Belle Haven, Dogue Creek and Four Mile Run
Watershed Management Plan
DRAFT

Watershed Workbook
June 2010

Fairfax County Department of
Public Works and
Environmental Services

A Fairfax County, VA Publication

Belle Haven, Dogue Creek and Four Mile Run Watersheds

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1 Watershed Condition

1.1 Introduction

The Fairfax County Department of Public Works and Environmental Services (DPWES) is in the process of developing Watershed Management Plans (WMPs) for the 30 watersheds that comprise the county. A watershed is an area of land that drains either directly or through tributary streams into a particular river or water body. Watersheds vary greatly in size from only a few acres to many square miles, and are generally defined by topography. Elevated landforms such as ridges or even roads can serve as watershed divides. For this study, each of these watersheds has been further subdivided into watershed management areas (WMAs) averaging four square miles in size. WMAs are subdivided into subwatersheds, generally ranging in size from 100 to 300 acres.

The successful development of a WMP requires the assessment of the interaction between pollutant sources, watershed stressors, and conditions within streams and other waterbodies. Each watershed must be evaluated in light of its unique conditions. Management opportunities should be identified based on the effects of pollutants and stressors on watershed functions, both in the immediate vicinity of these stressors, as well as farther downstream. The purpose of this document is to provide consistent methods for evaluating watershed management needs while ensuring that WMPs are developed with appropriate attention to watershed-specific conditions. The DPWES Stormwater Planning Division will use the information from these plans to prioritize watershed restoration and protection projects.

The County has developed goals and objectives to be applied to all watersheds during the WMP development process. The three main goals are:

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.

The countywide objectives are linked to the above goals. These objectives were consolidated from the list of over 50 stakeholder-defined objectives from previous WMPs. The shorter list of objectives allows for a countywide evaluation that addresses stakeholder concerns while providing an efficient and effective means of assessment. The final objectives are presented in Table 1-1. This table also shows how each objective is linked to the three watershed planning goals. The countywide goals and objectives will be applied to all WMP assessments and recommendations. Additional watershed-specific goals and objectives that are recommended by local stakeholders may also be incorporated into the WMP development process. The objectives listed under Category 5 (Stewardship) will be considered during countywide watershed assessment but are not addressed in the subwatershed ranking approach.

Table 1-1 - Fairfax County Watershed Planning Final 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
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

This watershed workbook describes the current and projected conditions for the Belle Haven, Dogue Creek and Four Mile Run watersheds, presenting both watershed-wide information and, for the Dogue Creek watershed, characterization in more detail in Watershed Management Areas (WMAs). These watersheds are located in southeastern and eastern Fairfax County as shown on Map 1. Watershed Management Area (WMA) and subwatershed boundaries for these three watersheds are shown on Maps 2, 3 and 4, attached. The workbook combines information from field assessments of streams and upland areas, water quality monitoring data collected in past years and watershed modeling conducted for this plan. The information is used to rank problem areas and identify potential sites for improvements.

1.2 Watershed Characteristics

1.2.1 Belle Haven Watershed

The Belle Haven watershed is approximately 2.7 square miles and is located in southeastern Fairfax County, Virginia, as shown on Map 1. The entire watershed is located within the County jurisdiction. Major roads within the watershed include Richmond Highway (US 1), George Washington Memorial Parkway (Route 400), Belle View Boulevard and Fort Hunt Road (Route 629).

The Belle Haven watershed is part of the Potomac River Basin and contains 3.4 miles of stream within the Belle Haven Watershed Management Area (WMA) as shown in Table 1-2, below.

Table 1-2 - Belle Haven WMA Total Area and Stream Length

WMA	WMA Area (ac)	WMA Area (sq mi)	Stream Length (mi)
Belle Haven	1,737	2.7	3.4
Total Watershed	**1,737**	**2.7**	**3.4**

The main waterway within the Belle Haven watershed is Hunting Creek, 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 are direct tributaries to the Potomac River, one flowing northeast parallel to and east of Hunting Creek and draining to tidewater and the other flowing southeast directly to the Potomac River. The Belle Haven watershed was not subdivided into WMAs, as shown on Map 2, attached.

Approximately 69 percent of the watershed is developed, especially areas east of Fort Hunt Road.

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. Several problems, however, have been accelerated by development including increased stream erosion and stream sedimentation due to concentrated points of stormwater runoff.

1.2.2 Dogue Creek Watershed

The Dogue Creek watershed is approximately 19.5 square miles and is located in southeastern Fairfax County, Virginia, as shown on Map 1. Approximately 6.3 square miles (32 percent) of the watershed is located in areas outside of the County jurisdiction in the Fort Belvoir Military Reservation (30 percent) and other US government installations (2 percent). Major roads within the watershed include Richmond Highway (US 1), Mount Vernon Memorial Highway (Route 235), Old Mount Vernon Road (Route 623), Telegraph Road (Route 611), South Kings Highway (Route 633), Hayfield Road (Route 635), Manchester Boulevard, Kingstowne Boulevard and South Van Dorn Street.

The Dogue Creek watershed is part of the Potomac River Basin and contains over 35 miles of stream divided among the five Watershed Management Areas (WMAs) listed in

Table 1-3, below. The Potomac WMA is predominantly within the boundaries of Fort Belvoir Military Reservation and was not assessed.

Table 1-3 - Dogue Creek Watershed Total Area and Stream Length by WMA

WMA	WMA Area (ac)	WMA Area (sq mi)	Stream Length (mi)
Barnyard Run	1,529	2.4	5.3
Mainstem	3,776	5.9	12.4
North Fork	2,806	4.4	9.3
Piney Run	1,736	2.7	8.1
Potomac	2,629	4.1	n/a
Total Watershed	**12,476**	**19.5**	**35.1**

The mainstem of Dogue Creek flows for 12 miles in a southern 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. See Map 3, attached, for WMA locations.

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. 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. Several problems, however, have been accelerated by development including increased stream erosion and stream sedimentation due to concentrated points of stormwater runoff.

1.2.3 Four Mile Run Watershed

The Four Mile Run watershed is approximately 20 square miles and is located in eastern Fairfax County, Virginia, as shown on Map 1. Approximately 17 square miles of the watershed is located in areas outside of Fairfax County jurisdiction in the City of Falls Church, City of Alexandria and Arlington County. This Watershed Management 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 the Upper Long Branch subwatershed 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.

Major roads within the watershed include Interstate 66, Westmoreland Street (Route 693), Leesburg Pike (Route 7), Arlington Boulevard (Route 50), Columbia Pike (Route 244), and Glen Carlyn Road (Route 714).

The Four Mile Run watershed is part of the Potomac River Basin and contains approximately 1.8 miles of stream within the study area of the Four Mile Run WMA as listed in Table 1-4, below.

Table 1-4 - Four Mile Run WMA Total Area and Stream Length

WMA	WMA Area (ac)	WMA Area (sq mi)	Stream Length (mi)
Four Mile Run	1,306	2.0	1.8
Total Watershed	**1,306**	**2.0**	**1.8**

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. 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, see Map 4, attached, for details.

Approximately 95 percent of the watershed study area within Fairfax County is developed, with only small portions of open space along the headwaters of Four Mile Run and the mainstem of Long Branch. Several problems have been accelerated by the high level of development including increased stream erosion and stream sedimentation due to concentrated points of stormwater runoff.

1.3 Watershed History and Population Growth

In 1742, the City of Fairfax was founded and in 1800 became the County seat. At the turn of the century, as Washington, DC was developing into a major city, development pressures increased in the surrounding areas. By the late 1950s, development was beginning and sewer lines were being laid for residential development. Predicted growth in Fairfax County through 2030 is shown in Table 1-5.

Table 1-5 - Growth Trends in Fairfax County

Year	Population (1,000s)	Percent Change	Households (1,000s)	Percent	Employment (1,000s)	Percent Change
1970	454.3		126.5			
1980	596.9	31.4	205.2	62.2		
1990	818.6	37.1	292.3	42.4	371.7	
2000	969.7	18.5	353.1	20.8	518.8	39.6
2010	1133.0	16.8	411.5*	16.5	683.6*	31.8
2020	1193.4	5.3	462.4*	12.4	782.2*	14.4
2030	1334.0*	11.8*	482.3*	4.3*	847.6*	8.4*

All population data provided by Fairfax County except * from Metropolitan Washington Council of Governments

1.3.1 Watershed Development Patterns – Belle Haven

Development in the Belle Haven watershed began in the 1920s. Table 1-6 indicates the area of the watershed developed, by decade, based on the date of subdivision for each parcel. The first major residential subdivision was located in the northwestern portion of the watershed between Route 1 and Kings Highway (Route 241). Significant medium-density residential subdivision development was widespread in the 1950s with the heaviest concentrations in the central and southern portions of the watershed. By the 1980s, the watershed was essentially built-out with only parks, wetland areas and golf courses remaining undeveloped.

Table 1-6 - Belle Haven Watershed Development by Decade

Decade	Area (Acres)	Percent
Open, vacant, common areas	884	50.9
1900 and earlier	9	0.5
1920s	120	6.9
1930s	47	2.7
1940s	101	5.8
1950s	290	16.7
1960s	158	9.1
1970s	54	3.1
1980s	61	3.5
1990s	10	0.6
2000s	3	0.2
Total Belle Haven Watershed	**1,737**	**100.0**

Commercial areas in the watershed are primarily located along King and Richmond Highways in the northwestern portion of the watershed. There is one industrial parcel, located just east of Mount Vernon District Park. Aerial photos from 2002 indicate that this parcel is primarily forested.

1.3.2 Watershed Development Patterns – Dogue Creek

In 1976, approximately 24,500 people were living in the Dogue Creek watershed and there were still large areas of undeveloped lands and parklands. Industrial areas in the watershed were limited. About half of the Fort Belvoir Military Reservation lies within the Dogue Creek watershed. In 1976, this portion was primarily reserved for recreation and open space.

Development in Dogue Creek began in the 1940s. Table 1-7 indicates the area of the watershed developed, by decade, based on the date of subdivision for each parcel. The first significant residential subdivision developments began construction in the 1950s in the eastern areas of the watershed, particularly east of Fort Belvoir and south of Huntley Meadows Park. The majority of the development took place in the 1960s and 1970s, and it consisted primarily of medium-density residential housing. Development west of Telegraph Road is more recent, having primarily been developed since 1980 with high-density residential housing.

Table 1-7 - Dogue Creek Watershed Development by Decade

Decade	Area (Acres)	Percent
Open, vacant, common areas	4,550	36.5
Ft. Belvoir	3,566	28.6
1900 and earlier	292	2.3
1910s	4	0.0
1920s	45	0.4
1930s	64	0.5
1940s	192	1.5
1950s	656	5.3
1960s	1,485	11.9
1970s	595	4.8
1980s	474	3.8
1990s	441	3.5
2000s	114	0.9
Total Dogue Creek Watershed	**12,477**	**100.0**

There are two significant commercial areas in the watershed, the Kingstowne Towne Center and Festival and the Festival at Manchester Lakes Shopping Center in the northwestern portion of the watershed were developed after 1980. Commercial areas along Route 1 in the southeastern portion of the watershed were developed primarily in the 1960s and 1970s.

1.3.3 Watershed Development Patterns – Four Mile Run

The Fairfax County portion of the Four Mile Run watershed can be characterized as highly developed, with only 10 percent of the watershed remaining in open, vacant or common areas. Table 1-8 indicates the area of the watershed developed, by decade, based on the date of subdivision for each parcel. The first significant residential subdivision developments began construction in the 1940s just north of Falls Church and between Leesburg Pike and Arlington Boulevard. Expansion of both high- and medium-density residential and commercial areas continue through the 1950s and by the end of the 1960s, the watershed was mostly built-out.

Table 1-8 - Four Mile Run Watershed Development by Decade

Decade	Area (Acres)	Percent
Open, vacant, common areas	136	10.4
1900 and earlier	5	0.4
1920s	7	0.5
1930s	14	1.1
1940s	78	6.0
1950s	508	38.9
1960s	282	21.6
1970s	114	8.7
1980s	80	6.1
1990s	67	5.1
2000s	16	1.2
Total Four Mile Run Watershed	**1,306**	**100.0**

Commercial areas in the Fairfax County portion of the Four Mile Run watershed are situated in two areas: Seven Corners, near the intersection between Arlington Boulevard and Leesburg Pike, just south of Falls Church, and Bailey's Crossroads, at the intersection of Columbia Pike and Arlington Boulevard, just northwest of the city of Alexandria.

1.4 Land Use

1.4.1 Land Use – Belle Haven

Current land-use mapping shows that the Belle Haven watershed is 69 percent developed, with 31 percent remaining as either open space or water. Table 1-9 and Map 5 show the land use distribution throughout the watershed. Twenty-one percent of the watershed is in open space, parks and recreational land uses. The majority of the watershed, 41 percent, is in various residential land uses and 18 percent is in use for transportation. Only 6.5 percent is in use for commercial and one percent for industrial land uses.

Future land use, also shown in Table 1-9, was derived from a compilation of zoning and general land use plan information. The existing land use data was used as the base data for future land use. In many cases, the planned land uses corresponded roughly to the

zoning for the same parcels. Where the planned land use and the zoned land use differed, the classification that provided the greatest density was used.

Table 1-9 - Belle Haven Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	359.5	20.7	313.1	18.0	-46.4	-12.9
Golf Course	151.0	8.7	150.6	8.7	-0.4	-0.3
Estate residential	9.9	0.6	2.9	0.2	-7.0	-70.7
Low-density residential	72.2	4.2	42.3	2.4	-29.9	-41.4
Medium-density residential	434.7	25.0	499.1	28.7	64.4	14.8
High-density residential	190.1	10.9	190.9	11.0	0.8	0.4
Low-intensity commercial	26.2	1.5	19.3	1.1	-6.9	-26.3
High-intensity commercial	87.2	5.0	113.1	6.5	25.9	29.7
Industrial	24.0	1.4	24.0	1.4	0.0	0.0
Institutional	58.2	[illegible]	57.7	3.3	-0.5	-0.9
Transportation	311.3	[illegible]	311.3	17.9	0.0	0.0
Water	13.0	0.7	13.0	0.7	0.0	0.0
Total Belle Haven	**1,737.3**	**[illegible]**	**1**	**100.0**	**0.0**	**0.0**

Due to rounding error, total percentages may be slightly greater or lesser than 100.

As with Dogue Creek watershed, the watershed is essentially built out. Only 91 acres, or 5 percent, of the land use is forecast to change. The major changes are conversion of 76 acres of open space and redevelopment of 30 acres of low-density residential to 65 acres of medium-density residential and 26 acres of high-intensity commercial land use.

1.4.2 Land Use – Dogue Creek

Table 1-10 and Map 6 show the land use distribution throughout the watershed. Forty-one percent of the Dogue Creek watershed is in open space, parks and recreational land uses. An additional 33 percent of the watershed is in residential land uses, the majority being in medium-density residential use. Ten percent of the watershed is in institutional and industrial land uses; and another eight percent in use for transportation.

Future land use, also shown in Table 1-10, was derived from a compilation of zoning and general land use plan information. The existing land use data was used as the base data for future land use. In many cases, the planned land uses corresponded roughly to the zoning for the same parcels. Where the planned land use and the zoned land use differed, the classification that provided the greatest density was used.

Table 1-10 - Dogue Creek Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational	5,169.6	41.4	4,892.0	39.2	-277.6	-5.4

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
areas						
Golf Course	265.5	2.1	265.5	2.1	0.0	0.0
Estate residential	174.3	1.4	74.6	0.6	-99.7	-57.2
Low-density residential	835.4	6.7	791.0	6.3	-44.4	-5.3
Medium-density residential	1,834.9	14.7	2,168.2	17.4	333.3	18.2
High-density residential	1296.7	10.4	1,317.2	10.6	20.5	1.6
Low-intensity commercial	69.6	0.6	65.6	0.5	-4.0	-5.7
High-intensity commercial	219.2	1.8	277.7	2.2	58.5	26.7
Industrial	182.4	1.5	168.7	1.4	-13.7	-7.5
Institutional	1,062.3	8.5	1,086.0	8.7	23.7	2.2
Transportation	990.9	7.9	994.3	8.0	3.4	0.3
Water	374.3	3.0	374.3	3.0	0.0	0.0
Total Dogue Creek	**12,475.1**	**100.0**	**12,475.1**	**100.0**	**0.0**	**0.0**

Due to rounding error, total percentages may be slightly greater or lesser than 100.

The table shows that the watershed is essentially built out. Only 3.5 percent of the land use, or 439 acres, is forecast to change. The major changes are conversion of 278 acres of open space and redevelopment of 144 acres of estate and low-density residential to 333 acres of medium-density residential, 59 acres of high-intensity commercial and 24 acres of institutional land uses.

1.4.3 Land Use – Four Mile Run

Current land-use mapping shows that the Four Mile Run watershed is 90 percent developed, with 10 percent remaining as either open space or water. Table 1-11 and Map 7 show the land use distribution throughout the watershed. Currently, 49 percent of the watershed is in various residential land uses, 22 percent is in low- and high-intensity commercial uses and 19 percent is in use for transportation. Only 5 percent (62 acres) of the watershed is in open space, parks and recreational land uses.

Future land use, also shown in Table 1-11, was derived from a compilation of zoning and general land use plan information. The existing land use data was used as the base data for future land use. In many cases, the planned land uses corresponded roughly to the zoning for the same parcels. Where the planned land use and the zoned land use differed, the classification that provided the greatest density was used.

Table 1-11 - Four Mile Run Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	61.6	4.7	40.2	3.1	-21.4	-34.7
Estate residential	8.4	<1	0.0	0.0	-8.4	-100.0

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Low-density residential	72.6	5.6	51.9	4.0	-20.7	-28.5
Medium-density residential	313.7	24.0	357.7	27.4	44.0	14.0
High-density residential	247.5	19.0	249.0	19.1	1.5	<1
Low-intensity commercial	74.1	5.7	63.4	4.9	-10.7	-14.4
High-intensity commercial	215.6	16.5	261.2	20.0	45.6	21.2
Industrial	27.0	2.1	11.7	<1	-15.3	-56.7
Institutional	34.7	2.7	20.1	1.5	-14.6	-42.1
Transportation	243.8	18.7	243.8	18.7	0.0	0.0
Water	6.7	<1	6.7	<1	0.0	0.0
Total Four Mile Run	**1,305.7**	**100.0**	**1,305.7**	**100.0**	**0.0**	**0.0**

Due to rounding error, total percentages may be slightly greater or lesser than 100.
Includes only areas within Fairfax County.

The table shows that the portion of the watershed included in this study is essentially built out. Ninety-one acres, approximately 7 percent of the land use, is forecast to change. The major changes are conversion of 21 acres of open space and redevelopment of 21 acres of low-density residential and 30 acres of industrial and institutional land uses to 44 acres of medium-density residential and 46 acres of high-intensity commercial land uses.

Significant redevelopment of Seven Corners and Bailey's Crossroads can be expected as part of the County's revitalization plan for these areas. Redevelopment is not expected to change the area in each type of land use, but it may provide opportunities for watershed improvements as part of a coordinated plan.

1.4.4 Infill Development

Along with development and redevelopment at the scale of subdivisions and large commercial parcels, Fairfax County has been experiencing redevelopment of single lots for larger structures and infill development of vacant and larger single-family residential lots to higher density.

