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Executive Summary

The *Difficult Run Watershed Management Plan* presents a strategy for improving and preserving the water resources and aquatic habitat in the watershed. The plan was initiated by Fairfax County with input from watershed residents as a response to the area's rapid growth and the associated impacts on the stream system.

The approach to developing the *Difficult Run Watershed Management Plan* has been threefold:

- Work with County staff, Steering Committee and other stakeholders to identify the goals, issues, and problems affecting the watershed.
- Synthesize information from stream assessments, monitoring studies, and watershed modeling to pinpoint the location and severity of watershed impairments.
- Conduct field surveys and other analysis to identify constraints and select potential improvements.
- Develop cost estimates then rank and select alternatives.

Background

The Difficult Run watershed is located in the Chesapeake Bay watershed in northern Virginia. Difficult Run drains 58.3 square miles in the north-central portion of Fairfax County and continues to the Potomac River. Development and population growth over the past century have transformed Fairfax County, and the Difficult Run watershed, into a bustling suburban community. Today the watershed, the largest of the County's 30 watersheds, is a varied mix of open space, residential communities, and commercial centers.

In the mid to late 1970s, an environmental baseline and subsequent master plan for flood control and drainage were completed for Difficult Run. The plans recommended immediate and future projects that would address sanitary sewer issues, stream stability, detention ponds, and flooding through the year 2000. In addition, the *Difficult Run Headwaters Land Use Study* was prepared by the Fairfax County Office of Comprehensive Planning in 1978 to analyze the watershed's ability to accept various residential densities and simultaneously maintain high-quality environmental standards. In the late 1980s, Fairfax County proposed the installation of regional ponds to control erosion and flooding in the western portion of the County, including Difficult Run.

More recently, the 2001 *Stream Protection Strategy Baseline Study* recommended County watersheds for protection, restoration and further study. Spurred by the SPS baseline recommendations, the Chesapeake Bay 2000 agreement, and advances in stormwater management technologies, the Stormwater Planning Division of the Fairfax County Department of Public Works and Environmental Services (DPWES) initiated the creation of watershed management plans for the County's 30 watersheds.

The *Difficult Run Watershed Management Plan* is a response to the watershed's rapid growth. The plan presents the issues affecting the quality of the watershed's streams and receiving waters, builds on previous management efforts, and presents a comprehensive strategy for mitigating and reducing the impacts of development.

Purpose

The *Difficult Run Watershed Management Plan* was developed with four broad goals underlying the process and results of the plan.

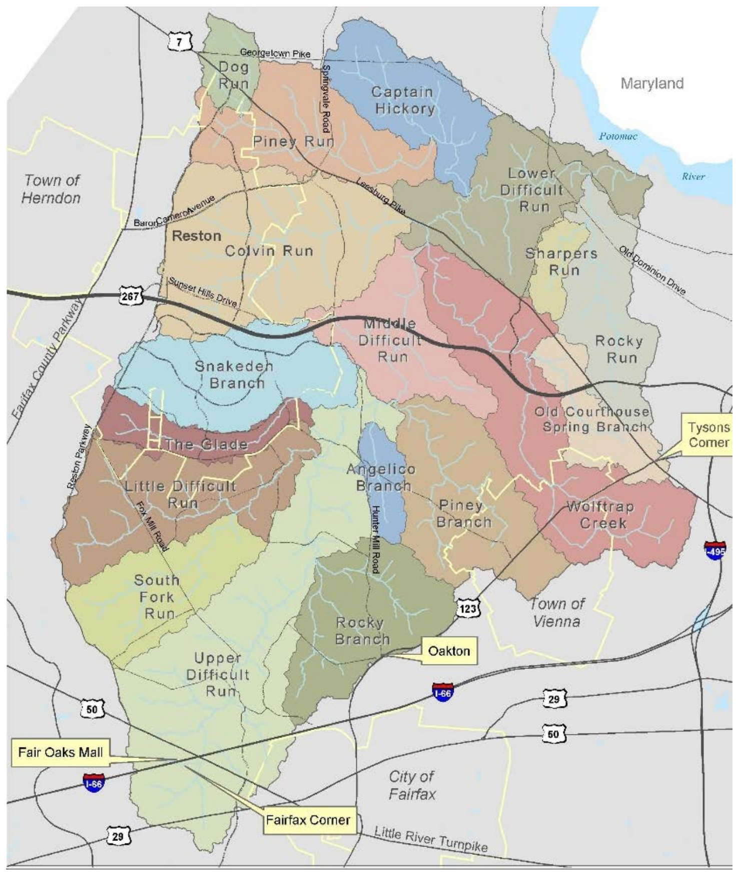
1. To restore and protect the County's streams, 70 percent of which are in fair to very poor condition.
2. To position the County to meet state and federal water quality standards, including listed impairments for Difficult Run.
3. To support Virginia's commitment to the Chesapeake 2000 Agreement to clean the Chesapeake Bay
4. To develop alternatives, where feasible, to the unbuilt regional ponds.

The goals were developed in partnership with Fairfax County staff and the Difficult Run Steering Committee. The plan provides a strategy to meet these goals, by identifying the watershed impairments and presenting solutions for restoration and preservation.

Watershed Condition

The Difficult Run watershed was subdivided into eighteen subwatersheds for the purpose of the study and further subdivided into 201 catchments for further analysis.

Land use within the Difficult Run watershed is currently dominated by residential use. Estate, low, medium and high-density residential areas 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. Open space makes up 20 percent of the Difficult Run watershed, much of it is found along the various stream valley parks and Resource Protection Areas that border the watersheds major streams.



Map ES.1 Difficult Run Subwatersheds

Commercial centers in the watershed are centered around Reston and along the corridor between Tysons Corner, the Town of Vienna, Oakton, and the City of Fairfax. Commercial use occupies approximately 9 percent of the watershed. Transportation use makes up 11 percent of the watershed as several major highways including Leesburg Pike (Virginia 7), The Washington Dulles Access and Toll Road (Virginia 267), I-66 and the Lee Jackson Memorial Highway (US Route 50) cross the watershed. The total impervious acreage for the watershed is currently 6,862 acres, or 18.4 percent of the total area.

Analysis of future land use conditions shows the largest potential percentage change in land use will be the conversion from open space to low and medium-density residential areas.

Growth in these areas will bring the total residential use to 63 percent of the watershed and contribute to a higher overall imperviousness of 20.6 percent.

The County's 2001 *Stream Protection Strategy Baseline Study* evaluated the overall health of the Difficult Run watershed and gave several of the subwatersheds a composite qualitative rating based on the biological condition (benthic macro-invertebrates and fish taxa richness), habitat assessment 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 subwatershed 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 the Difficult Run mainstem. All other sites within the Rocky Run subwatershed were in the "Fair" to "Poor" categories.

The Stream Physical Assessment was conducted in the Difficult Run watershed in the fall of 2002 and winter of 2003 to provide a baseline condition in support of the upcoming watershed management plans. As part of the assessment, field crews conducted a physical habitat assessment, a geomorphologic assessment and collected infrastructure information for all streams within the watershed. 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.

The segment of Difficult Run between the confluence with Captain Hickory Run and the Potomac River near Georgetown Pike (Virginia 193) has been placed on the 303(d) list for two impairments: benthic (bottom-dwelling) macroinvertebrate community and fecal coliform bacteria.

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 bottom-dwelling 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 benthic TMDL is scheduled to be developed by 2010 and a TMDL to address the recreation use impairment may extend to 2016.

Issues and Recommendations

The goals and issues for the watershed were based on analysis of watershed conditions, and reviewed by the community in Steering Committee meetings and public forums. The recommendations are those which were developed for both capital improvements and

Countywide policy implementation. Table ES.1 provides the list of proposed structural projects in the Difficult Run watershed, sorted by project number. The project number, type, subwatershed, location and implementation phase are listed. If the project is part of a regional pond alternative, the regional pond number is also given.

The issues identified during the watershed management plan development process have been addressed in the plan as follows:

Issue 1: Stormwater runoff pollution

Structural Project Action: Carry out preliminary engineering, design, and construction of LID retrofit projects recommended in Table ES-1 below. Culvert retrofit, pond retrofit, and new pond projects will also have a positive effect on this issue.

Policy Action 4.3.5 Continue efforts to add LID design criteria and keep PFM up to date.

Issue 2: Increased stormwater runoff

Structural Project Action: Carry out preliminary engineering, design, and construction of culvert retrofit and pond retrofit projects recommended in Table 5.1 below.

Policy Action 4.3.1 Evaluate revising land development regulations to set a maximum impervious percentage for each type of development.

Policy Action 4.3.2 Evaluate requesting road construction projects to manage the whole roadway, not just the added lane widths.

Policy Action 4.3.3 Evaluate and implement incentives where appropriate for the use of pavers or porous pavement for seasonal or overflow parking.

Policy Action 4.3.4 Evaluate and implement incentives into County ordinances to consider establishing more stringent stormwater quality control standards for redevelopment.

Issue 3: Uncontrolled stormwater

Structural Project Action: Carry out preliminary engineering, design, and construction of new pond projects recommended in Table ES-1 below.

Non-Structural Measure 4.3.7 Conduct a drainage study and develop an improvement plan for the right fork of Dog Run.

Non-Structural Measure 4.5.1 In partnership with the Town of Vienna, conduct a drainage study and develop an improvement plan to reduce flooding in Vienna near Echols Street.

Issue 4: Erosion and streambank stability

Structural Project Action: Carry out preliminary engineering, design, and construction of stream restoration and drainage retrofit projects recommended in Table ES-1 below.

Non-Structural Measure 4.2.2 Enhance inspections of all outfalls and other interfaces between the man-made and natural drainage systems for scour and erosion and make repairs as necessary.

Watershed-Wide Action 3.38.2: Remove obstructions from stream corridors.

Watershed-Wide Action 3.38.4: Repair utility crossings.

Issue 5: Stream water quality

Structural Project Action: Carry out preliminary engineering, design, and construction of buffer restoration projects recommended in Table ES-1 below.

Non-Structural Measure 4.2.3 Continue and enhance the volunteer monitoring program.

Policy Action 4.4.1 Evaluate and implement incentives that could be applied locally to encourage lawn care companies in Fairfax to enroll in the Virginia Water Quality Improvement Program.

Non-Structural Measure 4.4.2 Education and outreach for proper lawn care.

Non-Structural Measure 4.4.3 Golf course nutrient management. Work with golf course managers within the watershed to evaluate turf management practices.

Non-Structural Measure 4.4.4 Develop an enhanced illicit discharge and sewer infiltration / inflow removal program to eliminate potential sewer leaks, overflows and illegal cross-connections.

Watershed-Wide Action 3.38.1: Remove dumpsites from stream corridors.

Issue 6: Stream habitat loss

Structural Project Action: Carry out preliminary engineering, design, and construction of stream restoration projects recommended in Table ES-1 below.

Watershed-Wide Action 3.38.3: Remove fish passage obstructions

Watershed-Wide Action 3.38.5: Restore riparian buffers

Issue 7: Natural resource protection measures

Policy Action 4.6.2 Continue efforts to obtain develop a forest conservation ordinance that would preserve existing woodlands.

Issue 8: Stormwater regulatory compliance

Policy Action 4.3.5 Update and improve the County's database of all public and private SWM facilities.

Policy Action 4.3.6 Enhance SWM inspection, maintenance, and enforcement programs.

Table ES. 1 Difficult Run Watershed Proposed Improvement Projects

Project No	Type	Subwatershed	Location	Phase
DF9001A	Drainage Retrofit	Dog Run	Distributed at outfalls throughout the drainage area	B
DF9001B	Pond Retrofit	Dog Run	End of Branton Lane	A
DF9002A	Culvert Retrofit	Piney Run	Upstream of Riva Ridge Drive	B
DF9002B	Drainage Retrofit	Piney Run	Distributed at outfalls throughout the drainage area	B
DF9003AA	Pond Retrofit	Piney Run	Near Tottenham Court	A
DF9003AB	Pond Retrofit	Piney Run	Near Tottenham Court	A

Project No	Type	Subwatershed	Location	Phase
DF9003B	Drainage Retrofit	Piney Run	Distributed	A
DF9005B	Culvert Retrofit	Captain Hickory Run	At Polo Place	B
DF9006B	Drainage Retrofit	Captain Hickory Run	Distributed at outfalls throughout the drainage area	B
DF9007A	Drainage Retrofit	Captain Hickory Run	Distributed at outfalls throughout the drainage area	B
DF9007C	Culvert Retrofit	Captain Hickory Run	Upstream of Sunnybrook Drive	A
DF9007D	LID Retrofit	Captain Hickory Run	Commercial area W of Walker Road	A
DF9009A	Pond Retrofit	Lower Difficult Run	End of Lyons Street	A
DF9009B	Pond Retrofit	Lower Difficult Run	Near Wood Glade Drive	A
DF9009C	Drainage Retrofit	Lower Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9010A	Culvert Retrofit	Lower Difficult Run	Upstream side of Forestville Drive	B
DF9010B	Culvert Retrofit	Lower Difficult Run	Upstream side of Trotting Horse Lane	B
DF9010C	Culvert Retrofit	Lower Difficult Run	Upstream side of Tackroom Lane	B
DF9010D	Drainage Retrofit	Lower Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9010E	Stream Restoration	Lower Difficult Run	Upstream side of Tackroom Lane	A
DF9011A	Pond Retrofit	Middle Difficult Run	Upstream of Windstone Road	A
DF9011C	Drainage Retrofit	Middle Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9012	Pond Retrofit	Colvin Run	Private property off of Crowell Road	A
DF9013	Pond Retrofit	Colvin Run	Business Center Drive	A
DF9013A	Pond Retrofit	Colvin Run	Business Center Drive	A
DF9014A	Culvert Retrofit	Colvin Run	Upstream side of Little Run Court	B
DF9014B	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	B
DF9017A	Pond Retrofit	Wolftrap Creek	Existing pond along Spring Ridge Lane	A
DF9017B	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	B
DF9019A	Drainage Retrofit	Rocky Run	Distributed at outfalls throughout the drainage area	B
DF9020B	Drainage Retrofit	Sharpers Run	Distributed at outfalls throughout the drainage area	B
DF9023A	Pond Retrofit	Little Difficult Run	Birdfoot Lanet and Raccoon Ridge Ct	A
DF9024A	Pond Retrofit	Snakeden Branch	Existing facility near Clovermeadow Rd	A
DF9024B	Culvert Retrofit	Snakeden Branch	Upstream of the W&OD Trail	A
DF9024C	Drainage Retrofit	Snakeden Branch	Distributed at outfalls throughout the drainage area	B
DF9027A	Culvert Retrofit	Piney Branch	Upstream of Batten Hollow and Brookhill Roads	A
DF9027B	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	B
DF9028A	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	B
DF9028B	Culvert Retrofit	Wolftrap Creek	End of Ashgrove Lane	A
DF9028C	Pond Retrofit	Wolftrap Creek	Along Lupine Den Road	A

Project No	Type	Subwatershed	Location	Phase
DF9029A	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	B
DF9029B	New Pond	Piney Branch	Site of D-29	A
DF9030A	Pond Retrofit	Rocky Branch	End of Martinhoe Court	A
DF9030B	Drainage Retrofit	Rocky Branch	Distributed at outfalls throughout the drainage area	B
DF9031A	Pond Retrofit	Rocky Branch	Oakton Ridge Circle and Oakton Ridge Court	A
DF9031C	LID Retrofit	Rocky Branch	Oakton Ridge Circle and Oakton Ridge Court	A
DF9032A	Culvert Retrofit	Upper Difficult Run	Upstream side of Miller Heights Road	B
DF9032B	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9033	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9034A	Culvert Retrofit	Upper Difficult Run	Upstream side of Miller Heights Road	B
DF9034B	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9035A	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9035B	LID Retrofit	Upper Difficult Run	E side of Young Drive	A
DF9036A3	Pond Retrofit	Rocky Branch	Near Miller Road	A
DF9039A	Culvert Retrofit	Little Difficult Run	Upstream side of Westwood Hills Drive	B
DF9039B	Drainage Retrofit	Little Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9040A	Pond Retrofit	South Fork Run	End of Nathaniel Oaks Drive	A
DF9040B	Pond Retrofit	South Fork Run	Near Falkirk Drive	A
DF9040C	Pond Retrofit	South Fork Run	Birdsboro Drive and Country Ridge Lane	A
DF9040D	Pond Retrofit	South Fork Run	End of Navy Drive	A
DF9040E	Drainage Retrofit	South Fork Run	Distributed	A
DF9041A	Drainage Retrofit	South Fork Run	Distributed at outfalls throughout the drainage area	B
DF9041B	Pond Retrofit	South Fork Run	Tilton Valley Drive and Hickory Hills Drive	A
DF9041C	Pond Retrofit	South Fork Run	S Vale Road, E of Valewood Drive	A
DF9041D	LID Retrofit	South Fork Run	Along Brecknock Street	A
DF9041E	Pond Retrofit	South Fork Run	Along a private drive off Vale Road	A
DF9043A	Drainage Retrofit	Little Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9043B	Pond Retrofit	Little Difficult Run	Wild Cherry Place and Black Fir Court	A
DF9043C	LID Retrofit	Little Difficult Run	Parking lot of Fox Mill Swim and Tennis Club	A
DF9045A	LID Retrofit	Upper Difficult Run	Left of drive at Oakton Swim and Racquet Club	A
DF9045B	Pond Retrofit	Upper Difficult Run	Waples Mill Road and Bronzedale Drive	A
DF9045D	Stream Restoration	Upper Difficult Run	E side of Valeview Drive	A

Project No	Type	Subwatershed	Location	Phase
DF9051D	Culvert Retrofit	Angelico Branch	Upstream of Cedar Pond Road	B
DF9051E	Drainage Retrofit	Angelico Branch	Distributed at outfalls throughout the drainage area	B
DF9054A	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	B
DF9054B	New Pond	Wolftrap Creek	At Site of D-54	A
DF9058A	Culvert Retrofit	Little Difficult Run	Upstream side of Thoroughbred Road	A
DF9058B	Culvert Retrofit	Little Difficult Run	Upstream side of Folkstone Road	B
DF9059A	Pond Retrofit	Upper Difficult Run	Along Center Ridge Road	A
DF9059B	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9059C	Pond Retrofit	Upper Difficult Run	Upstream of Berryland Drive	A
DF9061A	Culvert Retrofit	Little Difficult Run	At Stuart Mill Road	A
DF9061B	Drainage Retrofit	Little Difficult Run	Distributed at outfalls throughout the drainage area	B
DF9061C	Culvert Retrofit	Little Difficult Run	Upstream of Foxclove Road	B
DF9061D	Pond Retrofit	Little Difficult Run	Along Foxclove Road	A
DF9064A	Pond Retrofit	Piney Run	Behind private residences by Challedon Road	A
DF9064B	Culvert Retrofit	Piney Run	N of Brevity Drive	B
DF9064C	Pond Retrofit	Piney Run	The end of Artemel Lane	A
DF9064D	Drainage Retrofit	Piney Run	Distributed at outfalls throughout the drainage area	B
DF9065A	New Pond	Wolftrap Creek	Near Pinstripe Court	A
DF9065B	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	B
DF9066A	Pond Retrofit	Rocky Run	Upstream of Daviswood Drive	A
DF9072A	Pond Retrofit	Upper Difficult Run	Across Vale Road from Chris Wood Court	A
DF9073A	LID Retrofit	Piney Branch	Madison HS and Flint Hill ES	A
DF9073B	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	B
DF9073C	Pond Retrofit	Piney Branch	Along Riviera Drive	A
DF9074A	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	B
DF9076A	Culvert Retrofit	Lower Difficult Run	Culvert under Falls Run Road	A
DF9076B	Pond Retrofit	Lower Difficult Run	Pond below Falls Run Road	A
DF9079A	Drainage Retrofit	South Fork Run	At outfalls within this drainage area	B
DF9079B	Culvert Retrofit	South Fork Run	Honda Road and Lariat Lane	A
DF9103	Pond Retrofit	Piney Run	Bright Pond Lane and Fieldview Drive	C
DF9106A	Pond Retrofit	Captain Hickory Run	At Georgetown Pike	A
DF9106B	Pond Retrofit	Captain Hickory Run	Downstream of Columbine Street	A
DF91135	Pond Retrofit	Dog Run	Water Pointe Lane and the Reston Parkway	C
DF9116A	Pond Retrofit	Wolftrap Creek	Kilby Glen Drive and South Courthouse Drive	D
DF9116B	Pond Retrofit	Wolftrap Creek	Along Deramus Farm Drive	D

Project No	Type	Subwatershed	Location	Phase
DF9117	Pond Retrofit	Wolftrap Creek	S Courthouse Drive and Towlston Road	E
DF9118A	Pond Retrofit	Colvin Run	Culvert under Sunset Hills Road	D
DF9118B	Pond Retrofit	Colvin Run	Facility on S side of Dulles Toll Road	D
DF9119	New Pond	Old Courthouse	West of Gosnell Road	B
DF9121	Pond Retrofit	Rocky Run	Retrofit regional pond D-67	C
DF9122	Pond Retrofit	Middle Difficult Run	Brittenford Drive and Hunt Country Lane	E
DF9123B	Pond Retrofit	Snakeden Branch	Existing pond on upstream side of Sugarberry Court	B
DF9124A	Pond Retrofit	Snakeden Branch	East of Barton Hill Road	D
DF9124C	Pond Retrofit	Snakeden Branch	Intersection of the Dulles Toll Road with W&OD Trail	E
DF9129	Pond Retrofit	Piney Branch	At the bend in Liberty Tree Lane	E
DF9133A	Pond Retrofit	Wolftrap Creek	At the outlet to Catchment 33	B
DF9133B	Pond Retrofit	Wolftrap Creek	Upstream side of Silentree Drive	B
DF9139	Pond Retrofit	Rocky Branch	Intersection of Rosehaven and Jermantown Roads	C
DF9141A	Pond Retrofit	Upper Difficult Run	Fair Oaks Mall property, near Lee Jackson Hwy	C
DF9141B	Pond Retrofit	Upper Difficult Run	N side of US 50	D
DF9142	Pond Retrofit	Upper Difficult Run	E end of the Fair Oaks Mall property	C
DF9143A	Pond Retrofit	Upper Difficult Run	E of the Fairfax Government Center	A
DF9143B1	Pond Retrofit	Upper Difficult Run	S of DF9143A and N of Rockaway Lane	A
DF9143B2	Pond Retrofit	Upper Difficult Run	S of DF9143A and N of Rockaway Lane	A
DF9143C	Pond Retrofit	Upper Difficult Run	N of Government Center Parkway	A
DF9143D	Pond Retrofit	Upper Difficult Run	N side of the stream from project DF9143C	A
DF9143E	Pond Retrofit	Upper Difficult Run	Glen Alden Road and Government Center Pkwy	A
DF9143F2	Pond Retrofit	Upper Difficult Run	N of the Government Center building	A
DF9143H	Pond Retrofit	Upper Difficult Run	Government Center Parkway and Legato Road	A
DF9151	Pond Retrofit	Colvin Run	S of Baron Cameron Avenue	D
DF9152	Pond Retrofit	Colvin Run	Bennington Woods Road and Baron Cameron Avenue	D
DF9157	New Pond	Old Courthouse	At Leesburg Pike and Laurel Hill Road	B
DF9157A	Pond Retrofit	Old Courthouse	At the crossing of Jarrett Valley Drive	B
DF9171	Pond Retrofit	Upper Difficult Run	East of Pender Drive	C
DF9172	Pond Retrofit	Upper Difficult Run	East of Lower Park Drive	C
DF9202	Stream Restoration	Dog Run	SW of Leesburg Pike and E of Reston Parkway	E
DF9205	Stream Restoration	Piney Run	S of Walker Mill Road	D
DF92101	Stream Restoration	Snakeden Branch	N of Sunrise Valley Road	A
DF92102	Stream Restoration	Snakeden Branch	S of N Shore Dr and E of Barton Hill	E

Project No	Type	Subwatershed	Location	Phase
			Rd	
DF92104	Stream Restoration	The Glade	SW of Stirrup Road	A
DF92106	Stream Restoration	Middle Difficult Run	Mainstem N of Dulles Toll Road	D
DF92108	Buffer Restoration	Middle Difficult Run	S of Dulles Toll Road, E of Hunter Mill Road	E
DF92110	Stream Restoration	Piney Branch	S off Fosbak Drive	D
DF92114	Stream Restoration	Little Difficult Run	E of Colt Run Rd before Stuart Mill Rd	D
DF92117	Stream Restoration	Angelico Branch	S of Whippoorwill Road and N of Lawyers Road	A
DF92120	Stream Restoration	South Fork Run	E of Fox Mill Road, N of Deerfield Drive	D
DF92124	Stream Restoration	Wolftrap Creek	S of Chain Bridge Road, W of Westwood Forest Road	D
DF92125	Buffer Restoration	Wolftrap Creek	Within the Westbriar Country Club golf course	E
DF92126	Stream Restoration	Wolftrap Creek	W of Foxstone Drive	D
DF9213	Stream Restoration	Colvin Run	In Lake Fairfax Park, W of Hunter Mill Road	C
DF92130	Stream Restoration	Rocky Branch	W of Mystic Meadow Road, S of Hunter Mill Road	D
DF92131	Stream Restoration	Rocky Branch	W of Hunter Mill Road before intersection with Vale Road	D
DF92135	Stream Restoration	Colvin Run	S of N Shore Drive	A
DF92136	Stream Restoration	Colvin Run	E of Wiehle Avenue and S of Yellowwood Court	A
DF9225	Stream Restoration	Snakeden Branch	E and W of Soapstone Road	B
DF9236	Stream Restoration	Little Difficult Run	W of intersection of Stuart Mill Road and Birdfoot Lane	D
DF9238	Buffer Restoration	Upper Difficult Run	N of intersection of Waples Mill Road and Fox Mill Road	E
DF9244	Stream Restoration	Upper Difficult Run	N of Government Center Parkway	E
DF9245	Stream Restoration	Upper Difficult Run	N of intersection of Fairfax Farms Road and Valley Road	E
DF9249	Stream Restoration	Colvin Run	S of Fairway Dr and W of Westbriar Dr	A
DF9263	Stream Restoration	Upper Difficult Run	SW of Lawyers Road before Hunters Crest Way	D
DF9265	Stream Restoration	Little Difficult Run	S of Thoroughbred Rd, W of Fox Mill Rd	D
DF9274	Stream Restoration	Captain Hickory Run	At end of Walker Glen Court	A
DF9278	Stream Restoration	Dog Run	By Georgetown Pike and Kimberly Place	A
DF9279	Buffer Restoration	Dog Run	E of Stones Throw Drive	E
DF9280	Buffer Restoration	Piney Run	On either side of Bishops Gate Road	E
DF9284	Stream Restoration	Lower Difficult Run	E of Old Dominion Drive	A
DF9285	Stream Restoration	Lower Difficult Run	Where Colvin Run Road intersects Leesburg Pike	A
DF9289	Stream Restoration	Lower Difficult Run	Confluence with Captain Hickory Run	D
DF9290	Stream Restoration	Sharpers Run	Downstream of Bellview Road	D

Project No	Type	Subwatershed	Location	Phase
DF9291	Stream Restoration	Rocky Run	N of Bellview Road, S of Galium Court	D
DF9295	Stream Restoration	Colvin Run	S of Colvin Forest Dr, W of Leesburg Pike	D
DF9501B	Culvert Retrofit	Dog Run	Upstream of Stones Throw Drive	E
DF9501C	Culvert Retrofit	Dog Run	End of Bright Pond Lane	E
DF9503	Culvert Retrofit	Piney Run	Intersection of Hawthorne Court and Reston Parkway	D
DF9504A	Culvert Retrofit	Piney Run	Upstream side of Tiverton Circle	E
DF9504B	Culvert Retrofit	Piney Run	Culvert under Wiehle Avenue	E
DF9507B	Culvert Retrofit	Colvin Run	Culvert under Wiehle Avenue	A
DF9508A	Culvert Retrofit	Colvin Run	Along Village Road and Baron Cameron Avenue	D
DF9508B	Culvert Retrofit	Colvin Run	Culvert under Baron Cameron Avenue	E
DF9512A	Culvert Retrofit	Colvin Run	Culvert under N Shore Drive	D
DF9512B	Culvert Retrofit	Colvin Run	Culvert under N Shore Drive	D
DF9512C	Culvert Retrofit	Colvin Run	Culvert under Wiehle Avenue	E
DF9515A	Culvert Retrofit	Lower Difficult Run	Under Leesburg Pike	D
DF9515B	Culvert Retrofit	Lower Difficult Run	Upstream of Locust Hill Drive	E
DF9520A	Culvert Retrofit	Wolftrap Creek	Culvert under Dulles Toll Road	B
DF9520B	Culvert Retrofit	Wolftrap Creek	Culvert under Dulles Toll Road	B
DF9522A	Culvert Retrofit	Middle Difficult Run	Driveway off of Willow Crest Court	E
DF9522B	Culvert Retrofit	Middle Difficult Run	Upstream of Brittenford Drive	E
DF9522C	Culvert Retrofit	Middle Difficult Run	At Brittenford Drive, E of Raleigh Hill Road	E
DF9522D	Culvert Retrofit	Middle Difficult Run	At Brittenford Drive, E of Landon Hill Road	E
DF9523	Culvert Retrofit	Snakeden Branch	Upstream side of Soapstone Drive	B
DF9524	Culvert Retrofit	Snakeden Branch	N of Sunrise Valley Dr, E of Preston White Dr	A
DF9531B	Culvert Retrofit	Wolftrap Creek	Above Creek Crossing Road	E
DF9532A	Culvert Retrofit	Wolftrap Creek	Upstream side of Follin Lane	B
DF9532B	Culvert Retrofit	Wolftrap Creek	Upstream side of Woodford Road	B
DF9535A	Culvert Retrofit	Snakeden Branch	Upstream side of Colts Neck Road	B
DF9535B1	Culvert Retrofit	Snakeden Branch	Culvert under Glade Drive	B
DF9535B2	Culvert Retrofit	Snakeden Branch	Culvert under Glade Drive	B
DF9540A	Culvert Retrofit	The Glade	Upstream side of Steeplechase Drive	E
DF9540B	Culvert Retrofit	The Glade	Upstream side of Colts Neck Road	C
DF9550A	Culvert Retrofit	Colvin Run	Culvert under Baron Cameron Avenue	A
DF9551	Culvert Retrofit	Colvin Run	Upstream of Gates Meadow Way	D
DF9552A	Culvert Retrofit	Colvin Run	Upstream of Bennington Woods Road	D
DF9552B	Culvert Retrofit	Colvin Run	Upstream of N Shore Drive	E
DF9555A	Culvert Retrofit	Middle Difficult Run	Upstream of Hunter Mill Road	E
DF9555B	Culvert Retrofit	Middle Difficult Run	Upstream of Dulles Toll Road	E
DF9555C	Culvert Retrofit	Middle Difficult Run	At Brittenford Drive, E of Rosaleigh Ct	E
DF9557	Culvert Retrofit	Old Courthouse	Upstream of Laurel Hill Road	B

Project No	Type	Subwatershed	Location	Phase
DF9558	Culvert Retrofit	Wolftrap Creek	Upstream side of Old Courthouse Road	E
DF9701	Drainage Retrofit	Dog Run	Distributed at outfalls throughout the drainage area	E
DF9706	Drainage Retrofit	Captain Hickory Run	Distributed	A
DF9707	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	E
DF9712	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	E
DF9716	Drainage Retrofit	Wolftrap Creek	Along Tuba and Laurlin Court	E
DF9722	Drainage Retrofit	Middle Difficult Run	Distributed at outfalls throughout the drainage area	E
DF9723	Drainage Retrofit	Snakeden Branch	Distributed at outfalls throughout the drainage area	B
DF9724	Drainage Retrofit	Snakeden Branch	Distributed at outfalls throughout the drainage area	E
DF9728	Drainage Retrofit	Snakeden Branch	Along Purple Beech Drive and Ridge Heights Road	E
DF9729	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	E
DF9730	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	E
DF9731	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	E
DF9735	Drainage Retrofit	Snakeden Branch	Distributed at outfalls throughout the drainage area	B
DF9740	Drainage Retrofit	The Glade	Distributed at outfalls throughout the drainage area	E
DF9741	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	E
DF9750	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	E
DF9751	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	E
DF9755	Drainage Retrofit	Middle Difficult Run	Distributed at outfalls throughout the drainage area	E
DF9757	Drainage Retrofit	Old Courthouse	Distributed at outfalls throughout the drainage area	B
DF9758	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	E
DF9806	LID Retrofit	Captain Hickory Run	N of Georgetown Pike	A
DF9807	LID Retrofit	Colvin Run	Rain garden at Wiehle Ave and N Shore Dr	C
DF9808	LID Retrofit	Colvin Run	Intersection of Village Drive and N Shore Drive	C
DF9809	LID Retrofit	Colvin Run	S of the intersection of Village Drive and N Shore Drive	C
DF9812	LID Retrofit	Colvin Run	Isaac Newton Square and Wiehle Avenue	C
DF9818	LID Retrofit	Colvin Run	Throughout catchment N of the Dulles	C

Project No	Type	Subwatershed	Location	Phase
			Toll Road	
DF9819	LID Retrofit	Old Courthouse	Intersection of Leesburg Pike and Chain Bridge Road	B
DF9830	LID Retrofit	Piney Branch	Along Maple Avenue and the W&OD Trail	C
DF9831	LID Retrofit	Wolftrap Creek	Rear parking lot on Follin Lane	B
DF9831B	LID Retrofit	Wolftrap Creek	On both sides of Maple Street	B
DF9832	LID Retrofit	Wolftrap Creek	Notre Dame and Our Lady of Good Counsel Catholic Church	B
DF9833	LID Retrofit	Wolftrap Creek	Upper third of Catchment 33	B
DF9835	LID Retrofit	Snakeden Branch	In and around Hunters Woods Village Shopping Center	B
DF9839	LID Retrofit	Rocky Branch	Around intersection of Jermantown and Route 123	C
DF9841	LID Retrofit	Upper Difficult Run	On and around Fair Oaks Mall	C
DF9842	LID Retrofit	Upper Difficult Run	Throughout the Fair Oaks Mall property	C
DF9843	LID Retrofit	Upper Difficult Run	Entire parking area for the Government Center	A
DF9871	LID Retrofit	Upper Difficult Run	E of Pender Drive	C

Benefits of Plan Actions

Plan benefits were estimated with the watershed computer model developed during the project. Proposed conditions were compared to future conditions to determine the benefits of the proposed projects.

Proposed stormwater treatment measures, , including pond retrofits, culvert retrofits, LID retrofits, and new ponds were modeled based on the amount of runoff each was capable of treating, and literature values for pollutant removal efficiency. Peak flow reductions were also modeled, again based on the amount of area draining to each retrofit project and its size. The majority of the proposed projects were designed to improve both water quality and water quantity control, and should help to reduce pollutant loads, but also to reduce the erosive peak flows that damage streambeds and scour stream systems.

Results of the modeling showed improvements in water quality constituents, such as reduction of nitrogen and phosphorus levels, throughout the entire Difficult Run watershed. Table ES-2 below compares the existing and future conditions model results for each subwatershed with the model containing the proposed concept plans.

The projects proposed in this report will reduce peak flows and pollutant loads throughout all of Difficult Run. The model results show an 8 percent decrease in Total Suspended Solids (TSS), an 11 percent decrease in Total Nitrogen (TN), and a 17 percent decrease in Total Phosphorus (TP) throughout the watershed.

Table ES.2: Pollutant Loads and Reductions

Subwatershed	Area (acres)	Scenario	Runoff Volume (in/yr)	Peak Flow (cfs/ac)	TSS (lb/ac/yr)	TN (lb/ac/yr)	TP (lb/ac/yr)
Angelico Branch	483	Existing	2.1	1.6	19.1	1.00	0.20
		Future	2.5	1.8	25.5	1.35	0.27
		Proposed	2.5	1.7	25.4	1.28	0.24
		Reduction	-2.6%	-5.8%	-0.5%	-5.0%	-12.5%
Captain Hickory Run	1,695	Existing	2.1	1.2	24.5	1.2	0.21
		Future	2.3	1.2	26.5	1.3	0.24
		Proposed	2.3	1.1	24.9	1.1	0.18
		Reduction	-2.6%	-8.1%	-6.1%	-13.4%	-23.6%
Colvin Run	3,876	Existing	5.1	2.1	108.6	4.3	0.52
		Future	5.7	2.2	119.4	4.6	0.55
		Proposed	5.3	1.8	103.1	3.9	0.44
		Reduction	-6.7%	-14.4%	-13.7%	-16.2%	-20.2%
Dog Run	516	Existing	3.0	1.5	35.7	1.8	0.32
		Future	3.4	1.6	43.0	2.1	0.40
		Proposed	3.3	1.4	42.8	1.8	0.25
		Reduction	-1.8%	-17.0%	-0.7%	-13.9%	-36.4%
The Glade	853	Existing	3.3	1.6	45.5	2.3	0.44
		Future	3.3	1.6	46.0	2.3	0.45
		Proposed	3.3	1.4	46.0	2.2	0.39
		Reduction	-1.4%	-13.0%	-0.1%	-4.9%	-12.2%
Little Difficult Run	2,590	Existing	2.0	1.4	20.2	1.1	0.21
		Future	2.2	1.5	23.5	1.3	0.25
		Proposed	2.2	1.3	23.5	1.2	0.23
		Reduction	-2.8%	-10.9%	0.0%	-3.2%	-8.6%
Old Courthouse Spring	981	Existing	9.3	2.7	192.9	7.7	0.88
		Future	9.5	2.8	197.9	8.0	0.93
		Proposed	9.4	2.7	191.8	7.6	0.86
		Reduction	-1.1%	-3.1%	-3.1%	-5.1%	-7.7%
Piney Branch	2,475	Existing	4.6	2.1	73.7	3.6	0.63
		Future	4.9	2.2	85.6	4.2	0.72
		Proposed	4.8	2.1	84.7	4.0	0.64
		Reduction	-3.0%	-7.5%	-1.0%	-4.8%	-11.5%
Piney Run	2,100	Existing	3.2	1.6	48.8	2.1	0.32
		Future	3.5	1.6	56.8	2.5	0.37
		Proposed	3.5	1.3	57.0	2.4	0.33
		Reduction	-2.0%	-19.0%	0.5%	-4.8%	-12.7%
Rocky Branch	2,167	Existing	3.4	1.6	47.9	2.3	0.39
		Future	3.7	1.7	53.2	2.5	0.44
		Proposed	3.6	1.6	53.2	2.3	0.36
		Reduction	-2.3%	-10.1%	0.1%	-7.0%	-17.7%

Subwatershed	Area (acres)	Scenario	Runoff Volume (in/yr)	Peak Flow (cfs/ac)	TSS (lb/ac/yr)	TN (lb/ac/yr)	TP (lb/ac/yr)
Rocky Run	1,673	Existing	4.0	1.9	64.5	2.9	0.36
		Future	4.2	2.0	66.2	3.1	0.40
		Proposed	4.1	1.8	65.5	3.0	0.40
		Reduction	**-2.1%**	**-9.2%**	**-1.2%**	**-1.5%**	**-2.3%**
Snakeden Branch	2,239	Existing	6.1	2.1	126.5	5.0	0.66
		Future	6.4	2.1	132.9	5.1	0.66
		Proposed	6.3	1.8	130.3	4.9	0.60
		Reduction	**-2.4%**	**-12.9%**	**-1.9%**	**-4.7%**	**-9.4%**
South Fork Run	1,745	Existing	2.1	1.3	23.4	1.3	0.25
		Future	2.3	1.3	25.4	1.4	0.27
		Proposed	2.2	1.2	25.3	1.3	0.23
		Reduction	**-2.1%**	**-10.4%**	**-0.2%**	**-6.2%**	**-15.7%**
Sharpers Run	415	Existing	1.7	1.2	21.3	1.2	0.18
		Future	2.2	1.2	30.0	1.6	0.23
		Proposed	2.1	1.1	29.8	1.6	0.23
		Reduction	**-3.1%**	**-10.9%**	**-0.7%**	**-0.4%**	**-0.5%**
Wolftrap Creek	3,631	Existing	5.1	2.3	80.8	3.7	0.60
		Future	5.6	2.5	95.4	4.5	0.74
		Proposed	5.3	2.0	84.4	3.8	0.58
		Reduction	**-5.0%**	**-20.2%**	**-11.5%**	**-15.8%**	**-22.7%**
Upper Difficult Run	5,684	Existing	3.7	1.8	60.6	2.5	0.34
		Future	4.1	1.9	73.1	3.0	0.39
		Proposed	4.0	1.5	60.5	2.3	0.30
		Reduction	**-2.2%**	**-20.4%**	**-17.3%**	**-20.9%**	**-24.8%**
Middle Difficult Run	1,721	Existing	3.3	1.7	41.2	1.9	0.31
		Future	3.5	1.8	45.1	2.1	0.33
		Proposed	3.3	1.5	42.8	1.9	0.26
		Reduction	**-5.6%**	**-14.0%**	**-5.1%**	**-11.8%**	**-20.8%**
Lower Difficult Run	2,450	Existing	1.9	1.4	17.5	0.9	0.17
		Future	2.0	1.5	19.0	1.0	0.19
		Proposed	1.9	1.4	18.9	0.9	0.16
		Reduction	**-1.5%**	**-5.1%**	**-0.5%**	**-4.7%**	**-12.6%**
Difficult Run Total	37,924	Existing	3.8	1.8	63.1	2.7	0.41
		Future	4.2	1.9	70.6	3.1	0.46
		Proposed	4.0	1.6	65.4	2.7	0.38
		Reduction	**-3.3%**	**-13.6%**	**-7.5%**	**-10.9%**	**-16.6%**

Implementation Plan

The recommended actions will potentially be implemented over the 25-year life of the *Difficult Run Watershed Management Plan*. This Plan will be a guide for all County agencies and officials in protecting and maintaining the health of the watershed. It will be an active or "living" document that will be revisited and updated regularly throughout the implementation phase.

The final scope and design of each project will be determined during implementation, in collaboration with all parties affected, including the Fairfax County Park Authority, homeowners associations, adjacent landowners and others.

The policy actions and many of the nonstructural actions will be considered with similar recommendations from other watershed plans and will potentially be implemented across all watersheds. Also, many of the actions involve coordination with other agencies such as the Northern Virginia Soil and Water Conservation Service, Fairfax County Health Department and Virginia Department of Conservation and Recreation.

A weighted set of five categories was used to prioritize each plan action. The following categories were used:

- Board Adopted Categories (40%)
- Direct Regulatory Contribution (10%)
- Public Support (10%)
- Effectiveness / Location (25%)
- Ease of Implementation (15%)

The Plan identifies the projects to be evaluated and implemented within each of the following five-year implementation phases, A through E. The implementation phase for each individual structural project is shown in Table ES.1.

A - Year 1 – 5

B - Year 6 – 10

C - Year 11 – 15

D - Year 16 – 20

E - Year 21 - 25

Plan Total Cost

The total cost of the proposed structural projects is approximately $71.0 million. Over the Plan's lifespan of 25 years, this will require approximately 4.9 Fairfax County Staff Year Equivalents for project management, land acquisition, and construction management, which are factored into the project costs.

1 Introduction

1.1 Background

Fairfax County contains all or part of 30 **watersheds**, of which Difficult Run is the largest. Development and population growth over the past century have transformed Fairfax County, and the Difficult Run watershed, into a bustling suburban community. Today the watershed is comprised of a mix of **open space**, residential areas, and commercial centers. The plan presents the issues affecting the quality of the watershed's streams and receiving waters, builds on previous management efforts, and presents a comprehensive strategy for mitigating and reducing the impacts of development.

In the mid to late 1970s, an environmental baseline and subsequent master plan for flood control and **drainage** were completed for Difficult Run. The plans combined the study of **aquatic** and terrestrial natural resources with modeled water quality results, to recommend immediate and future projects that would address sanitary sewer issues, stream stability, **detention** ponds, and **flooding** through the year 2000. In addition, the *Difficult Run Headwaters Land Use Study* was prepared by the Fairfax County Office of Comprehensive Planning in 1978 to study the area's ability to accept various residential densities and simultaneously maintain high-quality environmental standards. In the late 1980s, Fairfax County proposed the installation of regional ponds to control erosion and flooding in the western portion of the watershed, including Difficult Run.


Stream channel in Difficult Run Watershed

The County initiated the Stream Protection Strategy in 1998 to survey the health of the County's streams using measures of biological integrity, aquatic habitat and physical stream stability.

The 2001 *Stream Protection Strategy Baseline Study* recommended watersheds for protection, restoration and further study. Spurred by the Stream Protection Strategy results, the **Chesapeake Bay 2000 Agreement**, and advances in stormwater management technologies, the Stormwater Planning Division of the Fairfax County Department of Public Works and Environmental Services (DPWES) initiated the creation of watershed management plans for the County's 30 watersheds.

The management plans will provide an assessment of the watersheds' current conditions through evaluation of management needs and a prioritization of solutions within each watershed. The goal is to provide a consistent basis for the evaluation and implementation of solutions for protecting, enhancing and restoring the receiving water systems and to restore the habitat and water quality throughout the County. The Difficult Run watershed is the fifth in a series of 15 watershed management projects that are slated for completion over a seven-year period.

1.2 Watershed Planning Process and Public Involvement

The development of the plan for the Difficult Run watershed began in July 2004. The plan is intended to complement and supplement the County's policies and comprehensive plans over the next 25 years and support its commitment to the Clean Water Act and Virginia's commitment to the Chesapeake Bay Act. The County, which encompasses all County government entities, and other stakeholders of the Difficult Run Watershed, are committed to protecting Difficult Run from future degradation and promoting watershed-wide management actions that work to restore the stream and other areas in the watershed to an environmentally healthy ecosystem. This commitment emphasizes the importance of protecting the County's valuable natural resources, including surface waters, and supports the sustainability and improvement of the environment which has a direct impact on the quality of life of the County's residents.

Current stream conditions throughout the watershed are generally fair or poor based on the Stream Physical Assessment, and this plan proposes a comprehensive strategy for improving these conditions. The plan was written to manage future changes in the watershed to protect Difficult Run and its tributaries so they can be enjoyed by future generations. The objectives of the plan will also help the County meet or exceed federal, state, and local regulatory water quality requirements.

The planning process initiated by Fairfax County for development of this watershed management plan included the participation and recommendations of a watershed steering committee consisting of approximately 15-20 residents of the Difficult Run watershed. The Difficult Run Steering Committee and a broader group identified as the "advisory committee" were convened to assist the *Difficult Run Watershed Management Plan* project team in the development of the plan. The committee members served as liaisons between their respective communities or organizations and the project team.

The Steering Committee participated in monthly meetings to examine the issues facing the watershed and its residents. The committee is made up of residents from the community who represent a variety of **stakeholder** groups and interests such as environmental and conservation groups, homeowners associations, business groups, and state and local government.

The goal of the planning effort is expressed in the Steering Committee's process statement:

> *To develop an environmentally effective watershed management plan, created by community stakeholders, which protects and improves water quality and habitat in Difficult Run and reduces the adverse impacts of flooding and stormwater.*

Ultimately, the Steering Committee, with input from other residents, have assisted in the development of a comprehensive watershed plan that identifies the major issues in the watershed and recommends solutions.

In addition to the work being performed by the committee, members of the community have been involved through a series of public workshops and forums to ensure that the plan can be successfully implemented by Fairfax County and the residents living and working in the watershed.

1.3 Watershed Goals and Issues

With the assistance of the Steering Committee and Fairfax County staff, four broad goals were developed which governed the development of the plan:

1. To restore and protect the County's streams, 70 percent of which are in fair to very poor condition.
2. To position the County to meet state and federal **water quality standards**, including listed impairments for Difficult Run.
3. To support Virginia's commitment to the Chesapeake 2000 Agreement to clean the Chesapeake Bay.
4. To develop alternatives, where feasible, to the unbuilt regional ponds.

In addition, several more detailed watershed issues were identified, both through the Steering Committee and at the first public meeting, the Issues Scoping Forum, which was held on November 6, 2004. These were:

- <u>Issue 1 -- Stormwater runoff pollution</u> Most runoff in Difficult Run is not treated to remove pollutants. Runoff quantity controls were first implemented in 1974 and use of quality controls began in 1993. Proposed actions should reduce the amount of pollutants reaching Difficult Run and its tributaries.
- <u>Issue 2 -- Increased stormwater runoff</u> Increased stormwater flows increase the frequency of flooding, and contribute to stream erosion. Proposed actions should reduce both the volume and speed of stormwater.
- <u>Issue 3 --Uncontrolled stormwater</u> In older areas that were developed before stormwater management was required, the effects of increased runoff and non-point source pollution are not treated. Proposed actions have been recommended to retrofit either water quality or channel protection treatment in these areas.
- <u>Issue 4 -- Erosion and streambank instability</u> Stream bank erosion impacts properties, results in sediment deposits in lakes, and impairs aquatic habitat. Proposed actions should reduce further erosion or restore actively eroding streams to a stable state.
- <u>Issue 5 -- Stream water quality</u> Poor water quality can be harmful to organisms such as fish, benthic macroinvertebrates, and amphibians. Proposed actions should reduce runoff pollution and help restore stream health.
- <u>Issue 6 -- Stream habitat loss</u> Streams face many stressors that can degrade stream habitat, including channelization, increased stormwater flow, and stream erosion. Because stream habitat is dependent on so many factors, there are many ways to protect and enhance it. Stormwater management can reduce erosion and trap pollutants. Stabilizing streams can reduce erosion and sedimentation. Protecting and replanting riparian vegetation provides shade and bank protection.
- <u>Issue 7 -- Natural resource protection measures</u> Watershed issues are not always problems of declining water quality or environmental degradation. In most watersheds, there are also areas of good stream habitat or high quality environment. Proposed actions are intended to preserve these areas from disturbance.
- <u>Issue 8 -- Stormwater regulatory compliance</u> Maintenance of privately-owned stormwater facilities, and waivers of Stormwater Management and Resource Protection Area regulations during development can limit the effectiveness of a stormwater program. Proposed actions are intended to improve compliance with the existing programs.

1.4 Plan Layout

The *Difficult Run Watershed Management Final Plan* provides a detailed approach for attaining the goals outlined above. The plan includes analysis of the historic and current watershed condition and presents management alternatives designed and selected to address watershed issues. Due to the size of the watershed, 58 square miles, this is a large management plan; however, the plan should be utilized as 18 individual subwatershed action plans as put forward in Chapter 3.

The management plan chapters include the following topics:

Chapter 1	Introduction: Background, goals, plan layout.
Chapter 2	Watershed Condition: Watershed history and condition, current and future land use, **impervious surfaces**, aquatic and terrestrial environments, and modeling results.
Chapter 3	Subwatershed Condition and Plan Action: Subwatershed current and future land use, stormwater management, stream condition including **geomorphology**, habitat, water quality, problem areas and modeling results.
Chapter 4	Watershed-wide Policy Recommendations: Recommended policy and ordinance changes. Watershed improvement recommendations, including structural and non-structural projects and programs. Concept plans for each project are shown in Volume 2 of this plan.
Chapter 5	Summary of Watershed Plan Action and Benefits: This section recaps the watershed goals and issues, and lists the actions which address each goal. A summary of pollutant reduction benefits, derived from the watershed modeling, is provided as well.
Chapter 6	Implementation Plan: Project prioritization and long-term monitoring.
Appendices	Extensive data on soils, land use and stormwater facilities and more detailed procedures for the modeling and candidate site selection.
Glossary	A Glossary is presented that defines many of the terms and concepts used in the plan. Terms shown in the document in **bold typeface** are found in the Glossary.

1.5 How to Use the Plan

Because the *Difficult Run Watershed Management Plan* is organized by subwatershed, the key to finding information of interest is to locate the appropriate subwatershed, then find the problem areas and proposed projects at a particular location. Map 2.2 in Chapter 2 shows the major road network and subwatershed boundaries. More detailed maps in each subwatershed section show the street network and street names.

Each subwatershed has sections describing the following:

- Subwatershed characteristics
- Existing and future land use
- Existing stormwater management
- Soils
- Geomorphology
- Stream habitat and water quality
- Hydrology and water quality modeling
- Hydraulic modeling
- Candidate sites for improvements
- Subwatershed plan action
    - Regional pond alternative projects
    - Catchment improvement projects

- Stream restoration projects

Along with the text, each subwatershed section of Chapter 3 includes five maps that depict the subwatershed and stream conditions, the selected candidate sites and the resulting projects.

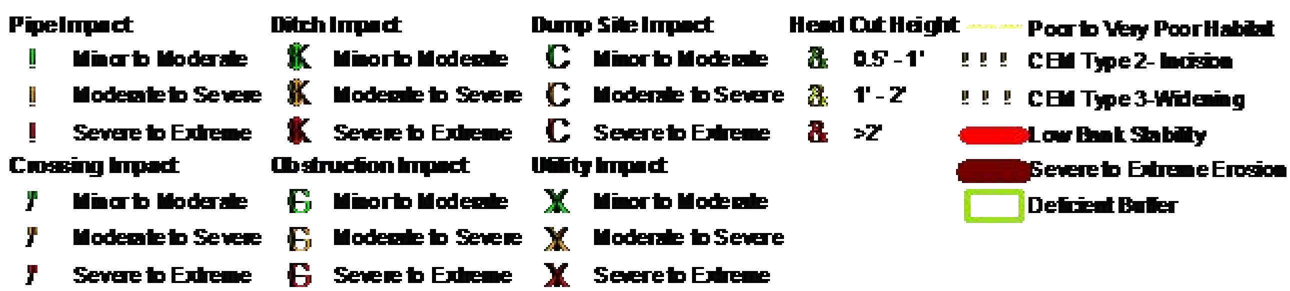
- Subwatershed Characteristics
- Future Land Use
- Stream Condition
- Candidate Sites for Improvements
- Proposed Improvements

The following sections describe the information that is presented on the maps.

Subwatershed Characteristics

The first of the four maps depicts the overall subwatershed characteristics including the land use, wetlands and resource protection areas and the stormwater management that is currently in place. The layers are described and shown below.

Map Layer	Description
Subwatershed Boundary	The delineated drainage areas for the subwatersheds is shown
Streams, Lakes	Stream layer from the Stream Physical Assessment
Existing Flood Limit (100 yr)	The modeled 100-year flood limit is provided.
Wetlands (NWI)	The National Wetlands Inventory
Resource Protection Area	Component of the Chesapeake Bay Preservation Area comprised of lands adjacent to waterways that have an intrinsic ecological and biological value
Regional Ponds	Sites of constructed and unconstructed regional ponds; drainage areas to these sites are also provided
Quantity/Quality control	Areas with existing stormwater management are shown. Parcels with quality
Current Land Use	Fairfax County's land use parcel data coded according to the Stormwater Planning Division's designations for watershed management planning studies.



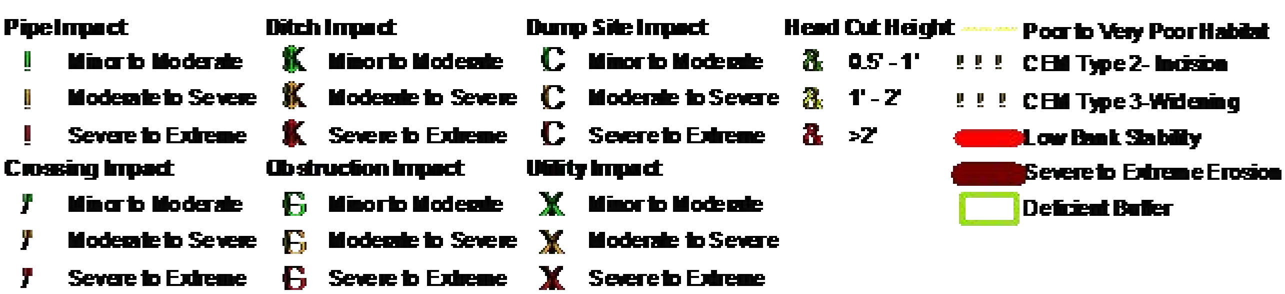
Future Land Use

The Future Land Use map shows two things: the forecast land use for each subwatershed using the same color coding as the previous map, and the parcels where land use changes are projected to occur. These are shown with the outline of the parcel highlighted in black.

Stream Condition

The Stream Condition map provides a graphical representation of much of the data generated by the Stream Physical Assessment. The purpose of the map is to highlight problem areas related to stream condition. The layers are described briefly and shown below. The layers are descibed in more detail in section 3.2.5 above.

