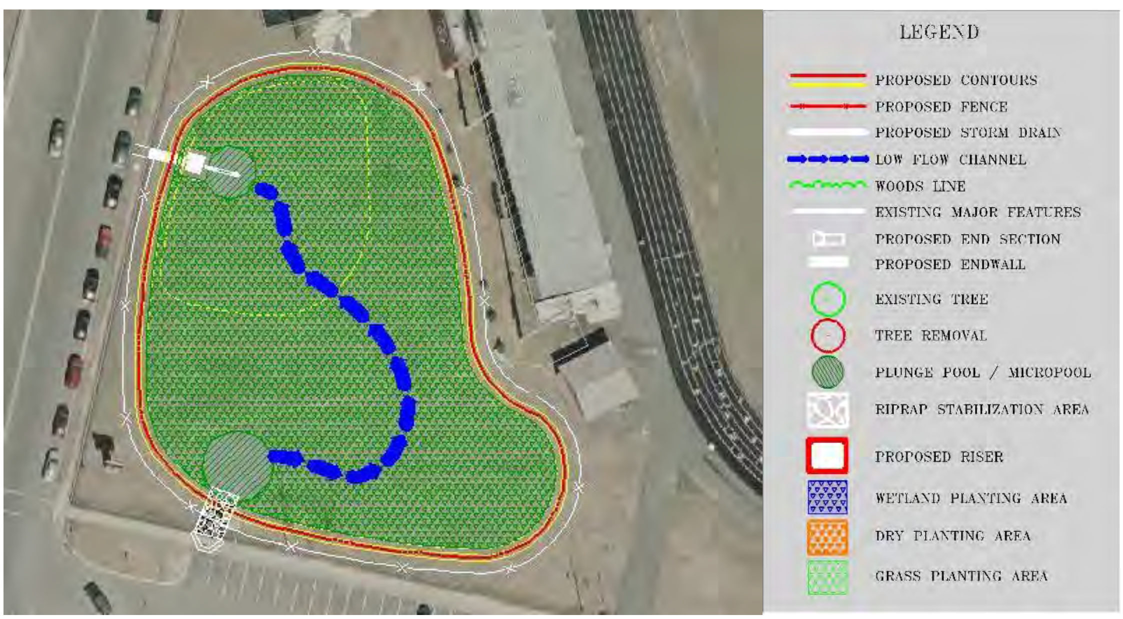
DC9100 New Stormwater Pond

Vicinity Map

Address:	8515 Old Mt Vernon Rd
Location:	Mount Vernon High School
Land Owner:	County - FCPS
PIN:	1014 01 0034
Control Type	Water Quality and Quantity
Drainage Area	22.45 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: The project proposes creation of an extended detention dry pond with a sediment forebay at Mt.Vernon High School. Runoff from the roofs and parking lots will be treated for water quantity control and water quality. The proposed pond will be implemented in open space adjacent to the track and field.



Project Area Map

Project Benefits: This facility has the potential to meet the water quality treatment requirement for the contributing drainage area via extended detention of the half inch, 48 hour storm and provide peak flow management of the 2-year and 10-year design storm. Constructing this facility would promote uptake of nutrients, removal of pollutants via suspension of floatables, and overall water quality and habitat improvements. Peak flow rates, erosive velocities, and channel sediment loads will also be reduced by this project. It is estimated that a total of 2,270 lbs of sediment, 20.0 lbs of nitrogen and 5.6 lbs of phosphorus would be reduced annually by this project. The proposed location of this facility is on the Mt. Vernon High School grounds, which will eliminate or reduce the need for land purchase or acquisition and provides an environmental education/stewardship opportunity for students and parents within the Dogue Creek community.

Project Design Considerations: The area where the facility will be located is flat. This reduces the depth potential of the pond which requires a larger surface area/footprint to meet the management requirements. A fence around the proposed facility would be necessary to ensure public safety. No environmental permitting issues are anticipated for this project. Access to the proposed facility is good. Existing utility conflicts are not anticipated. Existing storm drain characteristics may affect the potential to provide stormwater management at this location.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	0.84	AC	$8,500.00	$7,140
Curb Opening	1	EA	$2,000.00	$2,000
Rip Rap Stabilization	35	SY	$100.00	$3,500
New Riser	1	LS	$8,000.00	$8,000
Embedded Dewatering Pipe	1	EA	$500.00	$500
Plungepool / Micropool	2	EA	$300.00	$600
Grading and Excavation	3506	CY	$35.00	$122,710
Embankment	877	CY	$50.00	$43,850
Outflow Pipe	50	LF	$125.00	$6,250
Excavate to create low-flow channel	225	LF	$25.00	$5,625
Soil Borings	1	LS	$10,000.00	$10,000
			Initial Project Costs	**$210,175**
Plantings	1	LS	5% of Project	$10,509
Ancillary Items	1	LS	5% of Project	$10,509
Erosion and Sediment Control	1	LS	10% of Project	$21,018
			Base Construction Cost	**$252,211**
			Mobilization (5%)	$12,611
			Subtotal 1	$264,822
			Contingency (25%)	$66,206
			Subtotal 2	$331,028
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$148,963
			Estimated Project Cost	**$480,000**

DC9100_1.jpg: Location for proposed pond

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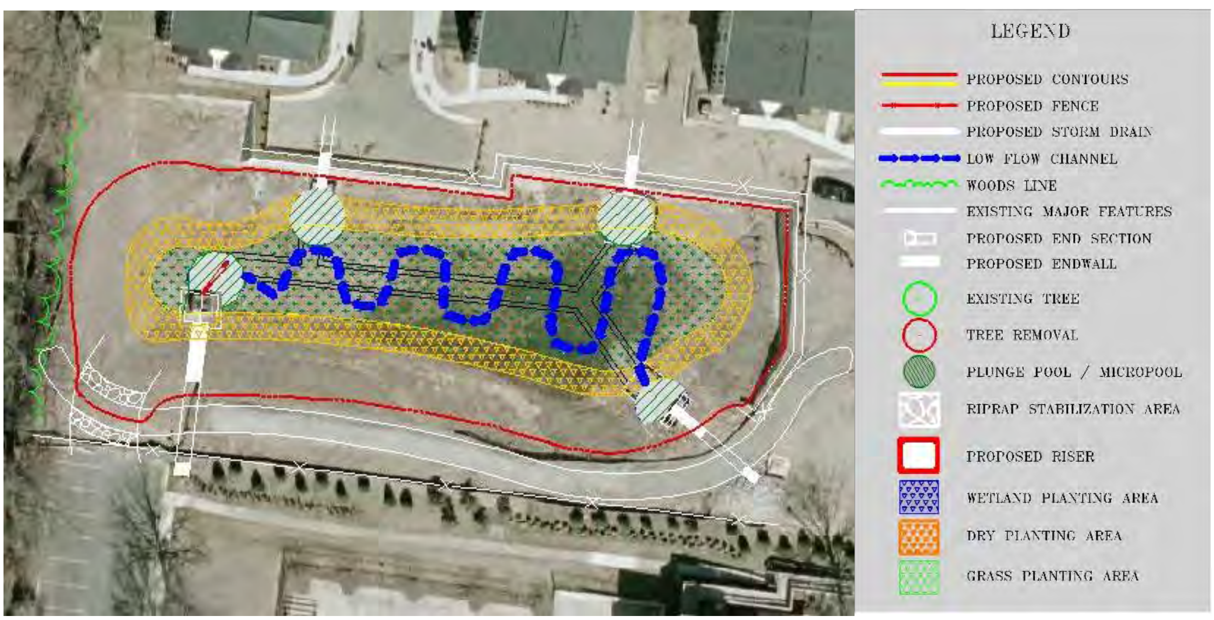
DC9106 Stormwater Pond Retrofit

Vicinity Map

Address:	Near 7147 Huntley Creek Pl
Location:	Groveton Woods Condominium
Land Owner:	Private
PIN:	
Control Type	Water Quality and Quantity
Drainage Area	11.59 acres
Receiving Waters	Unknown tributary of Barnyard Run

Description: An existing detention basin located at Groveton Woods Condominium and adjacent to Lafayette Village Apartments will be converted to a shallow wetland by removing the existing concrete low flow channels, excavating the bottom to incorporate wetland planting zones and meandering flow channels, and adjusting the dewatering orifice and riser characteristics. The pond will receive runoff from a high density residential area and provide detention along with treatment for nitrogen, phosphorus and total suspended solids.



Project Area Map

Project Benefits: This facility has potential to meet the water quality treatment requirement via extended detention of the half-inch, 48 hour storm, and manage 2-year and 10-year peak flow volumes for the contributing drainage area. Retrofits to this facility will promote the removal of suspended solids and floatables to downstream channels, help prevent future downstream channel erosion, and promote overall water quality and healthy habitat. It is estimated that a total of 2,370 lbs of sediment, 29.2 lbs of nitrogen and 5.9 lbs of phosphorus would be reduced annually by this project.

Project Design Considerations: Environmental permitting issues are not anticipated for this pond retrofit. Access to the facility is good. The community where this facility is located is gated and ownership is likely private. Minimal design and construction issues were identified at this site.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	0.56	AC	$8,500.00	$4,760
Paved Ditch Demolition & Haul Away	235	LF	$30.00	$7,050
Plungepool / Micropool	4	EA	$500.00	$2,000
Riser Retrofit	1	LS	$4,000.00	$4,000
Excavate to create low-flow channel	342	LF	$25.00	$8,550
Grading and Excavation	148	CY	$35.00	$5,180
Soil Borings	1	LS	$7,500.00	$7,500
			Initial Project Costs	**$39,040**
Plantings	1	LS	5% of Project	$1,952
Ancillary Items	1	LS	5% of Project	$1,952
Erosion and Sediment Control	1	LS	10% of Project	$3,904
			Base Construction Cost	**$46,848**
			Mobilization (5%)	$2,342
			Subtotal 1	$49,190
			Contingency (25%)	$12,298
			Subtotal 2	$61,488
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$27,670
			Estimated Project Cost	**$89,000**

DC9106_1.jpg: View of the existing pond

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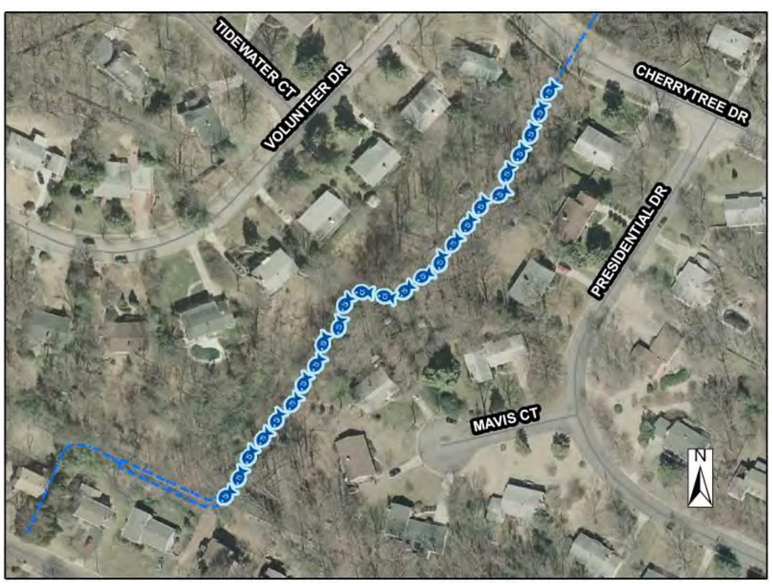
DC9201 Stream Restoration

Vicinity Map

Address:	9200 Block, Cherrytree Drive
Location:	Between Presidential Drive and Volunteer Drive
Land Owner:	Private - Residential
PIN:	1104 03 0097
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Dogue Creek

Description: This project is located between Volunteer Drive and Presidential Drive and extends from the upstream limit of DC9200 (near Robertson Boulevard) to the downstream side of a culvert under Cherrytree Drive. Currently, this natural channel is experiencing moderate to severe erosion on the outside of meander bends and where the channel parallels the valley walls. An exposed sanitary sewer concrete casing within the channel is present just downstream of the culvert under Cherrytree Drive and a headcut is also present near the middle of the proposed project limits. Restoration of this channel will include regrading and stabilizing eroded stream banks with armor-in-place techniques on outer meander bends and bioengineering techniques on straight portions to create a stable cross-section. Due to the existing headcut, the channel bed will need to be adjusted and grade controls will be needed to dissipate energy and adjust for changes in channel slope. The exposed sanitary sewer casing should be stabilized and covered as part of this restoration. Since this restoration is entirely contained within private residential property, raising the bed elevation of this channel to reconnect higher flows to the floodplain or regrading the floodplain to create a new bench is not desirable. Currently, this restoration is within forested conditions.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: New channel geometry and stabilization of existing banks will allow for reduced sediment loads to downstream channels. By reducing sedimentation within this channel and providing stable habitat along restored banks, overall instream water quality and habitat may be improved with this project. It is estimated that a total over 27,360 lbs of sediment, 22.0 lbs of total nitrogen and 8.5 lbs of total phosphorus would be reduced by this project. This project will also protect an exposed sanitary sewer casing within this channel and prevent the further upstream migration of a headcut.

Project Design Considerations: This project is entirely contained within private residential properties along Volunteer Drive, Presidential Drive, and Mavis Court and will require significant coordination with property owners for access and construction. Access to this project may need to occur off of Cherrytree Drive at the upstream end of this project or from individual property owners that grant access. This project will require environmental permitting due to construction and modifications to a perennial stream channel and floodplain. Moderate to significant tree loss can be expected with this restoration and restoration benefits may not outweigh overall construction impacts.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	1	Ac	$10,000.00	$10,000
Plantings	1	Ac	$25,000.00	$25,000
Construct New Channel	800	LF	$200.00	$160,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$295,000**
Ancillary Items	1	LS	5% of Project	$14,750
Erosion and Sediment Control	1	LS	10% of Project	$29,500
			Base Construction Cost	**$339,250**
			Mobilization (5%)	$16,963
			Subtotal 1	$356,213
			Contingency (25%)	$89,053
			Subtotal 2	$445,266
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$200,370
			Estimated Project Cost	**$646,000**


DC9201_1.jpg: Erosion on outside meander bend

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DC9202 Stream Restoration

Vicinity Map

Address:	4100 Block, Sulgrave Drive
Location:	Between Sulgrave Dr and Adrienne Dr
Land Owner:	Private - Residential
PIN:	1101 11 0083
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Dogue Creek

Description: This project is located between Adrienne Drive, Renault Place, and Sulgrave Drive and extends from a 48" storm drain outfall just north of Renault Place and extends downstream to the upstream side of the culvert under Adrienne Drive. This channel is characterized by moderate to severe erosion occurring on the outside of meanders and in the upstream portion, especially where the channel becomes very sinuous between Renault Place and Sulgrave Drive. Restoration of this channel will include regrading and stabilizing eroded stream banks with armor-in-place techniques on outer meander bends and bioengineering techniques on straight portions to create a stable cross-section. Restoration will include grade controls to dissipate energy and require some installation of stone toe protection to ensure future bank stability. Some areas within the project limits may require adjusting the bed elevation of the channel to reconnect higher flows to the floodplain and to promote stability near existing stormdrain outfalls. Currently, this restoration is within moderately forested conditions.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: This restoration will be designed to withstand large, flashy flows that originate from the 48” RCP storm drain outfall. Implementation of this project will provide a reduction in sediment supply to receiving stream channels by reducing bank scour and meander bend migration while providing a floodplain to dissipate energy and encourage deposition of sediment. By reducing sedimentation within the channels and providing stable habitat along restored banks, overall instream water quality and habitat may be improved with this project. It is estimated that a total over 102,700 lbs of sediment, 82.1 lbs of total nitrogen and 31.8 lbs of total phosphorus would be reduced by this project. This project will also stabilize several storm drain outfalls and conveyances that drain to this channel.

Project Design Considerations: This project is entirely contained within private residential properties along Adrienne Drive, Renault Place, and Sulgrave Drive and will require significant coordination with property owners for access and construction. Access to this project could occur at the end of Renault Place or Sulgrave Drive where existing stormdrain outfalls exist. Both of these access points will require moderate tree removal. This project will require environmental permitting due to construction and modifications to a perennial stream channel and moderate tree loss. Existing utility impacts are not anticipated with this restoration.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	1.5	Ac	$10,000.00	$15,000
Plantings	1.5	Ac	$25,000.00	$37,500
Construct New Channel	1350	LF	$200.00	$270,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$322,500**
Ancillary Items	1	LS	5% of Project	$21,125
Erosion and Sediment Control	1	LS	10% of Project	$42,250
			Base Construction Cost	**$485,875**
			Mobilization (5%)	$24,294
			Subtotal 1	$510,169
			Contingency (25%)	$127,542
			Subtotal 2	$637,711
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$286,970
			Estimated Project Cost	**$925,000**

DC9202_1.jpg: View of the stream section

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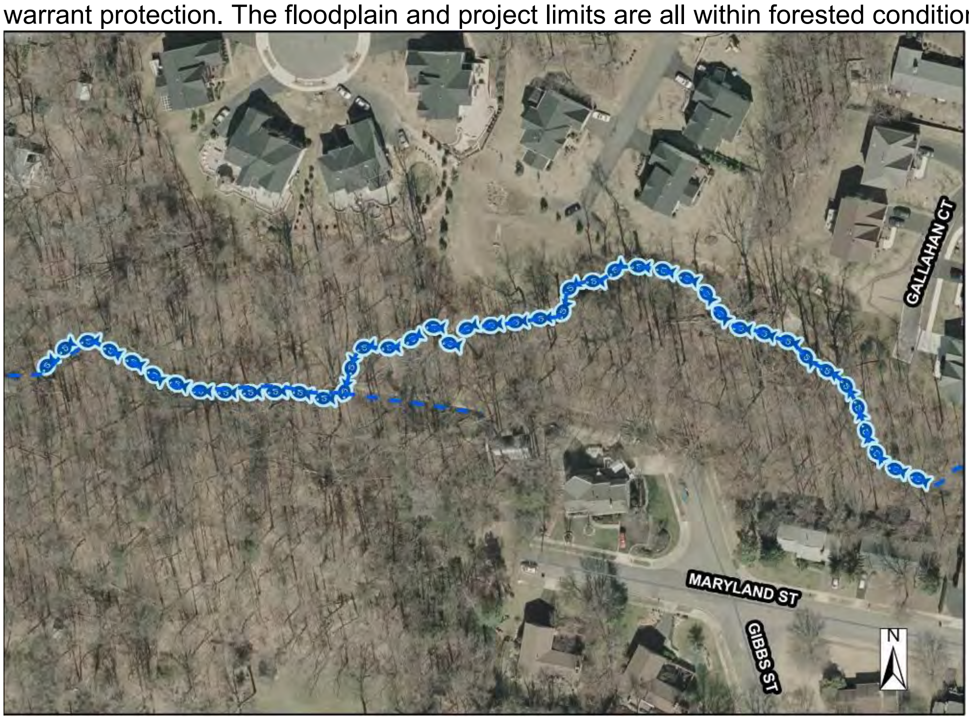
DC9203 Stream Restoration

Vicinity Map

Address:	8500 Block, Mt. Zephyr Drive
Location:	Between Mt. Zephyr Dr, Kings Hill Ct and Maryland St
Land Owner:	Private - Residential
PIN:	1014 21 A, 1014 32 A1, 1014 36 A
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Dogue Creek

Description: This project is entirely contained within HOA property and is located between Mt. Zephyr Drive, Kings Hill Court, and Maryland Street. The upstream limit of this project starts at the end of Gallahan Court and extends downstream to the upstream side of a culvert under Mt. Zephyr Drive. This channel is experiencing moderate to severe erosion on outside meanders and straight sections and is actively incising. Several stormdrain outfalls drain to this project, in which two stormdrain outfalls from Maryland Street and Nalls Road drain directly within the project limits. Restoration will include reconnecting this channel back to the original floodplain and installing grade controls to help prevent future downcutting and overwidening. Reducing the existing channel dimensions and raising the bed elevation of the channel will help to reconnect flows to the floodplain. Armor-in-place or bioengineering techniques and stone toe protection may be needed around the two stormdrain outfalls or where peak flows and channel velocities warrant protection. The floodplain and project limits are all within forested conditions.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: This project will reconnect the channel back to the original floodplain which will allow sediment to settle out and reduce overall stream energy during high flows. This project will reduce sediment loads to downstream channels by correcting channel downcutting, bank scour, overwidening, and meander bend migration. It is estimated that a total over 61,000 lbs of sediment, 48.8 lbs of total nitrogen and 18.9 lbs of total phosphorus would be reduced by this project. Overall, stream habitat and water quality may be improved due to stable habitat creation and reductions in available sediment supply.

Project Design Considerations: Environmental permitting and significant forest impacts are expected with this restoration due to construction and modifications to a perennial stream channel as well as obtaining access to the channel; however, restoration benefits will outweigh overall construction impacts. This project is entirely contained within several private HOA properties and will require significant coordination with property owners for access and construction. Access will most likely occur at a stormwater facility at the end of Nalls Road or at the end of Maryland Street. Utility impacts are not anticipated with this restoration.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	1	Ac	$10,000.00	$10,000
Plantings	1	Ac	$25,000.00	$25,000
Construct New Channel	1025	LF	$200.00	$205,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$340,000**
Ancillary Items	1	LS	5% of Project	$17,000
Erosion and Sediment Control	1	LS	10% of Project	$34,000
			Base Construction Cost	**$391,000**
			Mobilization (5%)	$19,550
			Subtotal 1	$410,550
			Contingency (25%)	$102,638
			Subtotal 2	$513,188
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$230,935
			Estimated Project Cost	**$744,000**


DC9203_1.jpg: View of the eroded stream section

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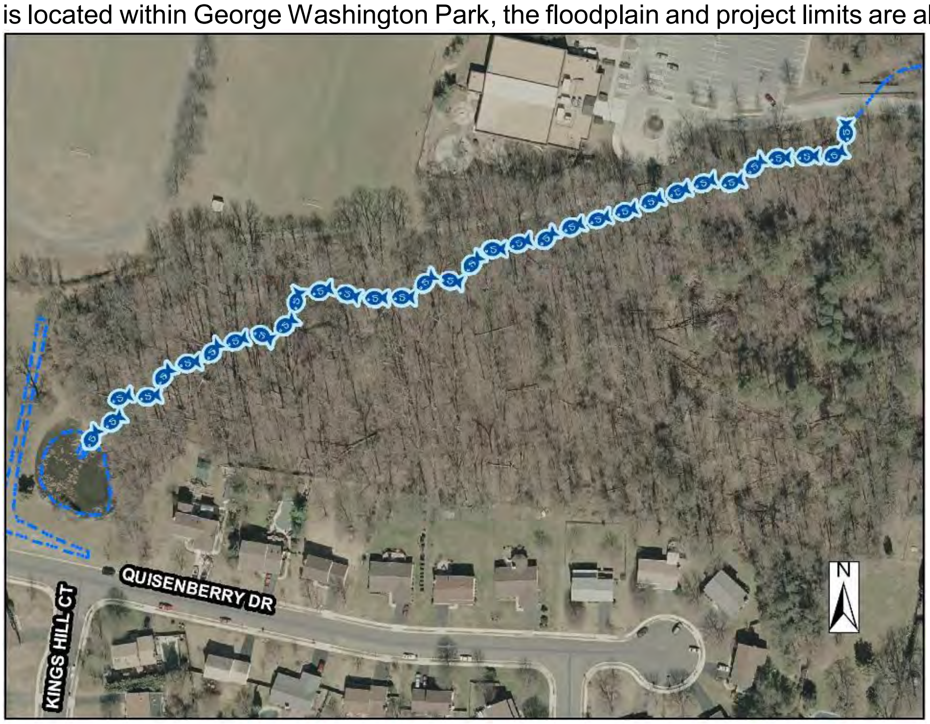
DC9204 Stream Restoration

Vicinity Map

Address:	8426 Old Mt. Vernon Rd
Location:	George Washington Park
Land Owner:	County - FCPA
PIN:	1014 01 0047A
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Dogue Creek

Description: This project is entirely contained within George Washington Park and extends from the downstream end of the culvert under George Washington Recreation Center driveway downstream to a stormwater facility located at the intersection of Quisenberry Drive and Kings Hill Court. The current channel is incised and over-widened and is actively downcutting with headcuts and moderate to severe erosion on the outside of meander bends as well as straight sections. Two stormdrain outfalls originating from the George Washington Recreation Center and the park should be stabilized with this restoration due to existing erosion. An exposed sanitary sewer utility concrete casing is also present within the channel and should be stabilized as well. Restoration efforts should focus on reconnecting this channel to the floodplain by reducing channel dimensions and raising bed elevations. Reconnection to the floodplain along with installing grade controls will help to prevent further downcutting and over-widening. Since this project is located within George Washington Park, the floodplain and project limits are all within forested conditions.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Restoration of this channel will help to reduce sediment loads that could be transported to downstream portions of this watershed. Reductions in channel downcutting, bank scour, and over-widening will allow for reduced sediment loads. Reconnecting this channel to the original floodplain will dissipate high flows that could cause erosion and can reduce downstream sediment loads by depositing suspended sediment on the floodplain. This project will stabilize storm drain outfalls and conveyances and may improve instream habitat by limiting the amount of sedimentation due to bank and bed erosion and the creation of stable habitat within the newly constructed channel. This project is completely contained within park property, which alleviates the need for land purchase or acquisition.