In the late 1990s, concerned with potential problems related to these types of impacts on the surrounding areas, the County initiated a study to develop recommendations which would address commonly raised issues of infill and residential development, including lack of compatibility with the existing communities, added traffic and potential congestion, tree and open space loss and stormwater management and erosion control issues (Infill & Residential Development Study, 2000). The study made recommendations to address issues of site compatibility (12 recommendations), added traffic and potential congestion (five recommendations), loss of open space (four recommendations) and stormwater management and erosion control (13 recommendations).

As a result of the Infill Study, the Board of Supervisors approved some of the recommendations and made amendments to the Policy Plan and Public Facilities Manual addressing factors of site design, neighborhood context, environment, tree preservation, transportation, public facilities, affordable housing, heritage resources and stormwater management and sediment control. Further details of proposed actions can be found in County Environmental Improvement Program (EIP) documents on the EIP homepage (www.fairfaxcounty.gov/living/environment/eip/).

1.5 Impervious Area

As the area of impervious surfaces such as streets, parking lots and driveways increases within the watershed, the amount of rainfall that can be absorbed into the ground is reduced. This can cause more water to quickly run off the land and into the streams in a short period of time. The storm drainage system is designed to direct this excess stormwater runoff into the stream system, and consequently concentrates the flow. Peak flows during storm periods not only cause flooding but can change the shape of the channel by causing accelerated erosion of the stream banks. An increase in the stream channel width can change the aquatic environment within the stream. As the stream channel widens, the water become shallower, and sun protection from tree cover decreases as mature trees are lost due to bank failure. This can cause the water temperatures to rise and stress aquatic life within the stream.

The acres of impervious surface for each of the following watersheds were calculated from geographic information system (GIS) planimetric layers provided by the County. Impervious surfaces include roads, parking lots, buildings, sidewalks and driveways.

1.5.1 Impervious Area – Belle Haven

The Belle Haven watershed is 32 percent impervious, as shown on Table 1-12. Imperviousness across the watershed is expected to increase by approximately 1.5 percent from future development.

Table 1-12 - Belle Haven Imperviousness

WMA	Total Area (ac)	Impervious Area (ac)	Percent Impervious
Belle Haven	1,737.4	551.5	31.7
Total Belle Haven Watershed	**1,737.4**	**551.4**	**31.7**

1.5.2 Impervious Area – Dogue Creek

Overall, the Dogue Creek watershed is 19 percent impervious, as shown in Table 1-13. 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 from future development.

Table 1-13 - Dogue Creek WMA Imperviousness

WMA	Total Area (ac)	Impervious Area (ac)	Percent Impervious
Barnyard Run	1,528.7	193.6	12.7
Mainstem	3,775.8	784.0	20.8
North Fork	2,805.6	768.7	27.4

Potomac	2,629.0	282.3	10.7
Piney Run	1,736.1	395.7	22.8
Total Dogue Creek Watershed	**12,475.2**	**2,424.3**	**19.4**

1.5.3 Impervious Area – Four Mile Run

As shown on Table 1-14, the Fairfax County portion of the Four Mile Run watershed is 36 percent impervious. Imperviousness is expected to increase by approximately 1.5 percent from future development.

Table 1-14 - Four Mile Run Imperviousness

WMA	Total Area (ac)	Impervious Area (ac)	Percent Impervious
Four Mile Run	2,278.2	824.7	36.2
Total Four Mile Run Watershed	**2,278.2**	**824.7**	**36.2**

Includes areas outside of Fairfax County

1.6 Aquatic Resources

The Dogue, Little Hunting, Belle Haven Environmental Baseline study completed in 1976 by Parsons, Brinckerhoff, Quade and Douglass indicated that the faunal quality of the streams in the Dogue Creek watershed ranged from good to fair on the North Fork of Dogue Creek to poor on the mainstem of Dogue Creek, with five of the seven assessment sites in the watershed in the fair to poor range. Three sites were assessed in the Belle Haven watershed resulting in two ratings of poor and one fair. There was no data available during the same time period for Four Mile Run watershed.

In 1999, the County developed the Stream Protection Strategy program to:

- determine the extent of stream degradation and identify areas with the greatest need;
- develop strategies to minimize or prevent additional degradation;
- recommend preservation and restoration efforts;
- support comprehensive watershed planning;
- better integrate environmental policies and regulatory requirements; and,
- promote environmental stewardship and public education programs.

The goal of the Stream Protection Strategy is not to restrict new development, but to provide for more ecologically sensitive and sustainable development. Three watershed management categories were developed to provide more efficient watershed planning and future watershed management (Fairfax County Stream Protection Strategy Baseline Study, 2001). Categories apply to areas within the watershed that can be grouped for similar restoration treatments. Each category includes goals and recommendations to be implemented for watershed protection and restoration.

In addition to monitoring conducted by the County, the Northern Virginia Soil and Water Conservation District (NVSWC) maintains a volunteer monitoring program throughout Fairfax County. A summary of any available volunteer data is presented below for Dogue Creek, Belle Haven and Four Mile Run watersheds.

1.6.1 Stream Protection Strategy (SPS) and Volunteer Monitoring Results – Belle Haven

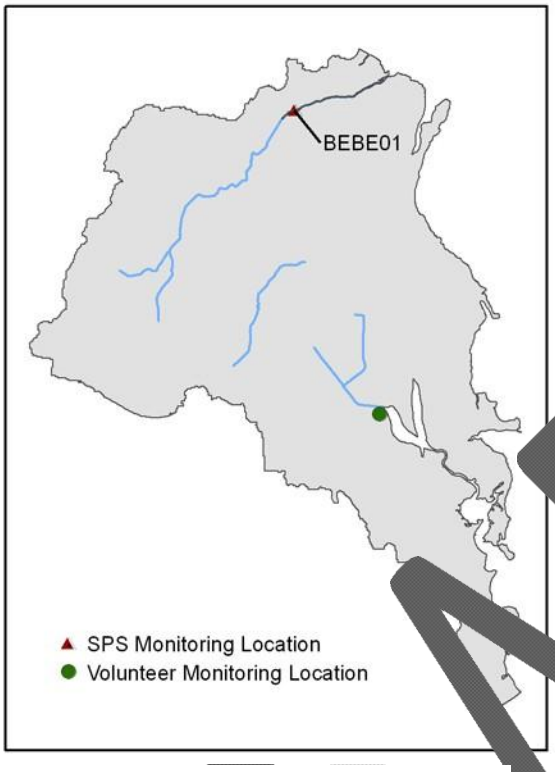


Figure 1-2 – SPS baseline and volunteer sampling sites – Belle Haven watershed.

The Belle Haven watershed is characterized as Watershed Restoration Level II. The primary goal for Restoration Level II watersheds is to prevent further degradation and to implement measures to improve water quality.

The results of the data collected from the one sampling site within the Belle Haven watershed for the SPS Baseline Study are shown in Table 1-15. The location of the site, located on Hunting Creek, is shown on Figure 1-2. 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.

There are no known active monitoring sites in the Belle Haven watershed under the NVSWC program. There was one site for which no data was available.

Table 1-15 - Stream Protection Strategy Baseline Data Summary – Belle Haven

Stream Name (Site Code)	Composite Site Condition Rating	Environmental Variables				Projected Percent Impervious
		Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Current Percent Impervious	
Belle Haven (BEBE01)	Very Poor	Very Poor	Very Poor	Very Low	36.4	50.0

Source: SPS Baseline Study Report, 2001.

1.6.2 Stream Protection Strategy (SPS) and Volunteer Monitoring Results – Dogue Creek

The Dogue Creek WMAs are divided among the three watershed management categories. The majority of the watershed, including all of Piney Run and Barnyard Run WMAs, Dogue Creek Mainstem downstream of Huntley Meadows Park, and the western Potomac WMA is categorized as Watershed Protection Areas. The primary goal for a Watershed Protection Area is to preserve biological integrity by protecting as much as possible the existing conditions responsible for the current higher quality ratings of these streams.

The portion of the Dogue Creek Mainstem WMA upstream of Huntley Meadows Park is characterized as Watershed Restoration Level I. The primary goal for Restoration Level I watersheds is to re-establish healthy biological communities by identifying and improving areas of stream degradation as much as possible.

The North Fork of Dogue Creek WMA is characterized as Watershed Restoration Level II. The primary goal for Restoration Level II watersheds is to prevent further degradation and to implement measures to improve water quality.

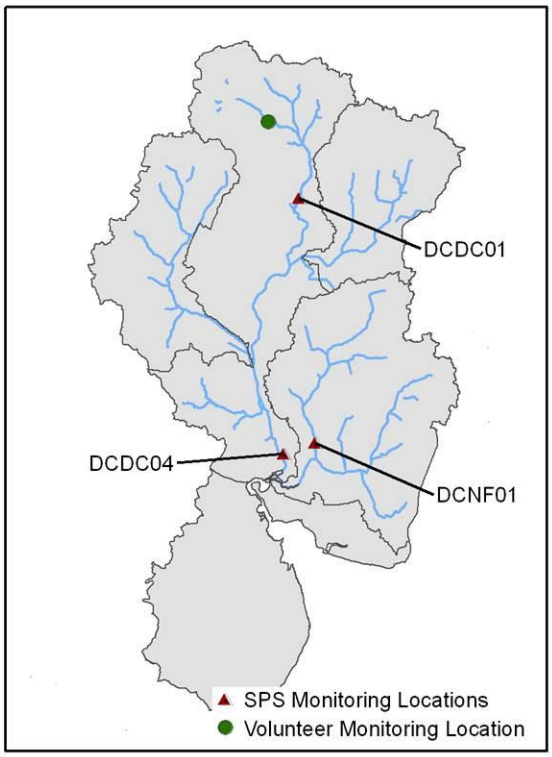


Figure 1-1 – SPS baseline and volunteer sampling sites – Dogue Creek watershed.

The results of the data collected from the three sampling sites within the Dogue Creek watershed for the SPS Baseline Study are shown in Table 1-16 (listed generally upstream to downstream). Locations are shown on Figure 1-1, with SPS monitoring locations labeled. 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 index of biotic integrity scores 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.

There is one NVSWC monitoring site in the Dogue Creek watershed. 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 1-16 - Stream Protection Strategy Baseline Data Summary – Dogue Creek

Stream Name (Site Code)	Composite Site Condition Rating	Environmental Variables				Projected Percent Impervious
		Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Current Percent Impervious	
Dogue Creek 1 (DCDC01)	Good	Good	Fair	High	19.1	36
North Fork 1 (DCNF01)	Poor	Very Poor	Fair	Low	24.3	32
Dogue Creek 2 (DCDC04)	Good	Fair	Fair	Moderate	14.1	26

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

1.6.3 Stream Protection Strategy (SPS) and Volunteer Monitoring Results – Four Mile Run

The Four Mile Run watershed is characterized as Watershed Restoration Level II. The primary goal for Restoration Level II watersheds is to prevent further degradation and to implement measures to improve water quality.

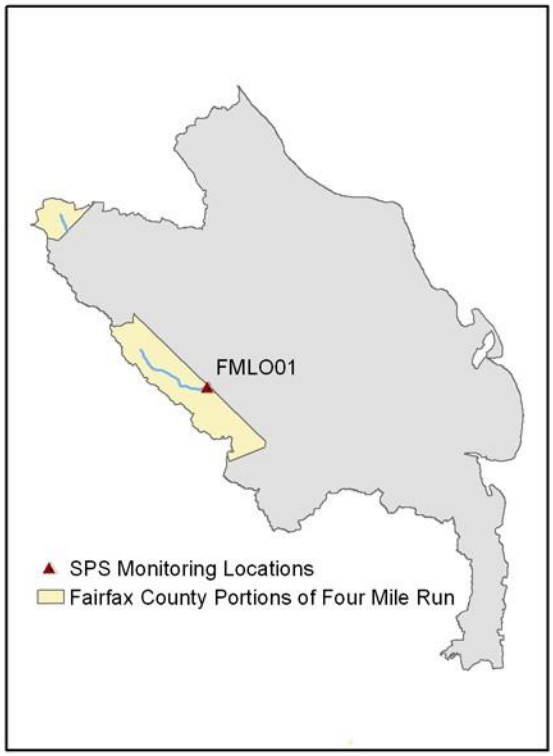


Figure 1-3 – SPS baseline and volunteer sampling sites – Dogue Creek watershed.

The results of the data collected from the single sampling site in the Fairfax County portion of the Four Mile Run watershed for the SPS Baseline Study are shown in Table 1-17. The location of this sampling site is shown on Figure 1-3. 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 1-17 - Stream Protection Strategy Baseline Data Summary – Four Mile Run

Stream Name (Site Code)	Composite Site Condition Rating	Environmental Variables				Projected Percent Impervious
		Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Current Percent Impervious	
Four Mile Run (FMLO01)	Very Poor	Poor	Very Poor	Very Low	43.7	51.0

Source: SPS Baseline Study Report, 2001.

1.6.4 Stream Physical Assessment (SPA)

To supplement the biological and habitat data collected by the Stream Protection Strategy Baseline Study, 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 portions of the Four Mile Run watersheds. The results of the assessment will be used in the watershed planning process to develop management strategies. As part of the SPA, field crews conducted a physical habitat assessment, a geomorphologic assessment and collected infrastructure information for all streams in the watershed with a drainage area greater than 50 acres.

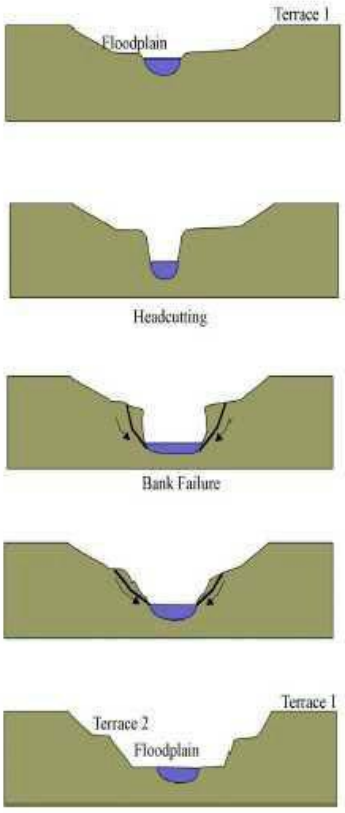
SPA Physical Habitat Assessment Overview

A visual assessment of stream sites, although qualitative, can provide valuable information that may help explain more quantitative data. Field teams collect data for 10 habitat assessment metrics specific to either a high or low gradient stream, corresponding primarily to streams in the piedmont and coastal plain physiographic provinces, respectively. The Belle Haven and Dogue Creek watersheds are in the Coastal Plain province, while the Four Mile Run watershed is divided between the Coastal Plain and the Piedmont provinces. Parameters for both the Coastal Plain and Piedmont provinces assess perceived quality of instream habitat (for both macroinvertebrates and fish), channel morphology (channel alteration, sinuosity and sediment deposition) and riparian bank structure (bank stability and buffer).

SPA Geomorphology Assessment Overview

Stream geomorphology describes how a stream channel adjusts to changes in its watershed. Stream erosion is a natural process which occurs slowly in an undeveloped setting, with the stream forming a dynamically stable channel. The size and shape of the stream channel are dependent on the type of soils, the steepness of the grade and the amount of water that flows into the channel. If one of these conditions is changed, the channel will adjust itself to accommodate the new conditions and find a new stable size and shape. The most significant change that occurs with development in a watershed is an increase in the amount of water flowing in a channel during storm events because of concentrations of flow from impervious surfaces.

The geomorphologic assessment of the stream channels in the Dogue Creek, Belle Haven and Four Mile Run watersheds are based on the Channel Evolution Model (CEM) which gives insight into how stream channels change after a disturbance such as a change in watershed land use. The CEM classifies streams into the five categories shown below in Figure 1-4, and can be useful for predicting future conditions:



Type I – This represents pre-disturbance condition, with well-vegetated streambanks.

Type II – This is the first stage after disturbances to the watershed. The dominant physical process in this stage is bed degradation, with the beginning stages of stream incision (downcutting).

Type III – At this stage bed degradation has led to overly steep banks, and bank failure is common. This stage is the most unstable of all CEM stages. Channel widening is the dominant physical process in a Type III channel.

Type IV – The dominant physical process in a Type IV channel is sediment aggradation. This stage is considered the beginning phase of stream stabilization after disturbance.

Type V – Type V channels are similar to the stream's Type I channel in dimension and capacity. The new channel is lower than the original channel and the original flood limit is now a terrace.

Figure 1-4 - CEM categories

Infrastructure Inventory
The infrastructure inventory conducted by field crews for the 2002 SPA study includes all structures and conditions that may have potential impacts on the stream, such as sources of contamination or pipes, ditches, stream obstructions, dump sites, head cuts, utilities, erosion problem areas, stream crossings and areas of deficient buffer.

1.6.4.1 SPA Summary – Belle Haven

Habitat Assessment. There were two miles of stream assessed in the Belle Haven watershed with all habitat rated as fair to very poor. Based on the length-weighted habitat score, the Belle Haven watershed is the poorest quality watershed in the County.

Geomorphology Assessment. Stream evaluations of the stream channels in the Belle Haven watershed resulted in classifying all channels as Type III, indicating unstable channels with severe bank erosion.

Infrastructure Inventory. There were 38 inventory points collected for the infrastructure inventory of the Belle Haven watershed. 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.

1.6.4.2 SPA Summary – Dogue Creek

Habitat Assessment. Habitat was assessed on approximately 17 of the 32 miles of stream within the Dogue Creek watershed. In comparison with the rest of the County, the Dogue Creek watershed is in the lower range of quality. Of the assessed reaches, 3 miles (9 percent) of stream were rated as good, 9 miles (28 percent) as fair and 5 miles (16 percent) as poor for habitat conditions. There were no reaches rated as excellent.

Geomorphology Assessment. CEM stream channel evaluations resulted in classifying approximately 50 percent of the channels in the Dogue Creek watershed as Type III, indicating unstable stream channels experiencing severe bank erosion. Most of the remainder of the watershed was categorized as Type IV, indicating the stream channels are beginning to recover after disturbance.

Infrastructure Inventory. The infrastructure inventory of the Dogue Creek watershed resulted in 313 inventory points. The most significant problems were four head cuts, three obstructions, two buffer points and one erosion point. These points were all rated as having an extreme impact on the stream system.

1.6.4.3 SPA Summary - Four Mile Run

Habitat Assessment. Habitat was assessed on approximately one mile of stream in the Four Mile Run watershed, the entire length categorized as fair to poor. The majority of the watershed lies outside of Fairfax County jurisdiction and was not assessed. In comparison with the rest of Fairfax County, the Four Mile Run watershed falls in the lower range of quality.

Geomorphology Assessment. Of the one mile assessed in Four Mile Run, 60 percent was categorized as Type IV (recovering after disturbance), with most of the remainder categorized as Type III (actively eroding).

Infrastructure Inventory. There were 34 inventory points collected in the Fairfax County portion of the Four Mile Run watershed. Of these 34 points, none were considered as having more than a moderate impact on the stream system.

1.7 Wetlands

1.7.1 Wetlands – Belle Haven

There are 166 acres of wetlands in the Belle Haven watershed the majority of which are freshwater emergent or forested/shrub wetlands, as shown in Table 1-18. Nine acres are of unknown type and the remaining 14 are associated with stream systems or freshwater impoundments. Wetland areas in the Belle Haven watershed are primarily located in Dyke Marsh along the eastern edge of the watershed and east of the George Washington Memorial Parkway adjacent to the Potomac River.

