Appendix A: Draft Watershed Workbook

Appendix A includes a draft version of the Lower Occoquan watershed workbook (WW), which summarizes the overall condition of the Lower Occoquan watershed. This draft document was not intended to be updated past the point in the characterization process at which it was published. This document reflects the Lower Occoquan Watershed characterization work up to the point in the process where the WAG involvement began. This means that some of the information, maps, or tables in this document might have since become outdated.

The Lower Occoquan watershed is comprised of eight small watersheds: Old Mill Branch, Wolf Run, Sandy Run, Ryans Dam, Occoquan, Mill Branch, Kane Creek, and High Point. For Fairfax County planning and management purposes, most watersheds are subdivided into watershed management areas (WMAs), which typically consist of approximately four square miles (2,560 acres), each draining to a specific stream or tributary. For most of the small watersheds in Lower Occoquan, the entire watersheds themselves are defined as WMAs with the exception of the larger Mill Branch watershed, which has been divided into 3 individual WMAs. Fairfax County has further subdivided each WMA into smaller areas, herein called subwatersheds, which are typically 100-300 acres each. These areas are used to identify specific projects or opportunities for enhancement of the overall watershed and serve as the basic unit for watershed modeling and other evaluations.

A summary review of the existing conditions of the entire Lower Occoquan watershed are found in Chapter 1, whereas descriptions of each WMA within the Lower Occoquan watershed are detailed in Chapter 2.

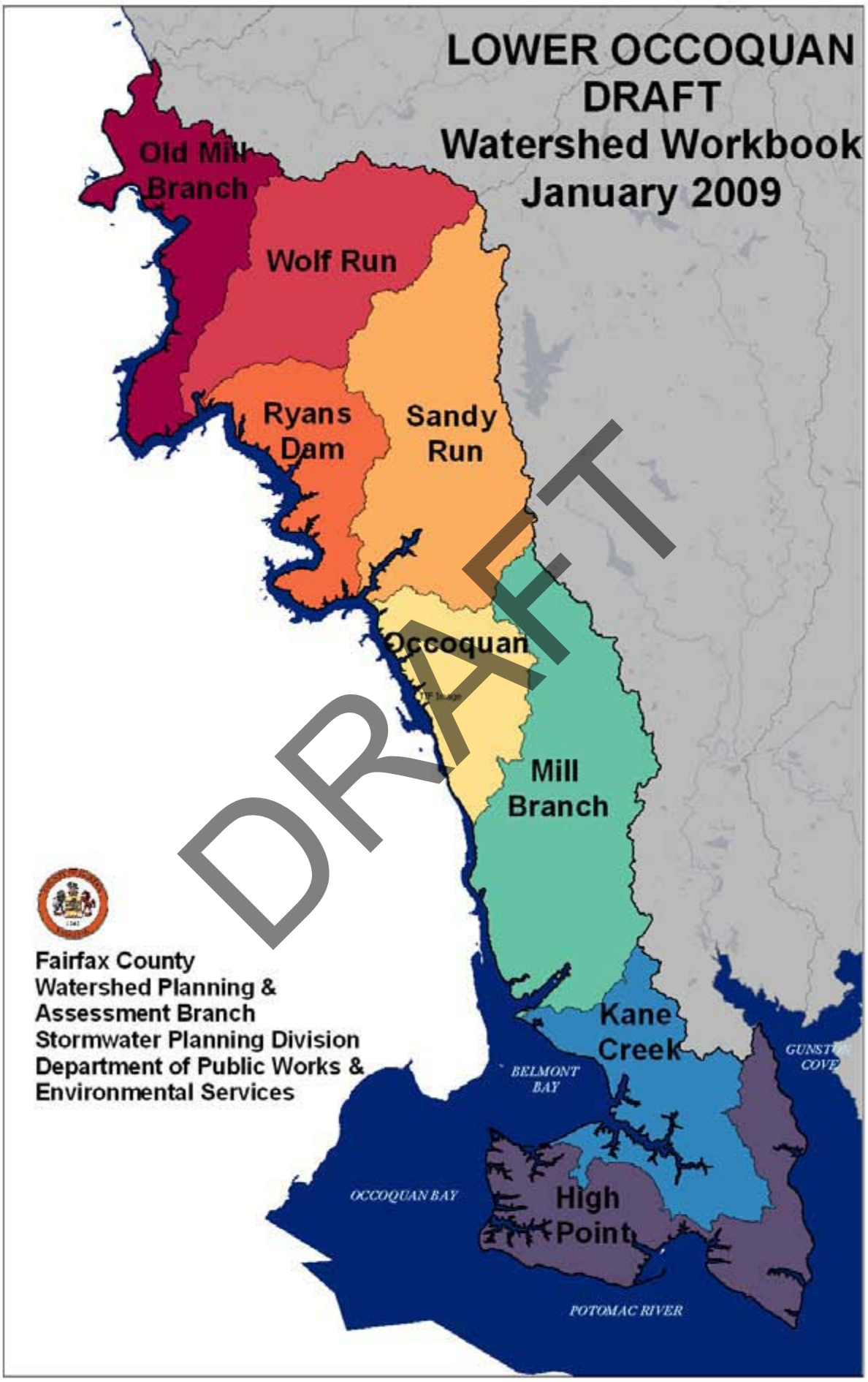

LOWER OCCOQUAN
DRAFT
Watershed Workbook
January 2009
Old Mill Branch
Wolf Run
Ryans Dam
Sandy Run
Occoquan
Mill Branch
Kane Creek
BELMONT BAY
GUNSTON COVE
OCCOQUAN BAY
High Point
POTOMAC RIVER
DRAFT
Fairfax County
Watershed Planning &
Assessment Branch
Stormwater Planning Division
Department of Public Works &
Environmental Services

Table of Contents

List of Tables

List of Figures

List of Maps

1.0 Compilation of Overall Watershed Condition Data

1.1 General Watershed Characteristics

The Lower Occoquan watershed is located along the southwestern border of Fairfax County. It comprises eight small watersheds: Old Mill Branch, Wolf Run, Sandy Run, Ryans Dam, Occoquan, Mill Branch, Kane Creek, and High Point. As Table 1 illustrates, collectively, these watersheds serve a drainage area of over 44 square miles. See **Map 1.1 and Map 1.2** for Fairfax County, and Lower Occoquan watershed respectively. Map 1.2 illustrates the relative locations of these watersheds within the Lower Occoquan Watershed.