Project Design Considerations: Since this channel is buffered by forest, access and construction for this project could cause a significant amount of tree loss. Designs should be approached to minimize impacts to the forest outside of the stream channel itself. This project will require environmental permitting due to construction and modifications to a perennial stream channel. Overall, restoration benefits will outweigh construction impacts. Access to this channel can be gained from the George Washington Recreation Center driveway or at the stormwater facility at the downstream limit of this project. Coordination with Rec Center staff will be required to minimize impacts to park operations and infrastructure. The exposed sanitary sewer casing within this project may constrain design of the proposed channel. Other utility impacts are not anticipated with this restoration.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	1.5	Ac	$10,000.00	$15,000
Plantings	1.5	Ac	$25,000.00	$37,500
Construct New Channel	1200	LF	$200.00	$240,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$392,500**
Ancillary Items	1	LS	5% of Project	$19,625
Erosion and Sediment Control	1	LS	10% of Project	$39,250
			Base Construction Cost	**$451,375**
			Mobilization (5%)	$22,569
			Subtotal 1	$473,944
			Contingency (25%)	$118,486
			Subtotal 2	$592,430
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$266,594
			Estimated Project Cost	**$859,000**


DC9204_1.jpg: Eroded and incised channel

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DC9207 Stream Restoration

Vicinity Map

Address:	8300 Block, Frye Road
Location:	Between Frye Rd and Colony Ct
Land Owner:	Private - Residential
PIN:	1013 01 0008
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Dogue Creek

Description: This project is entirely contained within private property and extends from the downstream end of a triple cell box culvert under Madge Lane downstream to the upstream side of the culvert under Frye Road. Most of this channel is over-widened, unstable, and incised with eroded banks on straight portions. A forest buffer surrounds this channel and the upstream portion is partially confined between Frye Road and Colony Court. Restoration of this channel will focus on creating a nested channel, in which the floodplain and banks of the current channel will be regraded to allow for a new floodplain at an elevation lower than the original floodplain. Other restoration components include reducing the existing channel dimensions, installing grade controls to prevent further incision and over-widening, and increasing the sinuosity of the channel . In some areas due to constraints and high flows or velocities, the original channel may need to be stabilized with armor-in-place or bioengineering techniques to create a stable cross-section. A storm drain outfall originating from Colony Court should be incorporated into this project to provide stability.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Restoration of this channel will help to reduce sediment loads that could be transported to downstream portions of this watershed. Stabilization of existing banks and new channel geometry will allow for reduced sediment loads to these channels. Reconnecting this channel to a newly created floodplain will dissipate high flows that could cause erosion and can reduce downstream sediment loads by depositing suspended sediment on the floodplain. It is estimated that a total over 45,000 lbs of sediment, 36.0 lbs of total nitrogen and 14.0 lbs of total phosphorus would be reduced by this project. This project will also improve instream habitat by limiting the amount of sedimentation due to bank and bed erosion and the creation of stable habitat within the newly constructed channel.

Project Design Considerations: This project is entirely contained within private property and will require significant coordination with property owners for access and construction. Sanitary sewer structures and other utilities may constrain design and construction during this project. Access to this project most likely will occur off of Frye Road. This project will require environmental permitting due to construction and modifications to a perennial stream channel and floodplain. Significant tree loss is expected with this restoration; however, restoration benefits will outweigh overall construction impacts.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	1	Ac	$10,000.00	$10,000
Plantings	1	Ac	$25,000.00	$25,000
Construct New Channel	800	LF	$200.00	$160,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$295,000**
Ancillary Items	1	LS	5% of Project	$14,750
Erosion and Sediment Control	1	LS	10% of Project	$29,500
			Base Construction Cost	**$339,250**
			Mobilization (5%)	$16,963
			Subtotal 1	$356,213
			Contingency (25%)	$89,053
			Subtotal 2	$445,266
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$200,370
			Estimated Project Cost	**$646,000**


DC9207_1.jpg: View of the stream section

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DC9210 Stream Restoration

Vicinity Map

Address:	Between Parsons Ct and Stover Dr
Location:	Woodstone
Land Owner:	Private - Residential
PIN:	0924 06 E
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Barnyard Run

Description: This project is located between Parsons Court and Stover Drive and extends from Bedrock Road downstream to an existing tree line just north of the Huntley Meadows Park boundary. Currently, this channel is concrete lined and very straight with a narrow strip of mowed grass on each side of the channel. Restoration efforts should focus on removing the existing 500' of concrete channel and replacing it with a more natural channel with an improved buffer on each bank.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Removal of the concrete and development of a natural system would create instream habitat and extend the lower reach's higher quality conditions upstream. A natural channel would help to slow erosive velocities, reduce water temperatures, allow for nutrient uptake from plantings, and promote groundwater recharge. Property owners along this project might welcome the aesthetic changes of the current channel to a natural, restored channel.

Project Design Considerations: This project is entirely contained within private HOA property and will require significant coordination with property owners for access and construction. This project will require environmental permitting due to construction and modifications to a stream channel. Adequate area for construction and development of a true natural channel may be lacking at this site. Access most likely will need to occur off of Bedrock Road. Design and construction may be constrained due to the location of several utilities adjacent to the existing concrete channel including electric and cable. Minimal tree loss can be expected with this project.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Concrete channel removal	500	LF	$30.00	$15,000
Clear and Grub	1	Ac	$10,000.00	$10,000
Plantings	1	Ac	$25,000.00	$25,000
Construct New Channel	500	LF	$200.00	$100,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$250,000**
Ancillary Items	1	LS	5% of Project	$12,500
Erosion and Sediment Control	1	LS	10% of Project	$25,000
			Base Construction Cost	**$287,500**
			Mobilization (5%)	$14,375
			Subtotal 1	$301,875
			Contingency (25%)	$75,469
			Subtotal 2	$377,344
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$169,805
			Estimated Project Cost	**$547,000**


DC9210_1.jpg: View of the existing concrete channel

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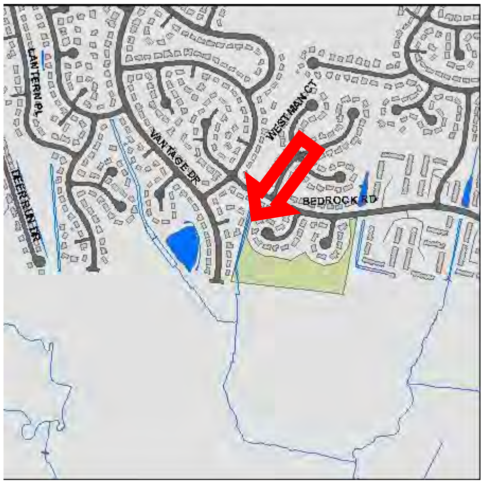
DC9211 Stream Restoration



Vicinity Map

Address:	Between Bedrock Ct and Vantage Dr
Location:	Woodstone
Land Owner:	Private – Residential
PIN:	0923 05 J
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Barnyard Run

Description: This project is located between Vantage Drive and Bedrock Court and extends from Bedrock Road downstream to just north of the Huntley Meadows Park boundary. Currently, this channel is concrete lined and very straight with a narrow strip of mowed grass on each side of the channel. The downstream portion of this channel is mostly forested especially on left bank facing downstream. Restoration efforts should focus on removing the existing 600' of concrete channel and replacing it with a more natural channel with an improved buffer on each bank. The existing forest buffer especially in the downstream portion of this project should be preserved and incorporated into the restoration design.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Removal of the concrete and development of a natural system would create instream habitat and extend the lower reach's higher quality conditions upstream. A natural channel would help to slow erosive velocities, reduce water temperatures, allow for nutrient uptake from plantings, and promote groundwater recharge. Property owners along this project might welcome the aesthetic changes of the current channel to a natural, restored channel.

Project Design Considerations: This project is entirely contained within private residential properties along Vantage Drive, Bedrock Road, and Bedrock Court as well as private HOA property and will require significant coordination with property owners for access and construction. This project will require environmental permitting due to construction and modifications to a stream channel. Access most likely will need to occur at the end of Vantage Drive. Design and construction may be constrained due to the location of several utilities adjacent to the existing concrete channel including electric and cable.

Coordination with the Park Authority will be required to address drainage issues downstream in Huntley Meadows Park and potentially include stream stabilization within the park as an additional element of the project. In addition, there is a known historic site at the entry to the park so construction access and staging should be located in order to avoid it.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Concrete channel removal	600	LF	$30.00	$18,000
Clear and Grub	0.75	Ac	$10,000.00	$7,500
Plantings	0.75	Ac	$25,000.00	$18,750
Construct New Channel	600	LF	$200.00	$120,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$264,250**
Ancillary Items	1	LS	5% of Project	$13,213
Erosion and Sediment Control	1	LS	10% of Project	$26,425
			Base Construction Cost	**$303,888**
			Mobilization (5%)	$15,194
			Subtotal 1	$319,082
			Contingency (25%)	$79,771
			Subtotal 2	$398,853
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$179,484
			Estimated Project Cost	**$578,000**


DC9211_1.jpg: View of the existing concrete channel

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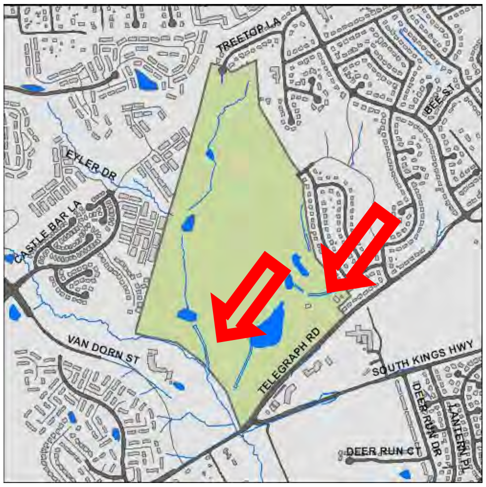
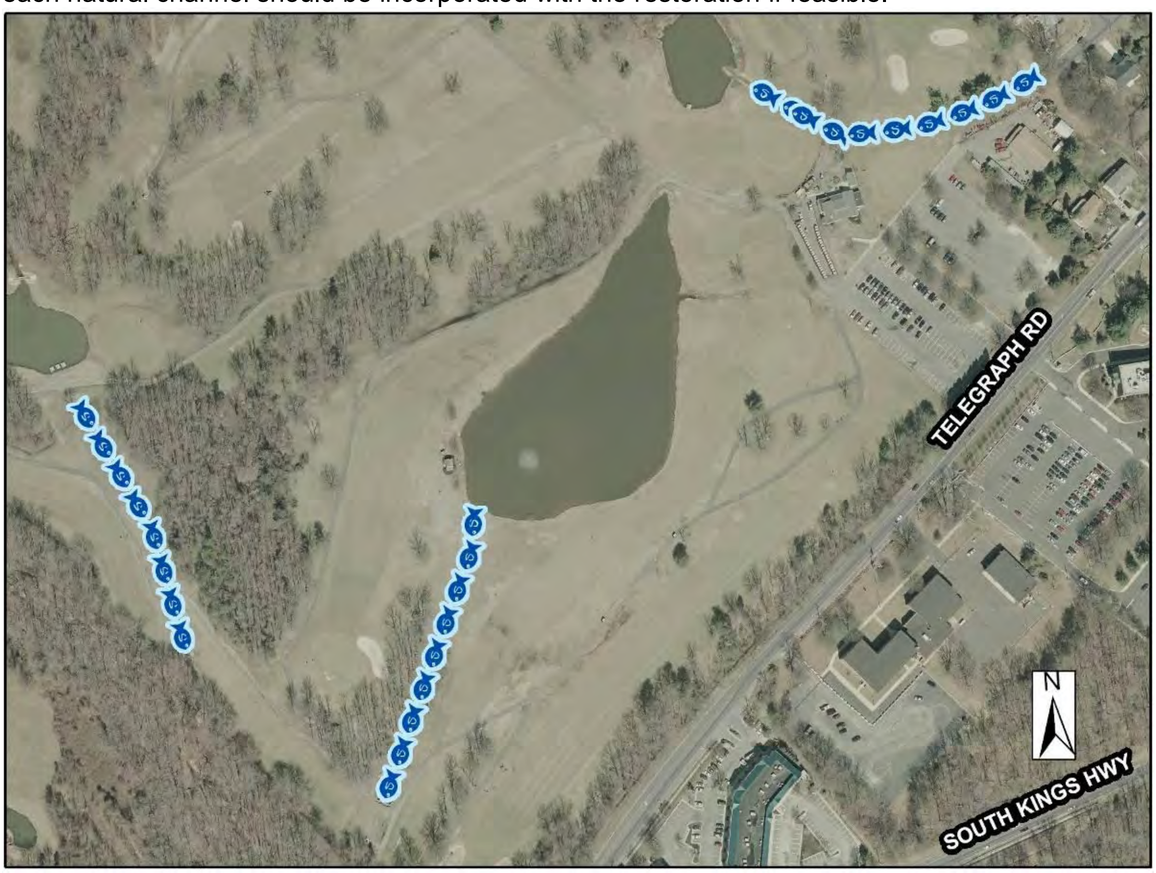
DC9213 Stream Restoration



Vicinity Map

Address:	6700 Telegraph Road
Location:	Greendale Golf Course
Land Owner:	County - FCPA
PIN:	0921 01 0001
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Dogue Creek

Description: This project is entirely contained within Greendale Golf Course and includes restoring three separate concrete lined stream channels that total 1700 feet. Currently, two of these channels are located downstream of large golf course ponds and the other receives runoff from a residential community stormdrain outfall at the end of Greendale Road. All of these channels are very open with few trees and border fairways or greens that are used by golfers. Restoration efforts should focus on removing the existing concrete channels and replacing them with a more natural channel. Development of a riparian buffer around each natural channel should be incorporated with the restoration if feasible.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Removal of the concrete channels and development of natural systems would create instream habitat, slow erosive velocities, reduce water temperatures, allow for nutrient uptake from plantings, and promote groundwater recharge. A riparian planting zone would also help to improve overall habitat and water quality at each restores channel. Local residents and visitors to the Greendale Golf Course might welcome the aesthetic changes of the current channels to natural, restored channels. This project is completely contained within County park property, which alleviates the need for land purchase or acquisition.

Project Design Considerations: This project is entirely contained within Greendale Golf Course and will require significant coordination with golf course management for access and construction. Modifications to stream channels as well as proposed buffers should be designed to minimize the impacts to the golf course. Adequate area for construction and development of true natural channels may be lacking with this project due to the existing layout of the golf course. The existing concrete channels are very accessible and will require environmental permitting due to construction and modifications to perennial stream channels. Design and construction may be constrained due to the location of several utilities including electric and irrigation. Tree loss is not expected with this project.

The project should be designed in close cooperation with Park Authority and Greendale Golf Course staff, particularly to insure that removal of the concrete channels does not lead ot increased erosion during high volume events. There is also the potential for disturbance to Civil War or Native American sites in the area, which may require archaeological testing and data recovery/avoidance measures.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Concrete channel removal	1700	LF	$30.00	$51,000
Clear and Grub	2	Ac	$10,000.00	$20,000
Plantings	2	Ac	$25,000.00	$50,000
Construct New Channel	1700	LF	$200.00	$340,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$561,000**
Ancillary Items	1	LS	5% of Project	$28,050
Erosion and Sediment Control	1	LS	10% of Project	$56,100
			Base Construction Cost	**$645,150**
			Mobilization (5%)	$32,258
			Subtotal 1	$677,408
			Contingency (25%)	$169,352
			Subtotal 2	$846,760
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$381,042
			Estimated Project Cost	**$1,228,000**


DC9213_1.jpg: Concrete channel at Greendale Golf Course

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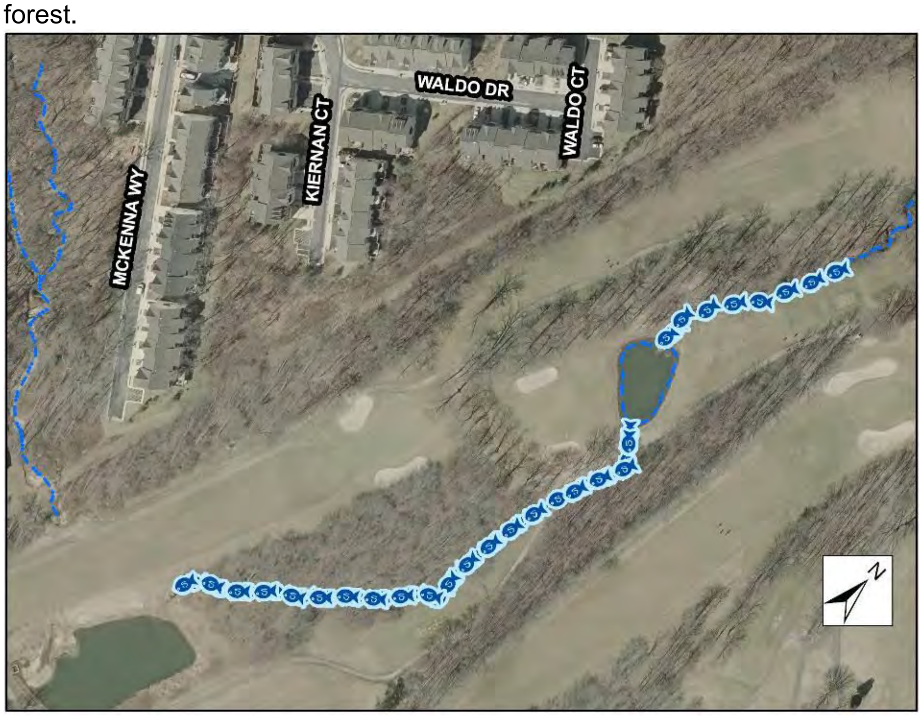
DC9214 Stream Restoration

Vicinity Map

Address:	6700 Telegraph Road
Location:	Greendale Golf Course
Land Owner:	County – FCPA
PIN:	0921 01 0001
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Dogue Creek

Description: This project is entirely contained within Greendale Golf Course and includes restoring two separate natural stream channels that total 2000 feet. Currently, these channels flow to golf course ponds and have a tree buffer on one bank and a fairway on the other bank. These channels are incised and over-widened with active erosion and downcutting. Restoration for this project will include regrading and stabilizing eroded stream banks with armor-in-place techniques on outer meander bends and bioengineering techniques on straight portions. Restoration will include grade controls to dissipate energy and require some installation of stone toe protection to ensure future bank stability. In particular, locations where these channels enter or exit the golf course ponds and on the downstream side of golf cart crossings should be stabilized as part of this project. Riparian buffers should be established as part of this restoration depending on golf course constraints. Since this restoration is entirely contained within the Greendale Golf Course, raising the bed elevation of this channel to reconnect higher flows to the floodplain or regrading the floodplain to create a new bench is not desirable. The current floodplain is a mix of trees with grass and forest.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of this project will help to stabilize golf course infrastructure and may decrease the frequency associated with pond dredging. Stabilizing these channels will reduce sediment loads to each golf course pond by preventing bank scour and channel incision. It is estimated that a total over 80,330 lbs of sediment, 64.3 lbs of total nitrogen and 25.0 lbs of total phosphorus would be reduced by this project. By reducing sedimentation within this channel and providing stable habitat along restored banks, overall instream water quality and habitat may be improved with this project. Restoring a riparian buffer along this reach will also provide future channel stability and ecological benefits.

Project Design Considerations: This project is entirely contained within Greendale Golf Course and will require significant coordination with golf course management for access and construction. Modifications to stream channels as well as proposed buffers should be designed to minimize the impacts to the golf course. The existing stream channels are very accessible and will require environmental permitting due to construction and modifications to perennial stream channels. Design and construction may be constrained due to the location of several utilities including electric and irrigation and the presence of golf cart crossings and golf course ponds. Minor tree loss can be expected with this project.

The project should be designed in close cooperation with Park Authority and Greendale Golf Course staff. High flows from the Rose Hill community north and east of the course will need to be considered in the restoration design.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	2	Ac	$10,000.00	$20,000
Plantings	2.25	Ac	$25,000.00	$56,250
Construct New Channel	2000	LF	$200.00	$400,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$576,250**
Ancillary Items	1	LS	5% of Project	$28,813
Erosion and Sediment Control	1	LS	10% of Project	$57,625
			Base Construction Cost	**$662,688**
			Mobilization (5%)	$33,134
			Subtotal 1	$695,822
			Contingency (25%)	$173,956
			Subtotal 2	$869,778
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$391,400
			Estimated Project Cost	**$1,261,000**

DC9214_1.jpg: View of stream section

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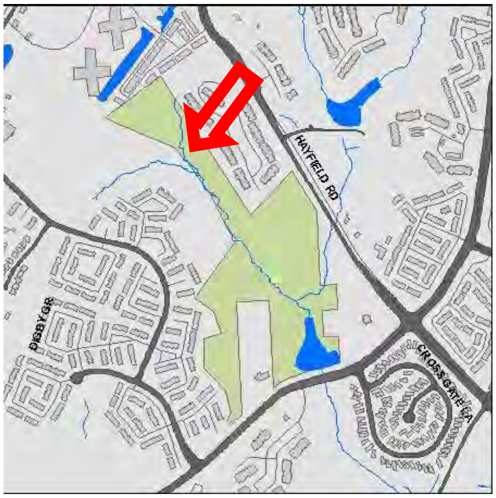
DC9215 Stream Restoration



Vicinity Map

Address:	6090 Kingstowne Village Pkwy
Location:	Behind Rockcliff La
Land Owner:	Private - Residential
PIN:	0913 01 0064B
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Piney Run

Description: The extents of this project are contained within forested HOA property. The upstream limit of the project is at Rock Cliff Lane and extends downstream to the upstream limit of stormwater facility DP0238. The upstream portion is experiencing moderate bank erosion on outside meanders and channel bed incision. The downstream portion is experiencing severe bank erosion and bed incision. Additionally, a storm drain pipe located in the middle portion of the project reach is causing severe erosion. As a result of erosion, a sanitary sewer manhole and pipe are exposed. Restoration of the channel will include reconnecting the upstream and downstream portions of the stream to the floodplain. This will be accomplished by reducing the existing channel dimensions, raising the bed elevation of the channel to correct the slope and installing grade controls to prevent future bed incision and bank erosion. Consideration will also be given to realigning the existing channel away from the sanitary sewer infrastructure.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Restoration would prevent significant future erosion throughout the project reach, stabilize and protect the exposed sanitary sewer infrastructure and reconnect the channel to the floodplain allowing sediment to settle out and reduce overall stream energy during high flows. It will reduce sediment loads to downstream channels by correcting channel downcutting, bank scour, over-widening, and meander bend migration. It is estimated that a total over 88,730 lbs of sediment, 71.0 lbs of total nitrogen and 27.5 lbs of total phosphorus would be reduced by this project. Overall, stream habitat and water quality may be improved due to stable habitat creation and reductions in available sediment supply.