Table 1-18 - NWI Wetlands by WMA in Belle Haven watershed

WMA	Freshwater Emergent Wetland	Freshwater Forested/ Shrub Wetland	Freshwater Pond	Riverine	Unknown	Total
Belle Haven	74.1	69.3	2.2	11.6	8.9	166.0
Total	74.1	69.3	2.2	11.6	8.9	166.0

1.7.2 Wetlands – Dogue Creek

There are 888 acres of wetlands in the Dogue Creek watershed, according to National Wetland Inventory (NWI) data shown in Table 1-19. Of this, approximately 690 acres are freshwater forested or shrub wetlands, primarily located in Huntley Meadows Park in the Mainstem and Barnyard Run WMAs. These types of wetlands generally lack continuously standing water but are subject to frequent flooding. There are an additional 104 acres of freshwater emergent wetlands, also primarily in the Mainstem and Barnyard Run WMAs. These types of palustrine wetlands are often dry for at least part of the year.

The remaining 83 acres or wetlands are of unknown classification, are associated with stream systems and are heavily influenced by stream flooding or are lacustrine wetlands associated with open water bodies such as lakes, reservoirs and other water impoundments.

Table 1-19 - NWI Wetlands by WMA in Dogue Creek watershed

WMA	Freshwater Emergent Wetland	Freshwater Forested/ Shrub Wetland	Freshwater Pond	Riverine	Unknown / Other	Total
Barnyard Run	43.0	291.3	6.9			341.2
Mainstem	53.0	302.2	32.1		0.9	388.1
North Fork	4.5	47.5	7.9		0.1	60.0
Piney Run	0.7	28.8	17.2		10.7	57.4
Potomac	3.1	20.5	0.4	9.6	7.1	40.8
Total	104.3	690.4	64.5	9.6	8.1	887.5

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. Additional information, including preliminary site plans and historical aerial photos of the wetland, is available at the County's project website: http://www.fairfaxcounty.gov/parks/huntley/restorationproject.htm.

1.7.3 Wetlands – Four Mile Run

As shown in Table 1-20, in the Fairfax County portion of the Four Mile Run watershed, there are two large areas of wetland totaling approximately 5 acres. Three acres are

freshwater forested/shrub wetlands located along Long Branch north of the Crossroads Center Shopping Center. The remaining 2 acres of wetlands are associated with freshwater impoundments.

Table 1-20 - NWI Wetlands by WMA in Four Mile Run watershed

WMA	Freshwater Forested/ Shrub Wetland	Freshwater Pond	Total
Four Mile Run	2.86	2.47	5.32
Total	2.86	2.47	5.32

1.8 Water Quality

The streams of the three watersheds are regulated by water quality standards set by the Virginia State Water Control Board (SWCB). Waters in the Dogue Creek, Belle Haven and Four Mile Run watersheds are designated as Class III waters (Nontidal Waters Coastal and Piedmont Zones), with regulated criteria for dissolved oxygen (4.0 mg/L minimum), pH (6.0 – 9.0), and maximum temperature (32° C/89.6° F). Fecal coliform is also regulated with an allowable geometric mean limit of 200 fecal coliform bacteria per 100 ml of water for two or more samples in a calendar month with no more than 10 percent of monthly samples collected exceeding 400 colonies per 100 ml of water. *Escherichia coli,* a type of fecal coliform bacteria, is also regulated with an allowable geometric mean limit of 126 colonies per 100 ml freshwater sample for two or more samples take during any calendar month, and a single sample maximum of 235 colonies per 100 ml freshwater sample.

Sampling Data – Water quality data is collected through ongoing monitoring conducted by the County and various volunteer organizations. Additionally, the Fairfax Department of Health's Division of Environmental Health has been sampling the waterways throughout Fairfax County since 1969.

Belle Haven Sampling Data. 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 parameters. This includes baseline SPS data as well as data collected after the baseline study was completed.

There are no health department sampling sites in the Belle Haven watershed.

Dogue Creek Sampling Data. Available County data within the Dogue Creek watershed, ranging from July 1999 to September 2006, including SPS Baseline and more recently collected data, indicate one site on Dogue Creek Mainstem and one site along the North Fork with a pH below the acceptable range of 6.0 and one site with a pH below the acceptable range of 6.

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 (7 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.

Four Mile Run Sampling Data. There was only one County data point available for the Four Mile Run watershed. Data at this site was collected during the SPS baseline study in August 1999, with no parameters falling outside of acceptable limits.

There is one health department sampling site in the Four Mile Run watershed. Of the 52 samples collected between 2000 and 2002, neither temperature nor dissolved oxygen exceeded allowable limits and pH fell below criteria limits only once. Fecal coliform samples exceeded the allowable criteria limit for 41 of 54 samples (76 percent), with the maximum value of colonies per 100 mL of water in August of 2001. Although this value is high, it was only reached on one occasion (1 of 54 samples, or 2 percent). In contrast, between 1997 and 2000, this high value was recorded for 32 of 223 total samples (14 percent).

303(d) List and TMDL – Section 303(d) of the Clean Water Act requires the state to identify and report water bodies for which water quality standards are not being met. The list of impaired waters is compiled into the 303(d) Impaired Waters Report (often referred to as the 303(d) List). This report specifically describes the locations of the listed water body and the cause and source of pollutants leading to the impairment. Once a water body is listed as impaired, a plan is developed to restore the water quality. This plan takes into account the total amount of pollution a water body can assimilate, or a total maximum daily load (TMDL), and still meet water quality standards. The restoration plan is often referred to as a TMDL and is accompanied by a target year for restoration. Impaired waters for which a TMDL is required are listed under Category 5 in the Impaired Waters Report.

There are no freshwater stream reaches in Dogue Creek, Belle Haven or the Fairfax County portions of the Four Mile Run watersheds that are listed as impaired (Category 5). Nontidal portions of Four Mile Run outside of Fairfax County are listed as impaired for bacteria and a TMDL was completed for this impairment in 2002.

In 2006, the tidal waters of Dogue Creek extending approximately from approximately rivermile 2.1 to the confluence with the Potomac River and tidal waters of Hunting Creek to which several stream reaches of Belle Haven watershed flow were listed in conjunction with portions of the Potomac River as Category 5 for aquatic plants (macrophytes) with a TMDL schedule of 2010.

1.9 Forests

Forests provide many benefits for aquatic systems. Vegetation and fallen leaves slow overland flow, reducing soil erosion. Nutrients are taken up by vegetation that might otherwise enter the stream system. Streamside forest canopy, or riparian buffers, provide shade and cool the water allowing for a higher dissolved oxygen concentration, which is needed by fish and aquatic macroinvertebrates. Additionally, aquatic habitat depends on the input of woody debris and stream bank root mats. Forest cover is also required for terrestrial fauna. However, various species require forest of a certain size and spatial distribution to provide adequate habitat. Stream corridors and the associated Chesapeake Bay Resource Protection Areas (RPAs), a 100-foot forested riparian buffer

around all perennial streams in the county, provide some connection between forest cover and stream valleys, however upland forest cover does not have direct connectivity in most parts of the watershed.

1.10 Stormwater Management

1.10.1 History of Stormwater Management in Fairfax County

In the early 1900s, the population of Fairfax County was only slightly over 12,000 and development was basically unregulated. Stormwater controls consisted primarily of digging ditches or using pastures to prevent flooding.

By 1964, with the adoption of the first Policy and Guidelines Manual, the main goal of stormwater management was flood prevention. Stormwater management only consisted of maintaining adequate drainage through curb-and-gutter construction leading to concrete pipes or channels, which emptied into the nearest stream. Several large storms, including Hurricane Agnes, occurred during this time creating intense peak flows in receiving streams causing erosion and damage to homes built in the floodplain. Consequently, costly flood control structures were required which prompted the County to set strict limits on new construction within any 100-year floodplain.

During the 1970s, the population of Fairfax County grew to 900,000 residents. The associated development increased runoff and flooding potential downstream. During this time, stormwater detention, with the primary focus of controlling water quantity, began to be implemented to reduce peak flows downstream. In 1976, Fairfax County became one of the first jurisdictions in the U.S. to adopt stormwater management as a development requirement when it was required by the Army Corps of Engineers as part of their agreement for flood control improvements in the Four Mile Run watershed. The regulations were extended to manage stormwater quality in 1993. These “best management practices,” or BMPs, are used to reduce or even prevent the discharge of pollutants into waters downstream of the BMP. BMPs can be either structural (such as ponds, designed wetlands or bioretention facilities) or non-structural (such as public education, preserving open space and managing development). See Table 1-21 for BMP treatment types by WMA.

Table 1-21 - BMP Treatment Types

WMA	Current Treatment Types		
	Quantity (acres)	Quality (acres)	Quantity Qualit (acres
Belle Haven	798		1
Belle Haven Total	**798**		**1**
Dogue - Barnyard Run	762		3
Dogue - Mainstem	1,599		1,45
Dogue - North Fork	1,255		27
Dogue - Potomac	3,350		74
Dogue - Piney Run	110		
Dogue Creek Total	**7,076**		**2,50**
BMP Data not available for Four Mile Run watershed			

1.10.2 Chesapeake Bay Preservation Ordinance

In 1993, 100-foot buffers around perennial stream corridors were designated as Resource Protection Areas (RPAs) and the rest of the County was designed as a Resource Management Area (RMA). These designations governed the type and amount of new development and redevelopment that could occur in the environmentally sensitive areas of the County.

1.10.3 Flooding and Drainage Complaints

A total of 254 complaints were received by the Maintenance and Stormwater Management Division throughout the Dogue Creek watershed, 71 in the Belle Haven watershed and 55 in Four Mile Run.

Complaints were organized into eight categories. Some of the comments that were received contained several different complaints, so it is possible for one comment to be placed into more than one category. The eight categories include: erosion, house flooding, road flooding, yard flooding, miscellaneous flooding, blockage/clog, cave-in/sink hole and other. Drainage complaints for the Dogue Creek, Belle Haven and Four Mile Run watersheds are broken down and summarized in Table 1-22.

Table 1-22 - Summary of Drainage Complaints

	Belle Haven		Dogue Creek		Four Mile Run	
Category	Total Complaints	Percentage	Total Complaints	Percentage	Total Complaints	Percentage
Erosion	1	1	3	1	0	0
House Flooding	14	20	37	15	14	25
Road Flooding	0	0	3	1	2	4
Yard Flooding	27	38	104	41	15	27
Miscellaneous Flooding	25	35	67	26	18	33
Blockage/Clog	4	6	35	14	3	5
Cave In/Sink Hole	0	0	1	0	3	5
Other	0	0	4	2	0	0
Total	**71**	**100**	**254**	**100**	**55**	**100**

The miscellaneous flooding category includes those comments regarding standing water, overflows and flooding which were not designated as a specific type (i.e. house, road or yard). The other category includes those complaints such as lost items in the storm drain, maintenance or repair needs or requests for more information.

As shown in Table 1-22, the majority of the complaints across all watersheds were regarding house, yard or miscellaneous flooding. Blocked or clogged inlets were the next most numerous type of complaint.

2 Watershed Management Area Characterization

All maps for Chapter 2 are attached as an Appendix to this document.

2.1 Introduction

Three levels of watershed management units have been used for this plan. The first level is the watershed, a land area typically from 10 to 100 square miles. The watersheds represented in this plan are the drainage areas for Dogue Creek, Belle Haven and Four Mile Run. Statewide water quality monitoring and management is focused at the watershed level.

The next smaller management unit for this plan is the Watershed Management Area (WMA). WMAs are areas of about one to 10 square miles, made up of one or more tributaries that drain parts of the watershed. Several of the larger tributaries of the Dogue Creek watershed have been defined as WMAs, including Barnyard Run tributary, Mainstem, North Fork, Piney Run and Potomac. Belle Haven watershed, adjacent to the Potomac River, is approximately 2.7 square miles with most streams draining directly to the Potomac and therefore was not further subdivided into WMAs. The Four Mile Run watershed was also not subdivided into WMAs. This large watershed lies primarily outside of Fairfax County with only three square miles inside the County borders.

Planning at the WMA level focuses on the condition of the tributary streams, including habitat for fish and other aquatic life. These management units are small enough that they are usually within one or two political jurisdictions so that regulatory authority to implement management measures is less complex. They also tend to be more uniform in relation to land use and pollutant sources, so that identification of problems and solutions is also less complex.

The most detailed level of management units for this plan is the subwatershed, areas of 100 to 300 acres. They are the smallest drainage areas and are modeled to estimate flows and pollutant loads. Subwatershed analysis is used to pinpoint areas within a WMA where stormwater retrofits or other management measures should be investigated.

2.1.1 Field Reconnaissance

Field reconnaissance was conducted to update and supplement existing Fairfax County geographic data so current field conditions were accurately represented. Once this data was acquired, spatial analysis was performed to characterize County watersheds as they currently exist using the County's GIS. The reconnaissance effort included the identification of pollution sources, current stormwater management and potential restoration opportunities across the various watersheds.

Neighborhood Source Assessment. The Neighborhood Source Assessment was conducted as part of the Unified Subwatershed and Site Reconnaissance (USSR), the purpose of which is to evaluate the pollution-producing behaviors in residential areas to help target education messages and voluntary stewardship programs. A subsample of neighborhoods within the watershed was assessed to provide representative coverage of existing residential areas. Field crews drove through each neighborhood to get a sense of its general characteristics, such as the location of downspout drainage, turf management status, curb and gutter condition and the amount of forest canopy. Where needed, the pre-identified neighborhood was split into multiple neighborhoods when one

portion of the neighborhood had significantly different characteristics (e.g., larger lawns, less forest canopy, etc.).

Hotspot Site Investigation. The Hotspot Site Investigation was conducted to evaluate the pollution-producing behaviors at commercial hotspots (e.g., gas stations, restaurants, industrial areas, etc.) to help target education messages and voluntary stewardship programs. The goal was to quickly identify areas where stormwater pollution is generated and identify ways to mitigate it. A subsample of potential hotspots within the watershed was assessed to provide representative coverage. At each hotspot, field crews evaluated various site activities, including vehicle operations, outdoor material storage, waste management, condition of the building, parking, and landscaped areas, and stormwater infrastructure. Due to the high number of sites visited, field crews completed the HSI form for only those sites that were found to have significant, solvable problems. Generally, recommendations for these sites fall into watershed-wide, non-structural recommendations such as better dumpster management and outdoor storage practices.

2.1.2 Existing Watershed Modeling

Storm events are classified by the amount of rainfall, in inches, that occurs over the duration of a storm. 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 two-year, 24-hour storm (having a 50 percent chance of happening in a given year) has less rainfall than a 10-year, 24-hour 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 ultimately is 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 the resulting pollution, such as nutrients (nitrogen and phosphorus) and sediment that are transported by the runoff.

- Hydraulic models represent the effect of stormwater runoff from a particular rainfall event on both man-made and natural systems. These models can predict both the ability of man-made culverts/channels to convey stormwater runoff and the spatial extent of potential flooding.

Table 2-1 below shows three storm events and the rationale for modeling.

Table 2-1 - Storm Event Modeling Rationale

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

Hydrologic Modeling. Hydrologic modeling was performed using the EPA Storm Water Management Model, version 5. At the time of this writing, model results were preliminary and a final calibrated model had not been developed.

Water Quality Modeling. Water quality modeling consisted of estimating pollutant loads from each subwatershed with STEPL, a spreadsheet model. The model estimates loads for total nitrogen (TN), total phosphorus (TP), biological oxygen demand (BOD) and total suspended solids (TSS).

Results of the water quality modeling are shown on Maps 8-16, attached and discussed at the subwatershed level in the following sections describing each WMA in more detail.

Hydraulic Modeling. Hydraulic modeling for the project was conducted using the HEC-RAS program developed by the Corps of Engineers. As of this writing, results of the modeling are preliminary and are not included.

2.1.3 WMA and Subwatershed Ranking

The purpose of the ranking approach is to provide a systematic means of compiling available water quality and natural resources information. Ranking WMAs and subwatersheds based on watershed characterization and modeling results provides a tool for planners and managers to use as they consider which areas should undergo further study and set priorities. The ranking will be updated based on issues and problem areas identified during the Introductory and Issues Scoping forum and advisory group meetings. The resulting data will be utilized to identify key issues and proceed with projects that will achieve the county's watershed management goals and objectives.

Three basic indicator categories are used to rank subwatershed conditions as shown in Table 2-2.

Table 2-2 - Indicator Categories used in Subwatershed Ranking

Indicator Type	Description
Watershed Impact	Diagnostic measures of environmental condition (e.g. water quality, habitat health, biotic integrity) which are linked to the county's goals and objectives
Programmatic	Reports the existence, location or benefits of stormwater management facilities or programs
Source	Quantifies the presence of stressors and/or pollutant sources

These indicators are combined to generate composite scores which are used in the prioritization and subwatershed ranking process.

2.2 Belle Haven Watershed

2.2.1 General Characteristics

The Belle Haven watershed includes the Belle Haven Estuary and two main tributaries: Spring Bank Tributary and Eastern Tributary.

The streams within the Belle Haven WMA extend for approximately 2.9 miles. Of this, approximately 1.75 miles were not assessed because they have been piped or channelized. All of the assessed streams within the Belle Haven WMA were categorized as CEM Type III riffle/run streams with moderate to high slopes in very poor condition. The dominant substrate in this WMA was sand.

2.2.2 Field Reconnaissance

In the Belle Haven WMA field crews conducted seven Hotspot Site Investigations and assessed nine neighborhoods to determine potential runoff pollution sources and identify potential treatment practices. The results of these assessments are discussed below.

Hotspot Site Investigations
Field crews assessed the Belle View Shopping Center, located at the northeast corner of Belle View Boulevard and Fort Hunt Road. The commercial site did not include any vehicle operations, outdoor material handling, or turf landscaping, so it was assessed for waste management and physical plant. Dumpsters and garbage handling were acceptable, and there was no evidence of leakage entering the storm drain system. While the parking lot appeared to be recently paved, portions of the paved areas in the back were beginning to break up. Only minor sediment and organic accumulation was noted in the gutters. The center was rated not a hotspot.

A strip mall on the northeast corner of Richmond Highway and Kings Highway was assessed for hotspot potential. Recently built in 1980, the mall's land use was commercial, with only waste management and physical plant sources. Of these, waste management measures were good. Buildings and parking lots were clean and no stains leading to storm drains were observed. The area was rated not a hotspot.

A largely abandoned commercial site east of the intersection of Richmond Highway and Kings Highway was assessed. The only current tenant is Chuck E. Cheese. No vehicle operations, outdoor materials, or turf landscaping was evident. Waste management consisted of dumpsters with no lid. The building showed stains and the parking lot was breaking up in places. One storm drain inlet was seen with considerable accumulation of sediment, organic material, and litter in the area upstream. There was also considerable litter on the edges of the property. The site was rated as a potential hotspot.

An assessment was made of two car dealerships at the northern end of the watershed in the 5900 block of Richmond Highway. Vehicle operations included storage, maintenance, and repair of vehicles. There was no evidence of any activity other than storage outside. No fueling areas, vehicle washing or evidence of spills were seen. One dealership had what appeared to be temporary storage of closed drums of materials outside uncovered. Containers were in good condition, although there was some staining visible in the vicinity. Waste management, turf landscaping, and the physical plant were not rated as potential pollutant sources. The site was rated not a hotspot.

