2 Watershed Condition

2.1 General Watershed Characteristics

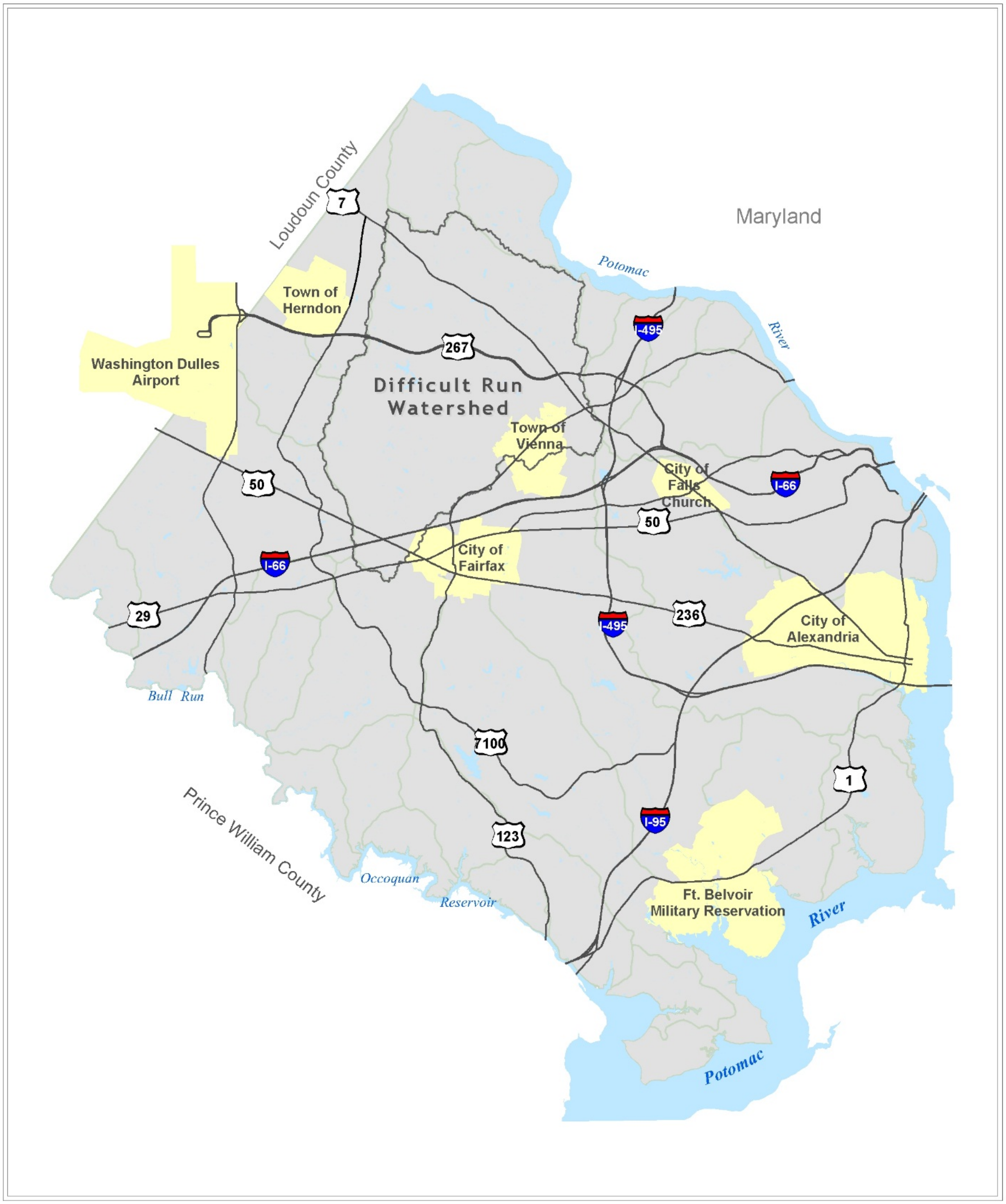
The Difficult Run watershed, the largest watershed in Fairfax County, covers 58.3 square miles and is bordered by several smaller watersheds and the Potomac River. Difficult Run is in the north-central portion of Fairfax County outside the Capital Beltway and generally north of I-66 as shown on Map 2.1, Watershed Location Map. Several major highways cross the watershed: Lee Jackson Memorial Highway (US Route 50), the Washington Dulles Access and Toll Road (Route 267) and Leesburg Pike (Route 7). The W&OD Trail also crosses the watershed.

The Difficult Run watershed is home to the Town of Vienna, a large portion of the planned community of Reston, Wolf Trap Farm Park and a portion of Great Falls Park operated by the National Park Service.

The Difficult Run watershed includes 145 miles of stream in 18 **subwatersheds**. Table 2.1 below provides the names of the 18 subwatersheds within Difficult Run, their area and length of stream. Refer to Map 2.2, Subwatershed Location Map, for the locations of each subwatershed.

Table 2.1: Total Area and Stream Length by Subwatershed

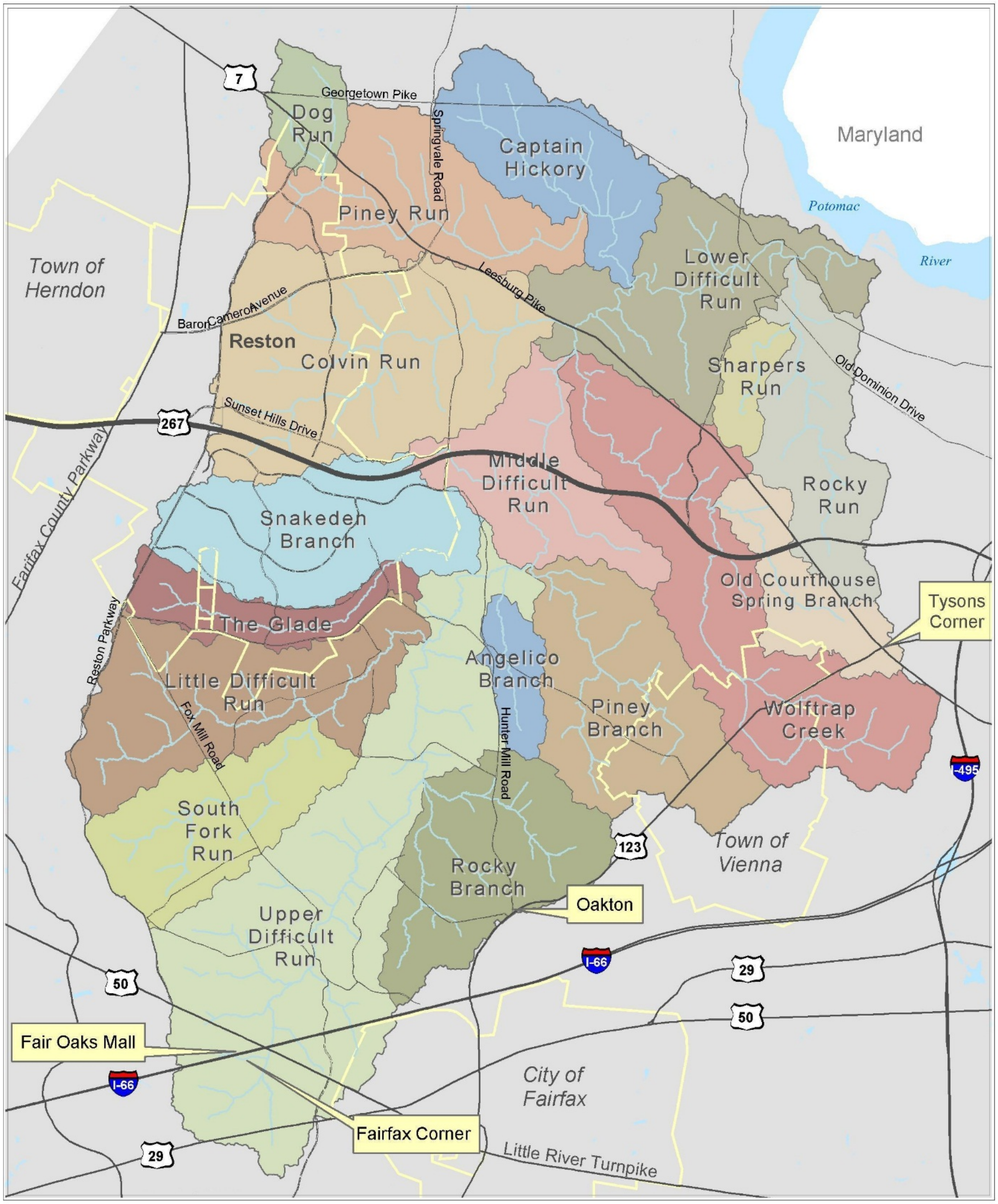
Subwatershed	Subwatershed Area (acres)	Stream Length (miles)
Angelico Branch	483	1.71
Captain Hickory Run	1,695	7.23
Colvin Run	3,875	14.94
Difficult Run (Lower)	2,450	9.79
Difficult Run (Middle)	1,721	6.62
Difficult Run (Upper)	5,683	22.73
Dog Run	515	2.07
The Glade	852	3.81
Little Difficult Run	2,589	10.72
Old Courthouse Spring Branch	981	2.81
Piney Branch	2,475	8.03
Piney Run	2,099	8.69
Rocky Branch	2,167	8.77
Rocky Run	1,673	6.47
Sharpers Run	415	1.55
Snakeden Branch	2,238	9.16
South Fork Run	1,744	7.03
Wolftrap Creek	3,631	13.10
Total Watershed	37,294	145.23



Difficult Run Watershed

0 1.5 3 6 Miles

Watershed Location Map **Map 2.1**



Difficult Run Watershed

0 0.45 0.9 1.8 Miles

Subwatershed Location Map **Map 2.2**

The mainstem of Difficult Run includes 39 miles of stream and flows in a northeasterly direction to a **confluence** with the Potomac River. The tributaries, therefore, make up the remaining 106 miles of stream within Difficult Run. The larger tributaries to Difficult Run mainstem are Piney Run, Colvin Run, Snakeden Branch, Little Difficult Run, Rocky Branch, Piney Branch, Wolftrap Creek, Old Courthouse Spring Branch and Rocky Run.

Difficult Run flows through a wide variety of watershed conditions, from forested basins to urban environments. Just before its confluence with the Potomac River, it takes on the characteristics of a mountain river, flowing through a narrow, cliff-lined valley. The watershed also contains four large impoundments: Lake Anne and Lake Fairfax on Colvin Run, and Lake Thoreau and Lake Audubon on Snakeden Branch.

The Difficult Run watershed falls entirely within the Piedmont physiographic province, which is generally characterized by rolling topography with low to moderate slopes. Stream systems can differ greatly in their physical and biotic components from one physiographic province to another. Piedmont streams are characterized by medium to high gradient valleys and **channels** with gravel and cobble **substrates** and **riffle** and **pool** dominated flow regimes.