Project Design Considerations: Environmental permitting and significant forest impacts are expected with this restoration. Impacts to forested areas will be caused by channel access and construction. Long-term benefits will outweigh construction impacts. This project is entirely contained within private HOA property and will require significant coordination with property owners for access and construction. Access may need to occur from several locations due to the length of the restoration. Potential access points are Rock Cliff Lane, Kingstowne Commons Drive and an existing embankment in the middle of the restoration reach. The exposed sanitary sewer casing and manhole may constrain the overall design of the proposed channel. Other utility impacts are not anticipated. There is also the potential for disturbance to a Native American sites directly to the east of the project site, which should be avoided during construction staging or access.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	2.75	Ac	$10,000.00	$27,500
Plantings	2.75	Ac	$25,000.00	$68,750
Construct New Channel	2400	LF	$200.00	$480,000
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$676,250**
Ancillary Items	1	LS	5% of Project	$33,813
Erosion and Sediment Control	1	LS	10% of Project	$67,625
			Base Construction Cost	**$777,688**
			Mobilization (5%)	$33,884
			Subtotal 1	$816,572
			Contingency (25%)	$204,143
			Subtotal 2	$1,020,715
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$459,322
			Estimated Project Cost	**$1,480,000**

DC9215_1.jpg: View of stream section

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DC9217 Stream Restoration

Vicinity Map

Address:	8801 Richmond Hwy
Location:	Between Old Mill Rd and Richmond Hwy
Land Owner:	Private
PIN:	1092 02 0010, 1092 02 0009, 1092 02 0018A, 1092 03E 0018, 1092 03E 0017, 1092 03E 0016, 1092 08 A
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Dogue Creek

Description: This project is comprised of three sections on the Dogue Creek mainstem. The northern section limits extend from the Richmond Highway bridge over Dogue Creek downstream approximately 400 ft along the mainstem channel. Currently, this section of the mainstem on the left bank facing downstream has little to no buffer with moderate to severe erosion. In isolated areas rock has been placed along the bank. The right bank facing downstream is eroded and undercut within this section near the bridge over Dogue Creek due to a mid channel obstruction directing flow toward the banks. The middle section limits extend from Cedar Court downstream approximately 177 ft along the mainstem channel. The left bank facing downstream is experiencing severe erosion and is threatening private property. The southern section is located adjacent to Old Mill Road where the existing mainstem channel left bank flows along the road shoulder. Since the mainstem of Dogue Creek flows along this road, several small areas of erosion and undercutting are occurring along the hardened shoulder of Old Mill Road. Restoration of these three sections will involve regrading of banks and placement of rigid and soft stabilization practices to reduce future erosion and protect property and public safety.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Restoration of these sections would prevent future erosion and reduce sediment loads to the downstream Dogue Creek tidal area by correcting bank scour, over-widening and meander bend migration. It is estimated that a total over 28,180 lbs of sediment, 22.5 lbs of total nitrogen and 8.7 lbs of total phosphorus would be reduced by this project.Overall, stream habitat and water quality improvements will be minor due to stabilizing as opposed to restoring the channel. Stabilizing the severely eroded banks and road embankment will help to prevent adverse impacts to private property and human safety.

Project Design Considerations: Environmental permitting and minor to moderate forest impacts are expected with this restoration due to construction and modifications to a perennial stream channel as well as obtaining access to the channel; however, stabilization benefits will outweigh overall construction impacts. This channel has numerous private property owners along the banks and will require significant coordination for access and construction. Access will need to occur from several locations due to the three sections being isolated from each other. The northern section can be accessed from Richmond Highway. The middle section can be accessed from either Cedar Court or Grist Mill Woods Way. The southern section can be accessed from Old Mill Road. Utility impacts are not anticipated with this restoration.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	1.5	Ac	$10,000.00	$15,000
Plantings	1.5	Ac	$25,000.00	$37,500
Construct New Channel	852	LF	$200.00	$170,400
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$322,900**
Ancillary Items	1	LS	5% of Project	$16,145
Erosion and Sediment Control	1	LS	10% of Project	$32,290
			Base Construction Cost	**$371,335**
			Mobilization (5%)	$18,567
			Subtotal 1	$389,902
			Contingency (25%)	$97,476
			Subtotal 2	$487,378
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$219,320
			Estimated Project Cost	**$707,000**


DC9217_1.jpg: Eroded stream banks


DC9217_2.jpg: Area to be stabilized along Old Mill Road

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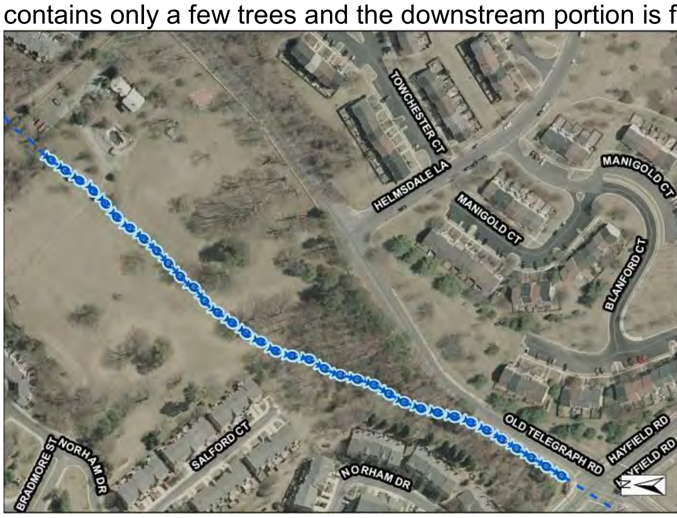
DC9218 Stream Restoration

Vicinity Map

Address:	7400 Old Telegraph Road
Location:	Banks Property
Land Owner:	County - FCPA
PIN:	0914 01 0023, 0914 01 0024, 0914 0922 A
Control Type	Water Quality
Drainage Area	NA
Receiving Waters	Unknown tributary of Piney Run

Description: This project extends from County-owned Banks property boundary to the upstream side of a culvert off of Old Telegraph Road near Hayfield Road. The downstream portion of the project reach is on HOA property. The stream channel within the Banks property is currently piped for several hundred feet. Areas not piped have been lined with rip rap and concrete. The pipes and crossings are in disrepair or are blocked causing high flows to overtop the structures. The downstream portion of this project, which is entirely contained within HOA property, is currently eroding, headcutting upstream to a culvert at the Banks property boundary and exposing a sanitary sewer pipe. The channel near the intersection of Old Telegraph Road and Hayfield Road is currently lined with concrete. Restoration in the upstream portion will involve removing the pipe, rip rap and concrete lined sections of the existing channel and restoring the stream to a more natural state with a healthy riparian buffer. Restoration in the downstream portion will include removing the concrete lined section of channel, reconnecting the channel to the original floodplain and installing grade controls to help prevent future incision and erosion. The upstream portion of this project contains only a few trees and the downstream portion is forested.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Removing the pipe, rip rap and concrete lining the channel and creating a natural channel with a sinuous design would attenuate stormflows, allow the stream to access its floodplain and improve downstream water quality and instream habitat. This project would also reduce future erosion in the downstream and upstream portions of this project, protect exposed sanitary sewer infrastructure and reconnect the channel to the floodplain which will allow sediment to settle out during high flows. Sediment loads to downstream channels may be reduced by correcting channel downcutting and bank scour in the downstream portion. It is estimated that a total over 10,910 lbs of sediment, 8.7 lbs of total nitrogen and 3.4 lbs of total phosphorus would be reduced by this project. Most of this project is contained within park property and could provide an educational opportunity for residents using the park.

Project Design Considerations: Most of this project is located on a historic property and consideration should be made to the integrity of the park and existing trees. The project should be developed in close cooperation with the Park Authority, and park amenities such as foot paths, bridges, and plantings will need to be incorporated into the overall design.

The downstream portion is contained within private HOA property and will require significant coordination with property owners for access and construction. Access to this project is good from the historic horse farm property and will only minimally impact trees within the park. The downstream portion will have moderate tree impacts due to access and construction. Environmental permitting is expected due to construction and modifications to a perennial stream channel. An exposed sanitary sewer pipe and utility are located within and near the current channel in the upstream and downstream portions of this project and may constrain design of the proposed channel. An access road within the horse farm park may constrain design of the proposed channel as well. Other utility impacts are not anticipated.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Concrete channel removal	210	LF	$30.00	$6,300
Pipe Removal	350	LF	$20.00	$7,000
Clear and Grub	0.75	Ac	$10,000.00	$7,500
Plantings	0.75	Ac	$25,000.00	$18,750
Construct New Channel	1294	LF	$200.00	$258,800
Additional Cost, First 500 LF	500	LF	$200.00	$100,000
			Initial Project Costs	**$398.350**
Ancillary Items	1	LS	5% of Project	$19,918
Erosion and Sediment Control	1	LS	10% of Project	$39,835
			Base Construction Cost	**$458,103**
			Mobilization (5%)	$22,905
			Subtotal 1	$481,008
			Contingency (25%)	$120,252
			Subtotal 2	$601,260
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$270,567
			Estimated Project Cost	**$872,000**

DC9218_1.jpg: Stream to be daylighted

DC9218_2.jpg: Downstream eroded channel

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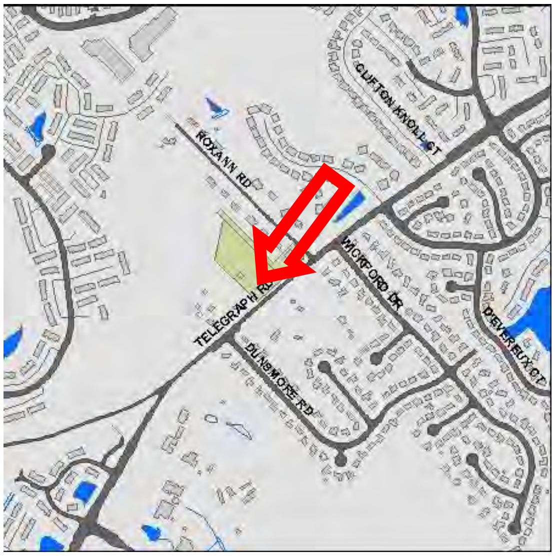
DC9400 Culvert Retrofit



Vicinity Map

Address:	7150 Telegraph Road
Location:	North side, Telegraph Road
Land Owner:	Private - Residential
PIN:	0914 01 0013
Control Type	Water Quality
Drainage Area	42.48 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: The project consists of providing an impoundment structure such as a weir wall across the existing stream channel on the upstream side of a culvert under Telegraph Road to provide stormwater management. The project will treat runoff from upstream low and high-density residential areas.

Project Area Map: Conceptual plan showing potential location of culvert retrofit

Project Benefits: A control structure installed on the upstream side of the existing cross culvert under Telegraph Road has potential to attenuate peak runoff volumes for a variety of design storm conditions. Reducing runoff volumes and slowing discharge velocities during storm events will promote settling of suspended particles and floatables, preserve future channel conditions, reduce erosion and promote habitat health downstream of the culvert. It is estimated that a total of 8,850 lbs of sediment, 108.0 lbs of nitrogen and 21.0 lbs of phosphorus would be reduced annually by this project

Project Design Considerations: During a storm event, the control structure will cause water levels on the upstream side of the cross culvert to elevate rapidly. This is a safety concern both for community residents and property. The base flow component of the control structure will require constant monitoring to prevent clogging. All components of the existing roadway and stream channel should be analyzed to ensure that the integrity of the culvert/stream is not compromised as a result of change in hydraulic characteristics at the crossing. Changes to the 100-year floodplain in this area due to a culvert retrofit must adhere to FEMA regulations.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
New Control Structure	1	LS	$12,000.00	$12,000.00
			Initial Project Costs	**$12,000**
Plantings	1	LS	5% of Project	$600
Ancillary Items	1	LS	5% of Project	$600
Erosion and Sediment Control	1	LS	10% of Project	$1,200
			Base Construction Cost	**$14,400**
			Mobilization (5%)	$720
			Subtotal 1	$15,120
			Contingency (25%)	$3,780
			Subtotal 2	$18,900
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$8,505
			Estimated Project Cost	**$27,000**

DC9400_1.jpg: Location of proposed project

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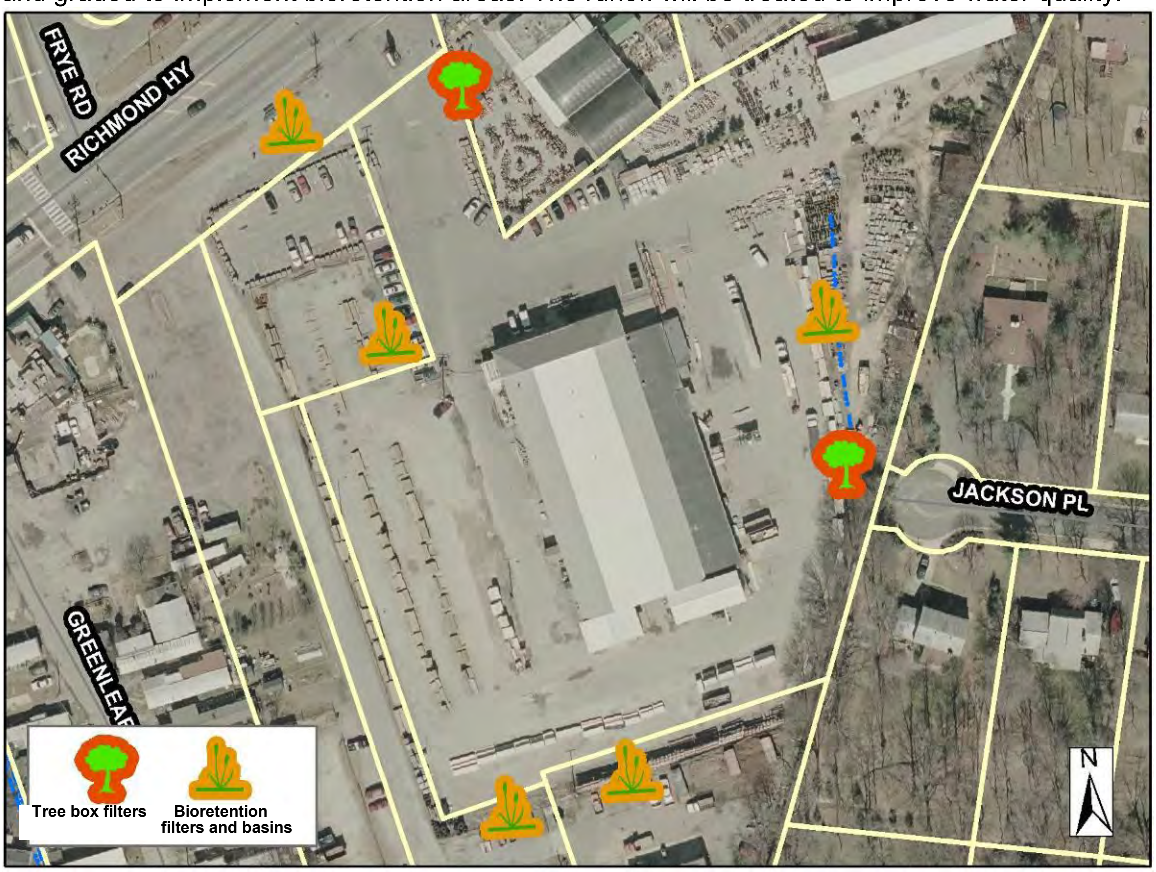
DC9500 BMP/LID

Vicinity Map

Address:	8453 Richmond Hwy
Location:	Smittys Building Supply
Land Owner:	Private - Commercial
PIN:	1013 01 0030
Control Type	Water Quality
Drainage Area	5.11 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Installation of bioretention filters and basins and tree box filters are proposed to treat runoff from the parking lot surrounding Smitty's Building Supply and adjacent areas along Richmond Highway. Two existing inlets will be retrofitted with tree box filters and unsed portions of the parking lot will be removed and graded to implement bioretention areas. The runoff will be treated to improve water quality.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of tree box filters and bioretention filters and basins will provide water quality treatment for this commercial/industrial area during storm events. These facilities remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total of 1.480 lbs of sediment, 20.0 lbs of nitrogen and 3.1 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. No tree removal is required for these sites. Access to the proposed sites is excellent from the parking lot around Smitty's Building Supply. Property ownership is private and coordination with the owner/management will be necessary for these sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	2	EA	$10,000.00	$20,000
Bioretention Filters & Basin	632	SY	$150.00	$94,800
			Initial Project Cost	**$114,800**
Plantings	1	LS	5% of project (excluding pervious pavement)	$5,740
Ancillary Items	1	LS	5% of project	$5,740
Erosion and Sediment Control	1	LS	10% of project	$11,480
			Base Construction Cost	**$137,760**
			Mobilization (5%)	$6,888
			Subtotal 1	**$144,648**
			Contingency (25%)	$36,162
			Subtotal 2	**$180,810**
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$81,365
			Estimated Project Cost	**$262,000**

DC9500_1.jpg: View of parking lot

DC9500_2.jpg: View of existing inlet

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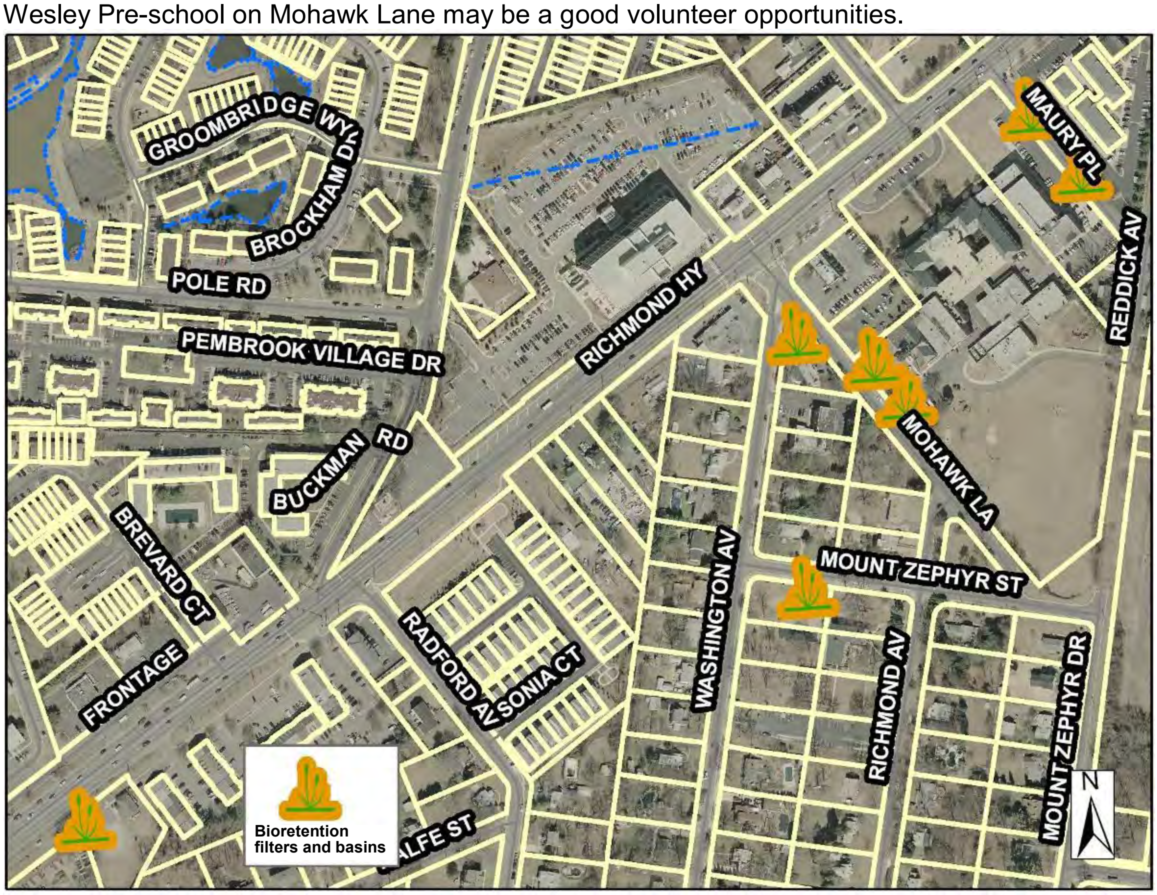
DC9501 BMP/LID

Vicinity Map

Address:	SE of 8300 Block of Richmond Hwy
Location:	Various
Land Owner:	County and Private
PIN:	1014 01 0005A
Control Type	Water Quality
Drainage Area	2.99 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Bioretention filters and basins are proposed for construction at low points of the parking lots in this area to capture and treat the runoff. The sites at Maury Place located between the street and the lot would require construction of a depressed berm. Removal of either play area or parking and curb cuts might be required for the site at the foot of Mohawk Lane. The sites at the church on Mt. Zephyr Street and Wesley Pre-school on Mohawk Lane may be a good volunteer opportunities.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Bioretention filters and basins can remove oil and grease, heavy metals, nutrients including phosphorus and nitrogen, and suspended solids from storm water runoff. It is estimated that a total of 70 lbs of sediment, 4.0 lbs of nitrogen and 0.6 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since a number of these sites are located on publicly-owned land or institutional properties, implementation is likely to be easier. It will also provide an environmental education/stewardship opportunity for residents in the community.

