2.0 Watershed Management Area Characterization

2.1 Introduction

The Environmental Protection Agency (EPA) considers a watershed as "the area in which all water, sediments, and dissolved materials flow or drain from the land into a common river, lake, ocean, or other body of water (EPA, http://www.epa.gov/owow/watershed/what.html). Watersheds are also known as drainage basins and can be defined by the topography of the land. The Chesapeake Bay watershed which spans more than 64,000 square miles and falls within Virginia, West Virginia, Maryland, Delaware, New York, Pennsylvania, and the entire District of Columbia and is one of the largest watersheds in the country. Each State has a unique approach to managing their smaller watersheds within the Chesapeake Bay. The Lower Occoquan watershed is located in the Chesapeake Bay watershed and comprises 8 of the 30 watersheds within Fairfax County.

For planning and management purposes, the County has defined drainage units called **watershed management areas** (WMAs), which are typically a few square miles of land area. For most of the small watersheds in Lower Occoquan, the entire watersheds, themselves are defined as WMAs. The larger Mill branch watershed has been divided into 3 individual WMAs. **Table 16** below identifies the 10 WMAs identified within Lower Occoquan. Refer to **Map 2.1-1** for the locations of each WMA within Lower Occoquan. For County planning and management purposes, WMAs are further subdivided into smaller **subwatersheds,** typically 100-300 acres. Refer to **Map 2.1-2** for the locations of each of the subwatersheds within Lower Occoquan. These areas can be used to identify specific projects or opportunities to enhance the overall stream conditions, as well as serving as the basic units for watershed modeling and other evaluations.

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Table 16: Lower Occoquan: Watershed Management Areas

	WMA:	Area (sq. miles)
1	Giles Run North (Mill Branch)	3.13
2	Giles Run South (Mill Branch)	3.63
3	Mill Branch (Mill Branch)	1.98
4	Sandy Run	8.12
5	Wolf Run	5.88
6	High Point	5.55
7	Kane Creek	4.81
8	Old Mill Branch	4.26
9	Ryans Dam	3.53
10	Occoquan	3.32

2.2 Current Conditions

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

Field maps, photos and data forms were used to capture current watershed conditions. Below provides an example of one of the field maps used to identify unique issues within the WMA.

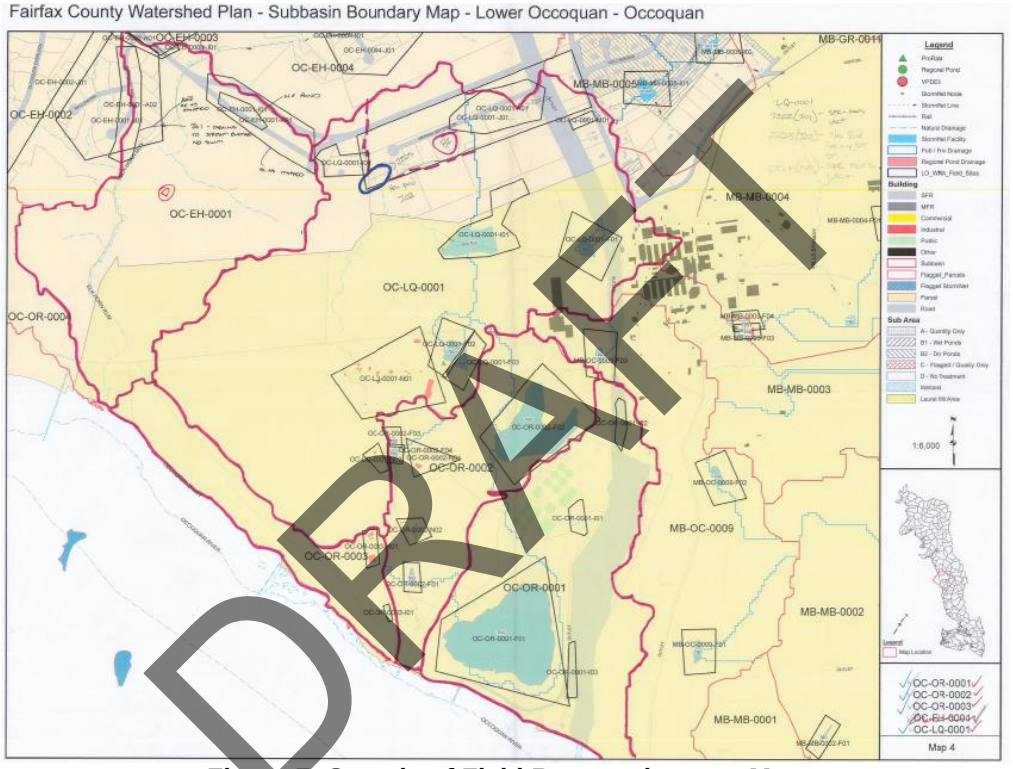

Figure 7: Sample of Field Reconnaissance Map

A description of the findings for each WMA is listed in the following sections including

1. General WMA Characteristics
2. Field Reconnaissance findings
3. Impervious Areas / Treatment Type
4. Stormwater Infrastructure
5. Stream Conditions.

Each WMA was examined at the subwatershed level in order to capture as much data as possible.

2.2.1 Giles Run North (Mill Branch)

General WMA Characteristics

The Giles Run North WMA is located in the eastern reaches of the collection of the Lower Occoquan watersheds and is a portion of the Mill Branch watershed. Giles Run North consists of 11 subwatersheds. The Giles Run North WMA is roughly bounded by Silverbrook Road to the north and northeast. The western border is roughly formed by Ox Road (Route 123) and the southern border of the WMA essentially follows Furnace Road east to Lorton Road. Giles Run North WMA lies entirely within the Coastal Plain physiographic province, characterized by relatively gentle topography.

Field Reconnaissance

The Giles Run North WMA is comprised primarily of single family detached residential properties in a number of established subdivisions, including Giles Runs, Crosspointe, Lorfax Heights, Silverbrook Estates, Spring Hill and Gunston Corner.

The majority of the observed single family detached dwellings were constructed on estimated 1/8 to 1/2 acre lots. The age of development in this WMA ranges from an estimated 30 to 35 years old (1970s) in the far western portions to newer single family, townhouse, and multi-family housing units in the southern and eastern portions of the WMA (2000s). In addition, a portion of the northeastern end of this WMA has been redeveloped as part of the Laurel Hill redevelopment project, including significant construction of residential structures and associated commercial and institutional development. In addition to the single family development, the Giles Run North WMA also contains a significant amount of single family attached (i.e. townhouses) development, especially in the Gunston Corner area, at the southeastern end of the WMA. These developments are characterized by their density, as well as street construction patterns that feature cul-de-sacs and dead end drives (i.e. limited through street access).

Among the observed infill/redevelopment evidence observed, the Giles Run North WMA lies within a portion of the Laurel Hill project in southern Fairfax County. Land cover consists primarily of impervious surface associated with residential development (i.e. rooftops, streets and driveways, sidewalks, etc.) and associated landscaping, including managed turf. Impervious estimates in areas of multi-family residential development in the Gunston Corner area exceed 70 percent.

Among the non-residential land uses observed, Giles Run North contains limited, low intensity commercial development, primarily associated with industries/activities supporting residential development. The largest commercial complex observed was the Shoppes of Lorton Valley, off Route 123 in the southern end of the WMA. Several significant institutional facilities were observed in the Giles Run North WMA, including Silverbrook Elementary School, William Halley Elementary School, and the South County Secondary School. Other school sites are located near this WMA as well. East of Hooes Road, the current and proposed Laurel Hill Park facilities, including the existing Laurel Hill Golf Course, occupies significant acreage in the south central portion of the WMA, which provides for significant open space retention but also additional managed

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turf cover. One house of worship was observed in the WMA, Christ United Methodist Church, located off Silverbrook Road.

Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the Technical Memorandum 3 guidance document, Table 17 below identifies the current and future impervious surface areas based on the existing and future land use conditions for Giles Run North as well as the associated treatment types. Since Giles Run North (MB) is fairly developed in certain areas, the WMA has relatively high levels of imperviousness when compared to the Lower Occoquan watershed as a whole. However, the overall the impervious surface area is only expected to increase less than 0.25% in the future. As Table 17 illustrates, the majority of stormwater in Giles Run North WMA is uncontrolled and drains untreated to receiving waters which is consistent with the small percentage of impervious area within the WMA.

Table 17: Giles Run North Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types				
	Current Condition		Ultimate Condition		Quantity	Quality		Quantity/ Quality	None
	(acres)	%	(acres)	%	(acres)	(acres)	(acres)	(acres)	(acres)
Giles Run North (MB)	324.65	*16.22*	329.91	*16.48*	40.26	12.27	171.54	171.54	1777.97

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Existing Land Use

See **Map 2.2.1-1** for existing and future land use for Giles Run North (MB). Giles Run North WMA consists of 2,002 acres, of which nearly half is open space, forest, parks, and/or recreational land use areas, much of this is due to the existing zoning regulations require minimum lot sizes of one acre for many areas of the WMA.

Table 18: Giles Run North Existing & Future Land Use (Co. GIS, 2008)

	Existing Conditions		Future Conditions	
Land Uses Description	**Acres**	**Percent**	**Acres**	**Percent**
Open Space, forest, parks, & recreational areas	922.89	46.10%	870.59	43.48%
Golf Course	0	0.00%	0.00	0.00%
Estate Residential	85.83	4.29%	37.89	1.89%
Low-Density Residential	170.54	8.52%	261.56	13.06%
Medium-Density Residential	291.92	14.58%	291.26	14.55%
High-Density Residential	114.58	5.72%	194.92	9.74%
Low-Intensity commercial	0	0.00%	0.00	0.00%
High-Intensity commercial	23.19	1.16%	28.44	1.42%
Industrial	0	0.00%	2.43	0.19%
Transportation	199.61	9.97%	199.61	9.97%
Water	30.68	1.53%	30.68	1.53%
Institution	162.82	8.13%	84.66	4.23%

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Stormwater Infrastructure

The Giles Run North WMA consists primarily of developed residential single family attached and detached properties, multi-family residential development, and institutional uses, including parklands and school properties. As a result, the watershed's stormwater infrastructure consists primarily of curb and gutter collection through a piped stormwater network discharging through both a variety of best management practices (BMPs) as well as directly to Giles Run and its tributaries.

The Giles Run North WMA contains a variety of additional stormwater infrastructure and BMPs which track with the watershed's development history. For example, in areas that developed earlier, stormwater management facilities, where present, consist primarily of dry detention basins designed to curb peak storm flows (quantity management). For areas that developed more recently, stormwater management facilities are more likely to include a water quality component, and the variety of facility types increases. Facilities found in these areas include underground chambers.

Map 2.2.1-2 demonstrates the observed stormwater infrastructure conditions in the Giles Run North WMA. The Giles Run North WMA contains approximately 14 dry detention and extended dry detention facilities designed to manage stormwater quantity and quality. In addition, the WMA contains three wet detention facilities, also designed for

water quality and quantity management, as well as one underground chamber, which provides quantity management. It should be noted that as part of the Laurel Hill redevelopment project, a number of additional stormwater management facilities appear planned for construction. Given the current County requirements for stormwater management, these facilities are likely to be designed to manage both the volume (quantity) of stormwater runoff as well as the quality of that runoff.

Stream Conditions

The Stream Conditions **Map 2.2.1-3** denotes the generally observed stream conditions as documented in the 2005 SPA and through additional windshield level field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the WMA along with a series of features that typically impact stream condition, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout the County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

While Giles Run North, Giles Run South, and Mill Branch WMAs data was not captured separately within the Mill Branch watershed, a total of 98 inventory points were visually assessed with only two scoring a 10 or higher. The highest scoring impacts in the Mill Branch watershed included a utility line scoring a 20 (very extreme) and a head cut scoring a 10. Table 19 summarizes all 98 inventory points captured in the 2005 SPA for the Mill Branch watershed.

Table 19: Overall Mill Branch watershed Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	0	0	9	4	13	7	3	0	1	0	0	N/A	37
Crossings	34	0	1	0	0	0	0	1	0	0	0	N/A	36
Ditches and Pipes	14	1	0	0	0	0	0	0	0	0	0	N/A	15
Erosion	0	0	0	0	0	0	1	0	0	0	0	N/A	1
Head Cut	0	0	1	0	2	0	0	0	0	0	1	N/A	4
Obstruction	0	1	1	1	0	0	0	0	0	0	0	N/A	3
Utility	1	0	0	0	0	0	0	0	0	0	0	1	2
Total	**49**	**2**	**12**	**5**	**15**	**7**	**4**	**1**	**1**	**0**	**1**	**1**	**98**

In the Giles Run North WMA, the most prevalent stream condition features noted include disturbed stream buffers and stream channel widening. Channel widening, coincident with poor overall stream habitat, is the primary feature for the main stem of Giles Run through the WMA. Channel incision is noted for tributaries running through the Laurel Hill Park area to the south and east. Pipe discharge into the WMAs streams have a

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demonstrated impact as well, as these pipes discharge stormwater runoff directly into the streams in areas that were developed prior to current stormwater management requirements for post-construction controls. These discharges contribute to the noted, upstream widening and erosive conditions. In addition, several one to two foot head cuts were noted on downstream tributaries in the WMA. Road crossing impacts in the Giles Run North WMA are generally minor. Crossing and head cut impacts tend to follow tributary junctions in the WMA, occurring at confluence points in the watershed. Finally, obstructions and utility impacts are noted as minor to moderate in the upstream tributaries running through Laurel Hill Park east to the Gunston Cove area.

Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data 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:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. Overall, the Mill Branch watershed was categorized as fair with a length-weighted habitat score of 106, which is slightly better than the Fairfax County average. As Table 20 shows, of the estimated 4.8 miles of stream assessed in Giles Run North, more than 50 percent were categorized as poor, the largest percent of any watershed in the Lower Occoquan in that category.

Table 20: Giles Run North Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		Poor		Fair		Good		Excellent		Total
Giles Run	1,065	2.20%	25,567	52.92%	9,245	19.14%	3,352	6.94%	9,087	18.81%	48,316

Stream Biological Habitat

In 2001 the County released the SPS Study documenting the current stream conditions throughout the county using physical, chemical and biological evaluations. The County developed a ranking of quality for each site. Of the 138 streams sites, one was located in Giles Run North WMA. Table 21 below summarizes the results. Overall, Giles Run North WMA is one of the highest quality Coastal Plain basins in the County, with the fish community rating and biological integrity rated as moderate and fair, respectively.

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Table 21: Giles Run North Biological Integrity Rating (SPS, 2001)

Stream Name and Site Code	Composite	Environmental Tables		
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Giles Run 1 (MBGR01)	Good	Fair	Fair	Moderate

Stream Channel

To identify and track stream evolution and 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.

- Stage I: Stable- well developed base flow and bankfull channel
- Stage II: Incision – down-cutting or head cuts occur
- Stage III: Widening –bank failure is occurring
- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. The majority of the streams surveyed within Giles Run North were classified as CEM Stage III- Widening as shown on Map 2.2.1-3. The remaining streams fall into CEM Evolutionary Stage II, indicating head cuts that could ultimately lead into Stage III.

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2.2.2 Giles Run South (Mill Branch)

General WMA Characteristics

The Giles Run South WMA is located in the eastern reaches of the collection of Lower Occoquan watersheds and is a portion of the Mill Branch watershed. Giles Run South consists of 14 subwatersheds. The Giles Run South WMA is roughly bounded by Lorton Road (Route 642) to the extreme north. The western border is roughly formed by a portion of Interstate 95 in the southern end and Furnace Road (Route 611) on the central and northern end. The eastern boundary of the WMA is formed by Gunston Road (Route 242) and Belmont Boulevard (Route 601) to the southern end of the WMA. The WMA discharges to the Occoquan River to the south, and is bisected by both Interstate 95 and the Richmond Highway (U.S. Route 1). Old Colchester Road also bisects the WMA south and east of U.S. Route 1. Giles Run South lies entirely within the Coastal Plain physiographic province, characterized by relatively gentle topography.

Field Reconnaissance

The Giles Run South WMA contains a wide variety of land uses and development, from single family residential to industrial park land. Residential developments in the WMA include portions of the Laurel Hill redevelopment project in the extreme north, the more established Colchester neighborhood to the south near the Occoquan River, and other, newer single family developments to the south and east including the western end of Gunston Heights to the east and Harbor View, which abuts Massey Creek.

The majority of the observed single family detached dwellings were constructed on lots estimated to be less than ¼ to one acre in size. The age of development in this WMA ranges from an estimated 30 to 35 years old (1970s) in the established neighborhoods such as Colchester, to newer single family detached housing units in the Harbor View, Laurel Hill, and Gunston Heights areas of the WMA (2000s). In addition to the single family development, the Giles Run South WMA also contains a significant amount of non-residential development, including the industrial properties Gunston Commerce Center and the Lorton Valley Industrial Park. These developments are characterized by their land use intensity and density, as well as street construction patterns that feature cul-de-sacs and dead end drives (i.e. limited through street access). In addition, the industrial sites offer large building footprints with large impervious areas for roadways and parking.

Among the observed infill/redevelopment evidence observed, the Giles Run South WMA lies within a portion of the Laurel Hill project in southern Fairfax County. Land cover consists primarily of impervious surface associated with the various forms of development (i.e. large rooftops, streets and driveways, sidewalks, parking lots, etc.) and associated landscaping, including managed turf. Impervious estimates in the WMA vary significantly based on the land use observed. In areas of residential development, approximately 10 to 15 percent impervious cover exists, whereas estimates for non-residential areas in the WMA, including industrial lands, may be as high as 70 percent in some cases.

Among the additional non-residential land uses observed, Giles Run South contains limited, low intensity commercial development, primarily associated with

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industries/activities supporting residential development. The largest commercial complex observed was the Lorton Station Marketplace, off Gunston Road. The Giles Run South WMA also includes the Mason Neck West Area Park

Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the Technical Memorandum 3 guidance document, Table 22 below identifies the current and future impervious surface areas based on the existing and future land use conditions for Giles Run South WMA as well as the associated treatment types. Since Giles Run South is fairly developed in areas and has a large industrial land use, the WMA has relatively high levels of impervious area when comparing against Lower Occoquan as a whole. While Giles Run South WMA is currently slightly more than 10 percent impervious, future imperviousness is only expected to increase by less than 3 percent. As Table 22 shows, the majority of stormwater in Giles Run South WMA is uncontrolled and drains untreated to receiving waters which is consistent with the small percentage of impervious area within the WMA and the overall age of development.

Table 22: Giles Run South Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types			
	Current Condition		Ultimate Condition		Quantity	Quality	Quantity/ Quality	None
	(acres)	*%*	(acres)	%	(acres)	(acres)	(acres)	(acres)
Giles Run South (MB)	271.25	*11.65*	309.34	*13.29*	1.25	7.15	40.20	2,278.92

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Existing Land Use

See **Map 2.2.1-1** for existing and future land use for Giles Run South WMA. This land use map includes the updated land use GIS layers developed for the Laurel Hill redevelopment area. Giles Run South WMA consists of 2,328 acres, of which the dominate land use type is open space, forest, parks, and/or recreational land use areas. Giles Run South WMA second highest land use is industrial which is expected with the variety of industrial facilities located in Giles Run South.

Table 23: Giles Run South Existing & Future Land Use (Co. GIS, 2008)

	Existing Conditions		Future Conditions	
Land Use Description	**Acres**	**Percent**	**Acres**	**Percent**
Open space, forest, parks, & recreational areas	916.99	39.40%	854.18	36.70%
Golf Course	0.00	0.00%	0.00	0.00%
Estate Residential	125.85	5.41%	284.05	12.20%
Low-Density Residential	147.91	6.35%	235.54	10.12%
Medium-Density Residential	49.38	2.12%	69.27	2.98%
High-Density Residential	76.53	3.29%	101.65	4.37%
Low-Intensity commercial	20.89	0.90%	19.95	0.86%
High-Intensity commercial	21.72	0.93%	33.15	1.42%
Industrial	608.60	26.15%	369.82	15.89%
Transportation	326.94	14.05%	326.94	14.05%
Water	15.88	0.68%	15.88	0.68%
Institution	16.85	0.72%	17.10	0.73%

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Stormwater Infrastructure

The Giles Run South WMA consists of a variety of land development patterns, including developed residential single family attached and detached properties, multi-family residential development, industrial development, commercial development, and institutional uses, including parklands. As a result, the watershed's stormwater infrastructure consists primarily of curb and gutter collection through a piped stormwater network discharging through a variety of BMPs as well as directly into Giles Run and its tributaries.

The Giles Run South WMA contains a variety of additional stormwater infrastructure and BMPs which track with the watershed's development history. For example, in areas that developed earlier, stormwater management facilities, where present, consist primarily of dry detention basins designed to curb peak storm flows (quantity management). For areas that developed more recently, stormwater management facilities are more likely to include a water quality component, and the variety of facility types increases. Facilities found in these areas include underground chambers, parking lot detention, rooftop detention, and manufactured BMP systems.

Map 2.2.2-2 demonstrates the observed stormwater infrastructure conditions in the Giles Run South WMA. The Giles Run South WMA contains approximately five dry detention and extended dry detention facilities designed to manage stormwater quantity and quality. In addition, the WMA contains one manufactured BMP for water quality management and one parking lot detention device and one underground chamber, which both provide quantity management. In addition, the WMA contains seventeen rooftop detention systems, located primarily on industrial facility buildings, for quantity management. It should be noted that as part of the Laurel Hill redevelopment project, a number of additional stormwater management facilities appear planned for construction. Given the current Fairfax County requirements for stormwater management, these facilities are likely to be designed to manage both the volume (quantity) of stormwater runoff as well as the quality of that runoff.

Stream Conditions

The Stream Conditions **Map 2.2.2-3** denotes the generally observed stream conditions as documented in the 2005 SPA and through additional, windshield level field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the WMA along with a series of features that typically impact stream condition, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout the County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

While Giles Run North, Giles Run South, and Mill Branch WMA data was not captured separately, within the Mill Branch watershed, a total of 98 inventory points were visually assessed with only two scoring a 10 or higher. The highest scoring impacts in the Mill Branch watershed included a utility line scoring a 20 (very extreme) and a head cut scoring a 10. Table 24 summarizes all 98 inventory points captured in the 2005 SPA for the Mill Branch watershed.

Table 24: Overall Mill Branch watershed Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	0	0	9	4	13	7	3	0	1	0	0	N/A	37
Crossings	34	0	1	0	0	0	0	1	0	0	0	N/A	36
Ditches and Pipes	14	1	0	0	0	0	0	0	0	0	0	N/A	15
Erosion	0	0	0	0	0	0	1	0	0	0	0	N/A	1
Head Cut	0	0	1	0	2	0	0	0	0	0	1	N/A	4
Obstruction	0	1	1	1	0	0	0	0	0	0	0	N/A	3
Utility	1	0	0	0	0	0	0	0	0	0	0	1	2
Total	**49**	**2**	**12**	**5**	**15**	**7**	**4**	**1**	**1**	**0**	**1**	**1**	**98**

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In the Giles Run South WMA, the most prevalent stream condition features noted include disturbed stream buffers and stream channel widening. Buffer disturbance appears coincident with roadways, including residential streets as well as major road arteries in the WMA. Channel widening, coincident with poor overall stream habitat, is the primary feature for the main stem of Giles Run through the WMA. Channel incision is noted for a tributary of South Branch near Gunston Heights. An extreme road crossing impact has been noted where Giles Run runs under Interstate 95, while the crossing at Route 1 downstream has been classified as minor to moderate. Upstream of the I-95 crossing, an extreme impact from a utility line has also been noted. Finally, minor obstructions and dump site impacts utility impacts are noted as minor to moderate throughout the WMA.

Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data 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:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. Overall, the Mill Branch watershed was categorized as fair with a length-weighted habitat score of 106, which is slightly better than the Fairfax County average. As Table 25 shows, more than one mile of stream assessed in Giles Run South, more than 50 percent were categorized as either excellent or good.

Table 25: Giles Run South Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		Poor		Fair		Good		Excellent		Total
South Branch	0	0.00%	0	0.00%	0	0.00%	6,403	100.00%	0	0.00%	6,403
Trib. to Occouan River	0	0.00%	4,951	31.76%	2,655	17.03%	3,132	20.09%	4,850	31.11%	15,588

Stream Biological Habitat

In 2001, the County released the SPS Study documenting the current stream conditions throughout the county using physical, chemical and biological evaluations. The County developed a ranking of quality for each site. Of the 138 streams sites, one was located in Giles Run North WMA. The table below summarizes the results. Overall, Giles Run

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South WMA is one of the highest quality Coastal Plain basins in the County, with the fish community rating and biological integrity rated as moderate and fair, respectively.

Table 26: Giles Run South Biological Integrity Rating (SPS, 2001)

Stream Name and Site Code	Composite	Environmental Tables		
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Giles Run 2 (MBGR02)	Excellent	Fair	Good	Moderate

Stream Channel

To identify and track stream evolution and 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.

- Stage I: Stable- well developed base flow and bankfull channel
- Stage II: Incision – down-cutting or head cuts occur
- Stage III: Widening –bank failure is occurring
- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. Within the Giles Run South WMA, a majority of the streams surveyed are classified as CEM Evolutionary Stage III, generally characterized as unstable and show signs of widening and deepening. The remaining streams fall into CEM Evolutionary Stage II, indicating head cuts that could ultimately lead into Stage III.

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2.2.3 Mill Branch (Mill Branch)

General WMA Characteristics

The Mill Branch WMA is located in the eastern reaches of the collection of the Lower Occoquan watersheds and is a portion of the Mill Branch watershed. Mill Branch WMA consists of nine subwatersheds. The Mill Branch WMA is roughly bounded by Furnace Road (Route 611) to the north and east. The western border is roughly formed by a portion of Ox Road (Route 123). The southern border is formed by Interstate 95 to the southeast and the Occoquan River to the southwest. Mill Branch lies entirely within the Coastal Plain physiographic province, characterized by relatively gentle topography. The Mill Branch WMA contains the Mill Branch tributary stream which flows southeast and drains a region containing an inactive landfill, a sewage treatment plant, and portions (approximately 3.5 square miles) of Laurel Hill. Mill Branch tributary discharges into the Occoquan River ultimately into the Potomac River.

Field Reconnaissance

The Mill Branch WMA contains a wide variety of land uses and development, from single family residential to industrial park land. Of note, the Laurel Hill redevelopment project in southern Fairfax County almost fully covers the Mill Branch WMA, and as such, land uses and development in this WMA are in the planning stages. Residential developments associated with the Laurel Hill redevelopment project include the areas of Cavanaugh's Crossing and Hollymeade in the northwest corner of the WMA. A significant portion of the old Lorton Correctional Facility resides in the WMA, and the property associated with the prison forms the centerpiece of the Laurel Hill redevelopment project. Additional portions of the prison grounds are slated for redevelopment as mixed use residential, commercial, and light industrial uses. Planned construction, or construction already underway, includes three schools, the Spring Hill redevelopment area, the Occoquan Workhouse Adaptive Re-use Area, and the I-95 Resource Recovery area and landfill.

The majority of the observed single family detached dwellings were constructed on lots estimated between ¼ and ½ acre in size. Development within this WMA ranges from an estimated 5 to 10 years old (late 1990s to early 2000s) to present day and includes Cavanaugh's Crossing and Hollymeade. In areas of residential development, to date, approximately 20 to 25 percent impervious cover exists, which was based on home sizes, ancillary impervious features, and lot sizes.

Along with the planned redevelopment sites in this WMA, the Occoquan Regional Park, in the southern end of the WMA near the Occoquan River, provides an additional, recreational land use.

Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious

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surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the Technical Memorandum 3 guidance document, Table 27 below identifies the current and future impervious surface areas based on the existing and future land use conditions for Mill Branch WMA as well as the associated treatment types. Since Mill Branch WMA is fairly developed in some areas, and a large percentage of industrial land use, the watershed has a high impervious percentage when compared to the Lower Occoquan watershed yet relatively low levels of imperviousness when compared to the County as a whole. The County has incorporated much of the change in land use due to the Laurel Hill redevelopment into the County GIS database. While historically Mill Branch WMA experienced lower impervious area, with the ongoing development which has occurred in recent years, and the ultimate development of the area, this area is only expected to see a 0.30% increase in impervious area in the future. As Table 27 shows, the majority of stormwater in Mill Branch WMA is uncontrolled and drains untreated to receiving waters, however, as the Laurel Hill redevelopment process continues, this areas of treated stormwater will increase.

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Table 27: Mill Branch Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types			
	Current Condition		Ultimate Condition		Quantity	Quality	Quantity/ Quality	None
	(acres)	%	(acres)	%	(acres)	(acres)	(acres)	(acres)
Mill Branch (MB)	130.35	*10.28*	134.48	*10.60*	0	0	27.59	1240.66

Existing Land Use

Since Mill Branch WMA is under long term redevelopment, currently more than 70% of the land use is dominated by industrial or institutional use. Since the majority of the old Lorton Correction facility fell within the Mill Branch WMA, and the County is in the process of redeveloping the area, the land use within this WMA is fairly unique and will experience higher development than other WMAs within Lower Occoquan.

Table 28: Mill Branch Existing & Future Land Use (Co. GIS, 2008)

Land Use Description	Existing Conditions		Future Conditions	
	Acres	Percent	Acres	Percent
Open space, forest, parks, & recreational areas	236.55	18.65%	204.17	16.10%
Golf Course	0.00	0.00%	0.00	0.00%
Estate Residential	28.08	2.21%	28.08	2.21%
Low-Density Residential	37.03	2.92%	62.06	4.89%
Medium-Density Residential	13.16	1.04%	13.16	1.04%
High-Density Residential	0.00	0.00%	0.09	0.005%
Low-Intensity commercial	0.00	0.00%	0.00	0.00%
High-Intensity commercial	0.00	0.00%	0.00	0.00%
Industrial	432.47	34.10%	439.72	34.67%
Transportation	48.19	3.80%	48.19	3.80%
Water	10.83	0.85%	10.83	0.85%
Institution	461.94	36.42%	461.94	36.42%

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Stormwater Infrastructure

For areas that are now developing and redeveloping, stormwater management facilities are more likely to include a water quantity and quality component, and the variety of facility types in use in this WMA is likely to increase as the redevelopment projects continues.

Map 2.2.3-2 demonstrates the observed stormwater infrastructure conditions in the Mill Branch WMA. It should be noted that as part of the Laurel Hill redevelopment project, a number of additional stormwater management facilities appear planned for construction. Given the current County requirements for stormwater management, these facilities are likely to be designed to manage both the volume (quantity) of stormwater runoff as well as the quality of that runoff. Facilities found in these areas may include extended detention dry ponds, wet detention ponds, underground chambers, parking lot detention, manufactured BMP systems, bioretention facilities, and constructed wetlands. At present, the Mill Branch WMA contains two extended dry detention facilities designed to manage stormwater quantity and quality. The County has also captured a number of surface water impoundments. Some are old farm ponds. Other catchments may provide some anecdotal stormwater management function, but for which no stormwater management design can be confirmed at the time of this draft. These features appear in the Fairfax County stormwater management facility inventory as “TBD” (To Be Determined). The Mill Branch WMA contains approximately eighteen TBDs.

Stream Conditions

The Stream Conditions **Map 2.2.3-3** denotes the generally observed stream conditions as documented in the Fairfax County 2005 SPA and through additional windshield level

field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the WMA along with a series of features that typically impact stream condition, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout the County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

While Giles Run North, Giles Run South, and Mill Branch WMA data was not captured separately, within the Mill Branch watershed, a total of 98 inventory points were visually assessed with only two scoring a 10 or higher. The highest scoring impacts in the Mill Branch watershed included a utility line scoring a 20 (very extreme) and a head cut scoring a 10. Table 19 summarizes all 98 inventory points captured in the 2005 SPA for the Mill Branch watershed.

Table 29: Overall Mill Branch watershed Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	0	0	9	4	13	7	3	0	1	0	0	N/A	37
Crossings	34	0	1	0	0	0	0	1	0	0	0	N/A	36
Ditches and Pipes	14	1	0	0	0	0	0	0	0	0	0	N/A	15
Erosion	0	0	0	0	0	0	1	0	0	0	0	N/A	1
Head Cut	0	0	1	0	2	0	0	0	0	0	1	N/A	4
Obstruction	0	1	1	1	0	0	0	0	0	0	0	N/A	3
Utility	1	0	0	0	0	0	0	0	0	0	0	1	2
Total	**49**	**2**	**12**	**5**	**15**	**7**	**4**	**1**	**1**	**0**	**1**	**1**	**98**

In the Mill Branch WMA, the most prevalent stream condition features noted include disturbed stream buffers and stream channel incision. Buffer disturbance appears coincident with channel widening and incision on the tributaries noted in this WMA, but appears limited to the downstream channels. An extreme head cut impact has been noted at the downstream end of an existing pond in the southern end of the WMA. Finally, minor to moderate crossing and pipe impacts are noted throughout the WMA. Of note, with so much planned redevelopment activity in this WMA, the stream conditions represented on Map 2.2.3-3 are subject to significant change based on grading activities and other physical amendments to the topography in the area.

Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data based on habitat conditions, impacts on streams, general stream characteristics and geomorphic classification, a length-weighted total

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habitat score was calculated for each watershed and categorized into one of five habitat assessment rating categories:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. Overall, the Mill Branch watershed was categorized as fair with a length-weighted habitat score of 106, which is slightly better than the Fairfax County average. As the table below illustrates, of the estimated 0.8 miles of stream assessed in Mill Branch, nearly 90 percent were categorized as fair.

Table 30: Mill Branch Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		Poor		Fair		Good		Excellent		Total
Mills Branch	0	0.00%	0	0.00%	4,376	88.06%	593	11.94%	0	0.00%	4,970

Stream Biological Habitat

In 2001 the County released the SPS Study documenting the current stream conditions throughout the county using physical, chemical and biological evaluations. The County developed a ranking of quality for each site. Of the 138 streams sites, one was located in Mill Branch WMA. The table below summarizes the results. Overall, Mill Branch WMA is one of the highest quality Coastal Plain basins in the County, with the fish community rating and biological integrity rated as moderate and fair, respectively

Table 31: Mill Branch Biological Integrity Rating (SPS, 2001)

Stream Name and Site Code	Composite	Environmental Tables		
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Mill Branch (MBMB01)	Fair	Fair	Poor	Moderate

Stream Channel

To identify and track stream evolution and 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.

- Stage I: Stable- well developed base flow and bankfull channel
- Stage II: Incision – down-cutting or head cuts occur
- Stage III: Widening –bank failure is occurring

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- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. Within the Mill Branch WMA the majority of the streams were classified as CEM Evolutionary Stage II, generally characterized as head cutting has occurred. The remaining of the streams classified fell into Stage III, generally characterized as unstable and show signs of widening and deepening.

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2.2.4 Sandy Run

General WMA Characteristics

Sandy Run WMA covers 8.12 square miles (5,198 acres) and is located along the central southwestern border of Fairfax County. Sandy Run is bounded by Pohick Creek to the North, Giles Run North to the East, Occoquan and Ryans Dam to the South, and Wolf Run to the West. Sandy Run is bounded on the northeast and east by Ox Road (Route 123), to the west and south by Hampton Road (Route 647). Henderson Road (Route 643) and Clifton Road (Route 645) both bisect the Sandy Run watershed's northern half.

Sandy Run lies entirely within the Piedmont Upland physiographic province, characterized by rolling hills underlain by metamorphic rocks. Sandy Run consists of approximately 20 miles of stream and includes two main tributary systems which discharge into the Occoquan River, and ultimately into the Potomac River. Sandy Run, the larger of the two systems, flows southeast in the northern half of Sandy Run then flows south in the southern half of Sandy Run, and drains the majority of the watershed's undisturbed areas. A small portion of southern Sandy Run is covered by Fountainhead Regional Park, which is a multi-use area consisting of numerous trails for both biking and hiking. This parkland, which serves as a forested buffer for the Occoquan River and Reservoir, is operated by the Northern Virginia Regional Park Authority.

Field Reconnaissance

In July 1982, the Fairfax County Board of Supervisors amended the County's Comprehensive Plan by down-zoning approximately 41,000 acres of the Occoquan watershed in Fairfax County to an R-C District (Residential – Conservation), which yields a maximum density of one dwelling unit per five acres. This down-zoning action, driven by the County's desire to protect the Occoquan Reservoir and the drinking water it supplies to well over one million people, has served to curb intense development in the area. The Sandy Run WMA lies within the area down-zoned by the County in 1982 and contains a total of 32 subwatersheds. As a result, development in the WMA is primarily estate residential, which includes several established, estate subdivisions such as Ardmore Woods, The English Hills, Summerwind, Dominion Valley Hunt, Cathedral Forest, and Shadowalk. The majority of the observed single-family residential parcels is over one acre in size, consistent with the zoning status, and was primarily developed in the 1980s and 1990s. Due to the lack of development density, fewer developmental details for residential properties were evident in the Sandy Run WMA (i.e., not necessarily visible from public streets).

As mentioned above, institutional uses in the watershed are primarily parkland and preserved open space managed by the Fairfax County Park Authority, including Sandy Run Regional Park and Fountainhead Regional Park. The WMA includes some additional institutional uses, including several houses of worship along Ox Road (Route 123).

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Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the Technical Memorandum 3 guidance document, Table 32 below identifies the current and future impervious surface areas based on the existing and future land use conditions for Sandy Run as well as the associated treatment types. Since Sandy Run is primarily undeveloped, with a very small area of residential and commercial development, the watershed as a whole exhibits levels of imperviousness below six percent with the projected nominal increase in the future. As Table 32 shows, the majority of stormwater in Sandy Run is uncontrolled and drains untreated to receiving waters, which is consistent with the small percentage of impervious area within the WMA.

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Table 32: Sandy Run Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types			
	Current Condition		Ultimate Condition		Quantity	Quality	Quantity/ Quality	None
	(acres)	%	(acres)	%	(acres)	(acres)	(acres)	(acres)
Sandy Run	301.70	*5.80*	312.25	*6.01*	95.06	132.76	281.06	4689.24

Existing land use

See **Map 2.2.4-1** for existing and future land use for Sandy Run. Sandy Run consists of 5,198 acres, of which approximately 85 percent is either estate residential or open space, forested, and/or parks, making it one of the least developed or rural WMA in Fairfax County. As mentioned above, Sandy Run falls within the WSPOD. The WSPOD

imposes restrictions on development and requires enhanced water quality controls for any development. Existing zoning regulations require minimum lot sizes of five-acres for the Sandy Run watershed. The WSPOD, in addition to Fountainhead Regional Park, have prevented the area from experiencing much development. Table 33 below summarizes the existing land use within the Sandy Run watershed.

Table 33: Sandy Run Existing & Future Land Use (Co. GIS, 2008)

	Existing Conditions		Future Conditions	
Land Use Description	**Acres**	**Percent**	**Acres**	**Percent**
Open space, forest, parks, & recreational areas	562.27	10.82%	281.47	5.41%
Golf Course	2.51	0.05%	2.51	0.05%
Estate Residential	3950.73	76.00%	4216.91	81.12%
Low-Density Residential	351.88	6.77%	360.37	6.93%
Medium-Density Residential	18.53	0.36%	18.53	0.36%
High-Density Residential	0.15	0.00%	0.15	0.003%
Low-Intensity commercial	1.19	0.02%	7.32	0.14%
High-Intensity commercial	2.85	0.05%	2.85	0.05%
Industrial	23.51	0.45%	23.51	0.45%
Transportation	198.55	3.82%	198.55	3.82%
Water	52.83	1.02%	52.83	1.02%
Institution	33.12	0.64%	33.12	0.64%

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Stormwater Infrastructure

The Sandy Run WMA consists primarily of estate residential development and open space/park lands. As a result, the watershed's stormwater infrastructure consists primarily of open drainage channels with limited hard infrastructure (pipes, stormwater management facilities, BMPs, etc.) in place.

The WMA also contains a wide variety of additional stormwater infrastructure and best management practices which track with the watershed's development history. For example, in areas that developed earlier, stormwater management facilities, where present, consist primarily of dry detention basins designed to curb peak storm flows (quantity management). For areas that developed more recently, stormwater management facilities are more likely to include a water quality component, and the variety of facility types increases. Facilities found in these areas include underground chambers, infiltration devices, and wetlands.

Map 2.2.4-2 demonstrates the observed stormwater infrastructure conditions in Sandy Run. Stormwater infrastructure consists primarily of open channel drainage to either dry detention basins or directly into Sandy Run and its associated stream valleys and tributaries. Sandy Run contains approximately 22 dry detention facilities designed to manage stormwater quantity, several of which are owned/maintained by the Virginia

Department of Transportation (VDOT). In addition, the County has captured a number of other surface water impoundments, old farm ponds, and other catchments that may provide some anecdotal stormwater management function, but for which no stormwater management design can be confirmed at the time of this draft. These features appear in the Fairfax County stormwater management facility inventory as "TBD." Finally, the WMA contains one underground storage chamber for volume control and one infiltration trench.

Stream Conditions

The Stream Conditions **Map 2.2.4-3** denotes the generally observed stream conditions as documented in the 2005 SPA and through additional windshield level field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the watershed along with a series of features that typically impact stream condition, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout the County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

In Sandy Run, a total of 171 inventory points were visually assessed with only two scoring a seven or higher. The highest scoring impacts in Sandy Run were a head cut and a crossing scoring a 10 and seven respectively. Table 34 below summarizes all 171 inventory points captured in the 2005 SPA for Sandy Run.

Table 34: Sandy Run Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	1	5	26	15	4	2	0	0	0	0	0	N/A	53
Crossings	24	42	16	11	2	1	0	1	0	0	0	N/A	97
Ditches and Pipes	1	1	0	1	0	0	0	0	0	0	0	N/A	3
Erosion	0	0	1	1	2	1	1	0	0	0	0	N/A	6
Head Cut	0	0	0	0	1	0	0	0	0	0	1	N/A	2
Obstruction	0	1	4	2	1	1	0	0	0	0	0	N/A	9
Utility	0	0	0	0	1	0	0	0	0	0	0	0	1
Total	**26**	**49**	**47**	**30**	**11**	**5**	**1**	**1**	**0**	**0**	**1**	**0**	**171**

In Sandy Run, the most prevalent stream condition features noted include disturbed stream buffers, stream channel erosion and/or widening, and crossing impacts from roads and utilities. Channel widening and incision conditions are noted in the head waters of the Sandy Run main stem, but the downstream main stem of Sandy Run, moving toward the park, generally appears more stable. Pipe discharge into the WMAs streams have a demonstrated impact as well, as these pipes discharge stormwater

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runoff directly into the streams in many instances, contributing to the upstream widening and erosive conditions. Road crossing impacts in Sandy Run are generally minor, with the exception of a severe instance on a small tributary upstream of the main stem's crossing with Henderson Road. A handful of minor obstructions are noted in the headwaters area of Sandy Run, as well as a couple of dump sites, which can be more prevalent in less populated and developed watersheds.

Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data 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:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. As illustrated below, of the estimated 20 sampled miles of stream assessed in Sandy Run, over 82 percent was considered fair, and 13 percent was considered good. Overall, Sandy Run was categorized as fair with a length-weighted habitat score of 104, equaling the Fairfax County average. Table 35 identifies the stream physical habitat conditions for the Sandy Run streams.

Table 35: Sandy Run Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		Poor		Fair		Good		Excellent		Total
Sandy Run	0	0.00%	0	0.00%	5,407	28.88%	13,315	71.12%	0	0.00%	18,722
Tributary to Occoquan River	0	0.00%	0	0.00%	12,270	90.83%	1,238	9.17%	0	0.00%	13,509
Tributary to Sandy Run	0	0.00%	4,734	6.28%	70,602	93.72%	0	0.00%	0	0.00%	75,337
Total	**0**	**0.00%**	**4,734**	**4.40%**	**88,280**	**82.07%**	**14,553**	**13.53%**	**0**	**0.00%**	**107,567**

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Stream Biological Habitat

In 2001, the County released the SPS Study documenting the current stream conditions throughout the county using physical, chemical, and biological evaluations. The County developed a ranking of quality for each site. Of the 138 stream sites, three were located in Sandy Run. Table 36 below summarizes the results. Overall, Sandy Run has some of the highest water quality in the County. However, the unnamed tributary within Sandy Run had a fish community rating and biological integrity rating of very low and good, respectively. According to the 2001 SPS report, this was a direct result of heavy loads of sediment entering the system, due to the insufficient maintenance of control structures at an upstream development site during the summer prior to the 2001 Stream Protection Baseline Study.

Table 36: Sandy Run Biological Integrity Ranting (2001 SPS)

Stream Name and Site Code	Composite	Environmental Tables		
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Sandy Run 1 (SASA01)	Excellent	Good	Good	High
Sandy Run 2 (SASA03)	Excellent	Good	Good	Moderate
Sandy Run Unnamed Tributary (SASA02)	Fair	Good	Fair	Very Low

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 37** below for monitoring results (Annual Report, 2006).

Table 37: Sandy Run Monitoring Results*

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

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

Stream Channel

To identify and track stream evolution and 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.

- Stage I: Stable- well developed base flow and bankfull channel
- Stage II: Incision – down-cutting or head cuts occur

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- Stage III: Widening –bank failure is occurring
- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. Table 38 below summarizes the CEM results for Sandy Run.

Table 38: Sandy Run CEM results (SPA, 2005)

	Evolution Stage										Total of Reach Length
	I		II		III		IV		V		
WMA	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%	(ft)
Sandy Run	0	0%	0	0%	66,114	65%	35102	35%	0	0%	101,217

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2.2.5 High Point

General WMA Characteristics

Although High Point is considered a small watershed covering only 5.55 square miles (3,555 acres), it is one of the larger WMAs which make up the Lower Occoquan watershed. Located on a peninsula in the southeastern corner of Fairfax County, more than two-thirds of High Point's boundary is surrounded by the Potomac River, resulting in all tributaries within High Point watershed draining directly to the Potomac River. The High Point WMA is roughly bounded on the north end by Pohick Bay Drive (Route 721) and on the west by Gunston Road (Route 242) down to the point at the confluence of Gunston Cove and the Potomac River. The High Point WMA also extends to points south and west along High Point Road adjacent to the Kane Creek WMA to the north and the Potomac River to the south. The High Point WMA is a portion of the 800 acre Mason Neck peninsula.

High Point lies entirely within the Coastal Plain physiographic province, characterized by relatively gentle topography. The majority of the High Point watershed is covered by wetlands and is protected as part of the Elizabeth Hartwell Mason Neck National Wildlife Refuge and State Park, which were established to help protect the declining bald eagle population and provide a habitat for a variety of wildlife. Since High Point has had minimal environmental impacts, the area may be used in the future as a source of small stream reference conditions in the Coastal Plain region, but further research is needed to evaluate the region as a source of potential reference. The County has experienced difficulty in sampling the streams within High Point, since the streams do not conform to the "wadeable, flowing stream" standard. The streams are almost flowing wetlands. Due to this limitation, the County has been unable to conduct biological monitoring of these systems.