Belle Haven Marina, the only VPDES permittee in the Belle Haven watershed, was assessed for hotspot status. There were no vehicle operations or material storage sources on the site. Waste management was acceptable, with no issues with dumpsters or litter. The physical plant showed signs of stains, dirt and general wear. Drainage from the entire site is direct to the Potomac River. Parking areas were gravel. Landscaped areas made up about 10 percent of the site. Half of this was turf and half was bare soil. No stormwater treatment was observed. Signs were posted describing procedures for handling hazardous material, and signs identifying the location of the oil spill cleanup kit. The site was rated a potential hotspot.

Neighborhood Source Assessments

Westgrove is a single-family development 50 to 60 years old located between Wake Forest Drive and Westgrove Boulevard. Villamay, just to the south and built in the1960s, was assessed at the same time. The neighborhoods were about 30 percent impervious, with 10 to 15 percent tree canopy. No pollution indicators were present. Sidewalks and curbs were clean with the exception of a minor amount of tree litter. There was no evidence of dumping, litter, sediment, or oil and grease. Storm drain inlets were clear of obstructions; however, they had not been stenciled. Villamay appeared to have a significant number of high-maintenance lawns. No stormwater treatment was observed in the field.

New Alexandria, immediately north of Belle View Shopping Center, consists of medium density single-family detached housing on small lots, built in the 1940s. The area was about 35 percent impervious, with the remainder of the lots covered with low- or medium-maintenance turf. About 15 percent of the area was covered by tree canopy. Most parking was on-street. Of the driveways, about 20 percent were gravel and the rest paved. Most of the streets were drained by grass channels rather than curb and gutter; these were in good condition. There was no sign of dumping, litter or sediment deposition. Less than 5 percent of the area was undergoing redevelopment. No pollution indicators were identified.

Belle View Condos, south of the Belle View Shopping Center, is made up of two- to three-story multifamily units built in the 1950s. No redevelopment was observed. The neighborhood is approximately 40 percent impervious, with the remainder in turf. About 10 percent of the neighborhood was covered with tree canopy. No pollution indicators were identified. There was no evidence of litter, dumping, or oil stains; only minor amounts of organic matter were seen in gutters. Stream channels through the area lacked buffers. There is good potential for onsite SWM and parking lot retrofits.

Belle Haven Meadows is a single-family detached subdivision built in 1989-1990 on approximately one-quarter-acre lots, estimated at 40 percent impervious with most of the remainder in turf and about 5 percent landscaped areas. Sidewalks, curb, and gutter were clean and dry and there was no evidence of litter or dumping. Storm drain inlets were also clean. No pollution indicators were found.

Temple View subdivision, west of West Potomac High School was assessed. The neighborhood consists of single-family detached housing on approximately one-quarter-acre lots, built in the 1940s and 1950s. The area is about 35 percent impervious, with about 60 percent in turf which appeared to be low- or medium-maintenance. A small area, less than 5 percent, was bare soil. No sidewalks were present: streets are drained by grass channels and roadside ditches which combine to flow between properties to

drain the neighborhood. There was evidence of infill development and remodeling. About half of the driveways were gravel and half were paved. No litter or trash was observed in yards. Because of the construction activity, unpaved driveways, and open section drainage, this neighborhood showed potential for sediment pollution. There is, however, good potential for onsite retrofits of the drainage system to dry or wet swales.

Belle Haven Towers, adjacent to Richmond Highway, is a high-rise apartment complex built in the 1960s and 1970s. It was estimated to be 85 percent impervious, with about 12 percent covered in turf and 3 percent in landscaped areas. Tree canopy was minimal. All parking areas were 100 percent impervious, and bordered with curb and gutter, which contained a minor amount of leaves organic matter. Despite the long-term car parking, the parking area showed little evidence of oil and grease stains. Storm drain inlets were clean and free of obstructions. The area is not a source of runoff pollution.

The Belle Haven neighborhood, extending south and west of the intersection of Richmond Highway and Fort Hunt Road, appears to have been built in two phases. The northeastern section consists of lots built from the 1920s to the present, while the southwestern section is more uniform, with most lots built in the 1950s. The area is undergoing infill redevelopment, with approximately 10 to 20 percent of the lots showing signs of reconstruction. The original lots are approximately 35 percent impervious; with 55 percent turf and 10 percent landscaped areas. The neighborhood is wooded with about 20 percent tree canopy. Streets are drained with curb, gutter, and storm drains. Curbs contained minor amounts of organic matter and inlets were clean. There was no evidence of litter or dumping. Other than potential construction sediment from infill development, the Belle Haven area is not a source of pollution.

2.2.3 Land Use

The Belle Haven WMA is characterized as 25 percent medium-density residential land use, 21 percent open space, parks and recreation areas, and 18 percent transportation. A summary of the land use within the WMA is shown in Table 2-3 and on Map 5.

Table 2-3 - Belle Haven Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open Space, Parks, and Recreational Areas	359.5	20.7	313.1	18.0	-46.4	-12.9
Golf Course	151.0	8.7	150.6	8.7	-0.4	-0.3
Estate Residential	9.9	0.6	2.9	0.2	-7.0	-70.7
Low-Density Residential	72.2	4.2	42.3	2.4	-29.9	-41.4
Medium-Density Residential	434.7	25.0	499.1	28.7	64.4	14.8
High-Density Residential	190.1	10.9	190.9	11.0	0.8	0.4
Low-Intensity Commercial	26.2	1.5	19.3	1.1	-6.9	-26.3
High-Intensity Commercial	87.2	5.0	113.1	6.5	25.9	29.7
Industrial	24.0	1.4	24.0	1.4	0.0	0.0
Institutional	58.2	3.4	57.7	3.3	-0.5	-0.9
Transportation	311.3	17.9	311.3	17.9	0.0	0.0
Water	13.0	0.7	13.0	0.7	0.0	0.0
Total	**1,737.3**	**100.0**	**1,737.3**	**100.0**	**0.0**	**0.0**

Total impervious area for the WMA is approximately 552 acres, or 32 percent of the total WMA area of 1,737 acres.

2.2.4 Stormwater Infrastructure

Stormwater Management
County records indicate that there are 20 stormwater management facilities within the Belle Haven WMA. These facilities provide control for 5 percent of the WMA. There are no existing or planned regional ponds in the WMA. Five percent of the total area has quantity control only and the remaining 2 percent receives only quality control. Stormwater infrastructure is shown on Map 17.

2.2.5 Stream Condition

Stream conditions for this WMA are shown on Map 18.

Erosion
There was a total of 1,800 linear feet of erosion on both the right and left stream banks identified in the WMA at three specific erosion locations. These erosion sites had low restoration potential.

Outfall Impacts
As part of the Stream Physical Assessment, 10 outfall pipes were located in the Belle Haven WMA. All were within 50 feet of the channel and ranged in size from 18 to 96 inches. None of the pipes were identified as causing erosion.

Stream Crossings
During the Stream Physical Assessment, five stream crossings were identified in the Belle Haven WMA. None of the crossings were having a significant impact on stream condition or causing any type of erosion.

Obstructions
There are two obstruction sites located in the Belle Haven WMA, both of which are debris. Neither of these obstruction sites is thought to be impacting fish movement within the stream.

Stream Buffers
The areas of deficient stream buffer in the Belle Haven WMA are a mix of lawn and pavement. There were 11 deficient buffer points. Three of the buffer encroachments were rated as severe.

Habitat
Of the assessed stream reaches within the WMA, 2,393 feet (36 percent) were classified as fair, 889 feet (13 percent) as poor and 3,416 feet (51 percent) as very poor.

None of the assessed streams were classified as optimal. All of the streams were classified as marginal for epifaunal substrate and channel flow status, drought and normal flow. Most of the streams were classified as poor for bank protection and vegetative buffer zone width.

2.2.6 WMA Modeling

Three subwatersheds on the northern end of the WMA (BE-BH-0010, BE-HC-0020, and BE-HC-0025) show the highest modeled pollutant loads, based primarily on medium and high-density residential development. The best quality subwatershed (BE-BH-0005) is on the southeast side of the WMA, containing open space. See Table 2-4 for results.

Table 2-4 - Belle Haven Water Quality Modeling Results

	Pollutant Loading		
	TN	TP	TSS
Subwatershed	lb/ac/yr	lb/ac/yr	t/ac/yr
BE-BH-0000	2.6	0.5	0.09
BE-BH-0005	5.5	0.8	0.13
BE-BH-0010	9.0	1.4	0.21
BE-BH-0015	6.2	1.0	0.14
BE-HC-0000	4.2	0.7	0.11
BE-HC-0005	0.6	0.2	0.05
BE-HC-0010	7.1	1.1	0.16
BE-HC-0015	5.6	0.9	0.13
BE-HC-0020	8.9	1.2	0.19
BE-HC-0025	10.8	1.6	0.24
BE-PO-0000	5.5	0.9	0.16
BE-PO-0005	6.7	1.1	0.16

2.2.7 Corps of Engineers Flood Analysis

In 2008, the US Army Corps of Engineers completed a Flood Damage Reduction Analysis study to examine various alternatives to reduce flooding in the Belle Haven watershed. The Corps performed a preliminary investigation and 5 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 with a top of protection to elevation 12 feet.

2.3 Dogue Creek Watershed – Barnyard Run WMA

2.3.1 General Characteristics

The streams within the Barnyard Run WMA extend for approximately 5.26 miles. Of this, approximately 4.7 miles (90 percent) were not assessed because they were classified as wetlands. Of the assessed streams within the Barnyard Run WMA, 2,271 linear feet were categorized in the CEM as Type II Channels in fair condition with silt substrate. Approximately 843 linear feet were categorized as Type III Channels in poor condition with sand substrate. All of the streams surveyed were characterized as glide/pool prevalent streams in low to moderate gradient landscapes.

2.3.2 Field Reconnaissance

The Barnyard Run WMA is primarily forested. There were no hotspots or neighborhoods identified during the initial GIS desktop analysis that required further investigation.

2.3.3 Land Use

The Barnyard Run WMA is characterized by open space, parks, and recreational areas, which make up 60 percent of the WMA. Residential land uses make up approximately 25 percent of the total with 16 percent in medium-density residential use. A summary of the land use within the WMA is shown in Table 2-5 and on Map 19, attached.

Table 2-5 - Barnyard Run Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open Space, Parks, and Recreational Areas	917.1	60.0	912.7	59.7	-4.4	<1
Golf Course	0.0	0.0	0.0	0.0	0	0
Estate Residential	11.2	<1	6.0	<1	-5.2	-46.4
Low-Density Residential	19.2	1.3	18.2	1.2	-1	-5.2
Medium-Density Residential	236.8	15.5	245.3	16.0	8.5	3.6
High-Density Residential	113.1	7.4	113.5	7.4	0.4	<1
Low-Intensity Commercial	0.8	<1	0.8	<1	0	0
High-Intensity Commercial	0.0	0.0	0.0	0.0	0	0
Industrial	6.3	<1	6.3	<1	0	0
Institutional	24.7	1.6	26.4	1.7	1.7	6.9
Transportation	77.6	5.1	77.6	5.1	0	0
Water	121.9	8.0	121.9	8.0	0	0
Total	**1,528.7**	**100.0**	**1,528.7**	**100.0**	**0**	**0**

Total impervious area for the WMA is approximately 194 acres, or 13 percent of the total WMA area of 1,529 acres.

2.3.4 Stormwater Infrastructure

Stormwater Management
County records indicate that there are eight stormwater management facilities within the Barnyard Run WMA. These facilities provide control for 15 percent of the WMA. Additionally, there are two existing regional ponds in the WMA. Stormwater infrastructure is shown on Map 20.

2.3.5 Stream Condition

Stream conditions for this WMA are shown on Map 21.

Erosion
There was a total of 400 linear feet of erosion on the outer bends of the stream bank identified in the WMA at one specific location. This site had moderate restoration potential.

Outfall Impacts
As part of the Physical Stream Assessment, eight outfall pipes were located in the Barnyard Run WMA. All were within 100 feet of the channel and ranged in size from 12 to 48 inches. None of the pipes were identified as causing major erosion.

Stream Crossings
During the Stream Physical Assessment, four stream crossings were identified in the Barnyard Run WMA. None of the crossings were having a significant impact on stream condition or causing any notable erosion.

Obstructions
There are two obstruction sites located in the Barnyard Run WMA, both of which are trees, debris and sediment. Neither of these obstruction sites is thought to be impacting fish movement within the stream.

Stream Buffers
All of the stream buffer encroachments in the Barnyard Run watershed are lawn. There were eight deficient buffer points all of which were severely impacting the stream.

Habitat
Of the assessed stream reaches within the WMA, 2,271 feet (73 percent) were classified as fair habitat for aquatic life and 843 feet (27 percent) as poor. Of the assessed streams, 50 percent were classified as optimal for channel alternation. All of the streams were classified as poor for bank vegetative protection and vegetative buffer zone width.

2.3.6 WMA Modeling

Three subwatersheds on the northern end of the WMA (DC-BY-0030, DC-BY-0035 and DC-BY-0040) show the highest modeled pollutant loads, based primarily on medium and high-density residential development. The best quality subwatersheds (DC-BY-0000 and DC-BY-0010) are at the center and south end of the WMA, containing open space. See Table 2-6 for results.

Table 2-6 - Barnyard Run Water Quality Modeling Results

	Pollutant Loading		
	TN	TP	TSS
Subwatershed	lb/ac/yr	lb/ac/yr	t/ac/yr
DC-BY-0000	0.8	0.1	0.03
DC-BY-0005	1.0	0.1	0.03
DC-BY-0010	0.4	0.1	0.03
DC-BY-0015	3.7	0.6	0.09
DC-BY-0020	0.9	0.1	0.03
DC-BY-0025	1.2	0.2	0.05
DC-BY-0030	7.7	1.1	0.15
DC-BY-0035	7.1	1.1	0.15
DC-BY-0040	5.4	0.8	0.12
DC-BY-0045	2.0	0.3	0.06

2.4 Dogue Creek Watershed – Mainstem WMA

2.4.1 General Characteristics

The streams within the Dogue Creek Mainstem WMA extend for approximately 10.4 miles. Of this, approximately 5.7 miles were not assessed. Of the assessed streams, 1,521 linear feet were categorized in the CEM as Type II channels in fair to good condition with sand and gravel substrate. Approximately 2.2 stream miles were categorized as CEM Type III channels in poor condition with sand, silt, and gravel substrate. Another 2.2 stream miles were categorized as CEM Type IV channels in fair condition with sand and gravel substrate. All of the streams surveyed within this WMA were characterized as glide/pool prevalent streams in low to moderate gradient landscapes.

2.4.2 Field Reconnaissance

In the Dogue Creek Mainstem WMA field crews conducted 10 Hotspot Site Investigations and assessed 2 neighborhoods to determine potential runoff pollution sources and identify treatment practices. Additionally, a neighborhood in the Potomac WMA adjacent to the Mainstem WMA was assessed. The results of these assessments are discussed below.

Hotspot Site Investigations
The Woodley Shopping Center had garbage dumpsters that were located near a storm drain without runoff diversion or secondary containment. Downspouts drain to the paved parking lot, which was clean at the time of inspection. A small amount of landscaping was present and accumulating organic matter on the nearby impervious surfaces that drained toward a stormwater inlet. Stormwater treatment practices were not apparent. This shopping plaza was classified as a potential hotspot.

A trailer dealership located near the intersection of Old Mill Road and Richmond Highway had a clean gravel parking lot and approximately 80 percent of low maintenance turf grass landscaping. No stormwater treatment practices were found. This site was not classified as a hotspot.

A hotspot containing a school, shopping plaza, 7-Eleven, auto center and two gas stations was investigated at the intersection of Richmond Highway and Mount Vernon Memorial Highway. Several vehicles were observed being maintained and repaired outside without runoff diversion methods. Fueling areas where found to be uncovered and directly connected to storm drains. Garbage dumpsters were in good condition, but drained toward storm drain inlets. Downspouts drained to either a clean paved parking or they were directly connected to the storm drain system. Approximately three percent of the site had some sort of landscaping that drained toward a storm drain. No stormwater treatment was present. This site was identified as a confirmed hotspot.

The Pear Tree Village Shopping Center locate at 8751 Richmond Highway was comprised of shops, apartments, a hotel and a restaurant with clean exteriors. Garbage dumpsters were observed to be in good condition or behind locked gates with no runoff diversion methods or secondary containment. Downspout drainage was discharging to both pervious and impervious surfaces throughout the site, in addition to being directly connected to the storm drain system in a few cases. A small amount of landscaping comprised of trees and turf grass with moderate upkeep drained toward storm drain

inlets and accounted for organic matter build up on impervious surfaces. This site was classified as a potential hotspot.

At the Kingstowne Shopping Center located at 5870 Kingstowne Center loading and unloading operations were present, but did not drain towards a storm drain. Landscaping areas were minimal and were primarily comprised of turf grass; these areas did drain to the storm drain system. A wet pond across the street from the shopping center treats the stormwater drainage from this site. This site was not classified as a hotspot

A shopping center located on Sir Viceroy Drive was identified as a potential hotspot. Onsite waste included both garbage and construction materials. Dumpsters were in poor condition and evidence of leaking was noted. Secondary containment or runoff diversion methods were not found. The paved parking lot was stained and downspouts were connected directly to storm drains. Maintained turf grass comprised approximately 10 percent of the site, and non-target irrigation that drained directly toward the storm drain system was noted. There were also leaking grease traps behind Wal-Mart observed during the time of the investigation. A small stormwater detention facility was present.

The Ruby Tuesday restaurant located at 6601 South Van Dorn Street, had garbage dumpsters that were in extremely poor condition. The dumpster was observed to be damaged, leaking, lacking cover and overflowing with signs of staining and discoloration on the storage area. Maintained turf grass areas drained toward the storm drain system. This site was classified as a potential hotspot.

Little Acorn Patch, a children's learning center located at 5801 Castlewellan Drive was a well-kept institutional facility with good waste management practices. Approximately 10 percent of the site was landscaped. These areas were observed accumulating organic matter on adjacent impervious surfaces that were by drained to a storm water inlet. This site was classified as a potential hotspot.

At The Hayfield Center located at 7566 Telegraph Road, loading and unloading operations were present, but did not drain toward storm drain inlets. Garbage dumpsters were in good condition, however, other storage containers were not. Landscaping was at a minimum and drained directly to storm drain inlets. Not stormwater treatment practices were found. This site was classified as a potential hotspot.

At KLNB Incorporated, located at the Shops at Telegraph on Telegraph Road, waste material was primarily composed of garbage that was stored appropriately in dumpsters with runoff diversion curbs. Landscaping was at a minimum and drained directly to storm drain inlets. No stormwater treatment practices were found. This site was not classified as a hotspot.

Neighborhood Source Assessments

Kingstowne Residential is a single-family development approximately 10 years old located along Greendale Village Drive, Castle Bar Lane, Castle Bar Court, Clonmel Court, Donegan Court, Trumpington Court, Green Glen Court and Green Glen Lane with less than one-quarter-acre lots. In this neighborhood there is approximately 65 percent impervious, 20 percent grass, 10 percent landscaping, 5 percent bare soil and 5 percent tree canopy. There was no dumping or trash present, and the sidewalks and curbs and gutters were clean. Storm drains were present, but not stenciled. Although the age of the development requires it, no stormwater treatment was observed in the field.

A multifamily dwelling approximately 15 years in age located on Castwellan Drive, Ballycastle Circle, Jowett Court, Castlefin Way, Dunman Way, Dustinable Lane, and Warren Point Court was evaluated. This complex was comprised of approximately 70 percent impervious, 20 percent grass, 5 percent landscaping, 5 percent bare soil, and 10 percent tree canopy. Sidewalks, curbs and gutters and storm drain inlets were present, and all appeared clean and dry. Storm drain inlets were not stenciled but were clean and free of obstructions. Open space was observed, but no stormwater treatment was evident.