Project Design Considerations: Because of the intensity of existing development, no environmental constraints or permitting issues are anticipated. In the publicly-owned and cultural sites, signs promoting environmental education/stewardship could be used to educate residents. No tree removal is required for the proposed sites. Access is excellent.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	202	SY	$150.00	$30,300
			Initial Project Cost	**$30,300**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,515
Ancillary Items	1	LS	5% of project	$1,515
Erosion and Sediment Control	1	LS	10% of project	$3,030
			Base Construction Cost	**$36,360**
			Mobilization (5%)	$1,818
			Subtotal 1	**$38,178**
			Contingency (25%)	$9,545
			Subtotal 2	**$47,723**
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$21,475
			Estimated Project Cost	**$69,000**


DC9501_1.jpg: Parking lot at Wesley PreSchool


DC9501_2.jpg: Parking lot along Mohawk Lane

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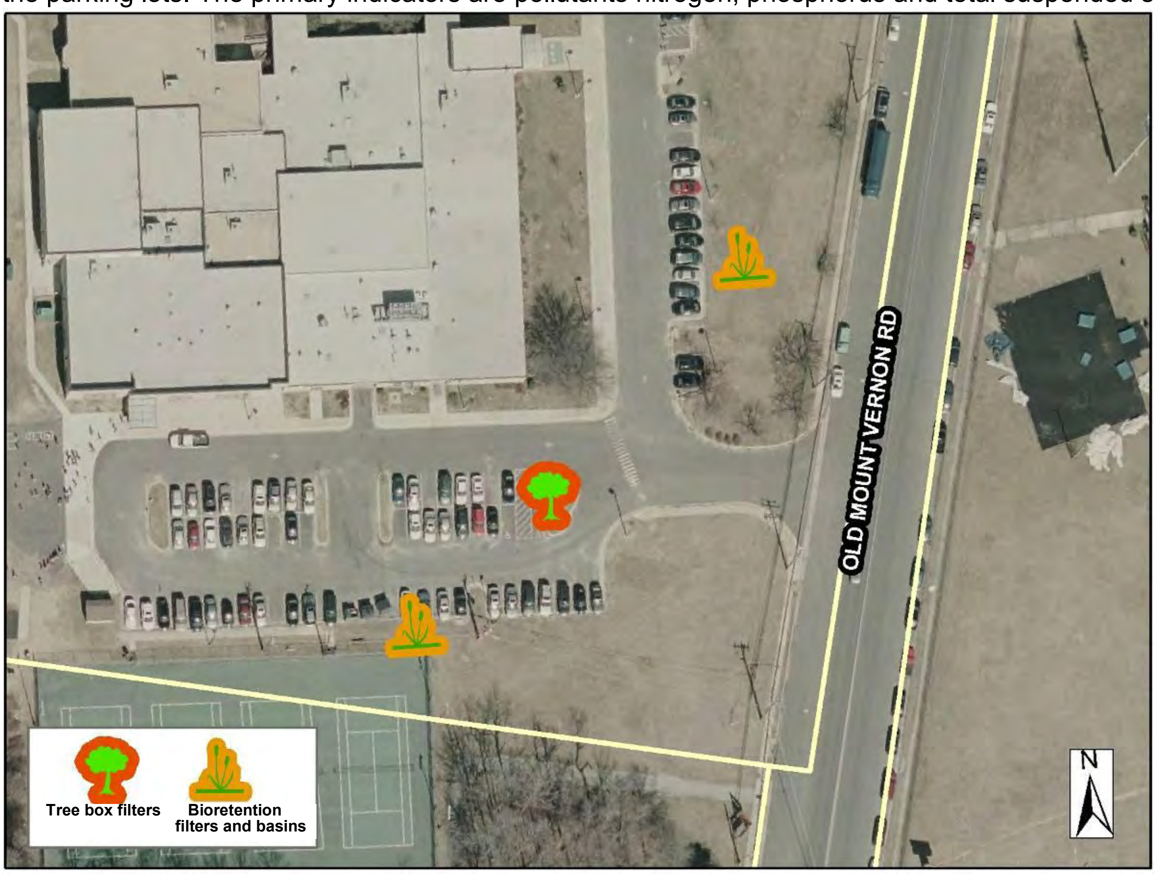
DC9503 BMP/LID

Vicinity Map

Address:	8410 Old Mt Vernon Rd
Location:	Riverside Elementary School
Land Owner:	County - FCPS
PIN:	1014 06 0011
Control Type	Water Quality
Drainage Area	2.03 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: This project would treat runoff from the parking lots at Riverside Elementary School and George Washington Recreational area by implementing bioretention filters and basins and tree box filters in the medians and in adjacent grassy areas in the parking lots. One tree box filter will be added to the existing inlet in the south parking lot. The bioretention areas will be created by grading the open space adjacent to the parking lots. The primary indicators are pollutants nitrogen, phosphorus and total suspended solids.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Tree box filters and bioretention filters and basins remove oil and grease, heavy metals, nutrients including phosphorus and nitrogen, and suspended solids from storm water runoff. It is estimated that a total of 246 lbs of sediment, 3.0 lbs of nitrogen and 0.7 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on school grounds, the need for land purchase or acquisition is eliminated while providing an environmental education/stewardship opportunity for students and parents within the community.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate students and parents in the community. Access to the proposed sites is excellent from the school parking lots.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	1	EA	$10,000.00	$10,000
Bioretention Filters & Basin	150	SY	$150.00	$22,500
			Initial Project Cost	**$32,500**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,625
Ancillary Items	1	LS	5% of project	$1,625
Erosion and Sediment Control	1	LS	10% of project	$3,250
			Base Construction Cost	**$39,000**
			Mobilization (5%)	$1,950
			Subtotal 1	**$40,950**
			Contingency (25%)	$10,238
			Subtotal 2	**$51,188**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$23,035
			Estimated Project Cost	**$74,000**


DC9503_1.jpg: Parking lot at Riverside Elementary School

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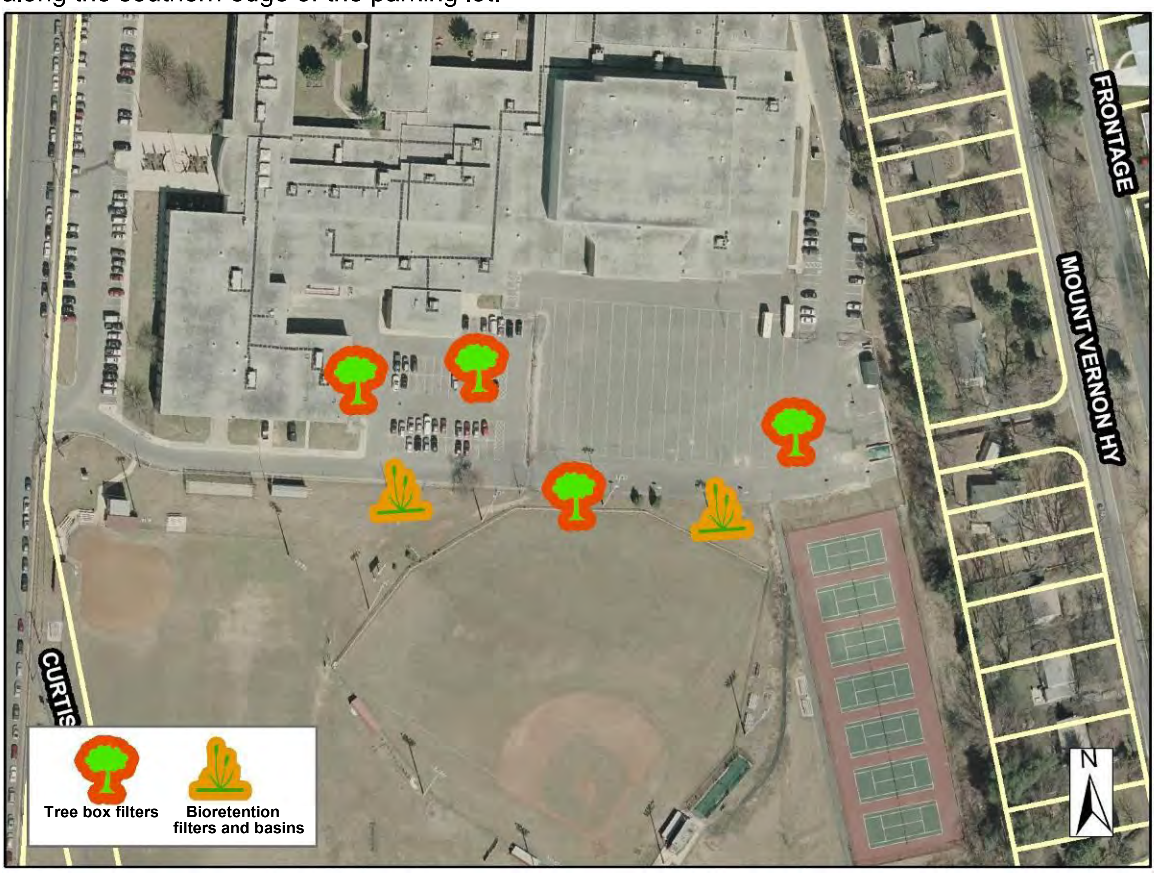
DC9504 BMP/LID

Vicinity Map

Address:	8515 Old Mt Vernon Rd
Location:	Mount Vernon High School
Land Owner:	County - FCPS
PIN:	1014 10010016
Control Type	Water Quality
Drainage Area	2.80 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Mount Vernon High School parking lot runoff would be treated by installing bioretention filters and basins and tree box filters in and along the edges of the parking lot. Tree box filters will be added to the four existing inlets in the parking lot and bioretention filters will be created by grading the open area along the southern edge of the parking lot.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Bioretention filters and basins and tree box filters remove oil and grease, heavy metals, nutrients including phosphorus and nitrogen, and suspended solids from storm water runoff. It is estimated that a total of 210 lbs of sediment, 7.4 lbs of total nitrogen and 0.3 lbs of total phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on school grounds, the need for land purchase or acquisition is eliminated while providing an environmental education/stewardship opportunity for students and parents within the community.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate students and parents in the community. Access to the proposed sites is excellent from the school parking lots. A temporary or permanent loss of parking spaces may occur with these sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	4	EA	$10,000.00	$40,000
Bioretention Filters & Basin	284	SY	$150.00	$42,600
			Initial Project Cost	**$82,600**
Plantings	1	LS	5% of project (excluding pervious pavement)	$4,130
Ancillary Items	1	LS	5% of project	$4,130
Erosion and Sediment Control	1	LS	10% of project	$8,260
			Base Construction Cost	**$99,120**
			Mobilization (5%)	$4,956
			Subtotal 1	**$104,076**
			Contingency (25%)	$26,019
			Subtotal 2	**$130,095**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$58,543
			Estimated Project Cost	**$189,000**

DC9504_1.jpg: Parking lot at Mount Vernon High School

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DC9505 BMP/LID

Vicinity Map

Address:	8515 Old Mt Vernon Rd
Location:	Mount Vernon High School
Land Owner:	County - FCPS
PIN:	1014 01 0034
Control Type	Water Quality
Drainage Area	4.883 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Mount Vernon High School parking lot runoff would be treated by installing bioretention filters and basins and tree box filters in and along the edges of the parking lot. All but one of these sites are located just upstream of a proposed stormwater project (DC9100) and could be designed as a system to maximize pre-treatment, water quality benefits, and water quantity storage.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Bioretention filters and basins and tree box filters remove oil and grease, heavy metals, nutrients, and suspended solids from storm water runoff. It is estimated that a total of 525 lbs of sediment, 6.7 lbs of nitrogen and 1.5 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on school grounds, the need for land purchase or acquisition is eliminated while providing an environmental education/stewardship opportunity for students and parents within the community.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate students and parents in the community. Access to the proposed sites is excellent from the school parking lots. Modifications to the existing storm drain system may be necessary to drain these sites. A temporary or permanent loss of parking spaces may occur with these sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	2	EA	$10,000.00	$20,000
Bioretention Filters & Basin	478	SY	$150.00	$71,700
			Initial Project Cost	**$91,700**
Plantings	1	LS	5% of project (excluding pervious pavement)	$4,585
Ancillary Items	1	LS	5% of project	$4,585
Erosion and Sediment Control	1	LS	10% of project	$9,170
			Base Construction Cost	**$110,040**
			Mobilization (5%)	$5,502
			Subtotal 1	**$115,542**
			Contingency (25%)	$28,886
			Subtotal 2	**$144,428**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$64,993
			Estimated Project Cost	**$209,000**

DC9505_1.jpg: Parking lot at Mount Vernon High School

DC9505_2.jpg: Parking lot at Mount Vernon High School

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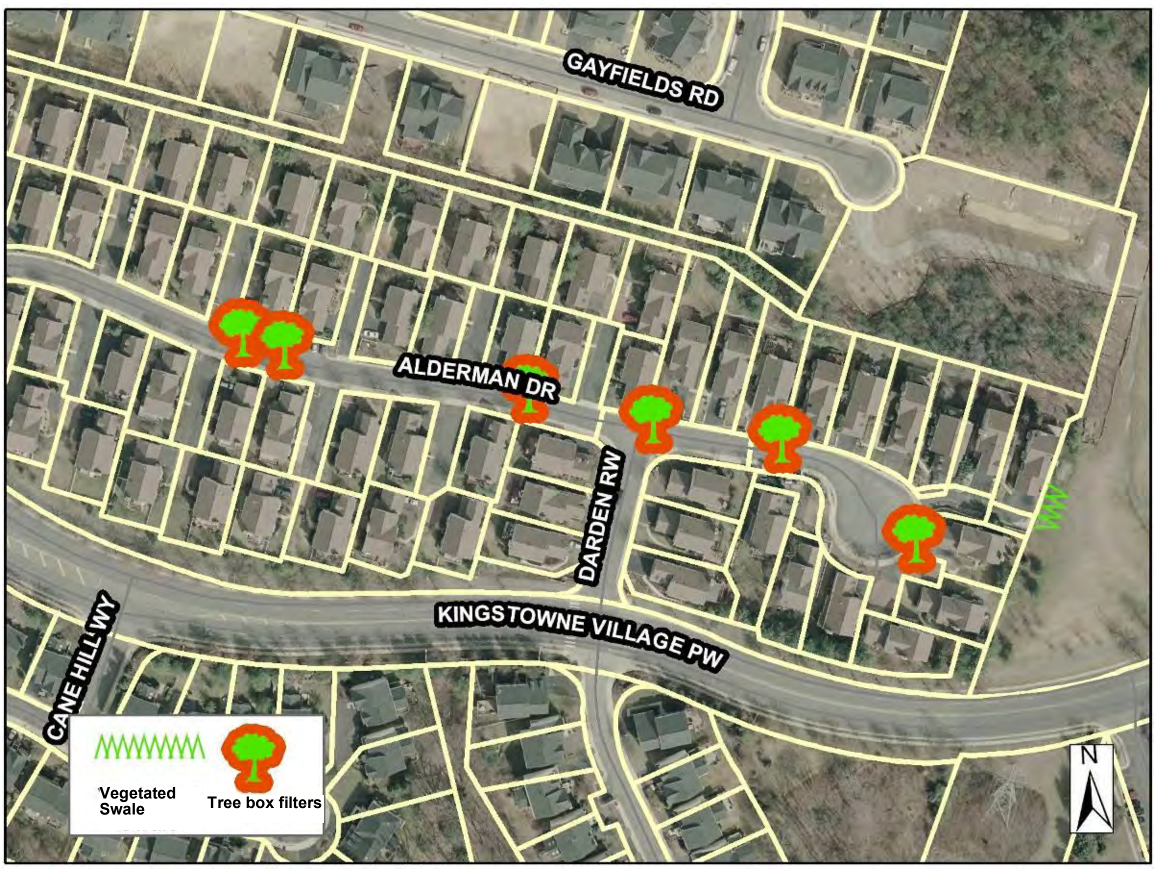
DC9506 BMP/LID

Vicinity Map

Address:	6300 Block, Alderman Drive
Location:	Alderman Drive
Land Owner:	State - VDOT
PIN:	0913 01 0064W
Control Type	Water Quality
Drainage Area	0.51 acres
Receiving Waters	Unknown tributary of Piney Run

Description: This proposed project includes installation of tree box filters and the implementation of a vegetated swale. Six tree box filters will be installed at the existing inlets and a vegetated swale will be implemented in the open area behind Alderman Dr. The proposed project will treat the rooftop and driveway runoff from the residential area.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of the proposed improvements will provide water quality treatment for residential runoff during storm events. Both the tree box filters and the vegetated swale will trap suspended solids, reduce trace metals, and uptake nutrients including phosphorus and nitrogen from storm water runoff. It is estimated that a total of 315 lbs of sediment, 3.5 lbs of nitrogen and 0.7 lbs of phosphorus would be reduced annually by this project. They also promote infiltration and can reduce the flow velocity of storm water runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Minimal tree removal is required for this site. Access to the proposed site is good from Alderman Drive; however, private driveways will need to be accessed to reach the proposed site. Property ownership is private and coordination with the homeowners/landowners will be necessary.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	6	EA	$10,000.00	$60,000
Vegetated Swale	73	SY	$50.00	$3,650
			Initial Project Cost	**$63,650**
Plantings	1	LS	5% of project (excluding pervious pavement)	$3,183
Ancillary Items	1	LS	5% of project	$3,183
Erosion and Sediment Control	1	LS	10% of project	$6,365
			Base Construction Cost	**$76,381**
			Mobilization (5%)	$3,819
			Subtotal 1	**$80,200**
			Contingency (25%)	$20,050
			Subtotal 2	**$100,250**
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$45,113
			Estimated Project Cost	**$145,000**

DC9506_1.jpg: View open area behind Alderman Drive

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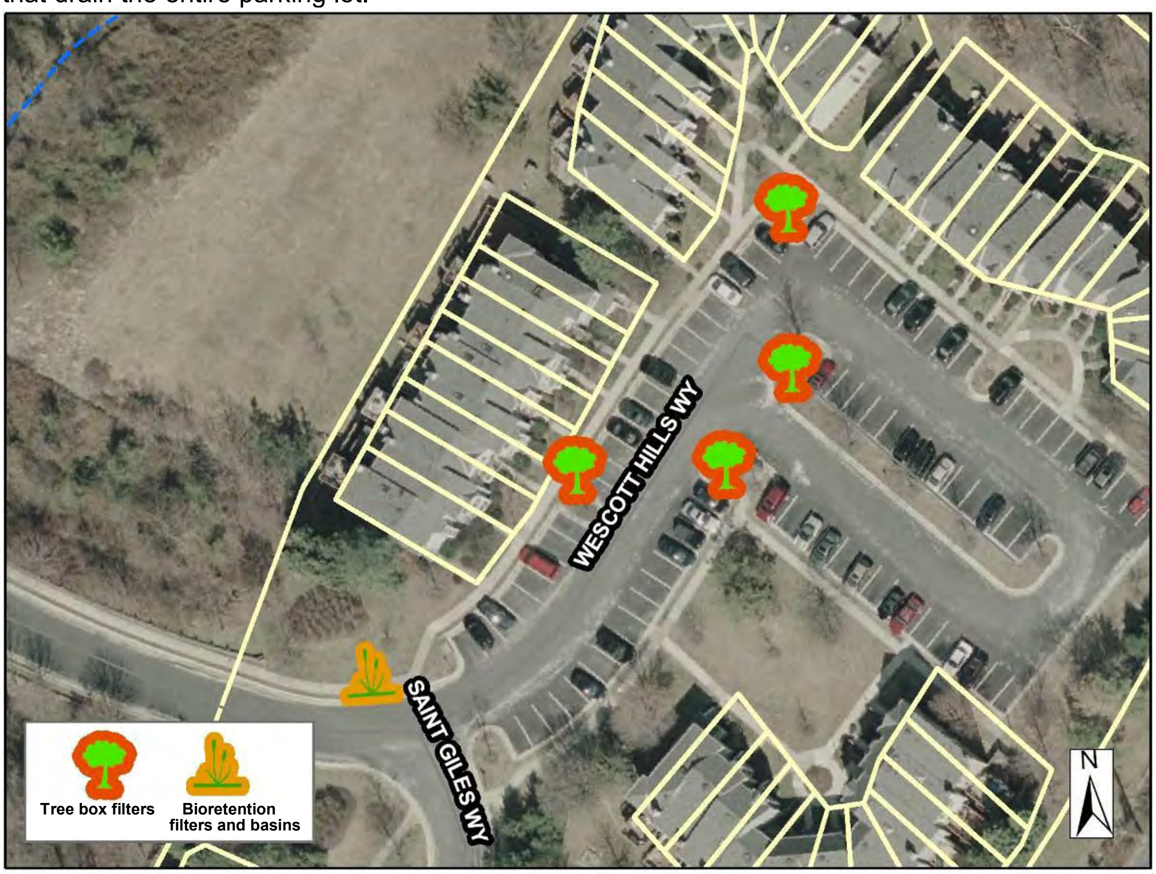
DC9507 BMP/LID

Vicinity Map

Address:	5800 Block, Wescott Hills Way
Location:	Parking lots along Wescott Way
Land Owner:	Private - Residential
PIN:	0914 0926 C
Control Type	Water Quality
Drainage Area	1.07 acres
Receiving Waters	Unknown tributary of Piney Run

Description: Installation of bioretention filters and basins and tree box filters are proposed to treat runoff from the residential parking lots along Wescott Hills Way. This project includes retrofitting four existing inlets that drain the entire parking lot.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Tree box filters and bioretention filters and basins remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total of 463 lbs of sediment, 5.0 lbs of nitrogen and 1.0 lb of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Access to the proposed sites is excellent in the parking lot; however, property ownership is private and coordination with the owners/management will be necessary. Modifications to the existing storm drain system may be necessary to drain the proposed sites. A temporary or permanent loss of parking spaces can be expected.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	4	EA	$10,000.00	$40,000
Bioretention Filters & Basin	88	SY	$150.00	$13,200
			Initial Project Cost	**$53,200**
Plantings	1	LS	5% of project (excluding pervious pavement)	$2,660
Ancillary Items	1	LS	5% of project	$2,660
Erosion and Sediment Control	1	LS	10% of project	$5,320
			Base Construction Cost	**$63,840**
			Mobilization (5%)	$3,192
			Subtotal 1	**$67,032**
			Contingency (25%)	$16,758
			Subtotal 2	**$83,790**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$37,706
			Estimated Project Cost	**$121,000**

DC9507_1.jpg: View of existing inlets at end of Wescott Hills Way

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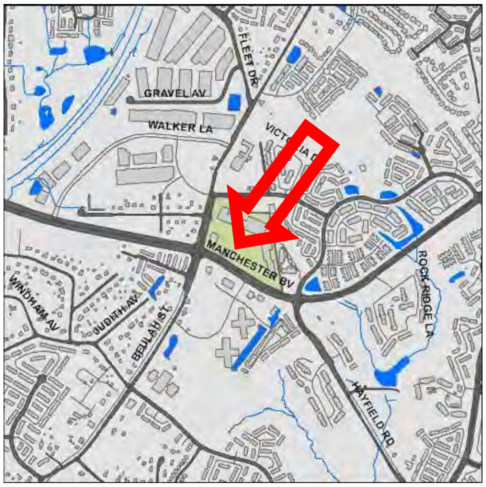
DC9508 BMP/LID



Vicinity Map

Address:	7000 Block, Manchester Blvd
Location:	Shoppers' parking lot
Land Owner:	Private - Commercial
PIN:	0911 12 N
Control Type	Water Quality
Drainage Area	5.83 acres
Receiving Waters	Unknown tributary of Piney Run

Description: Bioretention filters and basins are proposed in the medians of the Shoppers' parking lot to treat the runoff. Most of this parking lot drains to single inlets along medians. The medians will be graded to create bioretention areas that will treat the runoff for pollutants like nitrogen, phosphorus and total suspended solids.