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Field Reconnaissance

The High Point WMA includes portions of Pohick Bay Regional Park; Mason Neck State Park, operated by the Virginia Department of Conservation and Recreation's Division of State Park; the Mason Neck National Wildlife Refuge, operated by the United States Department of the Interior; and the Gunston Hall Plantation, the ancestral home of George Mason now operating as a museum. As a result, development in the WMA has been limited to the areas east of Gunston Road and south of the Gunston Hall Plantation site in the lower end of the Mason Neck peninsula. Two primary residential subdivisions have been developed in Mason Neck, Hallowing Point River Estates and Gunston Manor.

The majority of the observed single- family residential parcels were roughly ½ acre to over one acre in size and were primarily developed in the 1970s (30 plus years old) and 1980s (20 plus years old). Residential subdivision streets lack curb and gutter and no sidewalks were observed. Of note, in the Gunston Manor area, many of the residential parcels have been further subdivided as property owners have sold small plots to buyers desiring boat slip privileges in Gunston Cove. Many of the subdivided parcels have no public right of way access (i.e. no access from public streets). Very few of these parcels have any evidence of development or buildings.

As mentioned above, institutional uses in the watershed are primarily parkland and preserved open space managed by a variety of state, federal, and local government entities, including the Fairfax County Park Authority, as well as privately held historic properties. The High Point WMA contains one house of worship, the Shiloh Baptist Church, located on Gunston Road. As such, grass and tree cover is prevalent throughout the High Point WMA.

Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the Technical Memorandum 3 guidance document, Table 39 below identifies the current and future impervious surface areas based on the existing and future land use conditions for High Point as well as the associated treatment types. Since High Point is so virtually undeveloped, with only very small pocket areas of residential and commercial development, the watershed has relatively low levels of imperviousness. The impervious levels within High Point are expected to increase by less than one percent. As expected, with minimal older development, the majority of stormwater in High Point is uncontrolled and drains untreated to receiving waters, which is consistent with the small percentage of impervious area within the WMA.

Table 39: High Point Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types			
	Current Condition		Ultimate Condition		Quantity	Quality	Quantity/ Quality	None
	(acres)	*%*	(acres)	*%*	(acres)	(acres)	(acres)	(acres)
High Point	84.79	*2.38*	104.14	*2.93*	0	2.58	0	3552.77

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Existing land use

See **Map 2.2.5-1** for existing and future land use for High Point. High Point consists of 3,555 acres, of which, approximately 85 percent is either forested, wetland or pasture, making it one of the least developed or rural watersheds in the County. Since 1965, the Mason Neck peninsula has been protected by the Elizabeth Hartwell Mason Neck National Wildlife Refuge and Mason Neck State Park. As a result High Point has experienced minimal development. The development it does have is located on the far eastern shore, east of Gunston Road and South of the Gunston Hall Plantation. Table 40 below summarizes the land uses within the High Point WMA.

Table 40: High Point Existing & Future Land Use (Co. GIS, 2008)

	Existing Conditions		Future Conditions	
Land Use Description	**Acres**	**Percent**	**Acres**	**Percent**
Open space, forest, parks, & recreational areas	2953.99	83.09%	2697.40	75.87%
Golf Course	0.00	0.00%	0.00	0.00%
Estate Residential	203.31	5.72%	459.89	12.94%
Low-Density Residential	172.73	4.86%	172.73	4.86%
Medium-Density Residential	21.10	0.59%	21.10	0.59%
High-Density Residential	3.16	0.09%	3.16	0.09%
Low-Intensity commercial	0.00	0.00%	0.00	0.00%
High-Intensity commercial	0.00	0.00%	0.00	0.00%
Industrial	0.00	0.00%	0.00	0.00%
Transportation	106.50	3.00%	106.49	3.00%
Water	13.75	0.39%	13.75	0.39%
Institution	80.84	2.27%	80.84	2.27%

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Stormwater Infrastructure

The High Point WMA consists primarily of open space/park lands with two mature residential subdivisions. As a result, the WMA's stormwater infrastructure consists primarily of open drainage channels with limited hard infrastructure (pipes, stormwater management facilities, BMPs, etc.) in place.

Due to the overall lack of development in the High Point WMA, very little formal stormwater infrastructure exists today, which tracks with both the age of the residential development that does exist and the land uses represented. **Map 2.2.5-2** demonstrates the observed stormwater infrastructure conditions in the High Point WMA. Stormwater infrastructure consists primarily of open channel drainage to Gunston Cove, the Potomac River, and to Belmont Bay. Fairfax County has captured a number of surface water impoundments, old farm ponds, and other catchments that may provide some anecdotal stormwater management function, but for which no stormwater management design can be confirmed at the time of this draft. These features appear in the Fairfax

County stormwater management facility inventory as “TBD.” The High Point WMA contains approximately eight TBDs.

Stream Conditions

The Stream Conditions **Map 2.2.5-3** denotes the generally observed stream conditions as documented in the 2005 SPA and through additional windshield level field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the watershed along with a series of features that typically impact stream condition, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout the County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

In High Point, a total of six inventory points were visually assessed, with the two highest impacts both being deficient buffers, each scoring a five. Table 41 below summarizes all six inventory points captured in the 2005 SPA for High Point.

Table 41: High Point Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	0	0	0	0	0	2	0	0	0	0	0	N/A	2
Crossings	3	0	0	1	0	0	0	0	0	0	0	N/A	4
Ditches and Pipes	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Erosion	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Head Cut	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Obstruction	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Utility	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Total	**3**	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**6**

In the High Point WMA, the most prevalent stream condition features noted include disturbed stream buffers, stream channel erosion and/or widening, and crossing impacts from roads and utilities. Channel incision conditions and crossing impacts are noted in a tributary stream along Gunston Road draining into Gunston Cove. Channel incision was also noted on a tributary running through portions of the Mason Neck State Park and the Mason Neck National Wildlife Refuge. Very few pipe discharges are noted in the WMA, and road crossing impacts in the High Point WMA are generally minor. Stream buffer deficiencies are noted sporadically around the WMA, with the most significant, contiguous deficiencies noted in the residential area around Hallowing Point River Estates.

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Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data 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:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. Overall, High Point was categorized as good with a length-weighted habitat score of 124, which is one of the highest scores in Fairfax County. Of the estimated three miles of stream assessed in High Point, nearly 96 percent of the streams were categorized as good, the largest percent of any watershed in the Lower Occoquan. However, it should be noted, many of the streams in High Point were not sampled.

Table 42: High Point Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		Poor		Fair		Good		Excellent		Total
Trib. to Potomac River	0	0.00%	0	0.00%	638	4.02%	15,218	95.98%	0	0.00%	15,856

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Stream Biological Habitat

Due to the characteristics of the majority of streams within the High Point WMA, the County has been unable to obtain valuable biological monitoring data. According to the 2001 SPS "*Methods for monitoring coastal wetland areas with variable drainages, such as the entire High Point Watershed, will need to be developed. These areas cannot currently be sampled under the RBP protocol, which requires clearly defined stream systems. The value of various indicators, such as macro invertebrates, amphibians, and even plants, will need to be assessed with regard to their utility in highlighting degradation in wetland environments.*" (SPS, 2001)

Stream Channel

To identify and track stream evolution and 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.

- Stage I: Stable- well developed base flow and bankfull channel
- Stage II: Incision – down-cutting or head cuts occur
- Stage III: Widening –bank failure is occurring
- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. In the High Point watershed, 100 percent of the streams surveyed are classified as CEM Evolutionary Stage II, generally characterized by down-cutting in the channel bottom which ultimately leads to the heavy erosion and sediment production of a Stage III channel. Table 43 below summarizes the CEM results for High Point.

Table 43: High Point CEM Results (SPA, 2005)

	Evolution Stage									
	I		II		III		IV		V	
WMA	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%
High Point	0	0 %	15,856	100 %	0	0 %	0	0 %	0	0 %

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2.2.6 Wolf Run

General WMA Characteristics

Although Wolf Run is considered a small watershed covering only 5.88 square miles (3,762 acres) along the central southwestern border of Fairfax County, it is a medium-sized WMA within the Lower Occoquan watersheds. Wolf Run is bounded by Popes Head Creek to the North, Sandy Run to the East, Ryans Dam and the Occoquan River to the South, and Old Mill Branch to the West. The Wolf Run WMA is roughly bounded on the north end by Chapel Road (Route 641) east of the Town of Clifton, on the east by Wolf Run Shoal Road (Route 610) and roughly on the south and west by Henderson Road (Route 643), which bisects the extreme southern portion of the WMA. The Wolf Run WMA is bisected in the northern region by Clifton Road (Route 645) and Yates Ford Road (Route 612). The Wolf Run WMA outfalls directly into the Occoquan River and Reservoir.

Wolf Run lies entirely within the Piedmont Upland physiographic province, characterized by rolling hills underlain by metamorphic rocks. The Wolf Run watershed consists of approximately 16 miles of stream and includes one main tributary system, Wolf Run, which flows southwest and discharges directly into the Occoquan River, and ultimately into the Potomac River. A small portion of southern Wolf Run is covered by Fountainhead Regional Park, which is a multi-use area consisting of numerous trails for both biking and hiking. This parkland, which serves as a forested buffer for the Occoquan River and Reservoir, is operated by the Northern Virginia Regional Park Authority.

Field Reconnaissance

The Wolf Run WMA includes a portion of Fountainhead Regional Park at the downstream end of the WMA and also includes two significant named tributaries – Swift Run, located east of the main stem of Wolf Run with headwaters around Wolf Run Shoals Road; and Maple Branch, with its headwaters near the intersection of Henderson Road and Yates Ford Road. In July 1982, the Fairfax County Board of Supervisors amended the County's Comprehensive Plan by down-zoning approximately 41,000 acres of the Occoquan watershed in Fairfax County to an R-C District (Residential – Conservation), which yields a maximum density of one dwelling unit per five acres. This down-zoning action, driven by the County's desire to protect the Occoquan Reservoir and the drinking water it supplies to well over one million people, has served to curb intense development in the area. The Wolf Run WMA lies within the area down-zoned by Fairfax County in 1982 and consists of 24 subwatersheds.

As a result, development in the watershed is primarily estate residential, which includes several established, estate subdivisions such as Wolf Run Estates, Wolf Run, Wolf Run Hills, Lakewood Estates, Wolfs Landing, Plantation Hills, and Rose Hall. The majority of the observed single- family residential parcels are over one acre in size and were primarily developed in the 1980s (20 plus years old) and 1990s (10 plus years old). Residential subdivision streets lack curb and gutter and no sidewalks were observed. These larger lot developments also demonstrated significant grass and tree cover, with impervious cover estimates at ten percent or lower.

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Non-residential uses in the Wolf Run WMA appear to be limited to parkland (portion of Fountainhead Regional Park) and a few small, private cemeteries. No schools, shopping centers, or other institutional or commercial developments were observed. As such, grass and tree cover is prevalent throughout the Wolf Run WMA.

Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the Technical Memorandum 3 guidance document, Table 44 below identifies the current and future impervious surface areas based on the existing and future land use conditions for Wolf Run as well as the associated treatment types. Since Wolf Run is extremely undeveloped, with a very small area of commercial development, the area as a whole exhibits levels of imperviousness below five percent and are expected to increase by less than one-half percent in the future. As Table 44 shows, the majority of stormwater in Wolf Run is uncontrolled and drains untreated to receiving waters, which is consistent with the small percentage of impervious area within the WMA.

Table 44: Wolf Run Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types			
	Current Condition		Ultimate Condition		Quantity	Quality	Quantity/ Quality	None
	(acres)	*%*	(acres)	*%*	(acres)	(acres)	(acres)	(acres)
Wolf Run	163.51	*4.35*	172.34	*4.58*	0	105.68	12.68	3643.32

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Existing land use

See **Map 2.2.6-1** for existing and future land use for Wolf Run. Wolf Run consists of 3,762 acres, of which approximately 92 percent is either open space, forested, or estate residential, making it one of the least developed or rural watersheds in Fairfax County. As mentioned above, Wolf Run WMA lies within the WSPOD. The WSPOD imposes restrictions on development and requires enhanced water quality controls for any development. Existing zoning regulations require minimum lot sizes of five-acres for the Wolf Run WMA. The WSPOD, in addition to Fountainhead Regional Park, have prevented the area from experiencing much development.

Table 45: Wolf Run Existing & Future Land Use (Co. GIS, 2008)

	Existing Conditions		Future Conditions	
Land Use Description	**Acres**	**Percent**	**Acres**	**Percent**
Open space, forest, parks, & recreational areas	379.05	10.08%	170.67	4.54%
Golf Course	0.00	0.00%	0	0.00%
Estate Residential	3125.56	83.09%	3333.93	88.63%
Low-Density Residential	128.32	3.41%	128.31	3.41%
Medium-Density Residential	0.00	0.00%	0.00	0.00%
High-Density Residential	0.00	0.00%	0.00	0.00%
Low-Intensity commercial	0.93	0.02%	0.93	0.02%
High-Intensity commercial	0.002	0.00%	0.00	0.00%
Industrial	0.19	0.01%	0.19	0.01%
Transportation	77.56	2.06%	77.56	2.06%
Water	48.76	1.30%	48.76	1.30%
Institution	1.32	0.04%	1.32	0.04%

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Stormwater Infrastructure

The Wolf Run WMA consists primarily of multiple, mature, estate residential subdivisions upstream of open space located in Fountainhead Regional Park. As a result, the WMAs stormwater infrastructure consists primarily of open drainage channels with limited hard infrastructure (pipes, stormwater management facilities, BMPs, etc.) in place.

Due to the nature of development in the Wolf Run WMA, very little formal stormwater infrastructure exists today. Given that several areas in the Wolf Run WMA appear to have developed more recently, the stormwater management facilities present include both a water quality and water quantity management component. **Map 2.2.6-2** demonstrates the observed stormwater infrastructure conditions in the Wolf Run WMA. Two wet detention facilities are located in the Wolf Run WMA. Other stormwater infrastructure consists primarily of open channel drainage to main stem tributaries and eventually to the Occoquan River. Limited stormwater pipe infrastructure is present in the WMA, primarily in the southern reaches near Henderson Road. Fairfax County has

captured a number of surface water impoundments, old farm ponds, and other catchments that may provide some anecdotal stormwater management function, but for which no stormwater management design can be confirmed at the time of this draft. These features appear in the Fairfax County stormwater management facility inventory as "TBD." The Wolf Run WMA contains approximately 49 TBDs.

Stream Conditions

The Stream Conditions **Map 2.2.6-3** denotes the generally observed stream conditions as documented in the 2005 SPA and through additional, windshield level field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the watershed along with a series of features that typically impact stream condition, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout the County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

In Wolf Run, a total of 133 inventory points were visually assessed. The highest scoring impact in the Wolf Run watershed was a head cut with a score of 10. Table 46 below summarizes all 133 inventory points captured in the 2005 SPA for Wolf Run.

Table 46: Wolf Run Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	0	1	7	24	17	8	0	0	0	0	0	N/A	57
Crossings	33	11	11	6	4	0	0	0	0	0	0	N/A	65
Ditches and Pipes	4	0	1	1	0	0	0	0	0	0	0	N/A	6
Erosion	0	0	0	0	1	0	0	0	0	0	0	N/A	1
Head Cut	0	0	0	1	0	0	0	0	0	0	1	N/A	2
Obstruction	0	0	0	0	2	0	0	0	0	0	0	N/A	2
Utility	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**37**	**12**	**19**	**32**	**24**	**8**	**0**	**0**	**0**	**0**	**1**	**0**	**133**

In the Wolf Run WMA, the most prevalent stream condition features noted include channel widening coincident with poor overall stream habitat, disturbed stream buffers in the headwaters reaches of Wolf Run and its tributaries, and crossing impacts from roads and utilities. Channels noted as widening are almost universally impacted by multiple crossing impacts, including widening noted on Swift Run, Maple Branch, and the unnamed tributary following Lakewood Lane in the southern end of the Wolf Run WMA. Crossing impacts are noted as primarily minor, with the exception of a pair in the southern end of Wolf Run. In addition, several moderate to severe obstructions are noted in two different Wolf Run tributaries. Head cuts, including one severe instance –

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over two feet, were noted in the upper reaches of Wolf Run and two dump sites were identified as well.

Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data 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:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. Overall, Wolf Run was categorized as fair with a length-weighted habitat score of 99, which is slightly lower than the Fairfax County average. Of the estimated 16 miles of stream assessed in Wolf Run, approximately 70 percent was categorized as fair, with nearly ten percent being categorized as poor. Approximately four percent of the streams were categorized as very poor, the largest percent of any watershed in the Lower Occoquan in that category

Table 47: Wolf Run Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		Poor		Fair		Good		Excellent		Total
Maple Branch	0	0.0%	0	0.0%	7,679	100.0%	0	0.0%	0	0.0%	7,679
Swift Run	0	0.0%	0	0.0%	6,540	100.0%	0	0.0%	0	0.0%	6,540
Trib. to Wolf Run	3430	9.4%	8,042	22.2%	24,841	68.4%	0	0.0%	0	0.0%	36,313
Wolf Run	0	0.0%	0	0.0%	20,695	60.1%	13,761	39.9%	0	0.0%	34,456
Total	**3,430**	**4.0%**	**8,042**	**9.5%**	**59,756**	**70.3%**	**13,761**	**16.2%**	**0**	**0.0%**	**84,989**

Stream Biological Habitat

The 2001, the County released the SPS Study documenting the current stream conditions throughout the county using physical, chemical, and biological evaluations. The County developed a ranking of quality for each site. Of the 138 stream sites, 2 were located in Wolf Run. Table 48 below summarizes the results. Overall, Wolf Run's biological integrity was rated as excellent and is among the highest in the County, but the fish community rating was very low to moderate, among the worst in the County.

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Table 48: Wolf Run Biological Integrity Ranting (2001 SPS)

Stream Name and Site Code	Composite	Environmental Tables		
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Wolf Run 1 (WRWR01)	Fair	Excellent	Fair	Very Low
Wolf Run 2 (WRWR02)	Excellent	Excellent	Good	Moderate

Stream Channel

To identify and track stream evolution and 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.

- Stage I: Stable- well developed base flow and bankfull channel
- Stage II: Incision – down-cutting or head cuts occur
- Stage III: Widening –bank failure is occurring
- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. In the Wolf Run watershed, approximately 98 percent of the streams are classified as CEM Evolutionary Stage III, generally characterized as unstable and show signs of widening and deepening. The remaining streams fall into CEM Evolutionary Stage II, indicating head cuts that could ultimately lead into Stage III. Table 49 below summarizes the CEM results for Wolf Run.

Table 49: Wolf Run CEM results (SPA, 2005)

WMA	Evolution Stage										Total of Reach Length
	I		II		III		IV		V		
	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%	(ft)
Wolf Run	0	0%	1,665	2%	83,324	98%	0	0%	0	0%	84,989

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2.2.7 Kane Creek

General WMA Characteristics

Kane Creek is located on a peninsula in the southeastern corner of Fairfax County and covers 4.81 square miles (3,076 acres). Kane Creek lies entirely within the Coastal Plain physiographic province, characterized by relatively gentle topography and consists of approximately 8.5 miles of stream. The Kane Creek WMA consists of several small independent streams, with four main tributary systems which discharge into the Belmont Bay along the Potomac River. The two largest systems, Kane Creek and Thompson Creek, flow south and drain the majority of the WMA. The southern and eastern portions of the Kane Creek watershed are mostly covered by wetlands and are protected as part of the Elizabeth Hartwell Mason Neck National Wildlife Refuge and Mason Neck State Park. These areas were established to help protect the declining bald eagle population and provide a habitat for a variety of wildlife. As a result of this protection, Kane Creek is one of the highest quality Coastal Plain basins within Fairfax County and has been used as a source for reference conditions for other watersheds.

The Kane Creek WMA is roughly bounded on the north end by Gunston Road (Route 242) and to the west by Belmont Boulevard (Route 601) and by Belmont Bay, to which Kane Creek's non-tidal tributaries drain. The Kane Creek WMA is roughly bounded to the south by High Point Road and extends east into portions of the Mason Neck National Wildlife Refuge. Kane Creek is tidally influenced well into Mason Neck State Park. The WMA includes other tributary streams of note, including Thompson Creek, which runs through the Meadowood Special Recreation Management Area described below.

Field Reconnaissance

The Kane Creek WMA includes a total of 22 subwatersheds as well as a significant portion of the 800-acre Mason Neck peninsula, which in turn contains Gunston Hall - historic home of George Mason IV, author of the Virginia Bill of Rights. Public uses on Mason Neck include the Mason Neck National Wildlife Refuge managed by the U.S. Fish and Wildlife Service, Mason Neck State Park managed by the Commonwealth of Virginia's Department of Conservation and Recreation, and Pohick Bay Regional Park managed by the Northern Virginia Regional Park Authority. Similar to the High Point WMA, development in the Kane Creek WMA has been limited, primarily to the areas south of Gunston Road and west of Springfield Road. Several residential subdivisions have been developed in the Mason Neck area, including Springfield Farms, Belmont Park Estates, Gunston Heights, and Wiley. The majority of the observed single-family residential parcels were over one acre in size and were primarily developed in the 1980s (20 plus years old) and 1990s (10 plus years old). Residential subdivision streets lack curb and gutter and no sidewalks were observed.

As mentioned above, institutional uses in the watershed are primarily parkland and preserved open space managed by a variety of public entities, including the Fairfax County Park Authority, as well as privately held historic properties. For example, the Kane Creek WMA contains the Meadowood Special Recreation Management Area, operated by the federal Bureau of Land Management, an agency of the Department of the Interior. Meadowood Recreation Area encompasses several hundred acres of

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forests, meadows, hiking and horseback riding trails, and an equestrian facility. Thompson Creek runs through the Meadowood property.

These institutional uses account for a great deal of preserved open space, woodlands, and tidal wetlands in the Kane Creek WMA. As such, grass and tree cover is prevalent throughout the WMA.

Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the Technical Memorandum 3 guidance document, Table 50 below identifies the current and future impervious surface areas based on the existing and future land use conditions for Kane Creek as well as the associated treatment types. Since Kane Creek is almost completely undeveloped, with only very small areas of residential and commercial development, the entire area exhibits levels of imperviousness below two percent. As Table 50 shows, the majority of stormwater in Kane Creek is uncontrolled and drains untreated to receiving waters, which is consistent with the small percentage of impervious area within the WMA.

Table 50: Kane Creek Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types			
	Current Condition		Ultimate Condition		Quantity	Quality	Quantity/ Quality	None
	(acres)	*%*	(acres)	%	(acres)	(acres)	(acres)	(acres)
Kane Creek	57.93	*1.88*	70.70	*2.30*	0	4.03	11.76	3060.11

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Existing land use

See **Map 2.2.7-1** for existing and future land use for Kane Creek. Kane Creek consists of 3,076 acres, of which more than 75 percent is either forested, wetland or pasture, making it one of the least developed or rural watersheds in Fairfax County. The southern portion of Kane Creek is located on the Mason Neck peninsula, which has been protected since 1965 by the Mason Neck National Wildlife Refuge and State Park to protect the area's wildlife and habitat, preventing the area from experiencing much development.