Table 1: Lower Occoquan Watersheds

Watersheds	Area (sq. miles)	Area (Acres)	Rank Size
Mill Branch	8.75	5,598	1
Sandy Run	8.12	5,198	2
Wolf Run	5.88	3,762	3
High Point	5.55	3,555	4
Kane Creek	4.81	3,076	5
Old Mill Branch	4.26	2,724	6
Ryans Dam	3.53	2,262	7
Occoquan	3.32	2,126	8
Watershed Total	**44.22**	**28,301**	

The Lower Occoquan watershed has many unique facets; it is home to local, regional, state and federal parks including Laurel Hill (formerly the District of Columbia Department of Correction Facility, located in Lorton), Fountainhead Regional Park, Mason Neck State Park and the Mason Neck National Wildlife Refuge. In addition, it contains the Occoquan Reservoir which serves as one of the two major drinking water sources for Fairfax County. More than half of the watersheds fall within the Water Supply Protection Overlay District (WSPOD). WSPOD was established in 1982 to protect water quality in the Occoquan Reservoir. With the exception of Mill Branch, Kane Creek, and High Point, the remaining watersheds lie within the WSPOD.

In addition, much of northern portion of Lower Occoquan lies in the R-C District or Residential-Conservation district. The R-C District was established to protect streams, ecological areas, and minimize impervious surfaces to protect water quality. R-C district restricts development size within the watershed to a minimum of 5 acres per residential dwelling unit. Consequently, the Lower Occoquan is one of the least developed watersheds in the County. As a result of minimal development, large parks and open space, the overall stream habitat condition of the watershed is considered good to excellent. The Lower Occoquan watershed contains some of the highest stream quality in Fairfax County.

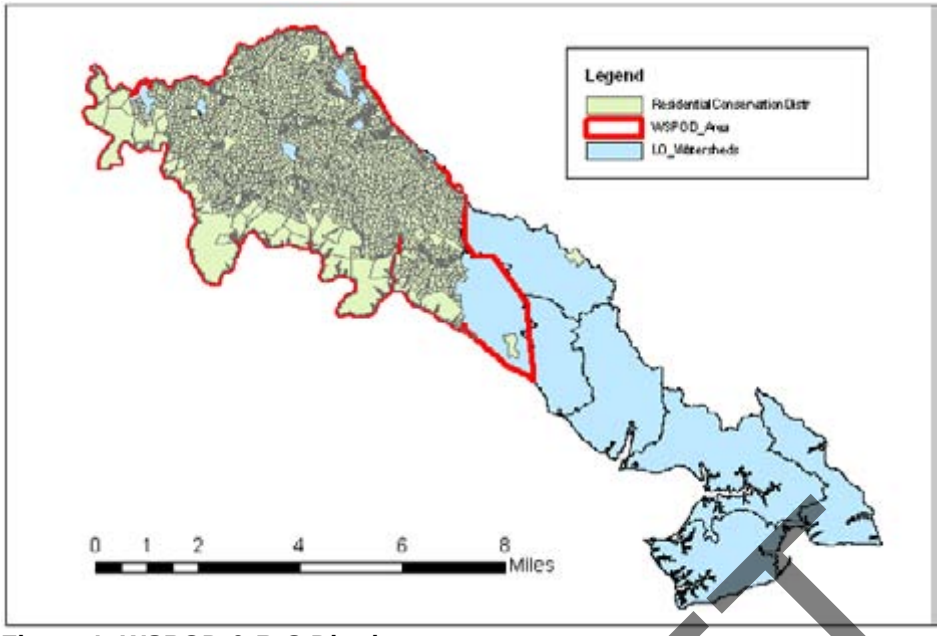


Figure 1: WSPOD & R-C District

Lower Occoquan watershed is fairly equally divided between two physiographic provinces: the Piedmont Upland province and the Coastal Plain province. Approximately 57 percent of the land within the Lower Occoquan watershed lies within the hard, Paleozoic metamorphic rocks of the Piedmont Upland physiographic province, while the remaining 43 percent lies within the Coastal Plain physiographic province, which is characterized by soft, flat Mesozoic and Tertiary sedimentary rocks. Both provinces have characteristic gently sloping landscapes; however, the streams of the Coastal Plain are dominated by low-velocity pool-and-glide habitats while the streams of the Piedmont have higher-velocity riffle-run habitats. According to the Virginia Department of Quality (VDEQ), the "Coastal Plain region is the only one in Virginia that is composed mostly of unconsolidated deposits, primarily alternating layers of sand, gravel, shell rock, silt, and clay and more ground water is stored in these very permeable materials than in any other province in the state(VDEQ, Physiographic Provinces of Virginia)".

1.2 Population Growth and Watershed History

Fairfax County's original boundary lines were drawn in 1741, yet over the next 50 years, portions of the County would become areas of the District of Columbia and Loudoun County. From 1750 to 1930, Fairfax County was largely considered agricultural, with a large population of dairy and tobacco farms. Over the next 20 years the population would grow from 25,000 in 1930 to almost 100,000 by 1950. The availability of the automobile and the expansion of the federal government were key factors for the County's population boom to 450,000 by the 1970's. Over the next 20 years, as even more job opportunities became available, the population nearly doubled to 800,000, and by 2005, Fairfax County exceeded 1 million residents. Fairfax County as a whole is expected to experience more than a 37% population increase over the next 20 years.

Table 2: Growth Trends in Fairfax County 1990-2025

Year	Population (thousands)	Households (thousands)	Employment (thousands)
1990	818.6	292.3	403.7
2000	968.2	353.4	526.4
2010	1,112.9	412.5	644.4
2020	1,184.1	438.1	701.3
2025	1,203.7	445.0	727.8

(Source: Metropolitan Washington Council of Governments 2006)

Two large dams were built along the Occoquan River in the mid 1950's and 1960's to meet the increasing population's drinking water supply demands. These dams resulted in an impoundment of nearly 9.8 billion gallons of water. As a result of the rapid population growth, detrimental impacts to the County's natural resources began to surface, and in 1982 the Fairfax County Board of Supervisors approved the WSPOD, a down-zoning of more than 41,000 acres.

1.3 Existing & Future Land Use

Historically, Lower Occoquan has experienced relatively minimal development which has resulted in a low overall impervious area. Data collected from current County geographic information systems (GIS) illustrates the small percentages of impervious development.