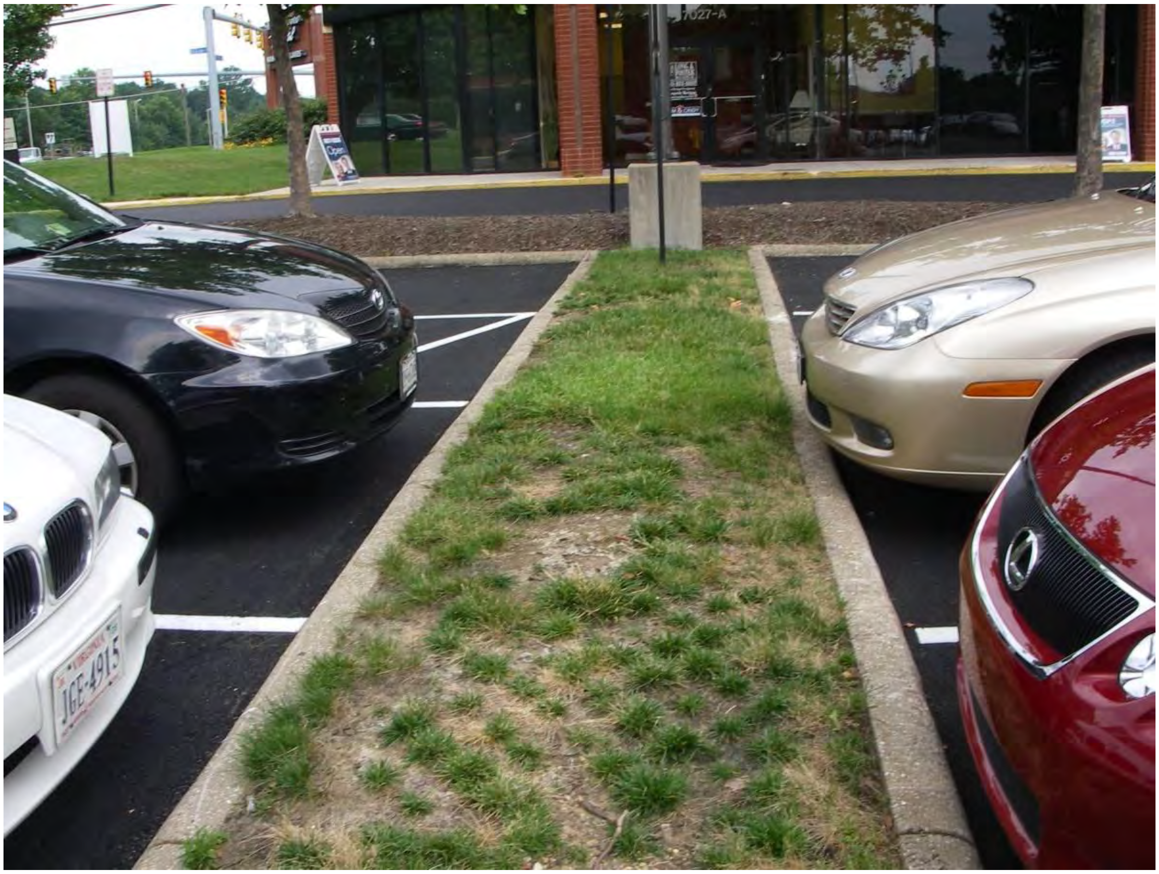
Project Area Map: Conceptual plan showing potential locations

Project Benefits: Implementation of bioretention filters and basins will provide water quality treatment for the Shoppers commercial parking lot runoff during storm events. These facilities can remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, and oil and grease from storm water runoff. It is estimated that a total of 2,040 lbs of sediment, 22.0 lbs of nitrogen and 4.1 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Access to the proposed sites is excellent from roads and the Shoppers commercial parking lot. Property ownership is most likely private and coordination with the shopping center owner/management will be necessary for these sites. A temporary or permanent loss of parking spaces can be expected with these sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	700	SY	$150.00	$105,000
			Initial Project Cost	**$105,000**
Plantings	1	LS	5% of project (excluding pervious pavement)	$5,250
Ancillary Items	1	LS	5% of project	$5,250
Erosion and Sediment Control	1	LS	10% of project	$10,500
			Base Construction Cost	**$126,000**
			Mobilization (5%)	$6,300
			Subtotal 1	**$132,300**
			Contingency (25%)	$33,075
			Subtotal 2	**$165,375**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$74,419
			Estimated Project Cost	**$240,000**



DC9508_1.jpg: View of existing medians in parking lot.

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DC9510 BMP/LID

Vicinity Map

Address:	7630 Telegraph Road
Location:	Hayfield Secondary School
Land Owner:	County - FCPS
PIN:	0914 01 0028
Control Type	Water Quality
Drainage Area	8.58 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Hayfield Secondary School parking lot runoff would be treated by installing bioretention filters and basins in the medians and adjacent grassy areas. The facilities would be installed by grading the low open area downstream side of each parking lot which will treat the runoff for pollutants like nitrogen, phosphorus and total suspended solids.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Bioretention filters and basins remove oil and grease, heavy metals, nutrients including phosphorus and nitrogen, and suspended solids from storm water runoff. It is estimated that a total of 720 lbs of sediment, 3.8 lbs of nitrogen and 1.6 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on school grounds, the need for land purchase or acquisition is eliminated while providing an environmental education/stewardship opportunity for students and parents within the community.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate students and parents in the community. Access to the proposed sites is excellent from the school parking lots.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	650	SY	$150.00	$97,500
			Initial Project Cost	**$97,500**
Plantings	1	LS	5% of project (excluding pervious pavement)	$4,875
Ancillary Items	1	LS	5% of project	$4,875
Erosion and Sediment Control	1	LS	10% of project	$9,750
			Base Construction Cost	**$117,000**
			Mobilization (5%)	$5,850
			Subtotal 1	**$122,850**
			Contingency (25%)	$30,713
			Subtotal 2	**$153,563**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$69,103
			Estimated Project Cost	**$223,000**

DC9510_1.jpg: Parking lot area at Hayfield Secondary School

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DC9511 BMP/LID

Vicinity Map

Address:	Hayfield Rd and Telegraph Rd
Location:	Hayfield Plaza parking lot
Land Owner:	Private - Commercial
PIN:	0914 01 0031
Control Type	Water Quality
Drainage Area	5.22 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: The project proposes implementation of bioretention areas to receive parking lot runoff at Hayfield Plaza. The southern grassy area of the parking lot can be graded to create bioretention areas. The runoff from the parking lot will primarily be treated to reduce nitrogen, phosphorus and total suspended solids.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of bioretention filters and basins will provide water quality treatment for this parking lot during storm events. It is estimated that a total of 1,000 lbs of sediment, 12.8 lbs of nitrogen and 2.0 lbs of phosphorus would be reduced annually by this project. These facilities remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Access to the proposed sites is excellent from roads and the commercial parking lot. Property ownership is most likely private and coordination with the shopping center owner/management will be necessary for these sites. A temporary or permanent loss of parking spaces can be expected with these sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	666	SY	$150.00	$99,900
			Initial Project Cost	**$99,900**
Plantings	1	LS	5% of project (excluding pervious pavement)	$4,995
Ancillary Items	1	LS	5% of project	$4,995
Erosion and Sediment Control	1	LS	10% of project	$9,990
			Base Construction Cost	**$119,880**
			Mobilization (5%)	$5,994
			Subtotal 1	**$125,874**
			Contingency (25%)	$31,469
			Subtotal 2	**$157,343**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$70,804
			Estimated Project Cost	**$228,000**

DC9511_1.jpg: Parking lot area at Hayfield Plaza

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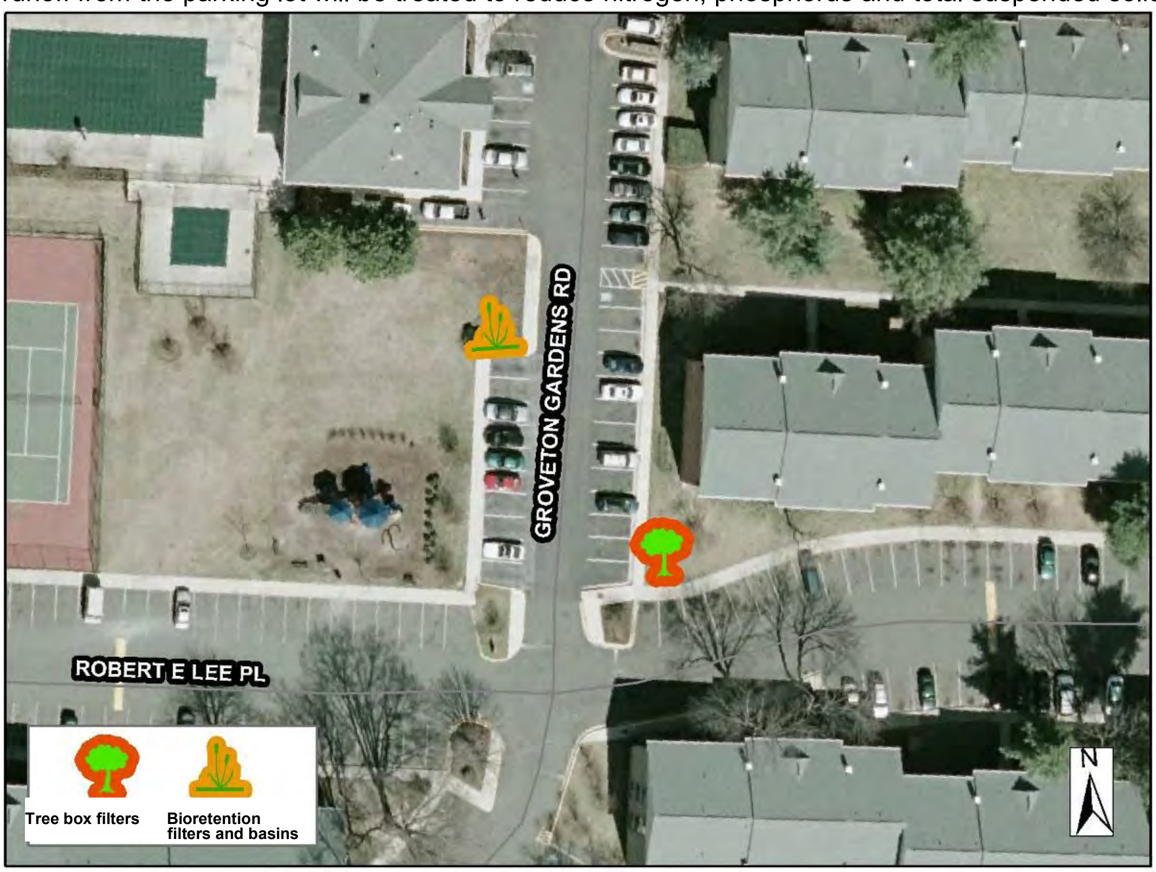
DC9512 BMP/LID

Vicinity Map

Address:	7140 Block, Groveton Gardens Rd
Location:	Parking lots
Land Owner:	Private
PIN:	0924 01 0013
Control Type	Water Quality
Drainage Area	0.43 acres
Receiving Waters	Unknown tributary of Barnyard Run

Description: This project proposes installation of tree box filters and creation of bioretention areas to receive the runoff from parking lots at Groveton Gardens. One existing storm drain inlet will be retrofitted with a filter and low open area adjacent to the parking lot will be graded to create a bioretention area. The runoff from the parking lot will be treated to reduce nitrogen, phosphorus and total suspended solids..



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Tree box filters and bioretention filters and basins remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total of 223 lbs of sediment, 2.6 lbs of nitrogen and 0.5 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Access to the proposed sites is excellent in the residential parking lots; however, property ownership is private and coordination with the owners/management will be necessary. A temporary or permanent loss of parking spaces can be expected with these sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	1	EA	$10,000.00	$10,000
Bioretention Filters & Basin	32	SY	$150.00	$4,800
			Initial Project Cost	**$14,800**
Plantings	1	LS	5% of project (excluding pervious pavement)	$740
Ancillary Items	1	LS	5% of project	$740
Erosion and Sediment Control	1	LS	10% of project	$1,480
			Base Construction Cost	**$17,760**
			Mobilization (5%)	$888
			Subtotal 1	**$18,648**
			Contingency (25%)	$4,662
			Subtotal 2	**$23,310**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$10,490
			Estimated Project Cost	**$34,000**


DC9512_1.jpg: View of the parking lot

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DC9513 BMP/LID

Vicinity Map

Address:	6900 Harrison Lane
Location:	Groveton Elementary School
Land Owner:	County - FCPS
PIN:	0922 01 0008
Control Type	Water Quality
Drainage Area	0.65 acres
Receiving Waters	Unknown tributary of Barnyard Run

Description: A tree box filter and bioretention filters and basins are proposed in the Groveton Elementary School parking lot to treat stormwater runoff. Field assessment showed that this parking lot was currently treated for quantity control. A bioretention area will be created in the open space south of the parking lot and one tree box filter will be installed at the existing inlet for quality control. The runoff from the parking lot will be treated to reduce nitrogen, phosphorus and total suspended solids.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Tree box filters and bioretention filters and basins remove oil and grease, heavy metals, nutrients including phosphorus and nitrogen, and suspended solids from storm water runoff. It is estimated that a total of 368 lbs of sediment, 6.5 lbs of nitrogen and 1.2 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on school grounds, the need for land purchase or acquisition is eliminated while providing an environmental education/stewardship opportunity for students and parents within the Dogue Creek Watershed community.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate students and parents in the community. Access to the proposed sites is excellent from the school parking lot.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	1	EA	$10,000.00	$10,000
Bioretention Filters & Basin	65	SY	$150.00	$9,750
			Initial Project Cost	**$19,750**
Plantings	1	LS	5% of project (excluding pervious pavement)	$988
Ancillary Items	1	LS	5% of project	$988
Erosion and Sediment Control	1	LS	10% of project	$1,975
			Base Construction Cost	**$23,701**
			Mobilization (5%)	$1,185
			Subtotal 1	**$24,886**
			Contingency (25%)	$6,222
			Subtotal 2	**$31,108**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$13,999
			Estimated Project Cost	**$45,000**


DC9513_1.jpg: View of the parking lot

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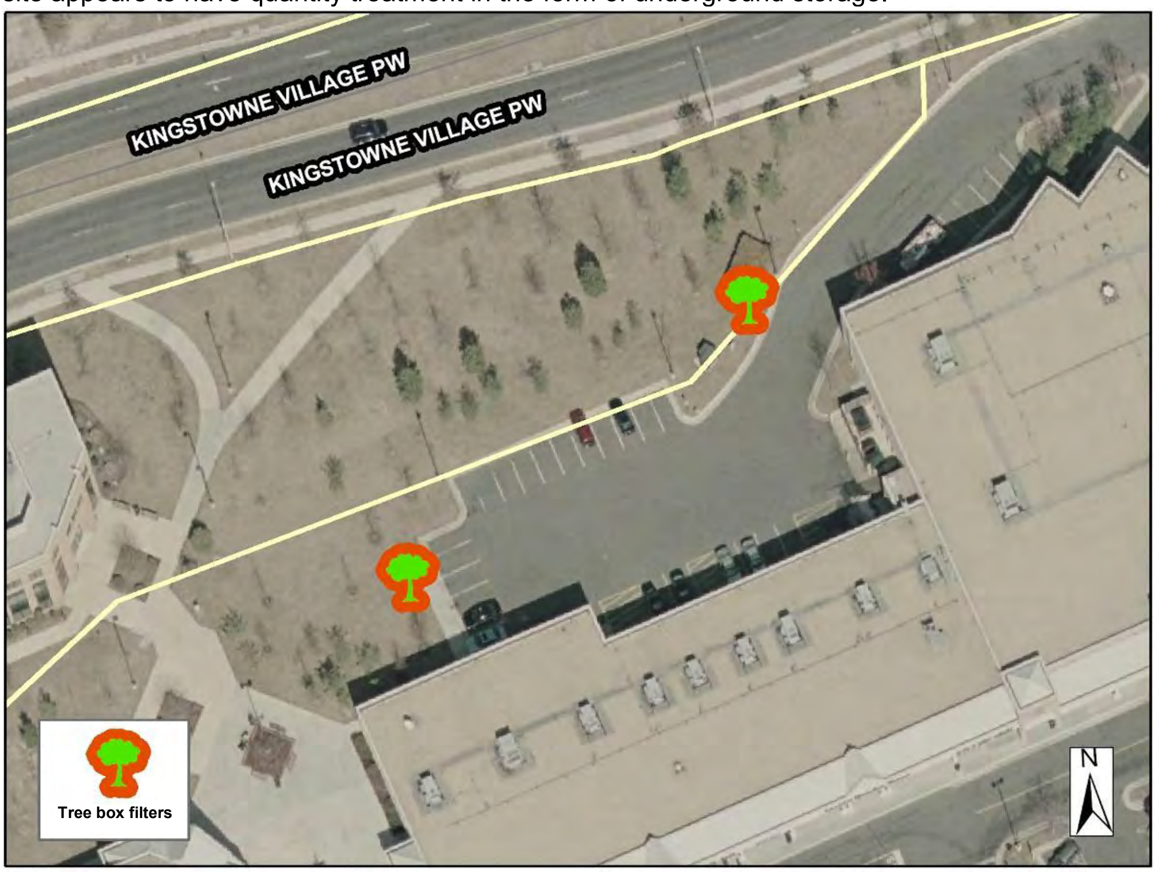
DC9518 BMP/LID

Vicinity Map

Address:	580 Block, Kingstowne Center
Location:	Kingstowne Village
Land Owner:	Private - Commercial
PIN:	0912 01 0032A
Control Type	Water Quality
Drainage Area	0.58 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Installation of tree box filters are proposed to provide water quality treatement for runoff from the parking lot behind the commercial strip mall located along Kingstowne Village Parkway. Currently, the site appears to have quantity treatment in the form of underground storage.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Tree box filters remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total of 572 lbs of sediment, 3.3 lbs of nitrogen and 0.8 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Access to the proposed sites is excellent from the parking lot; however, the property ownership is private and coordination with the owners/management will be necessary. Modifications to the existing storm drain system may be necessary to drain these proposed sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	2	EA	$10,000.00	$20,000
			Initial Project Cost	**$20,000**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,000
Ancillary Items	1	LS	5% of project	$1,000
Erosion and Sediment Control	1	LS	10% of project	$2,000
			Base Construction Cost	**$24,000**
			Mobilization (5%)	$1,200
			Subtotal 1	**$25,200**
			Contingency (25%)	$6,300
			Subtotal 2	**$31,500**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$14,175
			Estimated Project Cost	**$46,000**

DC9518_1.jpg: Parking lot area at Kingstowne Village

DC9518_2.jpg: Existing inlet in parking lot

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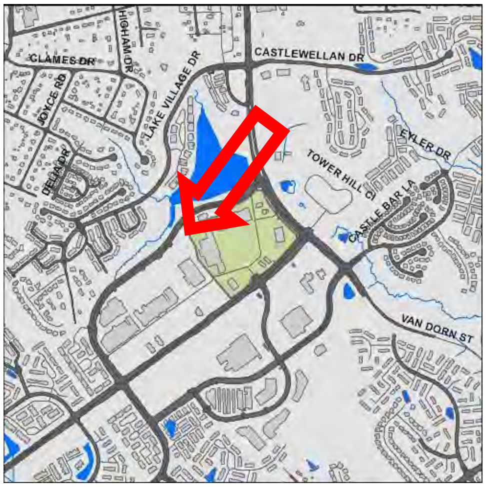
DC9519 BMP/LID



Vicinity Map

Address:	580 Block, Kingstowne Center
Location:	Kingstowne Village
Land Owner:	Private - Commercial
PIN:	0912 01 0032A
Control Type	Water Quality
Drainage Area	1.44 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Installation of bioretention filters and basins and tree box filters are proposed to treat runoff from the driveways and parking lots behind the commercial strip mall located between Kingstowne Boulevard and Kingstowne Village Parkway. The open area between the parking lots will be used for bioretention and one existing inlet will be retrofitted with a tree box filter.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Tree box filters and bioretention filters and basins remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total of 1,160 lbs of sediment, 4.8 lbs of nitrogen and 1.3 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Access to the proposed sites is excellent from driveways and parking lots; however, the property ownership is private and coordination with the owners/management will be necessary.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	1	EA	$10,000.00	$10,000
Bioretention Filters & Basin	104	SY	$150.00	$15,600
			Initial Project Cost	**$25,600**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,280
Ancillary Items	1	LS	5% of project	$1,280
Erosion and Sediment Control	1	LS	10% of project	$2,560
			Base Construction Cost	**$30,720**
			Mobilization (5%)	$1,536
			Subtotal 1	**$32,256**
			Contingency (25%)	$8,064
			Subtotal 2	**$40,320**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$18,144
			Estimated Project Cost	**$58,000**

DC9519_1.jpg: View of parking lot

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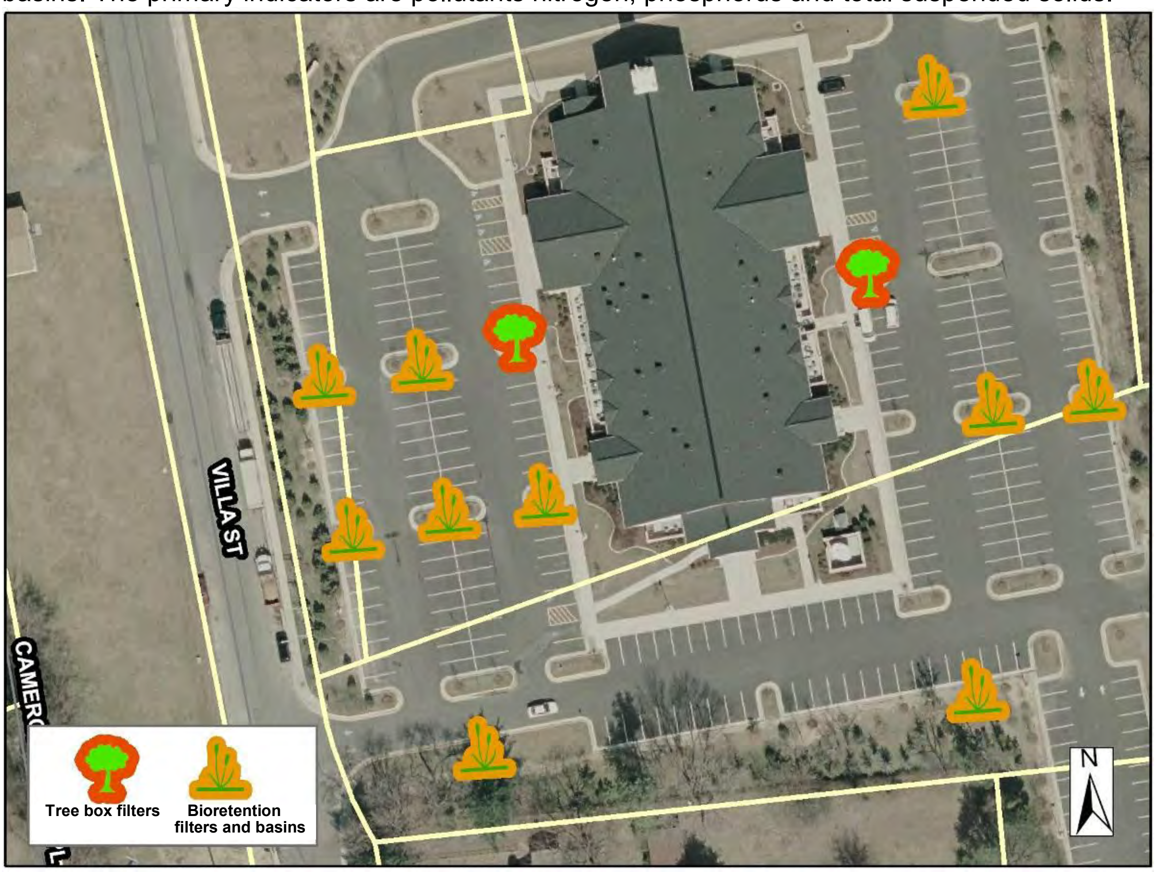
DC9520 BMP/LID

Vicinity Map

Address:	5900 Block, Franconia Road
Location:	Church of Jesus Christ of Latter Day Saints
Land Owner:	Private - Church
PIN:	0814 03 0006A
Control Type	Water Quality
Drainage Area	4.21 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Installation of bioretention filters and basins and tree box filters are proposed to treat runoff from the parking lot surrounding the church along Villa Street. Tree box filters can be added near the church building. Parking lot islands as well as adjacent grassy areas could be modified for bioretention filters and basins. The primary indicators are pollutants nitrogen, phosphorus and total suspended solids.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Bioretention filters and basins and tree box filters remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total of 556 lbs of sediment, 6.9 lbs of nitrogen and 1.4 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on church grounds, an environmental education/stewardship opportunity for residents within the community exists.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate residents in the community. Minimal tree removal may be required for the proposed island sites. Access to the proposed sites is excellent from the church parking lot; however, the property ownership is private and coordination with the church will be necessary. Modifications to the existing storm drain system may be necessary to drain these proposed sites. A temporary or permanent loss of parking spaces may occur.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	2	EA	$10,000.00	$20,000
Bioretention Filters & Basin	343	SY	$150.00	$51,450
			Initial Project Cost	**$71,450**
Plantings	1	LS	5% of project (excluding pervious pavement)	$3,573
Ancillary Items	1	LS	5% of project	$3,573
Erosion and Sediment Control	1	LS	10% of project	$7,145
			Base Construction Cost	**$85,741**
			Mobilization (5%)	$4,287
			Subtotal 1	**$90,028**
			Contingency (25%)	$22,507
			Subtotal 2	**$112,535**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$50,641
			Estimated Project Cost	**$163,000**