Table 51: Kane Creek Existing & Future Land Use (Co. GIS, 2008)

	Existing Conditions		Future Conditions	
Land Use Description	**Acres**	**Percent**	**Acres**	**Percent**
Open space, forest, parks, & recreational areas	2395.03	77.86%	2203.00	71.62%
Golf Course	8.09	0.26%	8.09	0.26%
Estate Residential	505.27	16.43%	697.30	22.67%
Low-Density Residential	70.29	2.29%	70.29	2.29%
Medium-Density Residential	6.30	0.20%	6.30	0.20%
High-Density Residential	0.00	0.00%	0.00	0.00%
Low-Intensity commercial	0.00	0.00%	0.00	0.00%
High-Intensity commercial	0.00	0.00%	0.00	0.00%
Industrial	0.24	0.01%	0.24	0.01%
Transportation	50.14	1.63%	50.14	1.63%
Water	39.48	1.28%	39.48	1.28%
Institution	1.06	0.03%	1.06	0.03%

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Stormwater Infrastructure

The Kane Creek WMA consists primarily of open space/park lands to the east with several mature, estate residential subdivisions to the west, abutting Mason Neck State Park. As a result, the WMAs stormwater infrastructure consists primarily of open drainage channels with limited hard infrastructure (pipes, stormwater management facilities, BMPs, etc.) in place.

Due to the overall lack of development in the Kane Creek WMA, very little formal stormwater infrastructure exists today. Some piped stormwater conveyances are noted, but no stormwater BMPs have been noted to date. **Map 2.2.7-2** demonstrates the observed stormwater infrastructure conditions in the Kane Creek WMA. Stormwater infrastructure consists primarily of open channel drainage to the tidal and non-tidal portions of Kane Creek and to Belmont Bay. Fairfax County has captured a number of surface water impoundments, old farm ponds, and other catchments that may provide some anecdotal stormwater management function, but for which no stormwater management design can be confirmed at the time of this draft. These features appear in

the Fairfax County stormwater management facility inventory as “TBD.” The Kane Creek WMA contains approximately thirteen TBDs.

Stream Conditions

The Stream Conditions **Map 2.2.7-3** denotes the generally observed stream conditions as documented in the 2005 SPA and through additional, windshield level field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the watershed along with a series of features that typically impact stream condition, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout the County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

In Kane Creek, a total of 13 inventory points were visually assessed, with the two highest impacts, a crossing and a deficient buffer, scoring a seven and five, respectively. Table 52 summarizes all 13 inventory points captured in the 2005 SPA for Kane Creek.

Table 52: Kane Creek Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	0	0	0	1	0	1	0	0	0	0	0	N/A	2
Crossings	9	0	0	0	0	0	0	1	0	0	0	N/A	10
Ditches and Pipes	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Erosion	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Head Cut	0	0	0	1	0	0	0	0	0	0	0	N/A	1
Obstruction	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Utility	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**9**	**0**	**0**	**2**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**13**

In the Kane Creek WMA, the most prevalent stream condition features noted include stream channel erosion, widening, and incision, and crossing impacts from roads and utilities. Channel incision conditions and crossing impacts are noted in most of the upstream, non-tidal tributaries in the Kane Creek WMA, including Thompson Creek in the Meadowood property. Most of the crossing impacts noted is minor, with the exception of one major impact noted near Belmont Landing Road in Belmont Park Estates. Very few pipe discharges are noted in the WMA, and road crossing impacts in the Kane Creek WMA are generally minor. Stream buffer disturbance has been noted in a few of the upstream tributaries, but is less prevalent than in other lower Occoquan WMAs. Where stream buffer deficiencies are noted, they appear more sporadically around the WMA, with no significant, contiguous deficiencies noted.

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Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data 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:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. Overall, Kane Creek was categorized as good with a length-weighted habitat score of 128, the second highest score in Fairfax County. Of the estimated seven miles of stream assessed in Kane Creek, approximately 76 percent were categorized as good, along with nearly 18 percent being categorized as excellent.

Table 53: Kane Creek Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		Poor		Fair		Good		Excellent		Total
Kane Creek	0	0.00%	0	0.00%	2,072	10.48%	10,666	53.94%	7,034	35.58%	19,772
Thompson Creek	0	0.00%	0	0.00%	0	0.00%	15,493	100.00%	0	0.00%	15,493
Trib. to Potomac River	0	0.00%	0	0.00%	0	0.00%	1,300	100.00%	0	0.00%	1,300
Trib. to Thompson Creek	0	0.00%	0	0.00%	0	0.00%	1,970	100.00%	0	0.00%	1,970
Total	**0**	**0.00%**	**0**	**0.00%**	**2,072**	**5.38%**	**29,429**	**76.37%**	**7,034**	**18.25%**	**38,535**

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Stream Biological Habitat

In 2001, the County released the SPS Study documenting the current stream conditions throughout the county using physical, chemical, and biological evaluations. The County developed a ranking of quality for each site. Of the 138 stream sites, one was located in the Kane Creek WMA. Table 54 below summarizes the results. Overall, the Kane Creek WMA represents the highest quality Coastal Plain basins in all of Fairfax County with the fish community rating and biological integrity rated as high and excellent, respectively.

Table 54: Kane Creek Biological Integrity Ranting (2001 SPS)

Stream Name and Site Code	Composite	Environmental Tables		
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Kane Creek (KCKC01)	Excellent	Excellent	Good	High

Stream Channel

To identify and track stream evolution and 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.

- Stage I: Stable- well developed base flow and bankfull channel
- Stage II: Incision – down-cutting or head cuts occur
- Stage III: Widening –bank failure is occurring
- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. In the Kane Creek WMA, approximately two-thirds of the streams are classified as CEM Evolutionary Stage II, indicating head cuts that could ultimately lead into Stage III. The remaining streams fall into CEM Evolutionary Stage II, generally characterized as unstable and show signs of widening and deepening.

Table 55: Kane Creek CEM results (SPA, 2005)

	Evolution Stage										Total of Reach Length
	I		II		III		IV		V		
WMA	Length		Length		Length		Length		Length		
	(ft)	%	(ft)	%	(ft)	%	(ft)	%	(ft)	%	(ft)
Kane Creek	0	0 %	24,118	64 %	13,861	36 %	0	0 %	0	0 %	37,979

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2.2.8 Old Mill Branch

General WMA Characteristics

Old Mill Branch, one of the smallest of the Lower Occoquan watersheds, is adjacent to Bull Run and the Occoquan River and covers 4.26 square miles (2,724 acres) along the central southwestern border of Fairfax County. Old Mill Branch lies entirely within the Piedmont Upland physiographic province, characterized by rolling hills underlain by metamorphic rocks. Old Mill Branch consists of approximately six miles of streams and includes several small tributary systems which discharge directly into Bull Run or the Occoquan River, and ultimately into the Potomac River.

The Old Mill Branch WMA is roughly bounded on the north end by Yates Ford Road (Route 615), on the east by Henderson Road (Route 643) to roughly the edge of Fountainhead Regional Park, to the west by Hemlock Overlook Regional Park and to the south by the Occoquan River. Old Yates Ford Road (Route 612) bisects the WMA from east to west. The Old Mill Branch WMA outfalls directly into Bull Run, which is a major tributary of the Occoquan River.

Old Mill Branch, the watershed's main tributary system, flows southwest and drains the northern portion of the watershed. The western boundary of Old Mill Branch is covered by parkland, which serves as a forested buffer for the Occoquan River and Reservoir, and is operated by the Northern Virginia Regional Park Authority. Fountainhead Regional Park, located along the southwestern half of the watershed, is a multi-use area consisting of numerous trails for both biking and hiking. Hemlock Overlook Regional Park, located along the northwestern half of the watershed, serves as an Outdoor Education Center, offering a wide variety of outdoor activities and is jointly operated by George Mason University.

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Field Reconnaissance

The Old Mill Branch WMA is roughly half parkland/open space and half estate residential development. The Old Mill Branch WMA includes a portion of Fountainhead Regional Park at the downstream end of the WMA as well as portions of Hemlock Regional Overlook Park to the north and west and the entire Bull Run Marina Regional Park.

In July 1982, the Fairfax County Board of Supervisors amended the County's Comprehensive Plan by down-zoning approximately 41,000 acres of the Occoquan watershed in Fairfax County to an R-C District (Residential – Conservation), which yields a maximum density of one dwelling unit per five acres. This down-zoning action, driven by the County's desire to protect the Occoquan Reservoir and the drinking water it supplies to well over one million people, has served to curb intense development in the area. The Old Mill Branch WMA lies within the area down-zoned by Fairfax County in 1982 and contains a total of 18 subwatersheds.

As mentioned, development in the watershed is primarily estate residential, which includes several established, estate subdivisions such as Mill Branch, Wyckland, Clifton Hunt Estates, Turtle Valley Estates, Squires Place, and Sylvan Manor. The majority of the observed single-family residential parcels are over one acre in size and were primarily developed in the 1970s (30 plus years old), 1980s (20 plus years old), and

1990s (10 plus years old). Residential subdivision streets lack curb and gutter and no sidewalks were observed. These larger lot developments also demonstrated significant grass and some tree cover, with impervious cover estimates at ten percent or lower.

Institutional uses in the Old Mill Branch WMA appear to be limited to parkland, as part of the Fountainhead Regional Park, Hemlock Overlook Regional Park, and the Bull Run Marina Regional Park, along with a few small, private cemeteries. No schools, shopping centers, or other institutional or commercial developments were observed. As such, grass and tree cover is prevalent throughout the Old Mill Branch WMA.

Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the Technical Memorandum 3 guidance document, Table 56 below identifies the current and future impervious surface areas based on the existing and future land use conditions for Old Mill Branch as well as the associated treatment types. Since Old Mill Branch is extremely undeveloped with a very small area of commercial development, the area as a whole exhibits levels of imperviousness 2.3 percent and is expected to increase less than 0.3 percent. As Table 56 shows, the majority of stormwater in Old Mill Branch is uncontrolled and drains untreated to receiving waters, which is consistent with the small percentage of impervious area within the WMA.

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Table 56: Old Mill Branch Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types			
	Current Condition		Ultimate Condition		Quantity	Quality	Quantity/ Quality	None
	(acres)	*%*	(acres)	%	(acres)	(acres)	(acres)	(acres)
Old Mill Branch	62.21	*2.28*	69.55	*2.55*	0	19.17	10.30	2694.16

Existing land use

See **Map 2.2.8-1** for existing and future land use for Old Mill Branch. Old Mill Branch consists of 2,724 acres, of which almost 90 percent is considered open space forested, or estate residential land use which makes Old Mill Branch one of the least developed or rural watersheds in Fairfax County. The Old Mill Branch WMA falls within WSPOD. The WSPOD imposes restrictions on development and requires enhanced water quality controls for any development. Existing zoning regulations require minimum lot sizes of five-acres for the Old Mill Branch WMA. The WSPOD, in addition to Fountainhead Regional Park and Hemlock Regional Park, have prevented the area from experiencing much development.

Table 57: Old Mill Branch Existing & Future Land Use (Co. GIS, 2008)

Land Use Description	Existing Conditions		Future Conditions	
	Acres	Percent	Acres	Percent
Open space, forest, parks, & recreational areas	1590.7	58.40%	1456.02	53.46%
Golf Course	0	0.00%	0.00	0
Estate Residential	1053.83	38.69%	1188.51	43.64%
Low-Density Residential	11.979	0.44%	11.98	0.44%
Medium-Density Residential	0	0.00%	0.00	0
High-Density Residential	0	0.00%	0.00	0
Low-Intensity commercial	0	0.00%	0.00	0
High-Intensity commercial	0	0.00%	0.00	0
Industrial	3.725	0.14%	3.72	0.14%
Transportation	26.799	0.98%	26.80	0.98%
Water	27.21	1.00%	27.21	1.00%
Institution	9.401	0.35%	9.40	0.35%

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Stormwater Infrastructure

The Old Mill Branch WMA consists primarily of multiple, mature, estate residential subdivisions upstream of open space located in Fountainhead Regional Park, Bull Run Marina Park, and Hemlock Overlook Regional Park. As a result, the WMAs stormwater

infrastructure consists primarily of open drainage channels with limited hard infrastructure (pipes, stormwater management facilities, BMPs, etc.) in place.

Due to the nature of development in the Old Mill Branch WMA, very little formal stormwater infrastructure exists today. Older development in the WMA likely pre-dates local requirements for stormwater management. For areas of the Old Mill Branch WMA that have been developed more recently, the stormwater management facilities present include both a water quality and water quantity management component. **Map 2.2.8-2** demonstrates the observed stormwater infrastructure conditions in the Old Mill Branch WMA. One wet detention facility is located in the Old Mill Branch WMA. Other stormwater infrastructure consists primarily of open channel drainage to main stem tributaries and eventually to Bull Run and to the Occoquan River. Limited stormwater pipe infrastructure is present in the WMA, primarily in the northern reaches near Henderson Road and Yates Ford Road. Fairfax County has captured a number of surface water impoundments, old farm ponds, and other catchments that may provide some anecdotal stormwater management function, but for which no stormwater management design can be confirmed at the time of this draft. These features appear in the Fairfax County stormwater management facility inventory as "TBD." The Old Mill Branch WMA contains approximately nine TBDs.

Stream Conditions

The Stream Conditions **Map 2.2.8-3** denotes the generally observed stream conditions as documented in the 2005 SPA and through additional, windshield level field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the watershed along with a series of features that typically impact stream condition, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout the County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

In Old Mill Branch, a total of 29 inventory points were visually assessed. The highest scoring impact in the Old Mill Branch watershed was a crossing with a score of nine. Table 58 below summarizes all 29 inventory points captured in the 2005 SPA for Old Mill Branch.

Table 58: Old Mill Branch Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	0	0	0	2	2	3	1	1	0	0	0	N/A	9
Crossings	9	2	0	1	1	0	1	1	0	1	0	N/A	16
Ditches and Pipes	1	0	0	0	0	1	0	0	0	0	0	N/A	2

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Erosion	0	0	0	0	0	0	1	1	0	0	0	N/A	2
Head Cut	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Obstruction	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Utility	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**10**	**2**	**0**	**3**	**3**	**4**	**3**	**3**	**0**	**1**	**0**	**0**	**29**

In the Old Mill Branch WMA, the most prevalent stream condition features noted include channel widening coincident with limited, poor overall stream habitat; disturbed stream buffers in the headwaters reaches of Old Mill Branch and its tributaries, and crossing impacts from roads and utilities. Channels noted as widening almost universally appear to be located in the residentially developed areas of the WMA. The stream conditions in the public lands in the Old Mill Branch WMA are noted as generally healthy. Crossing impacts are noted as minor, with the exception of a pair in the Bull Run Marina Regional Park area. One severe crossing impact is noted on Kinchloe Road near Bull Run. Another severe crossing impact is noted near the boat ramp in Bull Run Marina Regional Park.

Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data 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:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. Overall, Old Mill Branch was categorized as fair with a length-weighted habitat score of 99, which is slightly lower than the Fairfax County average. Of the estimated six miles of stream assessed in Old Mill Branch, nearly 89 percent was categorized as fair, the largest percentage of any watershed in the Lower Occoquan in that category, along with approximately five percent being categorized as poor.

Table 59: Old Mill Branch Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		Poor		Fair		Good		Excellent		Total
Old Mill Branch	0	0.00%	0	0.00%	8,755	100.00%	0	0.00%	0	0.00%	8,755
Trib. to Bull Run	0	0.00%	1,586	7.47%	17,734	83.47%	1,927	9.07%	0	0.00%	21,247

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Trib. to Old Mill Branch	0	0.00%	0	0.00%	1,627	100.00%	0	0.00%	0	0.00%	1,627
Total	**0**	**0.00%**	**1,586**	**5.02%**	**28,116**	**88.89%**	**1,927**	**6.09%**	**0**	**0.00%**	**31,629**

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Stream Biological Habitat

In 2001, the County released the SPS Study documenting the current stream conditions throughout the county using physical, chemical, and biological evaluations. The County developed a ranking of quality for each site. Of the 138 stream sites, one was located in the Old Mill Branch watershed. Table 60 below summarizes the results. Old Mill Branch's biological integrity was rated as excellent and is among the highest in the County, but the fish community rating was low, which ranks among the worst in the County.

Table 60: Old Mill Branch Biological Integrity Ranting (2001 SPS)

Stream Name and Site Code	Composite	Environmental Tables		
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Old Mill Branch (OMOM01)	Excellent	Excellent	Fair	Low

Stream Channel

To identify and track stream evolution and 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.

Stage I: Stable- well developed base flow and bankfull channel

- Stage II: Incision – down-cutting or head cuts occur
- Stage III: Widening –bank failure is occurring
- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. In the Old Mill Branch WMA, nearly three quarters of the streams are classified as CEM Evolutionary Stage III, generally characterized as unstable and show signs of widening and deepening. The remaining streams fall into CEM Evolutionary Stage IV, indicating re-stabilization and decreased stream bank slopes.

Table 61: Old Mill Branch CEM results (SPA, 2005)

	Evolution Stage										Total of Reach Length
	I		II		III		IV		V		
WMA	Length		Length		Length		Length		Length		
	(ft)	%	(ft)	%	(ft)	%	(ft)	%	(ft)	%	(ft)
Old Mill Branch	0	0 %	0	0 %	22,874	72 %	8755	28 %	0	0 %	31,629

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2.2.9 Ryans Dam

General WMA Characteristics

Ryans Dam, one of the smallest of the Lower Occoquan watersheds, is adjacent to the Occoquan River and Reservoir and covers 3.53 square miles (2,262 acres) along the central southwestern border of Fairfax County. Ryans Dam lies entirely within the Piedmont Upland physiographic province, characterized by rolling hills underlain by metamorphic rocks.

The Ryans Dam WMA is bounded on the north by Henderson Road (Route 643) and roughly to the west by Henderson Road as well. The WMA is bounded on the east by Hampton Road (Route 647) and to the south by the Occoquan Reservoir. The WMA contains a number of tributary streams and stream valleys, including Stilwell Run. The Ryans Dam WMA outfalls directly into the Occoquan River and Reservoir.

Since Ryans Dam is primarily undeveloped, much of the stream system within the WMA is undeveloped and runs naturally therefore Ryans Dam WMA has one of the higher values of stream lengths in the County. Ryans Dam consists of approximately 49 miles of stream and includes several small tributary systems which flow southwest and discharge directly into the Occoquan River, and ultimately into the Potomac River. Fountainhead Regional Park, operated by the Northern Virginia Regional Park Authority, is located along the southern half of the Ryans Dam watershed, and serves as a forested buffer for the Occoquan River and Reservoir. Fountainhead Regional Park is a multi-use area consisting of numerous trails for both biking and hiking.

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Field Reconnaissance

The majority of the Ryans Dam WMA is parkland/open space, including a significant portion of Fountainhead Regional Park, with the remaining portion estate residential development. In July 1982, the Fairfax County Board of Supervisors amended the County's Comprehensive Plan by down-zoning approximately 41,000 acres of the Occoquan watershed in Fairfax County to an R-C District (Residential – Conservation), which yields a maximum density of one dwelling unit per five acres. This down-zoning action, driven by the County's desire to protect the Occoquan Reservoir and the drinking water it supplies to well over one million people, has served to curb intense development in the area.

The Ryans Dam WMA lies within the area down-zoned by Fairfax County in 1982 and contains a total of 18 subwatersheds. As a result, development in the watershed is primarily upstream of Fountainhead Regional Park and consists of estate residential, which includes several established, estate subdivisions such as Fountainhead, Rondelay, Burkeridge Estates, and Crest Landing. The majority of the observed single-family residential parcels are over one acre in size and were primarily developed in the 1970s (30 plus years old) and 1980s (20 plus years old). Residential subdivision streets lack curb and gutter and no sidewalks were observed. These larger lot developments also demonstrated significant grass and some tree cover, with impervious cover estimates at ten percent or lower based on the size of the lots and the amount of development present.

Institutional uses in the Ryans Dam WMA appear to be limited to parkland, as part of the Fountainhead Regional Park, Hemlock Overlook Regional Park, and the Bull Run Marina Regional Park, along with a few small, private cemeteries. No schools, shopping centers, or other institutional or commercial developments were observed. As such, grass and tree cover is prevalent throughout the Ryans Dam WMA.

Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the Technical Memorandum 3 guidance document, Table 62 below identifies the current and future impervious surface areas based on the existing and future land use conditions for Ryans Dam as well as the associated treatment types. Since Ryans Dam is extremely undeveloped, with small areas of residential and commercial development, the area as a whole exhibits very low levels of imperviousness. The majority of stormwater in Old Mill Branch is uncontrolled and drains untreated to receiving waters, which is consistent with the small percentage of impervious area within the WMA.

Table 62: Ryans Dam Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types			
	Current Condition		Ultimate Condition		Quantity	Quality	Quantity/ Quality	None
	(acres)	*%*	(acres)	%	(acres)	(acres)	(acres)	(acres)
Ryans Dam	45.77	*2.02*	51.76	*2.29*	0	47.25	0	2214.56

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Existing land use

See **Map 2.2.9-1** for existing and future land use for Ryans Dam. Ryans Dam consists of 2,262 acres, of which almost 70 percent is either forested, wetland or pasture, making it one of the least developed or rural WMAs in the County. The Ryans Dam WMA falls within the WSPOD. The WSPOD imposes restrictions on development and requires enhanced water quality controls for any development. Existing zoning regulations require minimum lot sizes of five-acres for Ryans Dam. The WSPOD, in addition to Fountainhead Regional Park, have prevented the area from experiencing much development.

Table 63: Ryans Dam Existing & Future Land Use (Co. GIS layer, 2008)

	Existing Conditions		Future Conditions	
Land Use Description	**Acres**	**Percent**	**Acres**	**Percent**
Open space, forest, parks, & recreational areas	1516.12	67.03%	1380.84	61.05%
Golf Course	0.00	0.00%	0.00	0.00%
Estate Residential	673.67	29.78%	808.95	35.77%
Low-Density Residential	27.46	1.21%	27.46	1.21%
Medium-Density Residential	0.00	0.00%	0.00	0.00%
High-Density Residential	0.00	0.00%	0.00	0.00%
Low-Intensity commercial	0.00	0.00%	0.00	0.00%
High-Intensity commercial	0.00	0.00%	0.00	0.00%
Industrial	0.44	0.02%	0.44	0.02%
Transportation	28.44	1.26%	28.44	1.26%
Water	14.20	0.63%	14.20	0.63%
Institution	1.49	0.07%	1.49	0.07%

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Stormwater Infrastructure

The Ryans Dam WMA consists primarily of mature, estate residential subdivisions upstream of open space located in Fountainhead Regional Park. As a result, the WMAs stormwater infrastructure consists primarily of open drainage channels with limited hard infrastructure (pipes, stormwater management facilities, BMPs, etc.) in place.

Due to the nature of development in the Ryans Dam WMA, very little formal stormwater infrastructure exists today. Some piped stormwater conveyances are noted, but no stormwater BMPs have been inventoried to date. Older development in the WMA likely pre-dates current local requirements for stormwater management. **Map 2.2.9-2** demonstrates the observed stormwater infrastructure conditions in the Ryans Dam WMA. Stormwater infrastructure consists primarily of open channel drainage to main stem tributaries and eventually to the Occoquan River. Very limited stormwater pipe infrastructure is present in the WMA, primarily in the northern reaches near Henderson Road and Hampton Road. Fairfax County has captured a number of surface water

impoundments, old farm ponds, and other catchments that may provide some anecdotal stormwater management function, but for which no stormwater management design can be confirmed at the time of this draft. These features appear in the Fairfax County stormwater management facility inventory as "TBD." The Ryans Dam WMA contains approximately twelve TBDs, several of which are likely stormwater management facilities still under bond as of this draft.