Overall the Lower Occoquan watershed is dominated by two primary land types: Estate Residential and Open Space, both of which have very low imperviousness values. By examining future land use type data in the table below, and **Map 1.3**, residential land use increases by less than 3.5 square miles with the majority of increase reflected in estate residential, industrial land use should decrease by more than 0.5 square mile. In addition, commercial land use will increase less than 0.03% in the entire watershed; therefore Lower Occoquan is predicted to experience a very slight increase in imperviousness in the overall watershed. The entire impact to the Lower Occoquan watershed is less than a tenth of a percent change in land use.

Table 3: Existing & Future Land Use Lower Occoquan (Co. GIS dataset)

	Existing Conditions		Future Conditions	
Land Use Description	**Acres**	**Percent**	**Acres**	**Percent**
Open space, forest, parks, & recreational areas	12,324.53	43.55%	10,672.95	37.71%
Golf Course	10.60	0.04%	10.60	0.04%
Estate Residential	10,318.35	36.46%	11,762.44	41.56%
Low-Density Residential	1,245.09	4.4%	1,803.55	6.37%
Medium-Density Residential	433.09	1.53%	451.40	1.60%
High-Density Residential	194.52	0.69%	300.07	1.06%
Low-Intensity commercial	23.29	0.08%	28.48	0.10%
High-Intensity commercial	49.34	0.17%	68.25	0.24%
Industrial	1,430.21	5.05%	1,009.20	3.57%
Institution	794.46	2.81%	716.57	2.53%

Land Use Description	Existing Conditions		Future Conditions	
	Acres	Percent	Acres	Percent
Transportation	1,175.21	4.15%	1,175.21	4.15%
Water	302.03	1.07%	302.03	1.07%

Lower Occoquan is also home to a distinct land use area, Laurel Hill (formerly District of Columbia Department of Correction Facility, located in Lorton). As show in Figure 2 below, large sections of the Laurel Hill land bay lies within the Mill Branch watershed while a small sliver falls in the Occoquan watershed. The County is currently engaged with the redevelopment of this area and is in the process of identifying multiple stormwater management strategies to enhance the land use and improve overall stream conditions and water quality. Additional information on the Laurel Hill area can be found in Chapter 2 under the Giles Run North, Giles Run South and Mill Branch sections

Details of the master planning process for Laurel Hill can be found on the County website under: http://www.fairfaxcounty.gov/dpz/laurelhill/. In addition, the Laurel Hill Project Advisory Citizens Oversight Committee sponsors periodic newsletters about the ongoing process to reuse the Correction Facility. Links to the newsletters can be found on the County website listed above.

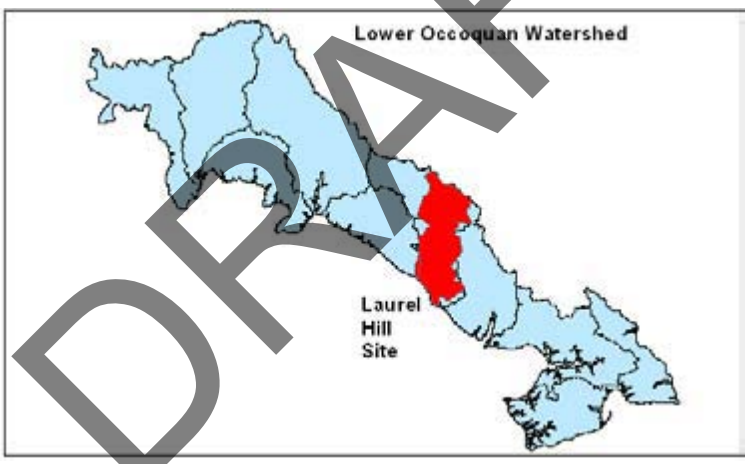


Figure 2: Laurel Hill Site

1.4 Impervious Areas

Impervious areas can be described as hard surfaces that stormwater (rain water) can not penetrate and consequently runs off into a collection system. Increased impervious surfaces can result in channel erosion and downstream degradation caused by the increased volume and velocity of new stormwater runoff reaching receiving waters. It has been shown that levels of 10-20% impervious surface significantly reduce stream health (Annual Report, 2005). Over the decades, Lower Occoquan has experienced minimal population growth and consequently an increase in impervious surface due to new development and supporting infrastructure development.

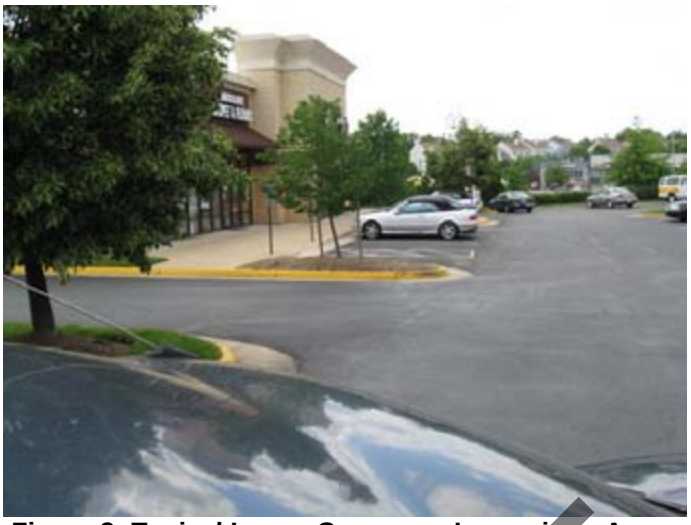


Figure 3: Typical Lower Occoquan Impervious Areas

With the exception of Mill Branch watershed which contains the Laurel Hill redevelopment, Lower Occoquan watershed is to have very minimal new development. However, the Lower Occoquan watershed has been experiencing pockets of redevelopment. Generally these areas are already considered developed and therefore do not typically create large tracks of new impervious areas, consequently the overall future impervious surface for all of Lower Occoquan is not expected to increase by any significant amount. As permitted redevelopment occurs, updates to the County's electronic GIS land use layers will be populated and impervious areas may reflect an increase. **Table 4** below identifies the historic and future planned imperviousness conditions throughout the Lower Occoquan watershed (excluding Laurel Hill redevelopment).