DC9520_1.jpg: View of parking lot

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DC9522 BMP/LID

Vicinity Map

Address:	6000 Block, Clames Drive
Location:	Clames Drive
Land Owner:	State – VDOT
PIN:	NA
Control Type	Water Quality
Drainage Area	0.72 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Installation of vegetated swales is proposed to treat road and residential runoff along Clames Drive and Higham Drive. The right-of-way along Clames Drive appears to have enough room for placement of the proposed projects. Coordination with existing driveway culverts and property owners will be needed.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: These vegetated swales will trap suspended solids, reduce trace metals and uptake nutrients including phosphorus and nitrogen from storm water runoff. It is estimated that a total of 327 lbs of sediment, 4.0 lbs of nitrogen and 0.8 lbs of phosphorus would be reduced annually by this project. Vegetated swales also promote infiltration and can reduce the flow velocity of storm water runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. No tree removal is required for this site. Access to the proposed site is good from Clames Drive; however, private driveways and landowners will need to be coordinated with. Current driveway culverts may impact the design of these swales.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Vegetated Swale	180	SY	$50.00	$9,000
			Initial Project Cost	**$9,000**
Plantings	1	LS	5% of project (excluding pervious pavement)	$450
Ancillary Items	1	LS	5% of project	$450
Erosion and Sediment Control	1	LS	10% of project	$900
			Base Construction Cost	**$10,800**
			Mobilization (5%)	$540
			Subtotal 1	**$11,340**
			Contingency (25%)	$2,835
			Subtotal 2	**$14,175**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$6,379
			Estimated Project Cost	**$21,000**

DC9522_1.jpg: View of proposed project location

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DC9523 BMP/LID

Vicinity Map

Address:	6021 Franconia Road
Location:	Virginia Presbyterian Church
Land Owner:	Private - Church
PIN:	0814 02 0005A
Control Type	Water Quality
Drainage Area	1.24 acres
Receiving Waters	Unknown tributary of Dogue Creek

Description: Bioretention filters and basins and rooftop disconnection are proposed to treat Virginia Presbyterian Church runoff before the runoff enters an existing dry pond located on the east side of the property. In particular, the drains located on the west side of the church could be disconnected and allowed to drain onto open area for filtration and bioretention filters and basins could be placed at the edge of the parking lot to treat water before entering the dry pond.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Bioretention filters and basins remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, oil and grease from storm water runoff. It is estimated that a total of 327 lbs of sediment, 3.5 lbs of nitrogen and 0.7 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on church grounds, an environmental education/stewardship opportunity for residents within the community exists.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate residents in the community. No tree removal is required. Access to the proposed sites is excellent from the church parking lot; however, the property ownership is private and coordination with the church will be necessary.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	140	SY	$150.00	$21,000
			Initial Project Cost	**$21,000**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,050
Ancillary Items	1	LS	5% of project	$1,050
Erosion and Sediment Control	1	LS	10% of project	$2,100
			Base Construction Cost	**$25,200**
			Mobilization (5%)	$1,260
			Subtotal 1	**$26,460**
			Contingency (25%)	$6,615
			Subtotal 2	**$33,075**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$14,884
			Estimated Project Cost	**$48,000**


DC9523_1.jpg: View of proposed bioretention site

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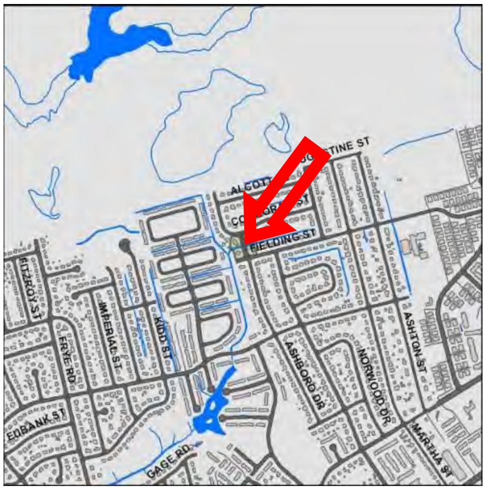
DC9600 Flood Protection/Mitigation



Vicinity Map

Address:	7918 to 7921 Ashboro Drive
Location:	Culvert under Ashboro Drive
Land Owner:	State - VDOT
PIN:	
Control Type	Peak flow control
Drainage Area	
Receiving Waters	Unknown Tributary of Dogue Creek

Description: The crossing at Ashboro Drive overtops and several upstream buildings are within the modeled 100-year flood limit. Reconstruction of the culvert to allow 100-yr event flows will reduce the backwater effects. The primary indicators are number of flooded buildings and the magnitude of the road hazard.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: The reconstruction of the structure under Ashboro Dr. will be able to convey the 100-year storm reducing the modeled overtopping at this location.

Project Design Considerations: The concrete channel under the crossing needs maintenance as the banks are overgrowing into the channel. Small widening of the structure is required which involves tearing down the existing box culvert. No other projects are located within the immediate vicinity. Homes in the vicinity are located close to the project area, therefore specific care should be taken to reduce impacts to private property. The project site can be accessed from Ashboro Dr.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Excavation	2100	CY	$30.00	$63,000
Stabilization graded base	600	CY	$50.00	$30,000
Structure (3 x 100 ft 4.5 CMP)	1	LS	$100,000.00	$100,000
Graded Base	560	SY	$15.00	$8,400
Curb and gutter	200	LF	$30.00	$6,000
Turfgrass establishment	480	SY	$3.00	$1,440
Placing topsoil	480	SY	$5.00	$2,400
Soil Stabilization matting	480	SY	$5.00	$2,400
			Initial Project Cost	**$213,640**
Plantings	1	LS	5% of project	$10,682
Ancillary Items	1	LS	5% of project	$10,682
Erosion and Sediment Control	1	LS	10% of project	$21,364
			Base Construction Cost	**$256,368**
			Mobilization (5%)	$12,818
			Subtotal 1	$269,186
			Contingency (25%)	$67,297
			Subtotal 2	$336,483
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$151,417
			Estimated Project Cost	**$488,000**


DC9600_1.jpg: View of existing culvert under Ashboro Dr

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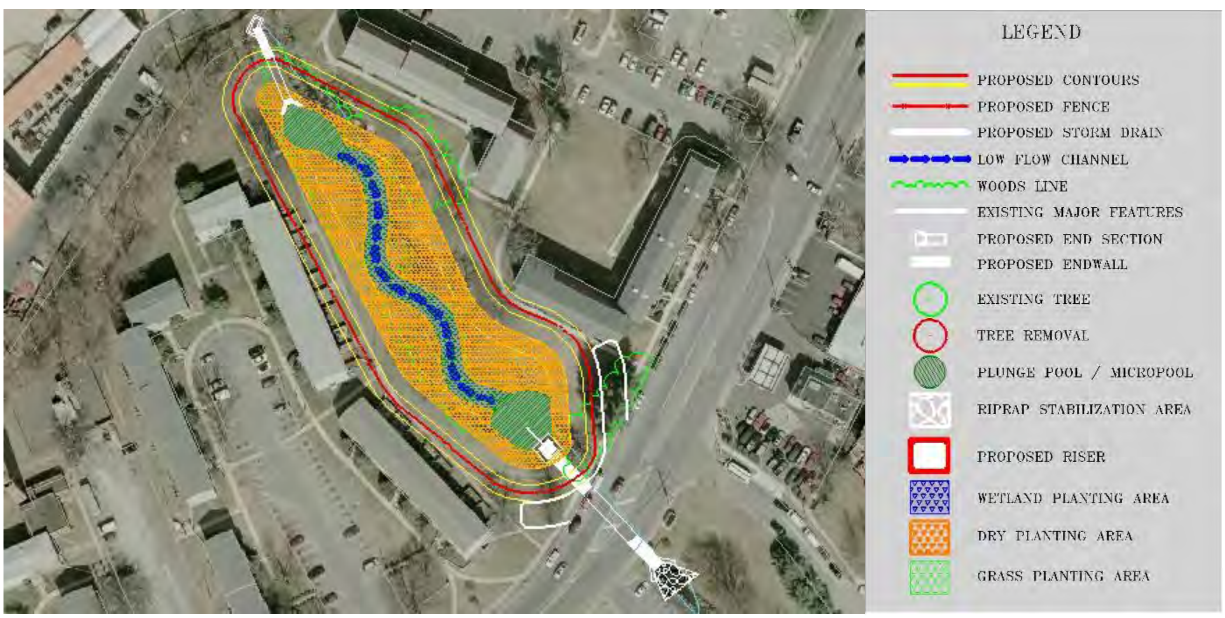
FM9102 New Stormwater Pond

Vicinity Map

Address:	Patrick Henry Dr and Brook Rd
Location:	Hollybrook II Condos
Land Owner:	Private – Residential
PIN:	NA
Control Type	Water Quality and Quantity
Drainage Area	134.09 acres
Receiving Waters	Upper Long Branch

Description: This project proposes creating a stormwater management facility upstream of the culvert on Patrick Henry Drive. Stream banks downstream of the proposed facility are eroded. The proposed project will treat runoff from a large drainage area consisting of commercial and high density residential areas.The runoff will be treated by the proposed project for pollutants nitrogen, phosphorus and total suspended solids.



Project Area Map

Project Benefits: This facility has the potential to meet the water quality treatment requirement for the contributing drainage area via extended detention and also meet the peak flow management requirements of the 2-year storm. Constructing this facility will promote the uptake of nutrients, removal of pollutants, suspension of floatables, and overall increases in water quality and habitat. It is estimated that a total of 20,810 lbs of sediment, 221.0 lbs of nitrogen and 35.3 lbs of phosphorus would be reduced annually. Peak flow rates, erosive velocities, and channel sediment loads can also be reduced by this project. The proposed location of this facility is in the middle of a large apartment complex, which provides an environmental education/stewardship opportunity for residents of this community.

Project Design Considerations: The maximum storage volume in this facility is not capable of reducing 10-year discharge volumes to pre-development conditions. A fence around the proposed facility would be necessary to ensure public safety. A loss of potential recreation area for residents in the apartment complex may result from construction of this facility. Tree removal will be required. Environmental permitting issues are anticipated due to the in-stream nature of the location. Access to the proposed facility is good. Existing utility conflicts are not anticipated.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	1.53	AC	$8,500.00	$13,005
New Inlet	1	EA	$2,500.00	$2,500
New Endwall	2	EA	$2,500.00	$5,000
Plungepool / Micropool	2	EA	$500.00	$1,000
New Riser	1	LS	$8,000.00	$8,000
Embedded Dewatering Pipe	1	EA	$500.00	$500
Drainage Pipe	215	LF	$125.00	$26,875
Rip Rap Stabilization	111	SY	$100.00	$11,100
Excavate to create low-flow channel	291	LF	$25.00	$7,275
Grading and Excavation	19650	CY	$35.00	$687,750
Embankment	4913	CY	$50.00	$245,650
Soil Borings	1	LS	$10,000.00	$10,000
			Initial Project Costs	**$1,018,655**
Plantings	1	LS	5% of Project	$50,933
Ancillary Items	1	LS	5% of Project	$50,933
Erosion and Sediment Control	1	LS	10% of Project	$101,866
			Base Construction Cost	**$1,222,387**
			Mobilization (5%)	$61,119
			Subtotal 1	$1,283,506
			Contingency (25%)	$320,877
			Subtotal 2	$1,604,383
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$721,972
			Estimated Project Cost	**$2,326,000**


FM9102_1.jpg: View of the proposed project site

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FM9104 Stormwater Pond Retrofit

Vicinity Map

Address:	4800 Leesburg Pike
Location:	Hampton Inn off 14th Street and Leesburg Pike
Land Owner:	Private - Commercial
PIN:	0623 01 0025A
Control Type	Water Quality and Quantity
Drainage Area	2.17 acres
Receiving Waters	Unknown tributary of Four Mile Run

Description: The existing detention basin located adjacent to the hotel parking lot will be converted to an extended detention basin by removing the existing concrete low flow channels, excavating the existing bottom to incorporate wetland planting zones and meandering flow channels, and installing a new control structure on the existing barrel pipe. The primary indicators are pollutants nitrogen, phosphorus and total suspended solids.

Project Area Map

Project Benefits: This facility has the potential to meet the water quality treatment requirement for the contributing drainage area by providing extended detention of the one half-inch, 48 hour storm and meets the peak flow management requirements of the 2 and 10-year storm. Retrofitting this facility would promote the removal of suspended solids and floatables to downstream channels thus improving water quality and habitat. It is estimated that a total of 819 lbs of sediment, 9.6 lbs of nitrogen and 1.8 lbs of phosphorus would be reduced annually by this project. These proposed improvements will also help prevent future downstream channel erosion.

Project Design Considerations: No environmental permitting issues are expected with this pond retrofit. Minimal tree loss will occur with this retrofit. Access to the existing facility is good from two adjacent parking lots; however, a wood fence will need to be removed prior to construction and replaced after construction. No design or construction issues were identified at this site.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	0.37	AC	$8,500.00	$3,145
Paved Ditch Demolition & Haul Away	235	LF	$30.00	$7,050
Plungepool / Micropool	3	EA	$500.00	$1,500
New Riser	1	LS	$8,000.00	$8,000
Embedded Dewatering Pipe	1	EA	$500.00	$500
Excavate to create low-flow channel	195	LF	$25.00	$4,875
Tree Removal	4	EA	$2,000.00	$8,000
Grading and Excavation	83	CY	$35.00	$2,905
Soil Borings	1	LS	$7,500.00	$7,500
			Initial Project Costs	**$43,475**
Plantings	1	LS	5% of Project	$2,174
Ancillary Items	1	LS	5% of Project	$2,174
Erosion and Sediment Control	1	LS	10% of Project	$4,348
			Base Construction Cost	**$52,171**
			Mobilization (5%)	$2,609
			Subtotal 1	$54,780
			Contingency (25%)	$13,695
			Subtotal 2	$68,475
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$30,814
			Estimated Project Cost	**$99,000**

FM9104_1.jpg: View of inflow to pond

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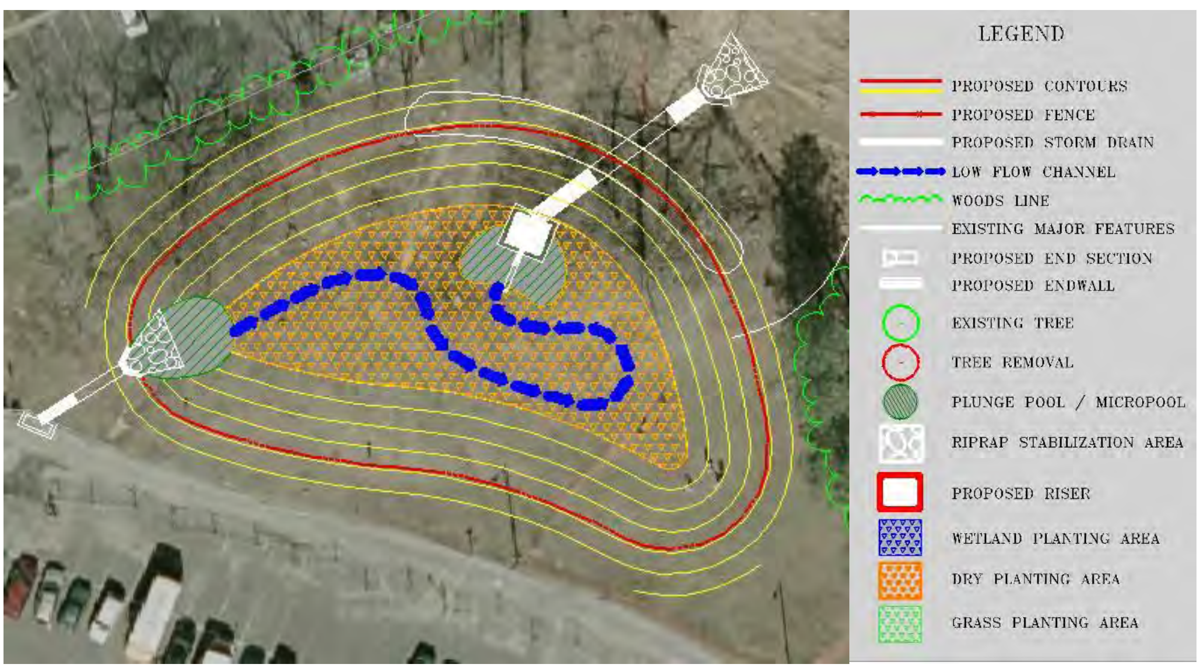
FM9105 New Stormwater Pond

Vicinity Map

Address:	3400 Block, Carlin Springs Rd
Location:	Between Carlin Hill Apts and Leesburg Pike Plaza
Land Owner:	Private - Commercial
PIN:	0621 01 0016F
Control Type	Water Quality and Quantity
Drainage Area	16.93 acres
Receiving Waters	Unknown tributary of Four Mile Run

Description: This project proposes creation of an extended detention dry pond with a sediment forebay at Leesburg Pike Plaza. The project will be sited in the open area adjacent to a parking lot. The pond will treat rooftop and parking lot runoff for water quantity control and water quality.



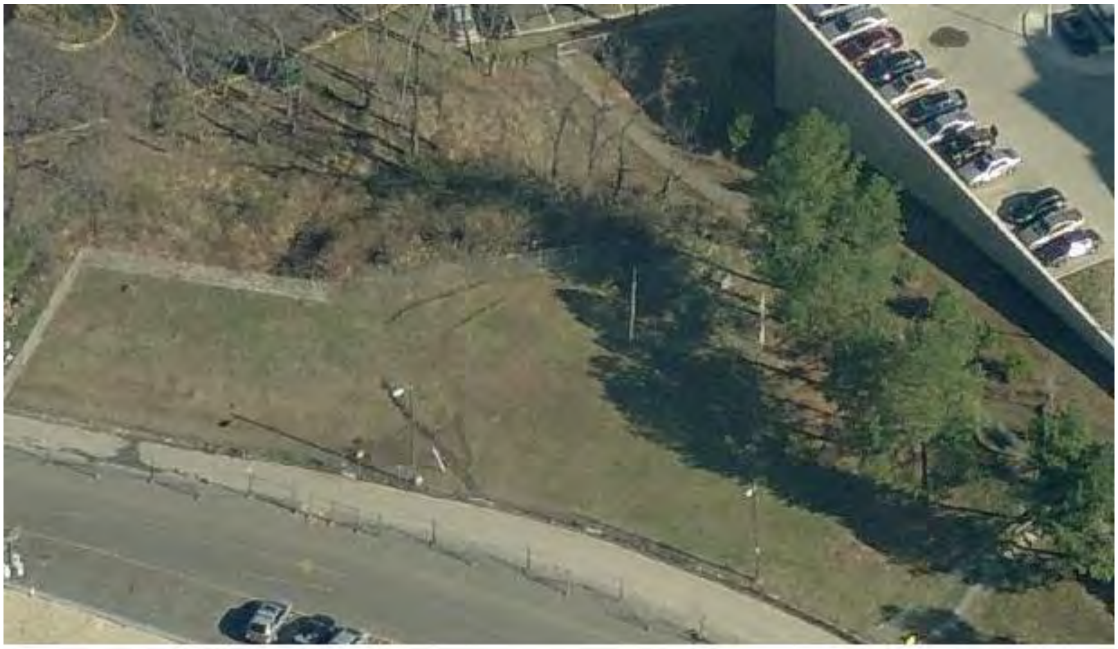
Project Area Map

Project Benefits: This facility has potential to meet the water quality treatment requirement for the contributing drainage area by providing extended detention of the half-inch, 48 hour storm and meet the peak flow management requirements for the 2-year storm. Constructing this facility would promote the removal of suspended solids and floatables to downstream channels thus improving water quality and habitat. It is estimated that a total of 5,880 lbs of sediment, 55.9 lbs of nitrogen and 8.4 lbs of phosphorus would be reduced annually by this project. This project can also help prevent future downstream channel erosion.

Project Design Considerations: The maximum storage volume in this facility is not capable of reducing 10-year discharge volumes to pre-development conditions. A fence around the proposed facility would be necessary to promote public safety due to adjacent residential properties. No environmental permitting issues are anticipated for this project. Access to the proposed facility is good. Existing utility conflicts are not anticipated. Existing stormdrain characteristics may affect the potential to provide stormwater management at this location.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Clear and Grub	0.43	AC	$8,500.00	$3,655
New Inlet	1	EA	$2,500.00	$2,500
New Endwall	2	EA	$2,500.00	$5,000
Plungepool / Micropool	2	EA	$500.00	$1,000
New Riser	1	LS	$8,000.00	$8,000
Embedded Dewatering Pipe	1	EA	$500.00	$500
Drainage Pipe	90	LF	$125.00	$11,250
Rip Rap Stabilization	44	SY	$100.00	$4,400
Excavate to create low-flow channel	191	LF	$25.00	$4,775
Tree Removal	2	EA	$2,000.00	$4,000
Grading and Excavation	3433	CY	$35.00	$120,155
Embankment	858	CY	$50.00	$42,900
Soil Borings	1	LS	$10,000.00	$10,000
			Initial Project Costs	**$218,135**
Plantings	1	LS	5% of Project	$10,907
Ancillary Items	1	LS	5% of Project	$10,907
Erosion and Sediment Control	1	LS	10% of Project	$21,814
			Base Construction Cost	**$261,763**
			Mobilization (5%)	$13,088
			Subtotal 1	$274,851
			Contingency (25%)	$68,713
			Subtotal 2	$343,564
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$154,604
			Estimated Project Cost	**$498,000**



FM9105_1.jpg: Proposed site for new pond

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FM9300 Area Wide Drainage Improvement

Vicinity Map

Address:	Various
Location:	North of Williamsburg Boulevard and Custis Memorial Parkway and south of Haycock Rd.
Land Owner:	Private – Residential, State - VDOT
PIN:	
Control Type	Water Quality
Drainage Area	136 acres
Receiving Waters	Four Mile Run

Description: The entire subwatershed FM-FM-0035 has medium density residential area land use and there are no existing stormwater management facilities. This project is distributed throughout the watershed and involves replacing the existing inlets with tree box filters and adding localized facilities to treat the runoff for water quality.

Project Area Map: Conceptual plan showing project area

Project Benefits: This project will provide water quality treatment for stormwater runoff by removing pollutants and promoting infiltration. Vegetative swales also provide runoff reduction for small events. It is estimated that a total of 9,700 lbs of sediment, 128.0 lbs of nitrogen and 24.0 lbs of phosphorus would be reduced annually by this project.