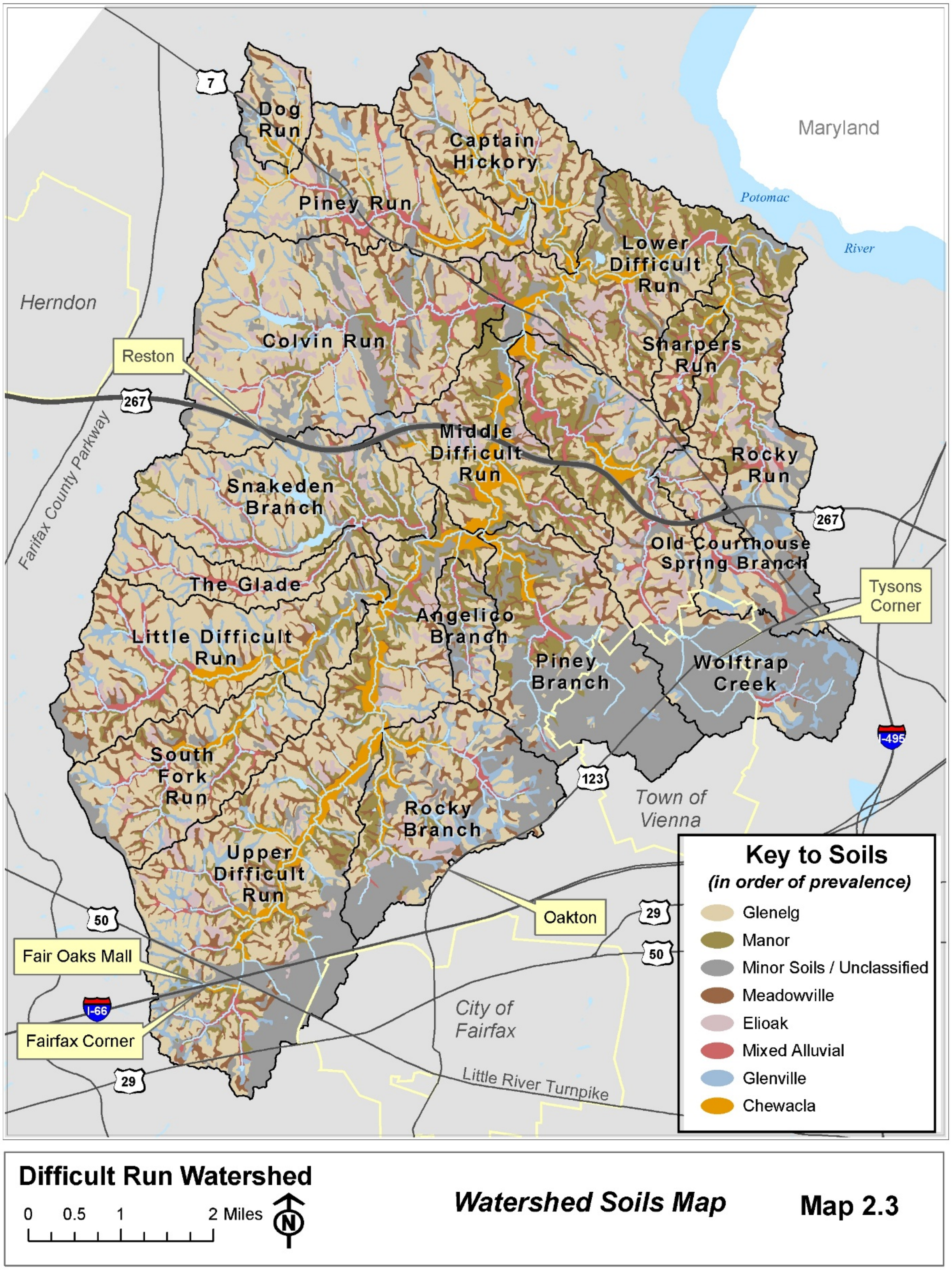
Soils affect the stream condition by differing in properties such as erosion potential and drainage. Soil characteristics can have an impact on the types of watershed issues that may occur and the types of solutions that are feasible. There are 41 different soil types found within the watershed; of these only seven soil types and urbanized areas underlie 90 percent of the watershed area. These soils are listed in Table 2.2 and shown on Map 2.3, Watershed Soils Map. There are two major soil groups: the Glenelg-Elioak-Manor association and the Manor-Glenelg-Elioak association.

The Glenelg soil type makes up 40.5 percent of the watershed area and is found throughout the watershed, primarily on hilltops and sideslopes. Glenelg soils have high mica content and are therefore highly susceptible to erosion. Manor soils are silty and sandy and make up almost 11 percent of the watershed. This soil type is commonly found on the floodplain fringe. Manor soils are also highly susceptible to erosion.

Table 2.2: Predominant Watershed Soil Types

Soil Type (Soil Number)	Area (square miles)	Percent of Watershed
Glenelg (55)	23.6	40.48
Manor (21)	6.4	10.92
Minor soil types	6.0	10.31
Unclassified*	5.3	9.03
Meadowville (20)	4.9	8.36
Elioak (24)	3.4	5.87
Mixed Alluvial (1)	3.1	5.25
Glenville (10)	3.0	5.06
Chewacla (2)	2.8	4.73

*unclassified areas generally include open water and urbanized areas that do not have soil classifications


Maryland
Potomac
River
Herndon
Reston
Fairfax County Parkway
Dog Run
Captain Hickory
Piney Run
Lower Difficult Run
Colvin Run
Sharpers Run
Middle Difficult Run
Rocky Run
Snakeden Branch
Old Courthouse Spring Branch
Tysons Corner
The Glade
Angelico Branch
Little Difficult Run
Piney Branch
Wolftrap Creek
South Fork Run
Rocky Branch
Town of Vienna
Upper Difficult Run
Oakton
Fair Oaks Mall
Fairfax Corner
City of Fairfax
Little River Turnpike
7
267
123
29
50
I-66
I-495
Key to Soils
(in order of prevalence)
Glenelg
Manor
Minor Soils / Unclassified
Meadowville
Elioak
Mixed Alluvial
Glenville
Chewacla
Difficult Run Watershed
0 0.5 1 2 Miles
N
Watershed Soils Map
Map 2.3

The stream valleys and floodplains are on Mixed Alluvial and Chewacla soils. Mixed Alluvial soils are comprised of organic silts, clays, and dense gravel-sand-silt-clay alluvium. Because of their unconsolidated nature these soils are susceptible to erosion. Chewacla soils consist of silty and clayey alluvium eroded from schist, granite and gneiss. Both soils are susceptible to flooding because of high seasonal water tables and floodplain location. Soil descriptions for each subwatershed are located in Chapter 3 and in Appendix A.

2.2 Watershed History and Population Growth

The current state of the Difficult Run watershed is linked to the history of **land development** and the dramatic changes in **land use** that occurred in Fairfax County and the Difficult Run watershed since settlement began in the 1600s. The County was established in 1742 at a time when the area was largely wilderness and tobacco cultivation was the dominant industry. Population in the watershed rose and fell in response to farming success and the settlement of Vienna and Oakton were spurred by the introduction of the Washington and Old Dominion Railroad after 1850.

By 1930, the population of Fairfax County had grown to 25,000. In the next twenty years, the population expanded to just less than 100,000. This growth can largely be attributed to the expansion of the federal government, the related increase in job opportunities, and the automobile's new popularity in the 1940's and 1950's. Significant single-family residential development occurred, particularly in the Town of Vienna as public sanitary sewer services became available.

Growth in the western portion of the Difficult Run watershed had been a planned response to the region's growth and included the development of Reston in the early 1960s. By the 1970s, Reston was developed with a wide range of units including multi-family units and townhouses in high-density clusters. This type of development allowed large open space lots and stream valleys to be preserved.

The population of the Difficult Run watershed in the mid 1970s was estimated at 60,000, and the majority of the watershed's residents inhabited Reston (25,000) and Vienna (30,000). Developed areas were generally residential and included a majority of single-family units in the eastern portions of the watershed at densities of 2-3 units per acre and 5-6 units per acre near Vienna. Tysons Corner had begun to emerge as a commercial and employment center. The central portion of the study area in the mid 1970s had retained its country feel and was largely undeveloped from the **headwaters** to the mouth of Difficult Run.

Additional job opportunities were generated as private firms and businesses moved to Fairfax in the 1970s and 1980s. The population in 2000 was 970,000, a 19 percent increase since 1990. The population estimate for Fairfax County in 2003 was more than 1 million residents.

Growth in population and employment in Fairfax County is expected to continue for the future, as shown in Table 2.3. The projections are based on estimates from Fall 2006, and do not include changes that will result from the Base Realignment and Closure process.

Table 2.3: Growth Trends in Fairfax County, 1990-2030

Year	Population (1,000s)	Percent Change	Households (1,000s)	Percent Change	Employment (1,000s)	Percent Change
1990	847.8		303.9		439.8	
2000	969.0	14.3%	350.5	15.3%	577.0	31.2%
2010	1132.5	16.9%	411.5	17.4%	683.9	18.5%
2020	1276.0	12.7%	462.6	12.4%	774.5	13.2%
2030	1330.9	4.3%	482.4	4.3%	844.6	9.1%

Source: Metropolitan Washington Council of Governments (MWCOG) 2006.

Part of the Difficult Run watershed was the subject of an environmental and land use study called the *Difficult Run Headwaters Land Use Study*, April 1978, prepared by the Fairfax County Office of Comprehensive Planning. The study area was analyzed for its ability to accept various residential densities and simultaneously maintain high-quality environmental standards. The primary environmental objectives for this area were to protect this fragile environment from the impacts of urbanization such as increased stormwater runoff, increased **nonpoint source pollution** loadings, stream channel enlargement and loss of high-quality wildlife habitats.

The result was an environmentally sensitive plan with land use boundaries determined by the environmental carrying capacity of the land. The environmental factors, together with other factors such as existing and committed development in the area and site and road design controls, were reflected in the Comprehensive Plan map for this area.

The plan served as a guide and indicated the type of future development that could be supported by the soils, vegetation, and topography. Areas with long narrow ridgelines, thin overburden, highly erodible soils, steep topography, high quality vegetation, and poor access were planned for very low density uses (less than one unit per five acres). One unit per two to five acres was proposed for areas adjacent to streams where topography was relatively steep, moderately thick overburden (10-50 feet), and soils were moderately erodible. Areas on plateaus or ridge lines with thick overburden (50 feet or more), gently sloping topography, mixed vegetation or varied access points were judged as capable of accommodating somewhat higher density development (one-half to one **dwelling units** per acre).

Based on the 1978 land use study's findings, the goals of the plan focused on accommodating the population increase in the Difficult Run watershed over 30 years. As a result, Fairfax County encouraged development that was more imaginative, preserved a variety of habitats, and provided recreational facilities and a variety of architectural styles. The County encouraged owners of large tracts to plan and develop these tracts as an entity. In addition, owners of small parcels adjacent to large parcels were urged to consolidate them with the larger tracts in order to create a more integrated development.

Table 2.4 shows population growth and change in the Difficult Run watershed from 1970 through 2000. The rate of growth slowed slightly between 1990 and 2000; however the rate is markedly higher than the County rate of 19 percent and the Virginia rate of 14 percent. Projected growth from 2000 to 2020 is expected to proceed at a slower rate than in recent decades.

Table 2.4: Watershed Population Growth and Projections, 1970-2020

Year	Population	Percent Change
1970	65,000	N/A
1980	86,000	32
1990	119,000	38
2000	144,000	21
2010	157,000	9
2020	171,000	9

Source: Chesapeake Bay Program, 2004.
Note that the watershed boundaries defined by the Chesapeake Bay Program website differ slightly from the boundaries defined by the County Watershed study and the projected population may differ slightly.

2.3 Existing Land Use

In order to develop hydrologic and subsequent hydraulic models for the Difficult Run Watershed, land uses were grouped in accordance with standards developed for the Countywide Watershed Management Program. These generalized land uses put specific zoning designations together based on impervious area. The groupings utilized in this plan are depicted in Table 2.5. Mapping was updated based on 2002 aerial photography.

Table 2.5: Generalized Land Use Categories

Land Use	Code	Description
Open Space	OS	Parkland, privately owned open space, and vacant developable land. Extensive parking areas or buildings associated with parkland are included as LIC.
Golf Course	GC	Open space associated with golf courses.
Estate-Residential	ESR	Single-family detached homes with more than two acres per residence.
Low-Density Residential	LDR	Single-family detached homes with 0.5 to 2 acres per residences.
Medium-Density Residential	MDR	Single-family detached homes with less than 0.5 acres per residence and attached multi-family residential with fewer than eight dwelling units per acre.
High-Density Residential	HDR	Single-family and multifamily residential with more than eight dwelling units per acres.
Institutional	INS	Facilities open to the public, including churches, schools, libraries and county office buildings.
Low-Intensity Commercial	LIC	Office parks and commercial facilities developed in a campus-ike setting. Also includes private recreational facilities such as swim clubs, tennis clubs, and buildings and parking associated with golf courses and parkland.
High-Intensity Commercial	HIC	Highly impervious commercial and office uses, including office complexes, shopping centers, strip malls, automobile dealerships and restaurants.
Industrial	IND	Industrial land use and industrial parks.
Water	WAT	Open water, lakes and ponds

The current land cover within the Difficult Run watershed is dominated by residential use. Residential areas, including estate, low, medium and high density make up more than 57 percent of the watershed. The distribution of the varying intensities of residential areas is similar to that reported 30 years ago with large lots occupying the central portion of the watershed along the mainstem of Difficult Run. Refer to Map 2.4, Existing Land Use Map, and Table 2.6 for the distribution of the land use and Appendix B for a full discussion on the land use methods used. The land use categories are specific to the County's watershed plans and are not the same as zoning classifications.