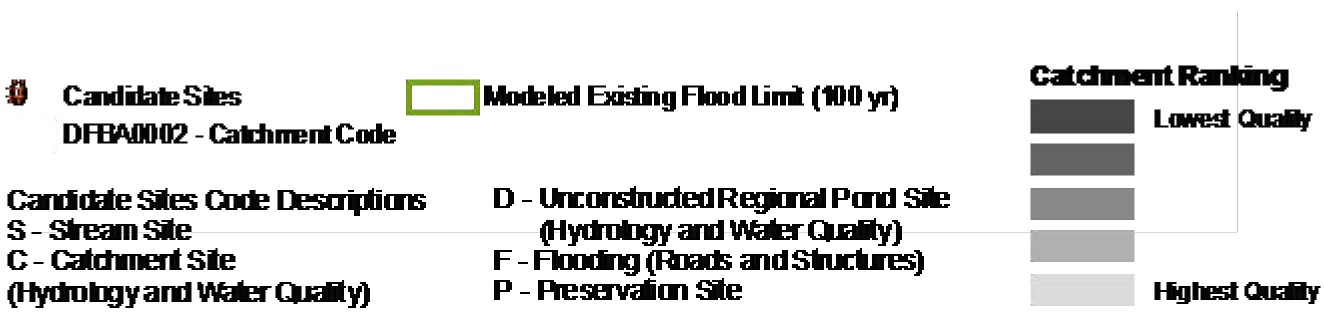
Map Layer	Description
Pipe Impact	Pipes with minor, moderate, severe and extreme impact.
Crossing Impact	Road crossings with minor, moderate, severe and extreme impact.
Ditch Impact	Ditches with minor, moderate, severe and extreme impact.
Obstruction Impact	Obstructions with minor, moderate, severe and extreme impact.
Dump Site Impact	Dump sites with minor, moderate, severe and extreme impact.
Utility Impact	Utilities with minor, moderate, severe and extreme impact.
Headcut Impact	Headcuts categorized by height, greater height is more severe.
Poor to Very Poor Habitat	Streams with a habitat assessment rating of poor or very poor.
Channel Evolution Model (CEM)	Streams that are undergoing incision (Type II) and widening (Type III)
Low Bank Stability	The bank stability indicator of the habitat assessment, indicates >60 percent of bank area with active erosion across the reach.
Severe to Extreme Erosion	Specific sites of severe and extreme erosion and moderate to high restoration potential.
Deficient Buffer	Specific sites of severe to extreme riparian buffer deficiency and moderate to high restoration potential.



Candidate Sites for Improvements

The Candidate Sites map shows the locations of the candidate sites and results of the catchment ranking procedure. The procedure for site selection and the catchment ranking is described in section 3.3 and Appendix G.

Map Layer	Description
Candidate Sites	Sites, stream reaches, or catchments that were identified to have a degraded condition and are potential areas for restoration. Additionally, areas that are currently in good condition but are vulnerable in the future due to changes in land use were selected as candidate sites for preservationSites selected from for further field investigation that
S-Stream Sites	Sites identified as candidate locations for stream restoration, channel stabiliazation or riparian buffer restoration.
C-Catchment Sites	Catchments identified as candidates for improvements to reduce stormwater impacts such as high levels of runoff.
D – Unconstructed Regional Pond Sites	Sites where regional ponds were planned but are yet unbuilt. These sites are candidates for alternative projects to reduce the impacts of stormwater.
F – Flooding	Sites where the potential of flooding currently exists at culverts and bridges are condidate sites for projects that would reduce the frequency of flooding.
P - Preservation	Areas of high quality habitat or land cover that should be preserved as the area is developed in the future
Catchments	The delineated drainage areas for the catchment is shown. The catchments are labeled with their codes such as DFAB0002
Modeled Existing Flood Limit (100 yr)	The modeled 100-year flood limit is provided.
Catchment Ranking	Ranking of the catchments from lowest quality to highest quality

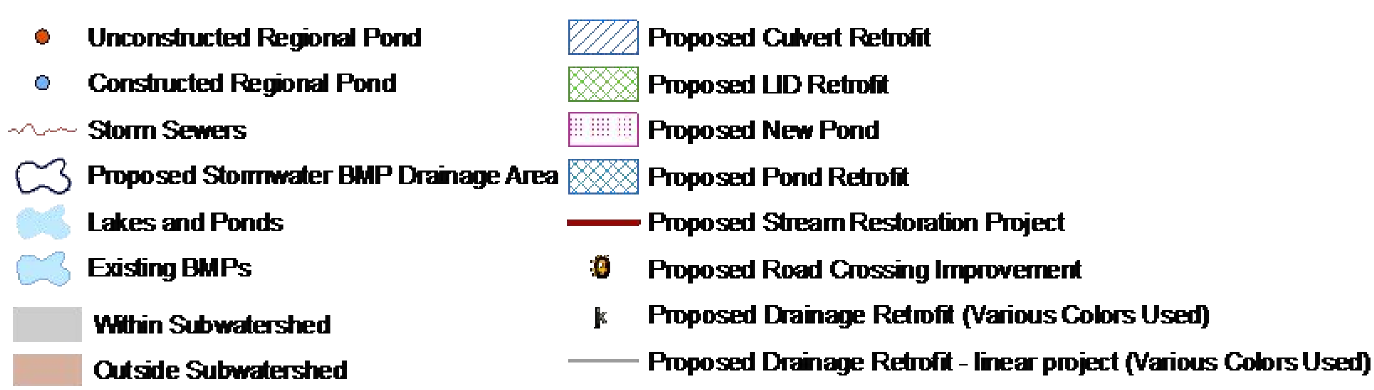


Proposed Improvements

The Proposed Improvements map shows the Projects and Actions that resulted from the field investigation of the candidate sites. There may be more than one project proposed for each candidate site.

The map layers and symbology used in the Proposed Improvements map are also used on the smaller maps for each project on the concept plans. They provide an overview of the project, its type, size, location and the potential benefits. Also described are the potential constraints for permitting, designing and constructing the project. The description and legend below is provided to describe the features in both maps.

Map Layer	Description
Regional Ponds	Sites of constructed and unconstructed regional ponds; drainage areas to these sites are also provided. Note: The concept plan maps do not differentiate between constructed and unconstructed.
Storm Sewers	The locations of storm sewers.
Paved Drainage Ditch	The locations of paved drainage ditches.
Streams	Stream layer from the Stream Physical Assessment
Proposed Stream Restoration Project.	Includes restoration, stabilization and riparian buffer enhancements.
Outside/Within Subwatershed	Indicates area that is either inside or outside the subwatershed in which the proposed project lies.
Proposed Stormwater BMP Drainage Area	The delineated drainage area
Existing BMPs	Locations of current best management practices (BMPs)
Lakes and Ponds	Locations of Lakes and Ponds from the County GIS
Proposed Improvements	The types of projects and actions are listed below in the legend and are described in section 3.4 above.



Notes:

- Proposed Drainage Retrofits (shown on the proposed improvement maps as an asterisk for outfalls or a line for ditches) are displayed in different colors on each map. The colors used for each particular project match those used on Chapter 3 mapping.

- The footprint for New Pond, Pond Retrofit, and Culvert Retrofit projects shows the maximum extent of bankfull conditions during storm events, and not a permanent pool.

Project Numbering

Projects are identified using a numbering convention (XX9YZZ) where:

XX = Watershed Code (DF for Difficult Run)
9 = County Watershed Project (all projects have this designation)
Y = 0 Regional Pond Alternative Projects
1 Non-Regional Ponds Or Pond Retrofits
2 Stream Restoration
3 Not Used
4 Road Crossing Improvements
5 Culvert Retrofits
6 Flood Control Projects
7 Drainage Improvements
8 LID Retrofits
9 Other
Z = ID number for unbuilt regional pond, catchment, or stream restoration site

For example, DF9051C in Angelico Branch is in Difficult Run (DF), a watershed project (9), a regional pond replacement project (0) for regional pond D-51 (51) and is one of a series of projects (C).

Project DF9236 in Little Difficult Run is in Difficult Run (DF), a watershed project (9), a stream restoration project (2) at stream site S36 (36).

Project DF9550B in Colvin Run is in Difficult Run (DF), a watershed project (9), a culvert retrofit project (5) at catchment site C50 (50) and is one of a series of projects (B).

Projects are listed in numerical order in the Executive Summary to make it easier to find a project by the project number. Projects in each subwatershed are listed in numerical order in the Subwatershed Plan Action section.

2 Watershed Condition

2.1 General Watershed Characteristics

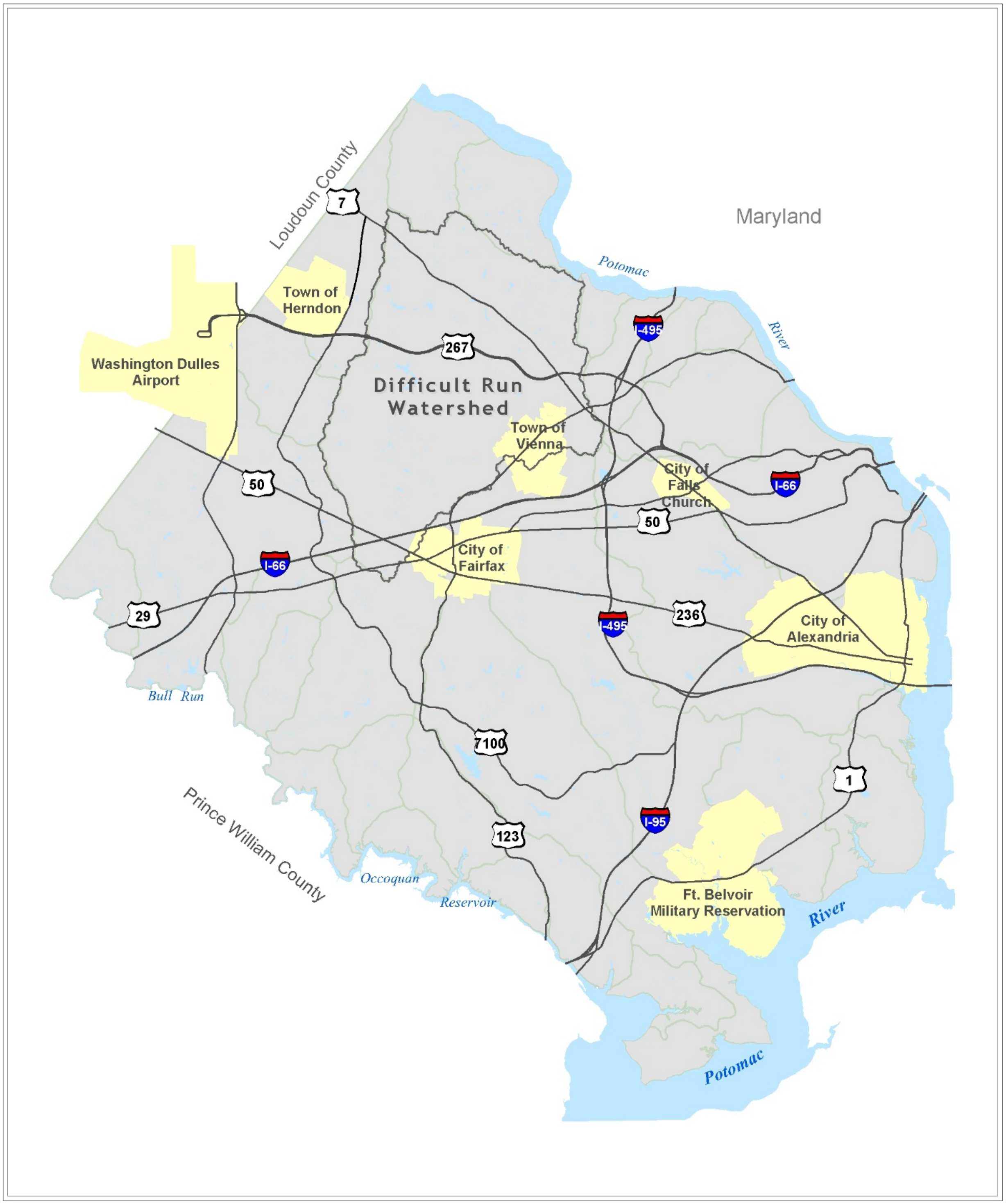
The Difficult Run watershed, the largest watershed in Fairfax County, covers 58.3 square miles and is bordered by several smaller watersheds and the Potomac River. Difficult Run is in the north-central portion of Fairfax County outside the Capital Beltway and generally north of I-66 as shown on Map 2.1, 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

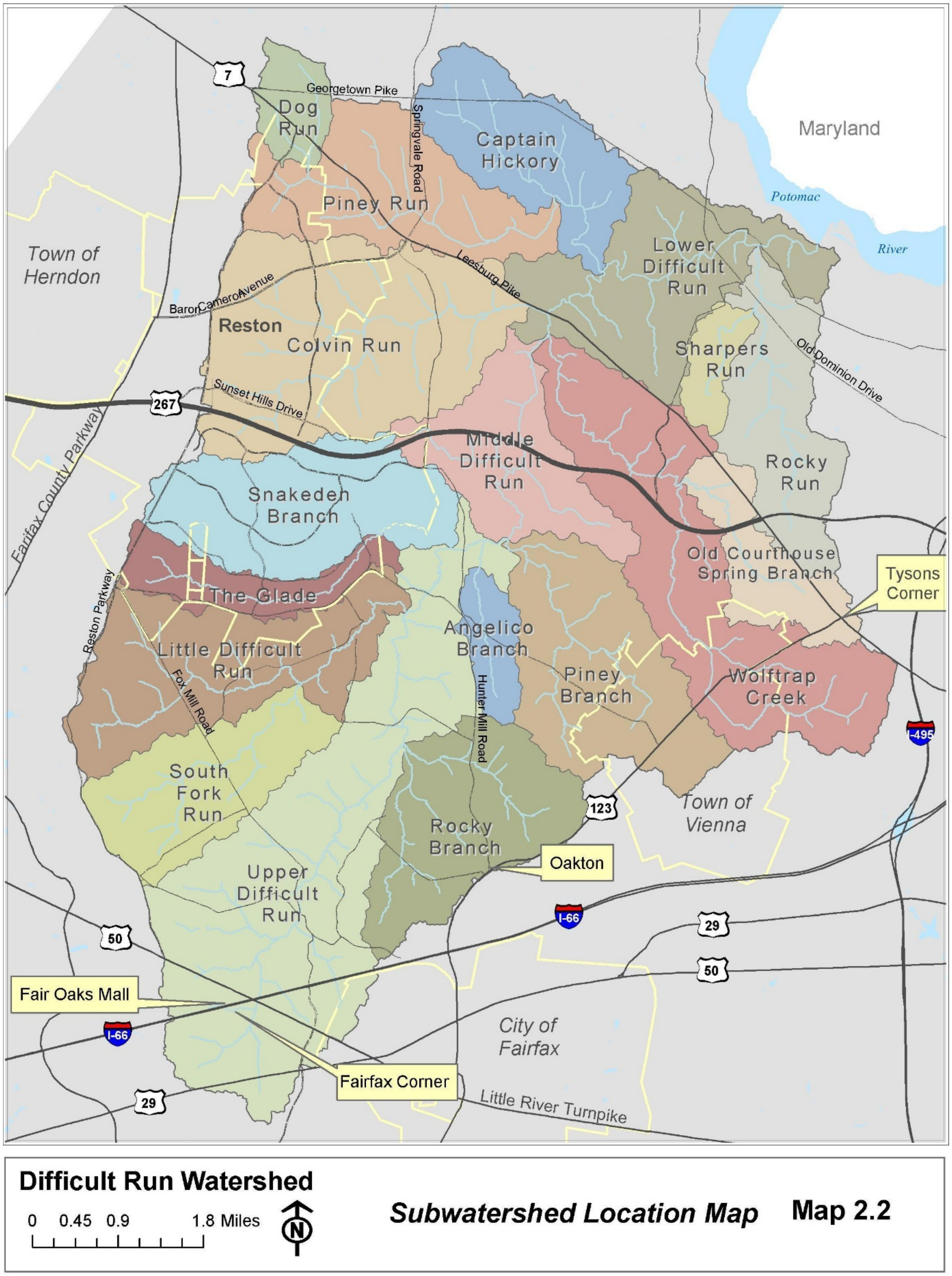


Difficult Run Watershed

0 1.5 3 6 Miles

N

Watershed Location Map **Map 2.1**


Dog Run
Georgetown Pike
Springvale Road
Captain Hickory
Maryland
Potomac
River
Piney Run
Town of Herndon
Leesburg Pike
Lower Difficult Run
Baron Cameron Avenue
Reston
Colvin Run
Sharpers Run
Old Dominion Drive
Sunset Hills Drive
Fairfax County Parkway
Middle Difficult Run
Rocky Run
Snakeden Branch
Old Courthouse Spring Branch
Tysons Corner
Reston Parkway
The Glade
Angelico Branch
Little Difficult Run
Fox Mill Road
Hunter Mill Road
Piney Branch
Wolftrap Creek
South Fork Run
Town of Vienna
Rocky Branch
Oakton
Upper Difficult Run
Fair Oaks Mall
City of Fairfax
Fairfax Corner
Little River Turnpike
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.

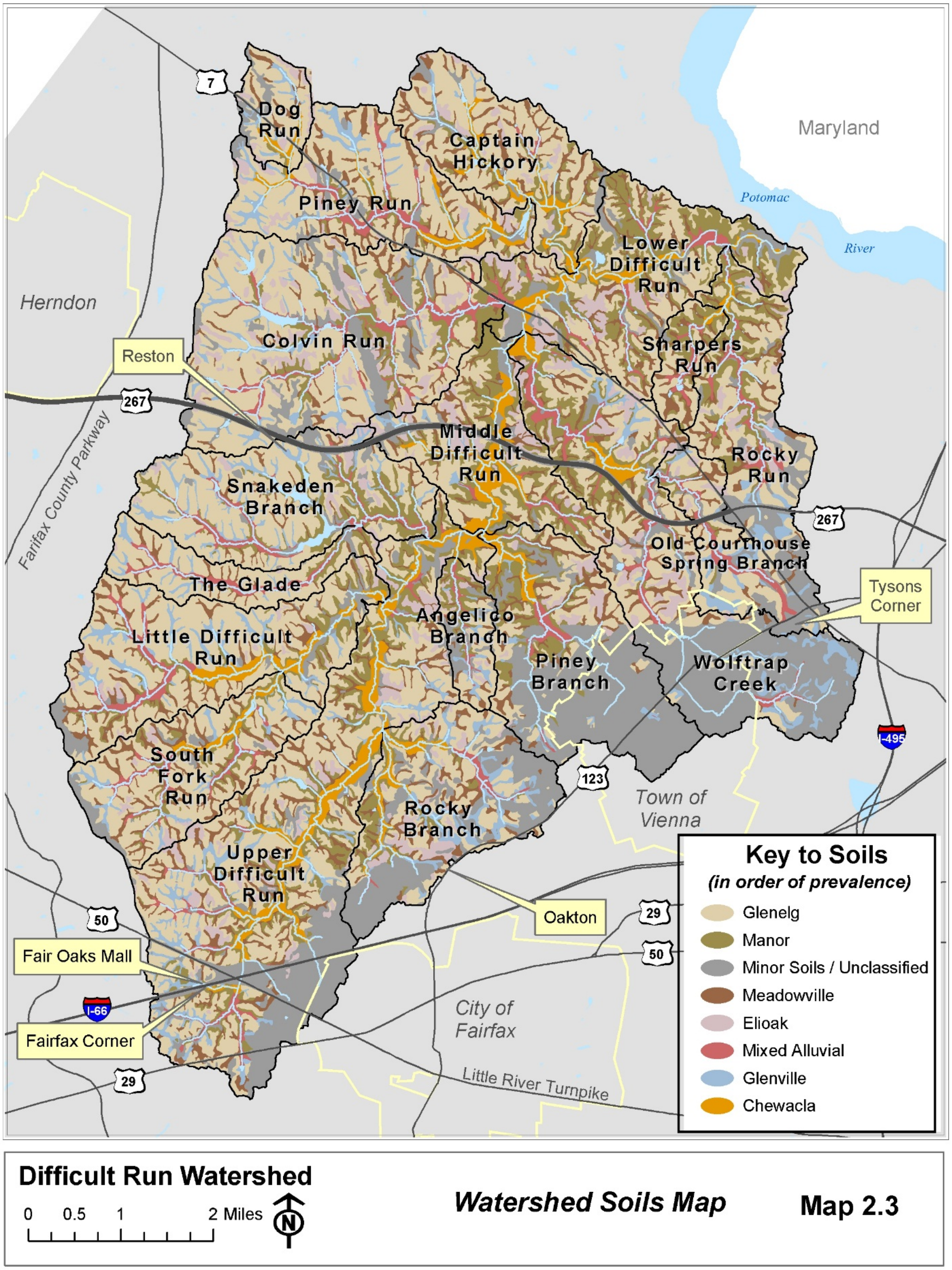
Soils affect the stream condition by differing in properties such as erosion potential and drainage. Soil characteristics can have an impact on the types of watershed issues that may occur and the types of solutions that are feasible. There are 41 different soil types found within the watershed; of these 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



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

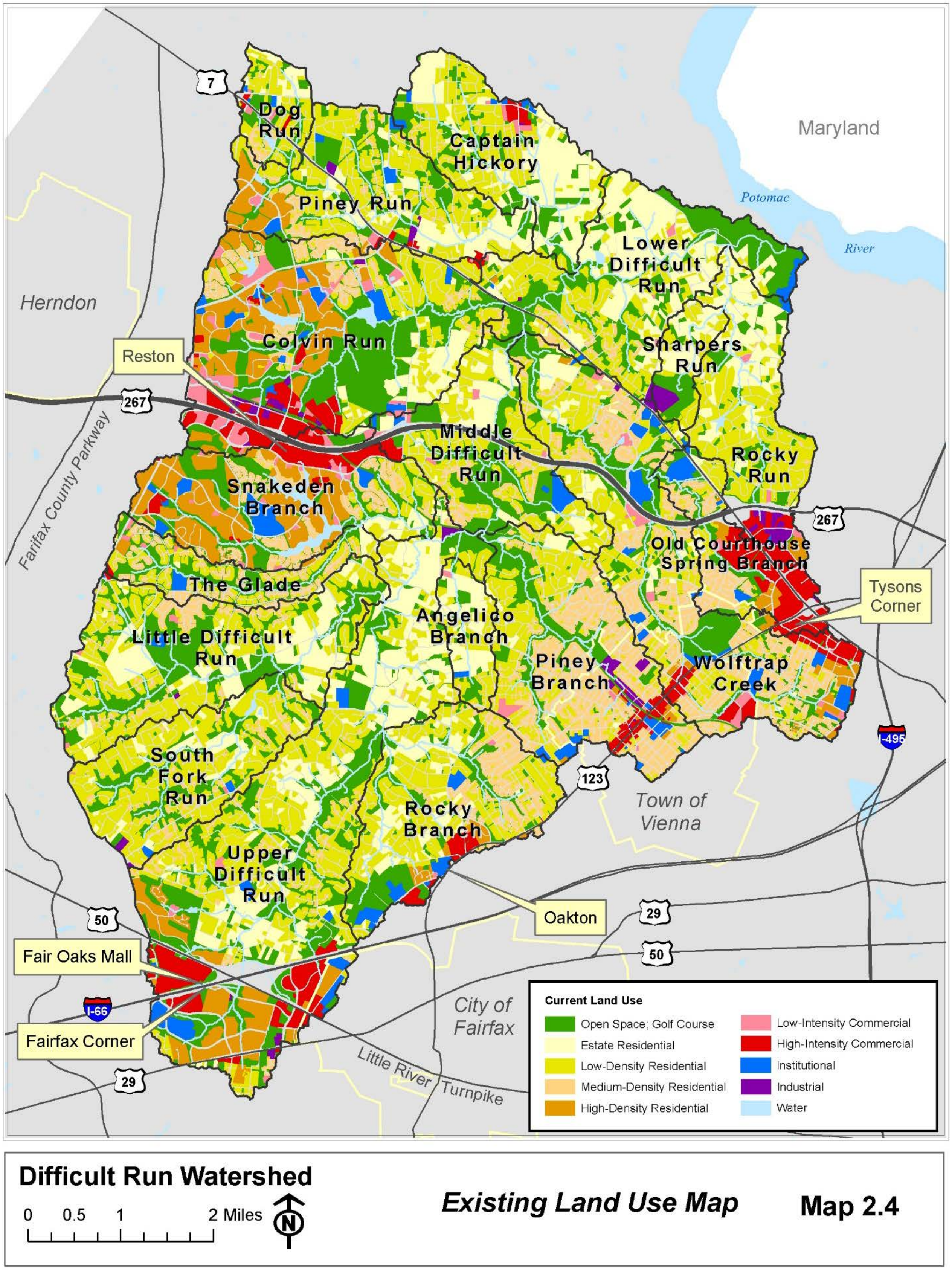
Future land use, shown in Table 2.7, was derived from a compilation of zoning and general land use plan information. A full description of the future land use methodologies can be found in Appendix B.

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

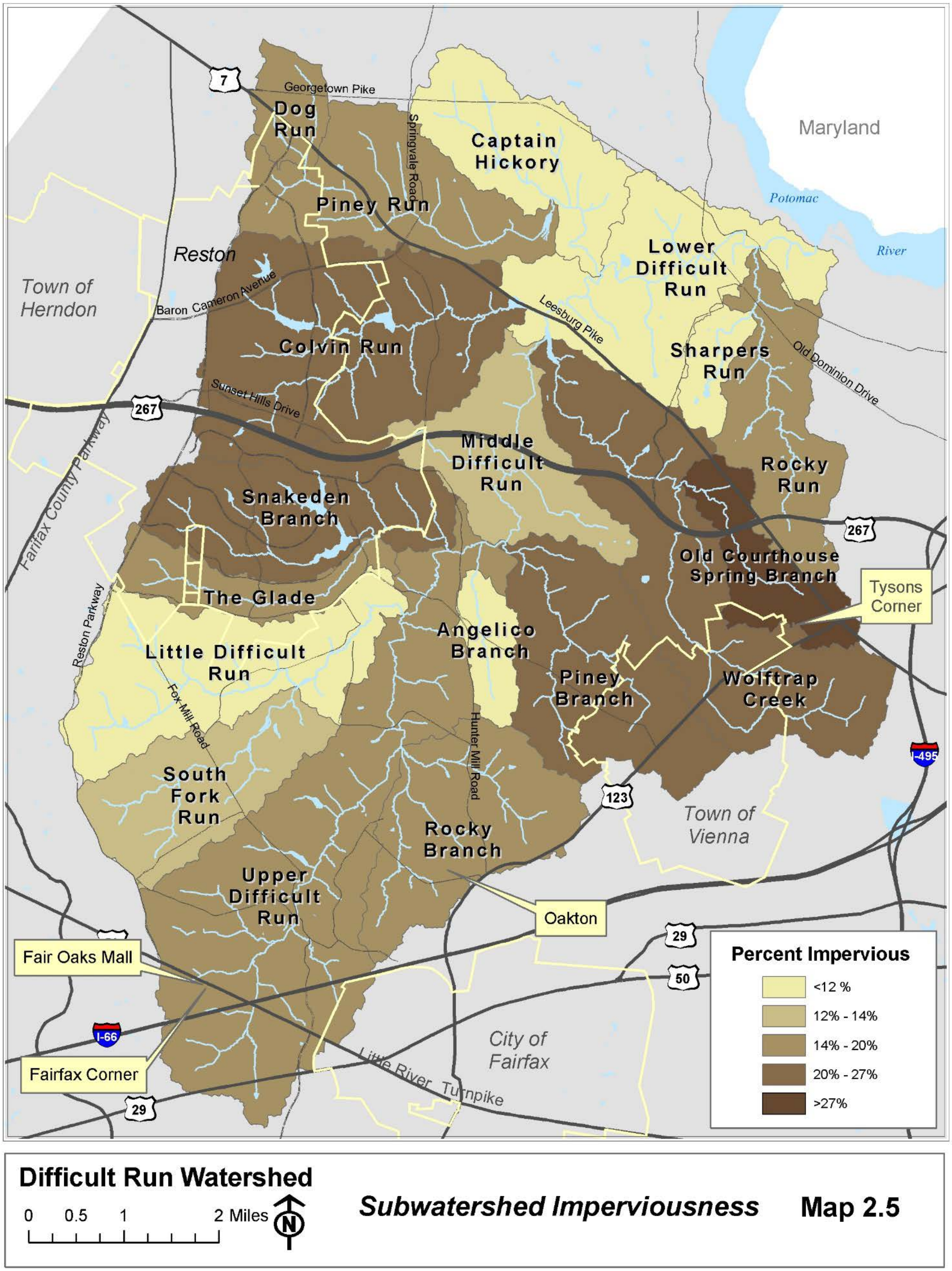
Future imperviousness was determined based on the assumption that the amount of impervious surface would not change in areas where the land use remained the same for existing and future conditions. The procedure is described in detail in Appendix B, and included the following steps:

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

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

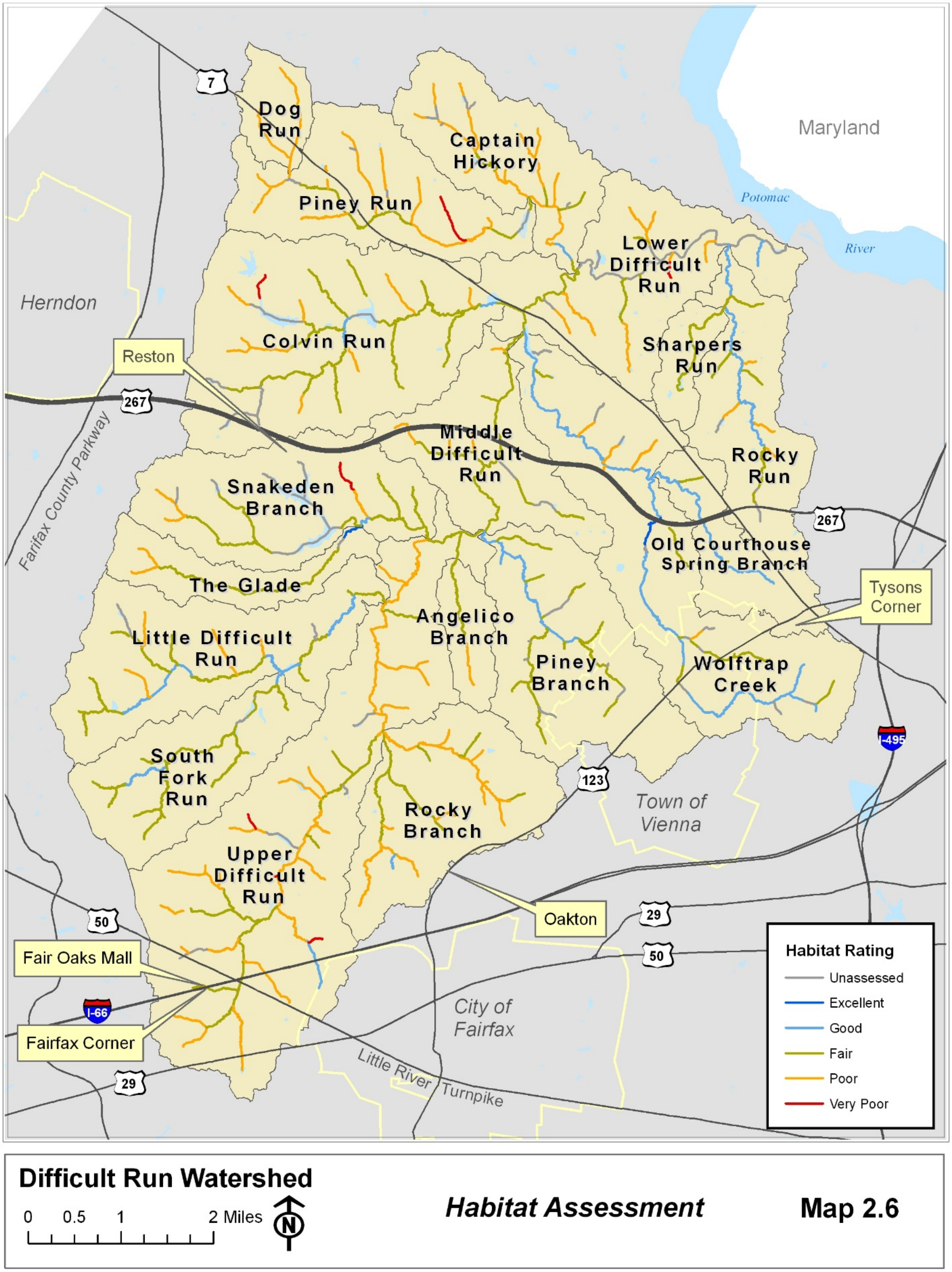
2.7.2 Stream Geomorphology

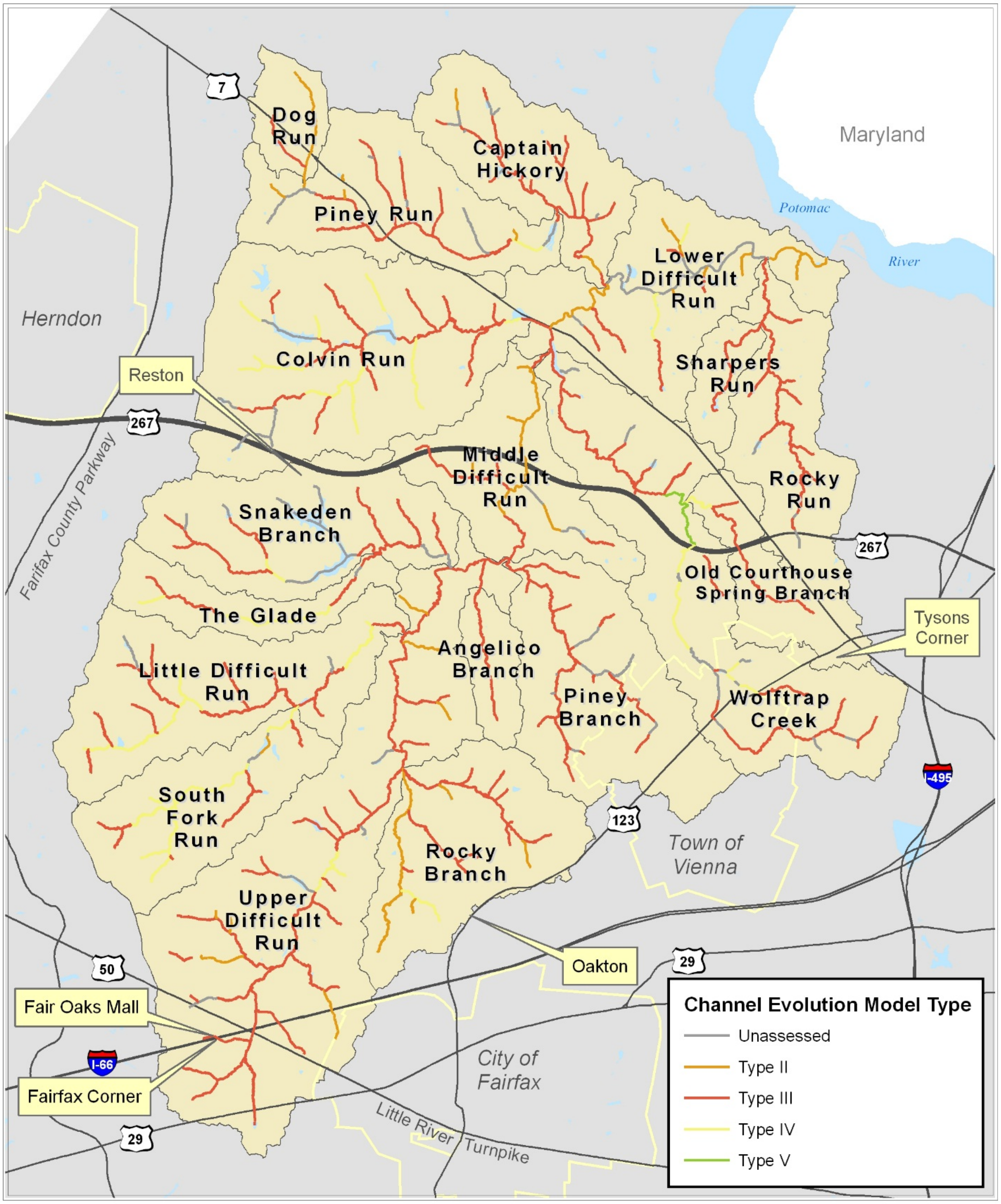
Geomorphology describes how a stream channel adjusts to changes in its watershed. In an undeveloped natural setting, the adjustment is a slow erosive process forming a dynamically stable channel. The size and shape of the stream channel are dependent on the type of soils, the steepness of the grade and 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.


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
The Glade
Tysons Corner
Angelico Branch
Little Difficult Run
Piney Branch
Wolftrap Creek
South Fork Run
Town of Vienna
Rocky Branch
Upper Difficult Run
Oakton
Fair Oaks Mall
Fairfax Corner
City of Fairfax
Little River Turnpike
7
267
123
29
50
I-66
I-495
Habitat Rating
Unassessed
Excellent
Good
Fair
Poor
Very Poor
Difficult Run Watershed
0 0.5 1 2 Miles
N
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

3 Subwatershed Condition and Plan Action

3.1 Introduction

The following sections provide individual descriptions of the 18 Difficult Run **subwatersheds**, the problems within each of the subwatersheds, the candidate sites that were selected for further investigation and the watershed action, or projects, that are proposed. Topics described for each subwatershed include the following:

- Subwatershed characteristics
- Existing and future land use
- Existing stormwater management
- Outfalls
- Stream crossings
- Soils
- Geomorphology
- Stream habitat and water quality
- Hydrology and water quality modeling
- Hydraulic modeling
- Candidate sites for improvements
- Subwatershed plan actions and recommendations

Mainstem of Difficult Run

The sections below provide background for the content and sources of information that is provided for each subwatershed.

3.1.1 Naming Conventions

Within the County's development of watershed plans, various spatial scales are used for evaluation. Watersheds are divided into subwatersheds, and subwatersheds have been further subdivided into **catchments**. Most analysis has been completed at the subwatershed and catchment levels. Each subwatershed is given a code that identifies its watershed and subwatershed. For example in the Difficult Run watershed (DF), the Captain Hickory Run (CH) subwatershed is coded DFCH. Catchments within the subwatershed are numbered sequentially with a four-digit number. Catchments within Captain Hickory Run are coded DFCH0001, DFCH0002 etc. Additionally, the three subwatersheds along the mainstem have been further subdivided into Difficult Run Lower, Middle and Upper, designated by the addition of L, M or U following the four digit code. Codes for each of the 18 subwatersheds are shown below in Table 3.1.

3.2 Subwatershed Characteristics

The location of each subwatershed and general characteristics are described. Stream lengths and a general stream description are included. Stream lengths are taken from the **geographic information system (GIS)** layers produced as part of the Stream Physical Assessment.

Table 3.1: Subwatershed Codes

Subwatershed	Code	Subwatershed	Code
Angelico Branch	DFAB	Old Courthouse Spring Branch	DFOR
Captain Hickory Run	DFCH	Piney Branch	DFPB
Colvin Run	DFCR	Piney Run	DFPR
Difficult Run, Lower	DFDFL	Rocky Branch	DFRB
Difficult Run, Middle	DFDFM	Rocky Run	DFRR
Difficult Run, Upper	DFDFU	Sharpers Run	DFSP
Dog Run	DFDG	Snakeden Branch	DFSB
The Glade	DFGL	South Fork Run	DFSF
Little Difficult Run	DFLD	Wolftrap Creek	DFWC

3.2.1 Existing and Future Land Use

Analysis of both the existing and future land use is critical to the success of any watershed plan as the land use can have a great impact on the stream system. The type and density of land use in a given area can affect the downstream water quality and stream condition. Each land use type introduces issues to the natural stream system. For example, agricultural land may contribute to higher nutrient **runoff**, while an urban area may contribute greater quantities of stormwater runoff. More intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute runoff and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

Changes in the land use that result in overall higher intensity uses in the future can result in stream degradation. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition through an increase in impervious surfaces. The land use plays an important role in the hydrology and water quality modeling.

The land use data presented in this section is based on the updated GIS land use layer provided by Fairfax County. The 2002 County aerial photography was overlayed with the 1997 land use coded parcel layer. The parcel layer was then updated to match the 2002 photo conditions. In most cases changes we made by recoding the parcel layer. In some instances the actual parcel boundaries were adjusted to match the 2002 data. Future land use was determined through analysis of the Fairfax County future land use GIS data, the County's Comprehensive Plan and Mapping, and the Reston Master Plan. The full land use mapping and imperviousness procedure can be found in Appendix B.

3.2.2 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. **Stormwater management facilities** can serve multiple purposes depending on their design. Most facilities constructed prior to 1994 are designed for quantity control only, indicating that they are intended to prevent excessive flows from eroding channels downstream of the facility. Most facilities built after 1994 are designed not only to retain large amounts of stormflow, but also to filter out pollutants that are found in runoff from smaller rainfall events, thereby decreasing the amount of pollutants leaving the facility in an attempt to maintain good water quality downstream of the facility.

Private and public stormwater management facilities are taken from information in Fairfax County's GIS. Information is presented for the percent of area within each subwatershed that receives no stormwater control, that which receives quantity control, and finally, that, which receives both quantity and quality control. Both regional ponds and smaller site-specific ponds are included. Stormwater management facilities are listed in Appendix D. Additionally, the current Master Plan Drainage Projects can be found in Appendix C.

Outfalls

Outfalls, pipes and ditches are the connection between stormwater systems and natural streams and thus are vitally important to the effectiveness of stormwater management and the health of the receiving waters. Field crews collected outfall information as part of the Infrastructure Inventory portion of the Stream Physical Assessment, which was conducted in the fall of 2002 in support of the County's watershed management plans. Outfalls were assessed for erosion and water quality if flowing. In-depth descriptions of the type of data collected by field crews can be found in the Fairfax County Stream Physical Assessment Protocols manual, which includes operating procedures and all field forms. Both qualitative and quantitative descriptions of the data are provided in this report where possible. A brief description of the methods used is provided in the Infrastructure Inventory discussion in Section 3.2.5.

Stream Crossings

Stream crossings are very common in urban and suburban stream systems such as Difficult Run. Crossings are assessed because they are potential locations of erosion, sediment and flooding issues and can present impediments to movement and migration of fish and other aquatic organisms. Field crews collected outfall information as part of the Infrastructure Inventory portion of the Stream Physical Assessment, which was conducted in the fall of 2002 in support of the County's watershed management plans. Crossings were assessed for bed and bank erosion, sedimentation and structural stability. In-depth descriptions of the type of data collected by field crews can be found in the Fairfax County Stream Physical Assessment Protocols manual, which includes operating procedures and all field forms. Both qualitative and quantitative descriptions of the data are provided in this report where possible. A brief description of the methods used is provided in the Infrastructure Inventory discussion in Section 3.2.5.

3.2.3 Soils

Soil erosion and sedimentation play a major role in overall stream health. Erosion is the movement of soil due to wind, rain and related natural forces that carries surface soil toward streams. Although this is a natural process, human activities, such as construction and agriculture, can greatly increase the rate of erosion.

Sedimentation occurs when water carrying the eroded soil particles slows enough to allow the particles to settle out and cover the substrate. Sedimentation can reduce storage volume in reservoirs and stormwater ponds and clog streams. Sediment can affect the physical, chemical and biological water quality and overall ecology of the receiving stream. Smaller particles, such as clays, can stay suspended in the water for very long periods contributing to water **turbidity** or reduced clarity. Chronic suspended solids can also inhibit photosynthetic plant growth. Sedimentation can destroy fish spawning beds, smother benthic invertebrates and submerged aquatic vegetation, destroying essential foods and habitat for fish species. Additionally, sediment can carry organic matter such as animal wastes, nutrients, chemicals and pesticides that may be toxic to aquatic plants and animals.

Soil information is provided for each subwatershed within the Difficult Run watershed. Soil information was obtained from the *Soil Survey of Fairfax County* (NRCS, 1963). Updates to the 1963 survey were added by the Fairfax County Soil Science Office between 1966 and 1990. Those additions were included in the GIS soils data used for the study.

Because there are well over 100 mapped soil types in Fairfax County the number of soils found in each subwatershed is also very high. Therefore, for each subwatershed, the percent coverage of each soil is included only for soils that cover at least 20 acres. Soils are divided for each subwatershed based on their erodibility and drainage properties. Soil erodibility is an estimate of the ability of soils to resist erosion, based on the physical characteristics of each soil type. Generally, soils with higher infiltration rates are less susceptible to erosion. Sand, sandy loam and loam textured soils tend to be less erodible than silt, very fine sand, and certain clay textured soils. Soils on higher slopes (hillside slopes and sloping uplands, for example) are also more susceptible to erosion.

Depth from the soil surface to groundwater is also very important. The closer the water is to the surface, the less chance there is for a pollutant to be filtered and broken down in the soil prior to reaching groundwater and eventually an open stream channel. Information is provided for soils with shallow water tables or shallow depth to bedrock. Information is provided for the hydrologic soil groups.

Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D. Where A soils generally have the smallest runoff potential (high infiltration) and Ds the greatest runoff potential (low infiltration).

Group A is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This group has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material. Information on the soil types found within each subwatershed can be found in Appendix A.

3.2.4 Geomorphology

The assessment of the stream channel **geomorphology** in the Difficult Run watershed is based on the Channel Evolution Model (CEM) by Schumm et al. (1984). The CEM assessment was conducted in the fall of 2002 as part of the Stream Physical Assessment. The model is based on a stream channel's response to anthropogenic activity. Channel types are categorized based on morphological characteristics that are believed to represent an evolutionary stage in a stream channel's response to disturbance. Each assessed stream segment within the Difficult Run watershed was assigned to a category based on visual observation of the channel cross section and other morphological observations. Additionally, cross-section measurements were taken at representative points along the channel. There are five CEM channel types. They are presented in Figure 3.1.

Types II and III are considered the stages that are the most unstable. In Type II, the channel begins adjusting to the higher volumes of flow, higher rates of flow, and more frequent high flows that typically result from changes in land use and increases in impervious surface. The channel first reacts to the higher flows by downcutting in an attempt to increase the channel size. The process continues in Type III channels as the steep banks, that are a result of the downcutting from Stage II, erode and the channel widens.

The downcutting and overwidening of streams is remedied by first controlling the flows through stormwater management techniques and then stabilizing the stream through stream restoration.

Figure 3.1 CEM Types

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

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

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

Type IV – In Stage IV the dominant physical process is sediment aggradation. This stage is considered the beginning phase of stream stabilization after disturbance.

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

3.2.5 Stream Habitat and Water Quality

Stream condition information is provided by the Stream Physical Assessment, which included habitat assessments and an inventory of physical habitat problems and infrastructure features.

Habitat Assessment

The Georgia Department of Natural Resources (GADNR) Barbour and Stribling habitat assessment protocol was adopted for the Countywide program with minor modifications. This protocol uses 10 habitat assessment parameters with scores ranging from 0 (worst condition) to 20 (optimal condition). All streams within the Difficult Run watershed are classified as **riffle/run** streams, characterized by high gradient and primarily course sediment substrates. The riffle/run habitat assessment was used. The parameters are presented in Table 3.2 with a brief description. Habitat assessments were conducted throughout the Difficult Run watershed to develop a complete picture of the instream and riparian conditions. The scores from each parameter are combined to produce an overall qualitative narrative rating of very poor, poor, fair, good or excellent.

Table 3.2: Habitat Assessment Parameters

Habitat Parameter	Description of Parameter
Instream Habitat	a measure of the streams suitability for aquatic organisms
Epifaunal Substrate	a measure of the availability of benthic habitat for aquatic macroinvertebrates
Embeddedness	a measure of the amount of fine sediment surrounding substrate rocks
Channel/Bank Alteration	a measure of anthropogenic disturbance
Sediment Deposition	a measure of sediment accumulation and resultant substrate modification
Riffle Frequency	an estimate of the frequency of riffles which are considered a high-quality habitat
Channel Flow Status	a measure of the degree to which the channel bed is covered by water. A decrease in water and subsequent decrease in wetted area reduces the available habitat for aquatic organisms
Bank Vegetative Protection	a measure of the banks ability to resist erosion and uptake nutrients
Bank Stability	a measure of the stream’s erosion potential
Vegetative Buffer Zone Width	a measure of the width and condition of the vegetation alongside and within the flood limit of the stream

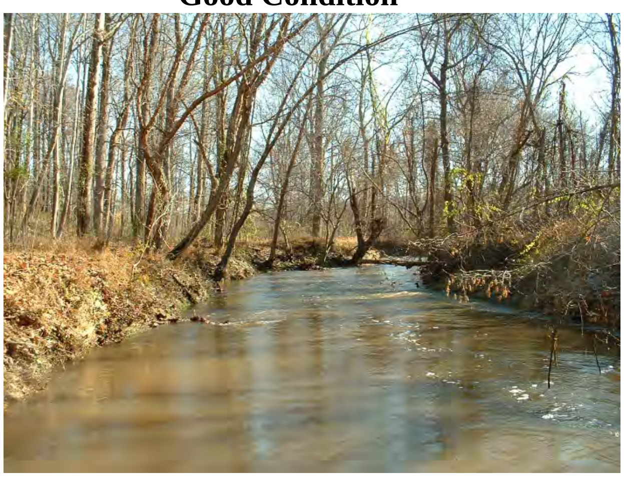
Infrastructure Inventory

The infrastructure inventory conducted by field crews during the 2002 Stream Physical Assessment includes all structures that may be potential sources of contamination or areas that have the potential for improvement. Information was collected for pipes, ditches, stream obstructions, dump sites, head cuts, utilities, erosion problem areas, stream crossings, and areas of deficient riparian buffer. With the exception of utilities, which are rated on a scale of 20, all infrastructure points are rated on a scale of 0 to 10 based on their perceived impact on stream integrity. The 0 to 10 scale corresponds to None (0) to Severe (10) impact. A brief description of the type of data collected as part of the infrastructure inventory and impact descriptions are included below (descriptions are from the *Fairfax County Stream Physical Assessment Protocols,* February 2004 Revision).

Deficient Buffer Areas *(scale of 0 – 10)*: These are areas within 100 feet of the streambank that are not forested. Scores are assigned and recorded separately for each bank and are an indication of the impact the deficient buffer has on the stream channel.

- *Extreme (10)*– Impervious/commercial area is in close proximity to the stream. Stream banks may be modified or engineered. Stream character (bank/bed stability; sediment deposition, and/or light penetration) is obviously degraded by adjacent use.
- *Severe (7)* – Some impervious and/or turf only up to bank and water. There is very little vegetation aside from turf within the 25-foot zone. There may be a home site very close to stream. The stream character is probably degraded by adjacent use.
- *Moderate (5)* – Buffer encroachment is mostly from residential uses and lawn. There is some vegetation within the 25-foot zone, but very little aside from turf within the remainder of the 100-foot zone. The stream character may be changed slightly by adjacent use.
- *Minor (2)* – The vegetated buffer primarily consists of native meadow. (Not Grazed)

Good Condition



Poor Condition

Areas of Erosion *(scale of 0 – 10)*: These are areas of active erosion that are at least 2 – 3 feet high. The height and length, in feet, of erosion and impact scores are recorded separately for each bank separately.

- *Extreme (10)* – Impending threat to structures or infrastructure
- *Severe (7)* – Large area of erosion that is damaging property and causing obvious instream degradation. Eroding bank is generally five feet or greater in height.

- *Moderate (5)* – Moderate area of erosion that may be damaging property and is creating some instream degradation. Eroding bank is generally two feet or greater in height.

Good Condition

Poor Condition

Obstructions *(scale of 0 – 10)*: Obstructions that are causing erosion problems or are causing flooding of manmade structures are recorded. Beaver dams are included as obstructions but are scored as zero impact unless significant bank damage is evident. Notation is also made concerning the obstructions impact on fish passage.

- *Severe (10)* – Blockage is causing significant erosion problem and/or creating potential for flooding that can cause damage to infrastructure. The stream is usually almost totally blocked (greater than 75 percent blocked).
- *Moderate (5)* – Blockage is causing moderate erosion and could cause flooding. Stream is only partially blocked, but the obstruction should probably be removed because the problem could worsen.
- *Minor (3)* – Blockage is causing some erosion problems and has the potential to worsen and probably should be looked at and/or monitored.

Poor Condition

Dump Sites *(scale of 0 – 10)*: Dump sites include all areas where inappropriate materials have been disposed. Yard waste and other organic debris is included if it is directly in the stream.

- *Severe (10)* – Active and/or threatening sites. Dumpsite material may be considered toxic or threatening to the environment (concrete, petroleum, empty 55 gallon drums, etc.) or the site is large (greater than 2,500 square feet and appears active.
- *Moderate (5)* – Dumpsite is less than 2,500 square feet and is non-toxic material. The dump site does not appear to be used often, however clean-up would definitely be a benefit.
- *Minor (1)* – Dumpsite appears small (less than 1,000 square feet) and materials are stable (will not likely be transported downstream by high water). These sites are not considered a high priority.

Poor Condition

Head Cuts *(scale of 0 – 10)*: A head cut is an erosional feature in which a sudden change in stream bed elevation occurs resulting in a small waterfall feature. Flow over the headcut results in a lowering of the stream bed elevation on the downstream side. The headcut will migrate upstream creating a deeper channel as it porgresses. Only active head cuts were recorded.

- Head Cut height greater than two feet *(10)*
- Head Cut height is equal to two feet *(5)*
- Head Cut height is equal to one foot *(3)*
- Head Cut height is less than one-half-foot or is inactive *(1)* (not recorded)

Poor Condition

Pipes and Drainage Ditches *(scale of 0 – 10)*: All drainage pipes and ditches were recorded. Information on each includes size and distance from channel, material, discharge (if present), and source of discharge (if known). The impact score assigned refers to the impact that the pipe or ditch has on the stream channel.

- *Severe (10)* – Storm flows through ditch or pipe is causing a significant erosion problem to stream bank or stream and/or the discharge that is coming from pipe appears not to be stormwater.
- *Moderate (5)* – Storm flows through ditch or pipe is causing a moderate erosion problem and should be fixed. The problem may get worse if left unattended. OR Discharge may be coming from pipe, probably stormwater but cannot be sure without further investigation.
- *Minor (0)* – Storm flows through ditch or pipe is not causing erosion problem and no discharge is occurring.

Poor Condition

Public Utility Lines *(scale of 0 – 20)*: This includes all exposed utility lines and manholes. Information on utility type was also collected if known.

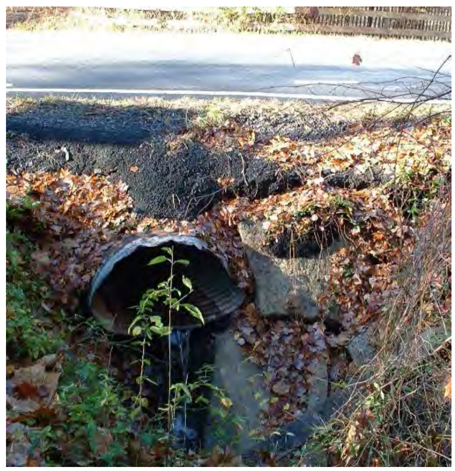
- *(20)* – Utility line is leaking.
- *(10)* – Exposed utility line is causing a significant erosion problem and/or obstruction (blockage) OR if sanitary line, potential to burst or leak appears high.
- *(7)* – Half exposed utility line is causing moderate erosion problem.
- *(5)* – Utility line is partially visible but mostly buried in stream bed. There is little if any erosion associated with the utility line.
- *(3)* – Utility line is exposed but is stabilized with concrete lining and stable anchoring into the bank.

Poor Condition

Road and Other Crossings *(scale of 0 – 10)*: All stream crossings, including foot bridges and man made fords were included. Information on upstream and downstream structural integrity and blockages was also included.

- *Extreme (10)* – Condition of debris, sediment, or erosion poses immediate threat to structural stability of road or other structure. Major repair will be needed if problem is not addressed.
- *Severe (7)* – Condition probably poses threat to road or other structure. Problem should be addressed to avoid bigger problem in the future.
- *Moderate (5)* – Condition does not appear to pose threat to road or other structure, but should be addressed to enhance stream integrity and future stability of structure.
- *Minor (2)* – Condition is noticeable, but may not warrant repair.

Poor Condition



3.2.6 Hydrology and Water Quality Modeling

Computer modeling of watershed processes is one of the key methods used to determine where there are problems and how effective a particular solution might be in correcting a problem. Hydrology modeling simulates how rainfall either infiltrates into the ground or runs off the land to enter the stream system. It provides a way to estimate the amount of runoff and the peak streamflow or **discharge** that results from changes in land use or stormwater management.

Water quality modeling is used to provide estimates of **pollutant loading** that can be used for planning. Three significant pollutants modeled for the Difficult Run Watershed Plan are total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS).

Hydrology and water quality were modeled for each subwatershed and **catchment** in the Difficult Run watershed. The models used in the plan incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams, and stormwater management to generate estimates of water quality and streamflow.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of what the land would look like if the lots were all developed to the highest density allowed by their zoning classification. The difference between the existing and future model results identifies areas that will need additional management measures.

Modeling of hydrology and water quality was conducted throughout the Difficult Run watershed using the PCSWMM model for both existing and future conditions. The results will identify problem areas and areas in need of improvements. The modeling discussed for each subwatershed includes the following.

Runoff volume:	reported in inches per year
Peak discharge:	reported in cubic feet per second
Total Nitrogen:	reported in pounds per acre per year for both runoff and septic sources
Total Phosphorus:	reported in pounds per acre per year for both runoff and septic sources
Total Suspended solids:	reported in pounds per acre per year for both runoff and septic sources

A more complete description of the modeling procedures can be found in Appendix E.

3.2.7 Hydraulic Modeling

Modeling of stream flow or **hydraulics** was conducted throughout the Difficult Run watershed using the HEC-RAS model. The model combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events.