Project Design Considerations: No other projects are recommended in this subwatershed. There are no environmental constraints since the disturbance would be limited to the area immediately around the project location.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	30	EA	$10,000.00	$300,000
Vegetated Swale	6700	SY	$75.00	$502,500
			Initial Project Cost	**$802,500**
Plantings	1	LS	5% of project	$40,125
Ancillary Items	1	LS	5% of project	$40,125
Erosion and Sediment Control	1	LS	10% of project	$80,250
			Base Construction Cost	**$963,000**
			Mobilization (5%)	$48,150
			Subtotal 1	$1,011,150
			Contingency (25%)	$252,788
			Subtotal 2	$1,263,938
Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)				$568,772
			Estimated Project Cost	**$1,833,000**

FM9300_1.jpg: View of section of area proposed for area wide improvement

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FM9500 BMP/LID

Vicinity Map

Address:	3301 Glen Carlyn Rd
Location:	St. Andrews Parish
Land Owner:	Private - Church
PIN:	0612 01 0008A
Control Type	Water Quality
Drainage Area	2.83 acres
Receiving Waters	Upper Long Branch

Description: This project proposes creation of bioretention areas to receive the runoff from roof top and parking lot at the St. Andrew Parish. The open area in front of the church and grassy area adjacent to the parking lots could be graded and used for bioretention areas.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Bioretention filters and basins remove oil and grease, heavy metals, nutrients including phosphorus and nitrogen, and suspended solids from storm water runoff. It is estimated that a total of 629 lbs of sediment, 6.8 lbs of nitrogen and 1.8 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on school grounds, it provides an environmental education/stewardship opportunity for students and parents as well as residents within the watershed.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate students, parents, and residents in the community. No tree removal is required for installation. Access to the proposed sites is excellent from the school/church parking lot; however, the property ownership is private and coordination will be necessary.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	268	SY	$150.00	$40,200
			Initial Project Cost	**$40,200**
Plantings	1	LS	5% of project (excluding pervious pavement)	$2,010
Ancillary Items	1	LS	5% of project	$2,010
Erosion and Sediment Control	1	LS	10% of project	$4,020
			Base Construction Cost	**$48,240**
			Mobilization (5%)	$2,412
			Subtotal 1	**$50,652**
			Contingency (25%)	$12,663
			Subtotal 2	**$63,315**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$28,492
			Estimated Project Cost	**$92,000**

FM9500_1.jpg: View of open areas in front of church to site bioretention filters

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FM9501 BMP/LID

Vicinity Map

Address:	3149 Glen Carlyn Rd
Location:	St. Katherine's Greek Orthodox
Land Owner:	Private - Church
PIN:	0612 01 0016
Control Type	Water Quality
Drainage Area	1.13 acres
Receiving Waters	Upper Long Branch

Description: Installation of bioretention filters and basins are proposed to treat runoff from St. Katherine's Greek Orthodox church parking lot. The southern portion of the parking lot presents the best opportunity for retrofit. The stormwater runoff will be treated primarily for nitrogen, phosphorus and total suspended solids.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: The proposed facilities remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, and oil and grease from storm water runoff. It is estimated that a total of 576 lbs of sediment, 5.6 lbs of nitrogen and 1.4 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff. Since this site is located on church grounds, an environmental education/stewardship opportunity exists for residents within the watershed.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Signs promoting environmental education/stewardship could be used at this site to educate residents in the community. No tree removal is required for the proposed sites. Access to the proposed sites is excellent from the church parking lot; however, the property ownership is private and coordination with the church will be necessary. Modifications to the existing storm drain system may be needed to create an underdrain for the proposed facilities.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	151	SY	$150.00	$22,650
			Initial Project Cost	**$22,650**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,133
Ancillary Items	1	LS	5% of project	$1,133
Erosion and Sediment Control	1	LS	10% of project	$2,265
			Base Construction Cost	**$27,181**
			Mobilization (5%)	$1,359
			Subtotal 1	**$28,540**
			Contingency (25%)	$7,135
			Subtotal 2	**$35,675**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$16,054
			Estimated Project Cost	**$52,000**


FM9501_1.jpg: Potential areas to implement bioretention

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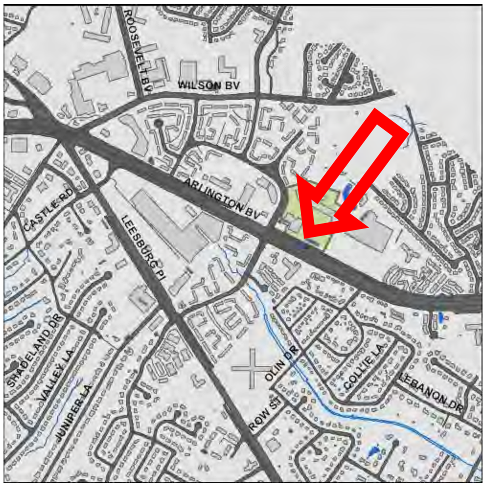
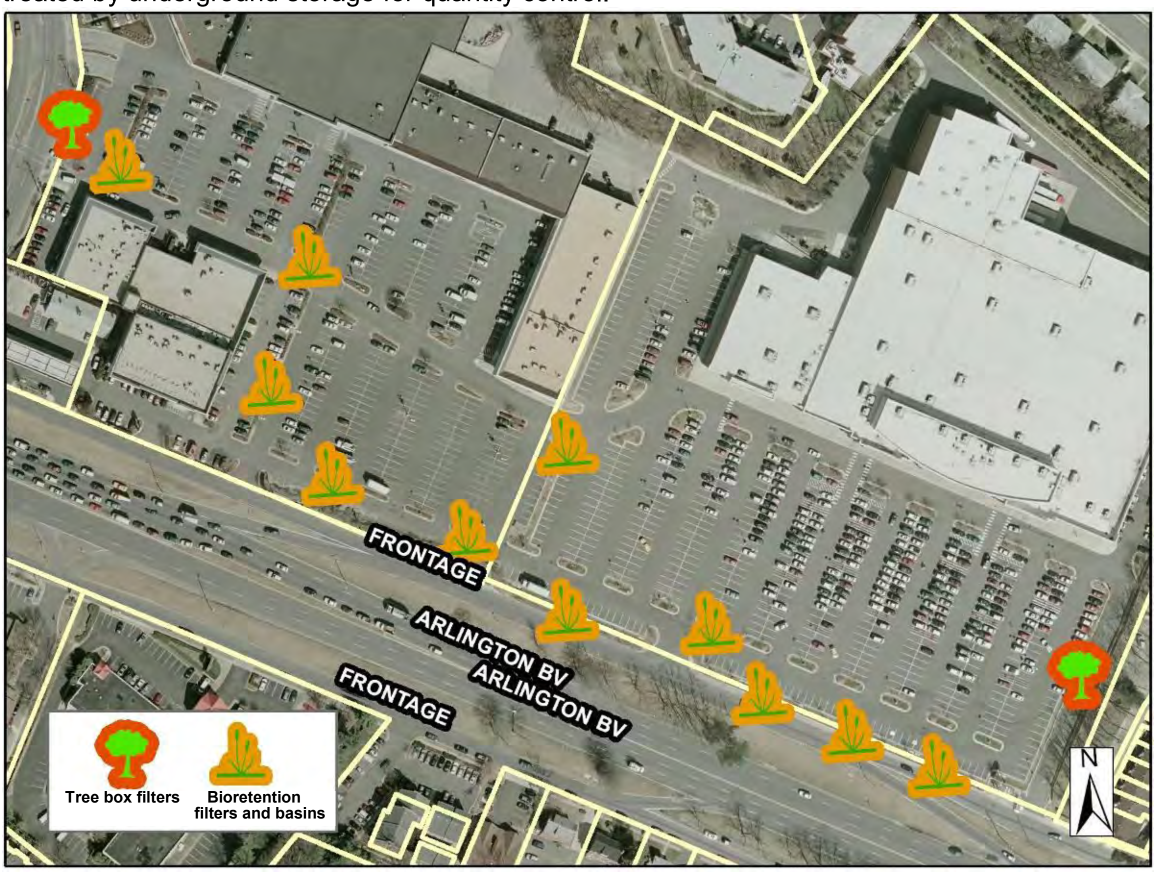
FM9502 BMP/LID



Vicinity Map

Address:	6100 Block, Arlington Blvd
Location:	Target Greatland
Land Owner:	Private - Commercial
PIN:	0514 01 0004
Control Type	Water Quality
Drainage Area	10.18 acres
Receiving Waters	Upper Long Branch

Description: This project would treat runoff from the strip mall parking lot (near Target) by implementing bioretention filters and basins in the southern portion of the parking lot where parking islands are located. Tree box filters are proposed on the edges of the strip mall parking lot. Portions of this site may already be treated by underground storage for quantity control.



Project Area Map: Conceptual plan showing potential project location

Project Benefits: Implementation of tree box filters and bioretention filters and basins will provide water quality treatment for this parking lot during storm events. These facilities remove suspended solids, heavy metals, nutrients including phosphorus and nitrogen, and oil and grease from storm water runoff. It is estimated that a total of 4,440 lbs of sediment, 50.7 lbs of nitrogen and 7.8 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool down warm runoff.

Project Design Considerations: No environmental constraints or permitting issues are anticipated. Minimal tree impacts are expected with this project. Access to the proposed sites is excellent from roads and the commercial parking lot. Property ownership is private and coordination with the shopping center owner/management will be necessary for these sites. A temporary or permanent loss of parking spaces may occur with these sites.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Tree Box Filters	2	EA	$10,000.00	$20,000
Bioretention Filters & Basin	1265	SY	$150.00	$189,750
			Initial Project Cost	**$209,750**
Plantings	1	LS	5% of project (excluding pervious pavement)	$10,488
Ancillary Items	1	LS	5% of project	$10,488
Erosion and Sediment Control	1	LS	10% of project	$20,975
			Base Construction Cost	**$251,701**
			Mobilization (5%)	$12,585
			Subtotal 1	**$264,286**
			Contingency (25%)	$66,072
			Subtotal 2	**$330,358**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$148,661
			Estimated Project Cost	**$479,000**

FM9502_1.jpg: View of existing inlets in parking lot

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FM9503 BMP/LID

Vicinity Map

Address:	6131 Willston Dr
Location:	Korean Cultural Center
Land Owner:	Private
PIN:	0513 18 0001
Control Type	Water Quality
Drainage Area	2.98 acres
Receiving Waters	Upper Long Branch

Description: Runoff characteristics at this site can be improved by removing the concrete immediately adjacent to the Korean Cultural Center. The storm inlet next to playground could also be replaced with a rain garden. Bioretention filters and basins would be installed in the median and edges of the parking lot.

Project Area Map: Conceptual plan showing potential project location

Project Benefits: Bioretention filters and basins have the capability to remove oil and grease, heavy metals, nutrients including phosphorus and nitrogen, and suspended solids from parking lot runoff. It is estimated that a total of 2,080 lbs of sediment, 25.2 lbs of nitrogen and 4.3 lbs of phosphorus would be reduced annually by this project. They also prevent trash and debris from entering the storm drain system and have the ability to cool warm runoff.

Project Design Considerations: Since the site is currently fully developed, no permitting issues are anticipated and there are no impacts to trees. Its use as a cultural center would make it appropriate for signs to encourage environmental education and stewardship. Access to the proposed sites is excellent and Fairfax County ownership simplifies implementation. The only design consideration is potential modifications to the existing storm drain system.

Costs:

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Bioretention Filters & Basin	230	SY	$150.00	$34,500
			Initial Project Cost	**$34,500**
Plantings	1	LS	5% of project (excluding pervious pavement)	$1,725
Ancillary Items	1	LS	5% of project	$1,725
Erosion and Sediment Control	1	LS	10% of project	$3,450
			Base Construction Cost	**$41,400**
			Mobilization (5%)	$2,070
			Subtotal 1	**$43,470**
			Contingency (25%)	$10,868
			Subtotal 2	**$54,338**
			Engineering Design, Surveys, Land Acquisition, Utility Relocations, and Permits (45%)	$24,452
			Estimated Project Cost	**$79,000**

FM9503_1.jpg: View of existing inlet in parking lot

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6 Benefits of Plan Implementation

In order to assess the benefits of the Belle Haven, Dogue Creek and Four Mile Run Watershed Management Plan, hydrologic, hydraulic and pollutant loading modeling was conducted for three separate scenarios:

- *Existing Conditions*: represented watershed conditions at the time the plan was prepared,
- *Future Conditions without Projects*: represented watershed conditions that included forecasts for changes in land use, and
- *Future Conditions with Projects*: added the proposed projects in this plan to the *Future Conditions without Projects* scenario.

All the proposed projects were modeled for pollutant loading reductions. Hydrologic and hydraulic benefits were calculated for the 34 10-year projects with significant storage, such as new stormwater ponds or pond retrofits. Additional information about the models used in this plan may be found in Section 2, while detailed results are discussed in Appendix B.

- Hydrologic modeling was conducted using SWMM. This model uses parameters for land cover, soils and stormwater management to estimate the amount and timing of runoff and stream flow that is generated from precipitation. Modeling was done for two precipitation events: the 2-year storm, with a 50 percent probability of occurrence in any one year, and the 10-year storm, which has a 10 percent probability of occurrence in any one year.
- HEC-RAS was used for hydraulic modeling. This model takes stream flow and estimates the speed and depth of the water. When the results are compared with elevations of buildings and structures, it is possible to determine whether or not they will be impacted.
- Pollutant loading is a type of water quality modeling that estimates how much of a particular pollutant (i.e. total suspended solids (TSS), total nitrogen (TN) or total phosphorus (TP) is being generated and delivered to streams and other water bodies through various land-use activities. The spreadsheet-based STEPL model was used to estimate stormwater runoff loads and assess the reductions of these pollutants through implementation of the proposed projects. Pollutant loads from stream erosion were estimated based on the length and severity of erosion identified in the SPA assessment. Stream restoration projects were assumed to reduce the TSS, TN, and TP loads to zero for the entire length of the restored reach.

6.1 Hydrology

The plan recommended eight stormwater pond projects: three in Belle Haven, two in Dogue Creek and three in Four Mile Run. Model results showed reduction of both peak flows (2- and 10-year) and surface runoff volumes for all three watersheds. Comparisons between the *Future Conditions without Projects* and *Future Conditions with Projects* scenarios showed a reduction in runoff volume from a low of 1.0 percent in for the 10-year event in Belle Haven to a high of 9.4 percent for the 2-year event in the Dogue Creek Barnyard Run WMA. Peak flow reductions varied from a low of 3.1 percent for the 2-year event in Belle Haven to a high of 7.4 percent for the 10-year event in Four Mile Run. There were no reductions in the Dogue Creek Piney Run or Potomac WMAs because no storage retrofits were proposed in these areas. A summary of the results is presented in Tables 6-1 and 6-2.

6.2 Hydraulics

Three projects were proposed in the plan to help alleviate roadway flooding problems identified through hydraulic modeling. Two were in Belle Haven (in areas outside of the Corps of Engineers study) and one was in the Dogue Creek North Fork WMA. Two projects are designed to reconstruct the road culvert to allow the 10- year and 100-year (1 percent annual probability of occurrence) flows to pass through the culvert unimpeded. The third project was a stream restoration project in the Belle Haven WMA downstream of Quander Road. The restoration will consist of daylighting a piped section of Quander Brook and restoring it to a natural stream system.

All proposed projects within VDOT right-of-way will be sent to VDOT for evaluation.

6.3 Pollutant Loading

The STEPL model showed slight increases in the modeled runoff pollutant loads between the *Existing Conditions* and *Future Conditions without Projects* scenarios for all watersheds.

- Belle Haven: There was a small increase in the pollutant loading, due to changes in land use from open space to residential.
- Dogue Creek: The Barnyard Run WMA had the smallest increase in loads, with less than one percent increase for TSS, TN and TP, while Piney Run had the highest increase of all the WMAs in Dogue Creek watershed, with TSS increasing by three percent, TN by six percent and TP by seven percent.
- Four Mile Run: Results were comparable to the Belle Haven watershed with a pollutant load increase less than three percent, primarily from forecast changes in residential density. The increase is small because almost 90 percent of the watershed has already been developed with commercial or residential land use.

All the structural projects were modeled for the *Future Conditions with Projects* scenario to determine the total pollutant removal of the proposed plan. .

- Belle Haven: There were notable reductions in TSS (53 percent), TN (8 percent) and TP (16 percent), largely from the reductions in stream erosion from the significant length of stream restoration projects proposed.
- Dogue Creek: The most significant reductions in pollutant loading were in the North Fork and Mainstem WMAs, with 16 percent and 14 percent reduction in TSS for the 25-year plan.
- Four Mile Run: Reductions in Four Mile Run were the lowest of the three watersheds overall, with about seven percent of TSS, three percent of TN, and four percent of TP removed as a result of the proposed projects.

6.4 Plan Cost and Benefits

The 60 priority projects in the 10-year plan will reduce total suspended solids by 744 tons per year, total nitrogen by 2,076 pounds per year and total phosphorus by 597 pounds per year. The full 25-year plan identifies an additional 29 structural projects for a total of 89, whose overall benefits include eliminating the overtopping of four road crossings and restoring almost five miles of streams and one half-mile of forested buffer. Full plan implementation will reduce pollutant loads by as much as 797 tons per year of total suspended solids, 2,544 pounds per year of total nitrogen and 711 pounds per year of total phosphorus. These benefits will help meet the County’s goals for water quality and stream improvements and provide a positive impact on the residents and conditions of the watersheds.

The total estimated cost for the structural projects for the 10-year plan is $26.7 million. This includes all three watersheds; $7.5 million for Belle Haven, $13.7 million for Dogue Creek and $5.5 million for Four Mile Run. Implementation of the 11-25 year structural projects adds $7.5 million for a total of $34.2 million; an additional $7.1 million for Dogue Creek and $0.4 million for Four Mile Run. Plan cost estimate include only structural projects and it should be noted that the 10-yr plan costs are more accurate as these projects were scoped in more detail.

Table 6-1: Pollutant Loading and Flow Reduction by Watershed

Watershed	Area (ac)	Scenario[3]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TSS (lb/ac/yr)[2]	TN (lb/ac/yr)[2,4]	TP (lb/ac/yr)[2,4]
			2 Year	10 Year	2 Year	10 Year			
Belle Haven	1,737.4	Existing	1.464	3.145	0.560	1.145	1,070.0	6.9169	1.2165
		Future without projects	1.515	3.208	0.576	1.181	1,076.0	7.1047	1.2381
		Future 10-yr projects	1.476	3.174	0.558	1.136	506.6	6.5143	1.0382
		Future 25-yr projects	N/A	N/A	N/A	N/A	506.6	6.5143	1.0382
		Reduction 10-year projects	0.039 (3%)	0.034 (1%)	0.018 (3%)	0.045 (4%)	569.4 (53%)	0.5904 (8%)	0.1999 (16%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	569.4 (53%)	0.5904 (8%)	0.1999 (16%)
Four Mile Run	1,953.0	Existing	1.592	3.287	0.816	1.604	245.7	5.4505	0.7964
		Future without projects	1.632	3.342	0.824	1.623	246.4	5.5786	0.8077
		Future 10-yr projects	1.583	3.264	0.766	1.503	230.3	5.3949	0.7764
		Future 25-yr projects	N/A	N/A	N/A	N/A	229.4	5.3934	0.7756
		Reduction 10-year projects	0.049 (3%)	0.078 (2%)	0.058 (7%)	0.12 (7%)	16.1 (7%)	0.1837 (3%)	0.0313 (4%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	17.0 (7%)	0.1852 (3%)	0.0321 (4%)
Dogue Creek	12,475.1	Existing	1.286	2.984	0.113	0.295	382.6	4.1327	0.6682
		Future without projects	1.325	3.031	0.127	0.343	390.6	4.3033	0.6932
		Future 10-yr projects	1.273	2.927	0.122	0.329	353.1	4.2479	0.6781
		Future 25-yr projects	N/A	N/A	N/A	N/A	344.8	4.2107	0.6690
		Reduction 10-year projects	0.052 (4%)	0.104 (3%)	0.005 (4%)	0.014 (4%)	37.5 (10%)	0.0554 (1%)	0.0151 (2%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	45.8 (11%)	0.0926 (2%)	0.0242 (4%)

[1]Flow is cumulative
[2]Loads are representative of individual land area contributions
[3]25-year projects were not evaluated in the hydrologic model
[4]Due to rounding effects four decimals were needed to make the total loads from WMA and watershed coincide.

Table 6-2: Pollutant Loading and Flow Reduction by WMA

WMA	Area (ac)	Scenario[3]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TSS (lb/ac/yr)[2]	TN (lb/ac/yr)[2,4]	TP (lb/ac/yr)[2,4]
			2 Year	10 Year	2 Year	10 Year			
Belle Haven	1,737.4	Existing	1.464	3.145	0.560	1.145	1,070.0	6.9169	1.2165
		Future without projects	1.515	3.208	0.576	1.181	1,076.0	7.1047	1.2381
		Future 10-yr projects	1.476	3.174	0.558	1.136	506.6	6.5143	1.0382
		Future 25-yr projects	N/A	N/A	N/A	N/A	506.6	6.5143	1.0382
		Reduction 10-year projects	0.039 (3%)	0.034 (1%)	0.018 (3%)	0.045 (4%)	569.4 (53%)	0.5904 (8%)	0.1999 (16%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	569.4 (53%)	0.5904 (8%)	0.1999 (16%)
Four Mile Run	1,953.0	Existing	1.592	3.287	0.816	1.604	245.7	5.4505	0.7964
		Future without projects	1.632	3.342	0.824	1.623	246.4	5.5786	0.8077
		Future 10-yr projects	1.583	3.264	0.766	1.503	230.3	5.3949	0.7764
		Future 25-yr projects	N/A	N/A	N/A	N/A	229.4	5.3934	0.7756
		Reduction 10-year projects	0.049 (3%)	0.078 (2%)	0.058 (7%)	0.12 (7%)	16.1 (7%)	0.1837 (3%)	0.0313 (4%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	17.0 (7%)	0.1852 (3%)	0.0321 (4%)
Dogue Creek - Barnyard Run	1,528.7	Existing	1.328	3.025	0.125	0.181	197.7	3.2353	0.5020
		Future without projects	1.334	3.032	0.173	0.416	198.9	3.2630	0.5058
		Future 10-yr projects	1.208	2.766	0.162	0.391	197.0	3.2386	0.5016
		Future 25-yr projects	N/A	N/A	N/A	N/A	197.2	3.2446	0.5023
		Reduction 10-year projects	0.126 (9%)	0.266 (9%)	0.011 (6%)	0.025 (6%)	1.9 (1%)	0.0244 (1%)	0.0042 (1%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	1.7 (1%)	0.0184 (1%)	0.0035 (1%)
Dogue Creek - Mainstem	3,775.8	Existing	1.329	3.036	0.124	0.312	350.9	4.0837	0.6544
		Future without projects	1.367	3.082	0.138	0.371	359.8	4.2895	0.6823
		Future 10-yr projects	1.302	2.951	0.132	0.353	327.5	4.2047	0.6654
		Future 25-yr projects	N/A	N/A	N/A	N/A	308.9	4.2293	0.6600
		Reduction 10-year projects	0.065 (5%)	0.131 (4%)	0.006 (4%)	0.018 (5%)	32.3 (9%)	0.0848 (2%)	0.0169 (3%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	50.9 (14%)	0.0602 (1%)	0.0223 (3%)

WMA	Area (ac)	Scenario[3]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TSS (lb/ac/yr)[2]	TN (lb/ac/yr)[2,4]	TP (lb/ac/yr)[2,4]
			2 Year	10 Year	2 Year	10 Year			
Dogue Creek - North Fork	2,805.5	Existing	1.448	3.176	0.175	0.392	585.9	5.6584	0.9337
		Future without projects	1.509	3.252	0.240	0.508	592.5	5.8593	0.9582
		Future 10-yr projects	1.479	3.220	0.225	0.473	506.8	5.7795	0.9292
		Future 25-yr projects	N/A	N/A	N/A	N/A	500.6	5.7130	0.9153
		Reduction 10-year projects	0.03 (2%)	0.032 (1%)	0.015 (6%)	0.035 (7%)	85.7 (15%)	0.0798 (1%)	0.0290 (3%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	91.9 (16%)	0.1463 (3%)	0.0429 (5%)
Dogue Creek - Piney Run[5]	1,736.1	Existing	1.225	2.864	0.214	0.492	605.6	3.7192	0.6398
		Future without projects	1.240	2.879	0.221	0.499	625.6	3.9516	0.6855
		Future 10-yr projects	1.240	2.879	0.221	0.499	566.7	3.8883	0.6644
		Future 25-yr projects	N/A	N/A	N/A	N/A	557.5	3.6694	0.6329
		Reduction 10-year projects	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	58.9 (9%)	0.0633 (2%)	0.0211 (3%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	68.1 (11%)	0.2822 (7%)	0.0526 (8%)
Dogue Creek – Potomac[6]	2,629.0	Existing	0.405	1.005	0.446	0.945	171.3	3.3700	0.5200
		Future without projects	0.421	1.026	0.483	1.015	175.7	3.5000	0.5400
		Future 10-yr projects	0.421	1.026	0.483	1.015	175.7	3.5000	0.5400
		Future 25-yr projects	N/A	N/A	N/A	N/A	175.7	3.5000	0.5400
		Reduction 10-year projects	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	0.0 (0%)	0.0 (0%)	0.0 (0%)

[1]Flow is cumulative
[2]Loads are representative of individual land area contributions
[3]25-year projects were not evaluated in the hydrologic model
[4]Due to rounding effects four decimals were needed to make the total loads from WMA and watershed coincide.
[5]No storage projects were recommended in Piney Run, so there are no reductions in volume or flow from 10-year projects.
[6]No projects were recommended in the Potomac WMA as it lies within Fort Belvoir.