Estate residential and low-density housing make up approximately 41 percent of the watershed. Estate residential lots are most prevalent in the northern end of the watershed, more specifically the downstream ends of Lower Difficult Run (33 percent of the subwatershed acreage), Captain Hickory Run (38 percent of the subwatershed acreage), Sharpers Run (37 percent of the subwatershed acreage), and Rocky Run (26 percent of the subwatershed acreage). Low-density lots also make up a large percentage of these subwatersheds along Leesburg Pike and Georgetown Pike just northeast of Reston and north of Tysons Corner along Old Dominion Drive. Estate residential and low-density land continues upstream along the mainstem of Difficult Run and occupies the central portion of the watershed between Reston and Vienna. Much of the area of Middle Difficult Run and Angelico Branch is occupied by estate residential use. Little Difficult Run, South Fork Run, and the downstream half of Upper Difficult Run are low-density residential.

Medium-density residential is present in approximately 10 percent of the watershed. The largest clusters of medium-density use are located in and around Vienna in the upstream **reaches** of Piney Branch, Wolftrap Creek, and Old Courthouse Spring Branch. Smaller clusters occur in northern Reston along Baron Cameron Avenue and in The Glade along Lawyers Road and Glade Drive.

High-density residential zones are most common in Reston in both Colvin Run and Snakeden Branch subwatersheds (670 acres and 668 acres, respectively). These acreages make up 60 percent of the total high-density residential uses in the overall watershed. These are two of the most densely populated subwatersheds. Smaller percentages of high-density use are located near Tysons Corner in the Old Courthouse Spring subwatershed, and south of the intersection between I-66 and the Lee Jackson Highway in the upstream portion of the mainstem headwaters just west of Fairfax and east of West Ox Road. Within the Upper Difficult Run subwatershed, there are 457 acres currently being used for high-density residential uses.

Commercial centers in the watershed are centered around Reston and along the corridor between Tysons Corner, Oakton, and Fairfax. Commercial use occupies approximately 5 percent of the watershed, with approximately 4 percent of the acreage in high-intensity commercial, and approximately 1 percent in low-intensity commercial uses. Snakeden Branch has 7 percent of its acreage in high-intensity commercial land use and Colvin Run in Reston has 8 percent of its acreage in this land use. High-intensity commercial use is clustered along Sunset Hill Road and Sunrise Valley Drive north and south of the Toll Road. Tysons Corner, a major commercial district is in the Old Courthouse Spring subwatershed, which has 28 percent high-intensity commercial uses, mostly along Route 7. Dense commercial development continues along Chain Bridge Road and Maple Avenue (Route 123) in the headwaters of Wolftrap Creek, Piney Branch, Rocky Branch and Upper Difficult Run. Low-density commercial development is also the highest in the Snakeden Branch and Colvin Run with 3 percent and 6 percent, respectively, of the subwatershed acreage in this land use category.

Transportation rights-of-way comprise approximately 4,002 acres or 11 percent of the watershed. Several major highways cross the watershed. Leesburg Pike (Route 7) crosses seven subwatersheds as it runs northwest to southeast between Dranesville and Tysons Corner. The Washington Dulles Access and Toll Road (Route 267) connects Tysons Corner with Reston and Herndon. The Toll Road bisects the watershed, crossing six subwatersheds. The southern tip of the watershed is crossed by and includes the interchange for I-66 and Lee Jackson Memorial Highway (US Route 50).

Table 2.6: Existing Land Use, Difficult Run Watershed

	Existing	
Land Use Type	Acres	Percent
Open space, parks, and recreational areas	7,741	21%
Golf Course	702	2%
Estate residential	5,755	15%
Low-density residential	9,692	26%
Medium-density residential	3,685	10%
High-density residential	2,234	6%
Low-intensity commercial	529	1%
High-intensity commercial	1,523	4%
Industrial	244	1%
Institutional	978	3%
Transportation	4,002	11%
Water	209	1%
Total	**37,294**	**100%**

Note: These are generalized land use groupings based on impervious area for modeling purposes only and do not necessarily represent specific zoning designations. All references to land use in this watershed plan and all land use maps utilize these designations as defined in Table 2.5

Open space (i.e., open space set-aside requirements for **subdivisions**, parks and recreational areas) makes up 21 percent of the watershed, helping to reduce the amount of stormwater runoff. In the mid 1970s, 50 percent of the watershed was classified as open space, indicating a decrease of 29 percent over time. The historical value included 87 percent in either vacant property or in agricultural use while the remainder was public parks or private recreation areas.

As of this report, the Fairfax County Park Authority owns much of the public parkland that is considered open space. Lake Fairfax Park is one of the largest open space tracts in the watershed. Many stream valley parks are owned by the Park Authority, creating a semi-continuous network of open space. Difficult Run Stream Valley Park, Colvin Run Stream Valley Park and Wolftrap Stream Valley create a large tract between Route 7 and the Dulles Toll Road east of Reston. The central portion of the watershed includes large open space areas comprised of Meadowlark Garden Regional Park, Tamarack Park and Clarks Crossing Park. Open space in the southwestern upstream portion of the watershed includes Fox Mill District Park and many smaller segments of the Difficult Run Stream Valley Park.

Only a few large tracts of developable land remain in Fairfax County and in the Difficult Run watershed. According to Fairfax County's Environmental Coordinating Committee (ECC), substantial changes in the County's land use distribution and character are not anticipated in the coming years (ECC, 2003). Most future development will involve small parcel development, **infill** development, or **redevelopment**.

2.4 Future Land Use

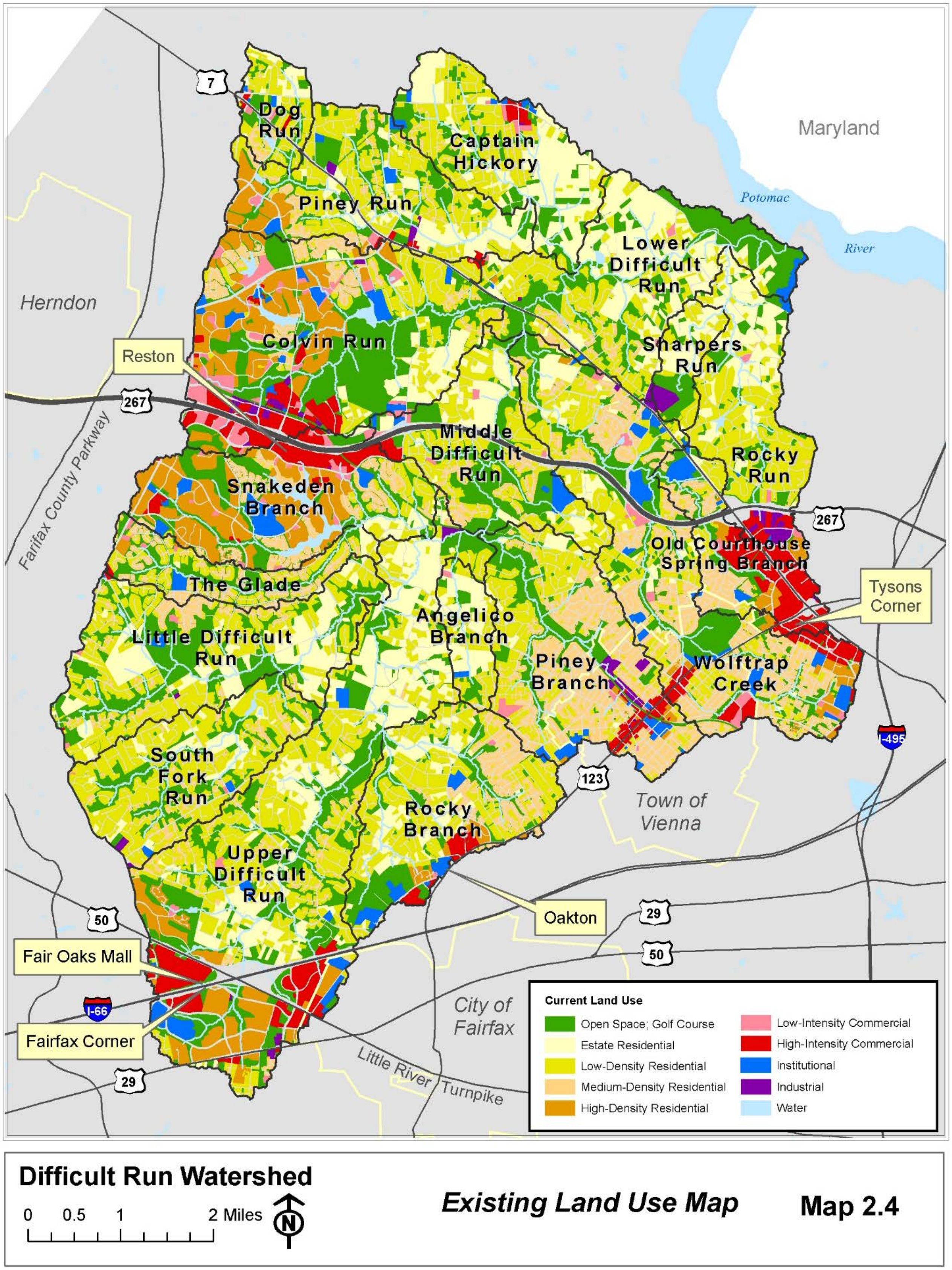
Future land use, shown in Table 2.7, was derived from a compilation of zoning and general land use plan information. A full description of the future land use methodologies can be found in Appendix B.

Table 2.7: Future Land Use, Difficult Run Watershed

	Future	
Land Use Type	Acres	Percent
Open space, parks, and recreational areas	5,641	15%
Golf Course	661	2%
Estate residential	5,191	14%
Low-density residential	11,445	31%
Medium-density residential	4,423	12%
High-density residential	2,262	6%
Low-intensity commercial	475	1%
High-intensity commercial	1,798	5%
Industrial	193	1%
Institutional	994	3%
Transportation	4,002	11%
Water	209	1%
Total	**37,294**	**100%**

Table 2.8 shows the change from existing to future conditions. A comparison of the parcels that change land use type shows that Difficult Run is largely built out: only 16 percent of the parcels in the watershed are projected to change. Maps of future land use and changed areas are shown with the description of subwatershed characteristics in Chapter 3.

The largest percentage change in land use is conversion of open space to residential areas, primarily in areas zoned for estate residential where there are vacant parcels still remaining. The next largest change is an increase in low-density residential uses, which occur in areas of current estate residential or open space development, both of which show a reduction in area between existing and future conditions.