A neighborhood in the Potomac WMA containing detached single family homes on one-half to three-quarter acre lots was located along Lynnhall Place, Kimberly Court, and Neitzey Place. Moderate infill and redevelopment was evident and approximately 40 percent of the neighborhood was characterized by grass cover. Downspout discharge to both pervious and impervious surfaces was approximately 50 percent. There were no sidewalks, curb and gutter or storm drain inlets present. No stormwater facilities were found.

2.4.3 Land Use

The Dogue Creek Mainstem is characterized as 40 percent open space, parks and recreation areas, 12 percent medium-density residential and 12 percent institutional. A summary of the land use within the WMA is shown in Table 2-7 and on Map 22.

Table 2-7 - Dogue Creek Mainstem Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open Space, Parks, and Recreational Areas	1,533.6	40.6	1,427.9	37.8	-105.7	-6.9
Golf Course	155.5	4.1	155.5	4.1	0.0	0.0
Estate Residential	55.6	1.5	25.9	<1	-29.7	-53.4
Low-Density Residential	104.7	2.8	115.1	3.0	10.4	9.9
Medium-Density Residential	462.7	12.3	569.0	15.1	106.3	23.0
High-Density Residential	357.7	9.5	360.7	9.6	3.0	<1
Low-Intensity Commercial	44.3	1.2	51.8	1.4	7.5	16.9
High-Intensity Commercial	131.3	3.5	156.9	4.2	25.6	19.5
Industrial	19.8	<1	7.0	<1	-12.8	-64.6
Institutional	447.2	11.8	442.6	11.7	-4.6	-1.0
Transportation	278.3	7.4	278.3	7.4	0.0	0.0
Water	185.1	4.9	185.1	4.9	0.0	0.0
Total	**3,775.8**	**100.0**	**3,775.8**	**100.0**	**0.0**	**0.0**

Total impervious area for the WMA is approximately 784 acres, or 21 percent of the total WMA area of 3,776 acres.

2.4.4 Stormwater Infrastructure

Stormwater Management
County records indicate that there are 51 stormwater management facilities within the Dogue Creek Mainstem WMA. These facilities provide control for 31 percent of the WMA. There are three existing and no planned regional ponds in the WMA. Stormwater infrastructure is shown on Map 20.

2.4.5 Stream Condition

Stream conditions for this WMA are shown on Map 21.

Erosion
There was a total of 3,300 linear feet of erosion on both the right and left stream banks identified in the WMA at eight specific erosion locations. These erosion sites had moderate restoration potential.

Outfall Impacts
As part of the Stream Physical Assessment, 15 outfall pipes were located in the Dogue Creek Mainstem WMA. All were within 100 feet of the channel and ranged in size from 12 to 72 inches. None of the pipes were identified as causing major erosion.

Stream Crossings
During the Stream Physical Assessment, 25 stream crossings were identified in the Dogue Creek Mainstem WMA. One circular pipe stream crossing was having a moderate impact on stream condition. This crossing does not pose an immediate threat to the roadway or other structures.

Obstructions
There are two obstruction sites located in the Dogue Creek Mainstem WMA, both of which are made up of trees, debris and sediment. One of these obstruction sites is thought to be impacting fish movement within the stream.

Stream Buffers
Most of the stream buffer encroachments in the Mainstem WMA are lawns, although a few have pavement buffering the stream. There were 23 deficient buffer points; 19 of these are severely impacting the stream.

Habitat
Of the assessed stream reaches within the WMA, 303 feet (one percent) was classified as good, 3.5 miles (74 percent) as fair, one mile (22 percent) as poor, and 700 feet (3 percent) as very poor.

Of the assessed streams, 23 percent were classified as optimal for bottom substrate and 45 percent as optimal for pool substrate characterization. Eighty-four percent of the streams were classified as poor for bank vegetative protection. The majority of streams were also classified as poor for bank stability and vegetative buffer zone width.

2.4.6 WMA Modeling

Four subwatersheds on the northern end of the WMA (DC-DC-0075, DC-DC-0085, DC-DC-0005 and DC-DC-0110) show the highest modeled pollutant loads, based primarily on medium and high-density residential development. The best quality subwatersheds

(DC-DC-0020 and DC-DC-0030) are on the southwest side of the WMA, containing open space and institutional development. See Table 2-8 for results.

Table 2-8 - Dogue Creek Mainstem Water Quality Modeling Results

	Pollutant Loading		
	TN	TP	TSS
Subwatershed	lb/ac/yr	lb/ac/yr	t/ac/yr
DC-DC-0000	3.5	0.5	0.09
DC-DC-0005	3.9	0.6	0.10
DC-DC-0010	3.9	0.6	0.09
DC-DC-0015	2.9	0.5	0.08
DC-DC-0020	0.7	0.1	0.04
DC-DC-0025	2.2	0.4	0.07
DC-DC-0030	0.4	0.1	0.03
DC-DC-0035	1.3	0.2	0.04
DC-DC-0040	2.4	0.4	0.06
DC-DC-0045	3.7	0.6	0.09
DC-DC-0050	5.8	0.9	0.13
DC-DC-0055	0.8	0.1	0.03
DC-DC-0060	4.4	0.7	0.10
DC-DC-0065	1.9	0.3	0.05
DC-DC-0070	4.5	0.7	0.09
DC-DC-0075	7.6	1.1	0.16
DC-DC-0080	5.6	0.8	0.12
DC-DC-0085	7.9	1.2	0.17
DC-DC-0090	5.6	0.9	0.13
DC-DC-0095	4.4	0.7	0.10
DC-DC-0100	2.8	0.5	0.08
DC-DC-0105	7.8	1.1	0.17
DC-DC-0110	6.1	0.9	0.13

2.5 Dogue Creek Watershed – North Fork WMA

2.5.1 General Characteristics

North Fork Tributary begins near Old Mount Vernon Road and flows for approximately three miles in a southwesterly direction to its confluence with Dogue Creek near Mount Vernon Memorial Highway.

The streams within the North Fork WMA extend for approximately 9.8 miles. Of this, approximately 2.9 miles were not assessed. All of the streams surveyed within this WMA were characterized as glide/pool prevalent streams in low to moderate gradient landscapes. Of the assessed length, three stream miles were categorized as CEM Type III channels in poor condition with sand and gravel substrate. Approximately 3.9 stream miles were categorized as CEM Type IV channels in poor condition with sand and gravel substrate.

2.5.2 Field Reconnaissance

In the Dogue Creek North Fork WMA field crews conducted 19 Hotspot Site Investigations and assessed seven neighborhoods to determine potential runoff pollution sources and identify treatment practices. The results of these assessments are discussed below.

Hotspot Site Investigations
The Mount Vernon Shopping Center was well kept and garbage dumpsters were observed to be in good condition. However, stains were observed on the concrete and paved areas of the parking lot. No stormwater treatment practices were found, and downspouts discharged directly to the impervious surfaces. This site was classified as a potential hotspot.

At a gas station and abandoned property in the vicinity of Russell Road was investigated. Vehicles were being repaired and fueled. The site was generally viewed to be in satisfactory condition with proper waste disposal and a clean exterior. This site was classified as a potential hotspot.

The Alexandria Mont Zephyr Business Center contained a shopping center, several businesses and a BP gas station. At the BP, vehicles were being maintained and onsite caged propane storage was noted. Garbage dumpsters associated with the business center were found to be in satisfactory condition. This site was classified as a potential hotspot.

Located off of Richmond Highway, a county office building, a veterinarian office and auto clinic were investigated. In the parking lot of the county office building, nine fleet vehicles were observed being maintained, repaired and stored. Garbage from the building was stored behind a locked containment area and stains on the pavement were observed. The county building was clean with approximately 10 percent landscaping and vegetated stormwater retention pond was located on the premises. Both the veterinarian office and auto clinic were fully fenced, and therefore no observations could be made. This site was classified as a potential hotspot.

The Sabor Catracho restaurant located at 8368 Richmond Highway had adequate garbage disposal and dumpster condition; however, it was located in close proximity to a

storm drain inlet. The structure itself was clean, while the parking lot was somewhat degraded. Landscaping and forest canopy were minimal. This site was classified as a potential hotspot.

NAPA Auto Parts and a sporting goods store, located at 8351 Richmond Highway, were assessed together due to their close proximity. Garbage dumpsters were in satisfactory condition, but the parking lot and paved areas were stained and degraded. Downspouts discharged directly to the pavement. This site was classified as a potential hotspot.

Pretty Pets, a pet grooming business located at 8369 Richmond Highway, was a well-kept facility with good waste management practices. Landscaping areas surrounding the business were comprised of approximately 20 percent forest canopy and 20 percent turf grass. These areas were observed accumulating organic matter on adjacent impervious surfaces that drained to a stormwater inlet. This site was not classified as a hotspot.

A commercial area containing several business, offices and shops was investigated at 8401 Richmond Highway. Waste material at the site was primarily composed of garbage that was stored appropriately in a dumpster with runoff diversion curbs. The building and parking lot were in good condition but storm drain gutters had some litter accumulation. This site was classified as a potential hotspot.

A Budget vehicle rental and Alexandria Rent-All Center located at 8412 Richmond Highway were found to be poor condition with dirty exterior. Garbage dumpsters were in good condition, but were located in close proximity to a storm drain inlet that lacked runoff diversion methods and secondary containment. Approximately seven fleet vehicles were found stored outside without runoff diversion methods. At the time of the investigation, Rent-All Center chairs were also observed being cleaned outside on paved areas that drained directly to storm drain inlets. Downspouts from the buildings were draining both to impervious surface and storm drains. No onsite stormwater treatment was apparent. This site was classified a confirmed hotspot.

Smitty's Building Supply, located at 8457 Richmond Highway has a large uncovered treated lumber yard on a gravel surface. This material storage was not found to be connected to the storm drain system, but uncovered loading and unloading operations that drained towards storm drain inlets were present. Downspouts from the commercial building discharged directly to impervious surface, and no stormwater treatment practices were found. This site was classified as a potential hotspot.

Located near Greenleaf Street, a gas station, vehicle service center and small business were investigated. Activities at this site that may be contributing to pollution included the fueling and maintenance of vehicles. Vehicle fueling areas were found to be uncovered and vehicles were observed being washed outside in an area that drained directly to the stormwater system. The parking lot had both paved and gravel surfaces with stains throughout and stormwater treatment practices were apparent. This site was classified as a potential hotspot.

A car care garage on Forest Place was observed in poor condition with a damaged and dirty exterior. Here, approximately three vehicles were observed being maintained and stored without runoff diversion methods. A garbage dumpster was noted to be in good condition, but wood pallets and other junk material was being stored behind the building. The parking lot was comprised of paved and gravel surfaces that were breaking up and

in poor condition. Downspouts discharged directly to impervious surfaces and no storm water treatment practices were found. This site was classified as a potential hotspot.

An animal hospital located off of Richmond Highway was well-kept and the dumpsters were observed to be in good condition. Landscaping was at a minimum, but did drain to storm drain inlets. Downspouts discharged directly to impervious surfaces and no storm water treatment practices were found. This site was classified as a potential hotspot.

At Wick's Repair Inc located at 8600 Richmond Highway, lawnmowers and propane tanks were observed being stored outside, uncovered, on an asphalt surface. Approximately half of the downspouts discharge to impervious surface and no stormwater treatment practices were present. Storm drain gutters were somewhat clogged with sediment, organic material and litter. This site was classified as a potential hotspot.

Located off of Richmond Highway, several commercial facilities including an auto body shop, shopping center, Taco Bell and a bank were investigated together. Vehicles were observed being maintained, repaired, and stored at the auto body shop. Garbage dumpsters behind the shopping center were found with the lids open and evidence of leakage was noted by trailing stains. The dumpsters were located near a storm drain that did not have runoff diversion methods or secondary containment. Parking lot pavement was dirty with scattered pieces of trash and exhibited evidence of cracking and deterioration. Landscaping was at a minimum and did drain directly to storm drain inlets. Downspouts discharged directly to impervious surfaces and no storm water treatment practices were found. This site was classified as a confirmed severe hotspot.

A shopping center, bank, and restaurant located at Sacramento Drive were clean, and for the most part, in satisfactory condition. Garbage dumpsters were found in good condition, but located near a storm drain inlet without runoff diversion methods or secondary containment. Minimal landscaping was found to be draining directly to storm drain inlets. Downspouts discharged directly to impervious surfaces and no storm water treatment practices were found. This site was classified as a potential hotspot.

Waste materials, including garbage and a type of solvent, were found at a shopping center and McDonalds on Cooper Road. Although both of these materials were properly stored, they were located in close proximity to a storm drain inlet without runoff diversion methods or secondary containment. There was moderate amount of landscaping area comprised of approximately 25 percent forest canopy. These landscape areas drained directly to the storm drain system. No stormwater treatment practices were found. This site was classified as a potential hotspot.

Neighborhood Source Assessment

A single-family development of detached homes on less than one-quarter-acre lots in the vicinity of Falkstone Lane and Granada Street had approximately 55 percent impervious cover, 35 percent grass cover, 5 percent landscaping, 5 percent bare soil and 5 percent tree cover. Sidewalks were present, as well as curb and gutter that were clear and free of obstruction. Storm drain inlets were not stenciled and no stormwater treatment facilities were present. There was open space with intact stream buffers within the floodplain and no encroachment was evident.

A single-family detached subdivision, approximately 30 years in age and in the vicinity of Gateshead Road, Old Mill Road and Falkstone Lane, with one-quarter-acre lots was assessed. On average, there was approximately 45 percent impervious cover, 40 percent grass, 10 percent landscaping, 5 percent bare soil and 5 percent tree canopy cover. Sidewalks, curbs and gutters were all clean and dry. Storm drain inlets were not stenciled but were also clean and free of obstructions. This neighborhood did contain open space, but is not receiving any stormwater treatment.

In a single family neighborhood located along Granada Street, Aragon Place, Flakestone Lane, and Gateshed Road, homes were detached and situated on half-acre lots. These homes where believed to be built in the 1960s and all had basements, and approximately 30 percent had garages. Lots were approximately 40 percent impervious cover, 40 percent grass, 5 percent landscaping and 15 percent tree canopy cover. No trash or illegal dumping was observed. Sidewalks were present with curbs and gutters. Approximately 70 percent of the downspouts in the community discharged to pervious surfaces. Organic matter, leaves and lawn clippings were present and some overhead tree canopy was also noted. Storm drain inlets were not stenciled, and there was no apparent stormwater treatment.

A single family neighborhood of detached homes located on Fenimore Place, Wood Drive, Badger Drive, Phylliss Street, Gateshead Road, Blyth Place, McNair Drive, and Flakestone Lane contained half-acre lots, some of which had been redeveloped. Lots were approximately 40 percent impervious and 30 percent of the downspouts discharged to these surfaces. There were no sidewalks, but clean curb and gutter were present in approximately 20 percent of the neighborhood. No stormwater management facility was present.

A neighborhood of single family detached homes located on Old Mill Road, Adrienne Drive, Dulgrave Drive, Renault Place, Beauchamp Drive, and Manard Court had moderate infill and redevelopment. These half-acre lots were composed of approximately 40 percent impervious cover. Approximately 70 percent of the downspouts in the neighborhood discharged to pervious surfaces. Sidewalks, curbs and gutters were present. Organic matter, leaves and lawn clippings were also noted, as well as some overhead tree canopy. Storm drain inlets were not stenciled, but were clean and fee of obstructions. There was no apparent stormwater treatment.

In a single family neighborhood of detached homes located along Continental Drive, Old Mount Vernon Road, Densmore Court, Westgate Drive, Chickawane Court, Cherrytree Drive, Nellie Custis Court, and Volunteer Drive was situated on half-acre lots and had some indications of minimal redevelopment. The lots were approximately 40 percent impervious. Approximately 70 percent of the downspouts in the community discharged to pervious surfaces, while 30 percent discharged to impervious. No sidewalks were present, while clean curbs and gutters were found in approximately 30 percent of the neighborhood. Storm drain inlets were not stenciled, but were clean and free of obstruction. No stormwater treatment facilities were found.

A single family neighborhood of detached homes located on Mount Vernon Circle and Mount Vernon Landing contained half-acre lots with signs of moderate redevelopment in the area. Approximately 40 percent of each lot was impervious, and open space was noted. Sidewalks were found in approximately half of the neighborhood, while curb and gutters were present throughout. Organic matter, leaves and lawn clippings were noted,

as well as some overhead tree canopy. Storm drain inlets were stenciled and clean. No stormwater treatment facilities were found.

Pinewood Lawns Condominiums located at 5601 Pole Road was a multifamily dwelling with approximately 65 percent impervious cover, 5 percent bare soil, 5 percent tree cover and the remainder in grass cover. Sidewalks and curbs and gutters were present, and there was some evidence of long-term car parking and associated oil leaks. Approximately 80 percent of the downspouts in the community discharged to impervious surfaces. Storm drain inlets were not stenciled but were free of obstructions. Open space was noted, but no stormwater facilities were found.

A single family neighborhood located on Rosemont Circle, was comprised of single family detached homes on one-half acre lots composed of 40 percent impervious cover and 5 percent landscaping. Some evidence of infill and redevelopment was noted in this neighborhood. Downspouts were observed to be discharging to pervious surfaces. Sidewalks were not found, but curb and gutter was present and clean. Storm drain inlets were also found to be clean and free of obstructions. Open space was noted, but stormwater facilities were not found.

2.5.3 Land Use

The North Fork WMA is characterized by 31 percent medium-density residential land use, 17 percent open space, parks, and recreation areas, 16 percent low-density residential and 14 percent transportation. A summary of the land use within the WMA is shown in Table 2-9 and on Map 23.

Table 2-9 - North Fork Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open Space, Parks, and Recreational Areas	484.8	17.3	388.7	13.9	-96.1	-19.8
Golf Course	109.4	3.9	109.4	3.9	0.0	0.0
Estate Residential	23.4	0.8	11.9	0.4	-11.5	-49.1
Low-Density Residential	470.4	16.8	421.0	15.0	-49.4	-10.5
Medium-Density Residential	864.4	30.8	999.3	35.6	134.9	15.6
High-Density Residential	251.7	9.0	265.3	9.5	13.6	5.4
Low-Intensity Commercial	23.7	0.8	12.2	0.4	-11.5	-48.5
High-Intensity Commercial	63.2	2.3	96.0	3.4	32.8	51.9
Industrial	6.1	0.2	5.2	0.2	-0.9	-14.8
Institutional	106.9	3.8	95.0	3.4	-11.9	-11.1
Transportation	378.6	13.5	378.6	13.5	0.0	0.0
Water	23.0	0.8	23.0	0.8	0.0	0.0
Total	**2,805.6**	**100.0**	**2,805.6**	**100.0**	**0.0**	**0.0**

Total impervious area for the WMA is approximately 769 acres, or 27 percent of the total WMA area of 2,806 acres.

2.5.4 Stormwater Infrastructure

Stormwater Management
County records indicate that there are 34 stormwater management facilities within the North Fork WMA. These facilities provide control for 21 percent of the WMA. One of

these facilities is the Mount Vernon High School regional pond. There are no additional planned regional ponds in the WMA. Stormwater infrastructure is shown on Map 24.

2.5.5 Stream Condition

Stream conditions for this WMA are shown on Map 25.