Stream Conditions

The Stream Conditions **Map 2.2.9-3** denotes the generally observed stream conditions as documented in the 2005 SPA and through additional, windshield level field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the watershed along with a series of features that typically impact stream conditions, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout the County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

In Ryans Dam, a total of ten inventory points were visually assessed with only two scoring a seven or higher. The highest scoring impacts in Ryans Dam were a crossing and a deficient buffer scoring an eight and seven, respectively. Table 64 below summarizes all ten inventory points captured in the 2005 SPA for Ryans Dam.

Table 64: Ryans Dam Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	0	0	0	0	0	0	0	1	0	0	0	N/A	1
Crossings	0	0	3	3	1	0	0	0	1	0	0	N/A	8
Ditches and Pipes	0	1	0	0	0	0	0	0	0	0	0	N/A	1
Erosion	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Head Cut	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Obstruction	0	0	0	0	0	0	0	0	0	0	0	N/A	0
Utility	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**0**	**1**	**3**	**3**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**10**

In the Ryans Dam WMA, the most prevalent stream condition features noted include channel widening, disturbed stream buffers in the headwaters reaches of the Ryans Dam WMA and its tributaries, and crossing impacts from roads and utilities. Channels noted as widening are almost universally located in the residentially developed areas of the WMA, including almost the entire length of Stilwell Run. The stream conditions in the public lands in the Ryans Dam WMA are noted as generally healthy. Crossing impacts are noted as minor, with the exception of a pair in the headwaters area. One severe

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crossing impact is noted in the area of Thomlar Drive just north of Fountainhead Regional Park. Another moderate to severe crossing impact is noted on an unnamed tributary near Wolf Run Shoals Road in the western reaches of the WMA. In addition, channel incision is noted on the length of a pair of tributaries in the center of the WMA running through the Rondelay and Burkeridge Estate areas.

Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data 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:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. Overall, Ryans Dam was categorized as excellent with a length-weighted habitat score of 145, the highest within Fairfax County. Of the estimated four miles of stream assessed in Ryans Dam, nearly 60 percent was categorized as excellent, the largest percent of any watershed in the Lower Occoquan in that category, with the remaining 40 percent being categorized as good.

Table 65: Ryans Dam Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		Poor		Fair		Good		Excellent		Total
Stillwell Run	0	0.00 %	0	0.00 %	0	0.00 %	0	0.00%	7,561	100.00 %	7,561
Trib. to Occoquan River	0	0.00 %	0	0.00 %	0	0.00 %	9,326	62.47 %	5,603	37.53%	14,929
Total	**0**	**0.00 %**	**0**	**0.00 %**	**0**	**0.00 %**	**9,326**	**41.47 %**	**13,164**	**58.53%**	**22,490**

Stream Biological Habitat

In 2001, the County released the SPS Study documenting the current stream conditions throughout the county using physical, chemical, and biological evaluations. The County developed a ranking of quality for each site. Of the 138 stream sites, one was located in the Ryans Dam watershed. Table 66 below summarizes the results. Overall, the Ryans

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Dam watershed is the highest quality watershed in all of Fairfax County with the fish community rating and biological integrity rated as moderate and excellent, respectively.

Table 66: Ryans Dam Biological Integrity Ranting (2001 SPS)

Stream Name and Site Code	Composite	Environmental Tables		
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Ryans Dam Unnamed Tributary (RDRT01)	Excellent	Excellent	Fair	Moderate

Stream Channel

To identify and track stream evolution and 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.

- Stage I: Stable- well developed base flow and bankfull channel
- Stage II: Incision – down-cutting or head cuts occur
- Stage III: Widening –bank failure is occurring
- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. In Ryans Dam, approximately 59 percent of the streams are classified as CEM Evolutionary Stage III, generally characterized as unstable and show signs of widening and deepening. The remaining streams fall into CEM Evolutionary Stage II, indicating head cuts that could ultimately lead into Stage III.

Table 67: Ryans Dam CEM results (SPA, 2005)

WMA	Evolution Stage										Total of Reach Length
	I		II		III		IV		V		
	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%	(ft)
Ryans Dam	0	0%	9,326	41%	13,164	59%	0	0%	0	0%	22,490

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2.2.10 Occoquan

General WMA Characteristics

Occoquan, the smallest of the Lower Occoquan watersheds, is adjacent to the Occoquan River and covers 3.32 square miles (2,126 acres) along the central southwestern border of Fairfax County. Occoquan lies entirely within the Piedmont Upland physiographic province, characterized by rolling hills underlain by metamorphic rocks. The Occoquan watershed consists of approximately six miles of stream and includes several small tributary systems which flow southwest and discharge directly into the Occoquan River, and ultimately into the Potomac River. Elk Horn Run, the watershed's main tributary system, flows southwest and drains majority of the watershed. A smaller tributary, Little Occoquan Creek runs parallel to Route 123 and also discharges to the Occoquan River. A small portion of northwestern corner of Occoquan is covered by Fountainhead Regional Park, which is a multi-use area consisting of numerous trails for both biking and hiking. This parkland, which serves as a forested buffer for the Occoquan River and Reservoir, is operated by the Northern Virginia Regional Park Authority.

The Occoquan WMA is roughly bounded on the northern and eastern ends by Ox Road (Route 123), to the north by Hampton Road (Route 647), and to the extreme west by Van Thompson Road. The Occoquan WMA outlets directly to the Occoquan River and Reservoir and also contains the waterworks facility operated by Fairfax Water, which supplies drinking water to over a million northern Virginia residents.

Field Reconnaissance

The Occoquan WMA includes the vast majority of Sandy Run Regional Park at the western end of the WMA and also includes two significant named tributaries – Little Occoquan Creek and Elk Horn Run. As mentioned above, the Occoquan WMA also contains the water supply and treatment center for Fairfax Water, which distributes water to customers in the Fairfax and Prince William County geographic areas. The Occoquan WMA also contains the Vulcan Quarry, a large rock quarry located to the west of the Fairfax Water facility.

In July 1982, the Fairfax County Board of Supervisors amended the County's Comprehensive Plan by down-zoning approximately 41,000 acres of the Occoquan watershed in Fairfax County to an R-C District (Residential – Conservation), which yields a maximum density of one dwelling unit per five acres. This down-zoning action, driven by the County's desire to protect the Occoquan Reservoir and the drinking water it supplies to well over one million people, has served to curb intense development in the area. The Occoquan WMA lies partially within the area down-zoned by Fairfax County in 1982 and contains a total of fourteen subwatersheds.

As a result, development in the western reaches of the Occoquan WMA is primarily estate residential, which includes several established, estate subdivisions such as Hampton Hunt Estates, Hampton Woods West, and Hampton Woods East. The majority of the observed single-family residential parcels are over one acre in size and are primarily newer residential development, constructed in the early 2000s (less than 10 years old). Residential subdivision streets lack curb and gutter and no sidewalks were

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observed. These larger lot developments also demonstrated significant grass and tree cover, with impervious cover estimates at ten percent or lower.

East of Elk Horn Run, development follows a different pattern, as this area is downstream of the Occoquan Dam and does not appear to be part of the down-zoned area mentioned above. In the areas north of the Fairfax Water facility, residential development and redevelopment has been occurring in the past 10 to 15 years as the entire Lorton area and areas around Laurel Hill are redeveloped. Observed lot sizes are estimated at ½ acre or smaller in some cases, with curb and gutter and sidewalks present. Grass cover is still prevalent, but an estimated 15 percent of the area is covered by impervious surfaces.

Institutional uses in the Occoquan WMA appear to be limited to parkland, as part of the Sandy Run Regional Park, the Vulcan Quarry facility, and the Fairfax Water supply facility. The Occoquan dam is located on the Occoquan River upstream of Route 123. No schools, shopping centers, or other institutional or commercial developments were observed, though newer commercial development has been constructed across Route 123 from the boundaries of this WMA. As such, grass and some tree cover are prevalent throughout the Occoquan WMA

Impervious Areas and Treatment Types

Increased impervious surfaces can result in channel erosion and downstream degradation. Water discharging from an impervious surface does not have time to slow down or infiltrate into the ground. This increases the quantity and velocity of stormwater runoff. This increased discharge into receiving waters begins to degrade the banks of the streams and instream habitat. It has been shown that levels of 10-20% impervious surface can significantly reduce the overall health of a stream (Annual Report, 2005). As one method of preventing stream degradation, stormwater management detention facilities are used throughout Fairfax County. By utilizing land use data and the contributing areas which drain to these stormwater management detention facilities, the County can identify areas of impervious surfaces and trace the flow path of the resulting discharges and quantify the treatment provided by the specific type of stormwater management detention facility. Below are the four primary stormwater management facility types and treatment provided.

- *Quantity* -Detention storage facilities that only provide quantity control
- *Quality*: -Detention storage facilities that only provide quality control
- *Quantity & Quality*:-Detention storage facilities that provide quantity + quality control
- *None*: -Areas that do not drain to detention facilities (uncontrolled runoff/no treatment), however some of these areas also are undeveloped open space and parks and therefore were not designed to capture and treat rainfall runoff.

Utilizing the County's Technical Memorandum 3 guidance document which outlines to process for determining future conditions, Table 68 below identifies the current and future impervious surface areas based on the existing and future land use conditions for Occoquan as well as the associated treatment types. Since Occoquan is fairly

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undeveloped, with only a few small areas of residential and commercial development, the area as a whole exhibits levels of imperviousness of just more than 6 percent and is expected to increase less than one percent in the future. As Table 68 shows, the majority of stormwater in Occoquan is uncontrolled and drains untreated to receiving waters, which is consistent with the small percentage of impervious area within the WMA.

Table 68: Occoquan Impervious Areas and Treatment Types

WMA Name	Percent Impervious				Current Treatment Types			
	Current Condition		Ultimate Condition		Quantity	Quality	Quantity/ Quality	None
	(acres)	*%*	(acres)	%	(acres)	(acres)	(acres)	(acres)
Occoquan	135.32	*6.36*	150.70	*7.09*	19.88	18.60	26.76	2061.13

Existing land use

See **Map 2.2.10-1** for existing and future land use for Occoquan. Occoquan consists of 2,126 acres, of which 40 percent is either forested, wetland or pasture, making it one of the least developed or rural WMAs in Fairfax County. The Occoquan WMA falls within the WSPOD. The WSPOD imposes restrictions on development and requires enhanced water quality controls for any development. Existing zoning regulations require minimum lot sizes of five-acres for the Occoquan watershed. The WSPOD, and the two large parks, Fountainhead Regional Park and Hemlock Regional Park, have prevented the area from experiencing much development. While Occoquan is primarily forested, two large industrial facilities reside in Occoquan, a large water treatment plant and the Vulcan Graham II Quarry.

Table 69: Occoquan Existing & Future Land Use (Co. GIS layer, 2008)

	Existing Conditions		**Future Conditions**	
Land Use Description	**Acres**	**Percent**	**Acres**	**Percent**
Open space, forest, parks, & recreational areas	850.96	40.02%	554.61	26.08%
Golf Course	0.00	0.00%	0.00	0.00%
Estate Residential	566.24	26.63%	706.92	33.25%
Low-Density Residential	126.97	5.97%	473.23	22.26%
Medium-Density Residential	32.70	1.54%	31.79	1.50%
High-Density Residential	0.09	0.00%	0.09	0.0044%
Low-Intensity commercial	0.28	0.01%	0.28	0.01%
High-Intensity commercial	1.58	0.07%	3.80	0.18%
Industrial	361.03	16.98%	169.13	7.95%
Transportation	112.48	5.29%	112.48	5.29%
Water	48.41	2.28%	48.41	2.28%
Institution	25.63	1.21%	25.63	1.21%

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Stormwater Infrastructure

The Occoquan WMA includes a variety of residential development along with institutional uses that include industrial and open space/parkland. The residential development includes estate residential and smaller lot residential subdivisions upstream of open space located in Sandy Run Regional Park. As a result, the WMAs stormwater infrastructure consists primarily of open drainage channels with limited hard infrastructure (pipes, stormwater management facilities, BMPs, etc.) in place.

Due to the nature of development in the Occoquan WMA, the formal stormwater infrastructure exists in some of the newer residential areas. Given that several of the developed areas in the Occoquan WMA developed more recently, the stormwater management facilities present include both a water quality and water quantity management component. **Map 2.2.10-2** demonstrates the observed stormwater infrastructure conditions in the Occoquan WMA. Approximately five dry, extended detention basins are located in the WMA, with one of those basins owned by the Virginia Department of Transportation. Other stormwater infrastructure consists primarily of open channel drainage to main stem tributaries and eventually to the Occoquan River. Limited stormwater pipe infrastructure is present in the WMA, primarily in the upper reaches near Davis Drive and Wrights Hollow Lane. Fairfax County has captured a number of surface water impoundments, old farm ponds, and other catchments that may provide some anecdotal stormwater management function, but for which no stormwater management design can be confirmed at the time of this draft. These features appear in the Fairfax County stormwater management facility inventory as “TBD.” The Occoquan WMA contains approximately 26 TBDs.

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Stream Conditions

The Stream Conditions **Map 2.2.10-3** denotes the generally observed stream conditions as documented in the 2005 SPA and through additional, windshield level field reconnaissance performed for this study. The Stream Conditions Map demonstrates the general conditions of the main stem streams and tributaries in the watershed along with a series of features that typically impact stream condition, including stream channel erosion, channel widening, stream buffer condition, discharge pipe and ditch impacts, and utility and road crossing impacts.

As part of the 2005 SPA, an inventory and assessment of stormwater infrastructure throughout Fairfax County was conducted to determine the impacts on streams from specific infrastructure and problem areas, with the primary focus on sources of bank and bed erosion. For each watershed, a visual evaluation of infrastructure such as road culverts and stormwater outfalls was performed, and 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, such as impervious/commercial encroachment near stream.

In Occoquan, a total of 40 inventory points were visually assessed with only three scoring a 10. The highest scoring impacts in the Occoquan WMA were two erosion areas and a head cut, each scoring a 10. Table 70 below summarizes all 40 inventory points for Occoquan.

Table 70: Occoquan Inventory Points (SPA, 2005)

Inventory Type	Impact Score												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**	**Total**
Deficient Buffers	0	0	0	3	5	0	0	0	0	0	0	N/A	8
Crossings	9	2	2	2	1	0	0	0	0	0	0	N/A	16
Ditches and Pipes	0	5	0	0	0	0	0	0	0	0	0	N/A	5
Erosion	0	0	0	0	0	0	0	0	0	0	2	N/A	2
Head Cut	0	0	0	1	1	0	0	0	0	0	1	N/A	3
Obstruction	0	0	3	1	1	0	0	1	0	0	0	N/A	6
Utility	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**9**	**7**	**5**	**7**	**8**	**0**	**0**	**1**	**0**	**0**	**3**	**0**	**40**

In the Occoquan WMA, the most prevalent stream condition features noted include channel widening coincident with poor overall stream habitat, disturbed stream buffers in the headwaters reaches of Elk Lick Run and its tributaries, and crossing impacts from roads and utilities. Disturbed stream buffer is noted in the headwaters of most of the tributaries in the WMA. Channels noted as widening are almost universally impacted by crossing impacts as well. Crossing impacts are generally noted as minor. Elk Lick Run was noted as having several minor crossing impacts, along with some moderate head cutting (one to two feet) and stream obstructions. One severe instance of stream head cutting (over two feet) was noted downstream of an impoundment near the Fairfax Water facility. In addition, a major obstruction was noted just upstream of the Sandy Run Regional Park on an unnamed tributary,

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Stream Physical Condition

The 2005 SPA conducted visual habitat assessments of the stream conditions throughout Fairfax County. Using data 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:

1. Excellent (142-168)
2. Good (114-141)
3. Fair (87-113)
4. Poor (59-86)
5. Very Poor (32-58)

The habitat scores ranged from 32 to 168 out of a possible 200, and the County was categorized as fair, having an average length-weighted total habitat score of 104. Overall, Occoquan was categorized as good with a length-weighted habitat score of 117, which is slightly better than the Fairfax County average. Of the estimated six miles of stream assessed in Occoquan, over 52 percent were categorized as fair, with the remaining stream miles being categorized as good.

Table 71: Occoquan Habitat Assessment Summary (SPA, 2005)

Stream	Linear Feet (Percent) of Stream										
	Very Poor		**Poor**		**Fair**		**Good**		**Excellent**		**Total**
Elk Horn Run	0	0.00%	0	0.00%	14,002	75.51%	4,542	24.49%	0	0.00%	18,544

Little Occoquan Creek	0	0.00%	0	0.00%	2,874	74.71%	973	25.29%	0	0.00%	3,846
Tributary to Elk Horn Run	0	0.00%	0	0.00%	0	0.00%	2,742	100.00%	0	0.00%	2,742
Tributary to Occoquan River	0	0.00%	0	0.00%	0	0.00%	6,796	100.00%	0	0.00%	6,796
Total	**0**	**0.00%**	**0**	**0.00%**	**16,876**	**52.85%**	**15,053**	**47.15%**	**0**	**0.00%**	**31,929**

Stream Biological Habitat

In 2001, the County released the SPS Study documenting the current stream conditions throughout the county using physical, chemical, and biological evaluations. The County developed a ranking of quality for each site. Of the 138 stream sites, 1 was located in the Occoquan watershed. Table 72 below summarizes the results. Overall, Elk Horn Run's biological integrity was rated as excellent and is among the highest in the County, but the fish community rating was very low to moderate, among the worst in the County.

Table 72: Occoquan Biological Integrity Ranting (SPS, 2001)

Stream Name and Site Code	Composite	Environmental Tables		
	Site Condition Rating	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness
Elk Horn Run (OCEH01)	Excellent	Excellent	Excellent	Low

In addition to the 2001 SPA data, 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 73** below for monitoring results (Annual Report, 2006).

Table 73: Occoquan Stream 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

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

Stream Channel

To identify and track stream evolution and 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.

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- Stage I: Stable- well developed base flow and bankfull channel
- Stage II: Incision – down-cutting or head cuts occur
- Stage III: Widening –bank failure is occurring
- Stage IV: Stabilizing –stream banks developing at a lower terrace
- Stage V: Stable – well developed base flow at a lower terrace

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. In Occoquan, approximately 78 percent of the streams are classified as CEM Evolutionary Stage III, generally characterized as unstable and show signs of widening and deepening. Another 16 percent fall into CEM Evolutionary Stage IV, indicating re-stabilization and decreased stream bank slopes, with the remaining six percent falling into CEM Evolutionary Stage II, indicating head cuts that could ultimately lead into Stage III.

Table 74: Ryans Dam CEM results (SPA, 2005)

	Evolution Stage										Total of Reach Length
	I		II		III		IV		V		
WMA	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%	Length (ft)	%	(ft)
Occoquan	0	0%	1,679	6%	21,806	78%	4368	16%	0	0%	27,853

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2.3 Hydrology and Water Quantity and Quality Modeling

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

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

- Hydrologic models take into account several factors; the particular rainfall event of interest, the physical nature of the land area where the rainfall occurs and how quickly the resulting stormwater runoff drains this given land area. Hydrologic models can describe both the quantity of stormwater runoff and resulting

pollution, such as nutrients (nitrogen and phosphorus) and sediment that is transported by the runoff.

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

Table 75 shows three storm events and the rationale for being modeled:

Table 75: Storm Event

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

2.3.1 SWMM and STEPL Results

The Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) was first developed in the early 1970s. Over the past 30 years, the model has been updated and refined and is now used throughout the country as a design and planning tool for stormwater runoff. Specifically, SWMM is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. The runoff component of SWMM operates on a collection of subwatershed areas (or in this case, areas which pertain to the various treatment types previously described) on which rain falls and runoff is generated. The routing portion of SWMM transports this runoff through a conveyance system of pipes, channels and storage/treatment devices. SWMM tracks the quantity and quality of runoff generated within each subwatershed, and the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period comprised of multiple time steps.

While the SWMM model can calculate pollutant loads, the Spreadsheet Tool for Estimating Pollutant Load (STEPL) was used to determine pollutant loads for Lower Occoquan watershed. Also developed by EPA, the STEPL worksheet calculates nutrient and sediment loads from various land uses as well as calculating the load reductions that would result from the implementation of various BMPs. The nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. Sediment loads are calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using known BMP efficiencies.

A major cause for many streams' poor water quality and aquatic habitat loss is increased levels of two particular nutrients, nitrogen and phosphorous. While, these nutrients occur naturally in soil, animal waste, plant material, and even the atmosphere, the increase of nitrogen and phosphorus from manmade sources, can be detrimental to the overall heath of the streams. Increased phosphorus and nitrogen pollutants in urbanized areas

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primarily come from chemical lawn fertilizers, vehicle emissions, and discharges from municipal wastewater treatment plans.

The data below reflects current conditions only, in addition the model will be updated and results will be produced as the work progresses towards project identification/prioritization and the Draft Plan phases.

Preliminary SWMM results

Table 76 shows the Peak Flow predicted by the SWMM model from each WMA. However, in several of the WMAs, the reported peak flow is calculated by adding the peak flow of multiple streams. For example, in the Ryans Dam WMA, there are multiple streams that discharge to the Occoquan River. The reported peak flow for the Ryans Dam WMA was calculated by estimating the peak flow for each of the streams and then adding those values. A similar process was followed for the Giles Run South, High Point, Kane Creek, Old Mill Branch, Mill Branch, and Occoquan WMAs. See **Map 2.3.1-1** for specific SWMM node locations. While some of the SWMM nodes appear to be located within the Occoquan River, the model is run parallel to the river edge picking up the outfall from each of the small basins as it moves to the southeast to the final collection point, flow from the Occoquan River is not included in each of the WMAs.

Table 76: Lower Occoquan SWMM Results

SWMM Node Number		Stormwater Runoff Peak Flow Values	
	WMA	2-yr storm (cubic ft/sec)	10-yr storm (cubic ft/sec)
28	High Point	609	1,586
10	Kane Creek	758	2,105
563	Giles Run North	653	1,479
9	Giles Run South	633	1,555
718	Mill Branch	433	1,379
575	Occoquan	601	1,662
684	Sandy Run	739	2,260
550	Ryans Dam	430	1,359
706	Wolf Run	557	1,651
249	Old Mill Branch	603	1,787

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STEPL results

The data provided below represents the results from the STEPL model by WMA. The pollutant loads are heavily dependent on land use distribution within the watershed management areas. **Maps 2.3.1-2, 2.3.1-3**, and **2.3.1-4** illustrate the Total Nitrogen, Total Phosphorus, and Total Suspended Solids loads respectively throughout the

watershed. As anticipated areas in the Mill Branch watershed (Giles Run North, Giles Run South and Mill Branch) experience higher levels of pollutant loading due to the redevelopment of the Laurel Hill area. In addition, WMAs with higher percentage of impervious surface areas and minimal stormwater controls experience higher levels of pollutant loading.