Table 6-3: Overall Pollutant Loading and Flow Reduction

	Area (ac)	Scenario[3]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TSS (lb/ac/yr)[2]	TN (lb/ac/yr)[2,4]	TP (lb/ac/yr)[2,4]
			2 Year	10 Year	2 Year	10 Year			
Full Plan	16,165.5	Existing	1.342	3.038	1.489	3.044	439.9	4.5911	0.7426
		Future without projects	1.383	3.088	1.527	3.147	446.8	4.7585	0.7656
		Future 10-yr projects	1.332	2.994	1.446	2.968	354.8	4.6301	0.7287
		Future 25-yr projects	N/A	N/A	N/A	N/A	348.3	4.6012	0.7216
		Reduction 10-year projects	0.051 (4%)	0.094 (3%)	0.081 (5%)	0.179 (6%)	92.0 (21%)	0.1284 (3%)	0.0369 (5%)
		Reduction 25-year projects	N/A	N/A	N/A	N/A	98.5 (22%)	0.1573 (3%)	0.0440 (6%)

[1]Flow is cumulative
[2]Loads are representative of individual land area contributions
[3]25-year projects were not evaluated in the hydrologic model
[4]Due to rounding effects four decimals were needed to make the total loads from WMA and watershed coincide.

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7 Glossary and Acronyms

Glossary

A

Armor-in-Place: Restoration technique intended to help stream banks withstand high flows from altered hydrology. “Armor” can consist of hard elements such as concrete, rip rap, or rock, or natural materials such as fiber logs or root wads. This technique is usually used when site constraints limit other restoration options.

B

Baseflow: The portion of stream flow that is not from runoff, resulting from seepage of groundwater into a channel. Also called dry weather flow.

Berm: A ridge of earth formed to direct or control the flow of surface water.

Best Management Practice (BMP): A practice designed to lessen the impacts of changes in land use on surface water and groundwater. Structural BMPs are physical structures which generally involve engineering, design and construction. Non-structural BMPs are more programmatic and usually focus on controlling stormwater at the source.

Bioengineering: Stream restoration techniques which use plants and living materials in preference to rock to stabilize eroding streams or to redirect flow to improve habitat.

Bioretention: A water quality practice that uses landscaping and soils to collect and treat urban stormwater runoff. Water is collected in shallow depressions in the ground and allowed to slowly filter through a layer of filter media and soil, while plants take up water and nutrients.

Build-out: The total potential land development area based on current and future land development and zoning plans.

Buffer: A vegetated, natural area adjacent to shorelines, wetlands, or streams. See also, *Resource Protection Area* and *Riparian Buffer*.

C

Channel: A natural or manmade waterway.

Chesapeake Bay Preservation Area (CBPA): Land area regulated during the process of development or redevelopment that is considered to have a significant effect on the water quality and health of the Chesapeake Bay, as established in accordance with Chapter 118 of the Fairfax County Code. See also *Intensely Developed Area, Resource Management Area, and Resource Protection Area.*

Confluence: The point where two or more streams join to create a combined, larger stream.

Control Structure: See *Riser*

D

Daylighting: A stream restoration technique which involves demolition and removal of a section of storm sewer and reconstructing a natural stream channel in its place, restoring the stream flow to “daylight”.

Deposition: The process in which particles (e.g., silt, sand, gravel) in the water settle to the stream bottom. Too much deposition can create a thick layer of particles on the stream bottom causing a loss of habitat and spawning areas for *aquatic* insects and fish. Stream bank erosion is a common source for the particles.

Detention: The temporary storage of stormwater runoff used to control peak runoff amounts and provide time for the gradual settling of pollutants.

Dewatering Device: A component of a stormwater pond which can be opened up to drain the pond completely dry for maintenance.

Discharge: The volume of water that passes a given location within a given period of time, usually expressed for stream flow and stormwater in cubic feet per second.

Disconnected Impervious Area (DCIA): Impervious area which drains to a pervious area. It is considered disconnected from the storm drain system because the flow can infiltrate and evaporate. A roof where the downspouts flow on to a lawn is disconnected.

Dissolved Oxygen (DO): The amount of oxygen that is present in water**.** An adequate supply of oxygen is necessary to support life in a body of water. Measuring the amount of dissolved oxygen in water provides a means of determining the water quality.

Drainage: The flow of surface water or *groundwater* from a land area.

Drainage Area: The area of land draining to a single outlet point.

Dry Pond: See *Detention Basin*.

Detention Basin: A stormwater management pond that temporarily holds runoff and slowly releases it to a downstream stormwater system. Since a detention basin holds runoff only temporarily, it is normally dry during periods of no rainfall. (Also called a *Dry Pond*.)

Dwelling Unit: A residential building or part of a building intended for use as a complete, independent living facility.

E

Ecosystem: All of the organisms in an ecological community and their environment that together function as a unit.

Effluent: Water that flows from a sewage or other type of treatment plant after it has been treated.

Embankment: The structure, typically of earth or concrete, which is designed to hold back water in a stormwater pond.

Endwall: A structure at the point where a free-flowing stream enters or discharges from a pipe or culvert. The endwall protects the pipe end from erosion and guides the flow in or out.

Ephemeral: A stream with no baseflow which flows only periodically or occasionally, usually during and immediately after precipitation.

Erosion: The wearing away of the land surface by running water, wind, ice, or other geological agents. In streams, erosion is the removal of soil from the stream banks or streambed by rapid flows.

Estuary: A partially enclosed body of water where freshwater from rivers and streams mixes with salty seawater. Although influenced by the tides, estuaries are protected from the full force of ocean waves, winds, and storms by the reefs, barrier islands, or fingers of land, mud, or sand.

Eutrophication: The process of over-enrichment of waterbodies by nutrients, often resulting in excess algae. Excess algae reduces dissolved oxygen in water, required for living organisms.

Evapotranspiration: The loss of water to the atmosphere from the earth's surface by both evaporation and by *transpiration* through plants.

Extended Detention: Additional depth in a stormwater pond (usually 2 to 3 feet) above the permanent pool or dry bottom to increase holding time and sedimentation. The additional storage is used for improving water quality or reducing flooding or peak discharges that can cause downstream channel erosion.

F

Fecal Coliform Bacteria: A group of organisms that live in the intestinal tracts of humans and animals. The presence of fecal coliform bacteria in water is an indicator of pollution from human and/or animal excrement.

Filter Strips: A vegetated area that treats *sheet flow* and/or interflow by removing sediment and other pollutants. The area may be grass-covered, forested or of mixed vegetative cover (e.g., wildflower meadow).

Fish Passage: Unobstructed movement of fish within the stream system. Fish require the ability to move between various habitat types and during migration.

Flashy: A description of stream flow that varies widely and rapidly between very low baseflow and significantly higher flows in wet weather.

Floatables: Trash, debris, and other large (gross) pollutants that tend to float on the surface of streams, lakes, and ponds, and which are not removed by sedimentation, filtration, or other processes in most stormwater management facilities.

Flood limit: Those land areas in and adjacent to streams subject to continuous or periodic inundation from flood events. A 100-year flood limit is an area with a 1 percent chance of inundation in any given year. Differs from a floodplain.

Floodplain: An ecosystem adjacent to a stream which undergoes fairly frequent inundation during high flows when the stream overtops its banks.

Forebay: A small storage area near the inlet of a stormwater pond to trap incoming sediment where it can be removed easily before it can accumulate in the pond.

G

Gabion: A wire basket or cage that is filled with rock, used to stabilize stream banks, change flow patterns, or prevent erosion.

Geographic Information System (GIS): A computer system for mapping and spatial analysis.

Grade Control (Streams): A method of stream restoration intended to halt and repair incision by adjusting the slope of the stream through a series of step pools, riffles and pools, or other constructed features.

Groundwater: Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturated zone is called the water table.

H

Habitat (Aquatic): A measurable description of the features of a stream which are necessary for insects, fish, and other creatures to thrive, including depth, flow, velocity, substrate, substrate size, and riparian cover.

Head Cut: A type of incision in a streambed consisting of a sudden change in elevation from upstream to downstream, similar to a waterfall. High flows erode the upstream channel at a headcut, resulting in the erosion and incision migrating upstream.

Headwater: The source of a stream or watercourse.

Hydraulics: The physical science and technology of the stationary and active behavior of fluids.

Hydrology: The science dealing with the distribution and movement of water, including the hydrologic cycle of rainfall, runoff, groundwater flow, surface water flow, and evaporation.

I

Incised (Stream): A channel which has cut downward through its bed, becoming disconnected from its floodplain. High flows which previously overtopped the stream banks and dissipated energy in the floodplain stay within the banks of an incised channel, increasing erosion.

Impervious Surface: A surface composed of any material that impedes or prevents *infiltration* of water into the soil. Impervious surfaces include roofs, buildings, streets, and parking areas. Also called impervious cover.

Infill: A residential development that has occurred near, or within, an already established neighborhood.

Inflow: The source of flow into a stormwater pond. Usually a pipe or man-made channel.

Infiltration: The process by which water drains into the ground. Some of this water will remain in the shallow soil layer, where it will gradually move through the soil and subsurface material. Eventually, it might enter a stream by seepage out of a stream bank or it may penetrate deeper, recharging *groundwater aquifers*.

Infiltration Facility: A stormwater management facility that temporarily stores runoff so it can be absorbed into the surrounding soil. Since an infiltration facility confines runoff only temporarily, it is normally dry during periods of no rainfall. Infiltration ponds, infiltration trenches, infiltration dry wells, and porous pavement are considered infiltration facilities.

Intensely Developed Area (IDA): CBPA areas consisting of existing development and *infill* sites where development is concentrated and little of the natural environment remains.

Invert: The lowest elevation of a feature in the drainage network: the bottom of a pond, the bottom of a manhole or pipe, the lowest part of a control structure,

L

Land Development: A man-made change to, or construction on, the land surface.

Land Use: Describes the type of activity on the land such as commercial or residential. The County zoning requirements dictates the type of land use allowed for a given area.

Low-flow Channel: In a stormwater pond, the low-flow channel guides baseflow through the pond during dry periods. Older designs used straight channels made with concrete; newer designs use meandering paths in natural soils, frequently planted with wetland vegetation.

Low-Impact Development (LID): A suite of stormwater management techniques that reduces the stormwater impacts from new development or redevelopment, which combines site design and onsite treatment techniques. Site design can include reducing the amount of *impervious surfaces* and designing the site to take advantage of the natural conditions can reduce the amount of runoff produced by a development area. Onsite treatments include techniques such as vegetated swales and *bioretention* filters or basins to reduce runoff rates and promote *infiltration*.

M

Marsh: A wet land area, periodically inundated with water.

Meander: A stream bend or series of stream bends. Erosion is frequently found on the outer banks of meander bends because they take the force of the flow as it turns.

Median (Parking lot): A small unpaved area in the middle of a parking lot. Most designs use raised medians with curbs. LID techniques can use depressed medians for stormwater treatment.

Micropool: A small permanent pool in a larger stormwater pond system, usually at the pond outlet to provide additional settling of pollutants.

Mitigation: To make a development scenario less harmful than the original plan; or to provide a habitat in another more conducive, larger, or better-suited area, typically in a different location from the original.

Municipal Separate Storm Sewer System (MS4) Permit: An NPDES (National Pollutant Discharge Elimination System) permit issued to municipalities requiring the reduction in pollutants contributing to the discharges from the municipality's storm sewer system outfalls.

N

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, monitoring, and enforcing permits under Sections 307, 402, 318 and 405 of the Clean Water Act. The NPDES permits regulate wastewater and stormwater discharges to the waters of the United States, and are administered by the Virginia Department of Environmental Quality and Virginia Department of Conservation and Recreation.

Nested Channel: A stream restoration technique for incised and overwidened streams which mimics a natural, recovered stream by constructing a small, low-flow channel with an adjacent floodplain bench, all within the existing channel.

Nitrogen: A chemical element that occurs naturally as a gas and makes up 78 percent of the atmosphere. Combined with oxygen as nitrate, it is required by plants for growth and is found in most fertilizers. Too much nitrogen in the water can cause *eutrophication* and result in excess algal blooms, reducing the amount of oxygen available to aquatic life. *Total Nitrogen* refers to all nitrogen compounds forms: nitrate, nitrite, ammonia, and organic nitrogen.

Nutrient: A substance that provides food or nourishment. In the aquatic environment, nutrients refer to compounds of phosphorus, nitrogen, and potassium that contribute to *eutrophication*.

O

Open Space: A portion of a development site that is permanently set aside for public or private use and will not be developed. The space may be used for recreation, or may be reserved to protect or buffer natural areas.

Outfall: Defined in the *NPDES* program as the point where discharge from a regulated system flows into waters of the United States.

Outlet: The point at which water flows from one waterbody to another, such as a stream or river to a lake or larger river.

Overwidened (Stream): A stream with a channel cross-section which has eroded and become wider over time. Low flows become very shallow and provide poorer habitat.

P

Peak Discharge: The maximum flow rate at a given location during a rainfall event. Peak discharge is a primary design factor for the design of stormwater runoff facilities such as pipe systems, storm inlets and culverts, and swales.

Perennial Streams: A body of water that normally flows year-round, supporting a variety of aquatic life.

Pervious: Any material that allows for the passage of liquid through it. Any surface area that allows *infiltration*.

Phosphorus: An element found in fertilizers and soil that can contribute to the *eutrophication* of waterbodies. It is the keystone pollutant in determining pollutant removal efficiencies for various *best management practices* as defined by the Virginia Stormwater Management Regulations. *Total Phosphorus* refers to all phosphorus compounds forms: orthophosphorus and both dissolved and particulate organic and inorganic phosphorus.

Plunge Pool: A small pond located at either a stormwater outfall or an inflow to a stormwater pond, designed to dissipate the energy of high-speed flows.

Pollutant: Any substance introduced to water that degrades its physical, chemical, or biological quality.

Pollutant Loading: The rate at which a pollutant enters a surface water or *groundwater* system. This is typically determined by water quality modeling and expressed in terms such as pounds per acre, per year.

Pollution Prevention: Any activity intended to reduce or eliminate stormwater pollution by reducing the amount of runoff, or by reducing the opportunity for stormwater to wash off and transport pollutants downstream.

Pool: The reach of a stream between two *riffles*; a small and relatively deep body of quiet water in a stream or river. Natural streams often consist of a succession of pools and riffles.

Post-Development: Refers to conditions that exist after completion of a land development activity on a specific site or tract of land.

Pre-Development: Refers to the conditions that exist at the time that plans for land development of a tract of land are approved by the plan approval authority.

Pre-Treatment: A smaller stormwater treatment system located upstream of another system, designed to reduce sediment or other pollutants that would make the downstream system less effective over time.

Q

Quantity Control: *Stormwater management facilities* designed to reduce *post-development peak discharge* to the peak *discharge* that occurred in the *pre-development* conditions, or to reduce the amount of runoff.

Quality Controls: *Stormwater management facilities* designed to remove *pollutants* from *runoff* and improve water quality.

R

Rain Barrel: A storage container connected to a roof downspout, typically including a hose attachment to allow for reuse of rooftop runoff.

Reach: General term used to describe a length of stream.

Recharge: The downward movement of water through the soil into *groundwater*; for example, rainfall that seeps into a groundwater aquifer.

Redevelopment: The substantial alteration, rehabilitation, or rebuilding of a property for residential, commercial, industrial, or other purposes.

Regional Ponds: Larger stormwater management facilities designed to treat the runoff from drainage areas of 100 to 300 acres.

Regrade: A stream restoration technique for incised or over-widened channels which involves excavation and fill to change the cross-section of the stream banks from an easily eroded, usually vertical, form, to a more stable, usually sloping, shape.

Resource Management Area (RMA): CBPA areas not adjacent to streams and shorelines where development may cause an impact to aquatic resources. May include steep slopes, erodible soils, or other areas designated by the locality.

Resource Protection Area (RPA): CBPA lands at or near shorelines or streams that have an intrinsic water quality value due to the ecological and biological processes they perform.

Retention Basin: A stormwater management pond that permanently stores water for the purpose of improving water quality. It is normally wet, even during periods without rainfall. Also called a *Wet Pond*.

Retrofit: The modification of stormwater management systems to improve water quality or to change characteristics of peak discharge control by adding storage, changing outflow characteristics, or adding water quality treatments such as pools, meanders, wetland plantings, or other features.

Riparian Buffer: Strips of grass, shrubs, and/or trees along the banks of rivers and streams that filter polluted runoff. These buffers provide a transition zone between water and human land use. Buffers are also complex ecosystems that provide habitat and improve the stream communities they shelter.

Riprap: A protective layer of large stones placed on a streambank to prevent erosion.

Riffle: A reach of stream that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.

Riffle/Run: Streams that are generally characterized by a high slope (gradient), and a mixture of riffle and run habitat.

Riser: A pipe or structure used to control the discharge rate from a stormwater management pond.

Runoff: The portion of precipitation, snowmelt, or irrigation water that flows off the land into surface waters instead of *infiltrating*.

Run: A segment of stream length that is characterized by moderate depths, smooth flowing water at a moderate pace. A run is intermediate between a *riffle* and a *pool*.

S

Sand Filter: A stormwater management facility consisting of a large, flat area which collects stormwater in a shallow pond and allows it to slowly percolate through a sand bed to remove sediment and pollutants. Usually has an underdrain to collect and convey the filtered stormwater.

Sanitary Sewer: The pipe network that carries domestic or industrial wastewater to a treatment plant. Some systems in older cities and towns may also convey stormwater; these are known as combined sewer systems.

Scour: Removal of sediment from the streambed and banks caused by fast moving water. See also *Erosion*.

Sedimentation (Treatment): In a water treatment context, sedimentation refers to a pollutant removal method in which pollutants are removed by gravity as sediment settles out of the water column. An example of a *best management practice* using sedimentation is a *detention pond/wet pond*.

Sedimentation (Streams): See *Deposition*

Sheet Flow: Runoff that flows over the ground surface as a thin, even layer, not concentrated in a channel.

Sinuous: Sinuosity describes how a stream or river turns back and forth across the land as it flows downstream. A stream with many tight meanders for its length is more sinuous than one with shallow bends.

Stakeholder: Stakeholders include groups of people within the watershed (e.g., residents, industry, local government, agencies, and community groups), as well as those who work in the *watershed*.

Storm Drain: See *Storm Sewer*.

Storm Sewer: A man-made drainage system that carries only surface runoff, street wash, and snow melt from the land. In a separate storm sewer system, storm sewers are completely separate from sanitary sewers that carry wastewater. In a combined sewer, a single conveyance system carries both stormwater and wastewater.

Stormwater: Surface water flow that results from rainfall.

Stormwater Management (SWM) Facility: A structure, such as a pond, that controls the quantity and quality of stormwater runoff.

Stormwater Outfall: A single location, pipe discharge, or outlet structure that releases stormwater into a stream, river, or pond.

Stormwater Ponds: A depression or dammed area with an outlet device that controls stormwater outflow. Stormwater ponds retain water from upstream areas, thereby reducing peak flows downstream. In Fairfax County, stormwater ponds are either dry (*dry pond*) or contain a permanent pool of water (*wet pond*) and are typically designed to control the peak runoff rate for selected storm events.

Stormwater Wetlands: Areas intentionally designed to emulate the water quality improvement function of wetlands for the primary purpose of removing pollutants from stormwater.

Stream Restoration: The reestablishment of the structure and function of a stream, as closely as possible to its pre-existing condition.

Substrate: The material forming the bottom of a stream channel. Channel materials are generally broken into categories (listed smallest to largest) such as clay, silt, sand, gravel, cobble and boulder.

Subwatershed: A smaller subsection of a larger *watershed*, often delineated to describe a particular tributary to a larger waterbody.

Suspended solids: Particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles as well as solids in wastewater.

Swale: A natural depression or wide shallow ditch used to temporarily store, route, or filter runoff.

T

Toe Protection (Streams): A stream restoration technique to provide erosion protection for the the bottom of the streambank. Typically constructed of stone and tied into a regraded and revegetated bank.

Transpiration: The process by which water vapor escapes from living plants and enters the atmosphere. Studies have shown that about 10 percent of the moisture found in the atmosphere is released by plants through transpiration.**Tree Canopy Cover:** The area directly beneath the crown and within the drip line of a tree.

Turbidity: The amount of solid particles that are suspended in water, making it cloudy or even opaque in extreme cases.

U

Underdrain: A series of perforated pipes installed under a filtration treatment system which collects filtered water and conveys it to a storm sewer or stream. May be installed in infiltration systems to divert high flows.

W

Watershed: An area of land that drains directly, or through tributary streams, into a particular river or waterbody. A watershed includes its associated groundwater. Elevated landforms, such as ridges or even roads can serve as watershed divides.

Weir: A section of a riser which limits the discharge from a stormwater pond to the level determined by the design.

Wetlands: Areas where the soil or substrate is saturated with water during at least a part of the growing season. These saturated conditions determine the types of plants and animals that live in these areas.

Wet Pond: See *Retention Basin*

Acronyms

BMP	Best Management Practice
BPJ	Best Professional Judgment
BRAC	Base Realignment and Closure
CBA	Cost Benefit Analysis
CEM	Channel Evolution Model
DCIA	Disconnected Impervious Area
DEQ	(Virginia) Department of Environmental Quality
DO	Dissolved Oxygen
DPWES	Fairfax County Department of Public Works and Environmental Services
EPA	Environmental Protection Agency
FCPA	Fairfax County Park Authority
FCPS	Fairfax County Public Schools
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center River Analysis System
HOA	Homeowners Association
HSI	Hotspot Site Investigation
IBI	Index of Biological Integrity
LID	Low Impact Development
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NSA	Neighborhood Source Assessment
NVSWCD	Northern Virginia Soil and Water Conservation District
NWI	National Wetland Inventory
RPA	Resource Protection Area
SPA	Stream Physical Assessment
SPS	Stream Protection Strategy
STEPL	Spreadsheet Tool for Estimating Pollutant Load
SWM	Stormwater Management
SWMM	Stormwater Management Model
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USLE	Universal Soil Loss Equation
VDOT	Virginia Department of Transportation
VPDES	Virginia Pollutant Discharge Elimination System

VWPP	Virginia Water Protection Permit
WAG	Watershed Advisory Group
WMA	Watershed Management Area

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