Table 4: Lower Occoquan Impervious Land Use

Year	Impervious Area (square miles)	Percent Impervious
1980	1.0	2.2%
1990	1.8	3.9%
Current	4.05	8.9%
Future	4.05	8.9%

While Lower Occoquan as a whole is primarily open space or estate residential, as highlighted above, pockets of Lower Occoquan has experienced slight increase in impervious area primarily due to the Laurel Hill redevelopment. Since the Laurel Hill redevelopment area is located primarily within the Mill Branch watershed, to highlight the differences in impervious area throughout this watershed, Mill Branch has been further divided into three smaller areas, Giles Run North, Giles Run South, and Mill Branch. Below provides a summary of the Lower Occoquan impervious areas.

Table 5: Lower Occoquan Percent Impervious

Watersheds	Percent Impervious			
	Current Condition		Ultimate Condition	
	(acres)	%	(acres)	%
Giles Run North (MB)	324.65	16.22	329.91	16.48
Giles Run South (MB)	271.25	11.65	309.34	13.29
Mill Branch (MB)	726.25	10.28	134.48	10.6
Sandy Run	301.7	5.8	312.25	6.01
High Point	84.79	2.38	104.14	2.93
Wolf Run	163.51	4.35	172.34	4.58
Kane Creek	57.93	1.88	70.7	2.3
Old Mill Branch	62.21	2.28	69.55	2.55
Ryans Dam	45.77	2.02	51.76	2.29
Occoquan	135.32	6.36	150.7	7.09

1.5 Existing Stormwater Controls

1.5.1 Historical Drainage Data

In 1978, the County sponsored a study to examine the baseline conditions for the Lower Occoquan watersheds. This study evaluated the surface water quality and physical stream channel conditions. It was concluded while some erosion and sedimentation was found throughout the watersheds, LO had not experienced increased peak flows due to urbanization as seen throughout other parts of the County (Parsons, 1978).

Based on information gathered in the 1978 study, the following year, the County published a proposed drainage plan for the Occoquan watersheds. The document recommended 20 drainage improvement projects for five of the eight watersheds. Fifteen of the twenty projects were identified as “raise road and replace culvert” while the remaining 5 projects focused on installing riprap bank protection (Parsons, 1979). Photo source: VDEQ *Unified Stream Methodology Photos*.

Figure 4: Typical riprap bank protection (VA DEQ)

1.5.2 Current Stormwater Controls

The watershed also contains a wide variety of additional stormwater infrastructure and best management practices which track with the watershed's development history. In areas that experienced early development, stormwater management facilities when present, consist primarily of dry detention basins. These dry detention basins were designed to curb peak storm flows only (quantity management). In areas with more recent development, stormwater management facilities are more likely to include a water quality component, and therefore the variety of facility types found in these areas. Facilities found in these areas include wet detention facilities, underground chambers, infiltration devices, and constructed wetlands. However, as a direct result of minimal development, the table below illustrates that more than 95% of Lower Occoquan has no stormwater treatment.

Table 6: Lower Occoquan Stormwater Treatment Types

	Current Treatment Types			
	Quantity	Quality	Quantity & Quality	None
Watershed	(acres)	(acres)	(acres)	(acres)
Mill Branch	42	19	239	5,297
Sandy Run	95	133	281	4,689
High Point	0	3	0	3,552
Wolf Run	0	106	13	3,643
Kane Creek	0	4	12	3,060
Old Mill Branch	0	19	10	2,694
Ryans Dam	0	47	0	2,214
Occoquan	20	19	27	2,061
Totals:	**157**	**350**	**582**	**27,210**

In 2005, the County released the Stream Physical Assessment (SPA) report which documented the instream conditions of more than 800 stream miles. Both habitat assessment and some infrastructure assessment (if found instream) were captured. The infrastructure assessment was included to determine the impacts on streams from

specific infrastructure and problem areas. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed; any potential impacts to the stream were documented with an impact score.

The impact scores ranged from zero to ten or greater, with zero indicating no impact and ten indicating extreme conditions. An extreme condition would include such things as impervious encroachment near the stream severe erosion areas and large obstructions in the channel. Below summarizes the total number of infrastructure assessments points documented within each watershed. Refer to Chapter 2 for details of individual watershed inventory points.

Table 7: Summary Lower Occoquan Inventory Points (SPA, 2005)

Watershed	Total Inventory Assessed	Percentage of County Inventory Points
Mill Branch	98	1.03%
Sandy Run	171	1.79%
High Point	6	0.06%
Wolf Run	133	1.39%
Kane Creek	13	0.14%
Old Mill Branch	29	0.30%
Ryans Dam	10	0.10%
Occoquan	40	0.42%

The majority Lower Occoquan streams are natural open channel flow, and the stormwater runoff is routed to the streams with minimal controls. While overall the majority of the streams in Lower Occoquan experience minimal impacts, some streams are experiencing erosion due to development and increased runoff. Below is an example of stream bank erosion in Lower Occoquan.

Figure 5: Lower Occoquan Bank Erosion

The Occoquan New Millennium Task Force released a report in 2003, detailing the history and future of the Occoquan watershed. The Occoquan watershed, which

includes the Occoquan Reservoir, consists of 590 square miles and lies in Fauquier, Prince William and Fairfax County. Five of the eight Lower Occoquan watersheds fall within the Occoquan watershed: Old Mill Branch, Wolf Run, Ryans Dam, Sandy Run, and Occoquan. The report focused on both the Occoquan reservoir storage capacity and reservoir water quality. The report detailed the health of the streams and aquatic systems within the entire watershed and outlined five recommendations for protecting or restoring the streams and ecosystems within the Occoquan watershed. The recommendations, listed below, focus on structural and nonstructural means for improving water quality.

1. Maintain the integrity of the WSPOD, or down-zoning
2. Continue monitoring stream health
3. Develop and implement the watershed management plans for all Fairfax County watersheds
4. Adopt stormwater management facilities that are less degrading to stream ecosystems
5. Encourage Low Impact Development (LID) techniques that are proven effective to local conditions

1.6 Stream Conditions

In 2001, the County released the Stream Protection Strategy Baseline (SPS) Study. This study documented the current stream conditions throughout the County using physical, chemical and biological evaluations. The County collected biological and habitat data from 138 stream sites and developed a ranking of overall quality for each of site. The rankings were based on the following four components of stream/watershed condition:

- Index of Biotic Integrity (IBI) incorporating 10 separate measures of benthic macro invertebrate (insect) community integrity,
- Habitat Score: evaluation of 10 stream valley features including riparian and instream assessments,
- Fish taxa richness (number of distinct species present), and
- Overall percent impervious cover within a contributing drainage area

While numeric scores were given to each of the above individual components, a composite value was determined and a qualitative category of: Excellent, Good, Fair, Poor and Very Poor; was assigned to each of the sites. Overall Lower Occoquan had some of the best ranked stream conditions in all of Fairfax County.