Table 77: Pollutant Loads - STEPL

WMA	Pollutant Loading			Pollutant Loading (area weighted)		
	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (tons/yr)	Total Nitrogen (lbs/ac/yr)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (tons/ac/yr)
High Point	6,271.25	1,148.97	323.17	1.764	0.323	0.091
Kane Creek	5,355.10	955.97	264.64	1.741	0.311	0.086
Giles Run North.	8,478.40	1,356.24	238.84	4.235	0.677	0.119
Giles Run South	15,574.38	2,238.46	438.66	6.691	0.962	0.188
Mill Branch	7,995.07	1,105.55	207.85	6.304	0.872	0.164
Occoquan	7,174.87	1,052.74	236.92	3.374	0.495	0.111
Old Mill Branch	3,708.30	663.42	194.09	1.362	0.244	0.071
Ryans Dam	2,958.06	553.31	181.95	1.308	0.245	0.080
Sandy Run	13,078.86	2,008.43	284.80	2.516	0.386	0.055
Wolf Run	8,073.92	1,235.08	170.13	2.146	0.328	0.045
TOTALS	**78,668.22**	**12,318.17**	**2,541.04**			

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2.3.2 HEC-RAS Modeling

The Hydraulic Engineering Centers River Analysis System (HEC-RAS) hydraulic model was initially developed by the U.S. Army Corp of Engineers in the early 1990 as a tool to manage the rivers and harbors in their jurisdiction. HEC-RAS is a one dimensional program that provides no direct modeling of the hydraulic effect of cross section shape changes, bends, and other two- and three-dimensional aspects of flow. Aside from this limitation, the model has found wide acceptance in simulating the hydraulics of water flow through natural and/or manmade channels and rivers. HEC-RAS is commonly used for modeling water flowing through a system of open channels with the objective of computing water surface profiles. The data presented in the following section is considered preliminary and will continue to be refined as more accurate flow information is available from the SWMM model calibration effort. Updated results will be produced as the work progresses towards project identification/ prioritization and the Draft Plan phases.

Preliminary HEC-RAS Development

Using HEC-RAS, hydraulic models were created for the major channels in the Lower Occoquan watershed. These major channels extend from the basin outlet to the most upstream subwatershed in the watershed. Cross sections were aligned based on

representative channel sections, and locations upstream and downstream of bridges/culvert structures. Structures such as these were identified along various stream reaches using county GIS road and stream spatial data along with the most recent aerial photography. All major structures that were considered likely to impact the water surface elevation were surveyed.

Once the HEC-RAS model are set up as described above, flow data will be entered from the SWMM model. Once the model is run, water surface elevations will be exported to GIS and the floodplain maps will be generated. A sample Lower Occoquan floodplain map is illustrated below. The flows used to develop this exhibit are not reflective of actual Lower Occoquan SWMM values.

Figure 8: Lower Occoquan draft floodplain map

Preliminary HEC-RAS Results

Since the flow results from the SWMM model was not finalized until recently, the floodplain maps are currently being developed and will be incorporated into the workbook as they become available.

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2.4 Ranking of Subwatershed Areas

The County has developed goals and objectives to be applied to all watersheds during the development process. The countywide goals and objectives allow recommendations to be linked to the countywide watershed assessment. The countywide watershed planning goals are to:

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 identified are linked to the above County goals. The list of objectives allows for a countywide evaluation that addresses stakeholder concerns while providing an efficient and effective means of assessment. In addition, watershed-specific goals and objectives that are recommended by local stakeholders may also be incorporated into the watershed workbook 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 78: 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

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Since the 5 objectives above cannot be directly measured, the methods require measurable indicators that are directly linked to the objectives. One or more indicators for each objective were selected, including predictive and non-predictive, or observed, indicators. Predictive indicators, such as simulated data, can be used to compare existing and future conditions. Non-predictive indicators cannot measure future conditions but will still be useful in assessing existing watershed impacts within Fairfax County.

The purpose of the subwatershed ranking approach is to provide a systematic means of compiling available water quality and natural resources information. Ranking subwatersheds based on watershed characterization and modeling results provides a tool for planners and managers to use as they consider which subwatersheds should undergo further study and/or 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 resultant data is then utilized to identify key issues and proceed with projects that will achieve the county's watershed management goals and objectives.

Three basic indicator categories identified below are used to rank subwatershed conditions:

Table 79: Subwatershed Ranking Indicators

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
Source	Quantifies the presence of stressors and/or pollutant sources
Programmatic	Reports the existence, location or benefits of stormwater management facilities or programs

Each of the 19 "Watershed Impact" indicators are tied to the County goals and objectives listed above. Below is the complete list of watershed impact indicators used to evaluate the Lower Occoquan watershed? The description column provides a clarification of how the scoring for a specific indicator was developed.

Table 80: Watershed Impact Indicators

Indicator	Description (Co. source)	Linked to Co. Objectives
Benthic Communities	Aquatic insects used as indicator of stream health (SPS, 1999)	1A, 2B, 3A
Fish Communities	Based on diversity of fish communities (SPS, 1999)	1A, 2B, 3A
Aquatic Habitat	Number of stream features that provide data about the habitat that support diverse aquatic communities (SPA, 2005)	1A, 2A
Channel Morphology	Assess the evolutionary stage of stream reaches (SPA,2005)	1A
Instream Sediment	Bank vegetative protection & bank stability (SPS, 1999)	1A, 3A, 4B
Hydrology	Dynamic rainfall-runoff simulation model	1A

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Indicator	Description (Co. source)	Linked to Co. Objectives
Number of Road Hazards	Hydraulic modeling using HEC-RAS	1B
Magnitude of Road Hazards	Hydraulic modeling using HEC-RAS	1B
Residential Building Hazards	Number of residential bldgs in floodplain per square mile	1B
Non-residential Building Hazards	Number of non-residential bldgs in floodplain per square mile	1B
Flood Complaints	Citizen flood complaints per square mile (Co. dbase)	1B
RPA Riparian Habitat	Percentage of riparian habitat regulated in the Chesapeake Bay RPA limits	2A
Headwater Riparian Habitat	Percentage of forest or wetland area within 100 ft. of streams upstream of RPA boundaries	2A
Wetland Habitat	Percentage of wetland habitat (NWI)	2A
Terrestrial Forested Habitat	Percentage of forested habitat (VDOF forest classification)	2A
E. Coli	Avg. of all reported concentration per 100mL (EPA STORET)	3A, 4A
Upland Sediment	STEPL modeling avg. annual sediment load in tons/ac/yr	3A, 4A, 4B
Nitrogen	STEPL modeling avg. annual nitrogen loads in pounds/ac/yr	3A, 4A
Phosphorus	STEPL modeling avg. annual phosphorus load in pounds/ac/yr	3A, 4A

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The watershed impact indicators provide information on how endpoints of watershed processes are impacted by adverse watershed conditions. Source indicators assist in the evaluation of the sources and stressors that impact these watershed endpoints. The County identified the following 12 source indicators to be used in evaluating the Lower Occoquan watershed. In addition to the following source indicators, field reconnaissance observations were included.

Table 81: Source Indicators

Indicator	Description
Quantitative Source Indicators	
Channelized/Piped Streams	Stream centerlines used to calculate stream length (Co. GIS data)
Directly Connected Impervious Area	Based on percent Directly Connected Impervious Area
Impervious Surface	Total Impervious Area metric values for the WMAs
Stormwater Outfalls	The number of outfalls per stream mile.

Parcels Served by Septic Tanks	Based on the number of parcels served per square mile
Sanitary Sewer Crossings	Indicator will not be used in subwatershed ranking
Streambank Buffer Deficiency	The area within the 50-foot natural streams buffer.
TN Load	STEPL modeling avg. annual sediment load in tons/ac/yr
TP Load	STEPL modeling avg. annual phosphorus load in tons/ac/yr
TSS Load	STEPL modeling avg. annual nitrogen load in tons/ac/yr
Total Urban Land Cover	Based on the parcel-based land use layer
VPDES Permitted Point Sources	Number of VPDES permitted point sources within each subwatershed per square miles
Field Reconnaissance indicators	
Hot Spot Investigations	From HSI forms
Neighborhood Source Assessment	From NSA forms
All other field reconnaissance observations	From Windshield Survey

The final set of indicators; called "Programmatic Indicators" will also used in evaluating the Lower Occoquan watershed management needs. These indicators illustrate the extent and location of existing and past management efforts. Metrics and composite scores for programmatic indicators will not be calculated for these indicators during subwatershed ranking; rather, data for these indicators will be considered during identification and evaluation of watershed management needs. The following programmatic indicators will be inventoried:

- Detention Facilities
- Stream Restoration
- Riparian Buffer Restoration
- BMP Facilities
- Low Impact Development
- Inspection and maintenance of stormwater management facilities
- Inspection and repair of stormwater infrastructure and outfalls
- Dumpsite Removal
- Regional Ponds
- Volunteer Monitoring
- Subarea Treatment (used in watershed modeling studies)

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The Watershed Impacts, Source Impact, and Programmatic Impact indicators are tied to a scoring process. These scores are rolled up into composite scores which are used in the prioritization and subwatershed ranking process. In the process of compiling the draft ranking for Lower Occoquan, surrogate metric values were assigned to a subwatershed when a particular indicator or actual data was missing. The approach followed in assigning surrogate values was based on the current Fairfax County Watershed Management Plan Subwatershed Ranking Approach document. This guidance document provided several factors in priority which should be considered when assigning surrogate metric values.

2.4.1 Lower Occoquan Results

The overall composite score for the Watershed Ranking is shown in **Map 2.4.1-1**. This displays the source composite score for all of the subwatersheds in the Lower Occoquan watershed. The Source Composite Score is computed as a simple average of roughly a dozen individual source indicator scores. The source composite score has a possible range from a maximum of 10 to a minimum of 2.5. The calculated source composite scores for the individual subwatersheds that make up the Lower Occoquan watershed range from a minimum of 4.58 to a maximum of 7.96. Since the source composite score is computed with a distinct set of indicators from the overall watershed impact score, the values corresponding with high quality or low quality may be different than for the overall watershed impact score This range establishes the bounds on the gradation from generally good quality (green) to comparatively poor quality (red) on the map.

In the Lower Occoquan watershed, different parts of the watershed differ considerably in terms of watershed quality as measured by the overall watershed impact composite score. The watershed's western and northern portions, (including Old Mill Branch, Wolf Run, Ryans Dam, and Sandy Run WMAs), all of which discharge directly to the Occoquan River and Reservoir, show generally good watershed quality. These subwatersheds include a wide area that was down-zoned by Fairfax County in 1982 to protect the water quality of the Occoquan Reservoir.

Several of the subwatersheds in the I-95 corridor of the southern grouping of subwatersheds, including Giles Run North and Giles Run South, show poorer overall watershed quality. The eastern portion of the watershed (including the majority of the Kane Creek and High Point WMAs) also shows generally good watershed quality, as much of this land is either Federally protected or a state park. The more developed central portion of the watershed (Mill Branch, Giles Run North and Giles Run South WMAs) shows a generally average watershed quality, but also a great deal of variation between individual subwatersheds. The older, more heavily developed headwaters of the Mill Branch watershed (Mill Branch, Giles Run North and Giles Run South WMAs) show the poorest watershed quality in general. The Mill Branch WMA is experiencing significant redevelopment as the Laurel Hill project. Pockets of better water quality still exist where undeveloped lands remain intact.

As a caveat, the watershed impact scores contain considerable uncertainty because on average, 28% of the weighted composite score is derived from surrogate metric values.

Fairfax County's 1982 downzoning of much of the County's Occoquan River watershed has preserved higher source quality in the watershed. The subwatersheds to the west of the Laurel Hill redevelopment project and Interstate 95 (Old Mill Branch, Wolf Run, Ryans Dam, Sandy Run, and Occoquan) each have generally high source quality. The

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more densely developed subwatersheds that include Laurel Hill and the I-95 corridor (Mill Branch, Giles Run North, and Giles Run South), however, have generally poor source quality, designated with a higher concentration of orange and red subwatersheds on the map. The eastern reaches of the Lower Occoquan subwatersheds, including Kane Creek and High Point, are characterized by above average to good source quality, with zones of average quality around the Mason Neck marina area. The source composite score has considerably less uncertainty than the overall watershed impact score because a much smaller percentage of the indicator scores (< 5%) were calculated based on surrogate metrics.

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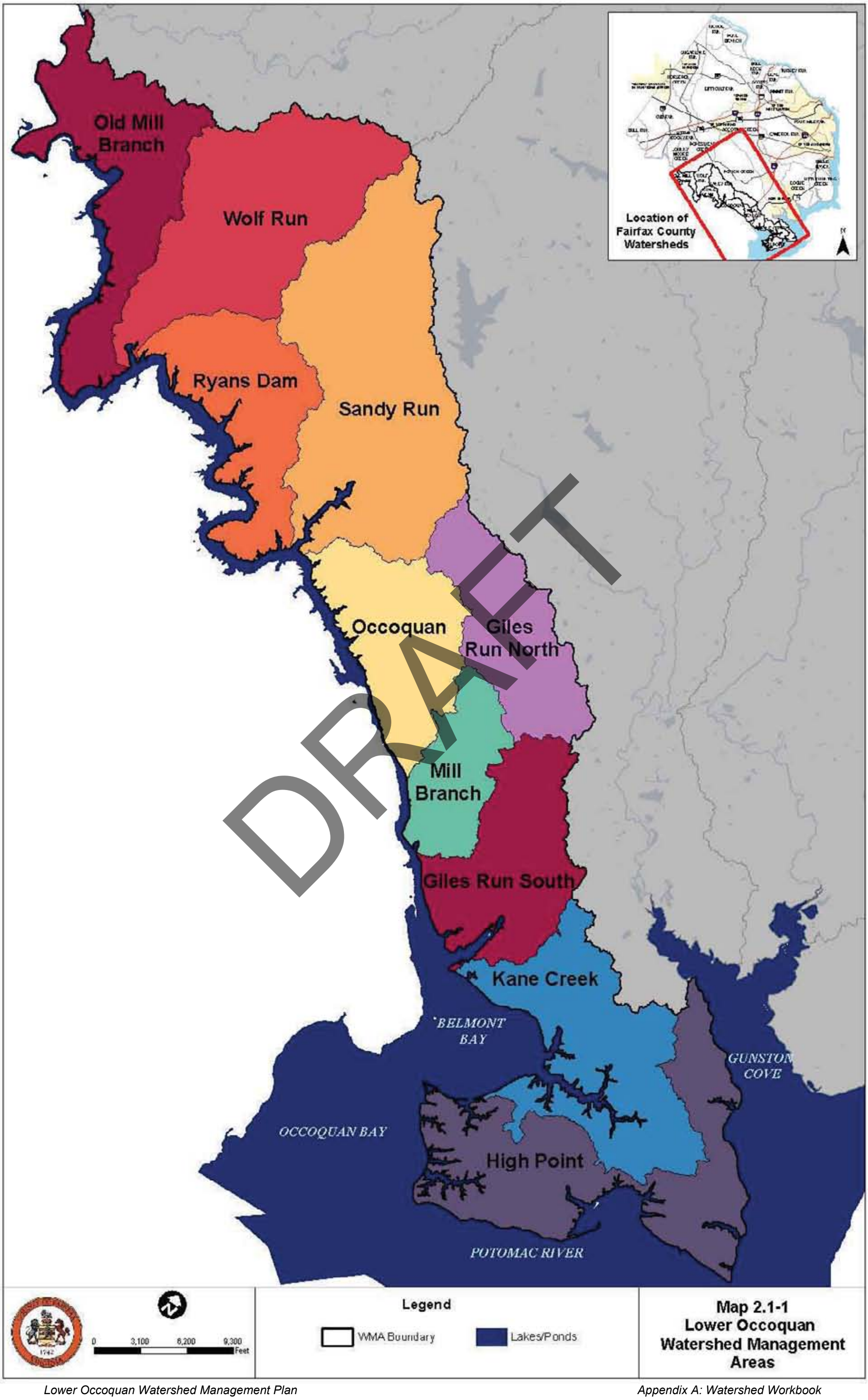
Old Mill Branch
Wolf Run
Ryans Dam
Sandy Run
Occoquan
Giles Run North
Mill Branch
Giles Run South
Kane Creek
BELMONT BAY
GUNSTON COVE
OCCOQUAN BAY
High Point
POTOMAC RIVER
Location of Fairfax County Watersheds
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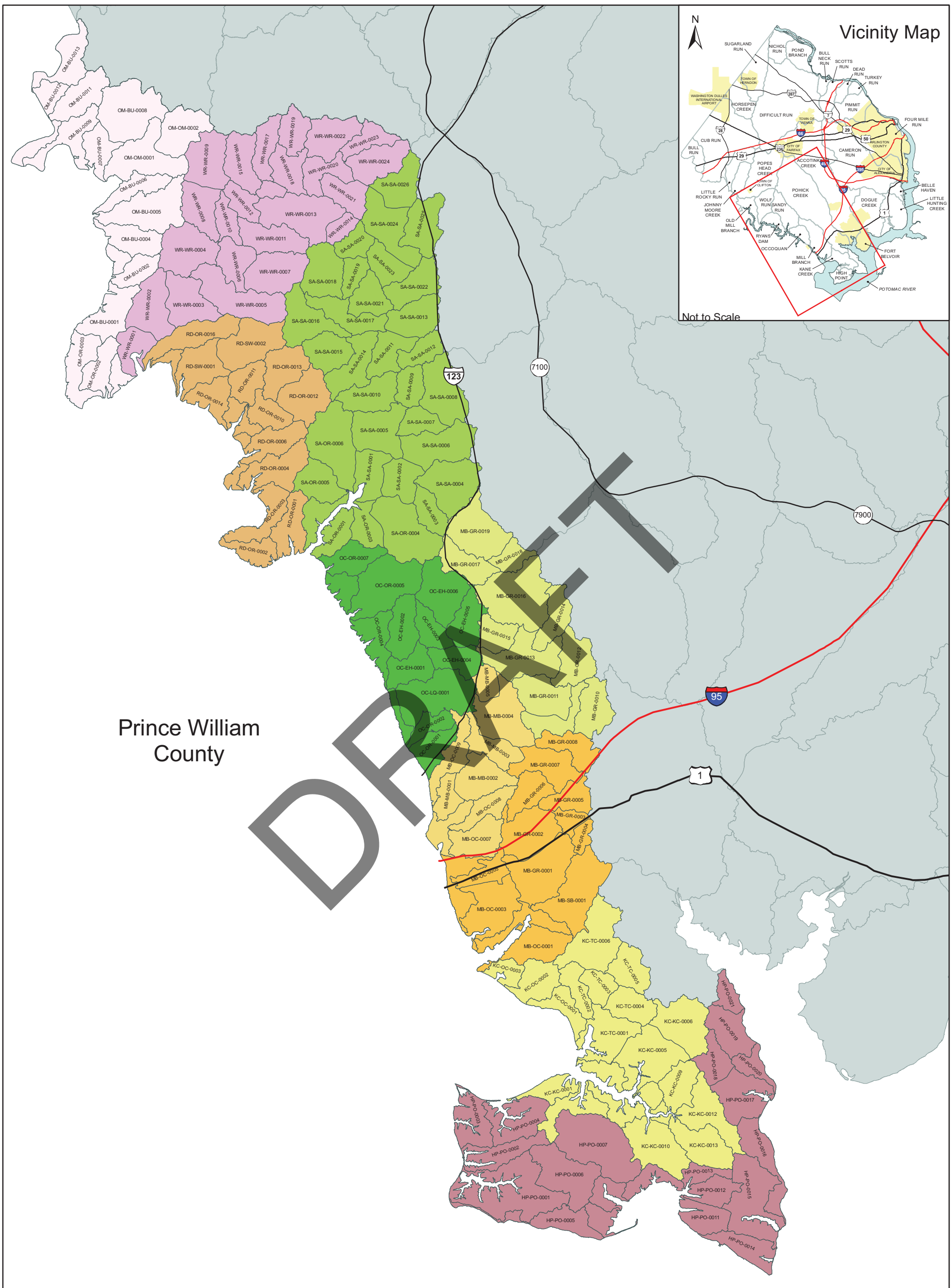
0 3,100 6,200 9,300 Feet
Legend
WMA Boundary
Lakes/Ponds
Map 2.1-1
Lower Occoquan Watershed Management Areas



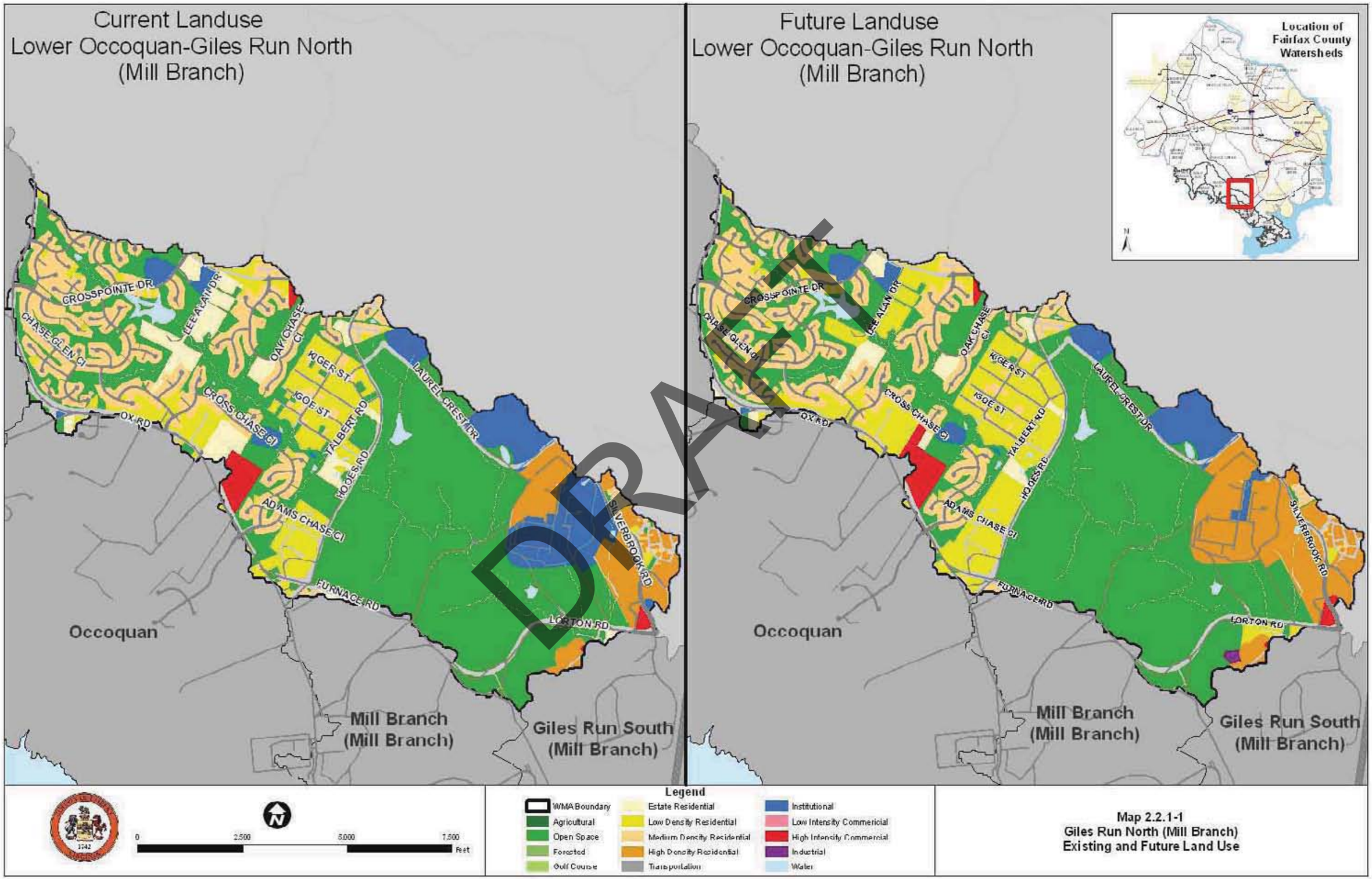
Legend

- County Highway
- State Highway
- Interstate
- US Highway
- High Point
- Kane Creek
- Mill Branch- Giles Run North
- Mill Branch- Giles Run South
- Mill Branch- Mill Branch
- Occoquan
- Old Mill Branch
- Ryans Dam
- Sandy Run
- Wolf Run
- Watershed Boundaries