Erosion
There was a total of 3,450 linear feet of erosion on the outer bends of the stream banks identified in the WMA at five specific erosion locations. The majority of these erosion sites had moderate to high restoration potential. Two head cuts were identified in the WMA. One was 4 feet and the second was 2.5 feet in height.

Outfall Impacts
As part of the Stream Physical Assessment, 39 outfall pipes were located in the North Fork WMA. All were within 120 feet of the channel and ranged in size from 12 to 96 inches. Outflow from one 12-inch pipe was identified as causing major erosion.

Stream Crossings
During the Stream Physical Assessment, 51 stream crossings were identified in the North Fork WMA. One bridge stream crossing located near Riverside Elementary School was having a severe impact on stream condition. This crossing could pose a threat to a road or other structure and should be addressed to avoid a bigger problem in the future. Another bridge stream crossing under Mount Vernon Memorial Highway near Grist Mill Park was having a moderate impact on stream condition. This crossing does not pose an immediate threat to the roadway or other structures, but should be inspected periodically.

Obstructions
There are 10 obstruction sites located in the North Fork WMA. Nine of these sites are trees, debris and sediment, while the tenth site is a beaver dam. Three of the sites obstructed with trees, debris and sediment are thought to be impacting fish movement within the stream.

Stream Buffers
The areas of deficient stream buffer in the North Fork WMA are a mix of lawn, forbs and pavement. There were 36 deficient buffer points. Thirty-two of the buffer encroachments were rated as severe and two were rated as extreme.

Habitat
Of the assessed stream reaches within the WMA, 5.6 miles (87 percent) were classified as poor and 4,271 feet (13 percent) as very poor.

Of the assessed streams, 43 percent and 21 percent were classified as optimal for channel flow status, drought and normal flow, respectively. The majority of streams were classified as poor for bank vegetative protection, bank stability, and vegetative buffer zone width.

2.5.6 WMA Modeling

Three subwatersheds, one on the southwest side and two on the north side of the WMA (DC-NW-0005, DC-NE-0025, DC-NW-0015, DC-NW-0025 and DC-NW-0030) show the highest modeled pollutant loads, based primarily on high and medium-density residential

development. The best quality subwatersheds (DC-NW-0020 and DC-NE-0003) are on the northwest and northeast sides of the WMA, containing open space, medium-density residential and institutional development. See Table 2-10 for results.

Table 2-10 - North Fork Water Quality Modeling Results

	Pollutant Loading		
Subwatershed	TN lb/ac/yr	TP lb/ac/yr	TSS t/ac/yr
DC-NE-0000	3.8	0.6	0.10
DC-NE-0003	3.0	0.5	0.08
DC-NE-0005	4.7	0.7	0.11
DC-NE-0010	4.3	0.7	0.10
DC-NE-0015	5.2	0.8	0.12
DC-NE-0020	5.6	0.9	0.12
DC-NE-0025	6.2	1.0	0.14
DC-NE-0030	5.3	0.8	0.12
DC-NE-0035	4.5	0.7	0.11
DC-NW-0000	4.9	0.7	0.11
DC-NW-0005	6.1	0.9	0.13
DC-NW-0010	5.4	0.8	0.12
DC-NW-0015	7.2	1.1	0.15
DC-NW-0020	3.6	0.6	0.09
DC-NW-0025	6.0	0.9	0.14
DC-NW-0030	6.1	1.0	0.14

2.6 Dogue Creek Watershed – Piney Run WMA

2.6.1 General Characteristics

The Piney Run tributary flows in a southeasterly direction until it reaches its confluence with Dogue Creek. As the Piney Run tributary approaches the community of Hayfield, located south of Old Telegraph Road, it is channeled through a 72-inch diameter concrete pipe. After exiting the pipe, it is discharged into a 20-foot wide concrete channel with five-foot high walls. The tributary continues in this channel until just before its confluence with Dogue Creek. As Piney Run Tributary approaches its confluence with Dogue Creek, the stream loses a defined bed and bank and becomes a marshy area.

The streams within the Piney Run WMA extend for approximately 6.6 miles. Of this, approximately 1.8 miles were not assessed. Ninety-five percent of all the streams surveyed within this WMA were characterized as glide/pool prevalent streams in low to moderate gradient landscapes. Of the assessed streams, 1.8 stream miles were categorized as CEM Type II channels in fair condition with sand and gravel substrate. Approximately 3.1 stream miles were categorized as CEM Type III channels in fair condition with silt, sand, and gravel substrate.

2.6.2 Field Reconnaissance

In the Dogue Creek Piney Run WMA field crews conducted three Hotspot Site Investigations and assessed one neighborhood to determine potential runoff pollution sources and identify treatment practices. The results of these assessments are discussed below.

Hotspot Site Investigations
The Festival at Manchester Lakes Shopping Center and the Shopping Center at Schoonmaker Court near the intersection of Beulah Street and Manchester Boulevard had covered outdoor loading operations present that were not situated near storm drains. An auto repair and tire business was also noted as part of the shopping centers, where 10 vehicles were being maintained, repaired and washed. Vehicles were being stored outside without runoff diversion methods and evidence of spills and leaks was evident. Tires were observed being stored outside, uncovered and on an asphalt surface. Staining and discoloration around this area was noted and it was connected to the storm drain system. Garbage dumpsters were in poor condition with evidence of damaged, leaking, and overflowing conditions. The dumpsters were not located in close proximity to a storm drain inlet, but did lack runoff diversion methods and secondary containment. The paved parking lot showed signs of staining and downspouts discharged directly to impervious surfaces. Landscaping was minimal and drained directly to storm drain inlets. This site was identified as a confirmed hotspot.

At a shopping mall located on Silver Lake Boulevard materials were observed being stored outside without cover and in containers that were in poor condition. Garbage dumpsters were without cover, overflowing, and in extremely poor condition with evidence of both damaged and leaking. The parking lot and buildings were both clean and in good condition, but no stormwater management facility was apparent. This site was classified as a potential hotspot.

Tiers at Manchester Lakes Condominiums off Manchester Lake Drive was a multifamily dwelling with approximately 60 percent impervious cover, 25 percent grass cover, 10

percent landscaping, 5 percent bare soil and 5 percent tree cover. Sidewalks and curbs and gutter were all present and clean. Storm drain inlets were not stenciled but were free of obstructions. Open space was noted, but no stormwater facilities were found.

Neighborhood Source Assessments
A multifamily dwelling approximately 10 years in age and located along Kingstowne Commons Drive and Park Village Drive was assessed. A general assessment of the site showed it had approximately 60 percent impervious cover, 30 percent grass cover, 5 percent landscaping, 5 percent bare soil and 10 percent tree cover. Sidewalks were present throughout the complex, and curb and gutter were clean and dry. Storm drain inlets were clean and free of obstruction, but were not stenciled. Open space was noted, and dumping was not a problem. No stormwater management was apparent.

2.6.3 Land Use

The Piney Run WMA is primarily characterized by 52 percent open space, parks, and recreation areas and 24 percent high-density residential. A summary of the land use within the WMA is shown in Table 2-11 and on Map 26.

Table 2-11 - Piney Run Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Ac	Percent
Open Space, Parks, and Recreational Areas	909.2	52.4	1.8	51.4	-17.4	-1.9
Golf Course	0.7	0.0		0.0	0.0	0.0
Estate Residential	40.9	2.4	23.2	1.3	-17.7	-43.3
Low-Density Residential	65.7	3.8	71.7	4.1	6.0	9.1
Medium-Density Residential	45.6	2.6	71.1	4.1	25.5	55.9
High-Density Resi al	417.3	24.0	420.8	24.2	3.5	0.8
Low-Intensity Commercial	0.8	0.0	0.8	0.0	0.0	0.0
High-Intensity Comme l	24.8	1.4	24.8	1.4	0.0	0.0
Industrial	3.2	0.2	3.2	0.2	0.0	0.0
Institutional	86.1	5.0	86.2	5.0	0.1	0.1
Transportation	104.2	6.0	104.2	6.0	0.0	0.0
Water	37.6	2.2	37.6	2.2	0.0	0.0
Total	**1, 1**	**100.0**	**1,736.1**	**100.0**	**0.0**	**0.0**

Total impervious area for the WMA is approximately 396 acres, or 23 percent of the total WMA area of 1,736 acres.

2.6.4 Stormwater Infrastructure

Stormwater Management
County records indicate that there are 26 stormwater management facilities within the Piney Run WMA, one of these being the Kingstowne regional pond. These facilities provide control for 56 percent of the WMA. There are no additional planned regional ponds in the WMA. Stormwater infrastructure is shown on Map 20.

2.6.5 Stream Condition

Stream conditions for this WMA are shown on Map 21.

Erosion
There was a total of 2,165 linear feet of erosion on both the right and left stream banks identified in the WMA at four specific erosion locations. The majority of these erosion

sites had moderate restoration potential. Three head cuts were identified in the WMA. One was 1.75 feet, the second was 3 feet and the third was 4.5 feet in height.

Outfall Impacts
As part of the Stream Physical Assessment, 14 outfall pipes were located in the Piney Run WMA. All were within 100 feet of the channel and ranged in size from 12 to 48 inches. One 24-inch pipe was identified as causing moderate erosion.

Stream Crossings
During the Stream Physical Assessment, 27 stream crossings were identified in the Piney Run WMA. One circular pipe stream crossing was having a moderate impact on stream condition. This crossing does not pose an immediate threat to the roadway or other structures, but should be inspected periodically.

Obstructions
There are seven obstruction sites located in the Piney Run WMA, all of which are beaver dams. None of the obstruction sites are thought to be impacting fish movement within the stream.

Stream Buffers
The areas of deficient stream buffer in the Piney Run WMA are a mix of lawn, pasture and pavement. There were 11 deficient buffer points, two of which were rated as severe.

Habitat
Of the assessed stream reaches within the WMA, 4.1 miles (85 percent) were classified as fair, 2,548 feet (10 percent) as poor, and 1,403 feet (5 percent) as very poor.

Of the glide/pool assessed streams (95 percent of the total stream length), 51 percent were classified as optimal for pool substrate characterization. All of the streams were classified as poor for pool variability. Two percent of the streams were characterized as riffle/run streams with moderate to high slopes. All of these streams were classified as optimal for epifaunal substrate and poor for bank vegetative protection and bank stability.

2.6.6 WMA Modeling

Four subwatersheds on the northern end of the WMA (DC-PY-0040, DC-PY-0045, DC-PY-0050 and DC-PY-0055) show the highest modeled pollutant loads, based primarily on high-density residential development. The best quality subwatersheds (DC-PY-0000, DC-PY-0005, DC-PY-0010 and DC-PY-0020) are at the southern end of the WMA, containing open space and institutional development. See Table 2-12 for results.

Table 2-12 - Piney Run Water Quality Modeling Results

	Pollutant Loading		
Subwatershed	TN lb/ac/yr	TP lb/ac/yr	TSS t/ac/yr
DC-PY-0000	0.6	0.1	0.03
DC-PY-0005	1.8	0.3	0.06
DC-PY-0010	1.9	0.3	0.06
DC-PY-0015	2.9	0.5	0.09
DC-PY-0020	2.2	0.4	0.06
DC-PY-0025	3.1	0.5	0.07

Subwatershed	Pollutant Loading		
	TN lb/ac/yr	TP lb/ac/yr	TSS t/ac/yr
DC-PY-0030	4.7	0.7	0.11
DC-PY-0035	4.5	0.7	0.10
DC-PY-0040	7.9	1.2	0.17
DC-PY-0045	5.5	0.8	0.13
DC-PY-0050	8.7	1.2	0.18
DC-PY-0055	6.4	1.0	0.14

2.7 Dogue Creek Watershed – Potomac WMA

This WMA is entirely within the boundaries of Fort Belvoir and was not assessed in detail as part of this project.

The Potomac WMA is characterized as having 50 percent open space, parks and recreational areas. Another 15 percent is in institutional land use (Fort Belvoir). Nine percent of the WMA has medium-density residential and another 7 percent has low-density residential. A summary of the land use within the WMA is shown in Table 2-13 and on Map 27.

Table 2-13 - Potomac Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open Space, Parks, and Recreational Areas	1,325.0	50.4	1,271.0	48.3	-54.0	-4.1
Golf Course	0.0	0.0	0.0	0.0	0.0	0.0
Estate Residential	43.2	1.6	7.7	0.3	-35.5	-2.7
Low-Density Residential	175.3	6.7	165.0	6.3	-10.3	-0.8
Medium-Density Residential	225.4	8.6	283.5	10.8	58.1	4.4
High-Density Residential	156.9	6.0	156.9	6.0	0.0	0.0
Low-Intensity Commercial	0.0	0.0	0.0	0.0	0.0	0.0
High-Intensity Commercial	0.0	0.0	0.0	0.0	0.0	0.0
Industrial	147.1	5.6	147.1	5.6	0.0	0.0
Institutional	397.3	15.1	435.6	16.6	38.3	2.9
Transportation	152.3	5.8	155.7	5.9	3.4	0.3
Water	6.6	0.3	6.6	0.3	0.0	0.0
Total	**2,628.9**	**100.0**	**2,628.9**	**100.0**	**0.0**	**0.0**

Total impervious area for the WMA is approximately 282 acres, or 11 percent of the total WMA area of 2,629 acres.

2.8 Four Mile Run Watershed

2.8.1 General Characteristics

The streams within the Fairfax County portion of the Four Mile Run WMA extend for approximately 1.8 miles. Of this, approximately one mile was not assessed. Of the assessed length, 1,654 linear feet were classified as CEM Type III channels in poor condition. Approximately 2,422 linear feet were categorized as Type IV channels in fair condition. All of the streams surveyed within this WMA were characterized as glide/pool prevalent streams in low to moderate gradient landscapes. The dominant substrate throughout the WMA was gravel.

2.8.2 Field Reconnaissance

In the Four Mile Run watershed field crews conducted 19 Hotspot Site Investigations and assessed eight neighborhoods to determine potential runoff pollution sources and identify treatment practices. The results of these assessments are discussed below.

Hotspot Site Investigations

At the Corner at Seven Corners office center located along Arlington Boulevard vehicles were observed being washed outdoors in an area that discharged to the storm drain system. Garbage dumpsters were in good condition, but drained toward storm drain inlets. Landscaping was minimal and did not drain toward the storm drain system, however, organic matter did accumulate on adjacent impervious surfaces. No stormwater treatment practices were found and the site was classified as a potential hotspot.

The Seven Corners Shopping Center located between Arlington Boulevard and Leesburg Pike had garbage dumpsters that were in good condition. The paved parking lot had concrete that was breaking up, and the downspouts discharged directly to the storm drain system. A minimal amount of landscaping was noted, but organic matter did accumulate on the adjacent impervious surfaces. Stormwater treatment for the commercial residence was not apparent. This site was classified as a potential hotspot.

A restaurant and office building located at the intersection of Arlington Boulevard and Sleepy Hollow Road were both in good condition, but downspouts discharged to impervious surfaces. No stormwater treatment was found. This site was not classified as a hotspot.

A county office building located at 6231 Leesburg Pike was in good condition, but downspouts discharged to impervious surfaces. A minimal amount of landscaping was noted, but organic matter did accumulate on the adjacent impervious surfaces. This site was classified as a potential hotspot.

The Williston Shopping Center located at 6182 Arlington Boulevard had garbage dumpsters that were in good condition. Downspouts discharged directly to the storm drain system. Minimal landscaping was noted, but it did accumulate organic matter on the adjacent impervious surfaces. No stormwater treatment was present. This site was classified as a potential hotspot.

At The Comfort Inn and other commercial businesses, located on the corner of Arlington Boulevard and Patrick Henry Drive, 10 vehicles were being repaired without runoff

diversion methods, and fueling areas were directly connected to the storm drain system. Parking lots for the most part were clean, but some staining near the 7-Eleven was noted. A small amount of landscaping was observed to be accumulating organic matter on adjacent impervious surfaces. No stormwater treatment facilities were found. This site was classified as a potential hotspot.

The Colombia Crossroads Church, located near the intersection of Glen Carlyn Road and Leesburg Pike, was approximated to be 50 years old. No garbage dumpsters were observed, however, covered cans were found in good condition. Downspouts discharged directly to impervious surfaces. The gutters had some accumulation of sediment and organic material. This site was classified as a potential hotspot.

Corpus Christ School and St. Anthony's Catholic Church, located at the intersection of Glen Carlyn Road and Leesburg Pike and believed to be built in the 1970s, were evaluated together due to their close proximity and similar characteristics. The buildings and parking lot were found to be in good condition, but downspouts were directly connected to the storm drain system. Minimal landscaping was noted, however, non-target irrigation draining toward the storm drain system was observed. In addition, organic matter was present on the impervious surfaces adjacent to the landscaping areas. This site was classified as a potential hotspot.

At St. Katherine's Greek Orthodox Church of Northern Virginia located at 3149 Glen Carlyn Road no dumpster was observed, but construction materials were noted. Both the building and parking lot were in good condition, but downspouts were connected directly to the storm drain system. A moderate amount of landscaping, comprised primarily of tuff grass, was recorded. This site was not classified as a hotspot.

At a gas station located at the intersection of Glen Carlyn Drive and Leesburg Pike vehicles were being repaired and fueled. Approximately 20 vehicles were observed stored outside in an area without run off diversion methods and fueling areas were uncovered and directly connected to the storm drain system. Garbage dumpsters were observed without cover, and the paved parking lot was stained. A small amount of landscaping was contributing to the accumulation of organic material on adjacent impervious surfaces. No stormwater treatment practices were present, and this site was classified as a potential hotspot.

A shopping center located adjacent to Crossroads Center Way was approximately 15 years old and in good condition with a clean exterior and paved parking lot. Dumpsters were also found in good condition, but the small landscaped areas did drain to the storm drain system. The presence or absence of a stormwater management facility is unknown. This site was not classified as a hotspot.

At The Leesburg Pike Plaza, located at 3533 South Jefferson Street, garbage dumpsters were found to be in good condition, but located in close proximity to storm drain inlets. The parking lot had some scattered trash at the time of the investigation, but was not considered to be severe. Downspouts discharged directly to impervious surfaces, and stormwater treatment practices were unknown. This site was not classified as a hotspot.

At a shopping center at the corner of Seminary Road and Dawes Avenue garbage dumpsters were located near a storm drain inlet with evidence of leaking. Downspouts were noted discharging to impervious surfaces and stormwater treatment practices were

not evident. Landscaped areas accumulated organic matter on adjacent impervious surfaces that drained to the storm drain system. This site was classified a confirmed hotspot.

A McDonalds and a gas station located at the intersection King Street and Dawes Avenue were assessed together because of their close proximity. Uncovered outdoor vehicle fueling was observed at the gas station. Garbage dumpsters were in good condition, but downspouts discharge to impervious surfaces. Small landscaped areas were accumulating organic matter on adjacent impervious surfaces and drained to the storm drain system. No stormwater treatment practices were present.

A shopping center located near the intersection of Leesburg Pike and South Forest Drive had garbage and construction material waste placed properly in dumpsters that were in good condition. Downspouts were found to be directly connected to storm drain inlets. A small amount of high maintenance landscaping was observed accumulating organic matter on adjacent impervious surfaces and draining toward the storm drain system. Stormwater treatment practices were unknown and this site was classified as a potential hotspot.

An office building and a Mr. Tire Auto Service Center located near the intersection of Carlyn Hill Drive and Columbia Pike were investigated together due to their close proximity. Both structures had a clean exterior and parking lot. Vehicles were observed being maintained, and the only waste material noted was garbage. A minimal amount of landscaped area was both accumulating organic matter on impervious surfaces and draining toward the storm drain system. No stormwater treatment practices were found. This site was classified as a potential hotspot.