Storm events are classified by the amount of rain that falls in 24 hours. The storms are then named by the probability of that storm event occurring within one year. The more rainfall in a storm, or the larger the storm event, the less likely it is to occur in any given year. Hence, a 1-year storm (likely to occur once every year) is smaller with less rainfall than a 10-year storm (likely to occur once every ten years).

Flooding occurs at road crossings when the crossings are not large enough to pass the streamflow during a storm. For larger roads that carry through traffic, called primary roads, the crossing must be large enough to permit the 25-year storm event to flow completely through it without flowing over, or overtopping, the road. For smaller roads used for access to residences or other local areas, identified as local roads, the crossing must permit the 10-year storm event to pass completely through.

The model results indicate where flooding of culverts and other structures may occur. The flow at these sites exceeds the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

3.3 Candidate Sites for Improvements

Candidate sites are those sites, stream reaches, or catchments that were identified to have a degraded condition and are potential areas for restoration. Additionally, areas that are currently in good condition but are vulnerable in the future due to changes in land use were selected as candidate sites for preservation. The full procedure used in the prioritization and selection process is located in Appendix G.

Candidate sites were selected from a combination of existing data sources, stream assessment data, model results and GIS data. The procedure consisted of using quantifiable indicators that describe the condition of the watershed with limited overlap, weighting them by importance, and then calculating a weighted average score for each area. This score is then used to rank them in priority order for restoration or preservation. Problems or overall condition were ranked and three different scales; sites, stream reaches and catchments.

A total of 253 candidate sites were selected for further field review and analysis based on the prioritization of problems in the catchments and at stream sites. Candidate sites were placed in several categories. The categories are listed below with its identifying code letter.

- Stream Restoration sites (S),
- Catchment sites (C),
- Regional pond alternatives sites (D),
- Flooding sites for roads (F) and
- Preservation sites (P).

Stream Restoration

A total of 88 Stream Restoration Sites were selected. Data from the Stream Physical Assessment were used to determine which sites were in the poorest conditions. Sites were typically selected if they showed two or more impairments in either habitat rating, channel morphology, stream erosion, bank stability, or riparian buffer. Notes on restoration potential recorded during the assessment were also taken into account.

Catchments

The 201 catchments in the Difficult Run watershed were ranked based on existing conditions using modeled peak discharge, runoff volume, nitrogen, phosphorus, suspended solids, and GIS calculations of the percent of the catchment in wetlands and forests. Each of the parameters was normalized according to the specific needs of the indicator and compiled into a single database. The value for each parameter was ranked within the range of values in the dataset. Scores from 1-10 were then applied to the ranked values.

The score for each catchment was then multiplied by the indicator weight to develop the weighted score. The weighted scores for all of indicators were then summed and placed on a 0-100 scale. Each catchment’s scaled score was then ranked within the 201 catchments. The lowest score indicates the lowest relative quality and the highest priority in the watershed. A total of 46 catchment sites received the lowest scores and were subsequently selected for restoration.

Regional Pond Alternatives

There are 52 known sites where Regional Ponds were planned but have not yet been built in Difficult Run. During the modeling task, the drainage area to each of these sites was delineated as one or more separate catchments, so it was possible to rank the unbuilt regional pond sites using the same prioritization scheme as the other areas of Difficult Run. Ranking results have been included with the catchments.

Flooding Sites for Road Crossings

Hydraulic modeling identified the culverts that were overtopped by any of the modeled storm years (1,2,5,10,25,50,100). The overtopping was then compared to the level of service for that road and the associated required flow that the road must pass. If the culvert did not pass the required flow it was selected as a candidate site. There were 89 culverts that overtopped for one or more storm flow, 34 were selected as candidate sites.

Preservation

A comparison between existing and future conditions model results was made to generate a ranking of vulnerability. The catchments that showed low pollutant loading for existing conditions and a large percent change between existing and future conditions were considered the most vulnerable to degradation and thus good candidates for preservation.

The threshold values for TSS, TN, and TP were used to determine good conditions. These were based on comparisons with values for the whole watershed, and with estimates of loadings from “irreducible concentrations” from stormwater runoff (Schueler, 2000). Values used to set the thresholds are shown in Table 3.3, in lb/ac/yr.

Table 3.3: Threshold Values for Preservation Candidate Sites

	TSS	TN	TP
Low	17.8	0.9	0.18
Average	63.1	2.8	0.41
High	197.9	7.9	0.92
Irreducible	20 to 40	1.9	0.20
Threshold	30.0	2.0	0.20

The percent change between existing and future loads was calculated. If one or more of the paramenters doubled (increase of 200% or more), then the catchment was flagged as a preservation candidate.

Similar to the existing conditions catchment ranking, the score for each catchment was multiplied by the indicator weight to develop the weighted score. The weighted scores for all of indicators were then summed and placed on a 0-100 scale. Each catchment’s scaled score was then ranked within the 201 catchments. The lowest score indicates the highest vulnerability and the highest priority in the watershed for preservation. A total of 34 catchment sites were selected.

3.3.1 Approach to Project Selection

The first step in developing stormwater management or other restoration alternatives was to determine the objective for each candidate site. This was usually clear from the type of impairment, and included such things as reducing peak flows, pollutant loads, erosive streamflows, or the amount of runoff.

Following this step, field surveys were made to determine if there were any site constraints which would prevent certain types of improvements from being implemented, or opportunities that would make others more likely to be successful.

While in the field, project staff made recommendations for improvements using the following basic approach. The approach works upstream to downstream, and should provide reduction in erosive streamflows so that when any stream restoration projects downstream are designed, they should be less complex and more likely to be successful.

- Locate projects in the headwaters of the stream to reduce runoff quantity and provide quality control if possible. These types of controls could include:
  - retrofits of existing stormwater management facilities for extended drawdown and channel protection
  - new stormwater management facilities or culvert retrofits
  - LID retrofit practice such as infiltration or porous pavers
- Identify locations for water quality controls, such as the following:
  - Retrofits of existing facilities for water quality control
  - Installation of LID controls in older watershed areas

  - LID retrofits practices such as bioretention or filtration
- Identify stream restoration projects
  - Stream restoration
  - Buffer restoration

There were a number of occasions where no projects resulted even after a catchment or stream reach was identified as a candidate site. For catchment sites, this generally occurred because there were no retrofit measures which appeared feasible, because of topography, lack of available land, land ownership, or the type of development in the catchment. For stream restoration sites, typically the constraints such as forest clearing outweighed the potential benefits or the stream conditions had changed in the time between the Stream Physical Assessment and the field investigation for this plan.

3.4 Subwatershed Actions

The proposed actions are based on the recommendations of the project team with guidance from the community. They are organized by subwatershed and type of project, as follows:

Table 3.4: Recommended Project Types

Regional Pond Alternatives	Projects to retrofit areas without stormwater management, such as conversion of existing quantity controls to water quality BMPs; new structures such as ponds, wetlands, culvert retrofits, outfall treatments, and onsite systems designed to reduce stormwater impact at the lot level
Catchment Improvements	Projects to retrofit areas to reduce stormwater impacts, including the same types of projects recommended for unbuilt regional pond sites
Stream Restoration	In-stream projects, such as channel stabilization or riparian buffer restoration
Road Crossing Improvements	Projects designed to reduce the frequency of flooding of culverts and bridges
Non-structural Measures	Pollution prevention and programs to reduce pollutants from non-stormwater discharges
Preservation	Areas of high quality habitat or land cover that should be preserved as the area is developed in the future. Specific programs are described in Chapter 4.

A brief summary of each candidate site and the resulting projects are provided for each subwatershed. The projects are listed with the Impairment, Improvement Goals, the Site Investigation results and the Projects and Actions that are generated.

The following sections provide a short description of each type of project that is proposed. Table 3.5 at the end of the descriptions provides more detail on the benefits that can be anticipated from the project types.

Stormwater Pond Retrofits

Description Stormwater ponds are designed to improve water quality by increasing pollutant removal. The amount of water treated (water quantity) can be improved by increasing the time the stormwater stays in the pond, making the pond bigger, and/or adding to the land area that drains to the pond. The addition of wetlands adds habitat, in addition to improving water quality.

Practices Retrofitting existing stormwater management ponds to increase pollutant removal includes:

- Adding small pools within the larger pond
- Creating multiple pond cells within a single pond
- Creating wetland areas within the pond
- Creating a forebay to capture sediment before it enters the pond
- Reconfiguring the pond and the landscape to capture more stormwater

Figure 3.2 Wet Pond

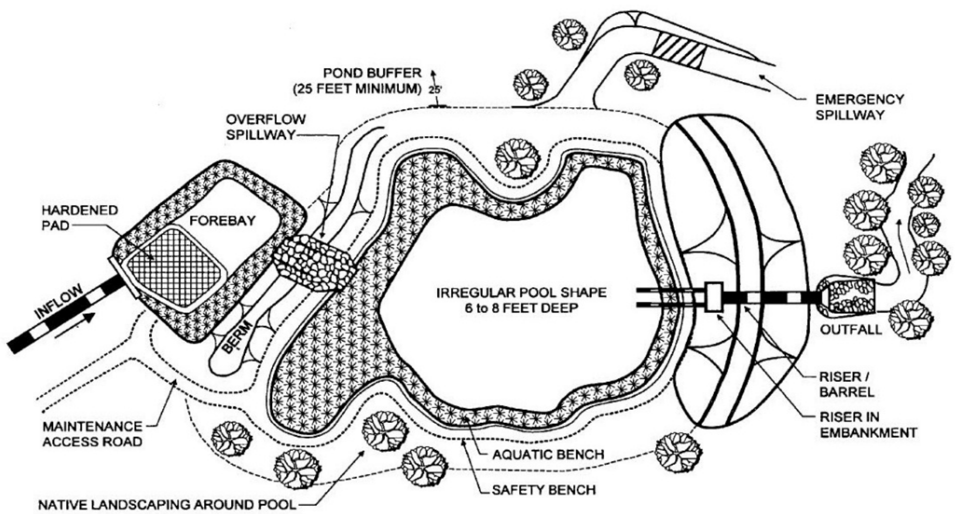
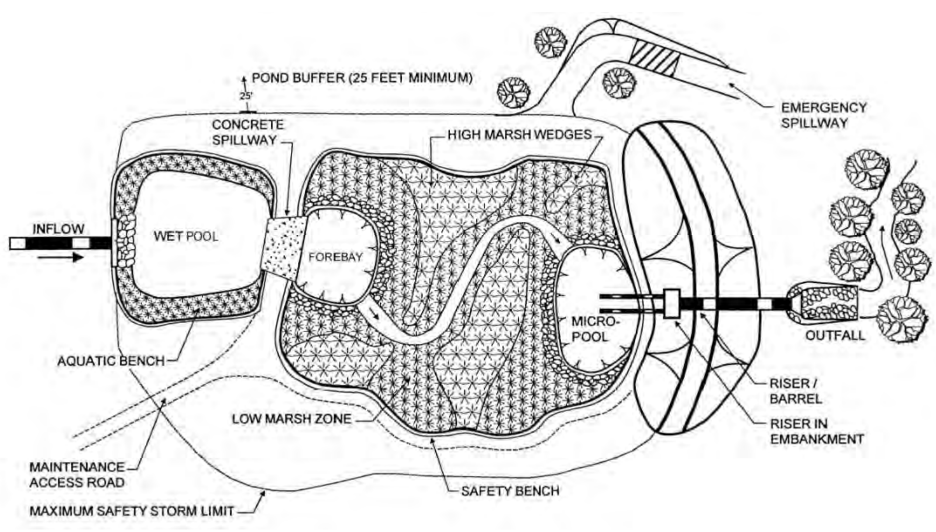


Figure 3.3 Pond/Wetland System



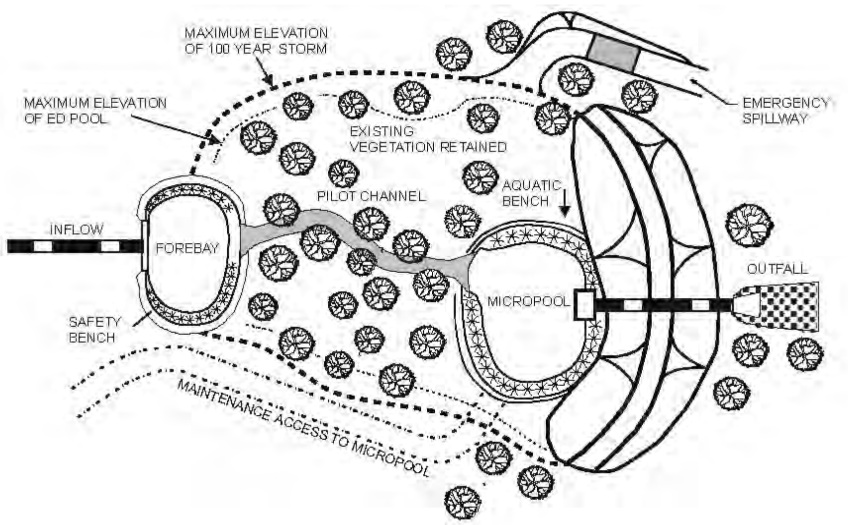
Source: *Maryland Stormwater Design Manual, Volumes I & II*. Performance Criteria for Urban BMP Design. Maryland Department of the Environment, 2000.

New Ponds

Description New ponds are designed to help reduce the impacts of stormwater runoff by either permanently or temporarily storing the water. This reduces both the amount of runoff delivered to receiving streams and the timing of that delivery. This helps to protect streams from land use changes in their watersheds. New ponds also improve water quality by allowing pollutants to settle.

Practices Wet ponds provide the most pollutant removal followed by extended detention and dry ponds. Extended detention ponds store runoff temporarily after a rainfall event. Extended detention ponds may have a permanent pool, be dry, or contain a wetland marsh. Dry ponds release stormwater runoff slowly after a storm event and provide temporary storage.

Figure 3.4 Micropool Extended Detention Pond



Source: *Maryland Stormwater Design Manual, Volumes I & II*. Performance Criteria for Urban BMP Design. Maryland Department of the Environment, 2000.

Stream Restoration

Description Stream restoration takes a holistic view of the stream system in the context of its watershed and addresses improvements to the stream bed, streambanks, and the low flow or aquatic channel. The goal of stream restoration is to return the stream to a stable state in which it neither significantly erodes or fills with sediment and has improved habitat conditions.

Practices Five treatment options are proposed in the plan, based on the type of impairment and constraints such as availability of adjacent land. The treatment options for each stream restoration project are specified in the concept plans included in Volume 2 of the watershed plan. For all of these projects, structures based on natural stream bed forms are created if necessary. Bioengineering techniques, and in some cases more traditional treatments, are used to provide for non-erosive stream banks. Wood and stone structures can be used to concentrate stream flow to the center of the channel to provide a good flow depth for aquatic life between storm events.

<u>Treatment Options for Incised Streams (CEM Type II)</u>

1. Option 1 creates a new meandering channel on a new alignment at its original floodplain elevation. The abandoned incised channel is either filled or converted into wetland ponds. This option is the most effective at restoring historical floodplain functions.
2. Option 2 creates a new, meandering channel with a new floodplain built at an elevation lower than the original floodplain elevation. This option does not reconnect to the original floodplain lost due to incision, but creates a new floodplain at a lower elevation. The new channel typically follows the general alignment of the incised channel, but with a stable planform.

<u>Treatment Options for Incised Streams (CEM Type II) or Widening Streams (CEM Type III)</u>

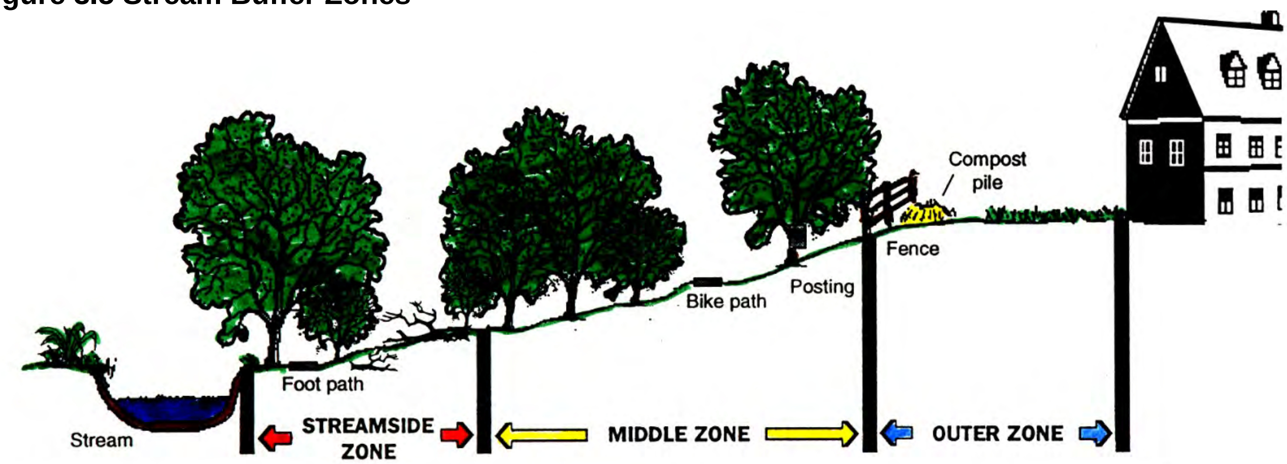
3. Option 3 stabilizes the channel by converting to a more stable stream type. Typically, these projects include, adjusting cross-section, reducing bank slope, and creating a new floodplain bench. This alternative includes different treatments for Type II and Type III streams. For incised channels with no room to increase meander width, Treatment 3A includes using grade controls to stop incision, flatten the slope of the stream and dissipate stream energy. For either incised or widening streams, Treatment 3B involves grading the banks and creating a nested channel with a new floodplain similar to a CEM Type V within the incised or widened streambed.
4. Option 4 stabilizes channels at the existing bed elevation and along the existing alignment. These projects are proposed where options 1-3 are not feasible. This approach is the traditional armor in-place approach to address incised channels and bank erosion. Treatment 4A involves grading and earthwork to lay back oversteepened banks and create a more stable cross-section. Treatment 4B is the traditional armor-in-place approach, with imbricated rip rap or bioengineering materials.
5. Option 5 projects consist of excavating the existing channel and reconstructing a new low-flow channel as part of a SWM facility providing storage volume to provide channel protection and water quality improvements downstream.

Stream Buffer Restoration

Description The vegetated land area on either side of a stream is referred to as the stream or riparian buffer. Buffers can be comprised of grasses, shrubs, trees, or a combination of the three. Forested buffers provide streambank stability, food for aquatic life, and shading of the stream. Stream buffers also provide important wildlife habitat. In many urban areas, stream buffers have been impacted. Restoring vegetation to these areas can improve the quality of the stream. Buffer restoration projects can be incorporated into streambanks stabilization and stream restoration projects to encourage multiple water quality and habitat benefits.

Practices The three types of buffer restorations are water pollution hazard setbacks, vegetated buffers, and engineered buffers. Water pollution hazard setbacks are areas that may create a potential pollution hazard to the waterway. By providing setbacks from these areas in the form of a buffer, potential pollution can be avoided. Vegetated buffers are any number of natural areas that exist to divide land uses or provide landscape relief. Engineered buffers are areas specifically designed to treat stormwater before it enters into a stream, shore or wetland.

Figure 3.5 Stream Buffer Zones



CHARACTERISTICS	STREAMSIDE ZONE	MIDDLE ZONE	OUTER ZONE
FUNCTION	Protect the physical integrity of the stream ecosystem	Provide distance between upland development and streamside zone	Prevent encroachment and filter backyard runoff
WIDTH	Min. 25 feet, plus wetlands and critical habitats	50 to 100 feet, depending on stream order, slope, and 100 year floodplain	25 foot minimum setback to structures
VEGETATIVE TARGET	Undisturbed mature forest. Reforest if grass	Managed forest, some clearing allowable	Forest encouraged, but usually turfgrass
ALLOWABLE USES	***Very Restricted*** e.g., flood control, utility right of ways, footpaths, etc.	***Restricted*** e.g., some recreational uses, some stormwater BMPs, bike paths, tree removal by permit	***Unrestricted*** e.g., residential uses including lawn, garden, compost, yard wastes, most stormwater BMPs

Source: Stormwater Manager's Resource Center www.stormwatercenter.net/

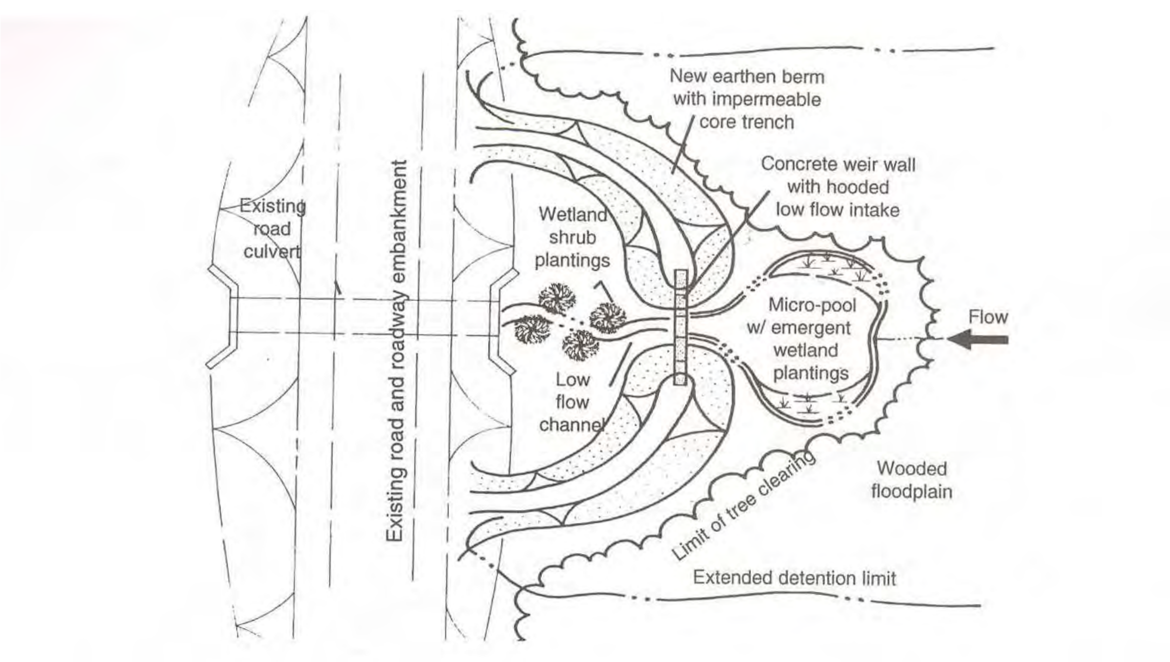
Road Crossing Improvements

Description	Culverts and bridges that can be flooded during a storm event may need improvements to reduce the frequency of flooding. Road crossings that were identified as having flooding problems based on hydraulic modeling have been compiled in Appendix F for further coordination with the Fairfax County Department of Transportation and the Virginia Department of Transportation.
Practices	These improvements can include raising the roadbed above the flood level, rebuilding culverts so they can pass more water, replacing worn or damaged culverts that impede water with newer ones that allow water to flow more quickly, or rebuilding bridges with a wider span to allow more space for floodwaters to pass.

Culvert Retrofits

Description	This retrofit option is installed upstream from existing road culverts by constructing a control structure and excavating a micro-pool. These projects are usually designed for intermittent streams. The control structure will detain and reduce stormwater flow; the micropool is a small pool that will infiltrate the first 0.1 – 0.2 inches of stormwater runoff, improving water quality.
Practices	If the upstream area is an open floodplain, it may be possible to construct a wet pond or stormwater wetland to improve water quality treatment. Since roadways are not always constructed as pond embankments, special measures may be necessary, such as a redundant embankment built upstream of the culvert. Secondary impacts need to be considered as well, including impacts to the 100-year floodplain, fish passage barriers, or impacts to wetlands and forest.

Figure 3.6 Culvert Retrofit



Source: Stormwater Manager's Resource Center www.stormwatercenter.net/

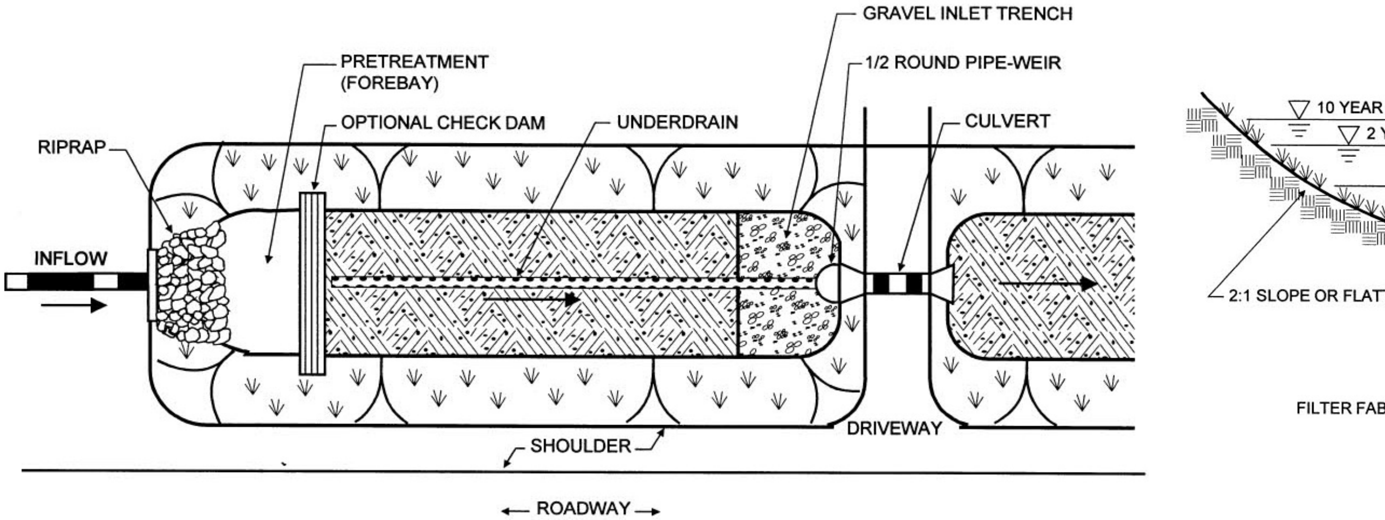
Drainage Retrofits

Description Drainage retrofits are designed to protect the natural stream channels in the watershed from fast draining water. These retrofits reduce the energy of the water flowing into and through streams, than can cause unstable streambeds and banks and erosion.

Practices Two basic types of retrofits are proposed. The first is to improve outfall structures to provide more energy dissipation and reduce scour and erosion. Methods include placement of rip rap, design of a plunge pool to break the flow of water, or provision of a designed energy dissipation structure which adds turbulence to reduce the velocity of the outfall discharge.

The second type is removal and replacement of concrete channels as roadside stormwater conveyances. Retrofit with grass channels, wet swales, or dry swales would increase stormwater detention time and reduce peak flows at the outfall.

Figure 3.7 Dry Swale



Source: *Maryland Stormwater Design Manual, Volumes I & II*. Performance Criteria for Urban BMP Design. Maryland Department of the Environment, 2000.

Low Impact Development (LID) Retrofits

Description — LID systems are designed to provide stormwater management on the site where runoff is generated, usually providing some reduction in stormwater, detention to reduce peak flows, and water quality treatment. The main objective is to mimic the pre-development runoff characteristics of the site.

Practices — LID systems that could be retrofit in the Difficult Run watershed include bioretention, infiltration, filter strips, sand filters, dry swales, wet swales, porous pavers, or proprietary filtration and bioretention systems.

Figure 3.8 Infiltration Trench

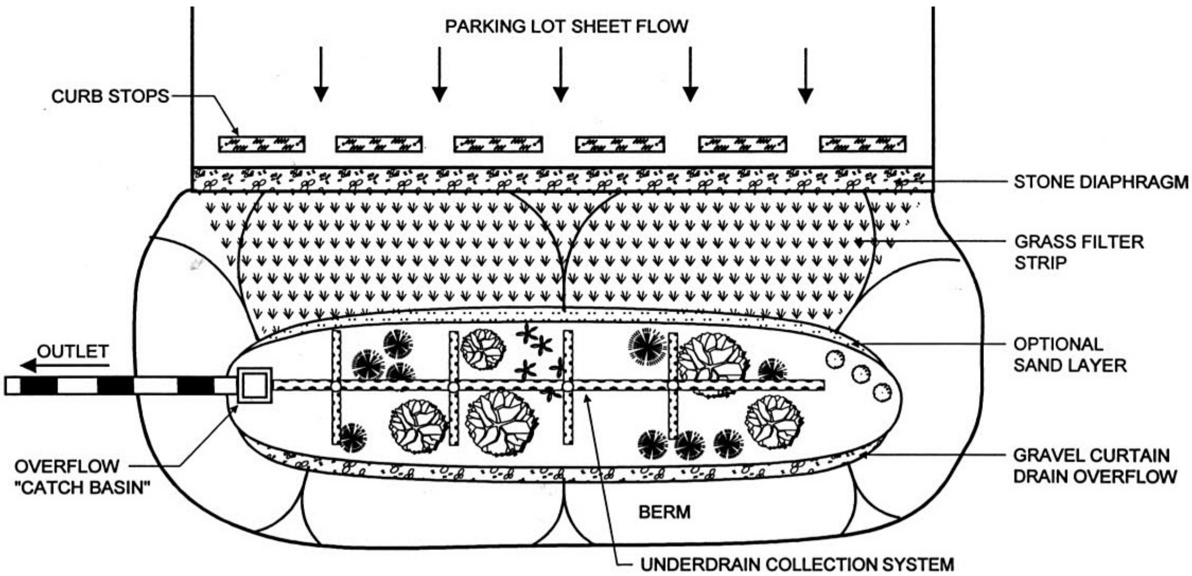


Figure 3.9 Bioretention

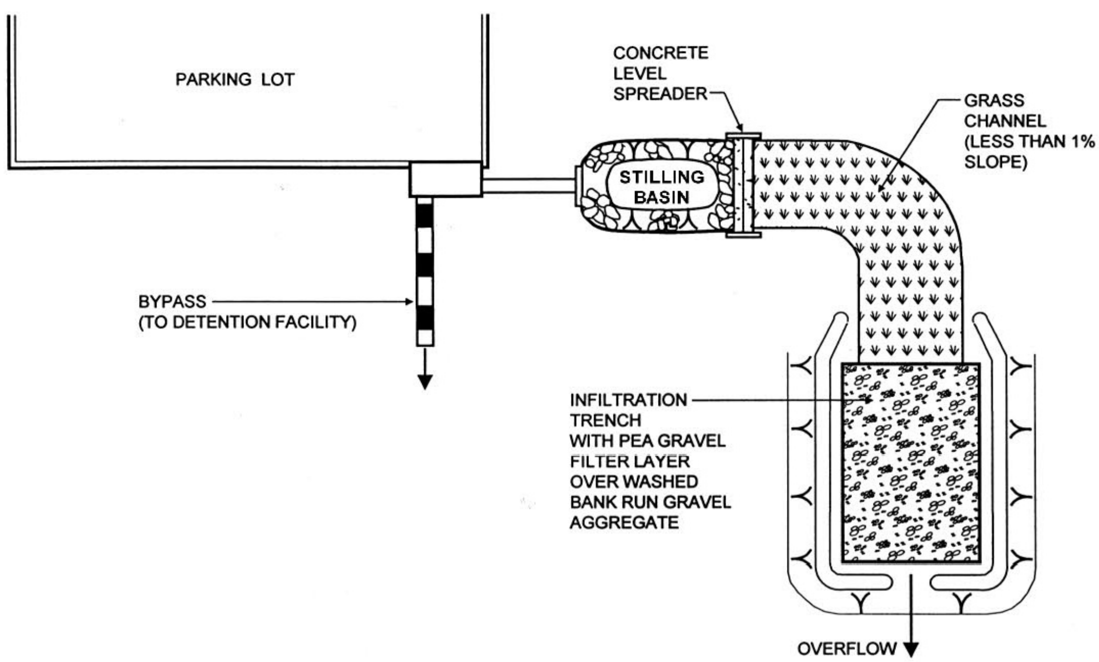


Figure 3.10: Sand Filter

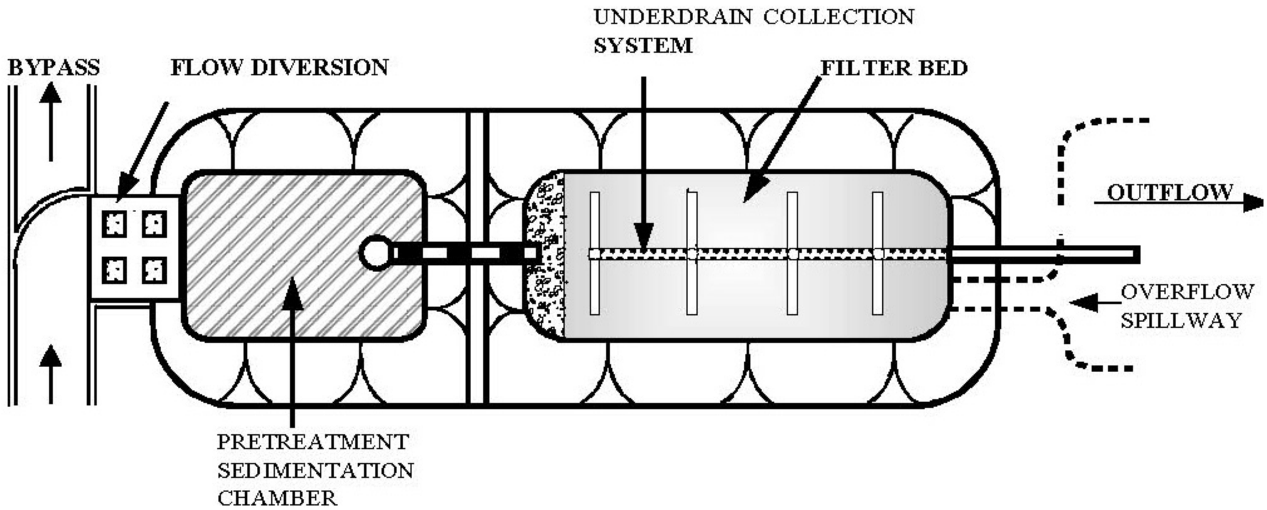
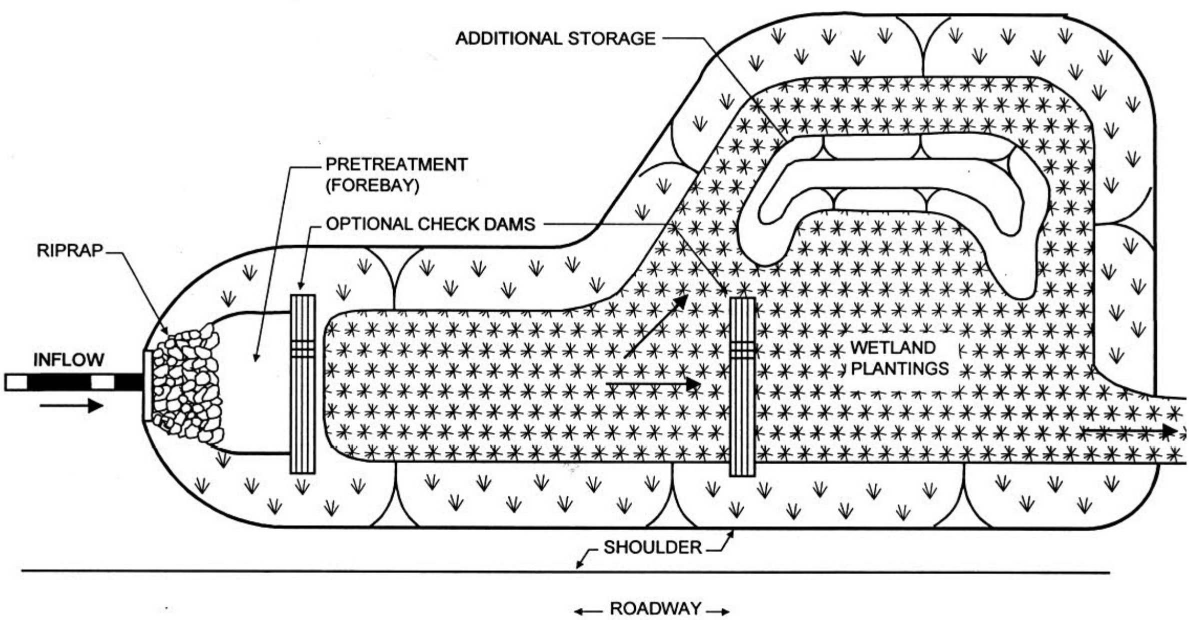


Figure 3.11: Wet Swale



Source: *Maryland Stormwater Design Manual, Volumes I & II*. Performance Criteria for Urban BMP Design. Maryland Department of the Environment, 2000.

Table 3.5: Benefits of Project Types

Category	Type	BMP	Flow Control	Water Quality	Aquatic Habitat	Channel Morphology
New Ponds	Ponds	Micropool ED Pond	2	1		
and Retrofits		Wet Pond, Wet ED Pond	1	2		
	Wetlands	Wetland / Shallow Marsh	2	1	3	
		Pond/Wetland System	2	1	3	
		ED Wetland	1	2		
Streams	Stream Restoration	New Alignment		3	2	1
and Buffers		Re-align Existing Channel		3	2	1
		Stable Stream Type		3	2	1
		Bank Stabilization		3	2	1
	Buffer Restoration	Buffer Restoration		3	1	2
	Watershed-Wide	Dumpsites		2	1	
		Obstructions			1	2
		Fish Passage Restoration			1	2
		Utility Crossings			1	2
Culverts	Road Crossings	Road Crossing			2	1
	Culvert Retrofit	Culvert Retrofit	1	2		
Drainage	Swales	Grass Channel / Dry Swale		1		
Retrofits		Wet Swale		1		
	Outfall Retrofit	Outfall Stabilization			2	1
LID	Filtration	Sand Filters		1		
Retrofits		Organic Filter		1		
		Bioretention / Rain Gardens	2	1		
	Infiltration	Infiltration Basin	1	2		
		Infiltration Trench	1	2		
	Disconnection	Porous Pavement	1	2		
		Rain Barrel / Cistern	1	2		
		Green Roof	1	2		
	Other WQ BMPs	WQ Inlets		1		
Watershed-		Dumpsites		2	1	
Wide		Obstructions			1	2
Projects		Fish Passage Restoration			1	2
		Utility Crossings			1	2
Benefits	1	Primary benefit				
	2	Secondary benefit				
	3	Supplemental benefit				

3.5 Captain Hickory Run – Subwatershed Condition

3.5.1 Subwatershed Characteristics

The Captain Hickory Run **subwatershed** has an area of approximately 1,695 **acres** (2.65 mi^2). It is located in northern Fairfax County with its northeast boundary running along Georgetown Pike (Virginia 193) to Walker Road (Virginia 681) where it extends just north of Georgetown Pike to Springvale Road (Virginia 674). Cavalcade and Harriman Streets form the approximate southern boundary.

The Captain Hickory Run subwatershed includes 7.2 miles of streams. The streams flow generally in a southeast direction through low-density residential areas. The Captain HickoryRun subwatershed flows into the mainstem of Difficult Run at the Difficult Run Stream Valley Park. Stream width varies from an average of 10 feet upstream to 25 feet downstream of Walker Road. Streambank height varies from three to five feet with higher banks in the downstream **reaches**. Historical reports indicate high **erodibility** in the lower reaches of the subwatershed and severe **deposition** of sand and gravel at the **confluence** with Difficult Run (PB 1976). The most recent field survey agrees with these reports, indicating that the most downstream portions of the Captain Hickory Run stream channel have eroding banks and a **substrate** that is 90 percent sand.

Refer to DFCH_1 for a map of the Captain Hickory Run subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.5.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The Captain Hickory Run subwatershed is characterized by estate and low-density residential development with a combined 69 percent of the area developed as low-density or estate residential. Another 19 percent is preserved for open space or parks. A summary of land use within the subwatershed can be found in Table 3.6. Great Fall Grange and the Turner Farm are two large parks found almost entirely within the Captain Hickory Run subwatershed. Three historical sites are located within the subwatershed.

There are 112 acres, 7 percent of the subwatershed, in transportation use, such as roads and highways. Less than 5 percent of the subwatershed is developed for commercial or industrial use. The majority of this commercial area is clustered along the northeastern edge of the subwatershed and contains Village Centre Shopping Center at the junction of Walker Road and Georgetown Pike.

Total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways, sidewalks and building rooftops is approximately 188 acres, or 11 percent of the total subwatershed area.

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

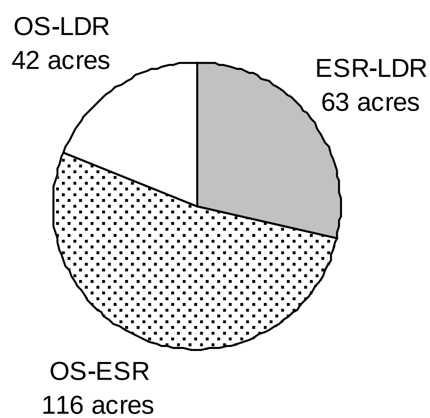
When comparing existing land use to future land use, the largest shifts are projected in the open space, estate residential and low-density residential categories. Nine percent of the open space has a future use zoning code that is higher intensity than the existing use. This open space area can be used for development/redevelopment in the future if and when the need presents itself. The low-density residential land use category is projected to gain 105 acres from existing to future, which represents a 6 percent increase to 636 acres. Likewise, the estate residential future land use category is projected to gain 53 acres, an increase of 3 percent.

Table 3.6 Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	319	19%	161	9%	-158	-9%
Golf Course	0	0%	0	0%	0	0%
Estate residential	637	38%	690	41%	53	3%
Low-density residential	531	31%	636	38%	105	6%
Medium-density residential	25	1%	25	1%	0	0%
High-density residential	0	0%	0	0%	0	0%
Low-intensity commercial	16	1%	16	1%	0	0%
High-intensity commercial	27	2%	28	2%	0	0%
Industrial	1	0%	1	0%	0	0%
Institutional	23	1%	23	1%	0	0%
Transportation	112	7%	112	7%	0	0%
Water	3	0%	3	0%	0	0%
Total	**1,695**	**100%**	**1,695**	**100%**		**0%**

According to Figure 3.2, 116 acres are projected to shift from open space to estate residential, 63 acres are projected to shift from estate residential to low-density residential, and 42 acres of open space are projected to shift to low-density residential. These larger shifts illustrate a demand for more housing and the overall conversion of a lower-density use to a higher-density use in the Captain Hickory Run subwatershed.

Figure 3.2 Changed Land Use



3.5.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are six stormwater management facilities within the Captain Hickory Run subwatershed, of which three are privately owned and three are public. Five of the facilities are dry ponds and one is a wet pond, which is located on Walker Road. Approximately 87 percent of the Captain Hickory Run subwatershed is not served by any stormwater management facility. Eleven percent of the total area has quantity control only and the remaining 2 percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (81 percent) and the area served by stormwater management (13 percent) indicates a possible need for additional management efforts, specifically in the low-intensity commercial and low-density residential areas. A list of stormwater management facilities in the Captain Hickory Run subwatershed is found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located 15 outfall pipes discharging into the Captain Hickory Run subwatershed. High stormflow from two pipes is causing erosion problems that should be repaired. The outfall in Photo 3.1 is located at the candidate site C06 and the erosion in Photo 3.2 is located upstream of candidate site S76.

Photo 3.1 Erosion at the end of stormwater pipe located off of Collin Farm Land (DFCH021.P003).

Photo 3.2 Erosion below stormwater pipe located at the end of Milburn Street (DFCH021.P001).

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. Results from the Stream

Physical Assessment show a total of 32 crossings in the Captain Hickory Run subwatershed. Fourteen of the crossings in the subwatershed are wooden footbridges, one is a 15-foot concrete bridge, and the remaining eight are box and pipe culverts. Stream flow was causing some moderate erosion downstream of one footbridge but was not significant enough to warrant further study. All other crossings were having only minor or no impact on stream integrity.

3.5.4 Soils

Soils found in the Captain Hickory Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes which can result in rapid **runoff** and **micaceous** soils, which are erodible. The groundwater is fairly shallow with numerous natural springs. The subwatershed contains 77 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (55 percent). Zones with Glenelg, Manor and Elioak soils may be compatible with **infiltration** practices and may provide potential stormwater management sites. The characteristics of soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.5.5 Geomorphology

A total of just over 6 miles (34,003 feet) of stream were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. Six stream reaches (4,218 feet) were not assessed because they were not natural channels. This includes 1,560 feet of piped channel and 2,307 feet of pond/wetland area.

The majority of assessed reaches in Captain Hickory Run were characterized as CEM Type III, which is indicative of a generally unstable channel that is actively widening in response to changes in stream flow. The substrate in the subwatershed is a combination of gravel and sand.

Sixty-three percent of the stream length is moderately unstable, indicating that there is high erosion potential during high flow events. There are five specific erosion locations that are impacting the stream integrity. The points are characterized by raw, actively eroding banks that are degrading the instream habitat and may be damaging property. Four of the five points are considered severe and should be addressed. All of these erosion points have high restoration potential. Photos of two of the more serious erosion areas are located below. Photo 3.3 is located at candidate site S54 and Photo 3.4 was taken at candidate site S76.

Photo 3.3 Erosion on the right bank of Captain Hickory Run near the end of Constellation Drive (DFCH010.E001)

Photo 3.3 Erosion on Captain Hickory Run along Milburn Street (DFCH012.E002).

Photo 3.5 Earthen berm located in the upper reaches of Captain Hickory Run near Thunderhill Court (DFCH009.T001)

There are two obstruction locations within the subwatershed both of which are restricting fish passage between habitats and possibly during migration. One obstruction is an earthen **berm** (used to block or redirect surface water flow) with an impact score of moderate to severe, indicating that it may be causing damage to stream (see Photo 3.5). This berm is located on a tributary just east of Walker Road near Thunderhill Court and is at candidate site S77.

3.5.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall of 2002.

- Of the assessed reaches, 76 percent is assessed as poor habitat, 20 percent is fair habitat and 4 percent is good habitat. The length of stream downstream of Roos Trail to the confluence with the Difficult Run mainstem comprises the entire length of good habitat.
- There is 25,270 feet (left and right banks combined), of **riparian buffer** encroachment within the Captain Hickory Run subwatershed. Of the 25,270 feet,

22,270 feet (88 percent) is lawn, 2,800 feet (11 percent) is pasture and 200 feet (<1 percent) is lawn/pasture mix. All areas of encroachment have moderate to low restoration potential. 7,400 feet of the identified reaches have buffer deficiencies that are degrading the stream quality.

- Sixty-seven percent of the total length has at least 50 percent vegetative cover, such as trees and shrubs, on both stream banks.

3.5.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Captain Hickory Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams, and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

In the Captain Hickory Run subwatershed, approximately 11 percent of the land is covered by impervious surface. More than three-quarters of the subwatershed is of lower density residential land use. The area of commercial development at the corner of Georgetown Pike and Walker Road is a likely contributor of the increased levels of pollutants seen in the results for catchment DFCH9801. See DFCH_4 for the catchment locations.

The nitrogen loading rate is highest in catchment DFCH9801, which is in the upstream north-central portion of the subwatershed, in the areas of the Village and the Great Falls Shopping Centers at Georgetown Pike and Walker Road. Here, the modeled loads are 3.2 pounds per acre per year. It is ranked low overall because it has high loading rates of nitrogen and phosphorus, and the highest volume of runoff. The phosphorus and nitrogen levels appear to be following similar trends such that in areas where phosphorus levels are high, the nitrogen levels are also high. See Table 3.7 below for the modeling results.

Table 3.7 Existing and Future Modeling

Captain Hickory Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFCH0002	E	1.77	0.08	18.7	1.0	0.2
	F	2.1	0.09	22.9	1.2	0.2
	C	19%	13%	22%	23%	26%
DFCH0003	E	2.49	0.1	25.7	1.4	0.3
	F	2.73	0.11	28.3	1.5	0.3
	C	10%	10%	10%	11%	11%

Captain Hickory Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFCH0004	E	2.3	0.1	21.2	1.2	0.2
	F	2.54	0.11	24.4	1.4	0.3
	C	10%	10%	15%	15%	17%
DFCH0005	E	1.07	0.05	7.4	0.4	0.1
	F	1.16	0.06	7.7	0.4	0.1
	C	8%	20%	4%	2%	13%
DFCH0006	E	1.04	0.15	6.9	0.4	0.1
	F	1.24	0.15	7.7	0.4	0.1
	C	19%	0%	12%	11%	13%
DFCH9701	E	1.62	0.15	11.5	0.6	0.1
	F	1.64	0.15	11.5	0.6	0.1
	C	1%	0%	0%	0%	8%
DFCH9801	E	3.77	0.1	63.6	2.7	0.4
	F	3.82	0.1	63.6	2.7	0.4
	C	1%	0%	0%	0%	0%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

Modeling results for future conditions show significant increases in flows and runoff pollutant loads from every catchment in the subwatershed. DFCH0002 has the largest percentage increase in every parameter except peak flows, due to change in land use from open space to low-density residential in the upper portion of the catchment and from open space and estate residential to low-density residential along the stream channel.

3.5.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Two culverts in the subwatershed were overtopped with existing flows, as shown in Table 3.8. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.8 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
65	Fringe Tree Rd	E	x	x	x	x	x	x	x
69	Sunnybrook Rd	E	x	x					

E – Existing conditions results, x – indicates overtopping

Culvert # 65 (Photo 3.6) overtopped for all events. From the photos, it appears that culvert #65 has recently been reconstructed and functions as a stream ford. This crossing is also a residential access road with a functional classification of "local". It should not be overtopped by storms more frequent than the10-year event.

Culvert #69 (Photo 3.7) overtopped for the 50- and 100-year events. This is a residential access road with a classification of "local," requiring the culvert to pass the 10-year event.

Photo 3.6 Captain Hickory Mainstem at End of Fringe Tree Road

Photo 3.7 Unnamed Tributary at Sunnybrook Drive.

3.5.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Captain Hickory Run subwatershed are listed below. Refer to DFCH_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S54 The Stream Physical Assessment survey indicated that bank stability was low, the channel was incised, and habitat was poor to very poor. (Photo 3.3)

S73 During the Stream Physical Assessment assessment, field crews noted wetlands being filled with soil piles on a reach near Polo Place where new construction was taking place (field assessment was completed in 2002). Widening and poor habitat were noted along this reach.

S74 The Stream Physical Assessment survey indicated that streambank erosion was severe or extreme, channel was widening, and habitat was poor to very poor.

S75 The Stream Physical Assessment survey indicated that streambank erosion was severe or extreme, channel was widening, and habitat was poor to very poor.

S76 This site at the end of Milburn Street is severely eroded, as shown in Photo 3.2 and Photo 3.4.

S77 This site has a significant amount of buffer encroachment, along with an area of erosion. Additionally, there is an earthen berm, which is blocking the stream and may be a fish blockage (Photo 3.5).

Hydrology and Water Quality

C06 (Catchment DFCH0003) This area has the second highest loads of total nitrogen and total suspended solids of all the catchments, and is tied for highest runoff volume. (Photo 3.1)

D05 (Catchment DFCH0002) The Modeling and stream assessment data did not show significant hydrologic or water quality problems within the drainage area. Streams, however, show signs of erosion and instability both within the drainage area and downstream. This is the site of unbuilt regional pond D05.

D06 (Catchment DFCH9701) Modeled water quality and hydrologic impacts from this catchment were in the mid-range for the subwatershed. This is the site of unbuilt regional pond D06.

D07 (Catchment DFCH9801) This catchment is the most highly impervious and has the highest modeled runoff loads of total suspended solids, total nitrogen and total phosphorus. This is the site of unbuilt regional pond D07.

Flooding

F65 This culvert overtops with existing conditions for all rainfall events from 1- to 100-year

Preservation

No sites were identified. Several catchments are in good condition, but model results show that future development does not make them significantly worse. This means that they are essentially preserved under the current development plans and regulations.

3.6 Captain Hickory Run - Subwatershed Plan Action

In the subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.9 below is a list of all projects proposed in this subwatershed.

Table 3.9 Recommendations for Captain Hickory Run

Project #	Project Type	Candidate Site
DF9005B	Culvert Retrofit	D-05
DF9006B	Drainage Retrofit	D-06
DF9007A	Drainage Retrofits	D-07
DF9007C	Culvert Retrofit	D-07
DF9007D	LID Retrofit	D-07
DF9106A	Pond Retrofit	C06A
DF9106B	Pond Retrofit	C06B
DF9274	Stream Restoration	S74
DF9706	Drainage Retrofits	C06
DF9806	LID Retrofits	C06

3.6.1 Regional Pond Alternative Projects

D05 (DFCH0002)

Site Investigation and Projects: The site investigation identified two projects, which would help meet the improvement goals and provide a replacement for the proposed regional pond.

> *DF9005B (Culvert Retrofit*) This project consists of modifying the culvert crossing at Polo Place to provide detention storage. Retrofits would be designed to reduce stream velocity through storage and detention. Water quality improvements are not as high a priority as storage due to the established wetland within the project area.

D06 (DFCH9701)

Site Investigation and Projects: The site investigation identified an additional improvement goal in this catchment. Fringe Tree Road is undergoing erosion and damage from flows of Captain Hickory Branch and the tributary draining the catchment. Protection of the gravel roadway is needed for public safety purposes.

> *D9006B (Drainage Retrofit)* Site investigation showed erosion and scour from the existing farm pond down to the main floodplain valley. This erosion appears to be related to the steep channel slope and the influences of the series of driveway culverts and the one culvert under Hickory Run. This project would consist of providing riprap outlet protection on the downstream side of each of these culverts.

D07 (DFCH9801)

Site Investigation and Projects: The site investigation identified opportunities for retrofit of older stormwater management facilities, LID retrofits, and a culvert retrofit that should provide benefits equivalent to the proposed regional pond.

DF9007A (Drainage Retrofits) These distributed projects are designed to correct impairments from poor outlet protection at eight locations where the storm drain network discharges into the floodplain. Improvements would consist of energy dissipation through riprap, plunge pools, or structures. The primary benefit would be reduction of sediment from localized scour or erosion.

DF9007C (Culvert Retrofit) This project consists of a culvert retrofit to the upstream side of the crossing of Sunnybrook Drive. A redundant embankment would be designed to store runoff on the upstream side of the roadway. This facility would use floodplain storage to settle out sediment provide vegetative uptake of nutrients.

DF9007D (LID Retrofit) LID or Filterra systems would be retrofit at storm drain inlets and parking islands in the commercial area west of Walker Road. The project would be designed to reduce runoff pollutant loads in the area. Storage volume for channel protection would not be provided.

3.6.2 Catchment Improvement Projects

C06 (DFCH0003)

Site Investigation and Projects: The site investigation identified opportunities for retrofit of older stormwater management facilities, LID retrofits, and drainage retrofits to mitigate the impairments.

DF9806 (LID Retrofits) This project consists of the replacement of a rigid boundary channel with a LID facility that is expected to include a bioswale, biofiltration retention/detention facility and natural channel improvement. This facility may provide some peak discharge reduction, but should primarily be designed as a water quality facility, as discharge impacts were not observed in this area.

DF9106A (Pond Retrofit) This project is a retrofit of an existing stormwater management facility upstream of the crossing of the main catchment tributary at Georgetown Parkway. The facility is showing signs of conversion into a wetland. Creation of additional storage for 1-year extended detention and water quality volume, modifying the control structure, and regarding the accumulated sediment would provide both channel protection and water quality improvements to a significant portion of the catchment.

DF9106B (Pond Retrofit) This project is a retrofit of an existing pond in the swale downstream of Columbine Street. Retrofits should include creation of additional storage for 1-year extended detention with a multi-stage riser and inclusion of water quality features and vegetation.

DF9706 (Drainage Retrofits) These distributed projects are designed to provide adequate energy dissipation at outfalls where the piped storm drain system discharges to a natural channel. Improvements would consist of energy dissipation through riprap, plunge pools, or structures.

3.6.3 Stream Restoration Projects

S54

Site Investigation and Projects: The site investigation showed that erosion at this site is not currently active and that the stream is relatively stable. It is anticipated that if natural hydrology can be restored through stormwater management retrofits upstream then a stream restoration project would not be necessary.

S73

Site Investigation and Projects: The site investigation did not find the area of wetlands, which may have been filled. Stream conditions appeared stable and no restoration projects were identified.

S74

Site Investigation and Projects: The site investigation showed that the stream through this reach was moderately to severely incised with raw, eroding, nearly vertical banks. The bed has eroded to weathered rock and riffle pool bed forms are largely absent. One stream restoration project was identified.

> *DF9274 (Stream Restoration)* The proposed restoration would involve excavating a new floodplain and re-meandering the stream to provide a pattern, dimension, and profile more consistent with a natural stream. This would prevent further mass erosion associated with channel widening and bank failure, would improve instream habitat, and provide access to a functional floodplain. The new floodplain would be planted with native woody vegetation and grasses.

S75

Site Investigation and Projects: The site investigation found evidence of erosion at channel bends throughout the stream reach. However, because access and construction feasibility restraints outweigh potential project benefits, no projects were identified. There is evidence that the stream is forming a floodplain within the widened channel and beginning to stabilize. It is anticipated that if natural hydrology can be restored through stormwater management retrofits upstream then a stream restoration project would not be necessary.