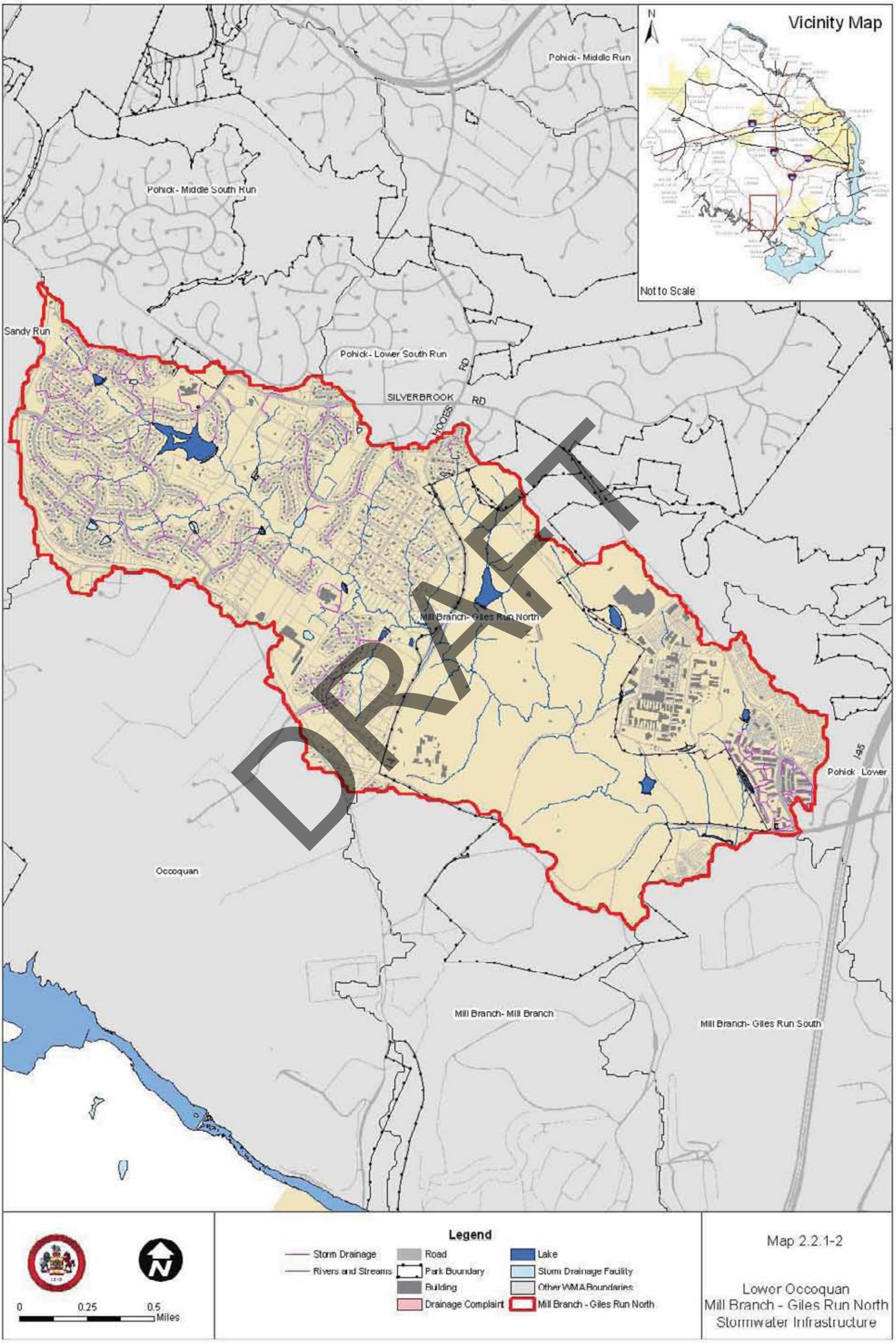
0 0.5 1 2 Miles

Map 2.1-2

Lower Occoquan Subwatersheds



Map 2.2.1-1
Giles Run North (Mill Branch)
Existing and Future Land Use


Vicinity Map
N
Not to Scale
Pohick - Middle Run
Pohick - Middle South Run
Sandy Run
Pohick - Lower South Run
SILVERBROOK RD
HOOTES RD
Mill Branch- Giles Run North
Pohick Lower
I-95
Occoquan
Mill Branch- Mill Branch
Mill Branch- Giles Run South
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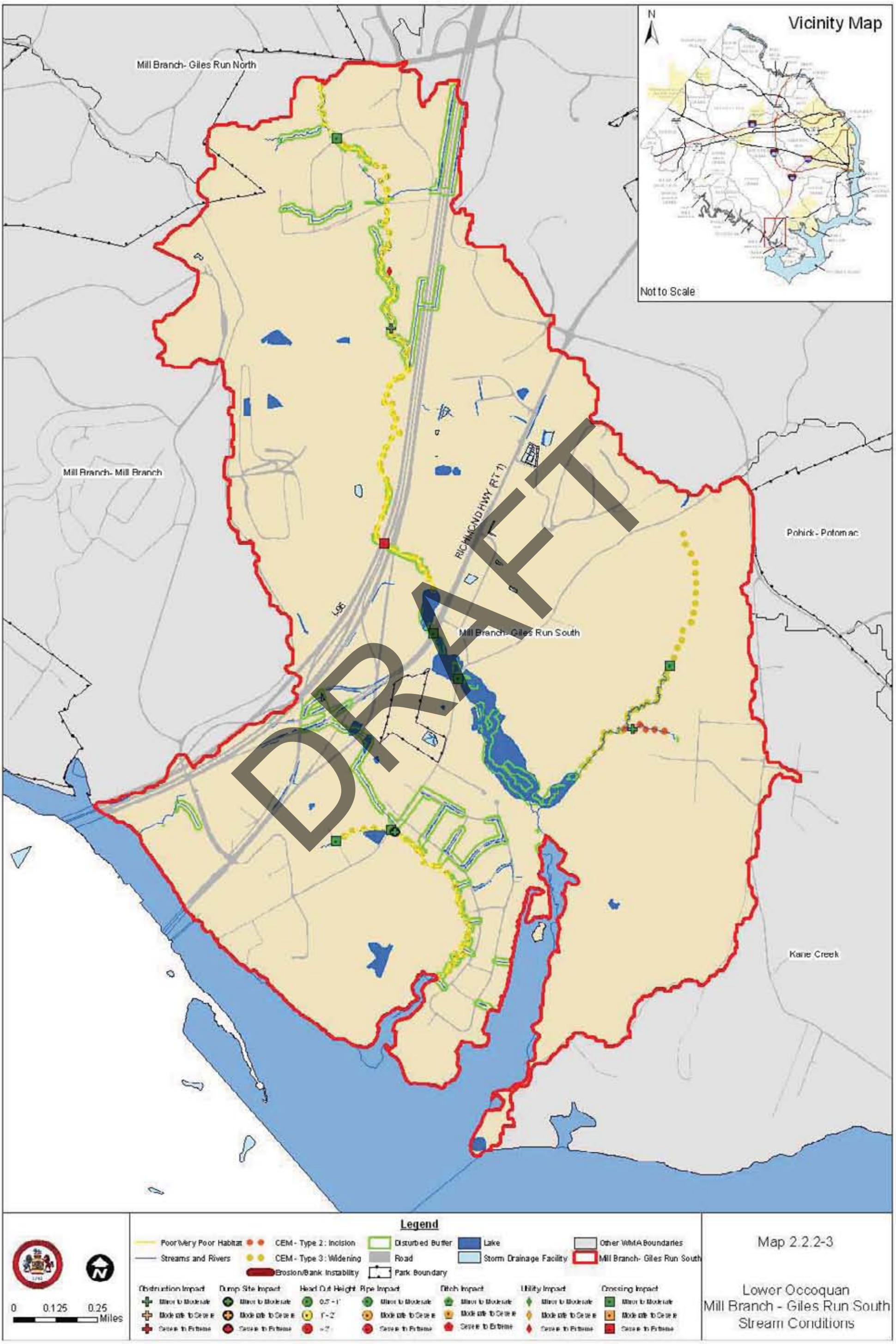
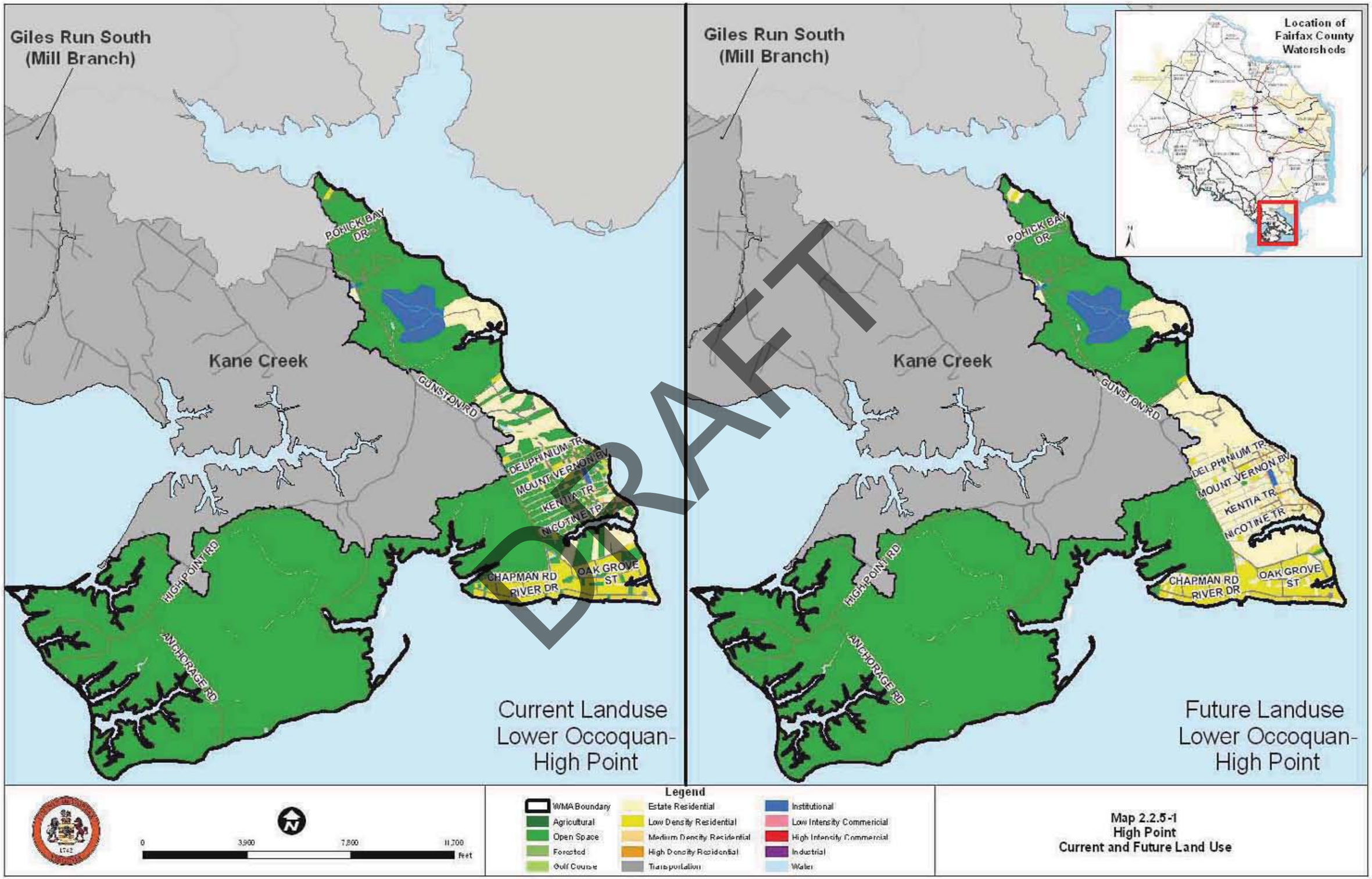
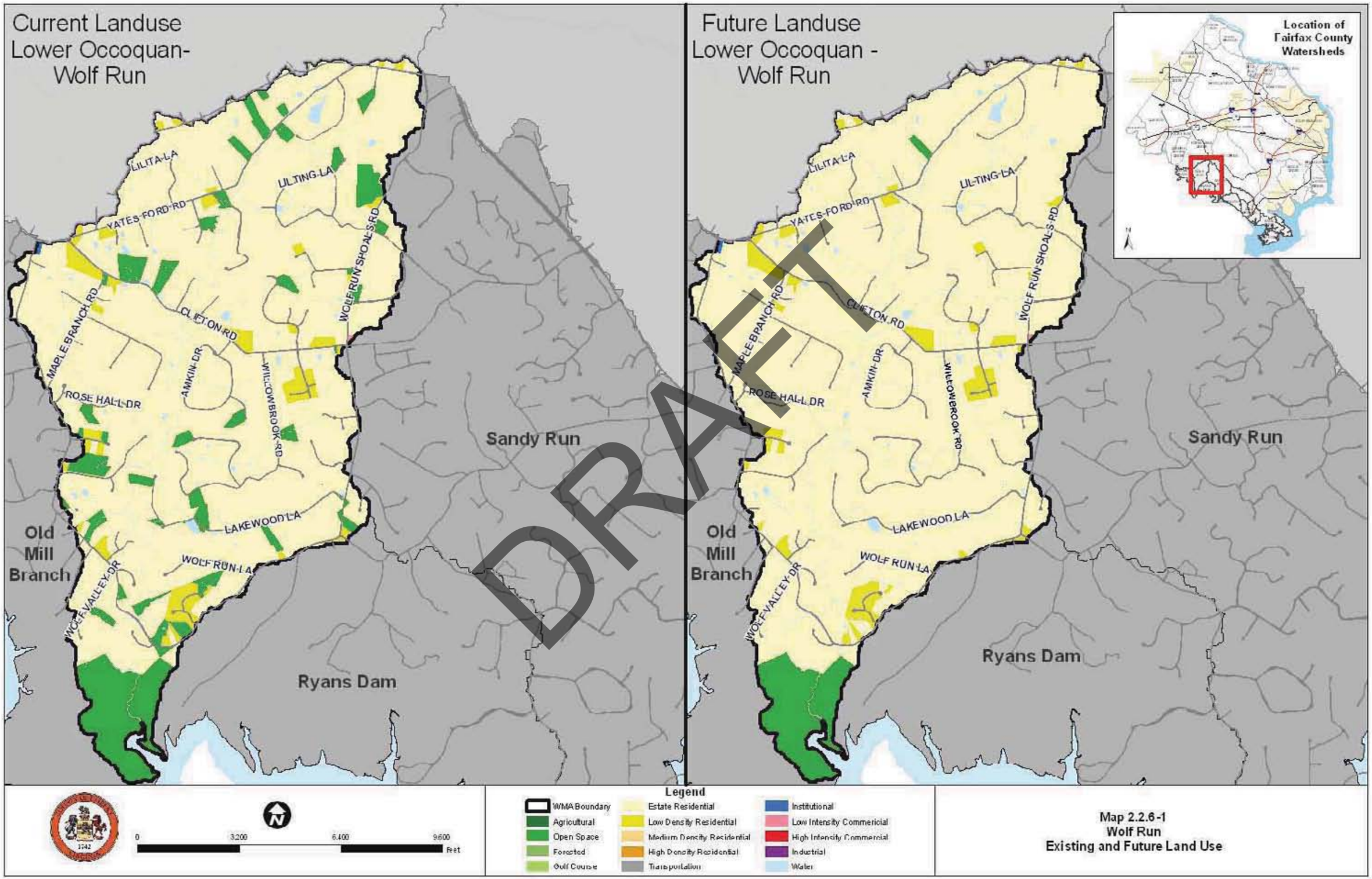
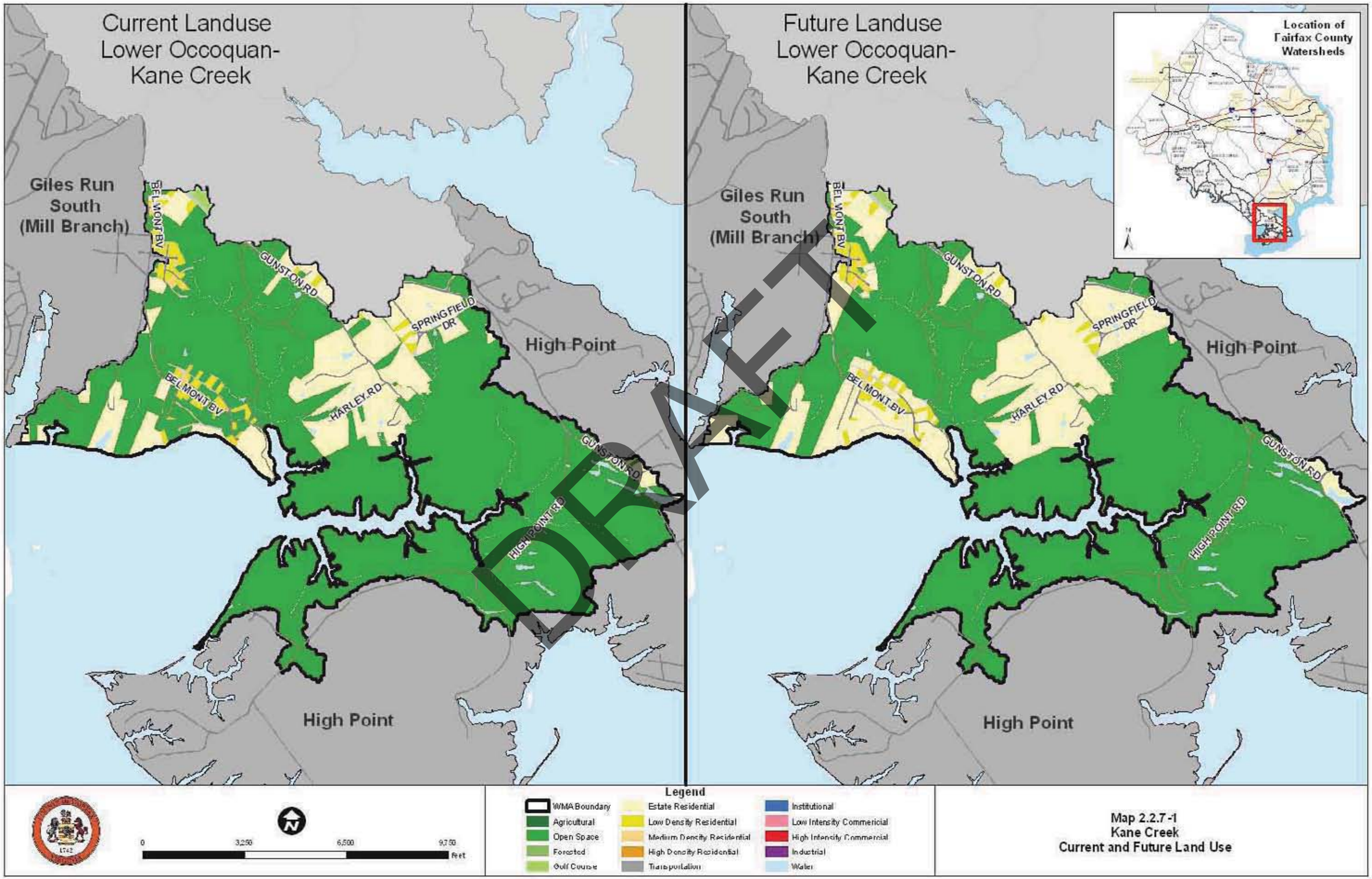
0 0.25 0.5 Miles
Legend
Storm Drainage
Rivers and Streams
Road
Park Boundary
Building
Drainage Complaint
Lake
Storm Drainage Facility
Other WMA Boundaries
Mill Branch - Giles Run North
Map 2.2.1-2
Lower Occoquan
Mill Branch - Giles Run North
Stormwater Infrastructure


Vicinity Map
N
Not to Scale
Mill Branch- Giles Run North
Mill Branch- Mill Branch
RICHMOND HWY (RT 1)
I-95
Mill Branch- Giles Run South
Potomac
Kane Creek
DRAFT
Legend
Poor/Very Poor Habitat
Streams and Rivers
CEM - Type 2: Incision
CEM - Type 3: Widening
Erosion/Bank Instability
Disturbed Buffer
Road
Park Boundary
Lake
Storm Drainage Facility
Other WMA Boundaries
Mill Branch- Giles Run South
Obstruction Impact
Dump Site Impact
Head Cut Height
Pipe Impact
Ditch Impact
Utility Impact
Crossing Impact
Minor to Moderate
Moderate to Severe
Severe to Extreme
0 0.125 0.25 Miles
Map 2.2.2-3
Lower Occoquan
Mill Branch - Giles Run South
Stream Conditions