Table 8: Lower Occoquan Stream Condition Ranking (SPS, 2001)

Stream Name and Site Code	Composite	Environmental Tables			
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	% Impervious Surface
Old Mill Branch (OMOM01)	Excellent	Excellent	Fair	Low	3.5
Wolf Run 1 (WRWR01)	Fair	Excellent	Fair	Very Low	3.3
Wolf Run 2 (WRWR02)	Excellent	Excellent	Good	Moderate	3.9

Ryan's Dam Unnamed Trib. (RDRT01)	Excellent	Excellent	Fair	Moderate	3.3
Sandy Run 1 (SASA01)	Excellent	Good	Good	High	6.1
Sandy Run 2 (SASA03)	Excellent	Good	Good	Moderate	4.4
Sandy Run Unnamed Trib. (SASA02)	Fair	Good	Fair	Very Low	1.0
Elk Horn Run (OCEH01)	Excellent	Excellent	Excellent	Low	3.6
Giles Run 1 (MBGR01)	Good	Fair	Fair	Moderate	11.4
Giles Run 2 (MBGR02)	Excellent	Fair	Good	Moderate	10.5
Mill Branch (MBMB01)	Fair	Fair	Poor	Moderate	8.0
Kane Creek (KCKC01)	Excellent	Excellent	Good	High	2.2

Following up from the 2001 SPS, the County released the SPA study which, in addition to identifying stormwater structural inventory, it documented the visual habitat assessments of the stream conditions throughout the County. Using information based on habitat conditions, impacts on streams, general stream characteristics and geomorphic classification, a length-weighted total habitat score was calculated for each watershed and categorized into one of five habitat assessment rating categories:

- Excellent (142-168): Minimally impaired habitat with a relatively high potential for supporting a diverse biological community
- Good (114-141): Slightly degraded habitat with a moderate potential for supporting a diverse biological community
- Fair (87-113): Moderately degraded habitat with a fair potential for supporting a diverse biological community
- Poor (59-86): Significantly degraded habitat with a low potential for supporting a diverse biological community
- Very poor (32-58): Severely degraded habitat with little potential for supporting a diverse biological community

Overall the County stream habitats were rated as 'fair' with scores ranging from 32 to 168 out of a possible 200 with an average length-weight total habitat score of 104. The majority of the watersheds scored equal to or higher than the County average. The following table illustrates each of the eight watersheds scores. Refer to Chapter 2 for detailed ranking information for each watershed:

Table 9: Lower Occoquan Habitat Assessment Summary (SPA, 2005)

Watershed	Total Habitat Score	Total Habitat Category
Mill Branch	106	Fair
Sandy Run	104	Fair
High Point	124	Good
Wolf Run	99	Fair
Kane Creek	128	Good
Old Mill Branch	99	Fair
Ryans Dam	145	Excellent

Occoquan	117	Good
Fairfax County (portion in watershed)	*104*	*Fair*

1.7 Stream Water Quality

In addition to collecting and analyzing biological data, the 2001 SPS classified each subwatershed into management categories which outline key strategies and goals for future stream restoration and protection. Three management categories were established based on overall stream rankings and projected development within the watersheds. These categories were developed as management planning tools. Table 10 below identifies the management categories and the associated goals.

Table 10: Management Category (SPS, 2001)

Management Category	Goal
Watershed Protection Areas	Preserve the quality rating of the streams
Watershed Restoration Level I (WRL I)	Take measures to re-establish a healthy biological community
Watershed Restoration Level II (WRL II)	Maintain areas to prevent further degradation, improve water quality to comply with Chesapeake Bay initiatives & TMDL regulations

While Lower Occoquan watershed contains a range of biological and habitat conditions from high to low, the majority of Lower Occoquan lies within the Watershed Protection Areas, with small portions of Wolf Run, Sand Run and Mill Branch falling within Watershed Restoration Level I (WRL I). The Lower Occoquan watershed is one of the least developed watersheds in the County. As a result of minimal development, large parks and open space, the overall stream habitat condition of the watershed, with a few exceptions, is considered 'good' to 'excellent' and contains some of the highest quality streams in Fairfax County. Protection of the existing higher-quality aquatic resources in these watersheds is the primary management approach recommended from the SPS study.

Fairfax County stream conditions are assessed through bacteria, physical, chemical and biological sampling at multiple monitoring stations through the County's stream monitoring program. These monitoring stations are randomly selected each year throughout the county to capture water quality and biological health data for various drainage areas and stream sizes. In 2006, the County had two monitoring stations located within Lower Occoquan, one in Sandy Run watershed and the second in the Occoquan watershed. See Table 11 below for monitoring results (Annual Report, 2006).

Table 11: Lower Occoquan Monitoring Results*

				Benthic		Fish		Bacteria
WMA	Site ID	Stream Order	Drainage Area (mi)	IBI	Rating	IBI	Rating	Sample Exceeding
Occoquan	OC0501	1	0.11	92	Excellent	N/A		2 of 4
Sandy Run	SA0501	1	0.17	47	Fair	N/A		1 of 4

(Annual Report, 2006 * monitoring results for 2005 sample year)

In 2007, the County identified 62 perennially flowing streams sites to determine stream conditions at a countywide scale. These sites were selected to capture a cross section of

the various streams throughout the county. It allowed the county to obtain statistically defensible determination of stream conditions at a countywide scale. Of the 62 sites sampled in 2007: 40 sites randomly selected within Fairfax County as part of the annual probabilistic monitoring program; 10 trend-monitoring sites in the County; 10 piedmont reference locations in Prince William National Forest Park; and two coastal plain reference sites in the Kane Creek watershed of Fairfax County. The results of the sampling suggest that approximately 67 percent of the county's waterways are in "Fair" to "Very Poor" condition based on a decrease in biological diversity. (Annual Report on the Environment, 2007)

1.7.1 Tributaries

The Lower Occoquan watershed contains more than 220 miles of stream within the eight watersheds. Included in the eight watersheds are 15 separate named tributaries. A tributary is considered a stream or a river that flows into a mainstem or a larger river. In addition to the 15 separate tributaries, the Occoquan River is considered a tributary (to the Potomac River) and is located along seven of the eight watersheds. Lower Occoquan is unique in that it consists of watersheds which comprise of individual streams or rivers draining directly to the Occoquan River (i.e. Occoquan) and watershed which comprise of tributaries which feed into a mainstem then discharge into the Occoquan River (i.e. Wolf Run).