S76

Site Investigation and Projects: The site investigation found evidence of erosion and deeply incised streambanks. However, because access and construction feasibility restraints outweigh potential project benefits, no projects were identified. It is anticipated that if natural hydrology can be restored through stormwater management retrofits upstream then a stream restoration project would not be necessary.

S77

Site Investigation and Projects: The site investigation found evidence of erosion and incision throughout this reach. However, due to issues of access and construction feasibility, no projects were identified. It is anticipated that if natural hydrology can be restored through stormwater management retrofits upstream (particularly the facility identified with project DF9007B) then a stream restoration project would not be necessary.

3.6.4 Preservation

No preservation candidate sites were identified for this subwatershed.

3.7 Dog Run – Subwatershed Condition

3.7.1 Subwatershed Characteristics

The Dog Run **subwatershed** is located in northeastern Fairfax County. This 515-**acre** (0.8 mi^2) subwatershed is the third-smallest subwatershed in the Difficult Run watershed. It is bound by Utterback Store Road (Virginia 717) to the east and Seneca Road (Virginia 602) to the west. Leesburg Pike traverses the southwest corner of the subwatershed.

There are 2.5 miles of stream within the subwatershed that flow south and join Piney Run north of Woodbrook Lane. The majority of the length of the stream flows through open space and estate residential areas. There is a short segment of the stream that is adjacent to a high-intensity commercial area just to the east of Northfalls Court.

Refer to DFDG_1 for a map of the Dog Run subwatershed highlighting the Subwatershed Characteristics including existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.7.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The Dog Run subwatershed development is not very densely developed. Fifty-three percent of the Dog Run subwatershed is developed as low-density or estate residential. Another 22 percent of the land in the Dog Run subwatershed is open space or parks, although there are no major park facilities located within the subwatershed. Six percent of the subwatershed is developed for commercial uses. The majority of this commercial area is clustered along the west-central edge of the subwatershed at the junction of Leesburg Pike (Virginia 7) and Georgetown Pike (Virginia 193). There are no industrial areas.

There are 71 acres, 14 percent of the subwatershed, used for transportation such as roads and highways. Total **impervious** area for the subwatershed, which includes all roads, parking lots, sidewalks, residential driveways and buildings, is approximately 81 acres, or 16 percent of the total subwatershed area. A summary of land use within the subwatershed can be found in Table 3.10.

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

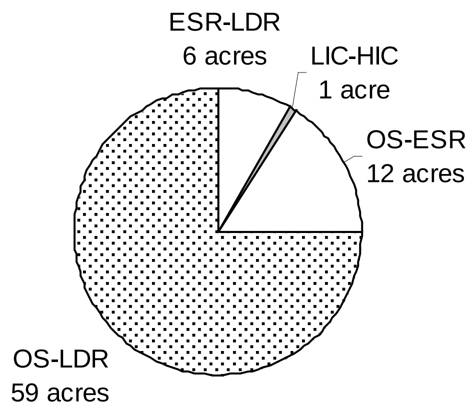
Table 3.10 Existing and Future Land Use

	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	111	22%	40	8%	-72	-14%
Golf Course	0	0%	0	0%	0	0%
Estate residential	73	14%	79	15%	6	1%
Low-density residential	199	39%	264	51%	66	13%
Medium-density residential	30	6%	30	6%	0	0%
High-density residential	0	0%	0	0%	0	0%
Low-intensity commercial	9	2%	8	2%	-1	0%
High-intensity commercial	9	2%	10	2%	1	0%
Industrial	0	0%	0	0%	0	0%
Institutional	8	2%	8	2%	0	0%
Transportation	71	14%	71	14%	0	0%
Water	5	1%	5	1%	0	0%
Total	**515**	**100%**	**515**	**100%**		**0%**

When comparing existing land use to future land use, major acreage shifts are projected in the open space and low-density residential categories. There is a projected 14 percent loss in the open space category. Gains in acreage are projected in the low-density residential (+13 percent) and estate residential (+1 percent) land uses.

According to Figure 3.3, 59 acres are projected to shift from open space to low-density residential. Twelve acres shift from open space to estate residential and 6 acres shift from estate residential to low-density residential.

Figure 3.3. Changed Land Use



There are approximately 32 acres of land along the Leesburg Pike in the western portion of the subwatershed that is currently designated as open space, but the future planned use is low-density residential. There is another larger swath of open space (~20 ac.) in the eastern portion of the subwatershed that is planned for a low-density residential use. There is no guarantee that these areas will be developed; yet, both pieces have adjacent low-density uses currently and will be well integrated into the existing land use pattern if and when the need arises to develop more residential uses. These shifts illustrate the demand for more housing within the Dog Run subwatershed and the potential for increases in impervious surfaces, which can contribute additional runoff and pollutants to the stream system.

3.7.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are seven **stormwater management facilities** within the Dog Run subwatershed, of which three are private and four are public. Eighty-six percent of the Dog Run subwatershed is not served by any stormwater management facility. Fourteen percent of the total area has quantity control only. There is no area within the subwatershed that receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (79 percent) and the area served by stormwater management (14 percent) indicates a possible need for additional management efforts, specifically in the low and medium-density residential and commercial areas. A list of all stormwater management facilities in the Dog Run subwatershed is found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located four **outfall** pipes discharging into the Dog Run subwatershed. None of the outfalls were having a significant impact on the stream system.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. Most of the stream crossings in Dog Run were having only very minor impact on the stream condition. One of the crossings is a stream ford, which has deficiencies that should be addressed to enhance stream integrity and future stability of the structure. The impairment is likely due to high levels of upstream debris. The ford, which is a shallow part of a stream that can be crossed by foot or by land vehicle, is shown in Photo 3.8 and is located just upstream of a stream restoration candidate site S78.

Photo 3.8 Ford located upstream east of Kimberly Place.

3.7.4 Soils

Soils found in the Dog Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 72 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (51 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. There are 16.9 acres of land with unclassified soils in the Dog Run subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.7.5 Geomorphology

There are approximately 2.5 miles of stream in the Dog Run subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes.

The eastern reach of Dog Run (7,333 ft.) is a Type II stream, where the streambed is degrading and incision is beginning, and is primarily sand and gravel substrate. There is major restoration potential for this reach. The west reach (3,976 ft.) is Type III, which is indicative of a generally unstable channel that is actively widening in response to changes in flow, and is primarily sand substrate.

The entire stream length of Dog Run is characterized by moderately unstable banks with high erosion potential during **floods** as in Type II and III channels. Two specific erosion locations where located that are impacting the stream system. The first is located south of Georgetown Pike and east of Kimberly Place, and is 1,800 linear feet on the outer bends (see Photo 3.9). The eroding area is causing instream degradation, may be damaging property and is a stream restoration candidate site S78. The second erosion location (Photo 3.10) is on the most downstream reach near the confluence with Piney Run. It is 50 linear feet in length, has instream degradation, and is also a stream restoration candidate site S02.

Photo 3.9 Erosion located south of Georgetown Pike, East of Kimberly Place (DFDG001.E002).

Photo 3.10 Erosion located near confluence of Dog Run with Piney Run (DFDG001.E001).

3.7.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the winter of 2002.

- The entire length of stream in the Dog Run subwatershed has poor habitat for aquatic insects and fish.
- There is 11,575 linear feet of the stream, or approximately 43 percent of the total, which does not have sufficient **riparian buffer** (the total is for both banks). Of this total, 9,360 feet of the impact is from lawns.
- The western tributary has less than 50 percent of the stream bank surface covered with vegetation such as trees and shrubs.
- Many of the missing riparian buffer areas have good potential for restoration. There is approximately 2,000 feet of deficient buffer located within the Estates at Wyndham Hills between Fieldview Drive and Stones Throw Drive. This area has the potential for stream and buffer restoration, candidate site S79, and is shown in Photo 3.11.

Photo 3.11 Deficient buffer located in the Estates at Wyndham Hills. (DFDG002.B001).

3.7.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Dog Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

The Dog Run subwatershed contains 16 percent impervious surface. Except for a few commercial areas around the intersection of Georgetown Pike and Leesburg Pike, the subwatershed is mostly low-density and estate residential land use.

The catchment with the highest modeled nitrogen and phosphorus overall is DFDG9901, which contains a long stretch of Leesburg Pike and also some medium density residential parcels off of Reston Parkway and Round Pebble Lane. Refer to DFDG_4 for the catchment locations. This catchment also has the highest amount of runoff volume, most likely because it has the most paved area, with 4.9 inches per year. The results of the modeling can be seen in Table 3.11.

Table 3.11 Existing and Future Modeling

Dog Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFDG0002	E	2.28	0.11	23.2	1.2	0.2
	F	2.53	0.11	27.5	1.4	0.3
	C	11%	0%	19%	17%	50%
DFDG0003	E	2.78	0.16	29.0	1.6	0.3
	F	3.31	0.17	37.9	2.0	0.4
	C	19%	6%	31%	25%	33%
DFDG9901	E	3.9	0.14	54.5	2.6	0.4
	F	4.43	0.15	64.7	3.1	0.5
	C	14%	7%	19%	19%	25%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

The catchment that is predicted to have the biggest percent change in the future is DFDG0003, as much of the open space located along the stream on both sides of Leesburg Pike will be changing to low-density residential.

3.7.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Of the two crossings in the subwatershed, neither overtopped with existing flows for any storm event.

3.7.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Dog Run subwatershed are listed below. Refer to DFDG_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S02 This reach has active widening, unstable banks, and erosion. It is located in the downstream portion of Dog Run near the confluence with Piney Run (Photo 3.10)

S78 This eastern reach is in an area with missing buffer and erosion problems combined. This stream has poor habitat (Photo 3.8 and 3.9).

S79 This reach has missing buffer on both the left and right banks along with poor habitat. Channel disturbance in the form of channelization is also an issue on this reach (Photo 3.11).

Hydrology and Water Quality

D01 (Catchment DFDG0002) This catchment has low runoff loads for the subwatershed. Site S78, with unstable banks and erosion problems, is within the catchment.

C01 (Catchment DFDG0003) This catchment has moderate runoff and pollutants. The streams in this catchment are eroding and have unstable banks.

C135 (Catchment DFDG9901) This catchment has the highest modeled pollutant nitrogen and phosphorus load. It also has one of the highest runoff volumes and peak flows. Site S79 is directly downstream of this catchment.

Preservation

No sites were identified. DFDG0002 is in good condition, but model results show that future development does not make it significantly worse. This means that it is essentially preserved under the current development plans and regulations

3.8 Dog Run - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments,

monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.12 below is a list of all projects proposed in this subwatershed.

Table 3.12 Recommendations for Dog Run

Project #	Project Type	Candidate Site
DF9001A	Drainage Retrofit	D-01
DF9001B	Culvert Retrofit	D-01
DF91135	Pond Retrofit	C135
DF9202	Stream Restoration	S02
DF9278	Stream Restoration	S78
DF9279	Buffer Restoration	S79
DF9501B	Culvert Retrofit	C01
DF9501C	Culvert Retrofit	C01
DF9701	Drainage Retrofit	C01

3.8.1 Regional Pond Alternative Projects

D01 (DFDG0002)

Site Investigation and Projects:

DF9001A (Drainage Retrofit) Where the piped drainage system flows into natural channels, scour and erosion have become evident. This project will provide improvements to the drainage infrastructure by improving outlet protection at the storm sewer outfalls.

DF9001B (Pond Retrofit) The existing pond at this site treats a large area of this catchment. This project would look to change the detention characteristics to reduce downstream impacts, and reconstruct the pond for improved water quality treatment. This would also help address the issue of road overtopping, discussed in DF9001C.

3.8.2 Catchment Improvement Projects

C01 (DFDG0003)

Site Investigation and Projects:

DF9501B (Culvert Retrofit) This project would be a retrofit to the two culverts crossing Stones Throw Drive. The goal would be dry detention storage in existing open space. This would provide peak attenuation as well as quality improvements.

DF9501C (Culvert Retrofit) This large, shallow area of unmanaged land would be used to store and treat streamflow. While this area is not able to store as much as the previous projects, the existing vegetation would help to improve water quality along with reducing the peak flows.

DF9701 (Drainage Retrofit) The developed area of this catchment is served by storm drains with outfalls that are experiencing erosion and scour. This project would consist of energy dissipation at those outfalls to reduce scour and erosion in the stream.

C135 (DFDG9901)

Site Investigation and Projects:

DF91135 (Pond Retrofit) This project would consist of retrofitting the existing pond located between Water Pointe Lane and the Reston Parkway by modifying the control structure to improve outflow for channel protection. An aquatic bench would be constructed for water quality treatment.

3.8.3 Stream Restoration Projects

S02 (DFDG0003)

Site Investigation and Projects: This site is located on what appears to be either homeowners association or County property.

DF9202 (Stream Restoration) A more natural stream would be established with meanders, dimension, and a profile. The stream would be reconnected with the floodplain, the banks would be stabilized, and a stream buffer would be reestablished.

S78

Site Investigation and Projects: This site is on the downstream side of Georgetown Pike, east of Kimberly Place.

DF9278 (Stream Restoration) A pattern, dimension and profile more consistent with a natural stream will be recreated. The stream would be re-connected to the floodplain. A riparian buffer would be established and bed features would be created.

S79

Site Investigation and Projects:

DF9279 (Buffer Restoration) The buffer at this site has been degraded by development and the clearing of trees up to the streams edge. The riparian zone would be replanted with native trees and shrubs in the non-forested areas.

3.8.4 Preservation

No preservation candidate sites were identified for this subwatershed.

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3.9 Piney Run– Subwatershed Condition

3.9.1 Subwatershed Characteristics

The Piney Run **subwatershed** has an area of approximately 2,100 **acres** (3.28 mi^2). It is located in northern Fairfax County with Leesburg Pike (Virginia 7) running through the center. The Dog Run subwatershed is in the headwaters of the Piney Run subwatershed. The northern border of the Piney Run subwatershed runs parallel with Georgetown Pike (Virginia 193) while the western boundary follows both the Reston Parkway (Virginia 602) and Reston Avenue. The intersection of Walker Road (Virginia 681) and Manning Street is located at the confluence of Piney Run and Captain Hickory Run. The Piney Run subwatershed is located in the northern portion of the Difficult Run watershed. The stream is approximately 7.5 miles in length and flows east from the Dog Run subwatershed until it joins Captain Hickory Run and then the mainstem of Difficult Run.

Refer to DFPR_1 for a map of the Piney Run subwatershed highlighting the Subwatershed Characteristics including existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.9.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

Piney Run subwatershed is moderately dense. Fifty-two percent of the Piney Run subwatershed is developed as low-density or estate residential. Another 21 percent is open space or parks. Major parks found either wholly or partially within the subwatershed boundary include Great Falls Nike Park, Baron Cameron Park, Lockmeade Park, Hickory Run Stream Valley Park, and the Turner Farm. Two historical sites lie within the subwatershed. Seven percent of the subwatershed is developed for commercial or industrial use. The majority of this area is clustered along the southwestern edge of the subwatershed within the planned community of Reston.

There are 219 acres, 10 percent of the subwatershed, used for transportation rights-of-way. Total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways, sidewalks and buildings, is approximately 343 acres, or 16 percent of the total subwatershed area. A summary of land use within the subwatershed can be found in Table 3.13.

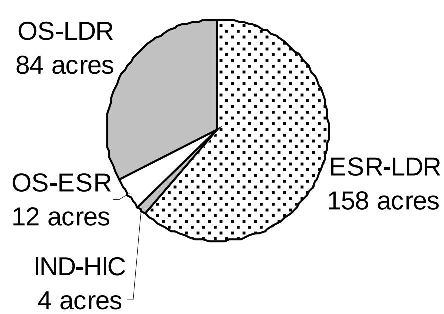
Table 3.13 Existing and Future Land Use

	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	431	21%	335	16%	-96	-5%
Golf Course	0	0%	0	0%	0	0%
Estate residential	353	17%	206	10%	-146	-7%
Low-density residential	728	35%	970	46%	242	12%
Medium-density residential	114	5%	114	5%	0	0%
High-density residential	163	8%	163	8%	0	0%
Low-intensity commercial	16	1%	15	1%	0	0%
High-intensity commercial	15	1%	19	1%	4	0%
Industrial	18	1%	14	1%	-4	0%
Institutional	38	2%	38	2%	0	0%
Transportation	219	10%	219	10%	0	0%
Water	5	0%	5	0%	0	0%
Total	**2,100**	**100%**	**2,100**	**100%**		**0%**

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

When comparing existing land use to future land use, significant shifts are projected in the open space, estate residential, and low-density residential land use categories. There is a projected 12 percent gain in the low-density residential category, in which compensating losses are projected in the estate residential (-7 percent) category and the open space (-5 percent) category.

Figure 3.4 Changed Land Use



According to Figure 3.4, 158 acres shift from estate residential in the existing land use to low-density residential in the future land use. Ninety-six acres shift from open space to either estate residential (12 acres) or low-density residential (84 acres). This does not guarantee that the open space will become developed; it suggests that these areas of open space can be used for development/redevelopment in the future.

3.9.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are 15 **stormwater management facilities** within the Piney Run subwatershed, one of which is an underground facility. Sixty-eight percent of the Piney Run subwatershed is not served by any stormwater management facility. Nineteen percent of the total area has quantity control only and the remaining 13 percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (82 percent) and the area served by stormwater management (14 percent) indicates a need for additional management efforts, specifically in the low-density residential areas in the northern and eastern portions of the subwatershed and the high-density residential and low-intensity commercial areas in the western half of the subwatershed. Additional information on the location of the stormwater management facilities in the Piney Run subwatershed is found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located 11 **outfall** pipes in the Piney Run subwatershed. None of the outfalls are having a significant impact on stream condition or causing any type of erosion.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. The Stream Physical Assessment located 32 total stream crossings in the Piney Run subwatershed. None of the crossing are having a significant impact on stream condition or causing any type of erosion.

3.9.4 Soils

Soils found in the Piney Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 64 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (51 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. There are 60.1 acres of land with unclassified soils in the subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.9.5 Geomorphology

There are approximately 6.59 miles (34,795 feet) of stream in the Piney Run subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. Five stream reaches (3,821 linear feet) were not assessed because they were not natural channels. This includes a large pond/wetland at the most downstream reach, an open wetland, and a **riprap** channel.

Seventy-six percent of the assessed channels are Type III, which indicates a generally unstable stream channel that is actively eroding in response to changes in flow. Smaller lengths were classified as Type IV (5 percent) and Type II (7 percent). Type II channels are beginning to undergo of bed degradation. Type IV channels are accumulating sediment and streambed is beginning to stabilize after disturbance.

Fifty-seven percent of the assessed stream length had at least one bank that was considered moderately unstable, with high erosion potential during **floods**. There is one specific erosion location comprising 2,800 linear feet that is damaging property and causing instream habitat degradation. It is located on the mainstem of Piney Run in the downstream end of the subwatershed. A portion of the erosion is shown in Photo 3.12. The site has high restoration potential and is a candidate stream restoration site S05.

Photo 3.12 Erosion just south of Eisenhower Lane (DFPR005.E001).

Photo 3.13 Obstruction located near the intersection of Walker Road with Manning Street (DFPR001.T001).

There are 11 obstruction locations within the Piney Run subwatershed, all of which are restricting fish passage. Many of the obstructions were beaver dams and are located in the central portion of the subwatershed on tributaries and on the mainstem. One obstruction is located at the very downstream end of the mainstem and is blocking fish passage. The site is shown in Photo 3.13 and is a candidate stream restoration site S83.

3.9.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall of 2002.

- Of the total stream length (including unassessed reaches), 26 percent is assessed as fair habitat for aquatic insects and fish, 58 percent assessed as poor habitat, and 7 percent is assessed as very poor habitat for aquatic insects and fish.
- There are just over 6 miles (32,445 feet) of the entire stream length in the Piney Run subwatershed missing sufficient buffer (both banks combined). Of the 6 miles without a buffer, 92 percent is lawn, and the remaining 8 percent is lawn/pavement mix.

Photo 3.14 Example of deficient buffer located south of Good Spring Avenue (DFPR009.B003).

Photo 3.15 Dump site located just north of Springvale Court (DFPR005.M001).

- A specific buffer encroachment area is located along a tributary between Riva Ridge Drive and Springvale Road and extends for approximately 350 feet. An example area is shown in Photo 3.14. The reach is a candidate stream restoration site S81.
- This is one dumpsite in the Piney Run subwatershed. It is located just north of Springvale Court. It contains non-toxic material, and does not appear to be used often. However, clean up would definitely be beneficial. The site is a candidate stream restoration site S82 and is shown in Photo 3.15.

3.9.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Piney Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS).

Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

Over 16 percent of the Piney Run subwatershed is covered by impervious surface. Most of the subwatershed is low density residential and estate residential land uses, but the headwaters, near the intersection of Reston Parkway and Wiehle Avenue, are almost entirely high-density residential and commercial areas. This is where the highest runoff amount is found, in catchment DFPR0001. Refer to DFPR_4 for the catchment locations.

The catchment with the highest modeled pollutant loading is DFPR0001, which is south of the intersection of Reston Parkway and Wiehle Avenue. Other areas of high runoff and pollutants include DFPR9801 (near Aldrin Elementary School) and DFPR9701 (north and east of Great Falls Nike Park). Results can be seen in Table 3.14.

Table 3.14 Existing and Future Modeling

Piney Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFPR0001	E	7.54	0.19	177.8	6.4	0.8
	F	7.51	0.19	177.6	6.4	0.8
	C	0%	0%	0%	0%	0%
DFPR0002	E	3.54	0.14	45.0	2.0	0.3
	F	3.68	0.14	47.7	2.2	0.4
	C	4%	0%	6%	10%	33%
DFPR0003	E	3.8	0.12	64.4	2.9	0.4
	F	4.3	0.12	89.4	3.9	0.4
	C	13%	0%	39%	34%	0%
DFPR0004	E	2.89	0.16	20.7	1.1	0.2
	F	3.37	0.17	29.4	1.5	0.3
	C	17%	6%	42%	36%	50%
DFPR0005	E	3.7	0.15	39.9	1.9	0.3
	F	3.94	0.16	44.2	2.0	0.3
	C	6%	7%	11%	5%	0%
DFPR0006	E	2.12	0.08	21.2	1.1	0.2
	F	2.78	0.09	37.2	1.8	0.3
	C	31%	13%	75%	64%	50%
DFPR0007	E	1.76	0.13	13.1	0.7	0.1
	F	1.94	0.13	14.8	0.8	0.2
	C	10%	0%	13%	14%	100%

Piney Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFPR9501	E	2.21	0.14	22.5	1.2	0.3
	F	2.42	0.14	25.9	1.4	0.3
	C	10%	0%	15%	17%	0%
DFPR9602	E	2.63	0.12	37.2	1.8	0.3
	F	2.95	0.13	43.3	2.1	0.3
	C	12%	8%	16%	17%	0%
DFPR9701	E	1.7	0.09	27.1	1.3	0.2
	F	2.02	0.09	32.6	1.6	0.3
	C	19%	0%	20%	23%	50%
DFPR9801	E	4.6	0.15	91.9	4.1	0.6
	F	4.84	0.16	97.1	4.4	0.7
	C	5%	7%	6%	7%	17%
DFPR9901	E	5.32	0.17	98.1	3.7	0.5
	F	5.33	0.17	99.0	3.8	0.5
	C	0%	0%	1%	3%	0%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

The catchment projected to have the greatest overall percent change is DFPR0006, which has several estate areas changing to low-density residential as well as one large area of open space changing to commercial. Catchment DFPR0004 will also have a large percent change, but mostly in the pollutants. This is because several areas along the stream are set to change from estate residential to low-density residential, increasing the pollutant loads from the catchment.

3.9.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Six stream crossings in the subwatershed were overtopped with existing flows, as shown in Table 3.15. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.15 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
64	Riva Ridge Drive	E	x	x					
67-A	Footbridge upstream of Springvale Road	E	x	x					
67-B	Springvale Road	E	x	x	x	x	x		
68-A	Leesburg Pike	E	x	x					
77	Walker Road	E	x	x	x	x			
78-B	Driveway pad next to Manning Street	E	x	x	x	x	x	x	X

E – Existing conditions results, x – indicates overtopping

Culvert #64 (Photo 3.16) overtopped for the 50- and 100-year events. Riva Ridge Drive can be classified as a local road, so it must pass the 10-year event, which it does. This is not considered a candidate site

Culvert #67-A (Photo 3.17) overtopped for the 50- and 100-year events. A footbridge is not a public road and has no requirements for overtopping. This is not considered a candidate site.

Photo 3.16 Piney Run Tributary at Riva Ridge Drive.

Photo 3.17 Piney Run Mainstem at the footbridge by Springvale Road.

Culvert #67-B (Photo 3.18) overtopped for events less frequent than the 2-year event. Springvale Road carries through traffic and so is considered a primary road, which must pass the 25-year event.

Culvert #68-A (Photo 3.19) overtopped for the 50 and 100-year events. Primary roads like Leesburg Pike are required to pass the 25-year event. This is not considered a candidate site.

Photo 3.18 Piney Run Mainstem at Springvale Road

Photo 3.19 Piney Run Mainstem at Leesburg Pike

Culvert #77 (Photo 3.20) overtopped for events less frequent than the five-year event. Walker Road is also considered a primary road that is required to pass the 25-year event.

Culvert #78-B (Photo 3.21) overtopped for all events. The driveway pad next to Manning Street is not a public road and is therefore not subject to overtopping requirements. This is not considered a candidate site.

Photo 3.20 Piney Run Mainstem at Walker Road

Photo 3.21 Piney Run Mainstem at the driveway pad by Manning Street

3.9.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Piney Run subwatershed are listed below. Refer to DFPR_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

Streams

S05 The Stream Physical Assessment survey found this site was found to have poor habitat and erosion resulting in unstable banks (Photo 3.12).

S80 The Stream Physical Assessment found that there are long reaches with limited buffer due to lawn encroachment on both sides of the channel (3200 feet along one reach).

S81 Also located at a confluence, the reported that this site had active widening on the mainstem and a severely deficient buffer with moderate restoration potential on the tributary (Photo 3.14).

S82 The Stream Physical Assessment survey noted significant trash and debris at the dumpsite located north of Springvale Court (Photo 3.15).

S83 The Stream Physical Assessment survey found an obstruction located at the very downstream end of Piney Run (Photo 3.13).

Hydrology and Water Quality

D02 (Catchment DFPR9701) The catchment has above average runoff volumes and pollutant loadings. The stream is categorized as having poor habitat.

D03 (Catchment DFPR9801) The catchment has one of the highest pollutant loads in the subwatershed. The habitat assessment on the reach through this catchment reveals poor habitat.

D64 (Catchment DFPR9501) The catchment has some of the highest pollutant loads and runoff volumes in the subwatershed. The stream is categorized as having poor habitat.

C03 (Catchment DFPR9901) This catchment also has above average runoff volume and peak flow and below average pollutants.

C04 (Catchment DFPR0001) The runoff volume and runoff pollutants in this catchment are the highest of the subwatershed.

Flooding

F67A The footbridge upstream of Springvale Road overtops for the 50- and 100-year events (Photo 3.17).

F67B The bridge on Springvale Road overtopped for all events except the one- and two-year. This is a primary road, so it is required to pass the 25-year event (Photo 3.18).

F77 The bridge at Walker Road overtops for events less frequent than the 5-year event. This is a primary road, so it must pass the 25-year event (Photo 3.20).

F78B The driveway pad next to Manning Street overtops for all events (Photo 3.21).

Preservation

P29 (Catchment DFPR0004) This catchment has land use changing along the stream from estate residential to low-density residential. The pollutant loads are expected to nearly triple due to this change in land use.

P30 (Catchment DFPR0005) This catchment also has several areas along the stream changing from estate residential to low-density residential. There are also areas of open space shifting to low-density residential and one industrial area changing to high-intensity commercial.

P31 (Catchment DFPR0006) Percent increases between the existing and future conditions are projected to be the highest for most parameters in this catchment due to losses of open space to low-intensity commercial areas, as well as some estate residential shifting to low-density residential.

P32 (Catchment DFPR9602) This catchment has one of the highest increases in nitrogen and phosphorus runoff due to changes from estate residential and open space to low-density residential.

3.10 Piney Run – Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments,

Monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.16 below is a list of all projects proposed in this subwatershed.

Table 3.16 Recommendations for Piney Run

Project #	Project Type	Candidate Site
DF9002A	Culvert Retrofit	D-02
DF9002B	Drainage Retrofit	D-02
DF9003AA	Pond Retrofit	D-03
DF9003AB	Pond Retrofit	D-03
DF9003B	Drainage Retrofit	D-03
DF9064A	Pond Retrofit	D-64
DF9064B	Culvert Retrofit	D-64
DF9064C	Pond Retrofit	D-64
DF9064D	Drainage Retrofit	D-64
DF9103	Pond Retrofit	C03
DF9205	Stream Restoration	S05
DF9280	Buffer Relocation.	S80
DF9503	Culvert Retrofit	C03
DF9504A	Culvert Retrofit	C04
DF9504B	Culvert Retrofit	C04

3.10.1 Regional Pond Alternative Projects

D02 (DFPR9701)

<u>Site Investigation and Projects</u>:

DF9002A (Culvert Retrofit) The project would consist of a culvert retrofit to create a storage area at the crossing of Riva Ridge Drive, which would help reduce erosive discharge rates and velocities downstream as well as increase storage.

DF9002B (Drainage Retrofit) The project would include outlet protection improvements to reduce scour velocities at outfalls around the catchment.

D03 (DFPR9801)

<u>Site Investigation and Projects</u>:

DF9003AA (Pond Retrofit) This project would retrofit an existing dry facility to provide more detention and channel protection downstream. Water quality improvements, including a forebay, wetland cell, or micro-pools, would help to allow nutrient settling and/or uptake.

DF9003AB (Pond Retrofit) This instream facility would be retrofit for channel protection by excavating within the existing pond footprint and modifying the riser structure. Creating wetlands within the pond and replacing the concrete pilot channel with meandering flow paths can enhance water quality treatment.

DF9003B (Drainage Retrofit) The project would include improvements to reduce scour velocities at outlets around the catchment, which would reduce sediment loads from stream erosion.

D64 (DFPR9501)

<u>Site Investigation and Projects</u>:

DF9064A (Pond Retrofit) This project would increase the detention volume of the existing pond, thus reducing the peak discharges in the catchment by simply installing a multi-stage riser. Water quality benefits are also included in this project, such as an aquatic bench, a reduction of depth, and a forebay.

DF9064B (Culvert Retrofit) The project would create a large amount of storage area at the crossing of Brevity Road. The project would help reduce erosive discharge rates and velocities downstream. Vegetation and micro-pools will increase the water quality benefits at the site.

DF9064C (Pond Retrofit) The location of this project is upstream of the crossing at Artemel Court. The project is a retrofit to provide channel protection volume with a multi-stage riser. Water quality will take place with the existing vegetation and meandering channel.

DF9064D (Drainage Retrofit) The project would include improvements to reduce scour velocities at outfalls to natural channels.

3.10.2 Catchment Improvement Projects

C03 (DFPR9901)

<u>Site Investigation and Projects</u>:

DF9503 (Culvert Retrofit) This project would consist of a retrofit to the culvert on the northwest corner of the intersection of Hawthorne Court and Reston Parkway. The area upstream of the culvert is a low-lying broad wet weather floodplain that is heavily overgrown with shrubs and other vegetation. This project would detain stormwater on the floodplain to provide sedimentation and allow vegetative uptake of nutrients.

DF9103 (Pond Retrofit) This project would be the retrofit of the existing pond near the outlet of this catchment. The primary opportunity at this facility is modify the control structure to create channel protection. The water quality volume can be stored within the facility with several existing water quality components around the pond perimeter to improve performance.

C04 (DFPR0001)

<u>Site Investigation and Projects</u>:

DF9504A (Culvert Retrofit) This project would consist of a culvert retrofit on the upstream side of Tiverton Circle near North Village Road. This retrofit would increase detention time and reduce the peak flows leaving the area.

DF9504B (Culvert Retrofit) This project is a culvert retrofit at the culvert under Wiehle Road at the downstream outlet to the catchment. It is designed for channel protection to help reduce peak flows downstream. There is area to excavate and increase the footprint of the pond without significant forest impacts.

3.10.3 Stream Restoration Projects

S05

Site Investigation and Projects: The site investigation showed three distinct segments. The upper section was recovering, the middle section has eroded outer meanders, and the lower section has erosive banks on both sides. The lower section is slightly incised with decent riffle pool morphology and some bed scour. Some portions of the riparian area were not forested. One project was identified

> *DF9205 (Streambank Stabilization/Buffer Restoration)* The streambanks would be reshaped and a floodplain bench excavated in the lower section. The riparian area would be planted with native trees and shrubs.

S80

Site Investigation and Projects: The site investigation found two areas of non-forested buffer. One project was identified.

> *DF9280 (Buffer Restoration)* The riparian zone would be replanted with native trees and shrubs in the non-forested areas.

S81

Site Investigation and Projects: The site investigation showed an area of non-forested buffer located in a gas easement. No project was identified because the easement must remain open and cannot be reforested.

S82

Site Investigation and Projects: The site investigation found a significant dumpsite. The dumpsite should be cleaned up but is not a stream restoration project. This site is included in the watershed-wide projects.

S83

Site Investigation and Projects: The site investigation did not find an obstruction to be cleared as a stream restoration project. This site is included in the watershed-wide projects.

3.10.4 Preservation

Improvement Goals for all Preservation Sites

Preservation goals for all the areas described earlier include reducing runoff volume, peak flows, and pollutant loads by preserving open space and forested land in key areas of the catchment such as headwaters.

Site Investigation and Projects

No site investigation was undertaken for preservation projects, and no specific proposals have been made for each area. Actions and policy changes needed to implement preservation for the areas listed earlier are described in Chapter 4.

3.11 Lower Difficult Run – Subwatershed Condition

3.11.1 Subwatershed Characteristics

The Lower Difficult Run **subwatershed** has an area of approximately 2,451 **acres** (3.8 mi^2). The Lower Difficult Run subwatershed is located in the northeast part of the Difficult Run watershed with portions in Great Falls National Park, The stream, which is approximately 9.3 miles long, flows in an easterly direction from the confluence with Wolftrap Creek to the outlet of the watershed where Difficult Run flows into the Potomac River in Great Falls National Park.The approximate northern boundary is near the intersection of Georgetown Pike (Virginia 193) and Leigh Mill Road (Virginia 683). Towlston Road (Virginia 676) lies along the eastern boundary while the southern border runs parallel to Leesburg Pike (Virginia 7).

Refer to DFDFL_1 for a map of the Lower Difficult Run subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.11.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The Lower Difficult Run subwatershed is the least developed subwatershed in the Difficult Run Watershed. Fifty-eight percent of the Lower Difficult Run subwatershed is developed as low-density or estate residential. Another 30 percent is open space or parks. Major parks that fall either partially or wholly within the subwatershed include Difficult Run Stream Valley Park, Colvin Run Mill Park, and Great Falls National Park. Ten historical sites lie within the subwatershed. Two percent of the subwatershed is developed for commercial use. The majority of the commercial development is in the southernmost portion of the subwatershed, and radiates northward from Leesburg Pike (Virginia 7). There are 166 acres, or 7 percent of the subwatershed, in transportation use such as roads and highways.

Total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 227 acres, or 9 percent of the total subwatershed area. A summary of subwatershed land use can be found in Table 3.17.

Table 3.17 Existing and Future Land Use

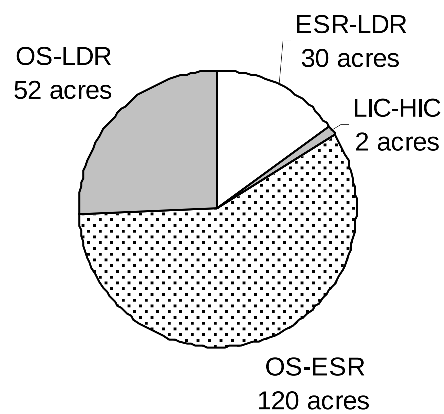
	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	740.04	30%	568	23%	-172	-7%
Golf Course	0	0%	0	0%	0	0%
Estate residential	801.9	33%	891	36%	89	4%
Low-density residential	604.6	25%	687	28%	83	3%
Medium-density residential	69.988	3%	70	3%	0	0%
High-density residential	3.2763	0%	3	0%	0	0%
Low-intensity commercial	12.81	1%	11	0%	-2	0%
High-intensity commercial	1.5704	0%	4	0%	2	0%
Industrial	8.2443	0%	8	0%	0	0%
Institutional	34.169	1%	34	1%	0	0%
Transportation	166.25	7%	166	7%	0	0%
Water	7.6927	0%	8	0%	0	0%
Total	**2,451**	**100%**	**2,451**	**100%**		**0%**

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

Changes between existing land use and future land use are projected in the open space, estate and low-density residential categories. There is a projected 7 percent loss in the open space category, with increases in the estate residential and low-density residential categories (4 percent and 3 percent respectively).

According to Figure 3.5, 120 acres are projected to shift from open space in the existing land use to estate residential in the future land use. Fifty-two acres are projected to shift from open space to low-density residential. These cumulative 172 acres of open space that are projected to shift to higher intensity use are not guaranteed to become developed - it suggests that these areas of open space can be used for development/ redevelopment in the future. Thirty acres in the Lower Difficult Run subwatershed are projected to shift from estate residential in the existing land use to low-density residential in the future land use. This illustrates a small demand for more housing in the Lower Difficult Run subwatershed.

Figure 3.5 Changed Land Use



3.11.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are 15 stormwater management facilities within the Lower Difficult Run subwatershed. Eighty-five percent of the Lower Difficult Run subwatershed is not served by any stormwater management facility. Ten percent of the total area has quantity control only and the remaining 5 percent receives both **quantity and quality control,** meaning both the amount of water and the pollutants in the water are controlled.

Lower Difficult Run is the least developed subwatershed in Difficult Run, however there is a gap between the amount of developed land (70 percent) and the amount of land containing stormwater management (15 percent). A list of all stormwater management facilities in the Lower Difficult Run subwatershed is found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. Field crews located 15 **outfall** pipes discharging into the Lower Difficult Run subwatershed during the Stream Physical Assessment. All were within 200 feet of the channel, and ranged in size from 12 to 18 inches. Stormwater from all of the pipes was causing at least minor to moderate erosion. Two pipes were identified with erosion downstream and some undermining of the structures. They are shown below in Photos 3.22 and 3.23.

Photo 3.22 Erosion at outfall pipe located near Mill Creek Landing (DFDF003.P001).

Photo 3.23 Erosion at outfall pipe located off of Hidden Creek Drive (DFDF020.P004).

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. During the Stream Physical Assessment, field crews located 30 stream crossings in the Lower Difficult Run subwatershed. Five of the crossings were having a moderate impact on stream condition. These crossings do not pose an immediate threat to the roadway or other structures, but should be inspected periodically. All other stream crossings were having a minimal impact on the stream condition. Two crossing with erosion are shown below in Photos 3.24 and 3.25.

Photo 3.24 Located near Leigh Mill Road has downstream and upstream bank erosion and minor bed erosion (DFDF019.C001).

Photo 3.25 Upstream and downstream bank erosion at Leesburg Pike (DFCR001.C001).

Soils

Soils found in the Lower Difficult Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 69 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (31 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. There are 27 acres of land with unclassified soils in the subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.11.4 Geomorphology

There are approximately 9.3 miles (49,185 feet) of stream in the Lower Difficult Run subwatershed. Most of this total were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. Six reaches (3.8 miles) were not assessed due to unsafe conditions, or because the stream system was comprised of wetlands and ponds.

The mainstem channel is Type II where the beginning stages of incision and degradation are present. The tributaries are a combination of Type II, III and IV. Type III channels are generally unstable and actively widening while Type IV channels are in the recovery stages and are stabilizing. Thirty-six percent of the total stream length is Type II, 23 percent is Type III, and 9 percent is Type IV. The channel substrate is generally a mixture of silt, sand and gravel. Boulder and bedrock are the dominant substrate on the mainstem downstream of Georgetown Pike.

Fifty-three percent of the stream length is moderately unstable with high erosion potential during flood events. Forty percent of the stream length was moderately stable with only slight potential for erosion at flood stages. There was a total of 8,375 feet of erosion identified in the subwatershed at 20 specific erosion locations. Fifty-five percent of the erosion sites (nine points) were having a severe impact on the stream channel, instream habitat or infrastructure. Several of the erosion areas have a high restoration potential. Two of the areas with the highest restoration potential are shown in Photos 3.26 and 3.27, which are candidates for stream restoration S85 and S84 respectively.

Photo 3.26 Severe erosion that could pose a threat to road safety along Route 7 to the east of Carpers Farm Way (DFCR001.E001).

Photo 3.27 Erosion located between Old Dominion Drive and Georgetown Pike (DFDF011.E001).

There are 10 obstruction sites located within the Lower Difficult Run subwatershed, most of which are trees and debris. Six of the obstruction sites are thought to be impacting fish movement within the stream. Of these six, one of the sites is on a downstream reach of the mainstem of Difficult Run (Photo 3.28) and has the potential for impacting a large majority of the entire Difficult Run watershed, as this is the only way for fish to get upstream to the rest of the watershed. This site is candidate site S86.

A second site impacting fish passage is located at the downstream end of one of the longer tributaries to mainstem Difficult Run (Photo 3.29). This site is candidate site S86.

Photo 3.28 Stream blockage located near Old Dominion Drive (DFDF002.T002).

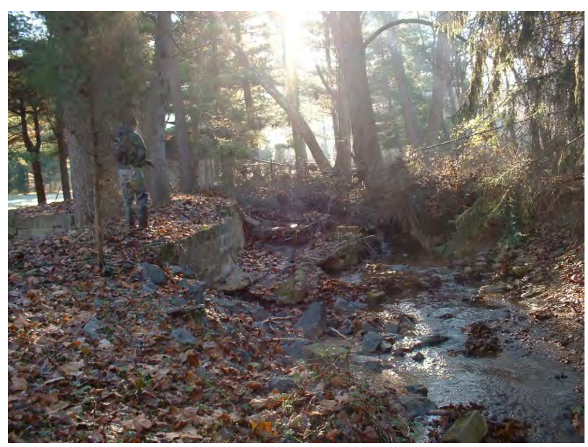


Photo 3.29 Stream blockage near Ramey Lane cul-de-sac (DFDF019.T001).

There were three ditches found in the subwatershed, two of which were discharging **stormwater.** Significant erosion was occurring in the ditch. There were two sanitary utility lines that were crossing the stream and partially buried. They were creating little, if any, impact on the stream. However, there was also a fiber optic utility line within the stream banks that was causing moderate erosion by impeding flow.

3.11.5 Stream Habitat and Water Quality

Field crews conducted an assessment of the streams within the Lower Difficult Run subwatershed in the fall of 2002. All assessed stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection.

- Of the assessed reaches, 57 percent has poor and very poor habitat for aquatic insects and fish, and 43 percent has good or fair habitat for aquatic insects and fish.
- There is 23,450 feet, or 24 percent of the total stream, of **riparian buffer** encroachment (this length includes left and right banks combined). Of this total, 18,350 feet (78 percent) is a combination of **pervious** surfaces, 3,700 feet (16 percent) is a combination of impervious surfaces, and the remaining 1,400 feet (6 percent) is some combination of impervious and pervious surfaces.
- Forty-six percent of the buffer encroachment length has no or low restoration potential due to the type of land use adjacent to the stream. Fifty-five percent of the length has moderate to high restoration potential. Much of the buffer encroachment is having an impact on stream character. Twenty-five percent of the areas with buffer encroachment are having a significant impact. An example of the impact by deficient buffer is shown below in Photo 3.30, which is located between Hidden Creek Drive and Forestville Drive. This area is a candidate site for restoration S88.

Photo 3.30 Buffer impact on a tributary west of Hidden Creek Drive (DFDF020.B001).

- There was one dumpsite found in the subwatershed. It did not appear to contain toxic material and was having little effect on the stream system.

3.11.6 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Lower Difficult Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

The Lower Difficult Run subwatershed is 9 percent impervious. The land use consists mostly of low density residential and estate residential. Within catchment DFDF0045 there is a small area of high density residential at Colvin Run Road and Robindale Drive. This, along with the other residential areas, is a likely contributor to the elevated levels of **nitrogen** and **phosphorus** loading on this **catchment**. Refer to DFDFL_4 for the catchment locations.

The highest volume of runoff occurs at a higher concentration of medium density residential areas than the rest of the subwatershed, in catchment DFDF6701, around Leesburg Pike and Middleton Ridge Road. Results are shown in Table 3.18.

Table 3.18 Existing and Future Modeling

Lower Difficult Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFDF0043	E	2.86	0.13	25.4	1.4	0.3
	F	2.9	0.13	26.2	1.4	0.3
	C	1%	0%	3%	0%	0%
DFDF0045	E	3.18	0.12	32.1	1.6	0.3
	F	3.47	0.13	32.9	1.6	0.3
	C	9%	8%	2%	0%	0%
DFDF0047	E	1.74	0.13	16.7	0.9	0.2
	F	1.75	0.13	16.8	0.9	0.2
	C	1%	0%	1%	0%	0%
DFDF0049	E	1.34	0.13	9.4	0.5	0.1
	F	1.4	0.13	9.5	0.5	0.1
	C	4%	0%	1%	0%	0%
DFDF0051	E	1.61	0.1	12.1	0.7	0.1
	F	1.66	0.11	12.4	0.7	0.1
	C	3%	10%	2%	0%	0%
DFDF0053	E	1.41	0.08	14.1	0.7	0.1
	F	1.49	0.08	14.5	0.7	0.1
	C	6%	0%	3%	0%	0%
DFDF0055	E	1.26	0.1	9.2	0.5	0.1
	F	1.24	0.1	9.0	0.5	0.1
	C	-2%	0%	-2%	0%	0%
DFDF0057	E	1.31	0.13	16.4	0.8	0.1
	F	1.31	0.13	16.4	0.8	0.1
	C	0%	0%	0%	0%	0%

Lower Difficult Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFDF5901	E	1.13	0.1	7.7	0.4	0.1
	F	1.19	0.1	7.9	0.4	0.1
	C	5%	0%	3%	0%	0%
DFDF5902	E	1.53	0.1	11.2	0.6	0.1
	F	1.56	0.1	11.3	0.6	0.1
	C	2%	0%	1%	0%	0%
DFDF6102	E	2.2	0.12	23.3	1.3	0.2
	F	2.57	0.13	28.0	1.5	0.3
	C	17%	8%	20%	15%	50%
DFDF6501	E	2.64	0.18	25.2	1.4	0.3
	F	2.75	0.18	26.6	1.5	0.3
	C	4%	0%	6%	7%	0%
DFDF6701	E	4.28	0.15	46.4	2.3	0.4
	F	4.77	0.16	62.2	3.1	0.5
	C	11%	7%	34%	35%	25%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

While most catchments are expected to have minor or negligible for all parameters, two catchments are projected to have the highest percent increase in pollutants: DFDF6701 and DFDF6102. In DFDF6701, the increase is most likely because of the expected change of some estate residential areas into low-density residential areas. DFDF6102 has a large area of open space changing to low-density residential which will increase both peak flow and runoff. The increases in land use intensity in these areas are projected to increase the runoff and pollutant loading to the streams in those catchments.

3.11.7 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Three crossings in the subwatershed were overtopped with existing flows, as shown in Table 3.19. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.19 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
58	Along Leesburg Pike	E	x	x	x	x	x	x	x
59	Leesburg Pike	E	x	x	x	x	x	x	x
72	Leigh Mill Road	E	x	x	x	x	x	x	x

E – Existing conditions results, x – indicates overtopping

Culvert #58 (Photo 3.31) overtopped for all events. From the photos, this culvert appears to be under a gravel drive, possibly a driveway or access road, and will be classified as a local road. Local roads are required to pass the 10-year event.

Culvert #59 (Photo 3.32) overtopped for all events. Leesburg Pike is a primary road, which is required to pass the 25-year event.

Photo 3.31 Lower Difficult Run Mainstem along Leesburg Pike

Photo 3.32 Lower Difficult Run Mainstem at Leesburg Pike

Culvert #72 (Photo 3.33) overtopped for all events also. Leigh Mill Road carries through traffic and is thus considered a primary road. Primary roads should pass the 25-year event.

Photo 3.33 Lower Difficult Run Mainstem at Leigh Mill Road

ents

Based on the review of the assessment data and modeling results, the most serious problem areas in the Lower Difficult Run subwatershed are listed below. Refer to DFDFL_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S84 A tributary of the Difficult Run mainstem is identified as having localized severe erosion with a high restoration potential and buffer encroachment by adjacent lawns between Old Dominion Drive and Georgetown Pike (Photo 3.27).

S85 The Colvin Run tributary has severe erosion (Photo 3.26) that could impact the safety of Carpers Farm Way and is missing buffer on both sides of the stream.

S86 The Stream Physical Assessment identified an obstruction affecting fish passage (Photo 3.29), which could possibly affect the entire Difficult Run watershed.

S87 The Stream Physical Assessment identified very poor habitat and severe erosion over half of the reach located at the end of Peacock Station Road.

S88 The stream between Hidden Creek Drive and Forestville Drive was identified during the assessment as having a severe obstruction, a pipe with moderate erosion and 800 feet of erosion with “moderate” restoration potential, and missing buffer over approximately half of the reach (Photo 3.30).

S89 The Stream Physical Assessment identified this site, located at the confluence of Captain Hickory Run and Difficult Run, as having areas of erosion ranging from moderate to severe as well as missing buffer.

<u>Hydrology and Water Quality</u>

D09 (Catchment DFDF6102) While the runoff and pollutants in this catchment are below average, there are several reaches that have severe erosion, notably at S88, including the reach immediately downstream of the outlet.

D10 (Catchment DFDF6501) This catchment has average runoff and peak flow for the subwatershed and average pollutant runoff. The stream within and immediately downstream of this catchment is incised.

D76 (Catchment DFDF5901) This site has conditions below the average for the subwatershed for runoff flows and pollutant loads. The stream is incised and has some unstable banks due to erosion in the catchment.

C15 (Catchment DFDF6701) This site has higher than average nitrogen and phosphorus loadings from runoff. Peak flows and runoff volume are the highest in the subwatershed. The stream within and immediately downstream of the catchment has poor habitat.

C53 (Catchment DFDF0047) This site has conditions similar to the average for the subwatershed for runoff flows and pollutant loads. Just before the confluence with Captain Hickory Run, the stream has severe erosion, a buffer deficiency, and is incised, as noted by S89.

Flooding

F58 The crossing along Leesburg Pike was overtopped for all events. Since it is classified as a local road, the culvert should pass the 10-year event (Photo 3.31).

F59 The crossing of Leesburg Pike was overtopped for all events. Classified as a primary road, this bridge should pass the 25-year event (Photo 3.32).

F72 The bridge on Leigh Mill Road overtopped for all events. It is also classified as a primary road, so it must pass the 25-year event (Photo 3.33).

Preservation

P23 (Catchment DFDF6102) Along the stream in this catchment, changes are projected to take place from open space to low-density residential. There is also some land changing from open space to estate residential. The majority of the modeled parameters are expected to double from the existing to the future conditions.

P24 (Catchment DFDF6501) This catchment is projected to have changes from open space to low density residential land use. Four out of five parameters modeled are expected to more than double.

3.12 Lower Difficult Run - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.20 below is a list of all projects proposed in this subwatershed.

Table 3.20 Recommendations for Lower Difficult Run

Project #	Project Type	Candidate Site
DF9009A	Pond Retrofit	D-09
DF9009B	Pond Retrofit	D-09
DF9009C	Drainage Retrofit	D-09
DF9010A	Culvert Retrofit	D-10
DF9010B	Culvert Retrofit	D-10
DF9010C	Culvert Retrofit	D-10
DF9010D	Drainage Retrofit	D-10
DF9010E	Stream Restoration	D-10
DF9076A	Culvert Retrofit	D-76
DF9076B	Pond Retrofit	D-76
DF9284	Stream Restoration	S84
DF9285	Stream Restoration	S85
DF9289	Stream Restoration	S89
DF9515A	Culvert Retrofit	C15
DF9515B	Culvert Retrofit	C15

3.12.1 Regional Pond Alternative Projects

D09 (DFDF6102)

Site Investigation and Projects:

DF9009A (Pond Retrofit) This project would retrofit an existing farm pond to not only treat more of the upstream area, but also to provide water quality improvements upstream of this pond and increase the detention time for peak flow attenuation. Some of these water quality improvements may include forebays, constructed wetlands, and aquatic fringe vegetation.

DF9009B (Pond Retrofit) This project would modify an existing stormwater management facility to increase the detention volume and potentially provide more water quality treatment. This project would be similar to DF9009A with additional improvements suggested: replace the existing corrugated metal pipe riser with a multi-stage concrete riser system to improve performance and install a forebay between the existing pond and the roadway to provide additional sediment and nutrient removal.

DF9009C (Drainage Retrofit) These distributed projects would provide protection, such as additional riprap, plunge pools, or structural energy dissipaters, to the transitions from paved channel to natural channel.

D10 (DFDF6501)

Site Investigation and Projects:

DF9010A (Culvert Retrofit) This project would retrofit the culvert under Forestville Drive to increase detention time and reduce peak flow rates, thus reducing erosive flows downstream.

DF9010B (Culvert Retrofit) This project would retrofit the culvert under Trotting Horse Lane to increase detention time and reduce erosive flows. This will also allow sedimentation to reduce pollutants.

DF9010C (Culvert Retrofit) This project would involve redesigning the existing dry pond facility upstream of Tackroom Lane to not only treat the local runoff, but the stream that now flows beneath the current facility as well.

DF9010D (Drainage Retrofit) These distributed projects would provide protection to the transitions from paved channel to natural channel in the form of additional riprap, plunge pools, or structural energy dissipaters.

DF9010E (Stream Restoration) This stream reach has become incised from the downstream culvert installation. Grade controls and step pools would be constructed, and the streambed would be raised in places to reconnect with the floodplain.

D76 (DFDF5901)

Site Investigation and Projects:

DF9076A (Culvert Retrofit) The topography upstream of Falls Run Road is ideal for detention storage due to the wide, flat floodplain and the grade difference between the roadway and the stream. This facility would use the floodplains to settle suspended solids.

DF9076B (Pond Retrofit) The farm pond at this location was not designed as a stormwater management facility. This project would include grading out the existing pond, installing an outlet structure and an embankment, and planting wetland vegetation for nutrient uptake.

3.12.2 Catchment Improvement Projects

C15 (DFDF6701)

Site Investigation and Projects:

DF9515A (Culvert Retrofit) This project consists of using the roadway embankment of Leesburg Pike to allow time for sediments to settle out of the water. Wetland vegetation will aid the sedimentation and nutrient uptake.

DF9515B (Culvert Retrofit) This project consists of using the roadway embankment of Locust Hill Drive to allow time for sediments, and possibly other pollutants, to settle out of the water.

3.12.3 Stream Restoration Projects

S84

Site Investigation and Projects: The site investigation showed a highly erosive and deeply incised stream with poorly defined bed forms. Several failing stone and concrete water diversion structures are located in the lower portion of the reach.

DF9284 (Stream Restoration) Bed features would be created to resemble stepped streambed morphology and the streambanks would be reshaped and stabilized. A floodplain bench would be excavated. The diversion structures would be removed.

S85

Site Investigation and Projects: The site investigation showed a straightened stream running along the embankment of the Leesburg Pike. Streambanks are steep and the stream is severely incised. The streambed is embedded with fine sediments. The right side of the stream is in pasture.

DF9285 (Stream Restoration) The stream would be relocated away from the Leesburg Pike embankment with a stable pattern, dimension and profile utilizing the available pastureland to create a meandering stream. The proposed streambanks and bed would be stabilized using natural channel structures.

S86

Site Investigation and Projects: The site investigation showed that the previously identified obstruction was mostly cleared and did not significantly impede flow. No project was identified.

S87

Site Investigation and Projects: The site investigation showed raw but moderately stable streambanks and moderate to severe incision in the straight and steep upper portion of the reach. The middle reach was slightly to moderately incised and had moderate to high sinuosity and some floodplain re-establishment. Downstream, two instream recreational ponds are largely filled and provide some control of sediments. Downstream of the ponds, the reach is largely in the Difficult Run floodplain. Access issues, wetland impacts, forest clearing and steep slopes outweigh the benefits of reduced sediment export from bank erosion by restoring the upstream reach, so no project was identified.

S88

Site Investigation and Projects: The site investigation found a significant buffer impairment. No erosion mitigation project was identified because potential project benefits did not justify the construction impacts that would be incurred. Buffer restoration and obstruction removal were included with the watershed-wide projects.

S89

Site Investigation and Projects:

DF9289 (Stream Restoration). The stream erosion would be repaired with moderate regrading and bank protection structures on the meanders, and the buffer would be revegetated.

3.12.4 Preservation

Improvement Goals for all Preservation Sites

Preservation goals for all the areas described above include reducing runoff volume, peak flows, and pollutant loads by preserving open space and forested land in key areas of the catchment such as headwaters.

Site Investigation and Projects

No site investigation was undertaken for preservation projects, and no specific proposals have been made for each area. Actions and policy changes needed to implement preservation for the areas listed below are described in Chapter 4.