Existing Land Use Map **Map 2.4**

Table 2.8: Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	7,741	21%	5,641	15%	-2100	-6%
Golf Course	702	2%	661	2%	-41	0%
Estate residential	5,755	15%	5,191	14%	-564	-2%
Low-density residential	9,692	26%	11,445	31%	1753	5%
Medium-density residential	3,685	10%	4,423	12%	738	2%
High-density residential	2,234	6%	2,262	6%	28	0%
Low-intensity commercial	529	1%	475	1%	-54	0%
High-intensity commercial	1,523	4%	1,798	5%	275	1%
Industrial	244	1%	193	1%	-51	0%
Institutional	978	3%	994	3%	16	0%
Transportation	4,002	11%	4,002	11%	0	0%
Water	209	1%	209	1%	0	0%
Total	**37,294**	**100%**	**37,294**	**100%**		**0%**

2.5 Existing Impervious Area

Impervious surfaces are those that do not allow precipitation to infiltrate through the natural soils and into the groundwater. They include roadways, parking lots, sidewalks, residential driveways, and rooftops. Imperviousness is one of the causes of the issues identified in Difficult Run:

- Impervious surfaces are a source of **runoff pollution**. Chemical contaminants such as oils, metals, and sediment, wash off from impervious surfaces.
- Higher levels of imperviousness are a source of **increased stormwater flow**, which is an increase in the volume of stormwater and an increase in the rate of flow of stormwater.
- **Stream instability and erosion** increases as a result of higher stormwater flows, resulting from higher levels of imperviousness.
- **Stream water quality** and **stream habitat** can become impaired from additional runoff pollution and the change in streamflow resulting from higher imperviousness.

While there is no single measure that indicates whether a watershed is healthy or degraded, research (CWP, 2003) has shown that stream channels become unstable and aquatic habitat becomes degraded when watersheds are more than 10 percent impervious. At 25 percent impervious, the same research indicates that it would be difficult if not impossible to restore stream health to pre-development conditions.

2.5.1 Methodology

The five types of features that make up the impervious area in the watershed are listed below followed by the methods used to estimate the area of each feature.

- Roads
- Parking Lots
- Buildings
- Sidewalks
- Driveways

Roads, parking lots, and buildings were estimated using a GIS coverage provided by the County. In some areas the coverage did not show recent development, so the mapping was updated to 2002 based on the County's aerial photography.

Sidewalk area was estimated using a GIS coverage that showed sidewalks as a single line. The length of sidewalk was multiplied by an average width of 4 feet to calculate the area.

Driveway areas in residential land uses were added to the total impervious surface by adding a driveway factor. The factor was developed by subsampling residential areas across the watershed and delineating the driveway area in each type.

2.5.2 Subwatershed Imperviousness

The total area of the Difficult Run watershed is 37,297 acres. Using the method described above, there are an estimated total of 6,862 acres (or 18.4 percent of the total watershed) covered by impervious surfaces, shown in Table 2.9.

Table 2.9: Impervious Surface in Difficult Run

Impervious Surface	Existing Impervious	
	Acres	Percent of Watershed
Roads and Parking Lots	3,450.2	9.3
Buildings	2,503.0	6.7
Sidewalks	154.0	0.4
Driveways	755.3	2.0
Total Watershed	6,862.5	18.4

According to Table 2.10 and Map 2.5, the subwatersheds with the highest impervious levels include Old Courthouse Spring Branch at 43 percent and Snakeden Branch at 27 percent. Colvin Run, Piney Branch, Rocky Run and Wolftrap Creek all have greater than 20 percent impervious surface. These subwatersheds, as expected, are located in Reston, Tysons Corner, and Vienna.

Table 2.10: Existing Impervious Area by Subwatershed

Subwatershed	Existing Impervious	
	Acres	Percent
Angelico Branch	51	10.5
Captain Hickory Run	188	11.1
Colvin Run	882	22.8
Difficult Run (Lower)	227	9.3
Difficult Run (Middle)	248	14.4
Difficult Run (Upper)	1,043	18.4
Dog Run	81	15.7
The Glade	138	16.1
Little Difficult Run	272	10.5
Old Courthouse Spring Branch	419	42.7
Piney Branch	565	22.8

Subwatershed	Existing Impervious	
	Acres	Percent
Piney Run	343	16.3
Rocky Branch	376	17.4
Rocky Run	334	19.9
Sharpers Run	39	9.3
Snakeden Branch	605	27.0
South Fork Run	215	12.3
Wolftrap Creek	839	23.1
Total Watershed	6,862	18.4

The subwatersheds with the lowest impervious values are located in the central portion of the watershed along the mainstem of Difficult Run. The northern portions of the watershed, including Captain Hickory Run, Lower Difficult Run and Sharpers Run are 11 percent or less. Likewise, the central region including Angelico Branch, Little Difficult Run and South Fork Run are all less than 12 percent impervious.

2.6 Future Impervious Surface

2.6.1 Methodology

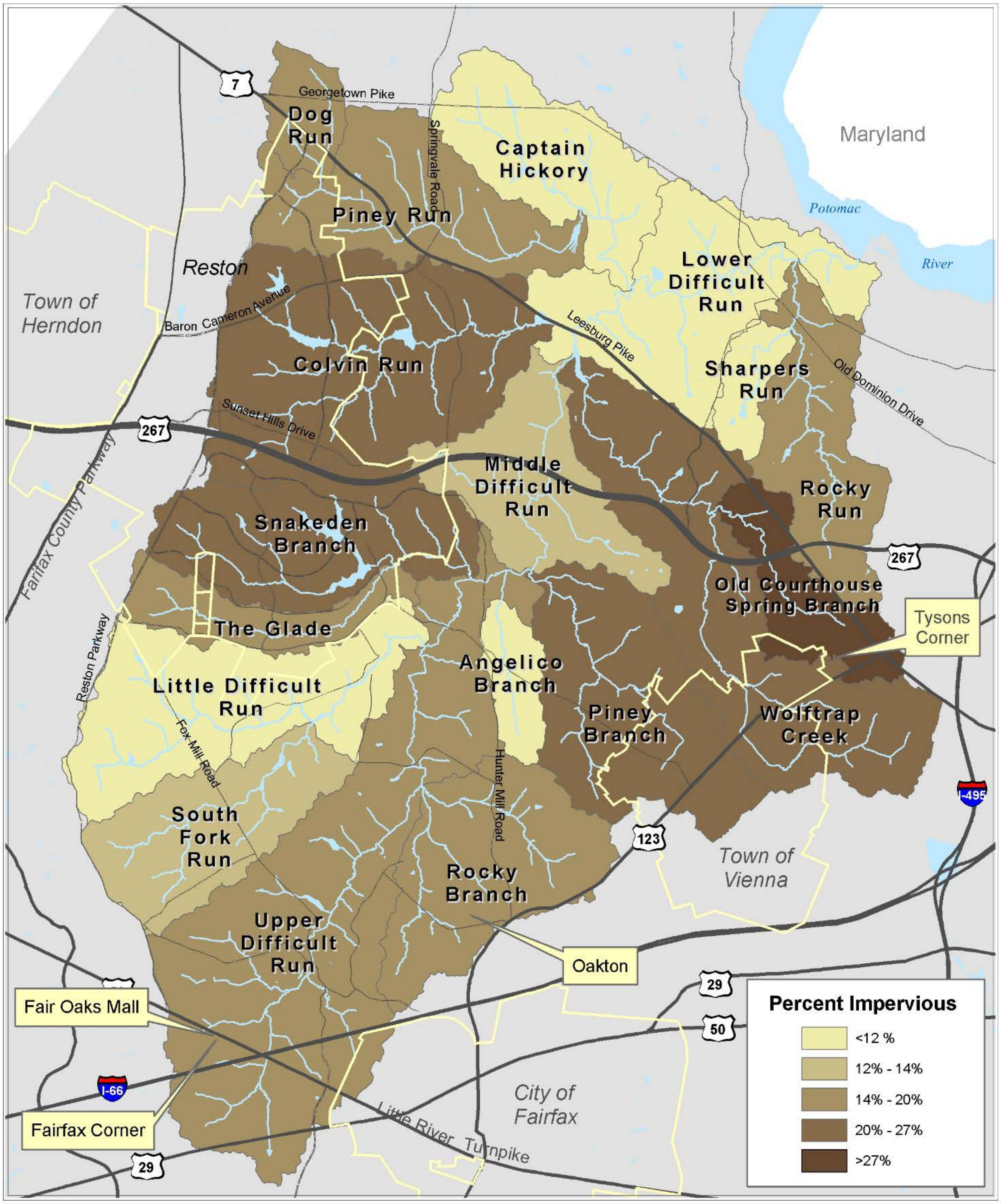
Future imperviousness was determined based on the assumption that the amount of impervious surface would not change in areas where the land use remained the same for existing and future conditions. The procedure is described in detail in Appendix B, and included the following steps:

1. Estimate imperviousness for each type of future land use.
2. Subtract the impervious acreage associated with changing land use from the total.
3. Determine the amount and type of future land use in the changed areas.
4. Multiply the area of each future land use type by the percent impervious to get future impervious acreage in the changed areas.
5. Add unchanged impervious area and future impervious area to obtain the total.

2.6.2 Subwatershed Imperviousness

Using this methodology, there is a projected increase of 840 impervious acres for the overall watershed, an increase of 2.2 percent to a total of 20.6 percent. Small increases in impervious area of 1 percent or less are projected to occur in eight of the subwatersheds. The smallest increases are noted in The Glade, Old Courthouse Spring Branch and Rocky Run. The largest increases are anticipated for Colvin Run and Snakeden Branch, both of which have increases above 5 percent and percent change greater than 20.

These results suggest that at a watershed or subwatershed scale, the impacts of future development may be minor, particularly if mitigated by stormwater management. This is consistent with the relatively built-out state of the watershed. Localized impacts in smaller areas, particularly in headwater streams, could still be significant, however. These impacts could include the effects of single-lot redevelopment with higher imperviousness.



Difficult Run Watershed

0 0.5 1 2 Miles

Subwatershed Imperviousness **Map 2.5**

Table 2.11: Future Impervious Area by Subwatershed

Subwatershed	Future Impervious			
	Acres	Percent	Increase in Impervious Percent	Percent Change
Angelico Branch	65	13.4	2.9	27.3
Captain Hickory Run	196	11.5	0.5	4.0
Colvin Run	1144	29.5	6.8	29.7
Difficult Run (Lower)	236	9.6	0.3	3.7
Difficult Run (Middle)	295	17.1	2.7	18.9
Difficult Run (Upper)	1202	21.2	2.8	15.2
Dog Run	94	18.2	2.4	15.3
The Glade	139	16.1	0.1	0.9
Little Difficult Run	322	12.4	1.9	18.5
Old Courthouse Spring Branch	418	42.6	0.1	0.1
Piney Branch	597	24.1	1.3	5.7
Piney Run	381	18.2	1.9	11.4
Rocky Branch	399	18.4	1.0	5.9
Rocky Run	337	20.1	0.2	0.9
Sharpers Run	51	12.4	3.0	32.6
Snakeden Branch	731	32.6	5.6	20.9
South Fork Run	229	13.1	0.8	6.5
Wolftrap Creek	868	23.9	0.8	3.5
Total Watershed	7702	20.7	2.2	12.2

2.7 Aquatic Environment

While a single measure cannot easily define stream health, several interrelated factors, such as water quality (including chemical and physical parameters such as pH, water temperature, **nitrogen**, **phosphorus**, and **suspended sediments**), stream morphology (stable banks and substrate), and riparian cover combine to provide adequate habitat for aquatic plants and animals. Because they integrate all these factors over time, field samples of aquatic organisms, more specifically aquatic **benthic macroinvertebrate** and fish communities, are often used as a measure of overall stream health.

The *Difficult Run Environmental Baseline* completed by Parsons Brinkerhoff Quade and Douglas (PBQD, 1976) presented a comprehensive baseline assessment of the terrestrial and aquatic environmental resources within the Difficult Run watershed. Four of the 15 stream sampling locations were considered to have “Very Good” faunal quality. Three of these sites were located in Little Difficult Run, Colvin Run and Captain Hickory Run.

The *Stream Protection Strategy Baseline Study* (SPS) conducted by Fairfax County focused on biological and habitat data in all Fairfax County watersheds and in 19 sites in Difficult Run. Each site was given a composite site condition rating based on an index of biotic integrity (IBI), habitat assessment, fish taxa richness and imperviousness. The ratings used were Very Poor, Poor, Fair, Good and Excellent. The ratings indicate divergence from reference, or the best possible conditions.