The Baileys Crossroads Shopping Center located at the intersection of Leesburg Pike and Columbia Pike had a parking lot and exterior that was clean and in good condition. Generally, dumpsters were closed, but one of the dumpsters located near a storm drain inlet showed evidence of leaking. A negligible amount of landscaping was noted to be accumulating organic matter on impervious surfaces. Downspouts were directly connected to the storm drain system, and no stormwater treatment practices were present. This site was classified as a potential hotspot. However, it is anticipated that SWM controls will be implemented during the redevelopment of Bailey's Crossroads.

At a cleaners and car repair shop located near the intersection of Williams Lane and Center Lane were evaluated together. Several hundred vehicles were observed either being repaired or stored outside without runoff diversion methods. It was noted that garbage dumpsters were overflowing and located near a storm drain inlet. The parking lot was found to be dirty due to sediment from local construction. The accumulation of organic matter on impervious surfaces from landscaping was observed, and the landscaped areas did drain toward the storm drain system. This site was confirmed as a hotspot.

An AutoZone and shopping mall located near the intersection of Carlin Springs Road and Leesburg Pike had garbage dumpsters that were in good condition but located near storm drain inlets. Downspouts discharged to impervious surfaces, and landscaped area both accumulated organic matter on these surfaces and drained to the storm drain system. No stormwater treatment was found, and this site was classified as a potential hotspot.

Neighborhood Source Assessments

A multifamily dwelling located along Patrick Henry Drive and Greenwood Drive contained approximately 60 percent impervious cover, 35 percent grass, and 5 percent landscaping. Sidewalks and curb and gutter were all present and clean. Forest canopy was prevalent throughout 20 percent of the neighborhood and all lawns had medium turf management. Downspouts discharged equally to both pervious and impervious surfaces. Open space was noted, but no stormwater treatment or storm drain inlets were found.

A single family neighborhood of detached homes located on Olin Drive, Worthington Circle, Celadon Lane, Wooten Drive, Collie Lane, and Brook Drive contained one-half acre lots, some of which had been redeveloped. Lots were approximately 20 percent impervious cover, 72 percent grass and 8 percent landscaping. Sidewalks were not found, but curb and gutter were present and clean. Storm drain inlets were present and clean, but not stenciled. All downspouts discharged to pervious areas and no stormwater management was located.

A neighborhood located along Munson Hill Road, Apex Circle, and Afton Court was built in the 1950s and made up of single family detached homes on one-quarter-acre lots. Some infill and redevelopment was noted and a wide range of turf management was observed. Lots were approximately 30 percent impervious cover, 60 percent grass and 10 percent landscaping with some forest canopy. Sidewalks and curb and gutter were both present and clean in approximately 50 percent of the neighborhood. All of the downspout discharged to pervious areas. Neither storm drain inlets nor a stormwater management pond were found, but open space was noted.

A single family neighborhood of detached homes one-quarter-acre lots is located along Glen Carlyn Road, Magnolia Avenue, 6th Street, Merritt Place, Olds Drive, Kimble Court and Lancaster Street and shows minimal signs of infill and redevelopment. The neighborhood is approximately 30 percent impervious cover, 60 percent grass, and 10 percent landscaping with some forest canopy. In general, the turf lawns were maintained at a medium level with a few cases of high maintenance. Almost all driveways were impervious but clean. No sidewalks or curb and gutter were found and all downspouts discharged to pervious areas.

In a single family neighborhood located along Magnolia Avenue, Redpine Street, Chicamuxen Court, Longbranch Drive, Pensa Drive, Boston Drive, Garland Drive, Glen Forest Drive, Longwood Drive, Kaywood Drive, Kaywood Place, and Durbin Place, homes were detached and situated on one-half-acre lots. These homes where believed to be built in the 1960s and had only slight evidence of infill and redevelopment. The neighborhood is approximately 20 percent impervious cover, 72 percent grass and 8 percent landscaping with some forest canopy as well. Sidewalks were present in some areas, while curb and gutter were found approximately 50 percent of the time. All sidewalks, curbs and gutters and driveways were clean. Turf lawns were moderately to highly maintained and all downspouts discharged to pervious areas. Storm drain inlets were clean, but not stenciled. No stormwater management or open space was noted.

A neighborhood comprised of both one-quarter and one-half-acre lots with single family homes located on Beacon Lane, Molly Drive, Primrose Drive, Orchid Drive, Tulip Drive, Fisher Avenue, and Osborn Street had some evidence of infill and redevelopment. The

lots were approximately 40 percent impervious cover, 55 percent grass and 5 percent landscaping with many mature trees scattered throughout. Sidewalks, and curbs and gutters were all present. Organic matter, leaves and lawn clippings were noted, as well as some overhead tree canopy. Storm drain inlets were not stenciled, but were clean and fee of obstructions. There was no apparent stormwater treatment or open space.

A neighborhood located along Brilyn Place, Gordon Avenue, Meridian Street, and Hollywood Avenue contained one-half-acre lots, some of which had been redeveloped. Lots were approximately 40 percent impervious cover, 50 percent grass and 10 percent landscaping with many mature trees. Sidewalks were not found, but curb and gutter were present and clean. Storm drain inlets were present and clean, but not stenciled. All downspouts discharged to pervious areas and no stormwater management facilities or open space was found.

A single-family neighborhood of detached homes on one-half-acre lots is located along 33rd Street, Whitcomb Place, Westmoreland Street, 32nd Street, North Underwood Street, North Tuckahoe Street, and Van Buren Court and shows minimal signs of infill and redevelopment. The neighborhood is approximately 40 percent impervious cover, 50 percent grass 9 percent landscaping and 1 percent bare soil with some older and larger trees. Sidewalks and curb and gutter were present, and the curb and gutter was slightly blocked by fallen branches from overhead tree canopy. Storm drains were both present and stenciled, but were also partially blocked by branches. No open space or stormwater treatment was apparent.

2.8.3 Land Use

The Four Mile Run WMA is characterized as 24 percent medium-density residential land use, 19 percent high-density residential, 19 percent transportation and 16 percent high-intensity commercial. A summary of the land use within the WMA is shown in Table 2-14 and on Map 7.

Table 2-14 - Four Mile Run Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open Space, Parks, and Recreational Areas	61.6	4.7	40.2	3.1	-21.4	-34.7
Estate Residential	8.4	<1	0.0	0.0	-8.4	-100.0
Low-Density Residential	72.6	5.6	51.9	4.0	-20.7	-28.5
Medium-Density Residential	313.7	24.0	357.7	27.4	44.0	14.0
High-Density Residential	247.5	19.0	249.0	19.1	1.5	<1
Low-Intensity Commercial	74.1	5.7	63.4	4.9	-10.7	-14.4
High-Intensity Commercial	215.6	16.5	261.2	20.0	45.6	21.2
Industrial	27.0	2.1	11.7	<1	-15.3	-56.7
Institutional	34.7	2.7	20.1	1.5	-14.6	-42.1
Transportation	243.8	18.7	243.8	18.7	0.0	0.0
Water	6.7	<1	6.7	<1	0.0	0.0
Total	**1,305.7**	**100.0**	**1,305.7**	**100.0**	**0.0**	**0.0**

Total impervious area for the WMA is approximately 824.7 acres, or 36.2 percent of the area analyzed (this includes some area adjacent to, but outside of, the Fairfax County border.)

2.8.4 Stormwater Infrastructure

Stormwater Management
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 planned regional ponds in the area. Stormwater infrastructure is shown on Map 28.

2.8.5 Stream Condition

Stream conditions for this WMA are shown on Map 29.

Erosion
There were no erosion or headcut sites located in the assessed portions of the Four Mile Run WMA.

Outfall Impacts
As part of the Stream Physical Assessment, 14 outfall pipes were located in the Four Mile Run WMA. All were within 50 feet of the channel and ranged in size from 12 to 60 inches. None of the pipes were identified as causing erosion.

Stream Crossings
During the Stream Physical Assessment, eight stream crossings were identified in the Four Mile Run WMA. None of the crossings were having a significant impact on stream condition or causing any type of erosion.

Obstructions
There were no obstructions recorded in the Four Mile Run WMA.

Stream Buffers
Most of the stream buffer encroachments in the Four Mile Run WMA are lawns, although one is a dirt path buffering the stream. There were six deficient buffer points. None of the buffer encroachments these were rated as severe.

Habitat
Of the assessed stream reaches within the WMA, 2,422 feet (59 percent) were classified as fair and 1,654 feet (41 percent) as poor.

Of the assessed streams, 43 percent were classified as optimal for bottom substrate. All of the streams were classified as suboptimal for channel flow status, drought and normal flow. All of the streams were classified as poor for bank vegetative protection, bank stability, and vegetative buffer zone width.

2.8.6 WMA Modeling

Modeled pollutant loads for Four Mile Run were high for all parameters. The highest modeled loads were found in subwatersheds FM-FM-0030 and FM-FM-0015. FM-FM-0030 lies outside of Fairfax County boundary, FM-FM-0015 is an area of high-intensity commercial development. The best quality subwatershed within County jurisdiction is FM-FM-0035, in the northern portion of the WMA. This subwatershed contains high-density residential development. See Table 2-15 for results.

Table 2-15 – Four Mile Run Water Quality Modeling Results

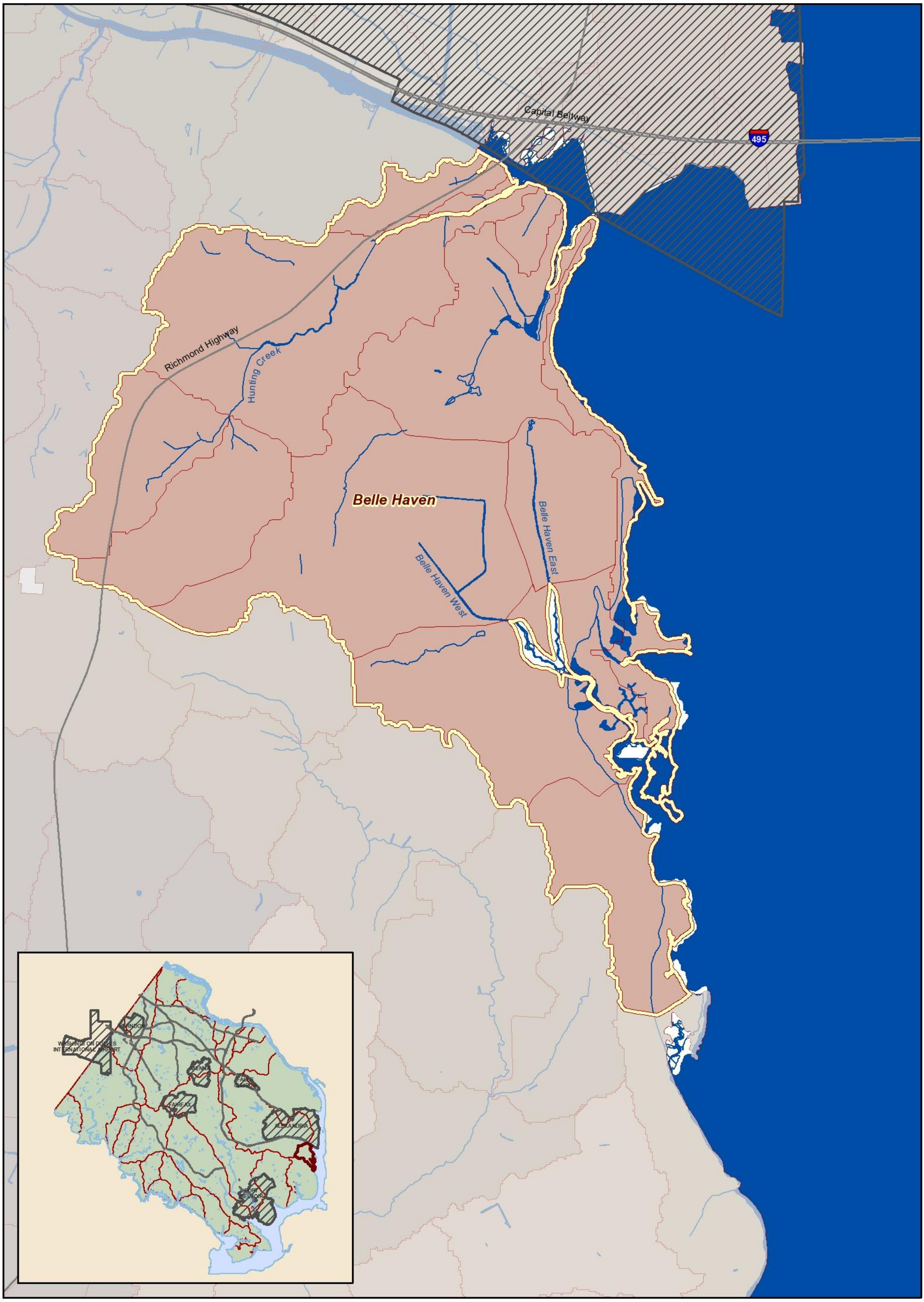
	Pollutant Loading		
Subwatershed	TN lb/ac/yr	TP lb/ac/yr	TSS t/ac/yr
FM-FM-0000	8.1	1.1	0.17
FM-FM-0005	7.5	1.1	0.17
FM-FM-0010	9.9	1.3	0.21
FM-FM-0015	10.3	1.5	0.23
FM-FM-0020	7.6	1.1	0.16
FM-FM-0025	6.4	0.9	0.13
FM-FM-0030	10.9	1.8	0.26
FM-FM-0035	6.3	1.0	0.14
FM-LO-0000	7.7	1.1	0.17

Maps

Map 1

Watershed Location Map

Belle Haven, Dogue Creek and
Four Mile Run Watersheds



0 0.25 Miles

Watershed Management Area (WMA) Boundary

Subwatershed Boundary

Lakes and Ponds

Map 2

Subwatershed Map

Belle Haven Watershed

95

Barnyard Run

Piney Run

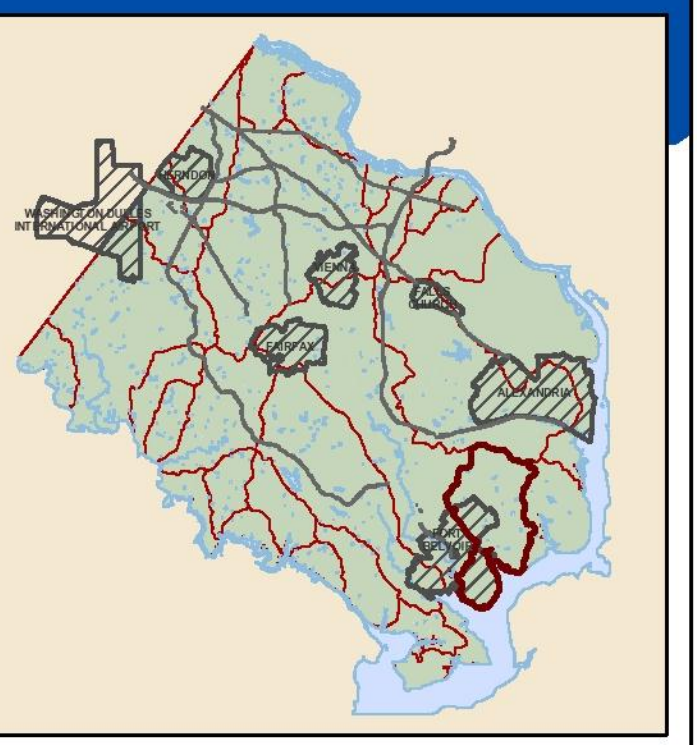
Dogue Mainstem

Richmond Highway

North Fork

FORT BELVOIR MILITARY RESERVATION

Potomac



COUNTY OF FAIRFAX 1742 VIRGINIA

0 0.5 Miles

Watershed Management Area (WMA) Boundary

Subwatershed Boundary

Lakes and Ponds

Map 3

Subwatershed Map

Dogue Creek Watershed

Four Mile Run

Broad St.

CITY OF FALLS CHURCH

Four Mile Run

King St.

ARLINGTON COUNTY
FAIRFAX COUNTY

I-395

0 0.25 0.5 Miles

Watershed Management Area (WMA) Boundary
Subwatershed Boundary
Lakes and Ponds
County Boundary

Map 4

Subwatershed Map

Four Mile Run Watershed

Existing Land Use

Future Land Use

0 0.5 Miles

Land Use

- Estate Residential
- City of Fairfax
- Golf Course
- High Density Residential
- High Intensity Commercial
- Industrial
- Institutional
- Low Density Residential
- Low Intensity Commercial
- Medium Density Residential
- Open Space
- Transportation
- Water
- WMA Boundary

Map 5

Land Use Map

Belle Haven Watershed

Existing Land Use

Future Land Use

0 0.5 1 Miles

Land Use

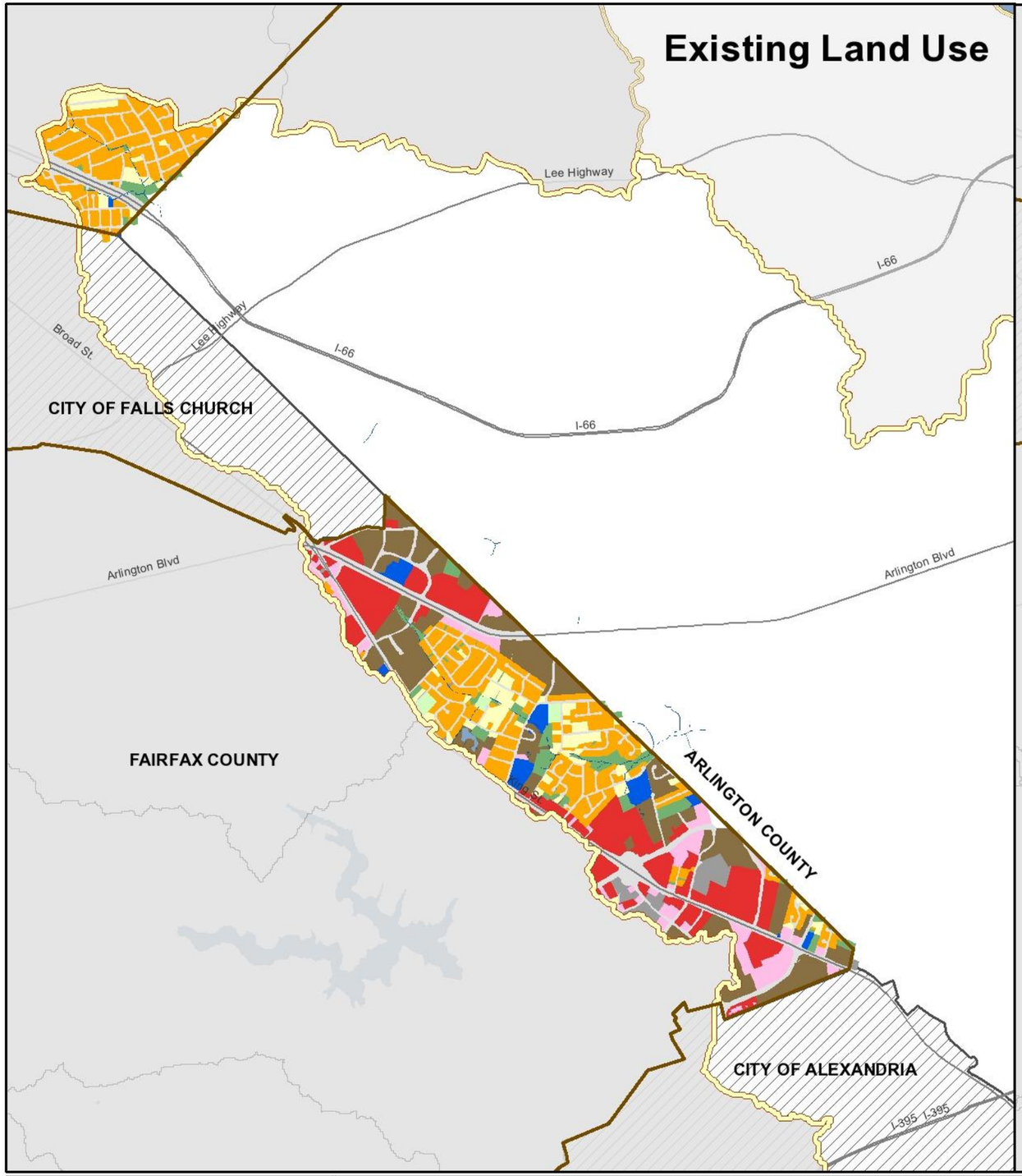
- Estate Residential
- City of Fairfax
- Golf Course
- High Density Residential
- High Intensity Commercial
- Industrial
- Institutional
- Low Density Residential
- Low Intensity Commercial
- Medium Density Residential
- Open Space
- Transportation
- Water
- WMA Boundary