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3.13 Sharpers Run – Subwatershed Condition

3.13.1 Subwatershed Characteristics

The Sharpers Run **subwatershed** is the smallest of all the subwatersheds in the Difficult Run watershed. It has an area of approximately 415 **acres** (0.65 mi^2). Towlston Road lies along the subwatershed's western boundary, while Leesburg Pike (Virginia 7) forms the approximate southern boundary. The Georgetown Pike (Virginia 193) forms the approximate northern boundary.

The Sharpers Run subwatershed is located in the downstream portion of the Difficult Run watershed. There is a single stream **channel** in Sharpers Run. The stream is approximately 1.6 miles in length and flows in a northerly direction until it joins Rocky Run and eventually the mainstem of Difficult Run.

Refer to DFSP_1 for a map of the Sharpers Run subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.13.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The Sharpers Run subwatershed is currently one of the most undeveloped areas in the Difficult Run watershed. Sixty-four percent of the Sharpers Run subwatershed is developed as low-density or estate residential. Another 24 percent is open space or parks, although there are no major parks found within the subwatershed boundary. One historical site lies within the subwatershed. There are no commercial uses in the subwatershed; however 8 percent is used for industrial purposes. Much of this activity is located at the southern boundary of the subwatershed near Woodside Lake, and the intersection of the Leesburg Pike (Virginia 7) and Towlston Road. There are 15 acres, or 4 percent of the subwatershed, occupied by transportation use such as roads and highways.

Total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 39 acres, or 9 percent of the total subwatershed area. A summary of land use within the subwatershed can be found in Table 3.21.

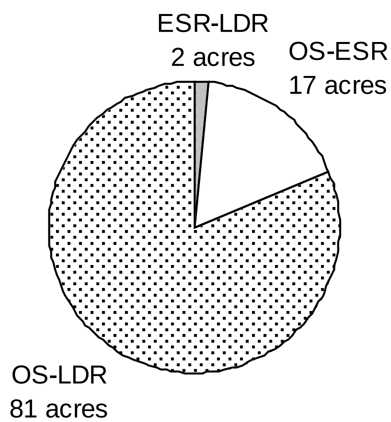
Table 3.21 Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	98	24%	0	0%	-98	-24%
Golf Course	0	0%	0	0%	0	0%
Estate residential	155	37%	171	41%	15	4%
Low-density residential	112	27%	195	47%	83	20%
Medium-density residential	0	0%	0	0%	0	0%
High-density residential	0	0%	0	0%	0	0%
Low-intensity commercial	1	0%	1	0%	0	0%
High-intensity commercial	0	0%	0	0%	0	0%
Industrial	34	8%	34	8%	0	0%
Institutional	0	0%	0	0%	0	0%
Transportation	15	4%	15	4%	0	0%
Water	0	0%	0	0%	0	0%
Total	**415**	**100%**	**415**	**100%**		**0%**

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

The notable changes between existing land use and future land use in Sharpers Run are projected in the open space, estate and low-density residential categories. There is projected to be a 24 percent loss in the open space category, with compensatory increases in the estate residential category and low-density residential categories (4 percent and 20 percent respectively).

Figure 3.6 Changed Land Use



According to Figure 3.6, 81 acres are projected to shift from open space to low-density residential and 17 acres are projected to shift from open space to estate residential. This does not guarantee that the open space will become developed – it suggests that these areas of open space can be used for development/ redevelopment in the future. There is the possibility that Sharpers Run could lose much of its open space to development, which may result in increased levels of **impervious** surface and contribute **runoff** to the stream system. These shifts illustrate a demand for additional housing in the future.

3.13.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are only two stormwater management facilities within the Sharpers Run subwatershed. Ninety percent of the Sharpers Run subwatershed is not served by any stormwater management facility resulting in uncontrolled volumes of water and pollutants. Eight percent of the total area has quantity control only and the remaining two percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (76 percent) and the area served by stormwater management (10 percent) indicates a potential for stream impairment due to uncontrolled stormwater and indicates a possible need for additional management efforts, specifically in the industrial and low-density residential areas. Additional information on the location of the stormwater management facilities in the Sharpers Run subwatershed is found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment field crews did not locate any **outfall** pipes discharging into Sharpers Run subwatershed.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. There were four crossings in the Sharpers Run subwatershed identified during the Stream Physical Assessment. Two of the crossings were circular corrugated metal pipes, and two were wooden bridges (one was a footbridge). None of the crossings were having an impact on the stream condition.

3.13.4 Soils

Soils found in the Sharpers Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 84 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (41percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. There are 5.3 acres of land with unclassified soils in the Sharpers Run subwatershed. Soils that cover at least 20 acres within the subwatershed are listed in Appendix A.

3.13.5 Geomorphology

There are approximately 1.6 miles (8,218 feet) of stream in the Sharpers Run subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the *Stream Physical Assessment*. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes.

All of the streams were classified as Type III, which is indicative of a generally unstable channel that is actively widening in response to changes in flow. All of the streams are considered moderately unstable with high erosion potential during flood events. The dominant substrate material was sand. In approximately half of the length, there was a combination of sand and gravel. Refer to DFSP_3 for the stream classifications.

There were three specific erosion points totaling 65 feet that were noted in the subwatershed. All were creating a severe impact on the stream condition and had moderate restoration potential.

There was one stream blockage made up of trees and debris that appeared to be restricting fish movement. The obstruction also has the potential to create **flooding** problems under high flow conditions. The obstruction is shown in Photo 3.35 and is a candidate site for restoration S90.

Photo 3.34 Eroding bank located east of the Lawns of Towlston Community (DFSP002.E001)

Photo 3.35 Obstruction at the northern end of Sharpers Run near the confluence with Rocky Run between the Bryan Pond and Peacock Station communities (DFSP001.T001).

3.13.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one-time visual inspection. Field crews conducted that assessment in the fall of 2002.

- All of the reaches have fair habitat for aquatic insects and fish.
- There is 6,450 feet of **riparian buffer** encroachment (this length includes left and right banks combined). Of this total, 5,650 feet (88 percent) is impacted by lawns, and 800 feet (12 percent) is bordered by meadow.
- Fifty-six percent of the buffer encroachment length is affecting the stream channel by reducing shading effects. One of the buffer encroachment sites is shown below in Photo 3.36. This site is a stream restoration candidate site S90.
- Seventy-one percent of the **buffer** encroachment length has a moderate restoration potential while 29 percent was identified only having low restoration potential.

- Seventy-eight percent of the assessed stream length had between 50 percent and 70 percent of both stream banks covered by vegetation. Typically this vegetation is scattered grasses, shrubs and forbs. Twenty-two percent of the assessed stream length had a variety of vegetation and covered 70 percent to 90 percent of the stream bank surface.

Photo 3.36 Buffer encroachment between Rocky Run Road and Cedrus Lane (DFSP001.B004).

3.13.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Sharpers Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

Sharpers Run subwatershed is comprised almost entirely of estate and low-density residential and open space land uses. The one exception is a large industrial area, at the intersection of Towlston Road and Leesburg Pike, in **catchment** DFSP9901. This area likely contributes a large percentage of the stormwater subwatershed. Refer to DFSP_4 for the catchment locations. Most all **pollutants** in this subwatershed come from runoff. The catchment with the most runoff volume is DFSP0002, located between Towlston Road and Union Church Road. There is more low-density land use in this catchment than estate residential, so the runoff volume is higher than DFSP0001, where estate residential area is greater than low-density residential area. Results can be seen in Table 3.22.

Table 3.22 Existing and Future Modeling

Sharpers Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFSP0001	E	1.7	0.13	13.8	0.7	0.2
	F	1.75	0.13	14.0	0.7	0.2
	C	3%	0%	1%	0%	0%
DFSP0002	E	1.95	0.12	15.8	0.9	0.2
	F	1.95	0.12	15.8	0.9	0.2
	C	0%	0%	0%	0%	0%
DFSP9901	E	1.63	0.08	28.5	1.6	0.2
	F	2.63	0.07	46.2	2.4	0.3
	C	61%	-13%	62%	50%	50%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

The future model shows minor or negligible increases in all parameters for all catchments except DFSP9901. All of the open space in this catchment is projected to change to low-density residential in the future. This change in surrounding cover will likely increase the pollutants and runoff volume delivered to the stream.

3.13.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

One culvert in the subwatershed was overtopped with existing flows, as shown in Table 3.23. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.23 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
80	Bellview Road	E	x	x	x	x	x		

E – Existing conditions results, x – indicates overtopping

Culvert #80 (Photo 3.37) overtopped for all events except the one and two-year. Bellview Road carries through traffic, so it is considered a primary road. This means that it must pass the 25-year event.

Photo 3.37 Sharpers Run mainstem at Bellview Road.

3.13.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Sharpers Run subwatershed are listed below. Refer to DFSP_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S90 The Stream Physical Assessment identified this site as having buffer and erosion problems along with active widening. There is also a stream blockage at this site (Photo 3.35, 3.36).

<u>Hydrology and Water Quality</u>

D20 (Catchment DFSP0001) This catchment has the below average runoff within the subwatershed. Site S90 is located within this catchment and all of Sharpers Run has active widening.

<u>Flooding</u>

F80 The culvert under Bellview Road, which is considered a primary road, overtops for 5-year and greater events. Primary roads must pass the 25-year event (Photo 3.37).

<u>Preservation</u>

No preservation sites were identified.

3.14 Sharpers Run - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.24 below is a list of all projects proposed in this subwatershed.

Table 3.24 Recommendations for Sharpers Run

Project #	Project Type	Candidate Site
DF9020B	Drainage Retrofit	D-20
DF9290	Streambank Stabilization	S90

3.14.1 Regional Pond Alternative Projects

D20 (DFSP0001)

Site Investigation and Projects:

> *DF9020B (Drainage Retrofit)* These distributed projects are designed to provide energy dissipation at outfalls where paved channels discharge into natural channels at high velocities. Possible energy dissipaters include riprap and plunge pools. This should reduce the sediment export and help prolong the life of local farm ponds.

3.14.2 Catchment Improvement Projects

No sites were identified.

3.14.3 Stream Restoration Projects

S90

Site Investigation and Projects*:* The site investigation showed moderately eroding streambanks and a non-forested area within the left riparian zone. The stream is located between two gravel residential driveways.

> *DF9290 (Streambank Stabilization/Buffer Restoration)* The banks would be regraded and stabilized. The left riparian area would be planted with native trees and shrubs.

3.14.4 Preservation

No preservation candidate sites were identified for this subwatershed.

3.15 Rocky Run – Subwatershed Condition

3.15.1 Subwatershed Characteristics

The Rocky Run **subwatershed** is located in north central Fairfax County. The headwaters of the subwatershed are in the Tysons Corner area. This 1,673-**acre** (2.61 mi^2) subwatershed is roughly bounded to the west by Towlston Road (Virginia 676) and Leesburg Pike (Virginia 7). The southern tip extends just past the Dulles Access Road to Westpark Drive and includes Exit 16 of the Access Road. The western boundary follows Georgetown Pike (Virginia 193) to the Madeira School property then cuts across Old Dominion Drive (Virginia 738) and through residential areas to Spring Hill Road (Virginia 684).

There are 6.5 miles of stream within the subwatershed. The mainstem of Rocky Run begins as a culvert under the Dulles Access Road and flows north through low-density residential neighborhoods for approximately 3 miles where it is joined by Sharpers Run just to the south of Old Dominion Drive. It continues through lightly developed areas for less than a mile to its **confluence** with Difficult Run, which is not far upstream of Difficult Run's connection with the Potomac River at Great Falls Park. According to historical reports, Rocky Run varies in size from 7 feet wide in the upper reaches to 25 feet wide downstream of Old Dominion Drive (PB 1976).

Refer to DFRR_1 for a map of the Rocky Run Hickory subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.15.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

Development in the Rocky Run subwatershed is moderately to heavily dense. Sixty-five percent of the subwatershed is low-density or estate residential, 2 percent is high-density residential, and 11 percent is designated as open space. Woodside Lake lies in the central portion of the subwatershed. There are no wetlands located within the subwatershed. Three historic sites are located within the Rocky Run subwatershed, but no large public parks.

Commercial and industrial areas are located primarily in the southern end of the subwatershed and comprise 9 percent of the total subwatershed area. The transportation use, such as roads and highways, are also primarily in the south and make up another 12 percent of the total subwatershed acreage. This southernmost portion of the subwatershed, upstream of the headwaters of Rocky Run, includes Tyco Commercial Park and Exit 16 of the Washington Dulles Access Road, the most heavily traveled roadway in the area.

Total impervious area, including all roads, buildings, residential driveways, and parking lots, is 334 acres, or 20 percent of the total area. This impervious area is predominantly clustered in the southern end of the subwatershed. A summary of land use within the subwatershed can be found in Table 3.25.

Table 3.25 Existing and Future Land Use

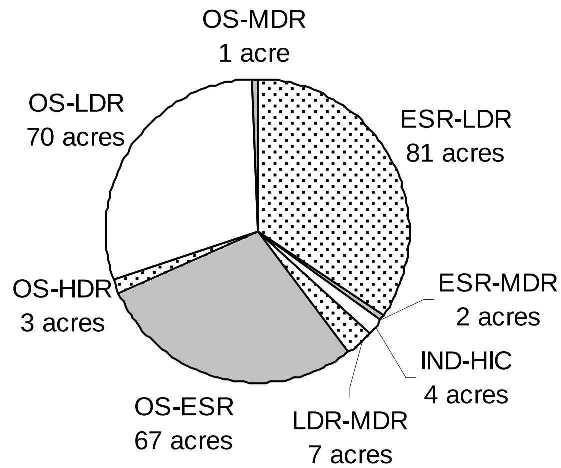
	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	189	11%	47	3%	-142	-8%
Golf Course	0	0%	0	0%	0	0%
Estate residential	435	26%	419	25%	-16	-1%
Low-density residential	654	39%	798	48%	144	9%
Medium-density residential	6	0%	17	1%	11	1%
High-density residential	26	2%	29	2%	3	0%
Low-intensity commercial	15	1%	15	1%	0	0%
High-intensity commercial	82	5%	85	5%	4	0%
Industrial	46	3%	42	3%	-4	0%
Institutional	13	1%	13	1%	0	0%
Transportation	200	12%	200	12%	0	0%
Water	7	0%	7	0%	0	0%
Total	**1,673**	**100%**	**1,673**	**100%**		**0%**

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

The notable changes between existing land use and future land use are projected in the open space, estate residential, and low-density residential.. There are projected losses in open space (-8 percent) and estate residential (-1 percent). .Increases are projected in the low-density residential (+9 percent) and medium-density residential (+1 percent),.

According to Figure 3.7, 83 acres are projected to shift from estate residential in the existing land use to low-density and/or medium-density residential in the future land use. Cumulatively, 141 acres or 60 percent of all land use changes, are projected to shift from open space to a higher-intensity use. This does not guarantee that the open space will become developed – it suggests that these areas of open space can be used for development/ redevelopment in the future.

Figure 3.7 Changed Land Use



3.15.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are 22 **stormwater management facilities** within the Rocky Run subwatershed. Eighty-one percent of the Rocky Run subwatershed was developed before stormwater management regulations were adopted, and is not served by any treatment facility. Seventeen percent of the total area has quantity control only and the remaining 2 percent receives both **quantity and quality control**. A list of all stormwater management facilities in the subwatershed is found in Appendix D.

Although a large percentage of the subwatershed is not served by stormwater management, those areas are generally located in the northern and central areas where the land use is largely estate and low-density residential. Because these areas typically leave some forest canopy intact and are disconnected from the stormwater system they may not require additional stormwater controls.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located 15 stormwater **outfall** pipes discharging into Rocky Run. All located pipes appeared to have minimal impact on the stream and did not warrant repair.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. The Stream Physical Assessment located 23 stream crossings within the subwatershed. Of these crossings, three are footbridges and seven are bridges or box culverts. Most crossings were creating only a minor impact on the stream condition. One crossing, located off of Brook Road in the Woodside Lake Area was having a slightly more significant impact on downstream streambed erosion but does not warrant immediate attention.

3.15.4 Soils

Soils found in the Rocky Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 60 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (35 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. There is less than one acre of land with unclassified soils in the Rocky Run subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.15.5 Geomorphology

There are approximately 6.5 miles of stream in the Rocky Run subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel’s physical condition and stability as a response to disturbances such as upstream land use changes.

Three stream reaches (2,288 feet) were not assessed because they were not natural **channels**. This includes the culvert under the Dulles Access Road.

All assessed stream reaches in Rocky Run were characterized as Type III. This indicates a generally unstable channel that has eroding banks and is actively widening in response to changes in flow. Most (62 percent) of the total reach length assessed has gravelly substrate while 13 percent is sand/gravel mix and 11 percent is cobble. Refer to DFRR_3 for the stream classifications.

Channel incision was especially notable on several tributaries to Rocky Run and on a segment of the mainstem of Rocky Run in the central portion of the subwatershed. Field crews noted and photographed five erosion points that were having a severe impact on Rocky Run and its tributaries. Four of these erosion points are located on the mainstem of Rocky Run and one on a minor tributary in the upper reaches of Rocky Run. An example is shown in Photo 3.38, which is stream restoration candidate site S92.

Photo 3.38 Significant erosion on the mainstem between Woodside Drive and Orlo Drive (DFRR013.E001).

Photo 3.39 Exposed utility located northeast of Old Dominion Drive near Tebbs Lane.

There was one utility pipe of an unknown type in reach on a tributary to Rocky Run as shown in Photo 3.39. This utility pipe is partially buried and did not appear to be causing erosion in the stream channel.

There were 16 sites along the stream within the subwatershed where trees and debris were obstructing flow. Of these, nine were considered significant enough to affect fish passage and three of the 16 had a greater than moderate impact. Photo 3.40 shows a representative blockage on a Rocky Run tributary that may be impeding fish passage.

Photo 3.40 Obstruction located between Tebbs Lane and Cilicia Street (DFRR001.T002).

3.15.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall of 2002.

- Of the 6.5 miles of stream assessed, 46 percent has good habitat for aquatic insects and fish, 31 percent exhibits fair habitat quality, and 16 percent has poor habitat quality.
- There are 3.1 miles of stream that are without adequate **riparian buffer** on either the left or right bank. There are 2,650 feet of stream that are missing adequate buffer on both the left and right banks combined.
- All reaches had at least 50 percent vegetative bank cover (usually shrubs and grasses).

3.15.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Rocky Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

The Rocky Run subwatershed is 20 percent impervious, a majority of which is in the portion of Rocky Run south of the Dulles Toll Road and east of Leesburg Pike. This is the location of **catchment** DFRR0001, which has the highest modeled pollutant loads in the subwatershed. Refer to DFRR_4 for the catchment locations. This is a concentrated area of commercial and industrial areas are the most probable source of the high levels of **nitrogen** begin delivered to the stream system.

Two catchments, DFRR9601 and DFRR9801, located in the Springhaven Estates and the Foxhall of McLean areas respectively, were ranked second and third for the subwatershed behind DFRR0001 in nitrogen loading rates. These three catchments also have higher than average **phosphorus** loading rates. Catchment DFRR0001 has the highest runoff volume in Rocky Run with 9.4 inches per year, almost double the amount of the next highest catchment. Results can be found in Table 3.26.

Table 3.26 Existing and Future Modeling

Rocky Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFRR0001	E	14.79	0.3	333.9	13.6	1.2
	F	14.14	0.3	321.3	13.8	1.2
	C	-4%	0%	-4%	1%	0%
DFRR0002	E	4.85	0.17	41.5	2.2	0.4
	F	5.53	0.2	52.9	2.8	0.5
	C	14%	18%	27%	27%	25%
DFRR0003	E	2.74	0.13	24.3	1.3	0.3
	F	3.27	0.14	31.7	1.7	0.4
	C	19%	8%	30%	31%	33%
DFRR0004	E	2.03	0.2	16.5	0.9	0.2
	F	2.52	0.21	23.1	1.3	0.3
	C	24%	5%	40%	44%	50%
DFRR0005	E	1.82	0.14	17.9	0.9	0.2
	F	2.04	0.14	21.4	1.1	0.2
	C	12%	0%	20%	22%	0%
DFRR0006	E	1.47	0.13	10.2	0.5	0.1
	F	1.58	0.13	10.9	0.6	0.1
	C	7%	0%	7%	20%	0%
DFRR0007	E	1.6	0.17	11.1	0.6	0.1
	F	1.61	0.17	11.0	0.6	0.1
	C	1%	0%	-1%	0%	0%
DFRR9401	E	1.09	0.1	12.9	0.6	0.1
	F	1.24	0.11	14.3	0.7	0.1
	C	14%	10%	11%	17%	0%
DFRR9501	E	2.03	0.14	19.3	1.1	0.2
	F	2.24	0.15	21.5	1.2	0.3
	C	10%	7%	11%	9%	50%
DFRR9601	E	2.09	0.1	19.0	1.0	0.2
	F	2.21	0.11	20.3	1.1	0.2
	C	6%	10%	7%	10%	0%
DFRR9702	E	2.23	0.12	22.4	1.2	0.3
	F	2.6	0.12	28.0	1.5	0.3
	C	17%	0%	25%	25%	0%
DFRR9801	E	2.68	0.11	28.0	1.6	0.3
	F	2.83	0.12	30.0	1.7	0.4
	C	6%	9%	7%	6%	33%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

Modeling results for future conditions show increases in flows and runoff **pollutant** loads from most of the catchments in the subwatershed. Percent increases in catchment DFRR0004 are projected to be the highest for all parameters. This catchment has a substantial amount of land changing from open space or estate residential to low density residential. Catchment DFRR0003 also has large predicted percent changes, also for the same land use changes. Many of the land use changes in this subwatershed are along the stream, especially in the headwaters. All of these changes will significantly increase the suspended solids along with the runoff volume and peak.

3.15.8

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Four crossings in the subwatershed were overtopped by existing flows. They are listed below in Table 3.27. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.27 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
74	Brook Road	E	x	x	x				
75	Bellview Road	E	x	x	x	x	x		
76	Towlston Road	E	x	x	x	x	x	x	
79	Old Dominion Drive	E	x	x	x				

E – Existing conditions results, x – indicates overtopping

Culvert #74 (Photo 3.41) overtopped for the 25, 50, and 100-year events. Since Brook Road does not allow through traffic, it is classified as a local road, which has to pass the 10-year

Photo 3.41 Culvert 74 at Brook Road on Rocky Run mainstem.

Photo 3.42 Culvert 75 at Bellview Road on Rocky Run mainstem.

flow. Since it does pass the 10-year flow, this culvert is not considered a candidate site.

Culvert #75 (Photo 3.42) overtopped for all events except the one and two-year. Bellview Road is a primary road and so must pass the 25-year event.

Culvert #76 (Photo 3.43) overtopped for all events except for the one-year. Primary roads, the classification for Towlston Road, must pass the 25-year event.

Culvert #79 (Photo 3.44) overtopped for the 25, 50, and 100-year events. Old Dominion Drive allows through traffic and is classified as a primary road. This means it must pass the 25-year event.

Photo 3.43 Culvert 76 on Rocky Run mainstem at Old Towlston Road

Photo 3.44 Culvert 79 on Rocky Run mainstem at Old Dominion Drive

Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Rocky Run subwatershed are listed below. Refer to DFRR_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S91 The Stream Physical Assessment identified this site as having severe erosion all with moderate restoration potential near Bellview Road.

S92 This site was identified as having significant erosion and a deficient buffer, where houses are built close to the stream (Photo 3.38).

S93 This site, located near the culvert at Towlston Road, was identified as having a deficient buffer, again because of the proximity to houses.

<u>Hydrology and Water Quality</u>

D18 (Catchment DFRR9601) This catchment has some of the highest modeled runoff volume and nitrogen loading in the subwatershed. Erosion is occurring at the junction between a manmade channel and the natural stream system.

D19 (Catchment DFRR9501) This site has better than average conditions for runoff flows and pollutant loads in the subwatershed. It was selected because it is a proposed site for a regional pond.

D21 (Catchment DFRR9401) This site has better than average conditions for runoff flows and pollutant loads in the subwatershed. Site S93 was identified downstream of this pond and an exposed utility (Photo 3.39) and obstruction (Photo 3.40) are located in the catchment.

D66 (Catchment DFRR9801) This catchment has above average pollutant loading rates. The reach in this catchment has unstable banks and poor habitat rating.

C21 (Catchment DFRR0001) This site has higher than average nitrogen and phosphorus loadings. Peak flows and runoff volume are also above average. There are no critical stream problems within the area or immediately downstream.

<u>Flooding</u>

F75 The crossing at Bellview Road overtopped for 5-year and greater events. To meet standards, however, it must pass the 25-year event because it is a primary road (Photo 3.42).

F76 The bridge on Towlston Road, a primary road, overtopped for all events except the one-year. This bridge must pass the 25-year event to meet requirements (Photo 3.43).

F79 The crossing at Old Dominion Drive overtopped for 25, 50, and 100-year events. Old Dominion Drive is classified as a primary road, so it must pass the 25-year event (Photo 3.44).

<u>Preservation</u>

P08 (Catchment DFRR0003) Percent increases between the existing and future conditions are projected to be the highest for all parameters in this catchment due to losses of open space.

P09 (Catchment DFRR0004) This area is projected to experience large changes from open space to estate and low-density residential use. Four out of the five modeled parameters are expected to more than double between the existing and future conditions.

3.16 Rocky Run - Subwatershed Plan Actions

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.28 below is a list of all projects proposed in this subwatershed.

Table 3.28 Recommendations for Rocky Run

Project #	Project Type	Candidate Site
DF9019A	Drainage Retrofit	D-19
DF9066A	Pond Retrofit	D-66
DF9121	Pond Retrofit	C21
DF9291	Stream Restoration	S91

3.16.1 Regional Pond Alternative Projects

D19 (DFRR9501)

Site Investigation and Projects:

> *DF9019A (Drainage Retrofit)* This project involves providing additional outlet protection, possibly riprap and/or structural measures, where the storm drain system discharges into natural channels. The project will reduce velocity from the outfall and help reduce erosive potential immediately downstream.

D21 (DFRR0007)

Site Investigation and Projects: See culvert site F76 for projects to address this site.

D66 (DFRR9801)

Site Investigation and Projects:

> *DF9066A (Pond Retrofit)* Retrofits to this pond include installing a multi-stage control structure over the existing outlet to significantly improve peak flow attenuation. The existing facility holds the necessary water quality volume to treat the full drainage area. To enhance the treatment function, the aquatic bench will be extended to encompass the entire perimeter of the facility.

3.16.2 Catchment Improvement Projects

C21 (DFRR0001, DFRR0002)

Site Investigation and Projects: The catchment is fully developed and almost 100 percent impervious. There is very little existing stormwater management and the streams in the catchment have been piped.

> *DF9121 (Pond Retrofit)* The wet pond at the downstream catchment should be retrofited by adding both wet and dry vegetation to the natural channels and surrounding banks. In addition, a sediment forebay constructed in front of the closed storm drain outlet will treat impervious runoff prior to flow entering the stream channel.

3.16.3 Stream Restoration Projects

S91

Site Investigation and Projects: The site investigation showed eroding banks on both sides of the stream with some widening apparent in the upper portion of the reach. The stream is actively meandering and has weak riffle pool morphology. Evidence of a high concentration of fines sediments was observed. One project was identified.

> *DF9291 (Stream Restoration)* The stream would be reconstructed to provide a pattern, dimension, and profile more consistent with that of a natural stream. Streambanks would be stabilized and riffle pool bed morphology would be created.

S92

Site Investigation and Projects: The site investigation showed eroded stream banks and slight incision. The stream appeared to be recovering as was evidenced by narrowing of the baseflow channel and the formation of shallow pools. The site is flanked by residential driveways on both sides. No other buffer deficiency was noted. No project was identified because potential project benefits did not justify the construction impacts that would be incurred.

S93

Site Investigation and Projects: The site investigation did not show significant erosion impairment. No project was identified.

3.16.4 Preservation

Improvement Goals for all Preservation Sites

Preservation goals for all the areas described below include reducing runoff volume, peak flows, and pollutant loads by preserving open space and forested land in key areas of the catchment such as headwaters.

Site Investigation and Projects

No site investigation was undertaken for preservation projects, and no specific proposals have been made for each area. Actions and policy changes needed to implement preservation for the areas listed below are described in Chapter 4.

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3.17 Colvin Run – Subwatershed Condition

3.17.1 Subwatershed Characteristics

The Colvin Run subwatershed is the second-largest **subwatershed** in the Difficult Run watershed, and has an area of approximately 3,876 **acres** (6.06 mi^2). It is located in northern Fairfax County. The subwatershed is bounded by the Reston Parkway (Virginia 602) to the west. The southern portion of the subwatershed extends south across the Dulles Access Toll Road (Virginia 267) and the northern portion extends across Baron Cameron Avenue (606) and runs generally along Leesburg Pike (Virginia 7).

The Colvin Run subwatershed is located in the northern, downstream portion of the Difficult Run watershed. The stream is approximately 15 miles in length and flows in an easterly direction until it reaches the mainstem of Difficult Run in the Colvin Run Stream Valley Park.

Refer to DFCR_1 for a map of the Colvin Run subwatershed highlighting the Subwatershed Characteristics including, existing **land use, flood limit, wetlands, resource protection areas and stormwater management.**

3.17.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

Colvin Run subwatershed is one of the more densely developed subwatersheds found within the Difficult Run watershed. Seventeen percent is developed as low-density or estate residential, while 32 percent of the subwatershed is developed for high-density residential, commercial, or industrial uses. The majority of this area is clustered along the Dulles Access Toll Road (Virginia 267) at the Wiehle Avenue (Virginia 828) interchange. Additional dense development is found along major arterials, Baron Cameron Avenue (Virginia 606) and the Reston Parkway (Virginia 602).

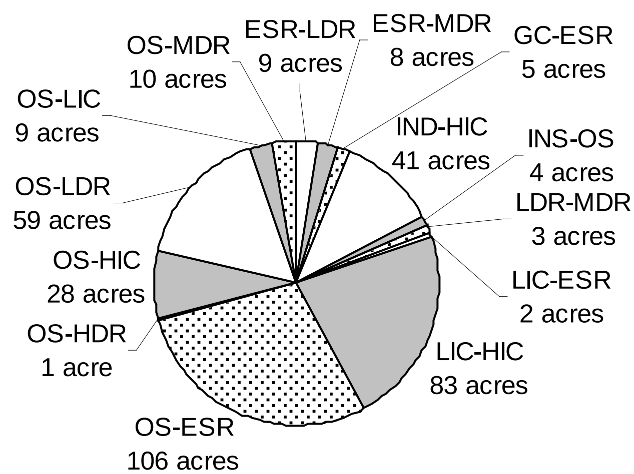
There are 371 acres, 10 percent of the subwatershed, used for transportation rights-of-way. However, total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 882 acres, or 23 percent of the total subwatershed area. Twenty-five percent is preserved for open space or parks. Major parks include Lake Fairfax Park, Hidden Creek Golf Course, a portion of Colvin Run Mill Park, and the majority of the Baron Cameron Park. Eight historical sites lie within the subwatershed.

Table 3.29 Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	961	25%	752	19%	-209	-5%
Golf Course	205	5%	200	5%	-5	0%
Estate residential	228	6%	323	8%	96	2%
Low-density residential	441	11%	506	13%	65	2%
Medium-density residential	253	7%	274	7%	22	1%
High-density residential	670	17%	670	17%	1	0%
Low-intensity commercial	225	6%	150	4%	-75	-2%
High-intensity commercial	291	8%	443	11%	152	4%
Industrial	45	1%	4	0%	-41	-1%
Institutional	117	3%	113	3%	-4	0%
Transportation	371	10%	371	10%	0	0%
Water	69	2%	69	2%	0	0%
Total	**3,876**	**100%**	**3,876**	**100%**		**0%**

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

Figure 3.8 Changed Land Use



When comparing existing land use to future land use, changes are projected in the open space, estate residential, low-density residential, low-intensity commercial, and high-intensity commercial areas. There is a projected 2 percent increase in estate residential, 2 percent increase in low-density residential, 1 percent increase in medium-density residential, and 4 percent increase in high-intensity commercial acreage. Decreases are projected to include a 5 percent loss of open space, 2 percent loss of low-intensity commercial acreage, and 1 percent loss of industrial acreage. A complete summary of land use within the subwatershed can be found in Table 3.29.The largest cumulative land use shifts are projected toward high-intensity commercial uses in the Colvin Run subwatershed. As shown in Figure 3.8, 83 acres are projected to shift from low-intensity commercial in the existing land use to high-intensity commercial in the future land use. In this case, the type of development would not necessarily change but the intensity would increase.

Forty-one acres are projected to shift from industrial uses to high-intensity commercial. In this case, intensity is projected to remain high; however, the types of uses would change.

Two-hundred and thirteen acres of open space are projected to shift to a higher-intensity use. This does not guarantee that the open space will become developed – it suggests that these areas of open space can be used for development/ redevelopment in the future.

3.17.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are 49 **stormwater management facilities** within the Colvin Run subwatershed. Seventy-six percent of the Colvin Run subwatershed is not served by any stormwater management facility. Twenty percent of the total area has quantity control only and the remaining 4 percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (79 percent) and the area served by stormwater management (24 percent) indicates a possible need for additional management efforts, specifically in the high-density residential and low intensity commercial areas. A list of all stormwater management facilities in the Colvin Run subwatershed is found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. Stream Physical Assessment field crews located 44 **outfall** pipes discharging into the Colvin Run subwatershed, the largest being a 60-inch stormwater pipe. There is severe erosion at several storm water outfalls, and repair is needed. One of these are shown below in Photo 3.45.. This outfall is in disrepair and is considered a candidate site for restoration (S135).

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. Stream Physical Assessment field crews located 73 stream crossings in the Colvin Run subwatershed, four were observed causing erosion through flow constriction, however none were identified as causing significant enough erosion to warrant repair.

Photo 3.45 Erosion at a 12-inch outfall located just south of North Shore Drive (DFCR013.POO3).

3.17.4 Soils

Soils found in the Colvin Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 63 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (50 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. There are 147.2 acres of land with unclassified soils in the Colvin Run subwatershed. Soils that cover at least 20 acres within the subwatershed are located in Appendix A.

3.17.5 Geomorphology

There are 12.7 (66,844 feet) of stream in the Colvin Run subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. Five stream reaches (totaling 2.9 miles, 15 percent of the total stream length) were not assessed because they were not natural channels.

Thirty-two percent of the total stream length in Colvin Run is Type III, which indicates an unstable channel that is eroding and widening as a response to changes in streamflow. Fifty-three percent of assessed reaches in Colvin Run were characterized as Type IV, indicative of a channel that is stabilizing with vegetation colonizing historically eroded areas.

Photo 3.46 Erosion located on a tributary to Colvin Run between Buttermilk Lane and Hunt Club Road (DFCR012.E002)

Photo 3.47 Erosion located on reach just west Hunter Mill Road near Little Run Farm Court (DFCR008.E001)

The streams in Colvin Run are dominated by gravel (47 percent of total stream length) and sand (26 percent of total stream length). Forty-five percent of the stream length is moderately unstable to unstable with high erosion potential during flood events.

Photo 3.48 Erosion on a tributary to mainstem Colvin Run near Mount Sunapee Road (DFCR006.E002).

Photo 3.49 Erosion on mainstem Colvin Run downstream of Lake Fairfax before Colvin Run crosses under Hunter Mill Road (DFCR009.E001).

In the stream reaches that are experiencing erosion, much of the erosion is occurring on the outer banks of bends. Several severe erosion locations exist in the Colvin Run subwatershed. Most of these areas have a good restoration potential. Photos of a few of the more serious erosion problems are shown in Photos 3.46 through 3.49. These example sites are all candidate sites for stream restoration (S98, S93, S96, S92 respectively).

There are 28 points along the stream that are blocked by trees, debris and sediment. Eleven of these are severe enough to be obstructing fish passage. Two are shown below in Photos 3.50 and 3.51 and are near stream restoration candidate sites S135 and S11, respectively.

Photo 3.50 Obstruction just upstream of Lake Fairfax to the west of Aldenham Lane (DFCR013.T001).

Photo 3.51 Obstruction upstream of Lake Fairfax located near Park Overlook Drive (DFCR015.T001).

3.17.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall of 2002.

- Of the assessed reaches, 69 percent has fair habitat for aquatic insects and fish, 5 percent is good habitat, 23 percent is poor habitat and 2 percent is very poor habitat for aquatic insects and fish. The majority of the mainstem of Colvin Run is considered to have fair habitat.
- There are 11.8 miles of **riparian buffer** encroachment (this length includes left and right banks combined). Of this, 55 percent of the impact is from lawns.
- Over 9 miles of buffer encroachment are significant enough to have an impact on the stream condition. Seventy-one percent of this total length is considered to have low to no restoration potential.
- Only 8 percent of the total length has vegetation present and covering at least 70 percent to 90 percent of the stream bank surfaces on both left and right bank.

3.17.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Colvin Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

The Colvin Run subwatershed is covered by 23 percent impervious surface. The headwaters are in the city of Reston, so there are many high-density areas. The catchment with the highest runoff as well as one of the highest pollutant loadings is DFCR9401. This catchment extends from the Reston Parkway to Wiehle Avenue and from Sunrise Valley Drive to Sunset Hills Road, and is made up almost entirely of commercial land use and the Dulles Toll Road. Refer to DFCR_4 for the catchment locations.

Most of the catchments west of Wiehle Avenue have a high concentration of high-density residential land use. One of the highest modeled pollutants per acre in this subwatershed comes from a small, 34-acre catchment, DFCR9702. Approximately two-thirds of this catchment is either commercial or high-density residential. Another catchment with both high pollutant loadings and runoff volume is DFCR9401. Portions of the Dulles Toll Road and several industrial parks along Sunrise Valley Drive are within this catchment. Results can be seen in Table 3.30.

Table 3.30 Existing and Future Modeling

Colvin Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFCR0001	E	7.76	0.22	216.5	8.2	0.8
	F	12.73	0.23	310.1	10.5	0.9
	C	64%	5%	43%	29%	21%
DFCR0003	E	6.42	0.16	144.6	5.8	0.6
	F	7.49	0.19	159.9	5.9	0.6
	C	17%	19%	11%	2%	7%
DFCR0004	E	7.11	0.16	153.9	5.9	0.6
	F	8.32	0.21	183.2	6.7	0.7
	C	17%	31%	19%	15%	11%
DFCR0005	E	1.08	0.17	9.1	0.5	0.1
	F	1.08	0.17	9.1	0.5	0.1
	C	0%	0%	0%	0%	0%
DFCR0006	E	1.92	0.16	50.2	2.1	0.2
	F	1.91	0.16	50.2	2.1	0.2
	C	-1%	0%	0%	0%	0%
DFCR0007	E	1.89	0.13	53.5	2.2	0.2
	F	1.92	0.13	54.3	2.3	0.2
	C	2%	0%	1%	2%	0%
DFCR0008	E	2.08	0.14	19.9	1.1	0.2
	F	2.58	0.14	24.7	1.3	0.3
	C	24%	0%	24%	18%	50%
DFCR0009	E	4.45	0.14	49.4	2.3	0.4
	F	4.88	0.16	55.4	2.6	0.4
	C	10%	14%	12%	13%	0%
DFCR8801	E	1.46	0.12	10.8	0.6	0.1
	F	1.46	0.12	10.8	0.6	0.1
	C	0%	0%	0%	0%	0%
DFCR8901	E	1.74	0.14	18.7	1.0	0.2
	F	2.11	0.15	23.4	1.3	0.3
	C	21%	7%	25%	30%	50%
DFCR9001	E	3.44	0.14	60.9	2.7	0.4
	F	3.93	0.15	72.9	3.2	0.5
	C	14%	7%	20%	19%	25%
DFCR9101	E	1.73	0.14	28.6	1.2	0.2
	F	1.93	0.12	34.3	1.4	0.2
	C	12%	-14%	20%	17%	0%
DFCR9201	E	0.49	0.15	3.9	0.2	0.0
	F	0.89	0.11	6.7	0.3	0.0
	C	82%	-27%	72%	50%	0%
DFCR9301	E	5.26	0.11	107.0	4.2	0.5
	F	6.66	0.14	146.6	5.5	0.6
	C	27%	27%	37%	31%	20%

Colvin Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFCR9401	E	12.73	0.32	270.0	10.5	1.0
	F	13.73	0.34	273.1	10.0	1.0
	C	8%	6%	1%	-5%	0%
DFCR9501	E	4.25	0.16	79.9	3.7	0.6
	F	4.66	0.17	92.4	4.4	0.7
	C	10%	6%	16%	19%	17%
DFCR9601	E	5.02	0.17	129.9	5.3	0.7
	F	5.13	0.17	133.5	5.4	0.7
	C	2%	0%	3%	2%	0%
DFCR9701	E	5.23	0.15	98.7	3.9	0.5
	F	5.23	0.15	98.7	3.9	0.5
	C	0%	0%	0%	0%	0%
DFCR9702	E	7.96	0.29	185.8	7.0	0.8
	F	7.97	0.29	185.7	7.0	0.8
	C	0%	0%	0%	0%	0%
DFCR9703	E	4.42	0.19	126.4	4.6	0.6
	F	4.41	0.19	126.3	4.6	0.6
	C	0%	0%	0%	0%	0%
DFCR9801	E	5.3	0.15	102.3	4.1	0.6
	F	5.3	0.15	102.4	4.1	0.6
	C	0%	0%	0%	0%	0%
DFCR9802	E	4.65	0.15	155.8	6.0	0.6
	F	4.65	0.15	155.9	6.0	0.6
	C	0%	0%	0%	0%	0%
DFCR9902	E	6.11	0.2	144.3	5.7	0.8
	F	6.11	0.2	144.3	5.7	0.8
	C	0%	0%	0%	0%	0%
DFCR9903	E	6.45	0.21	137.4	5.2	0.7
	F	6.45	0.21	137.3	5.2	0.7
	C	0%	0%	0%	0%	0%
DFCR9904	E	6	0.2	153.4	5.7	0.7
	F	6.01	0.2	154.8	5.8	0.7
	C	0%	0%	1%	2%	0%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures.

Many of the catchments in Colvin Run showed no change between existing and future conditions, reflecting built out conditions in much of this subwatershed. While most catchments showed an increase from the existing conditions to the future conditions in pollutants and flow, some of the larger percent changes occurred in catchment DFCR9201, currently completely forested, partly changing to estate residential, and DFCR9301, which is north of Sunset Hills Road around the Lake Fairfax Business Center and Equestrian Park. This catchment has some areas changing from open space to estate residential and also some changing from open space to high-intensity commercial. Also, catchment DFCR0008, around the Colvin Run Stream Valley Park, has a few large areas changing from open space to low-density residential. One Reston area catchment, DFCR0001 has low-intensity commercial areas that are forecast to redevelop to a higher intensity.

3.17.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Three crossings in the subwatershed were overtopped with existing flows, as shown in Table 3.31. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.31 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
40	Hunter Mill Road	E	x	x	x				
41	Lake Fairfax Drive	E	x	x	x	x	x	x	x
57	Carpers Farm Way	E	x	x	x	x	x		

E – Existing conditions results, x – indicates overtopping

Culvert #40 (Photo 3.52) overtopped for events less frequent than the 10-year. The road this bridge is on, Hunter Mill Road is classified as a primary road. This requires it to pass the 25-year event.

Culvert #41 (Photo 3.53) overtopped for all events. Lake Fairfax Drive is used as a local road to access Lake Fairfax Park. This requires it to pass the 10-year event.

Photo 3.52 Colvin Run Mainstem at Hunter Mill Road

Photo 3.53 Colvin Run Mainstem at Lake Fairfax Drive

Culvert #57 (Photo 3.54) overtopped for events less frequent than the 2-year. Carpers Farm Way is a local road, which means it must pass the 10-year event.

Photo 3.54 Colvin Run Mainstem at Carpers Farm Way

3.17.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Colvin Run subwatershed are listed below. Refer to DFCR_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

Streams

S11 The stream is severely eroded with unstable banks and active widening. The habitat directly upstream is considered poor. (Photo 3.52)

S13 This site has severe to extreme buffer deficiency with moderate restoration potential. The stream is also eroding, giving it unstable banks.

S49 This reach has severe erosion with unstable banks and buffer deficiency. Both have moderate potential for restoration.

S92 The Stream Physical Assessment noted this reach, which is directly downstream of S99, has extreme erosion with moderate restoration potential along with active widening. (Photo 3.50)

S93 This is another site with the most severe erosion combined with the highest restoration potential as defined by field crews. (Photo 3.47)

S94 The Stream Physical Assessment showed this stream as having active widening.

S95 This site has severe to extreme erosion with moderate restoration potential along with active widening.

S96 This reach, as well as the reach downstream around the D12 site, has severe erosion with moderate potential for restoration. (Photo 3.49)

S97 The Stream Physical Assessment identified this site, which is directly upstream of S13, as having extreme erosion with moderate restoration potential.

S98 The stream flows directly into Lake Fairfax and is extremely eroded with moderate restoration potential. (Photo 3.47)

S99 This site has missing buffer that is considered severe. It has the most severe impact from the missing buffer and the highest potential for restoration.

S135 The Stream Physical Assessment located a failing outfall where the flow is causing severe bank erosion and potentially unsafe conditions (Photo 3.45 and 3.51).

S136 The Stream Physical Assessment identified several outfalls in disrepair, obstructions, and severe stream bank erosion along this reach. (Photo 3.46)

<u>Hydrology and Water Quality</u>

D12 (Catchment DFCR8801) The stream within this area has two areas of erosion with unstable banks, including Site S96, as is Colvin Run Mainstem downstream at S95. The stream is also actively widening on the whole length.

D13 (Catchment DFCR9301) The stream in this catchment shows no problems. Runoff flows and pollutant loads are lower than the average for the subwatershed and Difficult Run.

D14 (Catchment DFCR0007) The stream has poor habitat and active incising. The mainstem immediately downstream of this catchment has erosion and unstable banks. Pollutant loads in this catchment are low for the subwatershed.

D16 (Catchment DFCR9201) The stream through the catchment has areas of poor habitat and active incision. Runoff flows and pollutant loads are better than most of the watershed.

D151 (Catchment DFCR9101) The stream in the catchment has degraded buffer with moderate potential for restoration. There is erosion downstream at Sites S97 and S13.

C07 (Catchment DFCR9904) Modeled runoff flows and pollutant loads in this catchment are average for in the Colvin Run subwatershed. Streams are eroding and the buffer is degrading.

C08 (Catchment DFCR9802) Runoff flows and pollutant loads in this catchment are among the highest in all of Difficult Run. This catchment is upstream of Lake Anne (C10), so all pollutants from this catchment flows directly into Lake Anne.

C09 (Catchment DFCR0001) Streams in this catchment and immediately downstream are actively widening. This may be due to the high runoff volumes plus pollutants in this area.

C10 (Catchment DFCR9903) This catchment also flows into Lake Anne, adding more high pollutant loads and high runoff volumes. The reach immediately downstream of the lake is widening and had buffer deficiency.

C12 (Catchment DFCR0003) Streams immediately downstream of this catchment are severely eroded. The catchment has below average runoff flows and pollutants for the subwatershed, but above average for the whole watershed.

C18 (Catchment DFCR9401) This catchment has one of the highest nitrogen loadings in the watershed. The streams in this catchment and immediately downstream show no signs of problems.

C50 (Catchment DFCR9601) The reaches in this catchment are eroding, have unstable banks, and one has a buffer deficiency with high restoration potential. Pollutants and runoff are about average for the subwatershed but well above average for Difficult Run.

C51 (Catchment DFCR9501) The streams are severely eroded with moderate restoration potential (S98). Modeled pollutant loads and runoff flows are high for the watershed.

C52 (Catchment DFCR9902) The reaches in this catchment were assigned a poor habitat rating and are eroding. The stream, which flows into Lake Anne, has high pollutant loads and high runoff volumes.

<u>Flooding</u>

F40 The bridge over Colvin Run on Hunter Mill Road overtops for flows less frequent than the 25-year event. Primary roads must pass the 25-year event. (Photo 3.52)

F41 The culvert under Lake Fairfax Drive overtops for all events. Local roads must pass the 10-year event. (Photo 3.53)

F57 The culvert under Carpers Farm Way overtops with existing conditions for all the modeled events. Local roads must pass the 10-year event. (Photo 3.54)

<u>Preservation</u>

P33 (Catchment DFCR0008) The percent increase in all modeled parameters is greatest in this catchment due to the loss of open space, particularly along the stream.

3.17.10 Reston Watershed Plan Assessment

Three tributaries of Colvin Run were assessed. Results of the physical assessments and hydraulic modeling for each of these reaches are discussed below, with a reference to the ID number of the equivalent catchment area defined in the Difficult Run Watershed Plan, followed by a comparison with the assessment between plans. Refer to Section 3.14 for a discussion of projects proposed to address these issues.

<u>Buttermilk Creek (Catchment DFCR9601)</u>

<u>Reston Plan</u> The streams through this catchment and the two that follow were found to be actively eroding at a higher rate of change than those in other areas of Reston. There are areas with active **headcut**s, areas of sediment deposits, exposed utilities, and little or no baseflow. Approximately 40% of the streambanks were actively eroding. Hydraulic modeling showed that 6 out of 13 cross-sections had erosive velocities from the 1-year storm, and 3 of these were highly erosive.

<u>Difficult Run Plan</u> The County's Stream Physical Assessment results showed similar results. The entire length of stream was found to be unstable, with 60% of the banks showing active erosion. The entire stream was also found to be actively widening, and there was an area of missing riparian buffer as well.

In this tributary, both the stream condition and catchment characteristics were considered a high priority in Difficult Run. The stream reach was selected for stream restoration potential as candidate site S135 because of unstable banks and buffer impairments. The catchment was selected to investigate stormwater management retrofits as candidate site C50.

<u>Brown's Chapel Creek (Catchment DFCR9501)</u>

Reston Plan Conditions in this creek are similar to those of Buttermilk Creek above. There is active erosion of the channel bed and banks, active head cuts, sediment deposits, and a high rate of change. The assessment showed 25% of the stream banks actively eroding in the upper reaches, and 50% eroding in the lower reaches. Two of the 8 cross-sections modeled had erosive velocities from the 1-year storm, and of these, 1 was highly erosive.

Difficult Run Plan The County's Stream Physical Assessment concurred with these results, showing the entire length of stream to have severe to extreme erosion impacts.

In this tributary, both the stream condition and catchment characteristics were considered a high priority in Difficult Run. The stream reach was selected as candidate site S98 because of the combination of erosion impacts and poor habitat. The catchment was selected as candidate site C51.

Lake Anne Tributary (DFCR9902)

Reston Plan Conditions in this tributary are similar to Buttermilk Creek and Brown's Chapel Creek. All three are headwaters channels with relatively small drainage areas. The stream bed and banks were found to be actively eroding, with head cuts, sediment deposits, and low baseflow. Erosion was active in 50% to 60% of the streambanks. Hydraulic modeling was not conducted for this drainage area.

Difficult Run Plan The County's Stream Physical Assessment showed similar results, with the entire length of stream having severe to extreme erosion impacts, and poor to very poor habitat ranking.

This stream reach was not selected as a candidate site to be investigated for restoration projects since it was not one of the highest priority sites in the overall watershed. The catchment was selected for potential stormwater management retrofits as site C52.

3.18 Colvin Run - Subwatershed Plan Actions

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.32 below is a list of all projects proposed in this subwatershed.

Table 3.32 Recommendations for Colvin Run

Project #	Project Type	Candidate Site
DF9012	Pond Retrofit	D-12
DF9013	Pond Retrofit	D-13
DF9013A	Pond Retrofit	D-13
DF9014A	Culvert Retrofit	D-14
DF9014B	Drainage Retrofit	D-14
DF9118A	Pond Retrofit	C18
DF9118B	Pond Retrofit	C18
DF9151	Pond Retrofit	C51
DF9152	Pond Retrofit	C52
DF9213	Stream Restoration	S13
DF92135	Stream Restoration	S135
DF92136	Stream Restoration	S136
DF9249	Stream Restoration	S49
DF9295	Stream Restoration	S95
DF9507B	Culvert Retrofit	C07
DF9508A	Culvert Retrofit	C08
DF9508B	Culvert Retrofit	C08
DF9512A	Culvert Retrofit	C12
DF9512B	Culvert Retrofit	C12
DF9512C	Culvert Retrofit	C12
DF9550A	Culvert Retrofit	C50
DF9551	Culvert Retrofit	C51
DF9552A	Culvert Retrofit	C52
DF9552B	Culvert Retrofit	C52
DF9707	Drainage Retrofit	C07
DF9712	Drainage Retrofit	C12
DF9750	Drainage Retrofit	C50
DF9751	Drainage Retrofit	C51
DF9807	LID Retrofit	C07
DF9808	LID Retrofit	C08
DF9809	LID Retrofit	C09
DF9812	LID Retrofit	C12
DF9818	LID Retrofit	C18

3.18.1 Regional Pond Alternative Projects

D12 (DFCR8801)

Site Investigation and Projects:

DF9012 (Pond Retrofit) The project would consist of a retrofit to an existing farm pond, which does not provide significant detention. A control structure would be designed to use the existing storage capacity for both water quality and channel protection, which would help reduce erosive discharge rates and velocities immediately downstream.

D13 (DFCR9301)

Site Investigation and Projects:

DF9013 (Pond Retrofit) This is one of two ponds within the commercial area on Business Center Drive that would be retrofit to provide channel protection storage by modifying the riser, and to improve water quality treatment by converting the dry pond to a wet marsh.

DF9013A (Pond Retrofit) This pond, which treats runoff from two large stormdrain systems, discharges into a severely eroded stream. The existing storage area would be utilized to reduce peak flow velocities and increase water quality improvements by modifying the riser and converting it to a wetland system.

D14 (DFCR0007)

Site Investigation and Projects:

DF9014A (Culvert Retrofit) The project is located on the upstream side of the culvert under Little Run Farm Court. It consists of providing storage to help improve water quality.

DF9014B (Drainage Retrofit) The project is distributed throughout the catchment. It consists of providing stabilization at outfalls where the discharge has caused scour and erosion.

D16 (DFCR9201)

Site Investigation and Projects: The field inspection showed that there is no development in this catchment and that it remains entirely forested. There is no need for retrofit or regional pond replacement projects at this time. It should be a focus of preservation programs.

3.18.2 Catchment Improvement Projects

C07 (DFCR9904)

Site Investigation and Projects: This catchment is made up of moderately dense residential properties, most of which have no substantial stormwater management. Generally speaking, the natural conveyance within this catchment shows little sign of degradation; therefore, minimal attention toward attenuation is deemed necessary.

DF9507B (Culvert Retrofit) This project is a retrofit to the culvert under Wiehle Avenue. The intent of this project is to improve channel protection for the degraded stream below North Shore Drive.

DF9707 (Drainage Retrofit) This project consists of energy dissipation in the form of outlet protection and plunge pools at each outfall. Of particular interest is the outfall to below the impoundment in Catchment 10. This location may need a more substantial energy dissipation system that allows discharges to be conveyed to the confluence below in a stable manner.

DF9807 (LID Retrofit) This project consists of placing a rain garden on the South side of North Shore Drive. This would impound water up to a foot deep to provide water quality treatment to the runoff from this area.

C08 (DFCR9802)

Site Investigation and Projects:

DF9808 (LID Retrofit) This project would be a fully holistic low-impact development retrofit analysis of the commercial property south of the intersection of Village Drive and North Shore Drive. The primary goal in this area is to reduce runoff impacts and improve the quality of the runoff that flows into the stream and then into Lake Anne

DF9508A (Culvert Retrofit) This project is a small culvert retrofit designed to improve water quality. There are no natural streams between the site and Lake Anne, so channel protection is not needed.

DF9508B (Culvert Retrofit) This project is a culvert retrofit to the culvert under Baron Cameron Avenue. The drainage area to this point is approximately 50 percent natural wooded cover and approximately 50 percent recreational uses (i.e. ball fields). The primary opportunity at this location is to focus on the water quality by the construction of a wetland detention area.

C09 (DFCR0001)

Site Investigation and Projects: This catchment consists of highly developed, highly impervious, commercial development. There is a substantial system of in stream ponds that appear to be in excellent condition, but it is unclear what design standards they are based upon.

DF9809 (LID Retrofit) This project would include a property-by-property assessment of opportunities to reduce imperviousness, increase the flow path, infiltrate surface runoff and strategically use vegetation to improve the quantity and quality of the runoff throughout the entire catchment.

C12 (DFCR0003)

Site Investigation and Projects:

DF9812 (LID Retrofit) The area indicated, which is mostly on the north side of Sunset Hills Road and between Isaac Newton Square and Wiehle Avenue, consists of almost total impervious area (much of which is parking lot). This project would include an assessment of opportunities to reduce imperviousness, increase the flow path, infiltrate surface runoff and strategically use vegetation to improve the quantity and quality of the runoff before discharging to the adjacent golf course and stream.

DF9512A (Culvert Retrofit) This project is a retrofit to the culvert under North Shore Drive. The drainage area to this culvert is a small section of the golf course. The primary focus of this culvert retrofit should be to provide some detention to storm runoff, as conditions allow, and to provide a water quality treatment area where biological processes can remove potential nutrient and pesticide contaminants in the runoff.