The only site in the Difficult Run watershed to receive a composite rating of “Excellent” was located in Captain Hickory Run. Sites in Rocky Run, Difficult Run at the very downstream end as well as just before its confluence with Little Difficult Run, and the south fork of Rocky Branch all received “Good” composite site ratings. Sites with “Very Poor” composite ratings include Snakeden Branch along its mainstem, Piney Branch, and Wolftrap Creek just before its confluence with Difficult Run. All other sites within the Rocky Run subwatershed were in the “Fair” to “Poor” categories.

Similar changes between the 1976 assessment and the 2001 assessment can be seen across all categories – with sites characterized as “Poor” in the 1976 assessment remaining “Poor” or degrading to “Very Poor” in the 2001 assessment. Although direct comparisons between 1976 and 2001 ratings are difficult to make given the different methods of evaluation, a general trend of decreasing quality is apparent.

The 2001 study showed that fish community assemblages at sampling sites in the Difficult Run Watershed were found to be more diverse than many of the other watersheds in the County probably due to the large size of the watershed, rather than as a representation of its health. Twenty-nine fish species were found throughout the watershed. The five most commonly found species were the Blacknose Dace, Creek Chub, Tessellated Darter, White Sucker and American Eel. With the exception of the American Eel, these same species were found in the 1976 study and also noted in a 1915 survey by McAtee and Weed. The American Eel was not sampled in the 1976 study but was noted as “probably present, but just missed.” In both the 1976 baseline study and the McAtee and Weed 1915 survey, a population of brook trout was found in the upper part of Difficult Run and at several other locations in the watershed in the 1976 study. This population was believed to be unstocked and naturally reproducing due to their small size and lack of stocking records. There were no trout found at any of the sampling locations in the SPS Baseline Study.

Benthic macroinvertebrate taxa richness varied throughout the watershed, indicating the range of stream health from Very Poor to Excellent. Scores ranged from three taxa in Snakeden Branch to 18 taxa in the South Fork of Rocky Branch. Only four samples were comparable to diversities found in reference sites. Species that are tolerant of poor water quality or degraded habitat, such as aquatic worms, dominated most communities.

Subwatersheds in the Difficult Run watershed encompass all management categories established by the SPS Baseline Study. The subwatersheds and their categories are shown below in Table 2.12. Streams in the Watershed Protection management category are in good health, so the primary goal is to preserve their biological diversity. Watershed Restoration Level I areas are characterized as having Fair biological conditions but have the potential for significant enhancement, so the primary goal in these watersheds is to re-establish healthy biological communities.

Watershed Restoration Level II subwatersheds are categorized as having high levels of development and significantly degraded instream habitat, so the goal for these areas is to prevent further degradation and improve water quality. This level includes the entire mainstem of Difficult Run. Although there are several sampling sites along the downstream portions of mainstem Difficult Run that rank as Good or Fair, the impact of the tributaries to Difficult Run should not be underestimated. Finally, tributaries designated as Assessment Priority Areas,or portions of subwatersheds, that were not assessed during the 2001 baseline study, and therefore no management category was assigned.

Table 2.12: Stream Protection Strategy Management Categories

Subwatershed	Management Category
Angelico Branch	Watershed Restoration Level I and Assessment Priority
Captain Hickory Run	Watershed Protection
Colvin Run	Watershed Restoration Level II
Difficult Run (Lower)	Watershed Restoration Level II and Assessment Priority
Difficult Run (Middle)	Watershed Restoration Level II and Assessment Priority
Difficult Run (Upper)	Watershed Restoration Level II
Dog Run	Watershed Restoration Level I
The Glade	Watershed Restoration Level I and Assessment Priority
Little Difficult Run	Watershed Restoration Level I and II
Old Courthouse Spring Branch	Watershed Restoration Level II
Piney Branch	Watershed Restoration Level II
Piney Run	Watershed Restoration Level I
Rocky Branch	Watershed Restoration Level I and Watershed Protection
Rocky Run	Watershed Protection
Snakeden Branch	Watershed Restoration Level II
South Fork Run	Watershed Restoration Level II
Sharpers Run	Watershed Protection
Wolftrap Creek	Watershed Restoration Level II

2.7.1 Stream Habitat

To supplement the biological and habitat data collected by the SPS baseline study, beginning in the fall of 2002, field crews conducted a detailed Stream Physical Assessment (SPA) of all watersheds in Fairfax County. The Difficult Run Watershed was assessed between October 31, 2002 and January 9, 2003. As part of the SPA, field crews conducted a physical habitat assessment, a geomorphologic assessment and collected infrastructure information for all streams within the watershed. Of the 145 miles of stream within the watershed, 130 miles were assessed and received habitat scores. Instream ponds, **wetlands**, piped stream segments, and reaches that exhibited dangerous conditions for field crews comprise the 15 miles that were not assessed.

The habitat assessment protocol uses 10 habitat assessment parameters with scores ranging from zero to 20. A description of each habitat parameter used in the habitat assessment can be found in Table 3.2 in the Stream Habitat and Water Quality subsection 3.2.5.

Each stream reach was assigned a habitat assessment category. Of the 130 miles of stream assessed, 48 percent (62 miles) was assessed as fair, 34 percent (44 miles) as Poor, 16 percent (21 miles) as Good, 1 percent (2 miles) as Very Poor and less than 1 percent (1 mile) as Excellent. A location of reaches in each of these categories is shown on Map 2.6. The results of the habitat assessment indicate that only a very small percent of streams in the Difficult Run watershed exhibit the highest level of habitat quality. Likewise very few streams have the worst quality. Results for each subwatershed are presented in Table 2.13.

Table 2.13: Habitat Assessment Summary (miles and percent* of total)

Subwatershed	Very Poor	Poor	Fair	Good	Excellent
Angelico Branch	0.00 (0.00)	0.49 (0.38)	1.22 (0.94)	0.00 (0.00)	0.00 (0.00)
Captain Hickory Run	0.00 (0.00)	4.87 (3.75)	1.29 (0.99)	0.28 (0.21)	0.00 (0.00)
Colvin Run	0.29 (0.23)	2.96 (2.28)	8.88 (6.85)	0.63 (0.49)	0.00 (0.00)
Difficult Run (Lower)	0.23 (0.17)	2.91 (2.24)	2.51 (1.94)	0.33 (0.26)	0.00 (0.00)
Difficult Run (Middle)	0.00 (0.00)	1.03 (0.79)	4.97 (3.83)	0.00 (0.00)	0.00 (0.00)
Difficult Run (Upper)	0.43 (0.33)	13.43 (10.36)	7.10 (5.48)	0.56 (0.43)	0.00 (0.00)
Dog Run	0.00 (0.00)	2.07 (1.60)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
The Glade	0.00 (0.00)	0.69 (0.53)	2.69 (2.07)	0.00 (0.00)	0.30 (0.24)
Little Difficult Run	0.00 (0.00)	1.90 (1.47)	5.52 (4.26)	2.72 (2.10)	0.00 (0.00)
Old Courthouse Spring Branch	0.00 (0.00)	0.00 (0.00)	0.35 (0.27)	2.46 (1.90)	0.00 (0.00)
Piney Branch	0.00 (0.00)	0.00 (0.00)	4.84 (3.73)	2.34 (1.80)	0.00 (0.00)
Piney Run	0.59 (0.46)	5.11 (3.94)	2.27 (1.75)	0.00 (0.00)	0.00 (0.00)
Rocky Branch	0.00 (0.00)	5.19 (4.00)	3.38 (2.61)	0.20 (0.15)	0.00 (0.00)
Rocky Run	0.00 (0.00)	1.04 (0.80)	2.03 (1.56)	2.97 (2.29)	0.00 (0.00)
Sharpers Run	0.00 (0.00)	0.00 (0.00)	1.55 (1.20)	0.00 (0.00)	0.00 (0.00)
Snakeden Branch	0.40 (0.30)	1.21 (0.93)	4.76 (3.67)	0.19 (0.14)	0.00 (0.00)
South Fork Run	0.00 (0.00)	0.00 (0.00)	5.87 (4.53)	0.96 (0.73)	0.00 (0.00)
Wolftrap Creek	0.00 (0.00)	1.35 (1.04)	2.43 (1.88)	7.48 (5.77)	0.40 (0.31)
Total	1.93 (1.49)	44.23 (34.12)	61.66 (47.56)	21.11 (16.28)	0.71 (0.55)

*percentages out of total assessed length

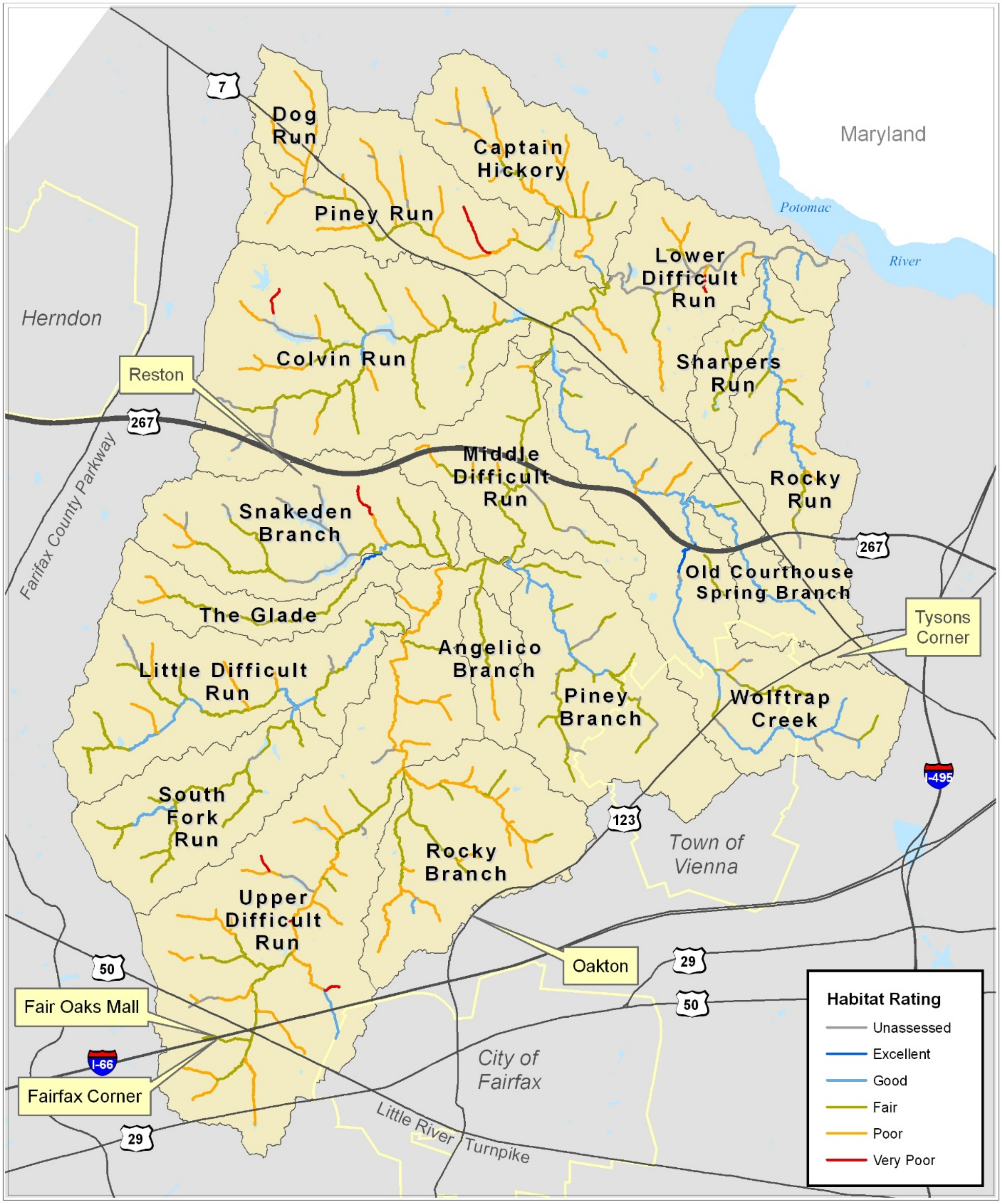
2.7.2 Stream Geomorphology

Geomorphology describes how a stream channel adjusts to changes in its watershed. In an undeveloped natural setting, the adjustment is a slow erosive process forming a dynamically stable channel. The size and shape of the stream channel are dependent on the type of soils, the steepness of the grade and the amount of water that flows into the channel. If one of these conditions is changed, the channel will adjust itself to accommodate the new conditions and find a new stable size and shape.

