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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

Belle Haven 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