DF9512B (Culvert Retrofit) This project is retrofit to a second culvert under North Shore Avenue. The drainage area to this culvert is highly impervious. The primary focus of this culvert retrofit should be to provide some detention to storm runoff and release the discharge at a slower rate.

DF9512C (Culvert Retrofit) This project is a retrofit to the culvert under Wiehle Avenue. The drainage area to this culvert consists of commercial, residential and recreational land uses. The primary focus of this culvert retrofit should be to provide channel protection detention. **This project may be constructed or superseded by Reston Association work in this stream channel.**

DF9712 (Drainage Retrofit) This project consists of energy dissipation in the form of outlet protection at each outfall from a piped storm drainage system into the natural channel.

C18 (DFCR9401)

Site Investigation and Projects:

DF9118A (Pond Retrofit) This project is a retrofit to the regional pond at the culvert under Sunset Hills Road. The drainage area to this culvert consists of highly impervious commercial and roadway land uses. The primary focus of this retrofit should be to change the storage and outlet configuration to provide better detention and create water quality features in the pond itself.

DF9118B (Pond Retrofit) This project is a retrofit to the existing stormwater management facility on the south side of the Dulles Toll Road. The primary focus of this retrofit should be to change the pond design to improve water quality treatment.

DF9818 (LID Retrofit) This project would include an assessment of opportunities to reduce imperviousness, increase the flow path, infiltrate surface runoff and strategically use vegetation to improve the quantity and quality of the runoff throughout the entire catchment.

C50 (DFCR9601)

Site Investigation and Projects:

DF9550A (Culvert Retrofit) This project is a retrofit to the culvert under Baron Cameron Avenue. The drainage area to this catchment is mostly medium density detached housing along with parking areas from the recreational facilities on the other side of Wiehle Avenue. The primary focus of this culvert retrofit should be to provide channel protection storage for the reach immediately downstream.

DF9750 (Drainage Retrofit) This project consists primarily of energy dissipation in the form of outlet protection at each outfall from a piped storm drainage system into the natural channel.

C51 (DFCR9501)

Site Investigation and Projects:

DF9551 (Culvert Retrofit) A culvert retrofit on the upstream side of Gates Meadow Way should be created to settle out solids that would otherwise end up in the stormwater wetland below. The primary objective for this project should be to create a pretreatment area that allows some settling of solids and flow regulation.

DF9151 (Pond Retrofit) This wet pond treats the drainage from a single-family residential area. The existing single-stage riser can be replaced with a multi-stage riser designed for increased management of smaller storms. There is sufficient storage to construct an aquatic bench to improve vegetative uptake.

DF9751 (Drainage Retrofit) This project consists primarily of energy dissipation in the form of outlet protection at each outfall from a piped storm drainage system into the natural channel.

C52 (DFCR9902)

Site Investigation and Projects:

DF9552A (Culvert Retrofit) A culvert retrofit upstream of Bennington Woods Road should be constructed to work as a treatment train with the pond to be retrofit downstream. The goal for the project would be to provide sedimentation to extend the life of the downstream pond.

DF9152 (Pond Retrofit) This project is a retrofit re-design of the existing pond between Bennington Woods Road and Baron Cameron Avenue. Channel protection volume can be created by constructing a weir in front of the existing culvert and small marsh areas currently function as water quality components. A forebay will be installed at the storm drain outfall to treat runoff before entering the stream.

DF9552B (Culvert Retrofit) A culvert retrofit on the upstream side of North Shore Drive should be created as the final step in a pre-treatment system to protect Lake Anne downstream. The primary objective for this project should be to create a stormwater wetland for vegetative uptake of nutrients.

3.18.3 Stream Restoration Projects

S11

Site Investigation and Projects: The site investigation showed steep, eroded, outer meander bends with point bar and floodplain redevelopment and a good aquatic channel width. Sinuosity is moderate. Bed forms are consistent and stable with much of the bed formed from fractured shale. Parallel sanitary sewers, wetland and forest clearing impacts, and limited construction access outweigh the benefits of erosion reduction through bank stabilization. No project was identified.

S13, S92, S97, S99

Site Investigation and Projects: The site investigation showed raw stream banks and moderate to severe incision. The riparian zone is non-forested for significant portions of the reach. A dam structure is located directly downstream of the confluence of the reach and Colvin Run. One project was identified for all four identified sites.

DF9213 (Stream Restoration) A pattern, dimension, and profile would be created that more closely resembles a natural stream. Banks would be stabilized and bed morphology would be improved. Native trees and shrubs would be planted in the riparian zone. Sites S13, S92, S97, and S99 would be combined as one project.

S49

Site Investigation and Projects: The site investigation showed eroded banks on both sides of the stream and severe incision. The stream is straight and has cut down to bedrock. A majority of the riparian zone is not forested. The reach is located on a golf course. One project was identified.

DF9249 (Stream Restoration) The bed would be reworked to promote stable, diverse bend features. The banks would be reshaped and stabilized and a floodplain bench would be excavated. Native trees and shrubs would be planted in the riparian zone to the maximum extent possible.

S93

<u>Site Investigation and Projects</u>: The site investigation showed eroded banks and moderate incision. However the stream is recovering and has a narrowed baseflow channel and good sinuosity. Access constraints, wetland impacts, and forest clearing outweigh the benefits of reducing streambank erosion. No project was identified.

S94

<u>Site Investigation and Projects</u>: The site investigation showed severe incision and moderate bank erosion. However, access constraints, wetland impacts, and forest clearing outweigh the benefits of reduced streambank erosion for a stream that is less than 300 feet in length. No project was identified

S95

<u>Site Investigation and Projects</u>: The site investigation showed severe incision and a meander pattern that did not match the existing flow regime.

DF9295 (Stream Restoration) The stream would be regraded, adjusting the pattern and profile to a more stable configuration. The streambed would be raised and bank protection structures would be constructed as needed. **Portions of this project may be constructed or superseded by Reston Association work in this stream channel.**

S96

<u>Site Investigation and Projects</u>: Site investigations showed moderate bank erosion and moderate to severe incision with floodplain development in some areas. The streambed appeared stable with good riffle/run morphology. The stream appeared to be recovering in many areas. Constraints associated with access, forest clearing and wetland impacts outweigh the sediment reduction benefits of restoring the stream. No project was identified.

S98

<u>Site Investigation and Projects</u>: The site investigation showed a moderately to severely incised stream with some raw and vertical banks. The stream did appear to be recovering with point bar development and a meandering, narrow baseflow channel. Severe utilities constraints, forest clearing and wetland impacts, and access and encroachment issues outweigh the benefits of reconnecting the stream to a functional floodplain. No project was identified.

S135

<u>Site Investigation and Projects</u>: The site investigation showed a failing outfall structure and bank erosion. One project was identified.

DF92135 (Stream Restoration) The outfall structure would be replaced and the stream banks stabilized. The channel would be reworked to promote stable, diverse bend features. The banks would be reshaped and stabilized and a floodplain bench would be excavated. Native trees and shrubs would be planted on the banks.

S136

Site Investigation and Projects: The site investigation showed a deeply incised channel and several failing outfalls located well above the channel bottom. One project was identified.

DF92136 (Stream Restoration) The outfall structures would be replaced and the stream banks stabilized. The channel would be reworked to promote stable, diverse bend features. The banks would be reshaped and stabilized and a floodplain bench would be excavated. Native trees and shrubs would be planted on the banks. **Portions of this project may be constructed or superseded by Reston Association work in this stream channel.**

3.18.4 Preservation

Improvement Goals for all Preservation Sites

Preservation goals for all the areas described below include reducing runoff volume, peak flows, and pollutant loads by preserving open space and forested land in key areas of the catchment such as headwaters.

Site Investigation and Projects

No site investigation was undertaken for preservation projects, and no specific proposals have been made for each area. Actions and policy changes needed to implement preservation for the areas listed below are described in Chapter 4.

3.18.5 Reston Watershed Plan Recommendations for Colvin Run

Structural measures were recommended in Colvin Run for drainage areas of Buttermilk Creek, Brown's Chapel Creek, and the Lake Anne Tributary. Specific locations were not identified. The recommendations included the following:

On-site stormwater controls

Reston Plan No retrofit projects were identified for specific areas.

Difficult Run Plan Several of these measures in Colvin Run are proposed in projects DF9808, DF9809, and DF9812, above. These projects identify general areas and parcels where topography and land use would make on-site controls particularly effective.

Stormwater Attenuation

Reston Plan (7 structures) These projects are designed for culvert entrances to detain and reduce the peak flow from the channel-forming discharge to reduce stream erosion. Smaller versions of these types of attenuation systems at unspecified storm sewer inlets are also proposed.

Difficult Run Plan Culvert retrofit projects DF9551, DF9552A and DF9552B recommended for Colvin Run are similar to the attenuation structures proposed in the Reston Plan.

Floodplain Spreaders

Reston Plan (8 structures) These projects are help to divert stormwater from paved ditches and storm sewers and allow it to flow over the floodplain at much lower energy levels and reduce scour at outfalls.

Difficult Run Plan These types of structures are a potential solution for the drainage retrofits at outfalls described in projects DF9750, and DF9751.

Check Dams

Reston Plan (5 structures) These projects provide stabilization for intermittent streams by creating step pools which lower the erosive velocity.

Difficult Run Plan There are no equivalent projects specifically called out in this Plan, although these techniques could be used as part of the drainage retrofits described above in this plan.

Stream Restoration

Reston Plan (2,000 Feet) The Reston Plan proposes restoration of up to 2,000 feet of stream throughout these three areas.

Difficult Run Plan The Plan identified one project in Buttermilk Run (DF92135) to restore a failed stormwater outfall and associated unstable stream banks. The candidate site at S98 in Brown's Chapel Creek was assessed but impacts from forest clearing and wetland encroachment appear to outweigh the benefits of a project.

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3.19 Snakeden Branch – Subwatershed Condition

3.19.1 Subwatershed Characteristics

The Snakeden Branch **subwatershed** has an area of approximately 2,239 **acres** (3.50 mi^2). Its northern boundary starts at the intersection of Sunrise Valley Drive (Virginia 5320) and Reston Parkway (Virginia 602), extends to the north past the Dulles Access Toll Road (Virginia 267) and generally borders Branches Road to the east. The Reston Parkway (Virginia 602) lies along the western edge and Glade Drive follows the southern watershed divide.

Snakeden Branch is located on the western side of the Difficult Run watershed. There are 8.2 miles of stream within the subwatershed that flow east and join The Glade before ultimately flowing into the mainstem of Difficult Run. The majority of the length of the stream flows through open space or higher-density residential areas.

Refer to DFSB_1 for a map of the Snakeden subwatershed highlighting the Subwatershed Characteristics including, existing **land use, flood limit, wetlands, resource protection areas** and **stormwater management.**

3.19.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

Snakeden Branch subwatershed is the second-most densely developed subwatershed in the Difficult Run watershed, with only 9 percent of its acreage developed as low-density or estate residential. Forty-six percent of the subwatershed is developed as high-density residential or commercial use. Most development is found along the Dulles Access Toll Road (Virginia 267), and also along major connector roads such as South Lakes Drive and Glade Drive. There are fewer parks and open space parcels in the Snakeden Branch subwatershed than other subwatersheds in the Difficult Run Watershed. Open space and parks account for 14 percent of the total acreage. Major parks include the South Lakes Drive Park – a small County park directly south of the sizeable Reston National Golf Course. Grounds and fields of several schools also constitute open space in this subwatershed. In addition, the South Lakes, Lake Audubon and Lake Thoreau are located in the Snakeden Branch subwatershed. No historical sites lie within the subwatershed.

There are 235 acres, 11 percent of the subwatershed, used for transportation such as roads or highways. Total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 605 acres, or 27 percent of the total subwatershed area. Snakeden Branch impervious levels are among the highest in the Difficult Run watershed. A complete summary of land use within the subwatershed can be found in Table 3.33.

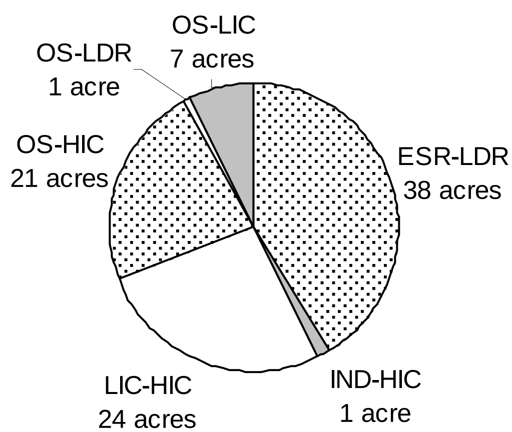
Table 3.33 Existing and Future Land Use

	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	312	14%	283	13%	-29	-1%
Golf Course	116	5%	116	5%	0	0%
Estate residential	72	3%	34	2%	-38	-2%
Low-density residential	142	6%	181	8%	39	2%
Medium-density residential	256	11%	256	11%	0	0%
High-density residential	668	30%	668	30%	0	0%
Low-intensity commercial	57	3%	39	2%	-18	-1%
High-intensity commercial	168	7%	214	10%	47	2%
Industrial	1	0%	0	0%	-1	0%
Institutional	121	5%	121	5%	0	0%
Transportation	235	11%	235	11%	0	0%
Water	91	4%	91	4%	0	0%
Total	**2,239**	**100%**	**2,239**	**100%**		**0%**

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

When comparing existing land use to future land use, the notable changes are projected in the open space, estate residential, low-density residential, low-intensity commercial, and high-intensity commercial categories. Intensity of commercial development is projected to increase in the Snakeden Branch subwatershed. Estate residential and open space acreages are projected to decrease (-2 percent and -1 percent, respectively) while low-density residential and high-intensity commercial acreages are projected to increase by 2 percent. Analysis shows that there is a small demand for both higher-density housing and commercial opportunities in the Snakeden Branch subwatershed.

Figure 3.9 Changed Land Use



According to Figure 3.9, a cumulative 46 acres (50 percent of all land use changes) are projected to shift to a high-intensity commercial use, and 29 acres (31 percent of all land use changes) are projected to shift from open space to a higher-intensity use. These shifts can lead to increases in impervious surface and the potential for additional runoff and pollutants to enter the stream.

3.19.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are 17 **stormwater management facilities** within the Snakeden Branch subwatershed. Seventy percent of the Snakeden Branch subwatershed is not served by any stormwater management facility. Twenty-eight percent of the total area has quantity control only and the remaining 2 percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (82 percent) and the area served by stormwater management (30 percent) indicates a possible need for additional management efforts, specifically in the industrial and high-density residential areas and low-intensity commercial areas in the upstream half of the watershed. Several medium-density residential areas along tributaries in the downstream half of the watershed would also benefit from additional stormwater management efforts. Additional information on the location of the stormwater management facilities in the Snakeden Branch subwatershed is located in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. Field crews located 42 **outfall** pipes in Snakeden Branch. Three of these pipes are having a major impact on the stream stability. All three of these are located on the same reach and have severe erosion.

A 16-inch concrete pipe is located south of the Dulles Access and Toll Road near Alexander Bell Drive. Severe erosion is occurring where the pipe segments have separated (Photo 3.55). A second outfall, located just downstream, is an 18-inch pipe located 75 feet from the channel as shown in Photo 3.56. These two outfalls together make up a candidate restoration site S101.

Photo 3.55 Severe erosion and pipe segment separation at a 16-inch outfall located near Alexander Bell Drive (DFSB006.P006).

The third outfall lies within the stream channel, and is located south of Sunrise Valley Drive and just east of Barton Hill Road (Photo 3.57). This site is identified a potential restoration site (S102) due to the severe erosion.

Photo 3.56 An 18-inch outfall causing severe erosion located downstream of the outfall shown in Photo 4.1 (DFSB006.P005).

Photo 3.57 Pipe located south of Sunrise Valley Drive and just east of Barton Hill Road. Major erosion around the structure is evident (DFSB006.P003).

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. Two of the 32 stream crossings in the Snakeden Branch subwatershed are having a severe to extreme impact on the stream character:

- A wooden footbridge has severe upstream and downstream bed erosion and high upstream bank erosion. The bridge is a located near a potential stream restoration site and will be addressed.
- The bridge under Hunter Station Road (Virginia 677) has some bed erosion and possibly some undermining of the bridge. The bridge is a possible site for alleviating flooding.

3.19.4 Soils

Soils found in the Snakeden Branch subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 71 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (55 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. There are 129.7 acres of land with unclassified soils in the Snakeden Branch subwatershed. Soils that cover at least 20 acres within the subwatershed are located in Appendix A.

3.19.5 Geomorphology

There are approximately 8.2 miles (43,296 feet) of stream in the Snakeden Branch subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes.

- Most of the total reach length is Type III, which is indicative of an unstable channel that is actively widening as a response to changes in the streamflow. The remaining portion is a small section of Type IV located just upstream of Lake Audubon that is in the beginning stages of recovery and stabilization.
- Channel **substrate** throughout the subwatershed is made up of gravel and sand.
- The majority of the stream banks were moderately unstable which can lead to stream erosion during high flows and **flood** events. There were 125 linear feet of erosion noted that were having an extreme impact on the stream with a potential threat to property and infrastructure. One of these points is located on a tributary to Snakeden Branch near the tributary's confluence with the mainstem and is shown in Photo 3.58. This site is potential stream restoration site S25.
- The other two areas of erosion are on a single reach approximately 500 feet from one another. These are located on the mainstem of Snakeden Branch upstream of Lake Audubon. This potential stream restoration site S103, shown in Photo 3.59

Photo 3.58 Erosion located south of South Lakes Drive (DFSB012.E001).

Photo 3.59 Erosion located between Old Trail Drive and Millenium Lane (DFSB015.E001).

- There are nine stream blockages, primarily trees. Four of these blockages are likely restricting fish passage. The worst obstruction is located at the confluence of the two upstream tributaries near Tanbark Drive and is a potential stream restoration site. All other stream obstructions were considered to have less significant and were not considered further for study.
- There are four sanitary lines either crossing the stream or within the stream banks that were exposed and causing erosion problems and/or an obstruction during higher flows.
- The sanitary line near Robert Fulton Drive is in severe disrepair and is a potential stream restoration site.
- The utility at the end of Wilder Point Road is shown in Photo 3.60 and is a potential stream restoration site.
- The utility at the southern end of Mossy Creek Lane is shown in Photo 3.61 and is also a potential stream restoration site.

Photo 3.60 Exposed sanitary utility line crossing stream (DFSB006.U002).

Photo 3.61 Exposed utility at the southern end of Mossy Creek Lane.

3.19.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall of 2002.

- Seventy-three percent or the streams have fair habitat for aquatic insects and fish, 18 percent is poor, 6 percent is very poor and only 3 percent is considered good habitat for aquatic insects and fish. With the exception of the most upstream reach of Snakeden Branch, the entire mainstem has fair to good habitat.
- There are 13,860 feet (2.6 miles) of buffer encroachment (this length includes left and right banks combined). Of this, 75 percent of the encroachment is from lawn or a combination of lawn and docks, 23 percent is golf course. None of the buffer impacts have good restoration potential due to the existing land use.
- Ninety-two percent of the assessed stream length has 70 percent or less of both stream banks covered by vegetation. Typically this vegetation is scattered grasses, shrubs and forbs.

3.19.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Snakeden Branch incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the

Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

Snakeden Branch has land cover that is 27 percent impervious. The majority of the subwatershed is a higher density residential, such as around Lake Audubon or Lake Thoreau, or commercial, such as along the Dulles Toll Road. The area with both the highest modeled runoff volume and the highest pollutant loadings is DFSB0002, which stretches from Springwood southeast to Glade Road. This catchment is well over two-thirds high-density residential area. Refer to DFSB_4 for the catchment locations.

West of catchment DFSB0002 is DFSB0001, another catchment with above average runoff and pollutants. This catchment contains Reston Parkway and east along the stream. While it also contains a large amount of high-density residential area, it contains open space and commercial areas as well. Results are shown in Table 3.34.

Table 3.34 Existing and Future Modeling

Snakeden Branch Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFSB0001	E	7.95	0.2	184.2	6.8	0.8
	F	7.94	0.2	183.9	6.8	0.8
	C	0%	0%	0%	0%	0%
DFSB0002	E	6.38	0.21	148.7	5.6	0.8
	F	6.34	0.2	148.5	5.6	0.8
	C	-1%	-5%	0%	0%	0%
DFSB0004	E	5.64	0.15	113.5	4.6	0.6
	F	5.62	0.15	113.4	4.6	0.6
	C	0%	0%	0%	0%	0%
DFSB0006	E	2.33	0.18	24.2	1.2	0.2
	F	2.65	0.19	29.8	1.5	0.3
	C	14%	6%	23%	25%	50%
DFSB9201	E	2.67	0.13	26.5	1.5	0.3
	F	3.25	0.14	45.6	2.3	0.4
	C	22%	8%	72%	53%	33%
DFSB9301	E	4.32	0.16	84.0	3.9	0.6
	F	4.43	0.16	90.5	4.0	0.6
	C	3%	0%	8%	3%	0%
DFSB9402	E	9.75	0.23	199.2	7.7	0.9
	F	11.67	0.23	238.0	8.6	0.9
	C	20%	0%	19%	12%	0%
DFSB9501	E	7.06	0.15	139.7	5.5	0.8
	F	7.01	0.15	136.2	5.4	0.7
	C	-1%	0%	-3%	-2%	-13%
DFSB9901	E	4.2	0.13	99.8	3.9	0.5
	F	4.2	0.13	99.9	3.9	0.5
	C	0%	0%	0%	0%	0%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

Most of the catchments saw an increase in runoff and pollutants, but the two catchments with the largest percent increase are DFSB9201 and DFSB0006, located at the outlet to the subwatershed. These catchments are relatively undeveloped with low existing pollutant loads, and have several areas changing from estate to low-density residential.

3.19.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Two crossings in the subwatershed were overtopped with existing flows, as shown in Table 3.35. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.35 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
10	Hunters Den Lane	E	x	x	x	x	x	x	
11	Hunter Station Road	E	x	x	x	x	x	x	x

E – Existing conditions results, x – indicates overtopping

Culvert #10 (Photo 3.62) overtopped for all events except the one-year. This is a local road, and so is required to pass the 10-year event.

Culvert #11 (Photo 3.63) overtopped for all events. Hunter Station Road is a primary road, uses mainly for through traffic. It is therefore required to pass the 25-year event.

Photo 3.62 Snakeden Branch Mainstem at Hunters Den Lane

Photo 3.63 Snakeden Branch Mainstem at Hunter Station Road

3.19.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Snakeden Branch subwatershed are listed below. Refer to DFSB_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

Streams

S25 The stream has signs of erosion considered severe but with a high potential for restoration (Photo 3.58).

S101 There are outfall pipes that are causing major erosion and have the potential to destroy existing parking lots and sanitary sewers (Photo 3.55, 3.56 and 3.60).

S102 There are utility lines in the stream that erosion has unearthed (Photo 3.57).

S103 There is erosion that is considered severe with a high potential for restoration at this site. It is located directly upstream of site S25 (Photo 3.59 and 3.61).

Hydrology and Water Quality

D24 (Catchment DFSB9201) This site has better than average conditions for the subwatershed for runoff flows and pollutant loads. It was selected because it is a proposed site for a regional pond.

C23 (Catchment DFSB0002) This catchment has the highest runoff flows and pollutant loads in the subwatershed. Within this catchment, the stream is actively widening. Site S103 is also in this catchment.

C24 (Catchment DFSB9402) This catchment has below average flows and pollutants. Within this catchment are two stream restoration sites, S101 and S102, both of which have erosion.

C28 (Catchment DFSB9501) This catchment has average flows and pollutants for the subwatershed, but they are high for the Difficult Run watershed as a whole.

C35 (Catchment DFSB0001) The runoff and pollutant loads are higher than average for Difficult Run. The streams within the catchment have erosion and poor habitat.

Flooding

F10 The culvert at Hunters Den Lane overtopped for all events except the one-year. This is a local road, so it must pass the 10-year event (Photo 3.62).

F11 The bridge on Hunter Station Road overtops for all events. Hunter Station Road is a primary road that should pass the 25-year event (Photo 3.63).

Preservation

P34 (Catchment DFSB0006) Percent increases in the pollutant loads between the existing and future conditions are projected to be the highest in this catchment due to changes from estate residential to low-density residential.

3.19.10 Reston Watershed Plan Assessment

Five areas of Snakeden Branch and its tributaries were assessed. Results of the physical assessments and hydraulic modeling for each of these reaches are discussed below, with a reference to the equivalent catchment area defined in the Difficult Run Watershed Plan, followed by a comparison with the assessment between plans. Refer to Section 3.16 for a discussion of projects proposed to address these issues.

Snakeden Branch (DFSB0001, DFSB0002)

Reston Plan Problems with bank erosion were evident, with about 50% of the banks affected in the stream reaches through these catchments. The problems appeared to be evenly distributed throughout the stream, with widespread channel instabilities caused by stormwater runoff. There were numerous exposed utilities, particularly sewers. Hydraulic modeling showed that 30 out of 33 cross-sections had erosive velocities from the 1-year storm, and 16 of these were highly erosive.

Difficult Run Plan The Stream Physical Assessment found similar results, with active channel widening and unstable banks in most of the stream.

In this tributary, both the stream and catchment are high priorities in Difficult Run. The stream reach was selected for stream restoration potential as candidate sites S25 and S103 because of severe erosion. The catchment was selected to investigate stormwater management retrofits as candidate sites C23 and C35.

Snakeden Tributary (DFSB9901)

Reston Plan The stream through this catchment showed similar erosion problems, although at a smaller scale, with about 10% to 30% of the banks eroded in the headwaters and 50% of the banks affected near the confluence with Snakeden Branch. Several exposed sewers were also found in these streams. Hydraulic modeling results showed 8 of 9 cross-sections had erosive velocities one of which was highly erosive.

Difficult Run Plan The Stream Physical Assessment showed active channel widening for the whole length of this tributary.

This stream reach was not one of the highest priority sites in the overall watershed and wasn't selected as a candidate site to be investigated for restoration projects. The catchment area was also had a low priority. As a result, no Fairfax County projects will be proposed for this tributary.

Western Lower Tributary (DFSB9402)

Reston Plan The stream through this catchment showed many areas with erosion from lateral streambank migration, with 75% of the banks affected in the upstream reaches and around 50% affected in the lower reaches. Seven of 10 reaches modeled for the 1-year storm showed erosive velocities, one of which was highly erosive.

Difficult Run Plan The Stream Physical Assessment showed active widening in the upper portion of the stream, instability in the lower portion, poor habitat throughout, and areas of missing riparian buffer.

Both the stream and catchment conditions for the Western Lower Tributary are high priorities in Difficult Run. The stream reach was selected for stream restoration potential as candidate sites S101 and S102 because of erosion, exposed utilities, and buffer impairment. The catchment was selected to investigate stormwater management retrofits as candidate site C24.

Eastern Lower Tributary (DFSB9301)

Reston Plan This tributary also had erosion problems similar to those in the western tributary; however, they were less severe with only 35% of the streambanks showing active erosion. All 10 cross-sections modeled for the 1-year storm showed erosive velocities; however, none were highly erosive.

Difficult Run Plan The Stream Physical Assessment showed similar results. The entire length of the tributary was assessed with active widening.

This stream reach was not one of the highest priority sites in the overall watershed and wasn't selected as a candidate site to be investigated for restoration projects. The catchment area was also in the lower half of the priority ranking for Difficult Run. As a result, no Fairfax County projects will be proposed for this tributary.

3.20 Snakeden Branch - Subwatershed Plan Actions

In the previous subwatershed condition section, information from stream assessments,

monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.36 below is a list of all projects proposed in this subwatershed.

Table 3.36 Recommendations for Snakeden Branch

Project #	Project Type	Candidate Site
DF9024A	Pond Retrofit	D-24
DF9024B	Culvert Retrofit	D-24
DF9024C	Drainage Retrofit	D-24
DF9123B	Pond Retrofit	C23
DF9124A	Pond Retrofit	C24
DF9124C	Pond Retrofit	C24
DF92101	Stream Restoration	S101
DF92102	Stream Restoration	S102
DF9225	Stream Restoration	S25
DF9523	Culvert Retrofit	C23
DF9524	Culvert Retrofit	C24
DF9535A	Culvert Retrofit	C35
DF9535B1	Culvert Retrofit	C35
DF9535B2	Culvert Retrofit	C35
DF9723	Drainage Retrofit	C23
DF9724	Drainage Retrofit	C24
DF9728	Drainage Retrofit	C28
DF9835	LID Retrofit	C35
DF9735	Drainage Retrofit	C35

3.20.1 Regional Pond Alternative Projects

D24 (DFSB9201)

<u>Site Investigation and Projects</u>

DF9024A (Pond Retrofit) There is an existing facility near the intersection of Clovermeadow Road and the right of way for the future alignment of Hunter Mill Road that could be expanded to provide additional storage for channel protection and water quality. Retrofits would include a excavation, a multi-stage riser, sediment forebay, micro-pools, and wetland cells to enhance pollutant removal.

DF9024B (Culvert Retrofit) This project is located upstream of the W&OD Trail. It would provide detention storage in the floodplain, incorporating wetland features and vegetation to improve pollutant removal.

DF9024C (Drainage Retrofit) This project would retrofit six outfalls throughout the catchment to reduce impacts from high stormwater discharges causing scour and erosion below the outfalls.

3.20.2 Catchment Improvement Projects

C23 (DFSB0002)

Site Investigation and Projects

DF9523 (Culvert Retrofit) This project is located on the upstream side of the culvert under Soapstone Road. The retrofit design would provide some detention through a rapid drawdown controlled structure, increase the time of concentration and provide some access to the broader floodplain for settling of solids and vegetative uptake. **Portions of this project may be constructed or superseded by Reston Association work in this stream channel.**

DF9123B (Pond Retrofit) This project would consist of the replacement of the existing riser to increase the extended detention in this dry pond on the upstream side of Sugarberry Court. Existing water quality components are in place to provide a degree of nutrient uptake and sediment removal.

DF9723 (Drainage Retrofit) The highly impervious cover of this catchment is located along the ridges, with drainage system discharging to the floodplain below. The energy released by these systems is a significant contributor to the scour and erosion found in this catchment. This project would provide outfall stabilization to reduce these impacts.

C24 (DFSB9402)

Site Investigation and Projects

DF9124A (Pond Retrofit) The existing pond at the outfall to this catchment has significantly aggraded over the years. This project would consist of a detailed analysis and re-design of the control structure to better enable this facility to provide channel protection storage and pollutant removal and if possible improve stream functions such as sediment transport and fish passage.

DF9124C (Pond Retrofit) This project is a retrofit design to the pond at the northwest corner of the intersection of the Dulles Toll Road with the W&OD Trail. This project involves excavation to maximize available storage space and installation of a multi-stage control structure to convert the dry pond to a wet marsh.

DF9724 (Drainage Retrofit) This project is intended to reduce the energy associated with runoff high runoff flows at outfalls to the stream system where it induces scour and erosion at the end of the pipes.

DF9524 (Culvert Retrofit) This project is a culvert retrofit upstream of Sunrise Valley Drive. This project consists of excavation of incised and overly steepened streambanks to create storage for channel protection and reduce erosive flows downstream. The project can be built simultaneously with stream restoration project DF92101.

C28 (DFSB9501)

Site Investigation and Projects This catchment is densely developed on rolling terrain that provides little opportunity to provide on-site drainage improvements.

DF9728 (Drainage Retrofit) Two areas that were found to have identifiable drainage improvements include the removal of the concrete trapezoidal channel that runs Purple Beech and Ridge Heights, west of Lake Thoreau. Concrete channels would be removed and replaced with grass-covered dry swales with an underdrain.

C35 (DFSB0001)

Site Investigation and Projects

DF9535A (Culvert Retrofit) This project is a culvert retrofit located on the upstream side of Colts Neck Road in the low-lying area which receives drainage from several high-density residential developments. There were no ponds found upstream of this location and this retrofit would provide channel storage volume to help reduce erosive flows downstream.

DF9535B1 (Culvert Retrofit) This project would consist of a retrofit to the western of the two culverts under Glade Road in the vicinity of the rear property line to Hunters Woods Elementary School.

DF9535B2 (Culvert Retrofit) This project is the eastern culvert draining catchment DFSB0001 beneath Glade Road. This project would provide stormwater management to a development lacking any.

DF9835 (LID Retrofit) This project is an LID retrofit of the entire development in and around the Hunters Woods Village Shopping Center that consists of several commercial businesses, two churches and other associated impervious areas. The LID retrofit approach should look for opportunities to minimize impervious cover, increase flow paths and durations and construct engineered infiltration facilities to better aid in the reduction of runoff volume.

DF9735 (Drainage Retrofit) This project consists of the addition of energy dissipation devices at each of the locations where outfalls discharge into the natural environment.

3.20.3 Stream Restoration Projects

S25

Site Investigation and Projects: The site investigation showed severe incision and raw vertical streambanks with limited recovery of the low flow channel and some floodplain re-establishment. One project was identified

DF9225 (Stream Restoration) The project would create a pattern, dimension, and profile more consistent with a natural stream. Banks would be stabilized and floodplain connections improved. Diverse riffle pool bed morphology would be created. *S25* and *S103* would be combined into a single project. **Portions of this project may be constructed or superseded by Reston Association work in this stream channel.**

S101

Site Investigation and Projects: The site investigation showed extreme incision and highly erosive banks on both sides of the stream. The stream had a poor riffle run bed morphology. In addition to the candidate reach, the site contains two side tributaries that are equally impaired. Further bank failure would threaten existing parking lots, sanitary sewers, and stormwater outfalls. One project was identified.

DF92101 (Stream Restoration) The project would create a pattern, dimension, and profile more consistent with a natural stream. Banks would be stabilized and floodplains would be excavated. Stormwater outfalls would be reconfigured and sanitary sewer lines would be permanently protected.

S102

Site Investigation and Projects: The stream is incised and has widened so that utility lines are exposed in several locations.

> *DF92102 (Stream Restoration)* The project will restore two of the reaches by reconstructing the existing channel. The remaining reaches can be stabilized in place either by regrading the streambanks, or by armoring.

S103

Site Investigation and Projects: See *S25.*

3.20.4 Preservation

Improvement Goals for all Preservation Sites

Preservation goals for all the areas described below include reducing runoff volume, peak flows, and pollutant loads by preserving open space and forested land in key areas of the catchment such as headwaters.

Site Investigation and Projects

No site investigation was undertaken for preservation projects, and no specific proposals have been made for each area. Actions and policy changes needed to implement preservation for the areas listed below are described in Chapter 4.

3.20.5 Reston Watershed Plan Recommendations for Snakeden Branch

Structural measures were recommended in Snakeden Branch for drainage areas of the mainstem of Snakeden Branch and three tributaries. Specific locations within these areas were not identified. The recommendations included the following:

Pollution Prevention

> Reston Plan No projects of programs were identified for specific areas.
>
> Difficult Run Plan One pollution prevention project specific to Snakeden Branch was identified in this plan, DF9902 for outreach to the Reston National Golf Course for fertilizer and pesticide management techniques.

On-site stormwater controls

> Reston Plan No retrofit projects were identified for specific areas.
>
> Difficult Run Plan Several of these measures are proposed for Snakeden Branch in project DF9835 above, which identifies general areas and parcels where topography and land use would make on-site controls particularly effective.

Stormwater Attenuation

> Reston Plan (20 structures) These projects are designed to detain and reduce the peak flow from the channel-forming discharge. Smaller versions of these types of attenuation systems at unspecified storm sewer inlets are also proposed in the Reston Plan.
>
> Difficult Run Plan Culvert retrofit projects DF9024B, DF9523, DF9535A, and DF9535B recommended for Snakeden Branch are similar to the Reston Plan attenuation structures.

Floodplain Spreaders

Reston Plan (10 structures) These projects are designed to divert stormwater from paved ditches and storm sewers and allow it to flow over the floodplain at much lower energy levels and reduce scour at outfalls.

Difficult Run Plan These types of structures are a potential solution for the drainage retrofits at outfalls described in projects DF9024C, DF9723, DF9724, DF9728, and DF9735.

Check Dams

Reston Plan (30 structures) These projects provide stabilization for intermittent streams by creating step pools which lower the erosive velocity. There are no equivalent projects in the Difficult Run Watershed Plan.

Difficult Run Plan There are no equivalent projects specifically called out in the this plan, although these techniques could be used as part of the drainage retrofits described in projects DF9024C, DF9723, DF9724, DF9728, and DF9735 in this plan.

Stream Restoration

Reston Plan (7,000 Feet) The Reston Plan proposes restoration of up to 7,000 feet of stream throughout Snakeden Branch.

Difficult Run Plan Two projects were identified in sites S25 and S101. Project DF9225 would restore 1,890 feet and project DF92101 would restore 610 feet of stream.

3.21 The Glade – Subwatershed Condition

3.21.1 Subwatershed Characteristics

The Glade **subwatershed** is one of the smaller subwatersheds in the Difficult Run watershed. It has an area of approximately 853 **acres** (1.33 mi^2). It is located in central Fairfax County. Much of the watershed lies between Glade Drive, which forms the northern boundary, and Lawyers Road (Virginia 673), which lies along the southern subwatershed divide. The subwatershed extends from Reston Parkway (Virginia 602) on the western edge to Hunter Station Road (Virginia 677) at the downstream end.

The Glade subwatershed is located in the west-central area of the Difficult Run watershed. The single 3.8 mile stream flows in an easterly direction to the confluence with Snakeden Branch.

Refer to DFGL_1 for a map of the Glade subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.21.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The Glade subwatershed is moderately densely developed. Twenty-nine percent of the Glade subwatershed is developed as low-density or estate residential, and 22 percent is developed as medium-density residential. Only 2 percent of the subwatershed is developed for high-density residential, commercial or industrial uses. The majority of the more developed area is along Lawyers Road (Virginia 673) and the major arterial Glade Drive. There are 106 acres used for transportation rights-of-way (12 percent of the subwatershed).

Total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 138 acres, or 16 percent, of the total subwatershed area. Twenty-nine percent of the subwatershed is open space although no major developed parks or recreational facilities exist. No historical sites lie within the subwatershed. A complete summary of land use within the subwatershed can be found in Table 3.35.

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

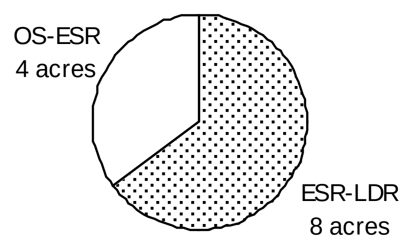
Table 3.37 Existing and Future Land Use

	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	250	29%	246	29%	-4	-1%
Golf Course	0	0%	0	0%	0	0%
Estate residential	26	3%	23	3%	-4	0%
Low-density residential	225	26%	233	27%	8	1%
Medium-density residential	190	22%	190	22%	0	0%
High-density residential	20	2%	20	2%	0	0%
Low-intensity commercial	12	1%	12	1%	0	0%
High-intensity commercial	4	0%	4	0%	0	0%
Industrial	0	0%	0	0%	0	0%
Institutional	19	2%	19	2%	0	0%
Transportation	106	12%	106	12%	0	0%
Water	0	0%	0	0%	0	0%
Total	**853**	**100%**	**853**	**100%**		**0%**

The Glade subwatershed had the least amount of change between existing and future land use projections in Difficult Run. There is a projected 1 percent increase in low-density residential acreage and a projected 1 percent decrease in open space.

According to Figure 3.10, 8 acres are projected to shift from estate residential in the existing land use to low-density residential in the future land use, and 4 acres were projected to shift from open space to estate residential in the future land use.

Figure 3.10 Changed Land Use



3.21.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are four **stormwater management facilities** within The Glade subwatershed. Ninety-two percent of the subwatershed is not served by any stormwater management facility. Eight percent of the total area has quantity control only. There is no area within the subwatershed that receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (69 percent) and the area served by stormwater management (8 percent) indicates a possible need for additional management efforts, particularly in the industrial and low and medium density residential areas that border most of the stream length. Additional information on the location of the stormwater management facilities in the Glade subwatershed can be found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews did not locate any **outfall** pipes that were having a significant impact on the stream.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. Seventeen of the 21 stream crossings in The Glade subwatershed are wooden footbridges. All but two crossings have very little impact on stream character. The two with more significant impact are wooden footbridges where the flow is creating moderate bank erosion. The erosion was not significant enough to warrant further study or restoration. The crossings are shown in Photos 3.64 and 3.65.

Photo 3.64 Wooden bridge where stream flow is causing moderate erosion. Located just off of Bassett Lane (DFGL008.C004).

3.21.4 Soils

Soils found in The Glade subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid runoff, and micaceous soils, which are erodible. The groundwater is fairly shallow with numerous natural springs. The subwatershed contains 78 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (66 percent). B soils and the Glenelg soil type are compatible with infiltration practices and may provide potential stormwater management sites. There are 0.6 acres of land with unclassified soils in the subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

Photo 3.65 Wooden bridge where stream flow is causing moderate erosion. Located just west of Steeplechase Drive (DFGL008.C001).

3.21.5 Geomorphology

Photo 3.66 Located north of Lawyers Road between Pegasus Lane and Charlestown Lane (DFGL005.E001).

There are approximately 3.7 miles (19,427 feet) of stream in The Glade subwatershed that were assessed and assigned a Channel Evolution Model classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. One reach (928 feet), near the north end of Howland Drive, was not assessed because it was not a natural stream channel.

The stream channel **substrate** is primarily a mix of cobble and gravel with some sand present. Fifty-one percent of the total reach length is Type III, which is indicative of an unstable channel that is actively widening as a response to changes in the flow. The remaining 45 percent of assessed channel is Type IV, which is the beginning of stream stabilization after disturbance.

There were only two specific erosion locations noted in the subwatershed. Both were considered to be of moderate impact. These are located just downstream of a candidate stream restoration site S26. An example of the erosion is shown in Photo 3.67.

There are ten stream blockages, primarily comprised of downed trees. Eight of these blockages are likely restricting movement of fish within the stream system and can block passage. Only one obstruction is thought to have a severe impact. This obstruction of trees and debris is located on an upstream reach near Stirrup Road, upstream of the candidate stream restoration area S26 (see Photo 3.68).

Photo 3.67 Erosion north of Lawyers Road near Pinoak Lane (DFGL006.E001)

Photo 3.68 Obstruction of trees and debris near Stirrup Road. (DFGL008.T001)

Photo 3.69 Utility line located just off of Stirrup Road on an upstream reach of the subwatershed (DFGL009.U001).

There were no **headcuts**, areas of distinct stream bed elevation change due to erosion, and no dumpsites within the subwatershed at the time of assessment. There were 14 ditches, of which the flows in four were causing some moderate erosion. One ditch located just downstream of a potential restoration site should be addressed with the stream restoration site.

The field crew found a total of five partially exposed utility lines in the subwatershed, which can pose potential problems for both the stream and the utility lines. One utility line of an unknown type was completely exposed. This utility line is located just off of Stirrup Road on an upstream reach of the subwatershed and is a candidate restoration site S104 (Photo 3.69).

3.21.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall of 2002.

- Of the assessed reaches, 71 percent is considered fair habitat for aquatic insects and fish, 18 percent is considered poor, and 8 percent is excellent. The reach considered excellent habitat is the most downstream reach near The Glade's confluence with Snakeden Branch.
- There were no points along the stream that were considered to have deficient **riparian buffer**.

3.21.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in The Glade incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

The Glade subwatershed has an impervious cover of 16 percent. This subwatershed runs parallel to and just north of Lawyers Road west of the intersection with Hunter Station Road. The land use is mostly composed of low and medium-density residential areas with open space around the stream.

Catchment DFGL0002, found from Steeplechase Drive east to Soapstone Drive, has the highest modeled pollutant loadings. Refer to DFGL_4 for the catchment locations. The highest runoff volume is found between Reston Parkway and Steeplechase Drive north of Lawyers Road, which is catchment DFGL0001. Results are in Table 3.36.

Table 3.38 Existing and Future Modeling

The Glade Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFGL0001	E	3.63	0.12	56.9	2.8	0.5
	F	3.63	0.12	56.9	2.8	0.5
	C	0%	0%	0%	0%	0%
DFGL0002	E	3.49	0.13	51.3	2.6	0.5
	F	3.49	0.13	51.6	2.6	0.5
	C	0%	0%	1%	0%	0%
DFGL0004	E	2.93	0.14	33.3	1.8	0.4
	F	2.97	0.15	34.3	1.9	0.4
	C	1%	7%	3%	6%	0%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

There is less land use change set to take place in this subwatershed than in most subwatersheds. There are only a few areas of open space changing to estate residential or estate residential changing to low-density residential.

3.21.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Two stream crossings were modeled in the subwatershed; neither was overtopped with existing flows.

3.21.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in The Glade subwatershed are listed below. Refer to DFGL_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S26 The Stream Physical Assessment identified a significant portion of the stream, including this reach, which has erosion causing unstable banks (Photo 3.67).

S104 A utility line was found in the stream along with unstable banks caused by erosion (Photo 3.69).

Hydrology and Water Quality

C40 (Catchment DFGL0001) Pollutant loads and flows are higher than the subwatershed average. S26, with unstable banks and erosion, is located downstream of this catchment

3.21.10 Reston Watershed Plan Assessment

The assessment covered the mainstem of The Glade down to the lowest reaches that were not assessed because they were primarily beaver habitat and no stream improvements were expected to be proposed. Results of the physical assessments and hydraulic modeling are discussed below, with a reference to the equivalent catchment areas defined in the Difficult Run Watershed Plan.

The Glade (DFGL0001, DFGL0002, upstream half of DFGL0004)

Reston Plan Problems with bank erosion were found during the assessment. The percentage of streambanks affected increased downstream, with 10 to 20 percent eroded in DFGL0001, 30 to 50 percent in DFGL0002, and 35 percent in DFGL0004. Exposed utilities were also found. Hydraulic modeling showed that 35 out of 40 cross-sections had erosive velocities from the 1-year storm; however, only 2 of these were highly erosive.

Difficult Run Plan The Stream Physical Assessment for this project found similar results, with active widening through DFGL0001 and DFGL0002, and more than 60 percent of the streambanks unstable for the entire length of the mainstem assessed in the Reston Plan.

The stream reach with the highest percentage of erosion was selected as candidate site S26. The catchment upstream of this site was a high priority and was selected for stormwater management project investigation as candidate site C40.

3.22 The Glade - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.37 below is a list of all projects proposed in this subwatershed.

Table 3.39 Recommendations for The Glade

Project #	Project Type	Candidate Site
DF92104	Streambank Stabilization	S104
DF9540A	Culvert Retrofit	C40
DF9540B	Culvert Retrofit	C40
DF9740	Drainage Retrofit	C40

3.22.1 Regional Pond Alternative Projects

There are no proposed regional pond sites.

3.22.2 Catchment Improvement Projects

C40 (DFGL0001)

<u>Site Investigation and Projects</u>:

DF9540A (Culvert Retrofit) This project would consist of a culvert retrofit on the upstream side of Steeplechase Road at the outlet to this catchment. This retrofit would be designed to reduce erosive flows downstream by extended detention of smaller storms, and allow for settling and vegetative uptake of pollutants.

DF9540B (Culvert Retrofit) This project would consist of a culvert retrofit on the upstream side of Colts Neck Road where the north branch of this tributary crosses. This retrofit would be designed designed as an extended detention dry pond with a sediment forebay and micropool with the primary goal of reducing erosive flows downstream, and secondarily to allow for settling and biological uptake of nutrients.

DF9740 (Drainage Retrofit) This project would include the removal of all concrete ditch conveyance channels with dry swales and the improvement of outfall protection throughout the catchment. The primary impact of this project would be to reduce erosive velocities, promote infiltration into the ground, and provide a slower, less destructive drainage system to convey runoff to receiving streams.

3.22.3 Stream Restoration Projects

S26

Site Investigation and Projects: The site investigation showed raw banks and moderate to severe incision. The stream had good pool variability and stable riffle bed features. The stream is largely recovered with some floodplain re-development. Constraints associated with utilities and wetland impacts outweigh the benefits of a bank stabilization project, so no project was identified.

S104

Site Investigation and Projects: The site investigation found three pieces of disconnected reinforced concrete stormwater pipe in the stream. The pipes have created an obstruction that has initiated streambank erosion. One project was identified

> *DF92104 (Streambank Stabilization)* The stream would be realigned with a new pattern and profile to be more stable with the existing flow regime. The obstruction would be removed as part of this project.**Portions of this project may be constructed or superseded by Reston Association work in this stream channel.**

3.22.4 Preservation

No preservation candidate sites were identified for this subwatershed.

3.22.5 Reston Watershed Plan Recommendations for The Glade

Structural measures were recommended for drainage areas of the mainstem of The Glade. Specific locations within these areas were not identified. The recommendations included the following:

Stormwater Attenuation

> Reston Plan (10 structures) These projects are designed to detain and reduce the peak flow from the channel-forming discharge, reducing scour at outfalls. Smaller versions of these types of attenuation systems at unspecified storm sewer inlets are also proposed.
>
> Difficult Run Plan Culvert retrofit projects DF9540A and DF9540B in this plan are similar to the Reston Plan attenuation structures.

Floodplain Spreaders

> Reston Plan (10 structures) These projects are designed to divert stormwater from paved ditches and storm sewers and allow it to flow over the floodplain at much lower energy levels.
>
> Difficult Run Plan Floodplain spreaders are a potential solution for the drainage retrofits at outfalls described in project DF9740A in this plan.

Check Dams

> Reston Plan (10 structures) These projects provide stabilization for intermittent streams by creating step pools which lower the erosive velocity.

Difficult Run Plan There are no equivalent projects specifically called out in this plan, although these techniques could be used as part of the drainage retrofits described project DF9740A in this plan.

Stream Restoration

Reston Plan (4,000 feet) The Reston Plan proposes restoration of up to 4,000 feet of stream throughout The Glade.

Difficult Run Plan Candidate site S26 was assessed in the field but restoration potential outweighed the constraints associated with access and construction. Project DF92104 would remove stream blockages and restore 920 feet of unstable streambanks.

3.23 Middle Difficult Run – Subwatershed Condition

3.23.1 Subwatershed Characteristics

The Middle Difficult Run **subwatershed** has an area of approximately 1,721 **acres** (2.69 mi^2) located in center of the Difficult Run watershed. The Dulles Access Toll Road (Virginia 267) virtually bisects the subwatershed into two pieces. Hunter Mill Road (Virginia 674) forms the approximate western boundary. Beulah Road (Virginia 675) forms the approximate eastern boundary. Crowell Road (Virginia 675) forms the approximate northern boundary. The Difficult Run Stream Valley Park provides the approximate southern boundary.

The 7.6 miles of stream generally flow in a northeast direction. The mainstem of this section of Difficult Run extends from the confluence with Piney Branch to the confluence with Wolftrap Creek.

Refer to DFDFM_1 for a map of the Middle Difficult Run subwatershed highlighting the Subwatershed Characteristics including: existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.23.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The Middle Difficult Run subwatershed is developed to a slight to moderate density with 47 percent developed as low-density or estate residential. Only 2 percent of the subwatershed is developed as a commercial use. The majority of this area is concentrated south of the Dulles Access Toll Road (Virginia 267), and along Hunter Mill Road (Virginia 674).

There are 231 acres of the subwatershed, or 13 percent, used for transportation such as roads and highways. Total impervious area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 248 acres, or 14 percent of the total subwatershed area.

Twenty-six percent of the subwatershed is preserved for open space or parks. Major parks include the majority of the Difficult Run Stream Valley Park, Tamarack Park, Meadowlark Gardens Regional Park (contains Sun Valley Park), and a portion of the Colvin Run Mill Park. No historical sites lie within the subwatershed.

A summary of land use within the subwatershed can be found in Table 3.38.

Table 3.40 Existing and Future Land Use

	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	445	26%	359	21%	-86	-5%
Golf Course	36	2%	0	0%	-36	-2%
Estate residential	268	16%	293	17%	25	1%
Low-density residential	537	31%	626	36%	90	5%
Medium-density residential	108	6%	110	6%	3	0%
High-density residential	0	0%	0	0%	0	0%
Low-intensity commercial	20	1%	14	1%	-7	0%
High-intensity commercial	24	1%	35	2%	12	1%
Industrial	0	0%	0	0%	0	0%
Institutional	52	3%	52	3%	0	0%
Transportation	231	13%	231	13%	0	0%
Water	0	0%	0	0%	0	0%
Total	**1,721**	**100%**	**1,721**	**100%**		**0%**

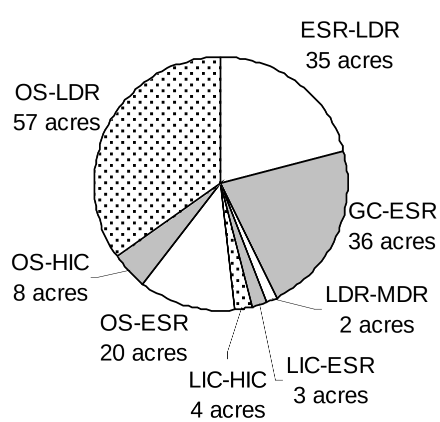
Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

When comparing existing land use to future land use, the notable changes are projected in the open space and low-density residential categories. Decreases are projected in the open space (-5 percent) and golf courses (-2 percent) categories, while increases are projected in the estate residential (+1%), low-density residential (+5 percent), and high-intensity commercial (+1 percent) land use categories.

According to Figure 3.11, 57 acres are projected to shift from open space in the existing land use to low-density residential in the future land use. Twenty acres may shift from open space to estate residential in the future land use. In fact, 85 acres, or 52 percent of all land use changes, are projected to shift from open space to a higher intensity use in the future. This does not guarantee that the open space will become developed – it suggests that these areas of open space can be used for development/ redevelopment in the future.

Thirty-five acres are projected to shift from estate residential to low-density residential in the future land use. This suggests a need for more and possibly higher-density residential uses in the Middle Difficult Run subwatershed.

Figure 3.11. Changed Land Use



3.23.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are three **stormwater management facilities** within the Middle Difficult Run subwatershed. Seventy-five percent of the Middle Difficult Run subwatershed is not served by any stormwater management facility. Nineteen percent of the total area has quantity control only and the remaining 5 percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (73 percent) and the area served by stormwater management (25 percent) indicates a possible need for additional management efforts, specifically in the low-density and medium-density residential areas. A list of all stormwater management facilities in the Middle Difficult Run subwatershed can be found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located four **outfall** pipes discharging into the Middle Difficult Run subwatershed. All pipes have little impact on stream integrity and do not require repair.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. There were 27 stream crossings located in the subwatershed during the Stream Physical Assessment. None of the crossings were having a significant impact on the stream condition.

3.23.4 Soils

Soils found in the Middle Difficult Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 61 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (31 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.23.5 Geomorphology

There is approximately 7.3 miles (38,310 feet) of stream in the Middle Difficult Run subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel’s physical condition and stability as a response to disturbances such as upstream land use changes.

Fifty-three percent of the total reach length is Type III, which is indicative of an actively widening and unstable stream channel as a result of changes in flow. The remaining 45 percent of assessed channel are Type II, which is generally characterized by a downcutting channel and the beginnings of instability in stream banks. A mix of sand, silt, and gravel with some areas of bedrock dominate the substrate of the Middle Difficult Run channel.

About thirty-five percent of both banks of the entire assessed stream reach were considered moderately unstable which can lead to high erosion potential during **flood** events.

There were 11 points of erosion noted in Middle Difficult Run. The combined length of the erosion points is approximately 6,660 feet (1.3 miles). Two of the 11 erosion points are having a severe impact on stream condition. They are shown here in Photos 3.70 and 3.71. The former is located at Candidate Site S56.

Photo 3.70 Eroding channel located between Brittenford Drive and Hunt Country Lane (DFDF049.E002).

Photo 3.71 Erosion on the mainstem of Difficult Run at the end of Tamarack Drive (DFDF008.E001).

3.23.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall of 2002 and winter of 2003. There were two reaches not assessed because they were ponds or wetlands.

- Of the assessed reaches, 82 percent have fair habitat for aquatic insects and fish, 14 percent is considered poor, and 4 percent is good.
- There are 12 stream blockages, primarily composed of trees and debris. Eight of these blockages are likely restricting movement of fish in the stream system between habitats and for migration. Three of these obstructions have a more significant impact on stream integrity. Two of them are shown below in Photos 3.72 and 3.73.

There was one dumpsite within the subwatershed at the time of assessment. The dumpsite was located in the stream and contained a residential oil tank. Although the dumpsite was not active, clean up would definitely be a benefit to the stream quality. The tank is shown in Photo 3.74 and is at candidate site S105.

Photo 3.72 Obstruction on the mainstem located in Tamarack Park (DFDF007.T002).

Photo 3.73 Obstruction to fish passage on the mainstem located at the terminus of Montafia Lane, Sun Valley subdivision, directly west of Sun Valley Park (DFDF007.T001).

- There was one sanitary line that was crossing the stream and partially buried (see Photo 3.75). Although the line was exposed in some parts, it was stabilized and anchored to the banks.

Photo 3.74 Residential oil tank located in a tributary near Asoleado Lane (DFDF055.M001).

Photo 3.75 Utility at the downstream end of the subwatershed near Valley Creek Lane (DFDF005.U001).