The geomorphologic assessment of the stream channels in the Difficult Run Watershed is based on the **Channel Evolution Model (CEM)** (Schumm et al. 1984), which gives insight into how stream channels change after a disturbance, such as a change in watershed land use. The Channel Evolution Model can act as a useful predictor of future conditions. A brief description of the channel types is presented here. See the Geomorphology subsection under section 3.1.6 for a complete description and diagram of the Channel Evolution Model methodology and types, and Map 2.7 for a map of the distribution of channel types within the watershed.

Type I – Pre-disturbance, stable
Type II – Bed degradation, downcutting
Type III – Bank failure, widening, most unstable
Type IV – Channel aggradation, beginning stabilization
Type V – Stable channel, similar to pre-disturbance

Sixty-four percent of the stream reaches within the Difficult Run watershed are characterized as CEM Type III, the most unstable of all CEM stages. These reaches are characterized by by unstable stream banks and increased **sediment** in the stream, especially during high flows. Results are located in Table 2.14.

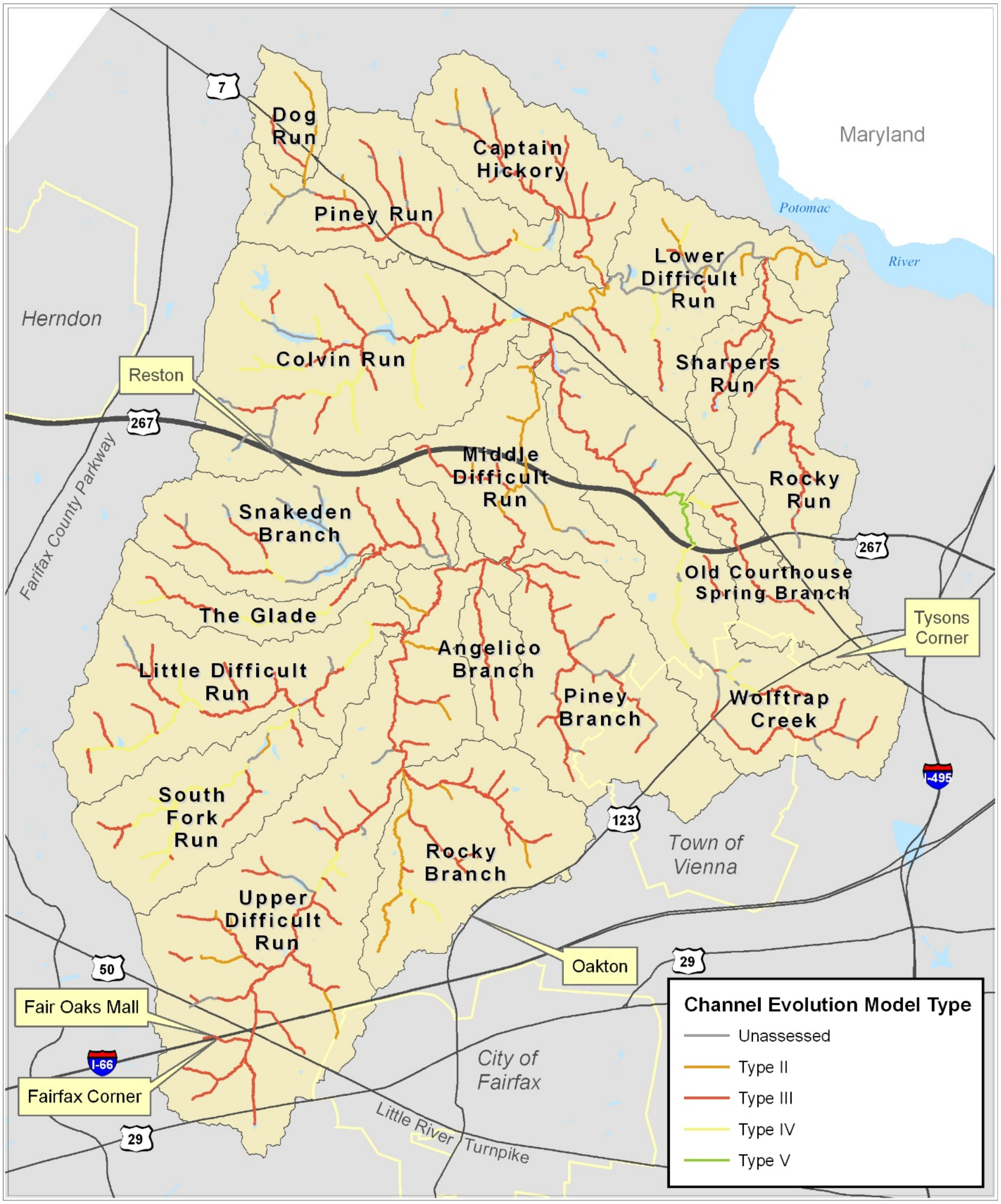


Difficult Run Watershed

0 0.5 1 2 Miles

Habitat Assessment

Map 2.6



Difficult Run Watershed

0 0.5 1 2 Miles

N

Channel Evolution Model **Map 2.7**

Table 2.14: CEM Results by Subwatershed (miles and percent* of total)

Subwatershed	Type I	Type II	Type III	Type IV	Type V
Angelico Branch	0.00 (0.00)	0.00 (0.00)	1.71 (1.34)	0.00 (0.00)	0.00 (0.00)
Captain Hickory Run	0.00 (0.00)	0.51 (0.40)	5.92 (4.65)	0.00 (0.00)	0.00 (0.00)
Colvin Run	0.00 (0.00)	0.00 (0.00)	8.05 (6.32)	4.71 (3.70)	0.00 (0.00)
Difficult Run (Lower)	0.00 (0.00)	3.36 (2.64)	2.59 (2.03)	0.84 (0.66)	0.00 (0.00)
Difficult Run (Middle)	0.00 (0.00)	2.96 (2.33)	3.03 (2.38)	0.00 (0.00)	0.00 (0.00)
Difficult Run (Upper)	0.00 (0.00)	2.52 (1.98)	18.08 (14.20)	0.91 (0.71)	0.00 (0.00)
Dog Run	0.00 (0.00)	1.32 (1.03)	0.75 (0.59)	0.00 (0.00)	0.00 (0.00)
The Glade	0.00 (0.00)	0.00 (0.00)	1.96 (1.54)	1.72 (1.35)	0.00 (0.00)
Little Difficult Run	0.00 (0.00)	0.00 (0.00)	6.93 (5.44)	3.21 (2.52)	0.00 (0.00)
Old Courthouse Spring Branch	0.00 (0.00)	0.00 (0.00)	2.32 (1.83)	0.49 (0.39)	0.00 (0.00)
Piney Branch	0.00 (0.00)	0.00 (0.00)	6.54 (5.14)	0.00 (0.00)	0.00 (0.00)
Piney Run	0.00 (0.00)	0.61 (0.48)	5.86 (4.60)	0.37 (0.29)	0.00 (0.00)
Rocky Branch	0.00 (0.00)	3.25 (2.55)	4.90 (3.85)	0.62 (0.49)	0.00 (0.00)
Rocky Run	0.00 (0.00)	0.00 (0.00)	6.04 (4.75)	0.00 (0.00)	0.00 (0.00)
Sharpers Run	0.00 (0.00)	0.00 (0.00)	1.55 (1.22)	0.00 (0.00)	0.00 (0.00)
Snakeden Branch	0.00 (0.00)	0.00 (0.00)	5.61 (4.40)	0.35 (0.28)	0.00 (0.00)
South Fork Run	0.00 (0.00)	0.24 (0.19)	2.29 (1.80)	4.29 (3.37)	0.00 (0.00)
Wolftrap Creek	0.00 (0.00)	0.00 (0.00)	8.20 (6.44)	1.76 (1.38)	0.94 (0.74)
Total	0.00 (0.00)	14.76 (11.60)	92.34 (72.53)	19.28 (15.14)	0.94 (0.74)

*percentages out of total assessed length

2.7.3 Infrastructure Inventory

The infrastructure inventory conducted by field crews for the 2002 SPA study includes all structures and conditions that may have potential impacts on the stream, such as sources of contamination or pipes, ditches, stream obstructions, dump sites, head cuts, utilities, erosion problem areas, stream crossings, and areas of deficient **buffer**. With the exception of utilities, which are rated on a scale of 20, all infrastructure points are rated on a scale of zero to 10 based on their perceived impact on stream integrity. The zero to 10 scale corresponds to None (0) to Severe (10) impact. A description of the type of data collected as part of the infrastructure inventory and impact descriptions are included in the Stream Habitat and Water Quality subsection of Section 3.2.5.

The section below discusses the two most significant infrastructure impacts found across the entire Difficult Run watershed.

Riparian Buffers - A riparian buffer is land next to a stream or river that is vegetated, usually with trees and shrubs. Buffers are complex **ecosystems** that improve streams by supplying food and habitat for fish and other wildlife, especially birds. Forest cover is important for a healthy stream system. The forest canopy provides shade, which cools the water, allowing more dissolved oxygen to be present for fish and invertebrates. Many aquatic animals, fish especially, are very sensitive to temperature changes and will leave an area once the average temperature becomes too elevated.

The root systems hold soils together, which provides for greater streambank stability. The vegetation and fallen leaves help to slow overland flow and reduce soil erosion. Nutrients are taken up by the vegetation that might otherwise enter the stream system. Aquatic habitat is dependent on the input of large and small woody debris and stream bank root mat. Woody material and leafy debris provide food sources and instream habitat for **benthic macroinvertebrates** and fish.

Buffers help protect streams as a line of defense from the effects of urban growth by stabilizing stream banks, reducing nonpoint source pollution, and filtering out harmful **nutrients** and sediment. A complete description of the methods used to assess riparian buffers is found in Section 3.2.5.

There were three locations in the Difficult Run watershed where the effect of a deficient buffer was an obvious source of degradation for the stream. The impacts of an additional 106 sites were considered severe or greater, indicating only turf or impervious cover within 25 feet of the stream bank. Within the watershed there are 85 miles of streambank that were considered to have deficient buffer (note that this total is the left and right bank combined). Sixty-nine percent (59 miles) of these deficient areas were areas where the buffer was replaced by residential lawns.

Erosion/Sedimentation – A stable stream channel provides high quality habitat for amphibians, aquatic insects, and fish. Stable instream habitat may be lost when excessive sediment from unstable and eroding banks accumulates in the channel, covering living spaces and filling in pools. Riparian vegetation, including large trees, may be lost due to eroding banks. A complete description of the methods used to assess erosion and **sedimentation** is found in Section 3.2.5.

Earlier studies noted that bank erosion was a major problem in Difficult Run (PBQD 1976). Erosion and sedimentation problems continue today. In the Stream Physical Assessment there were 144 areas of erosion in the Difficult Run watershed noted by field crews. The total linear length (both banks combined) of this erosion is 18 miles with 12 miles having an impact score of severe (score of 7) or higher. This indicates that the erosion is generally 5 feet or greater in height and causing obvious instream degradation.

This addition of sediment from stream banks combined with additional sediment from overland runoff leads to an unstable substrate that is unsuitable for aquatic habitat. Fine sediment will fill in pools, create islands and point bars, and decrease the amount of available living spaces. The substrate material in half of the total stream length within the watershed is considered to be 50 percent or greater embedded. This means that silt and sediment are surrounding more than 50 percent of the available substrate living space.