Map 6

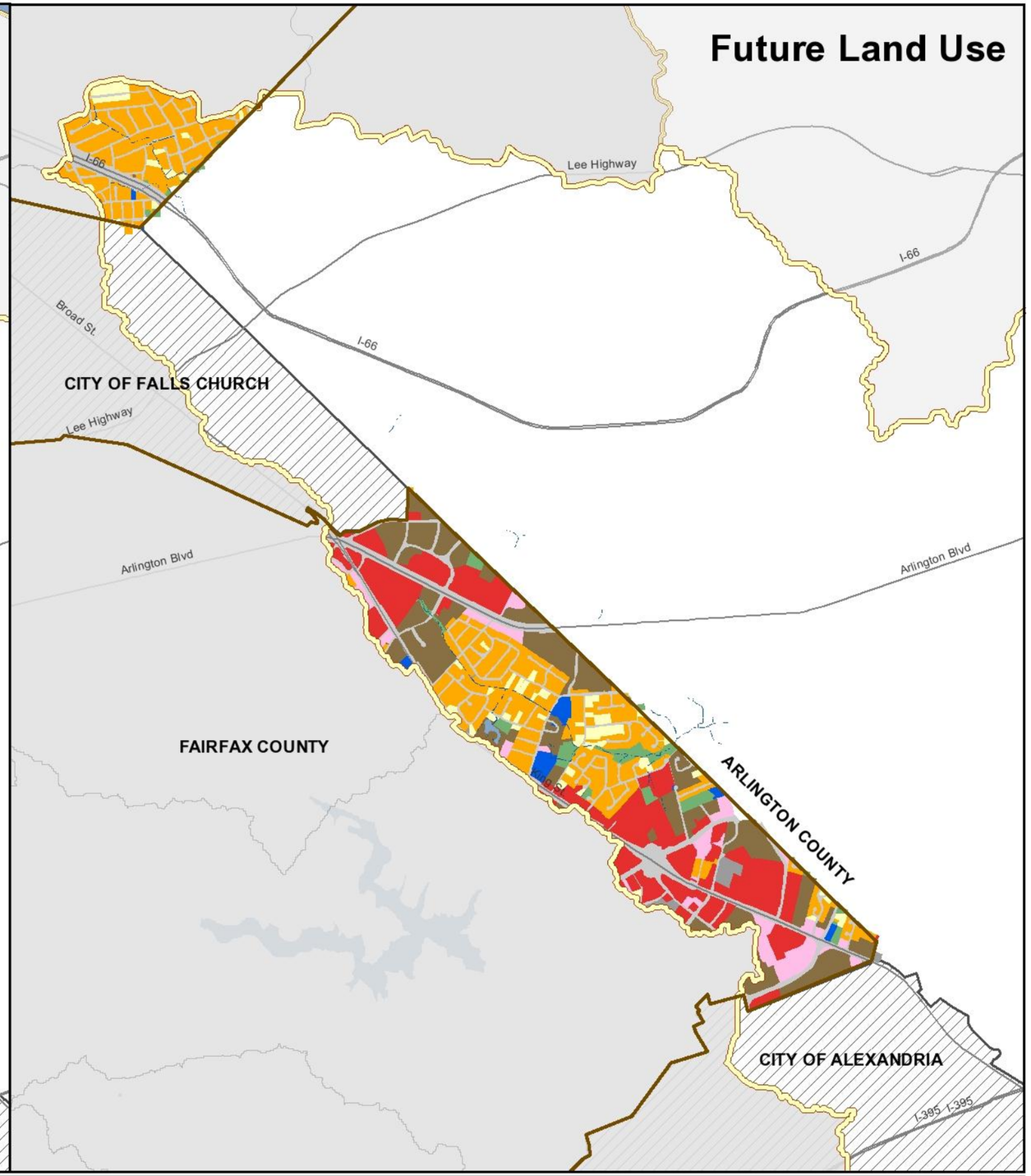
Land Use Map

Dogue Creek Watershed

Existing Land Use



Future Land Use



0 0.5 Miles

Land Use

- Estate Residential
- City of Fairfax
- Golf Course
- High Density Residential
- High Intensity Commercial
- Industrial
- Institutional
- Low Density Residential
- Low Intensity Commercial
- Medium Density Residential
- Open Space
- Transportation
- Water
- Watershed Boundary

Map 7

Land Use Map

Four Mile Run Watershed

Duke St.

Capital Beltway

Richmond Highway

Capital Beltway

0 0.125 0.25 Miles

Watershed Boundary
Subwatershed Boundary
Lakes and Ponds
Streams

Existing Total Nitrogen Load

No Data
Low
Moderate
High
Very High

Map 8

TN Loading Map

Belle Haven Watershed

Richmond Highway

0 0.25 0.5 Miles

Watershed Boundary
Subwatershed Boundary
Lakes and Ponds
Streams

Existing Total Nitrogen Load

No Data
Low
Moderate
High
Very High

Map 9

TN Loading Map

Dogue Creek Watershed

I-66
Lee Highway
Broad St.
I-66
I-66
Lee Highway
Arlington Blvd
Arlington Blvd
King St.
ARLINGTON COUNTY
I-395
I-395
Duke St.

0 0.25 0.5 Miles

Watershed Boundary
Subwatershed Boundary
Lakes and Ponds
Streams

Existing Total Nitrogen Load

No Data
Low
Moderate
High
Very High

Map 10

TN Loading Map

Four Mile Run Watershed

Duke St.

Capital Beltway

Capital Beltway

Richmond Highway

0 0.125 0.25 Miles

Watershed Boundary
Subwatershed Boundary
Lakes and Ponds
Streams

Existing Total Phosphorus Load

No Data
Low
Moderate
High
Very High

Map 11

TP Loading Map

Belle Haven Watershed

Richmond Highway

0 0.25 0.5 Miles

Watershed Boundary
Subwatershed Boundary
Lakes and Ponds
Streams

Existing Total Phosphorus Load

No Data
Low
Moderate
High
Very High

Map 12

TP Loading Map

Dogue Creek Watershed

I-66
I-66
Lee Highway
I-66
Broad St.
Lee Highway
Arlington Blvd
Arlington Blvd
ARLINGTON COUNTY
King St.
I-395
I-395
Duke St.

0 0.25 0.5 Miles

Watershed Boundary
Subwatershed Boundary
Lakes and Ponds
Streams

Existing Total Phosphorus Load

No Data
Low
Moderate
High
Very High

Map 13

TP Loading Map

Four Mile Run Watershed

Duke St.

Capital Beltway

Richmond Highway

Capital Beltway

Watershed Boundary
Subwatershed Boundary
Lakes and Ponds
Streams

Existing Total Suspended Solids Load

No Data
Low
Moderate
High
Very High

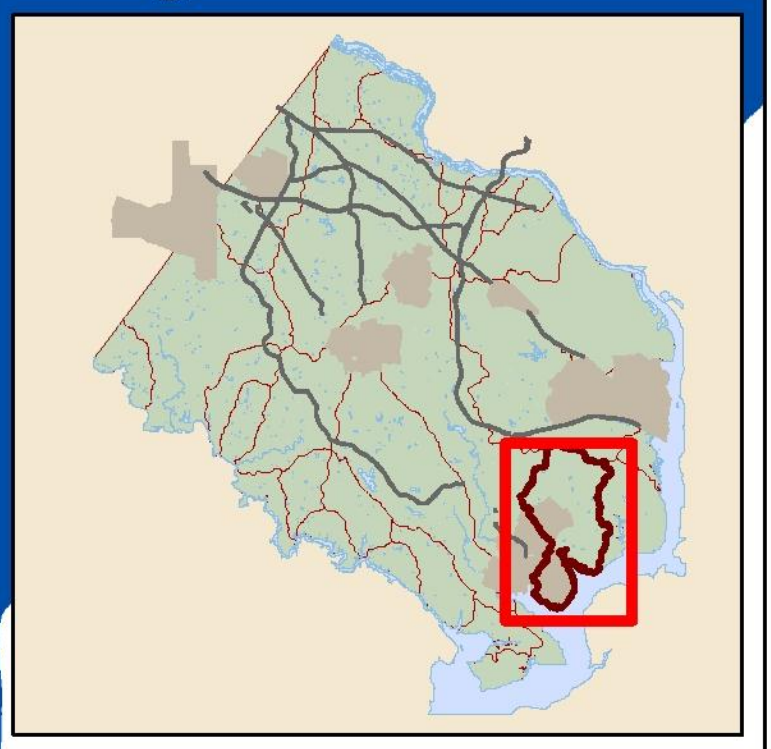
0 0.125 0.25 Miles

Map 14

TSS Loading Map

Belle Haven Watershed

Richmond Highway



0 0.25 0.5 Miles

- Watershed Boundary
- Subwatershed Boundary
- Lakes and Ponds
- Streams

Existing Total Suspended Solids Load

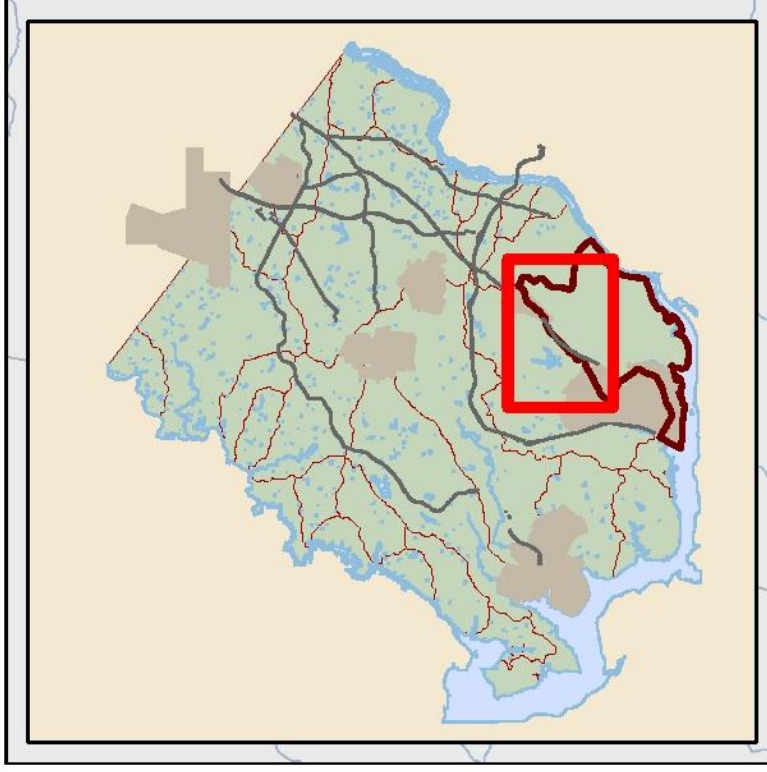
- No Data
- Low
- Moderate
- High
- Very High

Map 15

TSS Loading Map

Dogue Creek Watershed

I-66
I-66
Lee Highway
Broad St.
Lee Highway
Arlington Blvd
Arlington Blvd
King St.
ARLINGTON COUNTY
I-395
I-395
Duke St.



COUNTY OF FAIRFAX 1742 VIRGINIA

0 0.25 0.5 Miles

Watershed Boundary
Subwatershed Boundary
Lakes and Ponds
Streams

Existing Total Suspended Solids Load

No Data
Low
Moderate
High
Very High

Map 16

TSS Loading Map

Four Mile Run Watershed

0 0.125 0.25 Miles

WMA Boundary
303d Listed Streams
Stormwater Facilities
Stormwater Pipes
Parcels
MSMD Flooding/Drainage Complaints
Public Identified Problem Areas 2003 - 2006

Regional Ponds
Constructed
Planned

BMP Control Type
Quantity and Quality
Quantity

Map 17

Stormwater Infrastructure Map

Belle Haven Watershed

0 0.125 0.25 Miles

Obstruction Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Head Cut Height
- 0.5' - 1.0'
- 1' - 2'
- >2'

Dump Site Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Pipe Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Habitat Rating
- Excellent
- Fair
- Very Poor
- Good
- Poor
- Unassessed

Ditch Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Utility Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

CEM Category
- CEM 2 - Incising
- CEM 3 - Widening

Crossing Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

- Resource Protection Area (RPA)
- Deficient Buffer
- Erosion
- Lakes and Ponds

Map 18

Stream Condition Map

Belle Haven Watershed

Existing Land Use

Future Land Use

0 0.15 0.3 Miles

Land Use

- Estate Residential
- City of Fairfax
- Golf Course
- High Density Residential
- High Intensity Commercial
- Industrial
- Institutional
- Low Density Residential
- Low Intensity Commercial
- Medium Density Residential
- Open Space
- Transportation
- Water
- WMA Boundary
- Change in Land Use

Map 19

Land Use Map

Dogue Creek Watershed

Barnyard Run

HUNTLEY MEADOWS

FORT BELVOIR
MILITARY RESERVATION

0 0.25 0.5 Miles

WMA Boundary
303d Listed Streams
Stormwater Facilities
Stormwater Pipes
Parcels
MSMD Flooding/Drainage Complaints
Public Identified Problem Areas 2003 - 2006

Regional Ponds
Constructed
Planned (no facilities)

BMP Control Type
Quantity and Quality
Quantity

Map 20

Stormwater Infrastructure Map

Dogue Creek Watershed
Piney Run WMA
Dogue Creek Mainstem WMA
Barnyard Run WMA

HUNTLEY MEADOWS

FORT BELVOIR
MILITARY RESERVATION

0 0.25 0.5 Miles

Obstruction Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Head Cut Height
- 0.5' - 1.0'
- 1' - 2'
- >2'

Ditch Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Crossing Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Dump Site Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Pipe Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Utility Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Habitat Rating
- Excellent
- Good
- Fair
- Poor
- Very Poor
- Unassessed

CEM Category
- CEM 2 - Incising
- CEM 3 - Widening

- Resource Protection Area (RPA)
- Deficient Buffer
- Erosion
- Lakes and Ponds

Map 21

Stream Condition Map

Dogue Creek Watershed
Piney Run WMA
Dogue Creek Mainstem WMA
Barnyard Run WMA

Existing Land Use

Future Land Use

0 0.25 0.5 Miles

Land Use

- Estate Residential
- City of Fairfax
- Golf Course
- High Density Residential
- High Intensity Commercial
- Industrial
- Institutional
- Low Density Residential
- Low Intensity Commercial
- Medium Density Residential
- Open Space
- Transportation
- Water
- WMA Boundary
- Change in Land Use

Map 22

Land Use Map

Dogue Creek Watershed
Mainstem

Existing Land Use

Future Land Use

0 0.25 0.5 Miles

Land Use

- Estate Residential
- City of Fairfax
- Golf Course
- High Density Residential
- High Intensity Commercial
- Industrial
- Institutional
- Low Density Residential
- Low Intensity Commercial
- Medium Density Residential
- Open Space
- Transportation
- Water
- WMA Boundary
- Change in Land Use

Map 23

Land Use Map

Dogue Creek Watershed

North Fork

FORT BELVOIR
MILITARY RESERVATION

0 0.25 0.5 Miles

WMA Boundary
303d Listed Streams
Stormwater Facilities
Stormwater Pipes
Parcels
MSMD Flooding/Drainage Complaints
Public Identified Problem Areas 2003 - 2006

Regional Ponds
Constructed
Planned (no facilities)

BMP Control Type
Quantity and Quality
Quantity

Map 24

Stormwater Infrastructure Map

Dogue Creek Watershed
North Fork WMA
Potomac WMA

Obstruction Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Head Cut Height
- 0.5' - 1.0'
- 1' - 2'
- >2'

Ditch Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Crossing Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Dump Site Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Pipe Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Utility Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Habitat Rating
- Excellent
- Good
- Fair
- Poor
- Very Poor
- Unassessed

CEM Category
- CEM 2 - Incising
- CEM 3 - Widening

- Resource Protection Area (RPA)
- Deficient Buffer
- Erosion
- Lakes and Ponds

0 0.25 0.5 Miles

Map 25

Stream Condition Map

Dogue Creek Watershed
North Fork WMA
Potomac WMA

Existing Land Use

Future Land Use

0 0.25 0.5 Miles

Land Use

- Estate Residential
- City of Fairfax
- Golf Course
- High Density Residential
- High Intensity Commercial
- Industrial
- Institutional
- Low Density Residential
- Low Intensity Commercial
- Medium Density Residential
- Open Space
- Transportation
- Water
- WMA Boundary
- Change in Land Use

Map 26

Land Use Map

Dogue Creek Watershed

Piney Run

Existing Land Use

Future Land Use

0 0.25 0.5 Miles

Land Use

- Estate Residential
- City of Fairfax
- Golf Course
- High Density Residential
- High Intensity Commercial
- Industrial
- Institutional
- Low Density Residential
- Low Intensity Commercial
- Medium Density Residential
- Open Space
- Transportation
- Water
- WMA Boundary
- Change in Land Use

Map 27

Land Use Map

Dogue Creek Watershed

Potomac

ARLINGTON COUNTY

CITY OF FALLS CHURCH

CITY OF ALEXANDRIA

0 0.25 0.5 Miles

WMA Boundary
303d Listed Streams
Stormwater Facilities
Stormwater Pipes
Parcels
MSMD Flooding/Drainage Complaints
Public Identified Problem Areas 2003 - 2006

Regional Ponds
Constructed
Planned

BMP Control Type
Quantity and Quality
Quantity

Map 28

Stormwater Infrastructure Map

Four Mile Run Watershed

CITY OF FALLS CHURCH

ARLINGTON COUNTY

CITY OF ALEXANDRIA

0 0.25 0.5 Miles

Obstruction Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Head Cut Height
- 0.5' - 1.0'
- 1' - 2'
- >2'

Ditch Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Crossing Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Dump Site Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Pipe Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Utility Impact
- Minor to Moderate
- Moderate to Severe
- Severe to Extreme

Habitat Rating
- Excellent
- Fair
- Very Poor
- Good
- Poor
- Unassessed

CEM Category
- CEM 2 - Incising
- CEM 3 - Widening

- Resource Protection Area (RPA)
- Deficient Buffer
- Erosion
- Lakes and Ponds

Map 29

Stream Condition Map

Four Mile Run Watershed