- Fourteen percent of the total assessed length is somewhat channelized, indicating that a significant amount of the channel has been altered and is no longer the natural channel.
- There is 30,800 feet, or approximately 38 percent of the total, of **buffer encroachment** (this length includes left and right banks combined). Of this, 25,100 feet (82 percent) is lawn or meadow and most of the remaining 18 percent is some

combination of impervious and pervious surface. Approximately half of the buffer encroachment length has a high restoration potential. Approximately 9,000 feet of the buffer impact have a significant impact on the stream condition and habitat. Two buffer encroachments are shown below in Photos 3.76, which is at candidate site S106, and 3.78, which is site S108.

- Fifty-five percent of the assessed stream length has between 50 percent and 70 percent of both stream banks covered by vegetation. Typically this vegetation is scattered grasses, shrubs and forbs.

Photo 3.76 Buffer impact south of Windy Knoll Lane (DFDF053.B001).

Photo 3.77 2000 feet of buffer impact upstream of Brittenford Road (DFDF050.B002).

3.23.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Middle Difficult Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

The Middle Difficult Run subwatershed is covered by 14 percent impervious surface. While most of the subwatershed consists of estate and low-density residential land use, there is a large area of commercial development, including the Parkridge Bus Park, which is in the catchment with the highest runoff volume, DFDF6901. See DFDFM_4 for the catchment locations. This catchment also has the highest modeled nitrogen and phosphorus loading.

The Dulles Toll Road runs through several catchments in this subwatershed, including DFDF6901, DFDF6902, and DFDF0037. This is a large amount of impervious area that increases the amount of runoff in these catchments compared to the catchments that do not contain the Toll Road. Catchment DFDF6902 also contains a higher concentration of low and medium density residential areas, which is why it has the second highest nitrogen and phosphorus loadings behind DFDF6901. Results are in Table 3.39.

Table 3.41 Existing and Future Modeling

Middle Difficult Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFDF0035	E	1.85	0.12	20.0	1.1	0.2
	F	1.87	0.12	20.8	1.1	0.2
	C	1%	0%	4%	0%	0%
DFDF0037	E	4.06	0.14	29.1	1.6	0.3
	F	4.15	0.14	29.9	1.6	0.3
	C	2%	0%	3%	0%	0%
DFDF0039	E	2.56	0.14	19.4	1.0	0.2
	F	2.56	0.14	19.4	1.0	0.2
	C	0%	0%	0%	0%	0%
DFDF0041	E	1.89	0.15	16.1	0.9	0.2
	F	1.95	0.15	16.2	0.9	0.2
	C	3%	0%	1%	0%	0%
DFDF6801	E	1.86	0.1	24.1	1.2	0.2
	F	1.86	0.1	24.1	1.2	0.2
	C	0%	0%	0%	0%	0%
DFDF6901	E	8.32	0.23	135.1	5.5	0.6
	F	9.48	0.28	152.6	6.2	0.7
	C	14%	22%	13%	13%	17%
DFDF6902	E	3.99	0.13	54.5	2.6	0.4
	F	4.17	0.14	57.7	2.8	0.5
	C	5%	8%	6%	8%	25%
DFDF7102	E	2.03	0.12	39.2	1.7	0.2
	F	2.46	0.13	48.6	2.1	0.3
	C	21%	8%	24%	24%	50%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

The future modeling shows the highest percent increase to be in catchment DFDF7102, where there is a significant amount of area changing from open space to estate or low-density residential or from low-density residential to medium density residential. This area is situated approximately between Beulah Road and Brookside Lane.

3.23.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

One crossing in the subwatershed was overtopped by existing flows, as shown in Table 3.40. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.42 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
29	Browns Mill Road	E	x	x	x	x	x	x	x

E – Existing conditions results, x – indicates overtopping

Culvert #29 (Photo 3.78) overtopped for all events. Browns Mill Road is a local road, so it is required to pass the 10-year flow.

Photo 3.78 Difficult Run Mainstem at Browns Mill Road.

3.23.9 Hydraulic Modeling

Based on the review of the assessment data and modeling results, the most serious problem areas in the Middle Difficult Run subwatershed are listed below. Refer to DFDFM_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S56 The Stream Physical Assessment found severe bank erosion at this site, and the catchment has the second highest runoff volume in the subwatershed (Photo 3.70).

S105 The Stream Physical Assessment found a residential oil tank that should be removed from the stream. The catchment has average runoff and below average pollutant loading (Photo 3.74).

S106 Stream Physical Assessment inspections showed areas of unstable streambanks, incision, and deficient buffer in this area (Photo 3.76).

S107 This site has better than average conditions for the subwatershed for runoff flows and pollutant loads. The Stream Physical Assessment identified this site as having deficient buffer and widening.

S108 Inadequate buffer and stream erosion are both problems at this site. The catchment has the highest runoff volume and peak discharge in the subwatershed (Photo 3.77).

Hydrology and Water Quality

D11 (Catchment DFDF6801) This catchment has average pollutant loading. Directly downstream of this site is S106, which has problems with erosion.

C22 (Catchment DFDF6902) This catchment has above average runoff and average pollutant loads. The streams in the catchment have severe erosion, are incised (S56), and are actively widening.

C55 (Catchment DFDF6901) This site has the highest nitrogen and phosphorus loadings in the subwatershed. Peak flows and runoff volume are also above average. Stream site S108 in the catchment has a buffer deficiency and erosion problems. The streams are also actively widening and incised, leading downstream into S56.

Flooding

F29 The Browns Mill Road Bridge overtops for all events. Since it is classified as a local road, the bridge should pass the 10-year event (Photo 3.78).

Preservation

No sites were identified. Several catchments are in very good condition, but model results from future development do not make them significantly worse. This means that they are essentially preserved under the current development plans and regulations.

3.24 Middle Difficult Run - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.41 below is a list of all projects proposed in this subwatershed.

Table 3.43 Recommendations for Middle Difficult Run

Project #	Project Type	Candidate Site
DF9011A	Pond Retrofit	D-11
DF9011C	Drainage Retrofit	D-11
DF9122	Pond Retrofit	C22
DF92106	Stream Restoration	S106
DF92108	Buffer Restoration	S108
DF9522A	Culvert Retrofit	C22
DF9522B	Culvert Retrofit	C22
DF9522C	Culvert Retrofit	C22
DF9522D	Culvert Retrofit	C22
DF9555A	Culvert Retrofit	C55
DF9555B	Culvert Retrofit	C55
DF9555C	Culvert Retrofit	C55
DF9722	Drainage Retrofit	C22
DF9755	Drainage Retrofit	C55

3.24.1 Regional Pond Alternative Projects

D11 (DFDF6801)

<u>Site Investigation and Projects</u>

DF9011A (Pond Retrofit) This project would retrofit an existing wet pond located on the upstream side of Windstone Road by installling a multi-stage riser to control smaller storms and adding an aquatic bench to improve pollutant removal performance.

DF9011C (Drainage Retrofit) These distributed projects would be designed to dissipate energy where manmade channels flow into natural channels. This may include riprap, plunge pools, and structural energy dissipaters.

3.24.2 Catchment Improvement Projects

C22 (DFDF6902)

<u>Site Investigation and Projects</u>:

DF9522A (Culvert Retrofit) This project consists of using the embankment of the driveway off of Willow Crest Court to increase detention time, thus cutting down the peak discharges and allowing time for sediments and pollutants to be removed from the water.

DF9522B (Culvert Retrofit) This project consists of using the roadway embankment of Brittenford Drive Drive to create an extended detention dry pond for channel protection control.Use of wetland vegetation for nutrient uptake will improve treatment effectiveness.

DF9522C (Culvert Retrofit) This project consists of using the roadway embankment of Brittenford Drive, east of Raleigh Hill Road, to create an extended detention dry pond for channel protection control. Use of wetland vegetation and a micropool for sedimentation and nutrient uptake will improve treatment effectiveness.

DF9522D (Culvert Retrofit) This project consists of using the roadway embankment of Brittenford Drive, east of Rosaleigh Court, to create an extended detention dry pond for channel protection control.

DF9122 (Pond Retrofit) This project is located in an existing regional basin, between Brittenford Drive and Hunt Country Lane, and consists of a redesign of the existing dry pond to create a flat, wet marsh area will increase nutrient removal and promote settling of solids, and to provide a multi-stage riser to provide channel protection storage.

DF9722 (Drainage Retrofit) These projects distributed throughout the catchment are designed to provide adequate energy dissipation at outfalls where the piped storm-drain system discharges to a natural channel. Improvements would consist of energy dissipation through riprap, plunge pools, or structures.

C55 (DFDF6901)

Site Investigation and Projects:

DF9555A (Culvert Retrofit) This project consists of a culvert retrofit to the crossing of Hunter Mill Road. The retrofit would be designed to store runoff on the upstream side of the roadway. This facility would settle out sediment.

DF9555B (Culvert Retrofit) This project consists of using the roadway embankment of Sunset Hills Road to provide detention for channel protection and water quality improvements.

DF9555C (Culvert Retrofit) This project consists of using the roadway embankment of Brittenford Drive, just east of Landon Hill Road, reduce peak discharges and allow time for sedimentation and vegetative uptake..

DF9755 (Drainage Retrofit) This project consists of reconfiguring outfalls or retrofitting energy dissipation structures to reduce scour and erosion where flows from the storm drainage system enter the stream. Improvements would consist of energy dissipation through riprap, plunge pools, or structures. The primary benefit would be reduction of sediment from localized scour or erosion.

3.24.3 Stream Restoration Projects

S56

Site Investigation and Projects: The site investigation showed moderate bank erosion located on outer meander bends with slight incision and some floodplain bench development. The stream was moderately sinuous and the stream had downcut to bedrock. Upstream stormwater management retrofits are expected to reduce runoff impacts to the point that stream can recover naturally. No project was identified.

S105

Site Investigation and Projects: The site investigation did not find a tank located in the stream in the area indicated. It may have been removed between the assessment and the site investigation, so no project was identified.

S106

Site Investigation and Projects: The stream has widened and the banks are unstable in several reaches. The buffer is deficient for most of its length.

> *DF92106 (Stream Restoration)* The restoration approach consists of minor regrading of streambanks to a more stable angle, and armoring specific erosion points at meanders. Stream buffers will be restored where they are deficient.

S107

Site Investigation and Projects: The site investigation showed a stable stream without severe enough erosion problems to justify a project.

S108

Site Investigation and Projects: The site investigation showed moderate bank erosion located on outer meander bends with slight incision and some floodplain bench development. The stream was moderately sinuous and the stream had downcut to bedrock. Some buffer deficiencies were identified.

> *DF92108 (Buffer Restoration)* Areas in the riparian zone deficient in woody vegetation would be replanted with native trees and shrubs.

3.24.4 Preservation

No preservation candidate sites were identified for this subwatershed.

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3.25 Wolftrap Creek – Subwatershed Condition

3.25.1 Subwatershed Characteristics

The Wolftrap Creek **subwatershed** has an area of approximately 3,631 **acres** (5.67 mi^2). It is located in central Fairfax County just north of Vienna. Leesburg Pike (Virginia 7) runs along the northeast boundary. The Dulles Toll Access Road (Virginia 267) bisects the upper portion of the subwatershed and Beulah Road (Virginia 675) provides an approximate western boundary. Cedar Lane (Virginia 698) and Vienna Technical Park create the boundary.

Wolftrap Creek subwatershed is located in the east-central portion of the Difficult Run watershed. There are 13.1 miles of stream in this subwatershed. Many other subwatersheds border Wolftrap Creek on its northwestern course to intersect the mainstem of Difficult Run.

Refer to DFWC_1 for a map of the Wolftrap Creek subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.25.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The Wolftrap Creek subwatershed is one of the more dense subwatersheds in the Difficult Run watershed. Twenty-six percent is developed as low-density or estate residential. Six percent of the subwatershed is developed for commercial or industrial uses, and 28 percent is developed for medium or high-density residential. The largest **land use** category is medium-density residential, which constitutes 25 percent of the subwatershed's acreage. There are 536 acres, or 15 percent of the subwatershed, used for transportation use such as roads and highways. Total impervious area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 839 acres, or 23 percent of the total subwatershed area.

Seventeen percent of the land in this subwatershed is preserved for open space or parks. Major parks include the Wolftrap Stream Valley Park, the Wolftrap Farm Park, the Wolf Trails Park, the Spring Lake Park, Foxstone Park, the Westwood Golf Course, and Briarcliff Park. There are 12 historical sites that lie within the subwatershed. A summary of land use within the subwatershed can be found in Table 3.42.

Table 3.44 Existing and Future Land Use

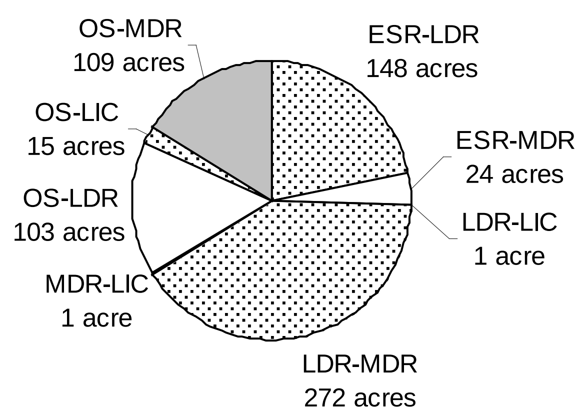
	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	601	17%	373	10%	-228	-6%
Golf Course	136	4%	136	4%	0	0%
Estate residential	213	6%	41	1%	-171	-5%
Low-density residential	718	20%	696	19%	-22	-1%
Medium-density residential	906	25%	1310	36%	403	11%
High-density residential	101	3%	101	3%	0	0%
Low-intensity commercial	69	2%	86	2%	17	0%
High-intensity commercial	161	4%	161	4%	0	0%
Industrial	9	0%	9	0%	0	0%
Institutional	178	5%	178	5%	0	0%
Transportation	536	15%	536	15%	0	0%
Water	3	0%	3	0%	0	0%
Total	**3,631**	**100%**	**3,631**	**100%**		**0%**

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

When comparing existing land use to future land use, the notable changes are projected in the medium-density residential, open space, and estate residential categories. Medium-density residential acreage is projected to increase by 403 acres, while estate residential acreage is projected to decrease by 171 acres. There is a loss of commercial acreage anticipated, but an increase in industrial land. Open space land is projected to decrease by 6 percent.

According to Figure 3.12, 272 acres are projected to shift from low-density residential in the existing land use to medium-density residential in the future land use. One hundred and forty-eight acres will shift from estate residential to low-density residential. One hundred and nine acres shifted from open space in the existing land use to medium-density residential in the future land use. One hundred and three acres are anticipated to shift from open space to low-density residential. Cumulatively, 227 acres, or 33 percent of all land use changes, are projected to shift from open space to a higher density use. This does not guarantee that the open space will become developed – it suggests that these areas of open space can be used for development/ redevelopment in the future.

Figure 3.12 Changed Land Use



The largest shifts in land use from existing to future illustrate the demand for accommodating new residential uses in Fairfax County. Other shifts show an exchange of a lower-intensity use for a higher-intensity use except for a few cases. The 6 percent loss of open space primarily stems from the addition of medium-density residential (403 acres) land uses in the future to accommodate housing.

3.25.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are 45 **stormwater management facilities** within the Wolftrap Creek subwatershed. Seventy-five percent of the Wolftrap Creek subwatershed is not served by any stormwater management facility. Twenty-one percent of the total area has quantity control only and the remaining 4 percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (81 percent) and the area served by stormwater management (25 percent) indicates a possible need for additional management efforts, specifically in the low-density and medium density residential areas, which account for 45 percent of the area. Additional information on the location of the stormwater management facilities in the Wolftrap Creek subwatershed is found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located 57 **outfall** pipes discharging into the Wolftrap Creek subwatershed. All pipes were smaller than 48 inches. All of these pipes were considered to have minimal impact on the stream condition.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. The Stream Physical Assessment identified 57 stream crossings in the Wolftrap Creek subwatershed. Of this total, only one was considered to have a moderate impact on the stream character; the remaining crossings were having a minimal impact on the stream.

3.25.4 Soils

Soils found in the Wolftrap Creek subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 41 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (23 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. There are 877.5 acres of land with unclassified soils in the Wolftrap Creek subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.25.5 Geomorphology

There are approximately 10.9 miles (57,554 feet) of stream in the Wolftrap Creek subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. Ten reaches were not assessed because they were wetlands or stormwater ponds, not listed, piped channels, or too channelized (made of concrete).

- Sixty-three percent of the total reach length is Type III, which is indicative of an unstable channel that is actively widening in response to changes in flow. The widening reaches are located on the lower portion of the reach below the Dulles Toll Road and upstream of Chain Bridge Road. Thirteen percent is type IV, which is the beginning stage of stream stabilization after disturbance, and the remaining 7 percent of assessed channel is Type V which is development of a new stable channel within the original and larger channel.
- Most of the channel substrate throughout the subwatershed is gravel with smaller amounts of cobble and silt present. The remaining channel consists of a previously restored stream reach that is dominated by boulder.
- There were no specific erosion points noted in the subwatershed, however 44 percent of the stream length is moderately unstable with high erosion potential during **flood** events.
- There were five stream blockages, primarily trees. Four of these blockages are likely restricting fish movement within the stream system. All stream obstructions were having a significant impact on stream condition. Photo 3.79 shows an obstruction that is candidate site S124.

Photo 3.79 A severe obstruction located upstream of Chain Bridge Road near Echols Street (DFWC028.T001).

- There were two utility lines (one sanitary, one unknown) both crossing the stream and partially buried, or within the buffer. Both were somewhat exposed, but stabilized and anchored to the bank, thus, having a very minor impact on the stream.

3.25.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, conducted in the fall of 2002, which provides a one time visual inspection.

Of the assessed reaches, 3 percent provides excellent habitat for aquatic insects and fish, 66 percent provides good habitat, 20 percent is fair, and 11 percent is poor habitat for aquatic insects and fish. The areas considered to be poor were noted mostly on the tributaries north of the Dulles Toll Road.

There is 55,800 feet, or 40 percent of the total stream miles, of riparian buffer encroachment (this length includes left and right banks combined). Out of this total, 34,975 feet (63 percent) of impact is from lawn, 19,275 feet (35 percent) is lawn/pavement mix, 1,050 feet (< 2 percent) is forbs, and 500 feet (<1 percent) is trees.

- 7,725 feet of the buffer encroachment is having a significant impact on the stream condition and habitat quality. Photos of an example are shown below in Photos 3.80 and 3.81 that are located at candidate site S123.
- Most (66 percent) of the total buffer encroachment has good restoration potential.

Photo 3.80 Buffer encroachment with high impact near Maple Avenue. (DFWC019.B002).

Photo 3.81 Buffer impact near Maple Avenue (DFWC019.B001).

- Forty-seven percent of the assessed stream length has between 50 percent and 70 percent of both stream banks covered by vegetation. Typically this vegetation is scattered grasses, shrubs and forbs.

3.25.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Wolftrap Creek incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

In the Wolftrap Creek subwatershed, 23 percent of the land is covered by impervious surface. This is higher than the majority of the other subwatersheds because several catchments are found within the limits of the Town of Vienna.

Wolftrap Creek

The catchment with the poorest modeled water quality is DFWC0001. Along with large commercial areas, this catchment contains several high and medium-density residential areas. Refer to DFWC_4 for the catchment locations. Results are found in Table 3.43.

Table 3.45 Existing and Future Modeling

Wolftrap Creek Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFWC0001	E	9.18	0.25	201.3	7.8	1.0
	F	9.66	0.27	225.7	8.8	1.1
	C	5%	8%	12%	13%	10%
DFWC0002	E	6.39	0.15	106.5	4.8	0.8
	F	7.32	0.19	144.7	6.6	1.1
	C	15%	27%	36%	38%	38%
DFWC0003	E	6.7	0.26	143.6	6.2	0.8
	F	6.97	0.28	151.4	7.3	0.9
	C	4%	8%	5%	18%	13%
DFWC0004	E	8.66	0.33	143.2	6.2	0.9
	F	9.34	0.36	161.6	7.6	1.2
	C	8%	9%	13%	23%	33%
DFWC0005	E	4.24	0.16	65.2	3.3	0.6
	F	4.96	0.19	84.3	4.4	0.8
	C	17%	19%	29%	33%	33%
DFWC0008	E	3.37	0.13	55.4	2.8	0.5
	F	3.73	0.14	63.4	3.2	0.6
	C	11%	8%	14%	14%	20%
DFWC0009	E	6.91	0.25	77.1	3.9	0.7
	F	6.94	0.24	77.9	3.9	0.7
	C	0%	-4%	1%	0%	0%
DFWC0010	E	4.18	0.12	68.8	3.2	0.5
	F	4.54	0.13	75.1	3.5	0.5
	C	9%	8%	9%	9%	0%
DFWC0011	E	5.51	0.17	66.7	3.1	0.5
	F	5.82	0.18	74.0	3.5	0.6
	C	6%	6%	11%	13%	20%
DFWC0012	E	2.45	0.16	27.0	1.5	0.3
	F	2.59	0.16	29.5	1.6	0.3
	C	6%	0%	9%	7%	0%
DFWC0015	E	2.19	0.16	19.5	1.1	0.2
	F	2.4	0.17	21.9	1.2	0.2
	C	10%	6%	12%	9%	0%
DFWC8901	E	1.53	0.17	22.3	1.0	0.2
	F	2.54	0.2	37.9	1.8	0.3
	C	66%	18%	70%	80%	50%

Wolftrap Creek Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFWC9001	E	2.21	0.11	22.6	1.2	0.3
	F	3.15	0.14	37.8	2.1	0.5
	C	43%	27%	67%	75%	67%
DFWC9101	E	4.15	0.14	44.4	2.4	0.5
	F	4.25	0.15	47.2	2.5	0.5
	C	2%	7%	6%	4%	0%
DFWC9201	E	4.57	0.17	61.4	3.3	0.6
	F	4.74	0.18	65.0	3.5	0.7
	C	4%	6%	6%	6%	17%
DFWC9301	E	4.76	0.16	115.5	5.4	0.7
	F	4.75	0.16	115.4	5.4	0.7
	C	0%	0%	0%	0%	0%
DFWC9401	E	3.16	0.16	38.3	2.0	0.4
	F	3.86	0.17	51.7	2.8	0.6
	C	22%	6%	35%	40%	50%
DFWC9501	E	2.47	0.14	24.5	1.3	0.3
	F	5.38	0.24	84.3	4.5	0.9
	C	118%	71%	244%	246%	200%
DFWC9801	E	5.63	0.2	72.8	3.7	0.7
	F	6.5	0.24	97.0	5.0	1.0
	C	15%	20%	33%	35%	43%
DFWC9802	E	1.92	0.15	19.6	1.0	0.2
	F	1.93	0.15	20.1	1.0	0.2
	C	1%	0%	3%	0%	0%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

For the future modeling, the catchment predicted to have the largest percent increase in pollutant loadings is catchment DFWC9501. There are areas changing from low density residential to medium density residential in this catchment. Similar changes are taking place in DFWC0001, DFWC0002, DFWC0003, DFWC0004, DFWC0005, and DFWC9801. Loads increase in DFWC9001 and DFWC9401 due to forecast changes from estate residential to low density residential.

3.25.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Wolftrap Creek

Three crossings in the Wolftrap Creek subwatershed overtopped for at least one event. These are shown in Table 3.44. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.46 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
28	Beulah Road	E	x	x	x	x	x	x	x
48-A	Creek Crossing Road	E	x	x	x	x	x	x	x
49	Old Courthouse Road	E	x	x	x	x	x	x	x

E – Existing conditions results, x – indicates overtopping

Culvert #28 (Photo 3.82) overtopped for all events. As Beulah Road is a through road, it can be classified as a primary road. This means that it must pass the 25-year event.

Culvert #48-A (Photo 3.83) overtopped for all events. Creek Crossing Road can also be used as a through road, so it too can be classified as a primary road. Primary roads must pass the 25-year event.

Photo 3.82 Wolftrap Creek Mainstem at Beulah Road.

Photo 3.83 Wolftrap Creek Tributary at Creek Crossing Road.

Photo 3.84 Wolftrap Creek Mainstem at Old Courthouse Road.

Culvert #49 (Photo 3.84) also overtopped for all events. Classified as a primary road, Old Courthouse Road is required to pass the 25-year event.

3.25.9 Candidate Sites for Improvement

s

Based on the review of the assessment data and modeling results, the most serious problem areas in the Wolftrap Creek subwatershed are listed below. Refer to DFWC_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

Streams

S59 The Stream Physical Assessment survey found unstable banks and poor habitat. The reach is located in the Lucky Estates and Wolf Den area near Cricklewood Court.

S60 Found between Sibelis Drive and Shouse Drive, this stream assessment found poor habitat and unstable stream banks.

S123 There is insufficient buffer near the intersection of Maple Avenue and Beulah Road. This area was determined to have low to moderate restoration potential (Photo 3.80 and 3.81).

S124 The Stream Physical Assessment survey found buffer encroachment in the form of lawns at this site. There was also a stream blockage found (Photo 3.79).

S125 This stream reach was assigned poor habitat quality and is missing buffer along the entire reach.

S126 Buffer encroachment in the form of lawns in residential areas was found at this site. There are also multiple pipes discharging directly into the stream.

Hydrology and Water Quality

D17 (Catchment DFWC9001) This site has better than average conditions for the subwatershed for runoff flows and pollutant loads. It was selected because it is a proposed site for a regional pond.

D28 (Catchment DFWC9401) Stream reaches upstream and downstream of the site show signs of widening with erosion causing unstable banks.

D54 (Catchment DFWC9101) This site has better than average conditions for the subwatershed for runoff flows and pollutant loads. It was selected because it is a proposed site for a regional pond.

D65 (Catchment DFWC8901) This site has below average pollutant loadings. Peak flows and runoff volume are average. There are no critical stream problems within the area or immediately downstream. It was selected because it is a proposed site for a regional pond.

C16 (Catchment DFWC9201) The catchment has average pollutants. Approximately half of the streams in the catchment have been assigned a poor habitat rating.

C17 (Catchment DFWC9301) The catchment has above average pollutant loads with very little stormwater management in place. S60 is incised with unstable banks due to erosion.

C20 (Catchment DFWC0009) The catchment has average runoff volume and peak flows. Pollutant loads are below average.

C31 (Catchment DFWC0004) The catchment has the second highest runoff volume in the subwatershed due to the amount of impervious surface. The stream has active widening and a deficient buffer at S123.

C32 (Catchment DFWC0003) This catchment has above average runoff and pollutants. There is active channel widening throughout the catchment.

C33 (Catchment DFWC0001) This catchment has the highest modeled runoff volume and pollutant loadings in the subwatershed. Pond WP-1A drains the whole catchment.

C58 (Catchment DFWC0005) The catchment has average runoff volume and peak flows. There are areas of buffer deficiency and pipes discharging into the stream located at S126.

C67 (Catchment DFWC9801) Pollutants and runoff are average for this catchment. Streams within this catchment are actively widening and have buffer deficiency at S124.

Flooding

F28 The bridge on Beulah Road that passes over Wolftrap Creek overtops for all events. Beulah Road is classified as a primary road, so it must pass the 25-year event (Photo 3.82).

F48 The culvert that flows Wolftrap Creek under Creek Crossing Road overtops for all events. Creek Crossing is a primary road, so it must pass the 25-year event (Photo 3.83).

F49 The culvert under Old Courthouse Road that passes Wolftrap Creek also overtops for all events. Old Courthouse Road is classified as a primary road, so it must pass the 25-year event (Photo 3.84).

Preservation

P27 (Catchment DFWC9501) More than 80 percent of the catchment is changing land use from the existing to future conditions. The majority of the changes are from estate residential areas changing to low-density residential.

3.26 Wolftrap Creek – Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.45 below is a list of all projects proposed in this subwatershed.

Table 3.47 Recommendations for Wolftrap Creek

Project #	Project Type	Candidate Site
DF9017A	Pond Retrofit	D-17
DF9017B	Drainage Retrofit	D-17
DF9028A	Drainage Retrofit	D-28
DF9028B	Culvert Retrofit	D-28
DF9028C	Pond Retrofit	D-28
DF9054A	Drainage Retrofit	D-54
DF9054B	New Pond	D-54
DF9065A	New Pond	D-65
DF9065B	Drainage Retrofit	D-65
DF9116A	Pond Retrofit	C16
DF9116B	Pond Retrofit	C16
DF9117	Pond Retrofit	C17
DF9133A	Pond Retrofit	C33
DF9133B	Pond Retrofit	C33
DF92124	Buffer Restoration	S124
DF92125	Buffer Restoration	S125
DF92126	Streambank Stabilization	S126
DF9520A	Culvert Retrofit	C20
DF9520B	Culvert Retrofit	C20
DF9531B	Culvert Retrofit	C31
DF9532A	Culvert Retrofit	C32
DF9532B	Culvert Retrofit	C32
DF9558	Culvert Retrofit	C58
DF9716	Drainage Retrofit	C16
DF9731	Drainage Retrofit	C31
DF9758	Drainage Retrofit	C58
DF9831	LID Retrofit	C31
DF9831B	LID Retrofit	C31
DF9832	LID Retrofit	C32
DF9833	LID Retrofit	C33

3.26.1 Regional Pond Alternative Projects

D17 (DFWC9001)

<u>Site Investigation and Projects</u>:

DF9017A (Pond Retrofit) This project consists of improving the existing in-stream pond to provide more runoff detention and water quality features, such as forebays and aquatic vegetation. A multi-stage riser will improve the peak flow reduction function of this pond.

DF9017B (Drainage Retrofit) These distributed projects are designed to provide energy dissipation at outfalls where the piped storm drain system discharges into a natural channel. Possible energy dissipaters include riprap and plunge pools.

D28 (DFWC9401)

Site Investigation and Projects:

DF9028A (Drainage Retrofit) These distributed projects are designed to decrease the momentum of the flow due to elevation drops at outfalls where the piped storm drain system or paved ditches discharge into a natural channel.

DF9028B (Culvert Retrofit) This project consists of redesigning a culvert for the purpose of providing channel protection downstream. Water quality features should also be incorporated if possible, including micro-pools and vegetation.

DF9028C (Pond Retrofit) This project includes excavating within the pond footprint to maximize the available storage, and modifying the riser to convert this dry pond to a wet marsh. Significant improvement in peak flow reduction and water quality treatment will be provided.

D54 (DFWC9101)

Site Investigation and Projects:

DF9054A (Drainage Retrofit) These distributed projects are designed to provide re-design and reconstruction of outlet protection to reduce scour and the amount of sediment transported downstream.

DF9054B (New Pond) This project is the implementation of the planned regional facility (D-54). The location has been refined to provide maximum benefit with the least amount of impact to the natural system. This pond would detain the higher frequency storms, thus reducing the peak velocities that cause scour and erosion in streams.

D65 (DFWC8901)

Site Investigation and Projects:

DF9065A (New Pond) This project is the implementation of the planned regional facility. To provide greater access to the pond, it is proposed to site it upstream of the original location. The project would increase detention time in the catchment and reduce peak flows, thus reducing or eliminating the scour and erosion in the receiving stream channel.

DF9065B (Drainage Retrofit) This project would be the addition of outlet protection at locations where paved channels transition to natural channels. This energy reduction would improve the stability in the channels by reducing high velocity flows.

3.26.2 Catchment Improvement Projects

C16 (DFWC9201)

Site Investigation and Projects: This area is single-family residential, and most of the original stream network has been converted into a storm sewer, or pipe network.

DF9716 (Drainage Retrofit) This project involves \ replacing the concrete drainage ditches throughout the catchment with dry swales to reduce volume and velocity, and to provide water quality treatment.

DF9116A (Pond Retrofit) The goal of this retrofit is to revise the pond outlet characteristics to improve channel protection through extended detention. Adding wetland vegetation would improve water quality as well.

DF9116B (Pond Retrofit) The goal of this retrofit is to improve channel protection through extended detention and improve water quality by converting the pond to a stormwater wetland.

C17 (DFWC9301)

Site Investigation and Projects: The catchment is developed with single-family residential land uses. An existing stormwater management pond treats most of the volume of runoff in the area.

DF9117 (Pond Retrofit) The pond retrofit includes realignment of the drainage system so all the storm sewers drain into the pond with forebays at each location for outfall protection. The embankment and riser should be reconstructed. Better wetland vegetation, a safety bench, and a fishing pier would enhance the community's use of the facility.

C20 (DFWC0009)

Site Investigation and Projects: The catchment is developed with single-family residential land uses with few opportunities for retrofits outside the stream channel,

DF9520A (Culvert Retrofit) This project would retrofit the culvert under Bois Avenue, directly upstream of project DF9520B. This area would provide storage for channel protection within this catchment.

DF9520B (Culvert Retrofit) Located directly upstream of the Dulles Toll Road, this project would retrofit the culvert to provide storage to improve channel protection

C31 (DFWC0004)

Site Investigation and Projects: The catchment is highly developed with a mixture of commercial and residential properties. The primary stream is laterally constrained, and in many cases the natural channel has been changed to a concrete channel. There is no apparent stormwater management within this catchment.

DF9531B (Culvert Retrofit) This site is located at the outlet of this catchment, above Creek Crossing Road. The retrofit could take advantage of the dual culverts under the road as well as the relatively flat floodplain area. The design should take into account any improvements necessary to eliminate overtopping of Creek Crossing Road (Site F48).

DF9831 (LID Retrofit) This project would retrofit the existing rear parking lot of the southwestern parcel associated with the Navy Federal Credit Union Complex on Follin Lane. Removal or renovation of this parking lot would allow a natural floodplain buffer, reduce imperviousness and reduce runoff velocities directly into the stream.

DF9831B (LID Retrofit) This project is located alongside another LID retrofit, project DF9830, and would retrofit the area of the Maple Avenue and Wolftrap Shopping Centers, which is highly impervious. Retrofitting the area with LID would help reduce the runoff volume and the pollutant load on the streams.

DF9731 (Drainage Retrofit) This project consists of reconfiguring outfalls or retrofitting energy dissipation structures to reduce scour and erosion where flows from the storm drainage system enter the stream.

C32 (DFWC0003)

Site Investigation and Projects: This catchment consists of both commercial (large facility) and single-family detached residential land uses. The drainage area coming to this catchment is relatively large resulting in a need to provide hydrographic restoration through small detention/uptake facilities in series.

DF9532A (Culvert Retrofit) This site is located at the bottom of this catchment on the upstream side of the crossing at Follin Lane. This retrofit would increase the detention time within this drainage area and protect channels downstream from high flow. This project would also use the wooded floodplain area to settle solids and provide for nutrient uptake.

DF9532B (Culvert Retrofit) This site is located on the upstream side of the crossing at Woodford Road. This retrofit would provide a detention structure that will use the wooded floodplain for storage to reduce energy in the stream, increase the uptake of nutrients by plants, and allow sediment to settle.

DF9832 (LID Retrofit) This project would be located on the parcel occupied by Notre Dame and Our Lady of Good Counsel Catholic Church. The existing development results in an almost total impervious area. The LID retrofit would reduce the runoff volume and improve water quality from these properties.

C33 (DFWC0001)

Site Investigation and Projects: This catchment is a fairly small, highly developed catchment at the headwater of Wolftrap Creek. Land uses include attached residential and commercial areas with some areas of open space, particularly along the stream corridor. There are two large ponds at the outlet to this catchment that have the potential to be retrofitted for additional performance.

DF9133A (Pond Retrofit) This site (or sites) is located at the outlet to Catchment 33. The existing pond would be improved by installing a multi-stage weir in front of the headwall. Although there is no wet storage at this location, extended detention time of runoff from storm events will provide some treatment for water quality.

DF9133B (Pond Retrofit) Significant improvement in peak flow attenuation and pollutant load reduction can be made by replacing the existing weir with a multi-stage control structure and excavating to maximize the available storage volume. Additional wetland planting will improve uptake of nutrients, pollutant removal, and settling of sediments.

DF9833 (LID Retrofit) The upper third of this catchment consists of dense residential/commercial land uses. The goal is look for places where the impervious surface of this highly developed area could be disconnected or replaced with pervious cover. Structural controls such as bioretention or swales would also be implemented.

C58 (DFWC0005)

Site Investigation and Projects: This catchment consists primarily of small lot, single family detached dwellings with a large, flat natural buffer to the stream area that includes a sanitary main trunk in close proximity to the channel. This catchment has a relatively large contributing drainage area and is substantially downstream from the headwaters of this stream. Projects in this catchment should focus on the restoration of pre-developed hydrologic extremes (i.e. provide attenuation of discharges, extension of the time of concentration and provide an environment that is conducive to natural stream functions such as sediment transport, fish passage, etc.)

> *DF9758 (Drainage Retrofit)* This project consists of reconfiguring outfalls or retrofitting energy dissipation structures to reduce scour and erosion where flows from the storm drainage system enter the stream.
>
> *DF9558 (Culvert Retrofit)* This site is located at the outfall from this catchment, on the upstream side of Old Courthouse Road. This retrofit would provide water quality treatment through extended detention on to the floodplain as part of a stormwater treatment train with the other projects of this catchment.

3.26.3 Stream Restoration Projects

S59

<u>Site Investigation and Projects</u>: The site investigation showed a recovering stream with a well-developed baseflow channel and significant floodplain reestablishment. Some homeowner stabilization was observed.. A completed restoration consisting of a stacked stone wall, live stakes, and fiber matting was noted at the downstream end of the reach. No project was identified because of these stabilization measures and the nested floodplain development.

S60

<u>Site Investigation and Projects</u>: The site investigation showed a severely incised stream with moderate to severe bank erosion. The stream is confined between residential properties on both sides. However, the streambed is stable and the aquatic channel is well defined at baseflow conditions. The upstream end of the reach is a concrete flume that is unstable and has formed a large scour pool. Constraints associated with adjacent utilities, access, residential encroachment, forest clearing and wetlands impacts outweigh the benefits of reconnecting the stream with a floodplain and reducing streambank erosion. No stream restoration project was identified; however, the headwater of the stream is a stormwater management pond, which is proposed for retrofit as project DF9117. The retrofit should improve conditions in the upstream reach and reduce high stream velocities causing erosion in this area.

S123

<u>Site Investigation and Projects</u>: The site investigation showed that the buffer deficiency was due to parking lots on both sides of the stream. Removing parking lots of existing businesses to establish a forested buffer is not always feasible, however a project for this purpose (DF9831 - LID Retrofit) has been added to site C31.

S124

<u>Site Investigation and Projects</u>: The site investigation showed a non-forested riparian zone on the right side of the stream on two residential parcels. One project was identified

> *DF92124 (Stream Restoration)* The proposed restoration would involve regrading and creating a nested channel with a bench to restore habitat and floodplain access. The riparian buffer would be planted with native trees and shrubs on the two residential properties.

S125

Site Investigation and Projects: The site investigation showed a small stream with a non-forested riparian buffer located on a golf course. One project was identified.

> *DF92125 (Buffer Restoration)* The non-forested riparian buffer would be planted with native trees and shrubs to the maximum extent possible given the current adjacent land use.

S126

Site Investigation and Projects: The site investigation showed moderate stream bank erosion with slight incision. The streambed was not observable due to storm flow. Much of the riparian zone is not forested. The reach is located in Wolftrap Stream Valley Park and has several stormwater outfalls directly connected to the stream. One project was identified.

> *DF92126 (Stream Restoration)* The proposed project would provide certain demonstration benefits given its location adjacent to a trail in a stream valley park. Streambanks would be reshaped and stabilized and limited floodplain benches would be excavated. Portions of the riparian zone would be planted with native trees and shrubs. Stormwater outfalls would be retrofitted. The project should also include adjustments to the existing asphalt trail and flood-proofing of the sanitary sewer main.

3.26.4 Preservation

Improvement Goals for all Preservation Sites

Preservation goals for all the candidate sites include reducing runoff volume, peak flows, and pollutant loads by preserving open space and forested land in key areas of the catchment such as headwaters.

Site Investigation and Projects

No site investigation was undertaken for preservation projects, and no specific proposals have been made for each area. Actions and policy changes needed to implement preservation for all candidate sites are described in Chapter 4.

3.27 Old Courthouse Spring Branch – Subwatershed Condition

3.27.1 Subwatershed Characteristics

The Old Courthouse Spring Branch **subwatershed** has an area of approximately 981 **acres** (1.53 mi^2). It is located in central Fairfax County on the eastern side of the Difficult Run watershed to the north of Vienna. The intersection of Chain Bridge Road (Virginia 123) and Leesburg Pike (Virginia 7) denotes the approximate southern boundary of the subwatershed. Leesburg Pike (Virginia 7) runs along the eastern edge of the subwatershed boundary while Courthouse Road (Virginia 677) to Irvin Street (local road) provides an approximate western boundary. The northern boundary is near the intersection of Lewinsville Road (Virginia 694) with Leesburg Pike (Virginia 7).

Old Courthouse Spring Branch is located on the eastern edge of the Difficult Run watershed. There are almost 3 miles of stream in the subwatershed flowing in a northerly direction. Old Courthouse Spring Branch joins the Wolftrap Creek subwatershed within the Wolftrap Farm Park.

Refer to DFOR_1 for a map of the Old Courthouse Spring Branch subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.27.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

Old Courthouse Spring Branch subwatershed is the most densely developed subwatershed found within the Difficult Run watershed. Thirty-four percent of the subwatershed is developed for high-density residential, commercial or industrial uses, and only 11 percent is developed as low-density or estate residential. The intense development is located along the Leesburg Pike (Virginia 7) between the Dulles Access Toll Road (Virginia 267 – exit 16) and Chain Bridge Road (Virginia 123). The Tysons Corner development is situated at the intersection of Chain Bridge Road (Virginia 123) with the Leesburg Pike (Virginia 7). Further eastward (outside of the subwatershed boundary) is I-495.

There are 172 acres, or 18 percent of the subwatershed, in transportation use such as roads and highways. Total impervious area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 419 acres, or 43 percent of the total subwatershed area.

Only 13 percent is remaining for open space or parks. Major parks include Raglan Road Park and Old Courthouse Spring Branch Valley Park. There are two historical sites that lie within the subwatershed. A summary of land use within the subwatershed can be found in Table 3.46.

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

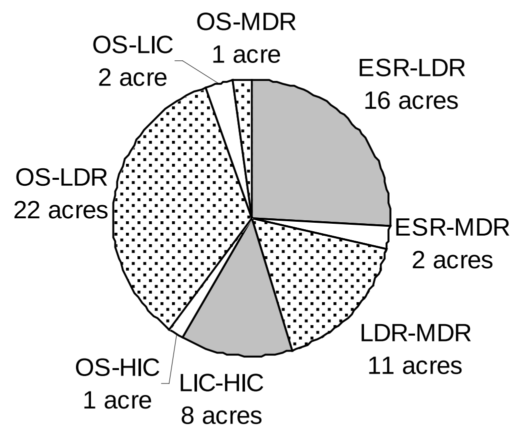
Changes are projected in the open space, estate residential, and low-density residential land use categories. Losses in the open space (-3 percent), estate residential (-2 percent) and low-intensity commercial (-1 percent) will be met with gains in the low-density residential (+3 percent), medium-density residential (+1 percent) and industrial (+1 percent) categories.

Twenty-two acres (34 percent of all land use changes) are projected to shift from open space to low-density residential. In fact, 41 percent of the overall land use changes may shift from open space to a higher intensity use. This does not guarantee that the open space will become developed but it suggests that these areas of open space can be used for development/ redevelopment in the future.

Table 3.48 Existing and Future Land Use

	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	128	13%	102	10%	-27	-3%
Golf Course	8	1%	8	1%	0	0%
Estate residential	18	2%	0	0%	-18	-2%
Low-density residential	89	9%	117	12%	28	3%
Medium-density residential	180	18%	194	20%	14	1%
High-density residential	50	5%	50	5%	0	0%
Low-intensity commercial	8	1%	2	0%	-7	-1%
High-intensity commercial	270	28%	279	28%	9	1%
Industrial	2	0%	2	0%	0	0%
Institutional	57	6%	57	6%	0	0%
Transportation	172	18%	172	18%	0	0%
Water	0	0%	0	0%	0	0%
Total	**981**	**100%**	**981**	**100%**		**0%**

Figure 3.13 Changed Land Use



Eighteen acres are projected to shift from estate residential to either low-density or medium-density residential use. An additional 11 acres are projected to go from low-density residential to medium-density residential. Many of the larger shifts illustrate the demand for accommodating new residential uses in the County. Lastly, 8 acres are projected to shift from low-intensity commercial to high-intensity commercial land uses. While intensity will remain high, the types of permitted uses may change in those areas.

3.27.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are 41 **stormwater management facilities** within the Old Courthouse

Spring Branch subwatershed. Even with the existing stormwater facilities in place, 68 percent of the Old Courthouse Spring Branch subwatershed is not served by any stormwater management facility. Twenty-seven percent of the total area has quantity control only and the remaining 5 percent receives both **quantity and quality control**.

Over 50 percent of the subwatershed is developed in high intensity and transportation uses while stormwater management treats only 32 percent. There is a gap between the development in the subwatershed and the treated portions, which means that excess water and water-containing pollutants is entering the stream system. This gap indicates a possible need for additional management efforts, specifically in the commercial and high-density residential areas. Additional information on the location of the stormwater management facilities in the Old Courthouse Spring Branch subwatershed can be found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located 15 **outfall** pipes discharging into Old Courthouse Spring Branch subwatershed. None of these pipes were considered to be having a major impact on stream character, and only two pipes were showing signs of runoff causing minor erosion in the stream.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of over-capacity or aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. None of the 10 crossings identified during the Stream Physical Assessment warranted repair. Four of the crossings in the subwatershed are concrete bridges, and the remaining six are wooden footbridges. All crossings have either minor or no impact on the stream's condition.

3.27.4 Soils

Soils found in the Old Courthouse Spring Branch subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly **micaceous** soils with rapid **runoff**. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 53 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (40 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. There are 64.4 acres of land with unclassified soils in the Old Courthouse Spring Branch subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.27.5 Geomorphology

There are 2.8 miles (14,882 feet) of stream in the Old Courthouse Spring Branch subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes.

Eighty-three percent of the total reach length is Type III, which is indicative of a generally unstable channel that is actively widening in response to changes in flow. The remaining 17 percent of the channel is Type IV, which is a channel in the first stages of stabilization characterized by sediment accumulation. Ninety percent of the stream length is moderately unstable with high erosion potential during **flood** events. Gravel is the dominant **substrate** type throughout the subwatershed.

One specific erosion point was noted in the subwatershed that was having a moderate impact on stream condition and had only a low restoration potential due to access constraints.

There was only one stream blockage, comprised of trees and debris, at the time of the assessment. The obstruction was causing some streambed erosion and was likely restricting fish passage. The area is shown in Photo 3.85 and is candidate site S109.

Photo 3.85 Stream blockage with a severe impact on the stream (DFOR701.T001).

3.27.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall of 2002.

- Good habitat for aquatic insects and fish was found in 88 percent of the streams; the remaining 12 percent had slightly less desirable habitat.
- There is 7,700 feet of **riparian buffer** encroachment (this length includes left and right banks combined). Of this total, 6,650 feet (86 percent) is impact from lawns. None of the buffer impacts were noted by the field crews to have good restoration potential.
- Ninety-four percent of the assessed stream length had between 50 percent and 70 percent of both stream banks covered by vegetation. Typically this vegetation is scattered grasses, shrubs and forbs.

3.27.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Old Courthouse Spring Branch incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

Old Courthouse Spring Branch subwatershed is covered by 43 percent impervious surface, the most of any subwatershed in the Difficult Run watershed. There is a large amount of commercial area along Leesburg Pike between the Dulles Toll Road and Chain Bridge Road. Most of this commercial area is in the two southern-most catchments, DFOR0099 and DFOR0001. Refer to DFOR_4 for the catchment locations.

DFOR0099 has the most commercial and high-density residential area, which is why it is the worst modeled catchment in terms of pollutants and runoff volume. Areas such as the Pike 7 Plaza and Tysons Square Center add a large amount of impervious cover with little area for infiltration. Catchment DFOR0001 has some commercial area as well as medium-density residential areas. Results are found in Table 3.47.

Table 3.49 Existing and Future Modeling

Old Courthouse Spring Branch Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFOR0001	E	8.38	0.2	164.7	6.8	0.9
	F	8.62	0.21	170.2	7.1	1.0
	C	3%	5%	3%	4%	11%
DFOR0002	E	7.51	0.15	139.6	5.6	0.7
	F	7.75	0.16	145.9	6.1	0.8
	C	3%	7%	5%	9%	14%
DFOR0004	E	4.08	0.14	79.1	4.2	0.5
	F	4.21	0.15	83.5	4.5	0.6
	C	3%	7%	6%	7%	20%
DFOR0099	E	16.89	0.38	376.1	13.5	1.3
	F	16.95	0.39	380.6	13.7	1.3
	C	0%	3%	1%	1%	0%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

All the catchments show some increase in loadings, as most of the low-density residential areas left in the subwatershed are projected to change to medium-density residential areas in the future.

3.27.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where flooding of culverts may occur. These culverts are likely over-capacity and do not allow all of the flow required to pass without flooding. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

One culvert in the subwatershed overtopped for at least one event. This is shown in Table 3.48. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.50 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
47	Northern Neck Drive	E	x	x	x	x	x		

E – Existing conditions results, x – indicates overtopping

Culvert #47 (Photo 86) overtopped for all events except for the one and two-year. This road can be classified as a local road since there is no through traffic. Local roads must be able to pass the 10-year event.

Photo 3.86 Crossing at Northern Neck Drive (DFOR701.T001).

3.27.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Old Courthouse Spring Branch subwatershed are listed below. Refer to DFOR_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding, and P – preservation sites).

<u>Streams</u>

S109 The Stream Physical Assessment survey identified a blockage in the stream that possibly inhibits fish passage (Photo 3.85).

<u>Hydrology and Water Quality</u>

D107 (Catchment DFOR0002) This site has higher than average peak flows and runoff volume. Nitrogen and phosphorus loadings from runoff are average. The stream through this catchment is actively widening.

C19 (Catchment DFOR0099) The runoff and pollutant loadings are highest in this catchment of the subwatershed, possibly due to the high amount of impervious surface in the area.

C34 (Catchment DFOR0001) This site has conditions similar to the average for the subwatershed for runoff flows and pollutant loads. The stream in this catchment is actively widening.

C57 (Catchment DFOR0004) This site has lower than average nitrogen and phosphorus loadings from runoff while the stream is actively widening in some parts of the catchment.

Flooding

F47 The crossing at Northern Neck Drive overtopped for 5-year and greater events. Northern Neck Drive is classified as a local road, so it must pass the 10-year storm (Photo 3.86).

Preservation

No candidate sites were identified.

3.28 Old Courthouse Spring Branch - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.49 below is a list of all projects proposed in this subwatershed.

Table 3.51 Recommendations for Old Courthouse Spring Branch

Project #	Project Type	Candidate Site
DF9119	New Pond	C19
DF9157	New Pond	C57
DF9157A	Pond Retrofit	C57
DF9557	Culvert Retrofit	C57
DF9757	Drainage Retrofit	C57
DF9819	LID Retrofit	C19

3.28.1 Regional Pond Alternative Projects

There are no unbuilt regional ponds in this subwatershed.

3.28.2 Catchment Improvement Projects

C19 (DFOR0099)

<u>Site Investigation and Projects</u>: The catchment is fully developed and almost 100 percent impervious, with very little existing stormwater management. There are no streams in the catchment.

> *DF9819 (LID Retrofit)* Retrofit the impervious area with LID facilities. Use porous pavement on relatively unused parking areas for general reduction of effective imperviousness. Install inlet filters or Filterra-type units at storm drain inlets. Reconstruct parking medians for bioretention.
>
> *DF9119 (New Pond)* Design and construct a new wet pond/wetland at the catchment outfall. If the LID upstream is designed for water quality, the pond storage could be for channel protection and would be smaller than a water quality facility and easier to fit into the site.

C34 (DFOR0001)

<u>Site Investigation and Projects</u>: Most of the commercial areas draining to the stream are already treated with stormwater management. The residential area is drained by storm sewers. Outfalls discharge into a flat floodplain and do not appear to cause problems. Most stream erosion appears to be caused by the upstream impervious catchment, so little more can be done as treatment in this catchment. No projects have been identified. Stream erosion appears to be a function of the untreated runoff from the impervious catchment.

C57 (DFOR0004)

<u>Site Investigation and Projects</u>:

DF9157 (New Pond) Design and construct a combined detention/water quality facility at the outfall of the residential area. The project would effectively treat the runoff from a residential area built before stormwater management regulations.

DF9157A (Pond Retrofit) This project is a retrofit of regional pond D-107, designed to change outflow characteristics to provide channel protection as a dry extended detention pond for the large, mostly untreated, drainage area upstream.

DF9557 (Culvert Retrofit) This project should be designed for both water quality and channel protection, if possible. The retrofit would be designed as an extended detention dry facility, with water quality features such as wetland plantings and a micropool to enhance pollutant removal.

DF9757 (Drainage Retrofit) Several outfalls in this area show evidence of scour and erosion. This project is designed to provide adequate energy dissipation, such as riprap, plunge pools, or structures, at outfalls where the piped storm drain systems discharge into a natural channel.

3.28.3 Stream Restoration Projects

S109

<u>Site Investigation and Projects</u>: The site investigation did not identify a significant stream blockage. It may have been removed in the intervening period. No project was identified.

3.28.4 Preservation

No preservation candidate sites were identified for this subwatershed.

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3.29 Piney Branch – Subwatershed Condition

3.29.1 Subwatershed Characteristics

The Piney Branch **subwatershed** is one of the larger subwatersheds, and has an area of approximately 2,475 **acres** (3.87 mi^2). Chainbridge Road (Virginia 123) runs near the southern boundary. Beulah Road (Virginia 675) runs approximately along the northeast boundary line. Meadowlark Road (Virginia 677) provides the approximate northern boundary of the subwatershed.

There are approximately 8 miles of stream in the Piney Branch subwatershed. The streams flow generally in a northwesterly direction until Piney Branch joins the mainstem of Difficult Run in the Difficult Run Stream Valley Park.

Refer to DFPB_1 for a map of the Piney Branch subwatershed highlighting the Subwatershed Characteristics including, existing land use, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.29.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The Piney Branch subwatershed is one of the most densely developed subwatersheds found within the Difficult Run **watershed**. Twenty-six percent is developed as low-density or estate residential, while 6 percent of the subwatershed is developed for commercial or industrial uses. The most common **land use** in this subwatershed is medium-density residential at 35 percent. Much of the development is found concentrated along Chainbridge Road (Virginia 123) in the southern portion of the subwatershed, generally in the Town of Vienna, and along the Washington and Old Dominion Railroad Trail. A summary of land use within the subwatershed can be found in Table 3.50.

Transportation use, such as roads and highways, make up 330 acres, or 13 percent of the overall subwatershed. Total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 565 acres, or 23 percent of the total subwatershed area.

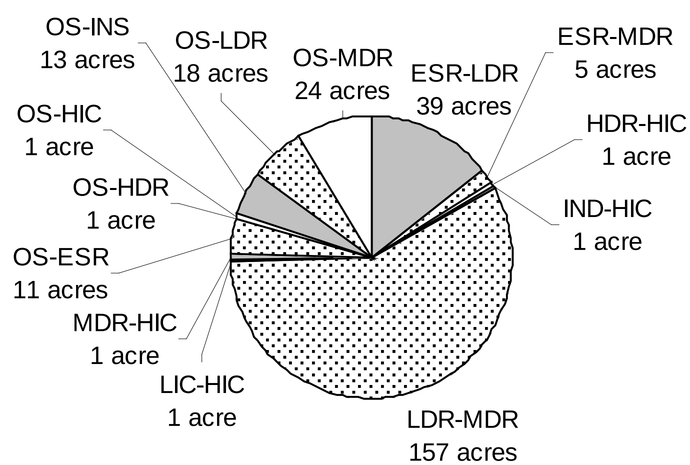
Seventeen percent of the land in the subwatershed is preserved for open space or parks. Major parks include North Side Park, Eudora Park, the majority of Clarks Crossing Park, a portion of Tamarack Park, Symphony Hills Park, Glyndon Park, Peterson Lane Park, and the fields and grounds of various schools. There are eight historical sites within the subwatershed.

Table 3.52 Existing and Future Land Use

	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	417					
Golf Course	0	0%	0	0%	0	0%
Estate residential	64	3%	31	1%	-33	-1%
Low-density residential	570	23%	470	19%	-100	-4%
Medium-density residential	857	35%	1042	42%	185	7%
High-density residential	22	1%	22	1%	0	0%
Low-intensity commercial	27	1%	26	1%	-1	0%
High-intensity commercial	72	3%	77	3%	5	0%
Industrial	47	2%	46	2%	-1	0%
Institutional	68	3%	81	3%	13	1%
Transportation	330	13%	330	13%	0	0%
Water	0	0%	0	0%	0	0%
Total	**2,475**	**100%**	**2,475**	**100%**		**0%**

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

Figure 3.14 – Changed Land Use



When comparing existing land use to future land use, there are several land use changes. The notable changes are projected in the open space, low-density residential, and medium-density residential land use categories. Losses projected in the open space (-3 percent), estate residential (-1 percent), and low-intensity residential (-4 percent) should be compensated with gains in the medium-density residential (+7 percent) and institutional (+1 percent) categories.