2.7.4 Water Quality

303(d) List and Total Maximum Daily Loads (TMDL) -- The segment of Difficult Run between the confluence with Captain Hickory Run and the Potomac River has been placed on the 303(d) list for two impairments: benthic (bottom-dwelling) community and fecal coliform bacteria. The 303(d) list is the report Virginia prepares for the US EPA to describe waters that do not meet the Clean Water Act fishable and swimmable water quality standards.

The Virginia Department of Environmental Quality (VDEQ) maintains a water quality monitoring station (1ADIF000.86) at the Route 193 bridge. Biological monitoring at this station was used to determine that the benthic community in the stream is moderately impaired. As a result, this segment was assessed as not supporting the Aquatic Life Use goal ("fishable") for the 2004 water quality assessment. This segment was first listed for an aquatic life use impairment in the 1994 303(d) report.

Sufficient exceedances of the instantaneous fecal coliform bacteria and *E. coli* bacteria criterion were recorded at the Route 193 bridge station to assess this stream segment as not supporting of the Recreation Use goal ("swimmable") for the 2004 water quality assessment. The recreation use impairment was added to this segment in 2004.

Once a waterbody has been listed as impaired, a Total Maximum Daily Load (TMDL) report identifying the sources causing the water quality problem and the reductions needed to resolve it must be developed and submitted to the United States Environmental Protection Agency (EPA) for approval. Upon approval, VDEQ must develop a TMDL Implementation Plan to restore water quality. A TMDL is scheduled to be developed for the aquatic life impairment by 2010 and a TMDL to address the recreation use impairment may extend to 2016.

Fairfax County Sampling --The Fairfax Department of Heath's Division of Environmental Health initiated the Stream Water Quality Program in the fall of 1969. Since 1969, the Division of Environmental Health (now the Fairfax County Health Department) has been sampling the waterways throughout Fairfax County, adding parameters to be sampled examined as the sampling technology is introduced. The most recent report (2002) includes data collected from 84 sampling sites in 25 watersheds in Fairfax County. At the time of the report there were 10 sampling sites in the Difficult Run Watershed. In 2003, the bacteria monitoring program was transferred to the Stormwater Planning Division. The program continues today, amended slightly from its original scope with the Health Department.

In 2003, VDEQ set geometric mean limits for bacteria for all surface waters except shellfish waters as follows:

- 200 fecal coliform bacteria per 100 ml of water for two or more samples over a calendar month
- no more than 10 percent of the total samples taken during any calendar month can exceed 400 fecal coliform bacteria per 100 ml of water

These are the limits above which the water body is considered unsuitable for body contact recreation such as swimming. Seventy-six percent of the 138 total samples (55 percent) evaluated for fecal coliform concentrations in the Difficult Run watershed had levels that exceeded one of these limits.

Other parameters tested by the Health Department appeared to be less of an immediate concern. All samples tested for nitrate nitrogen, phosphorus, and **dissolved oxygen** fell within acceptable levels. Additionally, there were only four individual samples (2 percent) that were outside the desired pH range of 6.0 to 8.5. The pH for these four samples ranged from 5.0 to 5.8. All four were collected during the winter months. Three of these samples were collected at a site located on a downstream reach of Captain Hickory Run and one was from a site at a downstream reach of mainstem Difficult Run near its confluence with Rocky Run.

2.7.5 Wetlands

There are 2,255 acres of wetlands in the Difficult Run watershed, based on National Wetland Inventory (NWI) mapping. This represents 6 percent of the total watershed area. Of these. 1,208 acres, or approximately half the total, are in the three subwatersheds that make up the mainstem, Upper Difficult Run, Middle Difficult Run, and Lower Difficult Run.

The majority (78 percent) of the wetlands in the watershed are Palustrine, which include all non-tidal freshwater wetlands that are both lacking vegetation or dominated by trees, shrubs, herbaceous plants, or other vegetation. Palustrine wetlands are found throughout the watershed. There are six classes of Palustrine wetlands in Difficult Run. The most common is Forested Wetland, where woody vegetation such as trees are the predominant vegetation. Seventy-two percent of the Palustrine wetlands are forested. This class covers 1,277 acres or 57 percent of all the wetlands in Difficult Run.

Other classes of Palustrine wetlands found in the watershed include Emergent (216 acres / 10 percent), Unconsolidated Bottom or Shore (188 acres / 8 percent), Scrub-Shrub (88 acres, 4 percent), and Aquatic Bed (0.3 acres or 0 percent).

Riverine wetlands include wetlands and deepwater habitats contained within a channel. Water is usually flowing in a riverine system. The Upper Perennial wetlands found in Difficult Run are steep streams with fast flowing water, with rock, cobble, or gravel substrate. Approximately 350 acres of this type (16 percent of the total) are found in Lower Difficult Run where the mainstem descends to the Potomac River.

Lacustrine wetlands are habitats associated with impounded water. In Difficult Run, these wetlands consist of 136 acres (6 percent of the total) of lake habitat in Colvin Run and Snakeden Branch consisting of Lake Anne, Lake Fairfax, Lake Thoreau, and Lake Audubon. They are further classified as Limnetic wetlands, which are all deepwater habitat, and the detailed classification describes them as man-made lakes.

Other lakes and ponds in the watershed, including Lake Newport, are classified as Palustrine - Unconsolidated Bottom - Flooded, because they are smaller than 20 acres.

Table 2.15 shows the distribution of mapped wetlands in the Difficult Run subwatershed, in acres.

Table 2.15: Wetlands in Difficult Run (Acres)

	Lacustrine Limnetic	Palustrine Aquatic Bed	Palustrine Emergent	Palustrine Forested	Palustrine Scrub-Shrub	Palustrine Unconsolidated Bottom	Palustrine Unconsolidated Shoreline	Riverine Upper Perennial	
Subwatershed	L1U	PAB	PEM	PFO	PSS	PUB	PUS	R3R	Total
Angelico Branch				0.5		0.2			0.7
Captain Hickory Run			3.2	40.3	1.1	7.5			52.1
Colvin Run	49.7		2.5	80.3		28.5			160.9
Dog Run			0.3	11.2		3.6			15.1

	Lacustrine Limnetic	Palustrine Aquatic Bed	Palustrine Emergent	Palustrine Forested	Palustrine Scrub-Shrub	Palustrine Unconsolidated Bottom	Palustrine Unconsolidated Shoreline	Riverine Upper Perennial	
Subwatershed	L1U	PAB	PEM	PFO	PSS	PUB	PUS	R3R	Total
Little Difficult Run			10.2	120.7	14.3	6.6			151.8
Lower Difficult Run			45.3	199.8		20.0		349.8	615.0
Middle Difficult Run			64.9	130.9	15.4	9.7	0.2		221.2
Old Courthouse Spring Branch				28.7		1.1			29.8
Piney Branch			11.8	50.8	14.7	1.3			78.7
Piney Run			23.1	55.8	13.7	19.0	1.0		112.6
Rocky Branch		0.3	6.3	42.7	1.4	8.8			59.5
Rocky Run			0.4	1.9	0.3	6.4			8.9
Sharpers Run				1.9		5.6			7.5
Snakeden Branch	86.9		0.4	35.0		3.4			125.7
South Fork Run			1.5	56.2		10.0			67.7
The Glade			2.6	30.5	0.6	0.7			34.5
Upper Difficult Run			9.8	302.2	23.2	36.7			372.0
Wolftrap Creek			34.0	87.2	3.1	13.1	4.4		141.8
Total	136.6	0.3	216.3	1,276.7	88.0	182.2	5.6	349.8	2,255.4

2.8 Terrestrial Environment

2.8.1 Forest Resources

Temperate forests once dominated Fairfax County. In the late 1800s, Fairfax County had a viable forest industry and was a source of timber for urban areas such as Washington D.C. As the County developed in the early part of the 20th century forest cover slowly decreased. The Virginia Department of Forestry reports that foresst occupied 62 percent of the landscape in Virginia. These forest resources provide both economic benefits such as tourism and a broad range of ecological benefits. In the 1970s, the awareness of water quality problems helped spur the conservation of forests, including riparian buffers as **best management practices**. In 1993, stormwater management requirements were established Countywide and **perennial stream** corridors shown on USGS quadrangle maps were designated **Resource Protection Areas (RPAs)** through the County's Chesapeake Bay Preservation Ordinance (CBPO). In 2003, the CBPO was amended to include previously undesignated perennial streams..

In the mid 1970s the forest environment in the Difficult Run watershed was 14,360 acres, close to 40 percent of the watershed. Of the various types of forest, the upland hardwood forest was dominant, making up 22 percent of the forest cover, found primarily in the undeveloped portions of the watershed. Typical native species in this community include oak, hickory, beech and maple. Other typical vegetation types include mixed upland hardwood forest with the addition of Virginia pine and mixed softwood forest which includes hickory, oak and tulip poplar. The stream valleys and lowlands are characterized by floodplain habitat and **marshes** on alluvial soils. The most common species in these habitats include willow, red maple, tulip poplar, sycamore and ash species.

Forests provide many benefits for aquatic systems, described earlier under **riparian buffers**. Forest cover also provides habitat for terrestrial fauna. However, to provide adequate habitat, various species require forest of certain size and spatial distribution. Today, open space occupies only 20 percent of the watershed, primarily along stream corridors. Roadways and development have effectively fragmented much of the remaining forest, compromising its ability to provide viable habitat. Stream corridors provide some connection between forest cover however upland forest cover does not have direct connectivity in most parts of the watershed.

2.8.2 Terrestrial Flora and Fauna

The Virginia Department of Conservation and Recreation's (DCR) Natural Heritage Program maintains a statewide biological inventory database of rare, threatened, or endangered (RTE) species or those that deserve special protection within the Commonwealth of Virginia. The most recent list (2004) of those found in Fairfax County are shown in Table 2.16 below with their DCR Natural Heritage Program rank definitions. Note that their presence or absence in the Difficult Run watershed is not known.

2.8.3 Potomac Gorge

Difficult Run flows to the Potomac in the Potomac Gorge—the 15-mile section of the Potomac River from above Great Falls south to Theodore Roosevelt Island. The Potomac Gorge serves as an unusual meeting place for species from different places and altitudes. The effect is 15 globally-rare species, 100 state-rare species, and 30 different vegetation communities existing within the Gorge, resulting in one of the highest concentrations of globally rare natural communities in the nation.

In June, 2006, The Nature Conservancy and the National Park Service; conducted a "BioBlitz" on national park land throughout the Potomac River Gorge, an effort to see how many species they could find during a 30-hour survey period. Their surveys revealed more than 1,000 species, including:

- A beetle (Strongylium crenatum), new to Virginia, found in Turkey Run and Great Falls for the first time;
- The first record of a fly (Scatophila carinata), which has never before been found east of Iowa;
- Two plants (black birch and Deschampsia flexuosa) in Great Falls Park that had not been collected since around 1880, both of which are montane species and usually found west in the Appalachians;
- Two rare land snails – a tiny snail (Punctum smithi) and a semi-aquatic snail (Potomapsis lapideria);
- And two new seeps in the Gorge with two globally rare species, Pizzini's amphipod (a crustacean) and Appalachian spring snail (a mollusk).

The Gorge harbors more than 1,400 distinct plant species and is a rugged haven for wildlife ranging from unique invertebrates to American shad and bald eagles.