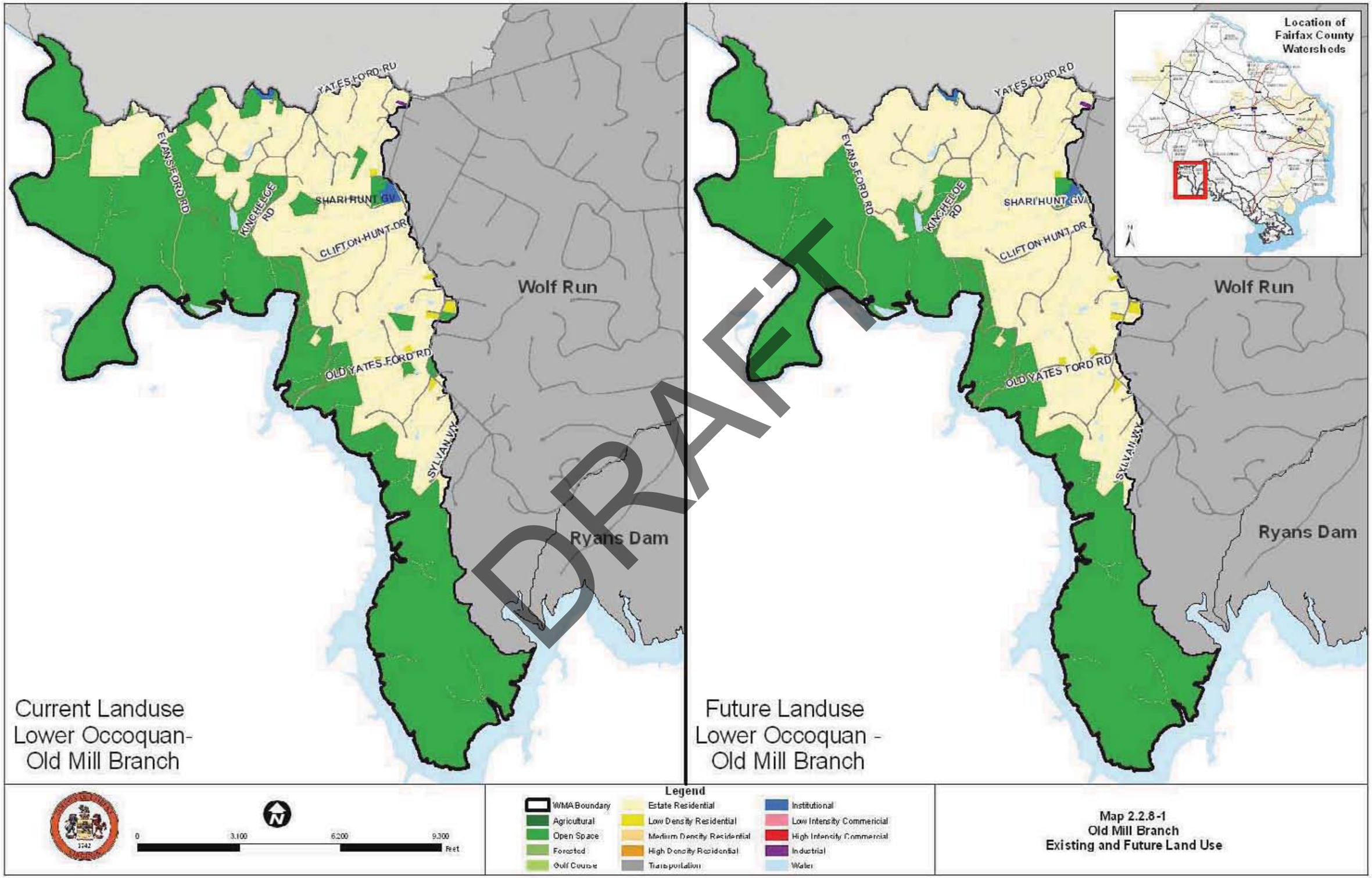

Giles Run South
(Mill Branch)
Kane Creek
POHICK BAY DR
GUNSTON RD
DELPHINIUM TR
MOUNT VERNON BV
KENTIA TR
NICOTINE TR
CHAPMAN RD
RIVER DR
OAK GROVE ST
HIGH POINT RD
ANCHORAGE RD
Current Landuse
Lower Occoquan-
High Point
Giles Run South
(Mill Branch)
Kane Creek
POHICK BAY DR
GUNSTON RD
DELPHINIUM TR
MOUNT VERNON BV
KENTIA TR
NICOTINE TR
CHAPMAN RD
RIVER DR
OAK GROVE ST
HIGH POINT RD
ANCHORAGE RD
Future Landuse
Lower Occoquan-
High Point
Location of
Fairfax County
Watersheds
DRAFT
0
3,900
7,800
11,700
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 2.2.5-1
High Point
Current and Future Land Use



Map 2.2.6-1
Wolf Run
Existing and Future Land Use

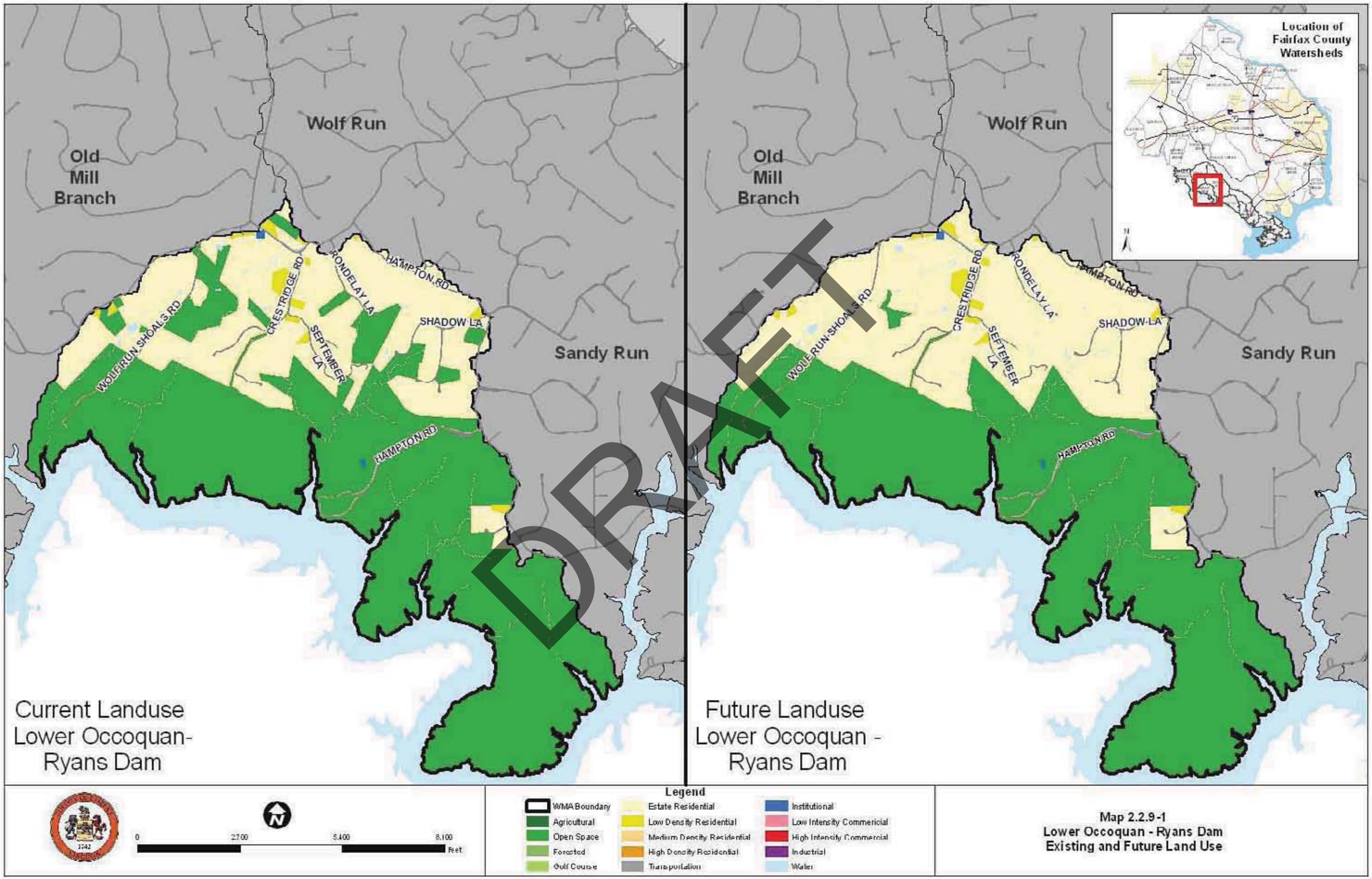


Map 2.2.7-1
Kane Creek
Current and Future Land Use

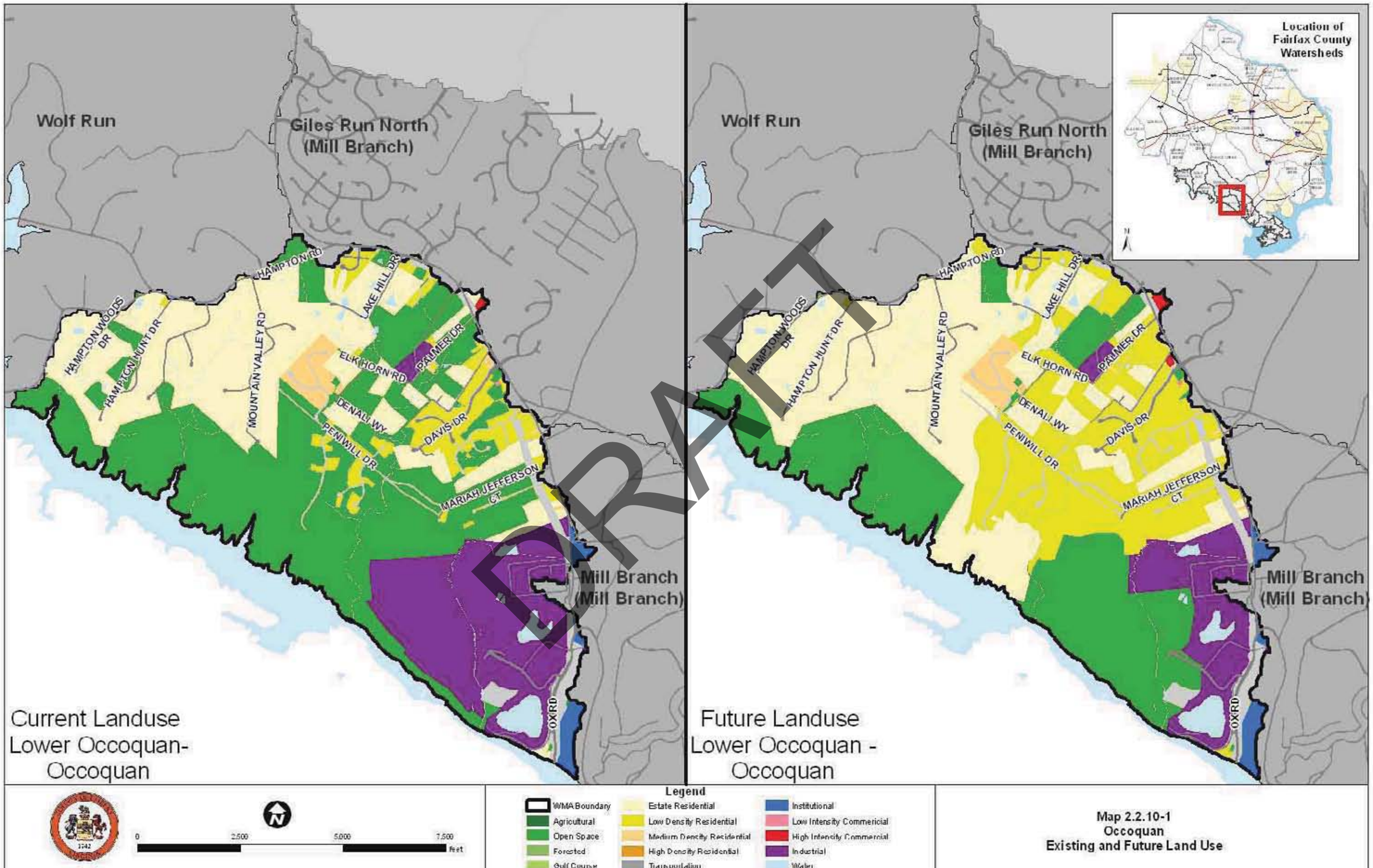


DRAFT

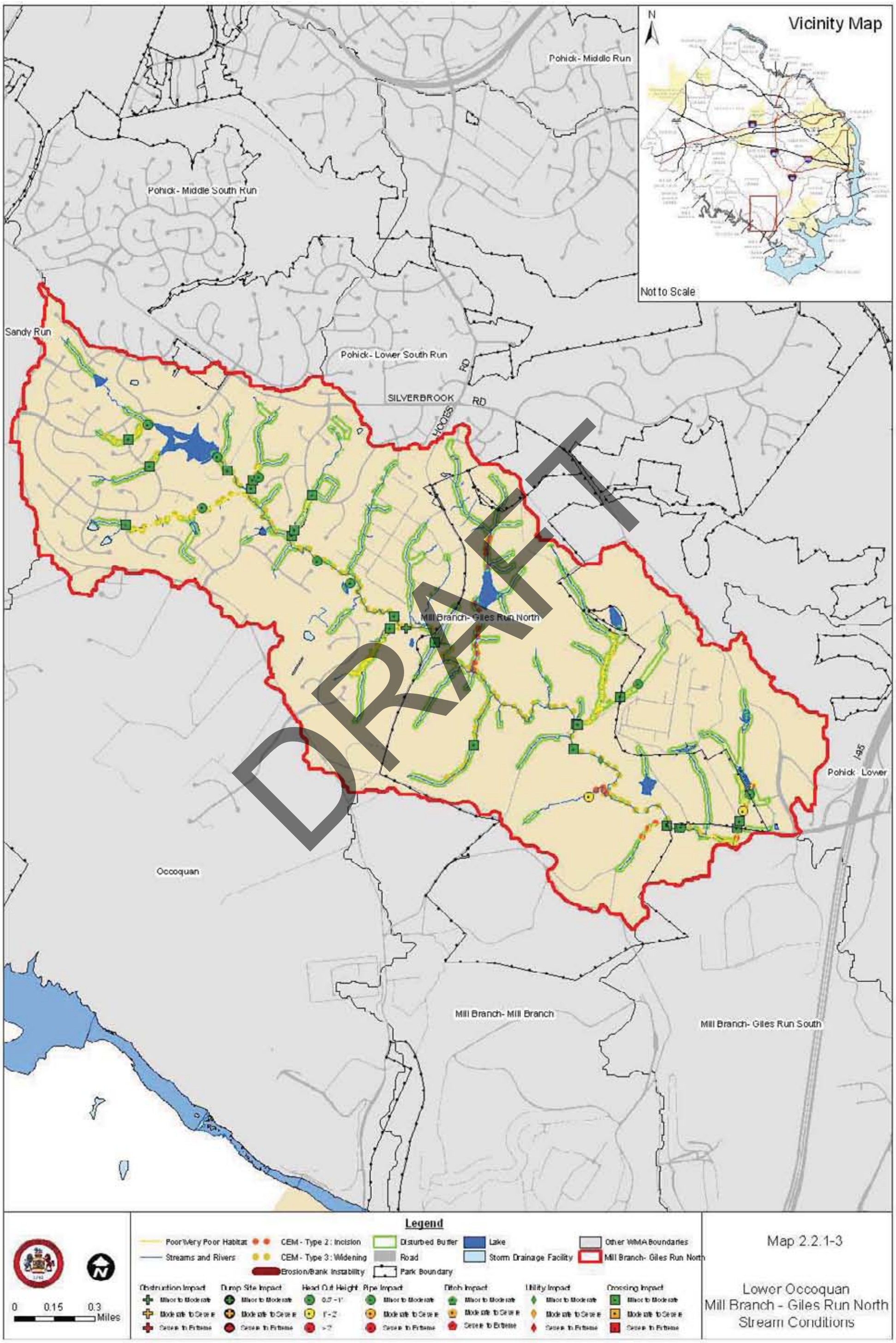
Map 2.2.8-1
Old Mill Branch
Existing and Future Land Use

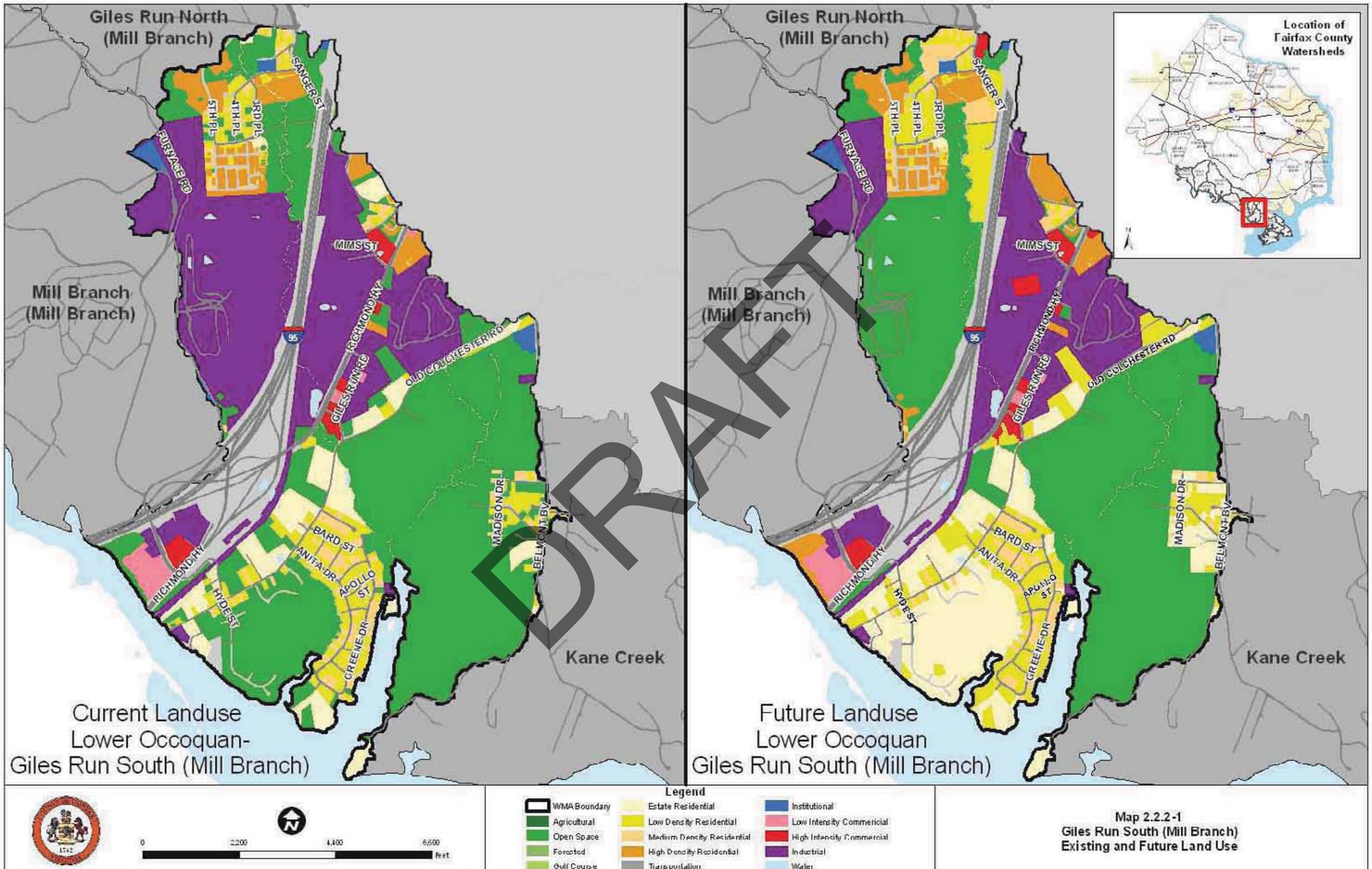


Map 2.2.9-1
Lower Occoquan - Ryans Dam
Existing and Future Land Use

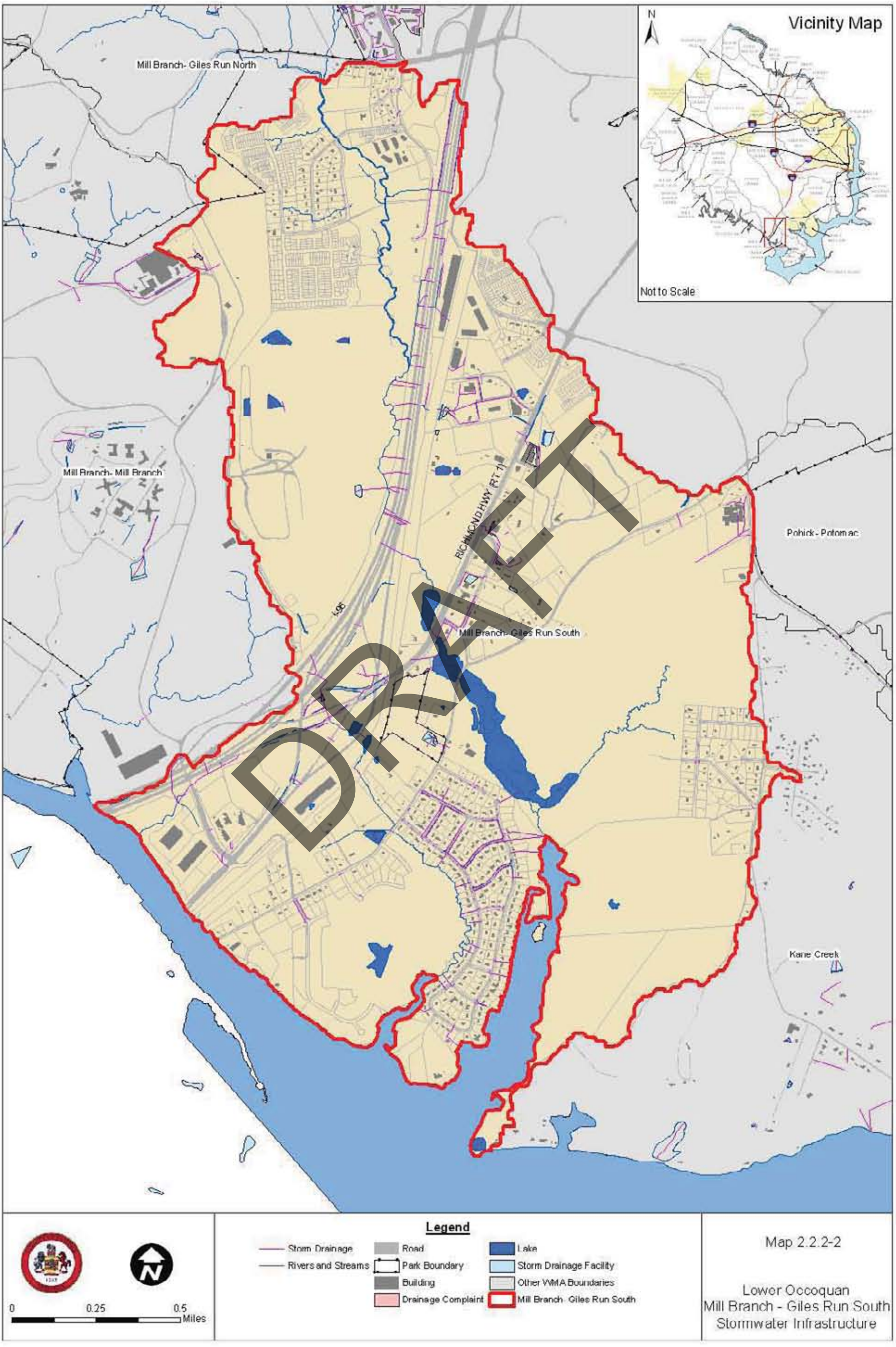


Map 2.2.10-1
Occoquan
Existing and Future Land Use


Vicinity Map
N
Not to Scale
Pohick - Middle Run
Pohick - Middle South Run
Sandy Run
Pohick - Lower South Run
SILVERBROOK RD
HOOTES RD
Mill Branch- Giles Run North
Pohick Lower
Occoquan
Mill Branch- Mill Branch
Mill Branch- Giles Run South
DRAFT
Legend
Poor/Very Poor Habitat
Streams and Rivers
CEM - Type 2: Incision
CEM - Type 3: Widening
Erosion/Bank Instability
Disturbed Buffer
Road
Park Boundary
Lake
Storm Drainage Facility
Other WMA Boundaries
Mill Branch- Giles Run North
Obstruction Impact
Dump Site Impact
Head Cut Height
Pipe Impact
Ditch Impact
Utility Impact
Crossing Impact
Minor to Moderate
Moderate to Severe
Severe to Extreme
0 0.15 0.3 Miles
Map 2.2.1-3
Lower Occoquan
Mill Branch - Giles Run North
Stream Conditions



Map 2.2.2-1
Giles Run South (Mill Branch)
Existing and Future Land Use


Vicinity Map
N
Not to Scale
Mill Branch- Giles Run North
Mill Branch- Mill Branch
RICHMOND HWY (RT 1)
Mill Branch- Giles Run South
Potomac
Kane Creek
DRAFT
Legend
Storm Drainage
Rivers and Streams
Road
Park Boundary
Building
Drainage Complaint
Lake
Storm Drainage Facility
Other WMA Boundaries
Mill Branch- Giles Run South
0
0.25
0.5
Miles
Map 2.2.2-2
Lower Occoquan
Mill Branch - Giles Run South
Stormwater Infrastructure