Seven of the eight watersheds drain entirely into the Occoquan River, High Point, the exception; drains into the Potomac River. Information relating to the hydraulic and hydrological modeling results of the streams can be found in Section 2.4.

1.7.2 Resource Protection Area /Perennial Streams

As one of many measures used to protect stream water quality, the County adopted the Chesapeake Bay Preservation Ordinance, which imposes restrictions on development for any land that lies within a Resource Protection Area (RPA). Resource protection areas are buffers which protect sensitive areas adjacent to or near the shorelines of streams, rivers and other waterways from the excessive influx of pollutants. The sensitive areas include tidal and non-tidal wetlands, tidal shorelines, floodplains and perennial streams (waters flowing year round). As **Map 1.4** indicates more than half of the streams within the Lower Occoquan watershed lie within a RPA. (County GIS, 2008)

While Lower Occoquan has more than 220 miles of streams, only about half are considered perennial streams. A perennial stream can be defined as a stream which has continuous flow in its channel year round. The remaining streams are either intermittent streams which flow during normal rainfall and can continue to flow for a few weeks or months or ephemeral streams which typically only flow for only a few hours during and after a rain event. Many of the streams in the Lower Occoquan watershed are protected under the Chesapeake Bay Preservation Act. Under the Act, RPAs were established to protect specific perennial streams from degradation. Table 12 below illustrates the break out of stream miles per watershed management area of RPAs. Since the County adoption of the Chesapeake Bay Preservation Ordinance in 1993, throughout the years, additional RPA areas have been identified and added to the County inventory and are reflected as a total in the table below.

Table 12: Lower Occoquan RPA streams*

Watershed	Total Stream (miles)	RPA Stream Length total (miles)
Giles Run North (Mill Branch)	17.39	9.90
Giles Run South (Mill Branch)	8.75	5.57
Mill Branch (Mill Branch)	4.35	2.47
Sandy Run	58.01	35.71
High Point	8.53	3.35
Wolf Run	36.18	22.74
Kane Creek	11.67	8.81
Old Mill Branch	31.62	16.41
Ryans Dam	49.71	13.97
Occoquan	13.70	9.17
Watershed Total	239.91	128.10

(*Based on Co. GIS data set)

1.7.3 Impaired Waters

In 1972, the Clean Water Act was established to provide a regulatory framework to protect the waters of the U.S. Under the Clean Water Act, water quality standards were developed to protect the public health and enhance the quality of surface waters. To meet these standards, *designated uses* have been developed to define the water quality needed to support each usage. In Virginia, "all State waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish" (9 VAC 25-260 Virginia Water Quality Standards, 2007).

To meet these standards, the county and other agencies regularly monitor water quality at various locations throughout the county. Utilizing physical, bacteria, chemical and biological sampling at multiple monitoring stations, overall stream conditions are analyzed. These monitoring stations are located throughout the entire watershed to capture water quality data for various drainage areas and stream sizes. In 2006, the Commonwealth of VA (DEQ) identified 101 total impairments throughout the county. Of the 101 total impairments only 18 fall within the Lower Occoquan watersheds (Annual Report on Fairfax County Streams, 2006).

The majority of the Lower Occoquan watershed resides in the down-zoned area and therefore has experienced some of the best water quality in the County. However, while many streams are considered "fair", three watersheds experience high levels recreational contact use impairments. 1.7 miles of Mills Branch streams experience higher then normal levels of Fecal Coliform and 2.3 miles of Wolf Run and 0.1 mile of Occoquan register higher then normal levels of E. coli.

Portions along Occoquan Bay, Belmont Bay, and Occoquan River make up the remaining impairments. These three estuarine impairments traverse the entire length of the LO watershed. These three waterbodies experience higher levels of aquatic life use

(plants, pH), and fish consumption use (PCB in fish tissue) impairments. See **Map 1.5** and Table 13 below for a complete listing of impairments in Lower Occoquan.

Table 13: Lower Occoquan Impaired Waters

	Aquatic Life			Fish Consumption		Recreation		
Segment ID	Submerged Aquatic Plants	DO	pH	PCB in Fish Tissue	E. coli	Fecal Coliform	Total	
Occoquan Bay	OCC01A04	0.5			0.5			0.5 mi^2
Occoquan Bay	OCC02A00	0.6		0.6				0.6 mi^2
Occoquan Bay/Belmont Bay	OCC20A02	5.4			5.4		5.4	5.4 mi^2
Occoquan Bay/Belmont Bay	POT20A04	0.2			0.2		0.2	0.2 mi^2
Occoquan River	OCC05A02	0.1			0.1		0.1	0.1 mi^2
Occoquan Reservoir	OCC01A02		1327.5					1327.5 ac
Mill Branch	WLB01A02						1.7	1.7 mi
Wolf Run	WOL01A06					2.3		2.3 mi

(Annual Report, 2006)

Section 303(d) of the Clean Water Act requires states to develop a list of impaired waters, commonly referred to as the "303(d) list." If a water body fails to meet the numeric or narrative criteria in a water quality standard or does not achieve its designated use, then a water body is considered impaired. Every two years, states are required to submit a list of impaired waters to EPA for approval.

In 2006, Virginia's Department of Environmental Quality (DEQ) developed an Impaired Waters list which was released to the public in draft form for a 30-day comment period. After receiving and reviewing comments, the list was revised and resubmitted to EPA. The following streams within Lower Occoquan watershed are considered Category 5 waters, or waters requiring a Total Maximum Daily Load (TMDL) Study. A TMDL is designed to identify the amount of pollution a specific stream can receive and still meet its designated use. See Table 14 below for Category 5 waters. Information is currently being compiled capturing data from the past two years (through 2008) and should be released for public review in early 2009.

Table 14: Lower Occoquan TMDL (2006 VDEQ Virginia 305(b)/303(d) list)

TMDL Group ID	Use	Impairment	Size	TMDL Development Date
Occoquan Reservoir 00282	Aquatic Life	Total Size Oxygen, Dissolved	1,328.00 reservoir acres	2010
Potomac River, Tidal (Pohick Creek) 20006	Fish Consumption	Total Size PCB in Fish Tissue	3.20 river miles	2014

1.8 Stream Geomorphology

Over time, stream morphology naturally evolves and changes. These natural dynamics can be drastically affected by human land use changes. To identify and track these physical changes, the Channel Evolution Model (CEM) (Schumm et al. 1984), was developed in the early 1980s. Based on visual observations, the CEM classifies a stream evolution into five channel stages.