Table 2.16: Fairfax County Rare, Threatened, and Endangered Species

Species	State Rank	Federal Status	State Status	Last Year Observed
BIRDS				
Common Moorhen, *(Gallinula chloropus)*	S1B, S1N		SC	1987
Bald Eagle, *(Haliaeetus leucocephalus)*	S2S3B, S3N	LT	LT	2002
Yellow-crowned Night-heron, *(Nyctanassa violacea)*	S2B, S3N		SC	1993
BIVALVIA (MUSSELS)				
Yellow Lance, *(Elliptio lanceolata)*	S2S3	SOC	SC	1997
CRUSTACEA (AMPHIPODS, ISOPODS & DECAPODS)				
Rock Creek Groundwater Amphipod, *(Stygobromus kenki)*	SH	SOC		1973
Northern Virginia Well Amphipod, *(Stygobromus phreaticus)*	S1	SOC		2003
Pizzini's Amphipod, *(Stygobromus pizzinii)*	S1S2		SC	1995
A Groundwater Amphipod, *(Stygobromus sp. 15)*	S1	SOC		1995
REPTILES				
Wood Turtle, *(Glyptemys insculpta)*	S2		LT	2003
VASCULAR PLANTS				
Yellow Nailwort, *(Paronychia virginica var. virginica)*	S1	SOC		1887
Blue Scorpion-weed, *(Phacelia covillei)*	S1	SOC		1993
Torrey's Mountain-mint, *(Pycnanthemum torrei)*	S2?	SOC		2002
Virginia Mallow, *(Sida hermaphrodita)*	S1	SOC		1979

State Rank:

- **S1** - Extremely rare; usually 5 or fewer populations or occurrences in the state; or may be a few remaining individuals; often especially vulnerable to extirpation.
- **S2** - Very rare; usually between 5 and 20 populations or occurrences; or with many individuals in fewer occurrences; often susceptible to becoming extirpated.
- **S3** - Rare to uncommon; usually between 20 and 100 populations or occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.
- **S#B** - Breeding status of an organism within the state.
- **SH** - Historically known from the state, but not verified for an extended period, usually > 15 years; this rank is used primarily when inventory has been attempted recently.
- **S#N** - Non-breeding status within the state. Usually applied to winter resident species

Federal Rank:

- **LT** - Listed Threatened
- **SOC** - Species of Concern species that merit special concern (not a regulatory category)

State Rank:

- **LT** - Listed Threatened
- **SC** - Special Concern - animals that merit special concern according to VDGIF (not a regulatory category)

2.9 Stormwater Management

2.9.1 Stormwater Management Background

Stormwater management (SWM) facilities are a part of the storm drain system designed to reduce the harmful effects of increased stormwater flows and pollution. They can be built as on-site SWM facilities, treating a single development site, or regional facilities, designed for larger areas of typically 100 to 300 acres. In 1974, Fairfax County adopted regulations requiring on-site SWM controls to reduce peak flows from new development. The regulations were extended to manage runoff water quality in 1993.

In 1989, the County adopted a Regional Stormwater Management Plan, which included 134 sites for pond construction, most of which were in the Cub Run and Difficult Run watersheds. Sixty-three regional ponds were planned for eventual construction in Difficult Run; however, only 10 were constructed.

Benefits from regional SWM facilities include:

- Generally higher pollution removal efficiencies than on-site SWM
- Regional ponds are generally less expensive to construct and maintain than a series of on-site ponds. The major factor is simply the difference in the number of ponds that need to be designed, constructed and maintained for the same level of treatment. More on-site facilities will also require more linear feet of access roads.
- In a system with multiple drainage areas the regional ponds can be sited and designed to work together as a system to control downstream flows and mimic that of an undeveloped area.
- Because regional ponds are further downstream and treat large drainage areas, they have the advantage of being able to control previously uncontrolled runoff from development built before on-site controls were required.
- Regional ponds can create open water and emergent wetland habitat if so designed.

Drawbacks of regional SWM facilities include:

- Stormwater runoff that enters streams upstream of regional ponds is not treated. These upstream reaches are subjected to erosive flows and pollutants.
- Siting and construction of regional ponds may incur habitat loss. Regional ponds typically have a large footprint and can disturb wetlands.
- When sited in stream channels or along relatively large tributaries, regional ponds can impede fish passage and interrupt wildlife movement along stream corridors.

In 2002, a multi-agency committee was tasked with developing a unified position on the use of regional ponds. The review was spurred by new development in technologies in stormwater management, the condition of the County's streams, which was highlighted by the Stream Protection Strategy published in 2001, and the Chesapeake Bay 2000 agreement. The study was completed in March of 2003 as *The Role of Regional Ponds In Fairfax County's Watershed Management* (ECC 2003). The review analyzed the current regional pond program in the context of categories such as ecology, economics, regulations, land use, public safety, design and construction. The subcommittee made many recommendations and offered an "ideal" stormwater program.

The study found that the regional pond program had not been rigorously implemented. Insufficient funding had been a major issue, resulting in only 48 out of 150 ponds being constructed as of 2005. The construction of regional ponds had also been delayed due to residents' concerns regarding tree loss, safety issues, and aesthetics. In areas where the proposed regional ponds were not constructed, downstream impacts remained untreated.

Land use conditions in the County show that watersheds with planned but unbuilt regional ponds are now largely developed: drainage areas to 97 unconstructed pond sites have an average of 14 percent vacant land, meaning that 86 percent of the contributing area is developed.

Recommendations provided in the regional pond report are too extensive to be fully addressed in this plan. The key elements are:

- Regional ponds should not be considered the preferred alternative but just one of many stormwater management techniques
- The watershed management plans include recommendations for alternative stormwater management practices
- Land use decisions need to be considered in tandem with stormwater management decisions
- Appropriate funding should be made available to accomplish the recommendations.

Specifically, the report recommended that where regional facilities were planned, temporary on-site facilities be constructed until final controls are in place. Conditions should be set on Stormwater Management waivers to offset the impacts of deferring or reducing stormwater management with waivers and to ensure that they are in line with watershed management plans. Finally that when regional ponds are necessary they be designed in such a way that the impacts of the pond are minimized.

2.10 Existing and Future Watershed Modeling

Hydrologic, hydraulic and water quality models were created for the Difficult Run Watershed to evaluate the existing conditions, including best management practices, pollution, and flooding, to determine the future impactsof land development, and to assess watershed restoration measuressuch as storm water management alternatives. The models have been designed show how different proposed alternatives affect specific hydrologic and water quality parameters. The County provided the *Technical Memorandum No. 3, Stormwater Model and GIS Interface Guidelines*, June 2003, to help the process of developing the models. Appendix E describes the modeling procedure in more detail.

2.10.1 Hydrologic Modeling

PC-SWMM was used to model hydrology (rainfall to runoff calculations) and runoff quality. A number of input parameters were measured or derived as follows:

Catchments Catchments are the smallest drainage area modeled. The watershed was delineated into 201 catchments for the hydrologic model, the average size being approximately 185 acres. Delineation was done to capture all runoff draining to regional pond sites (whether built or unbuilt), tributary confluences, and road crossings.

These catchments were further divided based on the existing stormwater management and other Best Managment Practice (BMP) facilities.

Imperviousness The existing impervious cover for the hydrologic model was measured directly using the GIS layers of major and minor roads, buildings, parking lots, and sidewalks. The area of the driveways was estimated per residential land use and added to the total impervious area result. The future imperviousness was estimated based on current land use and changes to the land use using the County's comprehensive plan. The average imperviousness over all existing land uses in the Difficult Run Watershed is about 18 percent. No additional imperviousness was modeled in the residential development of the future model other than those parcels that are predicted to change.

Land Use The main purpose of land use input is to develop the pollutant load factors governing water quality modeling. It is also used to estimate imperviousness for future conditions.

Soils Soils mapping was used to develop infiltration parameters that the model uses to determine how much rainfall percolates into the soil and how much runs off and enters the stream network. Soils data also provided information to estimate groundwater characteristics.

Stormwater Management SWM facilities were modeled, either as quantity controls or water quality treatment. In lieu of complete information on location, size, and type of SWM facilities, they were modeled under the assumption that parcels developed between 1972 and 1993 were managed for peak flow from the 2- and 10-year storms, and parcels developed after 1993 were managed for both peak flows and water quality improvements.

2.10.2 Hydraulic Modeling

Two models were used for hydraulic modeling. SWMM was used to develop flow rates for all the stream reaches in the watershed. HEC-RAS, a widely used hydraulic model developed by the US Army Corps of Engineers, was used as a steady-state model to find floodplains for the 100-year storm, showing flood potential for road crossings. It was also used to find velocity and shear stress for the 1- and 2-year storms, which gives an estimate of stream erosion potential.

The hydraulic model includes roughly 145 miles of stream with 80 crossings over the tributaries and streams throughout the watershed. Some small streams and tributaries were not included in the hydraulic model. The stream profiles were developed from the five-foot contour layer and the orthographic photos. Stream culvert crossing data and low flow channel measurements were compiled from the field survey data.

2.10.3 Water Quality Modeling

The water quality model was used to evaluate the pollutant loading rate for 12 constituents: biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS), total phosphorus (TP), total Kjeldahl nitrogen (TKN), total nitrogen (TN), total cadmium (TCd), total copper (TCu), total lead (TPb), and total zinc (TZn) for all of the Difficult Run watershed. Limno-Tech, Inc suggested these constituents in the article *Development of SWMM Water Quality Model Inputs for Fairfax County, Virginia*, March 2004. The hydrologic model was run for one continuous year, the most recent average rainfall year of 2002, to obtain the annual pollutant loads in tons per year and the annual pollutant loadings in pounds per acre per year. This was done for the existing and the future conditions as well as each of the proposed alternatives.

Nitrogen, phosphorus, and suspended solids are considered the three most detrimental pollutants to the Chesapeake Bay and its tributaries, so TN, TP, and TSS are the three constituents that were focused on in comparing results from the water quality model as well as in the evaluation of watershed improvements.

Both TN and TP promote algal growth in water bodies. Too much of either nutrient can lead to algae growth and subsequent removal of dissolved oxygen that causes eutrophication of the body of water. TSS in water comes from erosion of the land in disturbed or developed areas. Excess sediment in the water, in sufficient quantities, can block sunlight from reaching plants in the water, depriving them of their food source.

2.10.4 Model Results

Table 2.17 shows results of the hydrologic and water quality modeling, normalized by area, so that the subwatersheds can be compared directly. There is a correlation between the amount of development and the hydrologic results. Old Courthouse Spring Branch has the highest level of imperviousness and the highest runoff volume. Snakeden Branch, Wolftrap Creek, Colvin Run, and Piney Branch also show high runoff volume and high levels of imperviousness. The same five subwatersheds also have the highest peak flows.

Old Courthouse Spring Branch also shows up with the highest levels of TSS, TN, and TP from runoff. Wolftrap Creek, Colvin Run and Snakeden Branch also have high levels of these pollutants.

The best water quality is found in the few subwatersheds that are not developed at a high density: Lower Difficult Run, Angelico Branch, Little Difficult Run, and and Sharpers Run.

Table 2.17 Existing Conditions Watershed Model Results

Subwatershed	% Imperviousness	Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
Angelico Branch	10.5	2.1	1.6	19.1	1.0	0.2
Captain Hickory Run	11.1	2.1	1.2	24.5	1.2	0.2
Colvin Run	22.8	5.1	2.1	108.6	4.3	0.5
Upper Difficult Run	18.3	3.7	1.8	60.6	2.5	0.3
Middle Difficult Run	14.4	3.3	1.7	41.2	1.9	0.3
Lower Difficult Run	9.3	1.9	1.4	17.5	0.9	0.2
Dog Run	15.7	3.0	1.5	35.7	1.8	0.3
The Glade	16.1	3.3	1.6	45.5	2.3	0.4
Little Difficult Run	10.5	2.0	1.4	20.2	1.1	0.2
Old Courthouse	42.7	9.3	2.7	192.9	7.7	0.9
Piney Branch	22.8	4.6	2.1	73.7	3.6	0.6
Piney Run	16.3	3.2	1.6	48.8	2.1	0.3
Rocky Branch	17.4	3.4	1.6	47.9	2.3	0.4
Rocky Run	19.9	4.0	1.9	64.5	2.9	0.4
Snakeden Branch	27	6.1	2.1	126.5	5.0	0.7
South Fork Run	12.3	2.1	1.3	23.4	1.3	0.2
Sharpers Run	9.3	1.7	1.2	21.3	1.2	0.2
Wolftrap Creek	23.1	5.1	2.3	80.8	3.7	0.6