Figure 6 provides a visual representation of the steam evolution. A Stage I stream/channel is characterized as the most stable system in the group with a well developed flow and strong vegetation coverage – this is a stream in which the watershed has never been disturbed from its naturally-formed character. As flow rates increase (from land use changes), down-cutting occurs in the channel bottom creating a Stage II channel – which is typified by a very narrow, deeply incised channel.

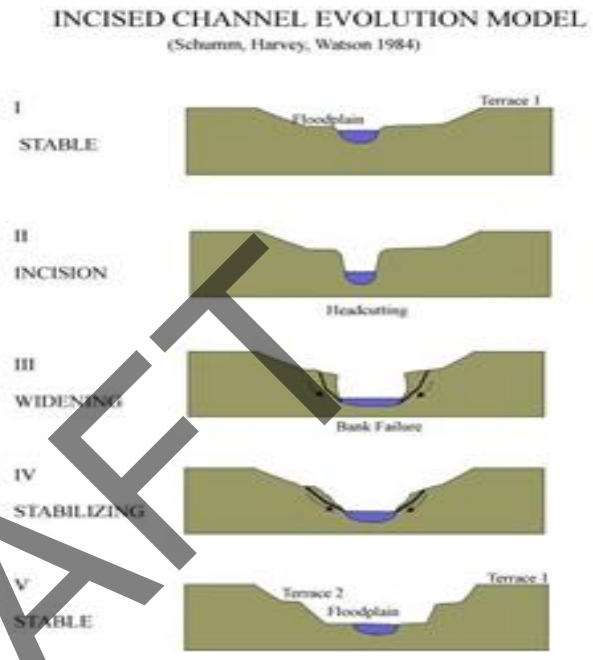


Figure 6: CEM

Heavy erosion begins to widen the channel bottom until stream bank failure occurs. This is a Stage III channel, which is the most unstable and typically generates the most issues. As stream bank erosion begins to decrease and the channel begins to re-stabilize according to the new flow regime, the channel is classified as a Stage IV. Finally at Stage V, the channel returns to a stable system with two floodplain terraces. Once a stream has reached this "dynamic equilibrium" it will remain in this stage until the watershed characteristics are once again changed (i.e.: increase in storm flows due to increased runoff from greater impervious area creation). This process can take decades. If the land uses are continuously changing, then the stream never quite reaches equilibrium and will continue to respond to changes in the flow (runoff) regime.

Using the CEM, the majority of Lower Occoquan streams are classified as Stage III. Stage III is generally characterized as unstable, showing erosion signs of widening and deepening (in response to altered hydrologic characteristics of the watershed – usually a result of changing land uses). Two of the eight watersheds stream channels are classified as Stage II, indicating incising head cuts (vertical erosion) that produces harmful amounts of instream sediments and could ultimately lead into Stage III. See table below for general CEM classification.

Table 15: Lower Occoquan CEM Results (SPA, 2005)

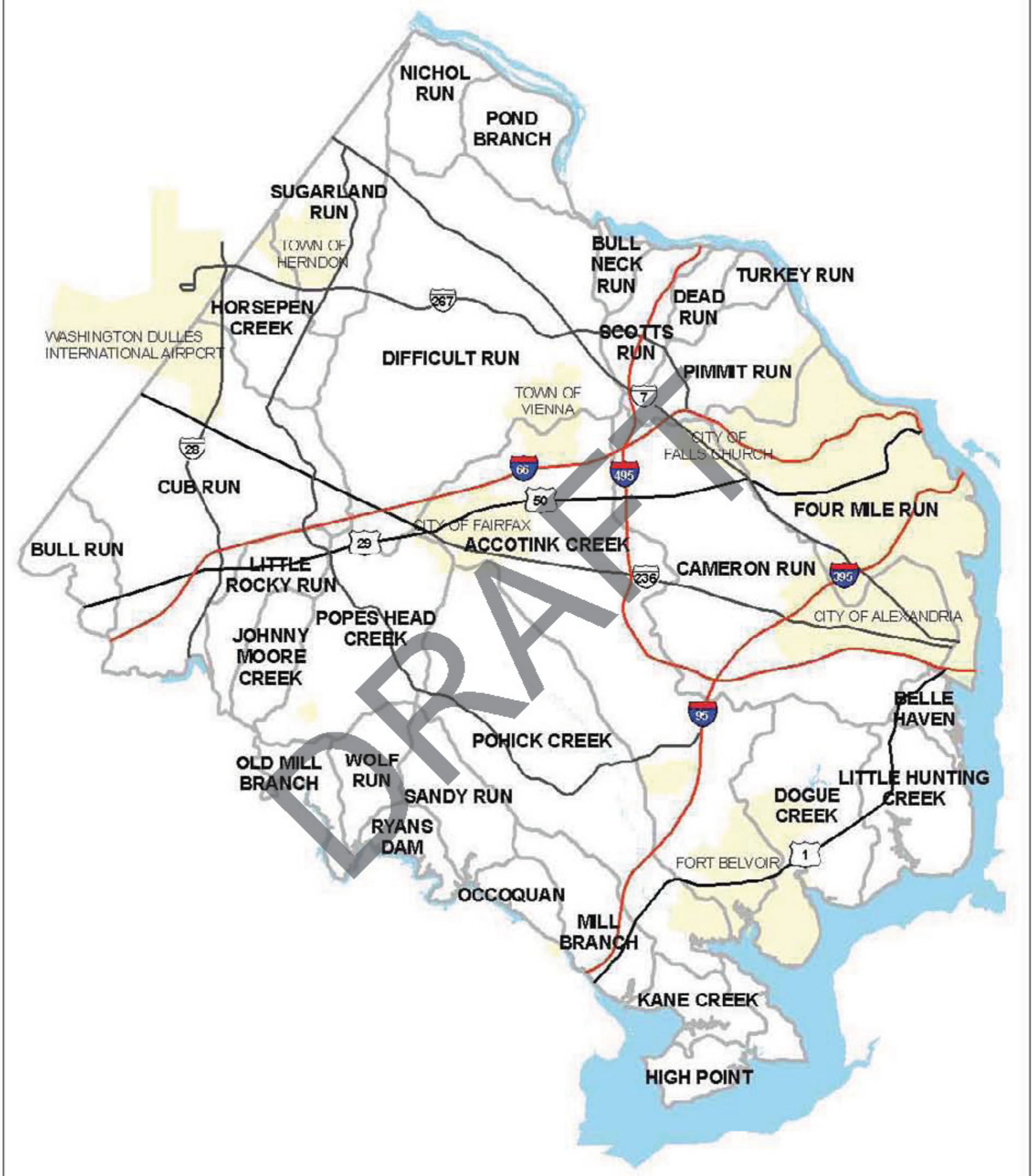
Watershed	Channel Evolution Model
Mill Branch	II/III*
Sandy Run	III/IV
High Point	III
Wolf Run	III
Kane Creek	II
Old Mill Branch	III/IV
Ryans Dam	II/III
Occoquan	III

*1st value represents the majority of the streams within the watershed

1.9 Concerns Identified by the Public

In the late 1970's the County began documenting and logging publicly reported drainage related complaints. Today, the County is still documenting stormwater management complaints via an electronic Microsoft Access database. This database allows the County to identify areas that may require additional attention and assist in prioritizing capital improvement projects. The complaints database can also assist the County identify target areas for public outreach projects.

Over the years, the County has logged 303 complaints within the Lower Occoquan watershed. Old Mill Branch received the fewest complaints (five) while Mill Branch watershed received the most with 131 complaints. The complaints range from yard / house flooding to cave-ins / sinkholes. Within the Mill Branch watershed, blockages, standing water and various types of flooding issues were the most common type of complaint reported.



Map 1.1
Fairfax County Watersheds

Old Mill Branch

Wolf Run

Ryans Dam

Sandy Run

Occoquan

Mill Branch

Kane Creek

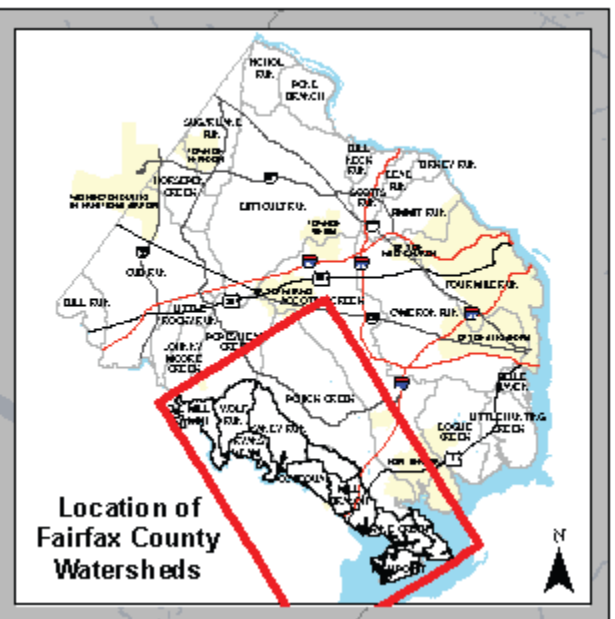
High Point

BELMONT BAY

OCCOQUAN BAY

POTOMAC RIVER

GUNSTON COVE



0 3,100 6,200 9,300 Feet

Legend

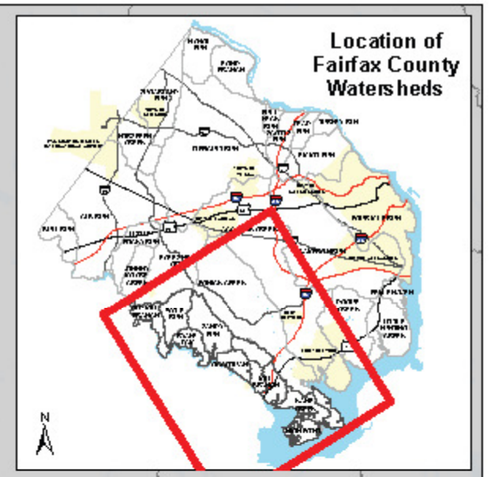
WMA Boundary

Lakes/Ponds

Map 1.2
Lower Occoquan Watershed

Current Landuse
Lower Occoquan
Watershed

Future Landuse
Lower Occoquan
Watershed



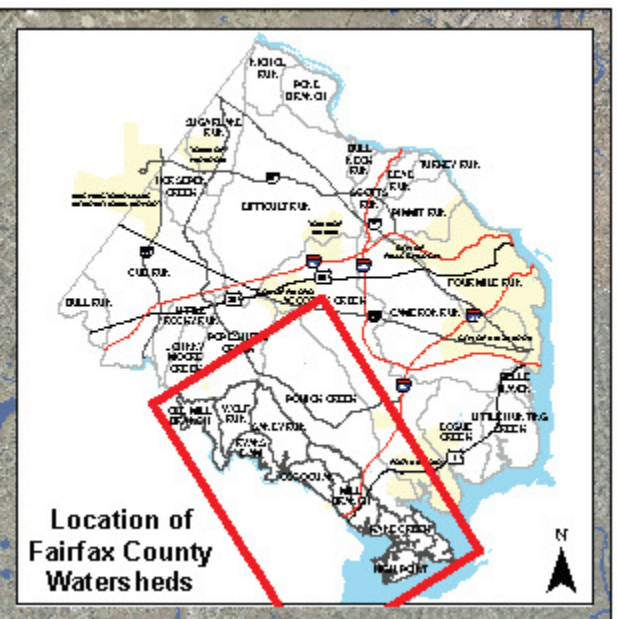
BELMONT BAY
GUNSTON COVE
OCCOQUAN BAY
POTOMAC RIVER

0 11,000 22,000 33,000 Feet

Legend

- WMA Boundary
- Agricultural
- Open Space
- Forested
- Golf Course
- Estate Residential
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Transportation
- Institutional
- Low Intensity Commericial
- High Intensity Commercial
- Industrial
- Water

Map 1.3
Lower Occoquan Watershed
Existing and Future Land Use



BELMONT BAY

GUNSTON COVE

OCCOQUAN BAY

POTOMAC RIVER

3,500 7,000 10,500 Feet

Resource Protection Areas

RPA Limits

Watersheds

Water

Map1.4
Lower Occoquan Watershed
Resource Protection Areas

Legend

Impaired Waters

Map 1.5
Impaired Waters Map
Lower Occoquan Watershed