According to Figure 3.14, 157 acres are projected to shift from low-density residential in the existing land use to medium-density residential in the future land use. Thirty-nine acres are projected to shift from estate residential in the existing land use to low-density residential in the future land use. These large transfers indicate a potential for an increase in additional housing in the Piney Branch subwatershed. Twenty-four acres are projected to shift from open space to a medium-density residential use. In fact, 68 acres, or 25 percent of all land use changes, are projected to shift from open space in the existing land use to some form of residential or commercial use in the future. This does not guarantee that the open space will become developed. This open space area can be used for development/ **redevelopment** in the future.

3.29.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are nine **stormwater management facilities** within the Piney Branch subwatershed. Eighty-five percent of the Piney Branch subwatershed is not served by any stormwater management facility. Twelve percent of the total area has quantity control only and the remaining 3 percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (62 percent) and the area served by stormwater management (15 percent) indicates a potential for impairment due to uncontrolled stormwater and a possible need for additional management efforts, specifically in the industrial, commercial and and low-density residential areas. A list of all stormwater management facilities in the Piney Branch subwatershed can be found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located 24 **outfall** pipes discharging into the Piney Branch mainstem and tributaries. None of these pipes were considered to be having an impact on stream character, nor were they creating any type of **erosion**.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. Results from the Stream Physical Assessment identified 21 crossings in the Piney Branch subwatershed. The majority (62 percent) were concrete bridges, while an additional 20 percent were footbridges made of wood or metal. None of the crossings were creating significant erosion or degrading the instream habitat and none warrant repair.

3.29.4 Soils

Soils found in the Piney Branch subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes which can result in rapid **runoff** and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 33 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (15 percent). Zones with Glenelg, Manor and Elioak soils may be compatible with infiltration practices. There are 1278.2 acres of land with unclassified soils in the Piney Branch subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.29.5 Geomorphology

Streams in the Piney Branch subwatershed were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. A total of 42,430 linear feet (approximately 8 miles) of stream are in the Piney Branch subwatershed. Of this length, ten reaches (4,539 feet) were not assessed because they were piped **channels**, had no water, were too small, or too channelized.

The majority (93 percent) of the channel has a gravel **substrate**. The remaining portions are primarily silt and sand. All of the reaches are Type III, which is indicative of an actively widening stream channel. There was one erosion point of moderate to severe erosion of approximately 300 feet. It is candidate site S110 and is shown in Photo 3.87. Refer to DFPB_3 for the stream classifications.

Photo 3.87 Streambank erosion just upstream from confluence with Difficult Run, west of Fosbak Drive (DFPB002.E001)

Photo 3.88 Obstruction point, mostly trees and debris, at the end of Corsica Street. (DFPB015.T001).

Photo 3.89 Sanitary line crossing the stream above the baseflow (DFPB010.U001).

All of the eight stream blockages were made up of trees and debris. Some had additional concrete and sediment. One-half of the obstructions had only minor impacts on the stream, causing some erosion. Thirty-eight percent of the obstructions were causing a greater impact on the stream condition. The example shown in Photo 3.88 is candidate site S134.

There was one sanitary line of approximately 10" that was crossing the stream above the base flow. The sanitary line is shown above in Photo 3.89 and is candidate site S111. Much of the stream length (74 percent) has high erosion potential during **flood** events.

3.29.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall of 2002.

- In the assessed reaches, 67 percent is considered to have fair habitat for aquatic insects and fish, and 33 percent has good habitat. The mainstem between Verdict Drive and the confluence with Difficult Run makes up the majority of good habitat.
- There is 35,400 feet, approximately 42 percent of the total stream length, of **riparian buffer** encroachment (this length includes left and right banks combined). Of this, 25,550 feet (72 percent) is lawn, and 2,300 (6.5 percent) is pavement. The remaining buffer encroachment area is some combination of lawn, meadow, trees and pavement. Eighty-two percent of the buffer encroachment length has no or low restoration potential due to existing infrastructure, however; 18 percent of the length has moderate to high restoration potential. Most of the percent of the buffer encroachment had only minimal impact, suggesting that the stream character may be changed slightly by adjacent use. Two of the areas with pavement buffer encroachment appear to present a greater impact and are shown in Photo 3.90 and 3.91.

Photo 3.90 Buffer impact in North Side Park (DFPB024.B002).

Photo 3.91 Buffer impact in the Somerset community at the end of Mill Street (DFPB024.B003).

- Sixty-five percent of the assessed stream length had between 50 percent and 70 percent of both stream banks covered by vegetation. Typically this vegetation is scattered grasses, shrubs and forbs. Twenty-five percent of the assessed stream length had a variety of vegetation and covered 70 percent to 90 percent of the stream bank surface.

3.29.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Piney Branch incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

The Piney Branch subwatershed is covered by almost 23 percent impervious surface. This impervious surface is highly concentrated in the headwaters of the subwatershed. Over one-third of Piney Branch is medium or high-density residential land use, followed by 10 percent commercial and industrial. The southern part of Piney Branch subwatershed encompasses part of the Town of Vienna.

Catchment DFPB0001, located in the vicinity of Maple Avenue and the W&OD Trail, has several commercial, industrial, and high-density residential areas. Refer to DFPB_4 for the catchment locations. Because runoff from commercial, industrial, and high-density residential areas has a higher chance of carrying **pollutants** than lower density residential or open space, **catchment** DFPB0001 has the second worst modeled water quality in the subwatershed. The other southern-most catchment is DFPB9801, found between Malcolm Road and Maple Avenue, has the highest nitrogen loading in the subwatershed. DFPB9801 has a high percentage of commercial area, so it also has the highest runoff volume per year and peak in the subwatershed because there is more impervious area associated with commercial areas than residential areas. Results can be seen in Table 3.51.

Table 3.53 Existing and Future Modeling

Piney Branch Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFPB0001	E	6.89	0.18	138.5	6.3	0.9
	F	7.26	0.19	154.9	7.1	1.1
	C	5%	6%	12%	13%	22%
DFPB0002	E	5.56	0.25	81.5	4.4	0.8
	F	5.74	0.26	89.9	4.8	0.9
	C	3%	4%	10%	9%	13%
DFPB0004	E	2.4	0.13	24.9	1.4	0.3
	F	2.49	0.13	30.3	1.6	0.3
	C	4%	0%	22%	14%	0%
DFPB0005	E	1.85	0.15	17.1	0.9	0.2
	F	1.92	0.15	22.9	1.2	0.2
	C	4%	0%	34%	33%	0%
DFPB9501	E	2.97	0.13	25.6	1.4	0.3
	F	3.7	0.12	37.6	2.0	0.4
	C	25%	-8%	47%	43%	33%
DFPB9601	E	3.26	0.14	28.6	1.5	0.3
	F	3.41	0.14	36.1	1.9	0.3
	C	5%	0%	26%	27%	0%
DFPB9701	E	4.32	0.15	64.7	3.5	0.7
	F	5.04	0.17	87.3	4.7	1.0
	C	17%	13%	35%	34%	43%

Piney Branch Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFPB9801	E	6.14	0.27	128.1	5.5	0.8
	F	6.75	0.3	149.3	6.4	1.0
	C	10%	11%	17%	16%	25%
DFPB9802	E	4.59	0.2	67.0	3.4	0.6
	F	4.94	0.21	75.5	3.9	0.7
	C	8%	5%	13%	15%	17%
DFPB9803	E	3.18	0.16	35.6	2.0	0.4
	F	3.71	0.16	54.1	2.8	0.5
	C	17%	0%	52%	40%	25%
DFPB9901	E	4.19	0.15	63.5	3.5	0.7
	F	4.4	0.15	69.0	3.8	0.8
	C	5%	0%	9%	9%	14%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

Future model results show moderate increases in flows and runoff pollutant loads from all catchments in the subwatershed. In the more developed areas, this is due to changes from low density to medium density residential. In the less developed areas, forecast changes from open space or estate residential to low density residential is the cause.

3.29.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. These culverts are over-capacity and do not allow all of the flow required to pass without flooding. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

One culvert in the subwatershed overtopped with existing flows, as shown in Table 3.52. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.54 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
25-A	Lawyers Road	E	x	x	x				

E – Existing conditions results, x – indicates overtopping

Culvert #25-A (Photo 3.92) overtopped for the 25, 50, and 100-year events. Lawyers Road has a classification of “primary,” which requires the culvert to pass the 25-year event.

Photo 3.92 Piney Branch tributary at Lawyers Road.

3.29.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Piney Branch subwatershed are listed below. Refer to DFPB_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

Streams

S110 The Stream Physical Assessment survey indicated that there was severe streambank erosion just upstream from confluence with Difficult Run, west of Fosbak Drive (Photo 3.87).

S111 During the Stream Physical Assessment, field crews noted an exposed sanitary line that should be examined and corrected (Photo 3.89).

S112 During the Stream Physical Assessment survey, riparian buffer was noted as being encroached upon by lawns and pavement. The Stream Physical Assessment survey indicated that streambank erosion was severe or extreme, channel was widening, and habitat was poor to very poor.

S134 The site is located downstream of and within catchments with high runoff volume and near obstructions identified during the Stream Physical Assessment (Photo 3.88).

Hydrology and Water Quality

C29 (Catchment DFPB9701) This catchment has average peak flow velocities, but they are significant enough to cause scour and erosion along stream banks and at outfalls. Also, the existing pond at the top of the stream shows signs of excessive flows and the spillway appears to be in use often.

C30 (Catchment DFPB0001) This catchment has one of the highest modeled pollutant load for both nitrogen and phosphorus. It also has one of the highest runoff volumes and peak flows.

C66 (Catchment DFPB0002) This catchment has one of the highest modeled runoff volumes and peak flows. It also has higher than average pollutant loads.

D27 (Catchment DFPB9501) This catchment has below average pollutant loading, peak flows, and runoff volume. This is the site of unbuilt regional pond D-27.

D29 (Catchment DFPB9802) This catchment has average peak flow. This is a moderately developed area and the higher peak flows could contribute to the loss of buffer at S134 within the catchment. This is the site of unbuilt regional pond D-29.

D73 (Catchment DFPB9801) This catchment has one of the highest runoff volumes, peak flows, and pollutants loads in the subwatershed. The high peak flows could potentially contribute to the loss of buffer at S134 and outlet erosion at D-29. This is the site of unbuilt regional pond D-73.

D74 (Catchment DFPB9901) This catchment has moderate runoff volume and peak flow. Most of the stormwater network is piped with outfalls in close proximity to one another. The flow could potentially contribute to the exposure of the utility at S111. This is the site of unbuilt regional pond D-74.

Flooding

F25A The crossing of Lawyer's Road was overtopped for 25-year and greater events. Since it is classified as a primary road, the culvert should pass the 25-year event (Photo 3.92).

Preservation

No preservation candidate sites were identified for this subwatershed.

3.30 Piney Branch - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.53 below is a list of all projects proposed in this subwatershed.

Table 3.55 Recommendations for Piney Branch

Project #	Project Type	Candidate Site
DF9027A	Culvert Retrofit	D-27
DF9027B	Drainage Retrofit	D-27
DF9029A	Drainage Retrofit	D-29
DF9029B	New Pond	D-29
DF9073A	LID Retrofit	D-73
DF9073B	Drainage Retrofit	D-73
DF9073C	Pond Retrofit	D-73
DF9074A	Drainage Retrofit	D-74
DF9129	Pond Retrofit	C29
DF92110	Stream Restoration	S110
DF9729	Drainage Retrofit	C29
DF9730	Drainage Retrofit	C30
DF9830	LID Retrofit	C30

3.30.1 Regional Pond Alternative Projects

D27 (DFPB9501)

Site Investigation and Projects:

DF9027A (Culvert Retrofit) This project would use two existing roadway embankments to create detention ponding areas. The primary goal of these retrofits will be to provide storage for channel protection.

DF9027B (Drainage Retrofit) These distributed projects are designed to provide energy dissipation at outfalls where the piped storm drain systems or paved channels discharge to a natural channel. Additionally, paved roadside ditches will be replaced with dry swale systems with an underdrain to provide water quality treatment.

D29 (DFPB9802)

Site Investigation and Projects:

DF9029A (Drainage Retrofit) These projects found throughout the catchment are designed to provide adequate energy dissipation where the drainage network discharges into the floodplain. Options include drop structures, plunge pools, bioengineering, or larger stone.

DF9029B (New Pond) This project is a modified regional pond at the original D-29 site, designed to store runoff for channel protection and reduce erosive streamflows downstream.

D73 (DFPB9801)

Site Investigation and Projects:

DF9073A (LID Retrofit) This project would consist of retrofitting both Madison High School and Flint Hill Elementary School with low impact development structures to reduce runoff volume and pollutant loads as close to the source as possible. Possible improvements include reduction of impervious surface, bioretention, swales, green roofs, and inlet filters.

DF9073B (Drainage Retrofit) The project is intended to replace a concrete channel and an armored, straightened stream with more natural drainage. The upstream flume would be removed and replaced with a dry swale. The lower reach would be reconstructed as a natural stream channel with step pools to reduce flow velocity

DF9073C (Pond Retrofit) This projects consists of redirecting the stream into an already existing farm pond, forming an in-stream pond. The proposed retrofit would consist of reconstructing the diversion structure and providing a riser for outlet control to allow the pond to function as water quality treatment for the first flush.

D74 (DFPB9901)

Site Investigation and Projects:

DF9074A (Drainage Retrofit) This project would consist of adding outlet protection as well as stream stabilization to several reaches throughout the catchment to reduce the scour and erosion within the channels.

3.30.2 Catchment Improvement Projects

C29 (DFPB9701)

Site Investigation and Projects:

DF9129 (Pond Retrofit) This project would consist of reconstructing an existing pond by installing a new, multi-stage riser and excavating to maximize storage within the facility boundaries. Grading a flat area at the base of the riser will create a wet marsh that will promote vegetative uptake of nutrients and settling of sediment.

DF9729 (Drainage Retrofit) This project would consist of energy dissipation at outfalls to reduce scour and erosion in the stream.

C30 (DFPB0001)

Site Investigation and Projects:

DF9730 (Drainage Retrofit) This project would consist of energy dissipation at outfalls to reduce scour and erosion in the stream.

DF9830 (LID Retrofit) This project consists of onsite LID retrofits along Maple Avenue and the W&OD Trail designed to reduce runoff volume and pollutant loads as close to the source as possible. Possible improvement measures include reduction of impervious surface, bioretention, swales, and inlet filters.

C66 (DFPB0002)

Site Investigation and Projects: Field investigation of this catchment revealed no areas where improvements can be implemented, so no projects are identified for this catchment.

3.30.3 Stream Restoration Projects

S110

Site Investigation and Projects: The site investigation showed a straightened portion of Piney Branch adjacent to railroad bed converted to a pedestrian trail. The bank was artificially stabilized adjacent to the railroad bed. The reach is slightly incised. One project was identified.

> *DF92110 (Stream Restoration)* The proposed restoration would stabilize one reach with imbricated rip-rap to protect the trail, and reconstruct another to provide a pattern, dimension, and profile more consistent with a natural system.

S111

Site Investigation and Projects: The site investigation showed an exposed sanitary line. The stream reach was relatively stable and the pipe did not appear to pose a significant risk. Additional rock placement around the pipe as ongoing maintenance would provide further protection, but no specific project was identified for the watershed management plan.

S112

Impairment: [sample verbiage] At the time of the Stream Physical Assessment, deficient buffers were noted; however, field investigations conducted during the watershed plan development process indicate that these areas don't appear to warrant a restoration project at this time.

S134

Site Investigation and Projects: The site investigation showed a small area of the buffer that was mowed. However, it is located within a gas easement and would most likely need to be maintained in its current state. No project was identified.

3.30.4 Preservation

No preservation candidate sites were identified for this subwatershed.

3.31 Little Difficult Run – Subwatershed Condition

3.31.1 Subwatershed Characteristics

The Little Difficult Run **subwatershed** has an area of approximately 2,590 **acres** (4.05 mi^2). The western most boundary runs along the Reston Parkway (Virginia 602). The northern most boundary runs along Lawyers Road (Virginia 673). The southern most boundary lies south of Stuart Mill Road (Virginia 669). The eastern most boundary is where Stuart Mill Road (Virginia 669) makes a hairpin turn southward.

There are just over 10 miles of stream in the Little Difficult Run subwatershed. The streams flow in a northeasterly direction. South Fork Run joins Little Difficult Run near Mattox Creek Road. Further downstream Little Difficult Run joins the mainstem of Difficult Run in Polo Place.

Refer to DFLD_1 for a map of the Little Difficult Run subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.31.2 Existing and Future Land Use

The Little Difficult Run subwatershed consists of mainly low density development. The density is equally dispersed throughout the subwatershed. Most of the land uses are residential. Fifty-five percent of the land is developed as low-density or estate residential while only one percent of the subwatershed is developed for commercial or industrial uses. There is no major concentration of development in this subwatershed. It is equally dispersed around the Fox Mill District Park and portions of the Difficult Run Stream Valley Park.

Transportation use, such as roads and highways, make up for 196 acres, or 8 percent of the overall subwatershed. Total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 272 acres, or 11 percent of the total subwatershed area.

Thirty percent of the land in the subwatershed is preserved for open space or parks. Major parks include Fox Mill District Park and the Little Difficult Run Stream Valley Park. One historical site lies within the subwatershed.

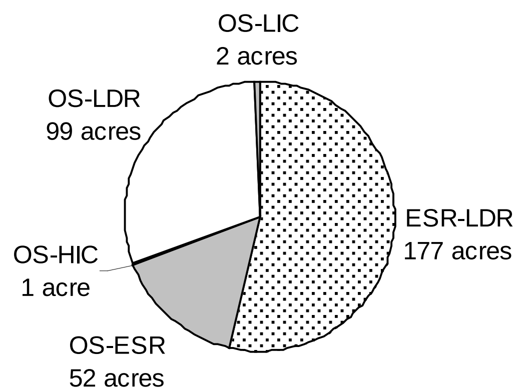
When comparing existing land use to future land use, there are few land use changes. The notable changes are projected in the open space, estate residential, and low-density residential land use categories. Losses projected in the open space (-6 percent) and estate residential (-5 percent) categories will be met with gains in the low-density residential (+11 percent) category. This shift shows the demand for higher-density housing in the Little Difficult Run subwatershed. A summary of land use within the subwatershed can be found in Table 3.54.

Table 3.56 Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	777	30%	624	24%	-153	-6%
Golf Course	0	0%	0	0%	0	0%
Estate residential	564	22%	438	17%	-126	-5%
Low-density residential	857	33%	1133	44%	276	11%
Medium-density residential	161	6%	162	6%	0	0%
High-density residential	0	0%	0	0%	0	0%
Low-intensity commercial	10	0%	12	0%	2	0%
High-intensity commercial	4	0%	4	0%	1	0%
Industrial	2	0%	2	0%	0	0%
Institutional	16	1%	16	1%	0	0%
Transportation	196	8%	196	8%	0	0%
Water	3	0%	3	0%	0	0%
Total	**2,590**	**100%**	**2,590**	**100%**		**0%**

One-hundred and seventy-seven acres are projected to shift from estate residential in the existing land use to low-density residential in the future land use. Ninety-nine acres are projected to shift from open space in the existing land use to low-density residential in the future land use. This does not guarantee that the open space will become developed; it suggests that these areas of open space can be used for development/redevelopment to a higher-density use in the future.

Figure 3.15 Changed Land Use



3.31.3 Existing Stormwater Management

County records indicate that there are eight stormwater management facilities within the Little Difficult Run subwatershed. Eighty-six percent of the Little Difficult Run subwatershed is not served by any stormwater management facility. Eleven percent of the total area has quantity control only and the remaining three percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (70 percent) and the area served by stormwater management (14 percent) indicates a potential for impairment due to uncontrolled stormwater and a possible need for additional management efforts, specifically in the industrial, commercial and medium-density residential areas. A list of all stormwater management facilities in the Little Difficult Run subwatershed can be found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located 11 **outfall** pipes discharging into the Little Difficult Run subwatershed. Most of the pipes were causing minor or no erosion to the streambed or banks; however, one pipe discharging from a neighborhood road was creating major erosion.

Photo 3.93 Pipe near the end of Checkerberry Court near Blue Smoke Trail (DFLD014.P001)

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. The Stream Physical Assessment results indicate 42 crossings in the Little Difficult Run subwatershed at the time of assessment. The majority (55 percent) of the crossings were circular pipe culverts. Most of the crossings (74 percent) had no significant impact on stream condition, while 24 percent were having some impact on the stream, such as evidence of erosion or sedimentation downstream. One of the concrete circular crossings, shown in Photo 3.94, has sedimentation problems upstream and downstream of the culvert that could block the stream flow and cause a flooding hazard.

Photo 3.94 Crossing under Fox Mill Road north of Shady Mill Lane. Crossing has excessive sedimentation (DFLD015.C002).

3.31.4 Soils

Soils found in the Little Difficult Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes which can result in rapid **runoff** and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 74 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (57 percent). Zones with Glenelg, Manor and Elioak soils may be compatible with infiltration practices. There are 8.62 acres of land with unclassified soils in the Little Difficult Run subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.31.5 Geomorphology

The streams in Little Difficult Run were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. There are a total of 53,502 linear feet (approximately 10 miles) of stream in the Little Difficult Run subwatershed. Of this length, two reaches (3,073 feet) were not assessed because they were a concrete drainage ditch with **riprap**, and a pond / wetland. Refer to DFLD_3 for the stream classifications.

Most **channels** (68 percent) were classified as Type III, which indicates an unstable channel that is actively widening in response to changes in stream flow.stream channel. The remaining 32 percent of the reaches are Type IV, which is the onset of channel stabilization. The majority (88 percent) of the reaches have a gravelly **substrate**. The remaining reach substrates are dominated by sand, silt or cobble.

Photo 3.95 Eroding bank directly north of the terminus of Hollybrook Place in the Hollybrook subdivision (DFLD004.E001).

Photo 3.96 Erosion area at the end of Millstream Court, in Little Difficult Run Stream Valley Park (DFLD024.E001).

Photo 3.97 Erosion located on the mainstem of Little Difficult Run, directly east of Colt Run Road in the Roan Stallion Estates subdivision (DFLD013.E001).

Photo 3.98 Headcut located northwest of Fox Mill District Park in the Fox Mill Woods subdivision. Directly east of the intersection of Steeplechase Drive and Aintree Lane (DFLD023.H001).

Sixty percent of the total stream length was moderately unstable with high erosion potential during flood events. Forty percent of the stream length was moderately stable with only slight potential for erosion at flood stages. There were four specific stream erosion points noted in the Little Difficult Run subwatershed. The combined length of the erosion points is approximately 230 feet. Three of the erosion points are considered severe indicating that erosion may be damaging property and causing instream degradation. All erosion points are considered to have moderate to high restoration potential. These erosion points are shown in Photos 3.95 to 3.97. Photo 3.95 is candidate site S115, 3.96 is candidate site S113, and 3.97 is candidate site S114. There was one **headcut** identified as having a significant impact with a height of 2.5 feet (Photo 3.98).

All but one of the 17 stream blockages was made up of trees and debris. The remaining obstruction was a beaver dam. Sixty-five percent of the obstructions appeared to be restricting fish movement within the stream system, while the rest did not. Streamflow around and over the obstructions is causing only minor amounts of erosion in the majoirity of the obstructed areas, while 23 percent of the obstructed channels are experiencing more significant erosion which can negatively affect the instream habitat. The obstructions have the potential to create flooding problems within the stream system and potentially affect buildings near the stream.

3.31.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one-time visual inspection. Field crews conducted that assessment in the fall of 2002 and winter of 2003.

- Of the assessed reaches, 60 percent have fair habitat for aquatic insects and fish, 29 percent have good habitat, and 21 percent have poor habitat.
- There are 14,450 feet of **riparian buffer** encroachment in the subwatershed (this length includes left and right banks combined). Of this total, 9,900 feet (69 percent) is a combination of **pervious** surfaces, 1,050 feet (7 percent) is a combination of different impervious surfaces, and the remaining 3,500 feet (24 percent) is some combination of impervious and pervious surfaces. Photos 3.99 above (which is candidate site S116) and 3.100 (which is candidate site S36) and 3.101 below show examples of buffer encroachment.

Photo 3.99 Severe buffer encroachment (in background) Little Difficult Run Stream Valley Park, directly south of Stuart Mill Road on the mainstem (DFLD011.B001)

- Forty-eight percent of the assessed stream length had between 50 percent and 70 percent of both stream banks covered by vegetation. Typically this vegetation is scattered grasses, shrubs and forbs. Fifty-two percent of the assessed stream length had a variety of vegetation, and covered 70 to 90 percent of the streambank surface.

Photo 3.100 Buffer encroachment in the Little Difficult Run Stream Valley Park. Directly east of Mill Road and Stuart Mill Road (DFLD003.B001).

Photo 3.101 Buffer impact in the Hollybrook community, directly north of the terminus of Hollybrook Place, mainstem of Little Difficult Run (DFLD003.B002).

3.31.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Little Difficult Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identify that will need additional management measures.

In Little Difficult Run subwatershed, over half of the land use is a lower density residential. Approximately 11 percent of the land is covered by impervious surface. This low imperviousness helps this subwatershed have below average pollutant loads for Difficult Run. See DFLD_4 for the catchment locations.

The poorest rating for water quality in this subwatershed is DFLD9401, located around the intersection of Soapstone Drive and Foxclove Road. DFLD0002, around the western end of Westwood Hills Drive, has one of the highest amounts of runoff volume in the subwatershed, along with DFLD9701 in the Blueberry Farm area between Lawyers Road and Fox Mill Road. Results can be seen in Table 3.55.

Table 3.57 Existing and Future Modeling

Little Difficult Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFLD0001	E	1.64	0.12	16.0	0.9	0.2
	F	2.66	0.14	31.8	1.7	0.3
	C	62%	17%	99%	89%	50%
DFLD0002	E	2.07	0.11	22.4	1.2	0.3
	F	2.2	0.12	24.2	1.3	0.3
	C	6%	9%	8%	8%	0%
DFLD0003	E	2.31	0.12	21.5	1.2	0.2
	F	2.58	0.13	26.2	1.4	0.3
	C	12%	8%	22%	17%	50%
DFLD0004	E	1.61	0.1	15.1	0.8	0.2
	F	1.61	0.1	15.1	0.8	0.2
	C	0%	0%	0%	0%	0%
DFLD0005	E	0.92	0.14	6.6	0.3	0.1
	F	1.07	0.14	7.2	0.4	0.1
	C	16%	0%	9%	33%	0%
DFLD0006	E	1.61	0.09	13.5	0.7	0.2
	F	1.69	0.09	14.3	0.8	0.2
	C	5%	0%	6%	14%	0%
DFLD0007	E	1.93	0.12	14.2	0.8	0.2
	F	1.94	0.12	14.4	0.8	0.2
	C	1%	0%	1%	0%	0%
DFLD0008	E	2.01	0.16	16.0	0.9	0.2
	F	2.03	0.16	16.4	0.9	0.2
	C	1%	0%	2%	0%	0%
DFLD9201	E	1.81	0.11	15.8	0.9	0.2
	F	1.84	0.11	16.1	0.9	0.2
	C	2%	0%	2%	0%	0%
DFLD9301	E	1.98	0.12	23.7	1.3	0.3
	F	2.05	0.13	24.0	1.3	0.3
	C	4%	8%	1%	0%	0%
DFLD9401	E	2.75	0.13	32.8	1.8	0.4
	F	2.75	0.13	32.8	1.8	0.4
	C	0%	0%	0%	0%	0%
DFLD9501	E	2.39	0.13	41.9	2.0	0.3
	F	2.39	0.13	41.9	2.0	0.3
	C	0%	0%	0%	0%	0%
DFLD9601	E	2.5	0.13	33.7	1.7	0.3
	F	2.5	0.13	33.7	1.7	0.3
	C	0%	0%	0%	0%	0%
DFLD9701	E	2.68	0.1	28.1	1.5	0.3
	F	2.98	0.11	33.7	1.8	0.3
	C	11%	10%	20%	20%	0%

Little Difficult Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFLD9801	E	1.84	0.14	15.5	0.8	0.2
	F	2.86	0.16	31.1	1.7	0.4
	C	55%	14%	101%	113%	100%
DFLD9901	E	2.36	0.13	22.7	1.2	0.2
	F	3.17	0.15	32.6	1.8	0.4
	C	34%	15%	44%	50%	100%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

The future modeling results show an increase in flow and runoff **pollutants** in all catchments. The large increases in both runoff volume and runoff pollutants, which occur in DFLD0001, DFLD9801, and DFLD9901, are due to a large amount of estate residential and open space changing into low-density residential land use.

3.31.8 Hydraulic Modeling Results

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. These culverts are over-capacity and do not allow all of the flow required to pass without flooding. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Seven culverts in the Little Difficult Run subwatershed overtopped for at least one storm event. These are shown in Table 3.56. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.58 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
3	Stuart Mill Road DS	E	X	x	x	x	x	x	
6	Colt Run Road	E	X	x	x	x	x	x	x
12	Polo Pointe Drive	E	X	x	x				
13	Fox Mill Road North	E	X	x	x	x	x	x	
15-B	Stuart Mill Road US	E	X	x	x	x	x		
16	Fox Mill Road South	E	X	x	x	x	x		
30	Westwood Hills Drive	E	X	x	x	x	x		

E – Existing conditions results, x – indicates overtopping

Culvert #3 (Photo 3.102) overtopped for all events except the one-year. Stuart Mill Road can be considered a primary road, which requires it to pass the 25-year event.

Culvert #6 (Photo 3.103) overtopped for all events. Colt Run Road is a residential access road, classified as local, requiring the culvert to pass the 10-year event. This culvert is candidate site F06.

Photo 3.102 Little Difficult Run at Stuart Mill Road

Photo 3.103 Little Difficult Run at Colt Run Road

Culvert #12 (Photo 3.104) overtopped for the 25, 50, and 100-year events. The culvert at Polo Pointe Drive, a local road, is required to pass the 10-year event. This culvert is not a candidate site.

Culvert #13 (Photo 3.105) overtopped for all events except the one-year. Fox Mill Road is a primary road, and is therefore required to pass the 25-year event.

Photo 3.104 Little Difficult Run tributary at Polo Pointe Drive.

Photo 3.105 Little Difficult Run mainstem at Fix Mill Road North

Culvert #15-B (Photo 3.106) overtopped for all events except the one and two-year. Stuart Mill Road, as mentioned above, can be considered a primary road, requiring it to pass the 25-year event.

Culvert #16 (Photo 3.107) overtopped for all events except the one and two-year. Fox Mill Road, also mentioned above, can be considered a primary road and must pass the 25-year event.

Culvert #30 (Photo 3.108) overtopped for all events except the one and two-year. The

Photo 3.106 Little Difficult Run mainstem at Stuart Mill Road

Photo 3.107 Little Difficult Run mainstem at Fox Mill Road South

culvert at Westwood Hills Drive, a local road, is expected to pass the 10-year event.

Photo 3.108 Little Difficult Run tributary at Westwood Hills Drive

3.31.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Little Difficult Run subwatershed are listed below. Refer to DFLD_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S36 There are significant riparian buffer impacts over 1,000 feet in length in the Little Difficult Run Stream Valley Park directly east of Mill Road and Stuart Mill Road (Photo 3.100).

S65 The reach between two overtopping culverts (culvert 13 and culvert 30) is exhibiting poor bank stability and has several crossing impacts.

S113 Erosion area at the end of Millstream Court, in Little Difficult Run Stream Valley Park (Photo 3.96).

S114 Erosion located on the mainstem of Little Difficult Run, directly east of Colt Run Road in the Roan Stallion Estates subdivision (Photo 3.97).

S115 Stream Physical Assessment found erosion and riparian buffer problems north of the terminus of Hollybrook Place in the Hollybrook subdivision (Photo 3.95)

S116 Buffer encroachment on the mainstem of Little Difficult Run along Stuart Mill Road in the Difficult Stream Valley Park (Photo 3.99).

<u>Hydrology and Water Quality</u>

D23 (Catchment DFLD0008) This site has better than average conditions for the subwatershed and for Difficult Run as a whole for runoff flows and pollutant loads. It was selected because it is a proposed site for a regional pond.

D39 (Catchment DFLD0002) This site has conditions similar to the average for the subwatershed for runoff flows and pollutant loads. It was selected because it is a proposed site for a regional pond.

D43 (Catchment DFLD9501) This site has higher than average nitrogen and phosphorus loadings from runoff. Peak flows and runoff volume are average. There are no critical stream problems within the area or immediately downstream. It was selected because it is a proposed site for a regional pond.

D58 (Catchment DFLD9801) This site has better than average conditions for the subwatershed and for Difficult Run as a whole for runoff flows and pollutant loads. There are no stream restoration sites downstream, however there are two culverts that are being overtopped. It was selected because it is a proposed site for a regional pond.

D61 (Catchment DFLD9401) Water quality and runoff volumes are slightly worse than the average for the subwatershed. Stream conditions within the drainage area and immediately downstream are relatively good.

D69 (Catchment DFLD9601) This site has average conditions for the subwatershed and for Difficult Run as a whole for runoff flows and pollutant loads. Field investigation showed no critical stream degradation within the drainage area or downstream.

D71 (Catchment DFLD0001) This site has average conditions for the subwatershed for runoff flows and pollutant loads. There is an area of streambank erosion downstream at site S113.

C64 (Catchment DFLD9701) This site has average pollutant loads and runoff flows in comparison with the subwatershed, and better than the average for the whole watershed. There is no significant stream degradation within the catchment or immediately downstream.

<u>Flooding</u>

F03 The bridge carrying Stuart Mill Road over the Mainstem of Little Difficult Run overtops for all events except the 1-year storm. It is required to pass the 25-year event (Photo 3.102).

F06 The culvert conveying Mainstem of Little Difficult Run under Colt Run Road overtops for all events. It is required to pass the 10-year event (Photo 3.103).

F13 The culvert conveying a tributary of Little Difficult Run under Fox Mill Road overtops for all events except the 1-year storm. It is required to pass the 25-year event (Photo 3.105).

F15B The culvert conveying Little Difficult Run under Stuart Mill Road overtops for all events except the 1-year and 2-year storms. It is required to pass the 25-year event (Photo 3.106).

F16 The culvert conveying a tributary of Little Difficult Run under Fox Mill Road overtops for all events except the 1-year and 2-year storms. It is required to pass the 25-year event. (Photo 3.107).

F30 The culvert conveying a tributary of Little Difficult Run under Thoroughbred Road overtops for all events except the 1-year and 2-year storms. It is required to pass the 20-year event (Photo 3.108).

<u>Preservation</u>

P05 (Catchment DFLD9801) This catchment has very high increases from existing to future conditions for many of the modeled results including runoff volume, total suspended solids, nitrogen and phosphorus.

P06 (Catchment DFLD0001) This catchment has very high increases from existing to future conditions for many of the modeled results including total suspended solids, nitrogen and phosphorus. The area includes a large percentage of open space.

P07 (Catchment DFLD9901) This catchment has moderate increases from existing to future conditions for many of the modeled results including total suspended solids, nitrogen and phosphorus. The area includes a large percentage of open space.

3.32 Little Difficult Run - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.61 below is a list of all projects proposed in this subwatershed.

Table 3.59 Recommendations for Little Difficult Run

Project #	Project Type	Candidate Site
DF9023A	Pond Retrofit.	D-23
DF9039A	Culvert Retrofit.	D-39
DF9039B	Drainage Retrofit.	D-39
DF9043A	Drainage Retrofit	D-43
DF9043B	Pond Retrofit	D-43
DF9043C	LID Retrofit	D-43
DF9058A	Culvert Retrofit	D-58
DF9058B	Culvert Retrofit	D-58
DF9061A	Culvert Retrofit	D-61
DF9061B	Drainage Retrofit	D-61
DF9061C	Culvert Retrofit	D-61
DF9061D	Pond Retrofit	D-61
DF92114	Stream Restoration	S114
DF9236	Stream Restoration	S36
DF9265	Stream Restoration	S65

3.32.1 Regional Pond Alternative Projects

D23 (DFLD9201)

<u>Site Investigation and Projects:</u> The site investigation showed few opportunities for retrofits in this low-density residential neighborhood. One project was identified:

> *DF9023A (Pond Retrofit)* This project is a retrofit of an existing dry facility at the outfall of the catchment. Retrofits would include installing a multi-stage riser for extended detention.

D39 (DFLD0002)

<u>Site Investigation and Projects:</u> The site investigation found relatively good conditions in the streams and outfalls within this drainage area, including the stream channel at the outlet of the watershed. There are few opportunities for onsite stormwater management or LID retrofits in the residential land uses that predominate.

> *DF9039A (Culvert Retrofit)* The project includes two small culvert retrofits on the south side of Westwood Hills Drive. The project would provide channel protection to reduce erosive discharge rates and provide an opportunity for water quality treatment.

DF9039B (Drainage Retrofit) This project consists of reconfiguring outfalls or retrofitting energy dissipation structures to reduce scour and erosion where flows from the storm drainage system enter the stream.Improvements would consist of energy dissipation through riprap, plunge pools, or structures.

D43 (DFLD9501)

Site Investigation and Projects:

DF9043A (Drainage Retrofit) This project is designed to reduce scour at outfalls where the piped storm drain system discharges to a natural channel. Improvements would consist of energy dissipation through riprap, plunge pools, or structures.

DF9043B (Pond Retrofit) This is a retrofit of an existing in-stream dry pond between the cul-de-sacs of Wild Cherry Place and Black Fir Court. The retrofit would incorporate a retrofit riser structure. For channel protection storage, the low-flow orifice should be modified to detain the 1-year storm.

DF9043C (LID Retrofit) The project involves coordinating with the Fox Mill Swim and Tennis Club to construct a biofiltration swale adjacent to the parking lot. The existing grass swale exhibits active erosion. This retrofit could serve as a community education and outreach project.

D58 (DFLD9801)

Site Investigation and Projects:

DF9058A (Culvert Retrofit) This project is located at the upstream side of Thoroughbred Road. It should be designed along with project DF9058B to reduce some of the peak flows from the drainage area.

DF9058B (Culvert Retrofit) The retrofit is located upstream of the crossing at Folkstone Road. An upstream embankment along with a retrofit of the culvert would provide a dry pondfor channel protection.

D61 (DFLD9401)

Site Investigation and Projects:

DF9061A (Culvert Retrofit) This project is located at the bottom of the catchment where the stream crosses Stuart Mill Road. It would be designed primarily for water quality treatment using extended detention on the floodplain..

DF9061B (Drainage Retrofit) This project is designed to provide energy dissipation at outfalls where the piped storm drain system discharges to a natural channel. Improvements would consist riprap, plunge pools, or bioengineered structures.

DF9061C (Culvert Retrofit) This culvert retrofit project would consist of a redundant embankment to create a backwater storage area at Foxclove Road, with the primary goal of reducing erosive flows downstream. The upstream area is forested so a dry detention facility is proposed.

DF9061D (Pond Retrofit) The project would retrofit a dry pond with the addition of a multi-stage riser to provide channel protection storage.

D69 (DFLD9601)

Site Investigation and Projects: The stream valley through the site is heavily wooded with no suitable locations for stormwater management ponds or onsite LID retrofits. No projects were identified for this site.

D71 (DFLD0001)

Site Investigation and Projects: The stream valley through the site is heavily wooded with no suitable locations for stormwater management ponds or onsite LID retrofits. No projects were identified for this site.

3.32.2 Catchment Improvement Projects

C64 (DFLD9701)

Site Investigation and Projects: The stream valley through the site is heavily wooded with no suitable locations for stormwater management ponds or onsite LID retrofits. No projects were identified for this site.

3.32.3 Stream Restoration Projects

S-36

Site Investigation and Projects: The site investigation found moderate to severe bank erosion, lack of riffle pool bed morphology, and slight to moderate incision. Some areas adjacent to the stream lacked a forested riparian buffer. One stream restoration project was identified.

> *DF9236 (Stream Restoration)* The proposed restoration would involve excavating a new floodplain and re-meandering the stream to provide a pattern, dimension, and profile more consistent with a natural stream. This would prevent further mass erosion associated with channel widening and bank failure, would improve instream habitat, and provide access to a functional floodplain. The new floodplain would be planted with native woody vegetation and grasses. A forested buffer would be established. *S-36 and S-115 would be combined as a single project*.

S-65

Site Investigation and Projects: The site investigation found areas of missing buffer and erosion on the west side of Fox Mill Road. The east side was forested with areas of localized erosion.

> *DF9265 (Stream Restoration)* The proposed restoration would involve excavating a floodplain bench and reshaping the streambanks on the west side and immediately downstream of Fox Mill Road. A forested buffer would be established to the extent possible in the riparian zone. Further downstream, restoration benefits would not outweigh the construction impacts to the forest.

S-113

Site Investigation and Projects: The site investigation found one area of severe bank erosion less than 100 feet in length. Given the short length of the impairment and significant access constraints, no project was identified. The bank erosion would be addressed by the proposed culvert retrofit (DF9406 below) located upstream of Colt Run Road.

S-114

Site Investigation and Projects: Site investigations found that the stream is severely incised with raw streambanks. However, the stream has re-established a good riffle pool sequence and has a clearly defined aquatic channel. One stream restoration project was identified.

> *DF92114 (Streambank Stabilization)* The proposed project would involve grading the eroded streambanks and excavating a floodplain bench at the channel forming elevation. The new floodplain would be planted with native woody vegetation and grasses.

S-115

Site Investigation and Projects: Work for this site would be combined with project DF9236.

S-116

Site Investigation and Projects: Buffer restoration will be completed as part of the watershed-wide projects.. No project was identified.

3.32.4 Preservation

Improvement Goals for all Preservation Sites

Preservation goals for all the candidate sites include reducing runoff volume, peak flows, and pollutant loads by preserving open space and forested land in key areas of the catchment such as headwaters.

Site Investigation and Projects

No site investigation was undertaken for preservation projects, and no specific proposals have been made for each area. Actions and policy changes needed to implement preservation for all candidate sites are described in Chapter 4.

3.33 Angelico Branch – Subwatershed Condition

3.33.1 Subwatershed Characteristics

The Angelico Branch **subwatershed** has an area of approximately 483 **acres** (0.76 mi^2). It is one of the smaller subwatersheds found within the Difficult Run. Lawyers Road (Virginia 673) makes a diagonal slice through the subwatershed from the northwest to the center. Hunter Mill Road (Virginia 674) provides the approximate western boundary line. The stream crossing at Cedar Pond Drive (local road) provides the northern boundary. Clarks Crossing Park designates an approximate eastern boundary. Vale Road (Virginia 672) forms the approximate southern boundary.

The Angelico Branch subwatershed is located in the central portion of the Difficult Run watershed. The Angelico Branch subwatershed contains only a single stream **channel**, which is approximately two miles long. Angelico Branch flows in a northerly direction until it joins with the mainstem of Difficult Run.

Refer to DFAB_1 for a map of the Angelico subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.33.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

Angelico Branch is one of the lower density subwaterseds. Seventy-five percent is developed as low-density or estate residential, while only 1 percent of the subwatershed is developed for commercial or industrial uses. The development in this subwatershed is equally dispersed throughout in residential subdivisions.

Transportation use, such as roads and highways, make up 34 acres, or 7 percent of the overall subwatershed. Total impervious area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 51 acres, or 11 percent of the total subwatershed area. Thirteen percent of the land in the subwatershed is preserved for open space or parks. Major parks include Fox Hunters Park and Kemper Park. No historical sites lie within the subwatershed. A summary of land use within the subwatershed can be found in Table 3.58.

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

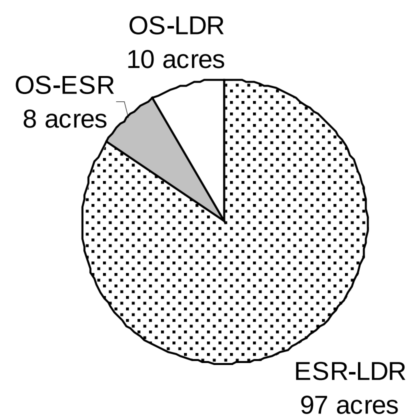
When comparing existing land use to future land use, there are several land use changes. The notable changes are projected to be made in the open space, estate residential, and low-density residential land use categories. A gain projected in the low-density residential (+22 percent) category is projected to be compensated with losses in the estate residential (-18 percent) and open space (-4 percent) categories. This suggests that there is a demand to increase the housing base in the Angelico Branch subwatershed.

Table 3.60 Existing and Future Land Use

	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	64	13%	46	10%	-18	-4%
Golf Course	0	0%	0	0%	0	0%
Estate residential	209	43%	120	25%	-89	-18%
Low-density residential	156	32%	262	54%	107	22%
Medium-density residential	9	2%	9	2%	0	0%
High-density residential	0	0%	0	0%	0	0%
Low-intensity commercial	4	1%	4	1%	0	0%
High-intensity commercial	0	0%	0	0%	0	0%
Industrial	0	0%	0	0%	0	0%
Institutional	7	1%	7	1%	0	0%
Transportation	34	7%	34	7%	0	0%
Water	0	0%	0	0%	0	0%
Total	**483**	**100%**	**483**	**100%**		**0%**

According to Figure 3.16, 97 acres are projected to shift from estate residential in the existing land use to low-density residential in the future land use. An additional 18 acres, or 16 percent of all land use changes, are projected to shift from open space to either a low-density residential (10 acres) or estate residential (8 acres) use. This does not guarantee that the open space will become developed; it suggests that these areas of open space have been identified as being appropriate for redevelopment of a higher-density use in the future if and when the need presents itself.

Figure 3.16 Changed Land Use



3.33.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there is only one **stormwater management facility** within the Angelico Branch subwatershed. The facility provides **quantity control** for 17 percent of the subwatershed. The remaining 83 percent of the subwatershed is not served by any stormwater management facility. The information on this facility can be found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located only one **outfall** pipe discharging into Angelico Branch. This pipe is a 12-inch stormwater pipe that has only a minor impact on stream character.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. There are seven stream crossings in the Angelico Branch subwatershed. Only one of these has more than a moderate impact on the stream, indicating that the structural condition was adequate but could be improved to enhance stream integrity and avoid future problems. This crossing is a pipe culvert near the **headwaters** of Angelico Branch at the end of Garrett Street. This pipe is shown in Photo 3.109.

Photo 3.109 Pipe culvert at the headwaters of Angelico Branch. This is the only crossing in the watershed that has more than a moderate impact on the stream. (DFAB002.C003)

3.33.4 Soils

Soils found in the Angelico Branch subwatershed belong primarily to the Glenelg– Elioak – Manor association. This association consists of rolling and hilly landscapes which can result in rapid **runoff** and **micaceous** soils, which are erodible. The subwatershed contains 57 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (31 percent). Zones with Glenelg, Manor and Elioak soils may be compatible with infiltration practices. The **groundwater** is fairly shallow with numerous natural springs. There are 0.2 acres of land with unclassified soils in the Angelico Branch subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.33.5 Geomorphology

Photo 3.110 Severe erosion located just west of Whippoorwill Road (DFAB001.E001)

Field crews conducted an assessment of the entire stream length in Angelico Branch subwatershed using the **Channel Evolution Model**. Each length was assigned a classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. All streams were assessed.

The **substrate** material found in Angelico Branch is a mix of silt, sand and gravel. The entire length of Angelico Branch is characterized as Type III, indicative of an unstable channel that is actively widening in response to changes in stream flow. Most of the stream between Lawyers Road and Whippoorwill Road is severely eroded, shown in Photo 3.110. This site is candidate site S117. Refer to DFAB_3 for the stream classifications.

There were three locations along Angelico Branch where field crews noted obstructions. All obstructions were restricting fish passage and can lead to flooding and stream erosion. Two of these are shown in Photos 3.111 and 3.112.

Photo 3.111 Obstruction located just west of Whippoorwill Road (just downstream of erosion shown in Photo 3.2) (DFAB001.T001)

Photo 3.112 Obstruction located just south of East Hunter Valley Road (DFAB002.T002)

3.33.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one-time visual inspection. Field crews conducted that assessment in the fall of 2002.

There is approximately one mile of riparian buffer encroachment (this length includes left and right banks combined). Sixty-six percent of this impact is from a combination of lawn and grasses. The remaining 34 percent is any combination of pavement and grasses/forbs/lawn. Only 1,000 feet of this total length was considered to have a significant impact on the stream.

- Seventy-six percent of the total stream has “fair” habitat for aquatic insects and fish, while the remaining 24 percent has “poor” habitat.
- At the time of assessment, field crews noted only 20 percent of the **channel** depth filled with water, which can indicate a channel overwidened by erosion or a lack of baseflow. This type of channel provides poor habitat for fish.
- The entire length of Angelico Branch received low scores for vegetative protection in the form of trees and shrubs and has impacted buffer zone width and bank stability. These factors indicate a stream with high erosion potential during rain events and one that could benefit from improved buffer.

3.33.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Angelico Branch incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff and streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

Angelico Branch subwatershed is covered by 11 percent impervious surface. It is comprised of more than three-quarters lower density residential land use. There are two areas of commercial land use, located along Hunter Mill Road, one just north and one just south of Lawyers Road. The larger commercial area to the south of Lawyers Road, along with low and medium density residential areas in **catchment** DFAB0001 combine to produce the highest **nitrogen** and **phosphorus** loading rates in the subwatershed. Refer to DFAB_4 for the catchment locations.

Catchment DFAB0001, located north of Vale Road and East of Hunter Mill Road, is the headwater for this subwatershed and received the poorest rating in terms of modeled water quality in the subwatershed. This same catchment also has the highest volume of runoff due to relatively more impervious surface. Results are in Table 3.59.

Table 3.61 Existing and Future Modeling

Angelico Branch Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFAB0001	E	2.31	0.12	25.6	1.3	0.3
	F	2.94	0.14	36.6	1.9	0.4
	C	27%	17%	43%	45%	44%
DFAB0002	E	2.2	0.15	17.5	1.0	0.2
	F	2.88	0.17	27.4	1.5	0.3
	C	31%	13%	57%	58%	57%
DFAB0003	E	1.92	0.14	15.3	0.8	0.2
	F	2.04	0.14	16.7	0.9	0.2
	C	6%	0%	9%	10%	6%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures.

All three catchments showed an increase in pollutants and flow from existing to future conditions due to projected changes in open space and estate residential to low density residential land use.

3.33.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts, may occur. These culverts are over-capacity and do not allow all of the flow required to pass without flooding. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Two culverts in the subwatershed were overtopped by at least one of the storm events, as shown in Table 3.60. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.62 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
19	Lawyers Road	E	x	x	x	x	x	x	
20	Cedar Pond Drive	E	x	x					

E – Existing conditions results, x – indicates overtopping

Culvert #19 (Photo 3.113) overtopped for all events except the 1-year. Lawyers Road is a primary road, which should allow the 25-year event to pass.

Culvert #20 (Photo 3.114) overtopped for the 50 and 100-year events. This is a residential access road, which can be classified as local, and is required to pass beneath it the 10-year event. This culvert is not considered a candidate site.

Photo 3.113 Angelico Branch at Lawyers Road

Photo 3.114 Angelico Branch at Cedar Pond Drive

3.33.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Angelico Branch subwatershed are listed below. Refer to DFAB_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S117 The Stream Physical Assessment survey noted severe erosion just west of Whippoorwill Road (Photo 3.110). The reach also was identified as having erosion problems and active widening.

S118 This site was identified in the Stream Physical Assessment survey as having erosion problems and active widening, along with a deficient buffer.

<u>Hydrology and Water Quality</u>

D51 (Catchments DFAB0001, DFAB0002, and DFAB0003) The site of this unconstructed regional pond collects the drainage from all three catchments in Angelico Branch. Model results for the overall subwatershed showed peak flows and runoff quality to be within normal ranges in comparison to other areas of Difficult Run so that no other candidate sites were identified.

<u>Flooding</u>

F19 This culvert overtops with existing conditions for all rainfall events from 2- to 100-year; however, it should pass the 25-year event to meet County standards (Photo 3.113).

<u>Preservation</u>

P04 (Catchment DFAB0002) Model results for pollutant loading and runoff volume more than doubled in this catchment based on the projected change from existing to future conditions.

3.34 Angelico Branch - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.61 below is a list of all projects proposed in this subwatershed.

Table 3.63 Recommendations for Angelico Branch

Project #	Project Type	Candidate Site
DF9051D	Culvert Retrofit	D-51
DF9051E	Drainage Retrofits	D-51
DF92117	Stream Restoration	S117

3.34.1 Regional Pond Alternative Projects

D51 (DFAB0001, DFAB0002, and DFAB0003)

Site Investigation and Projects: The site investigation showed that stream erosion upstream of this site was severe and among the worst conditions seen in the watershed. Along with a culvert retrofit at the regional pond site, upstream projects are being proposed which may help mitigate stream erosion and provide some improvements in water quality.

> *DF9051D (Culvert Retrofit)* This culvert retrofit is proposed for the original site of regional pond D-51. The primary role would be to reduce peak discharges, but water quality features could be designed to promote wetland growth and nutrient uptake through vegetation.
>
> *DF9051E (Drainage Retrofits)* These distributed projects are designed to provide energy reduction at outfalls where the piped storm drain system discharges to a natural channel to slow the scour and erosion at these points. Improvements would consist of energy dissipation through riprap, plunge pools, or structures.

3.34.2 Catchment Improvement Projects

No candidate sites of this type were identified.

3.34.3 Stream Restoration Projects

S117 and S118

Site Investigation and Projects: The site investigation showed moderate to severe incision with severe bank erosion against the valley walls in several locations. Bed features were transitional and inconsistent. The stream did not appear to be in its natural location in the center of its valley. It may have been moved and straightened at some time in the past.

> *DF92117 (Stream Relocation)* Sites 117 and 118 will be combined into a single project. The proposed restoration would create a new pattern and profile for most of the existing channel, except for the most eroded area, where a new stream channel would be created in the floodplain. Spot stabilization measures would also be constructed. The stream buffer would be restored on all restoration reaches.This

would improve instream habitat, provide access to a larger floodplain, and protect the eroding valley walls.

3.34.4 Preservation

Improvement Goals for all Preservation Sites

Preservation goals for all the candidate sites include reducing runoff volume, peak flows, and pollutant loads by preserving open space and forested land in key areas of the catchment such as headwaters.

Site Investigation and Projects

No site investigation was undertaken for preservation projects, and no specific proposals have been made for each area. Actions and policy changes needed to implement preservation for all candidate sites are described in Chapter 4.

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3.35 South Fork Run – Subwatershed Condition

3.35.1 Subwatershed Characteristics

The South Fork Run **subwatershed** has an area of approximately 1,745 **acres** (2.73 mi^2). Its western most boundary runs almost directly along West Ox Road (Virginia 608) where it becomes the Reston Parkway (Virginia 602). The southeast most boundary line runs along Vale Road (Virginia 672). The northeast most boundary is approximately Stuart Mill Road (Virginia 669) where it turns into Bennett Road.

The South Fork Run subwatershed includes 7.0 miles of streams. The subwatershed is in the southwestern corner of the watershed between Little Difficult Run and Upper Difficult Run.

Refer to DFSF_1 for a map of the South Fork Run subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.35.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The South Fork Run subwatershed is slightly to moderately dense. Sixty-two percent is developed as low-density or estate residential while only 1 percent of the subwatershed is developed for commercial or industrial uses. The most common land use in South Fork Run is low-density residential, which makes up 52 percent of the land area. Development is equally dispersed throughout the subwatershed in subdivisions.

Transportation use, such as roads, highways, and rights-of-way, make up 151 acres, or 9 percent of the overall subwatershed. Total **impervious** area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 215 acres, or 12 percent of the total subwatershed area.

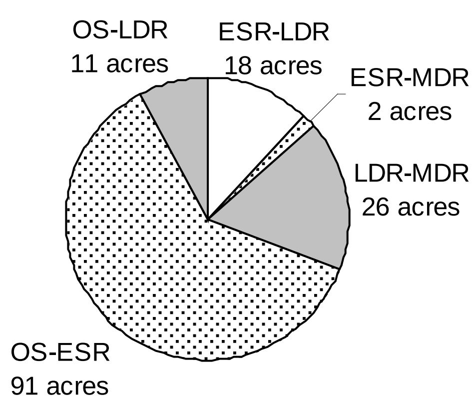
Twenty-two percent of the land in the subwatershed is preserved for open space or parks. Major parks include Garnchayne Park, Difficult Run Stream Valley Park and Clark's Landing Park. Three historical sites lie within the subwatershed. A summary of land use within the subwatershed can be found in Table 3.62.

When comparing existing land use to future land use, there are few land use changes. Changes are projected for the open space, estate residential and medium-density residential land use categories. Losses expected in open space (-6 percent) will be gained in the estate residential (+4 percent) and medium-density (+2 percent) categories. The projected shift to estate residential use, the lowest density for all residential uses within the subwatershed, is a rare occurrence, when compared with the other 17 subwatersheds.

Table 3.64 Existing and Future Land Use

Land Use Type	Existing		Future		Change	
	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	375	22%	273	16%	-103	-6%
Golf Course	0	0%	0	0%	0	0%
Estate residential	170	10%	240	14%	71	4%
Low-density residential	907	52%	911	52%	3	0%
Medium-density residential	110	6%	138	8%	28	2%
High-density residential	0	0%	0	0%	0	0%
Low-intensity commercial	3	0%	3	0%	0	0%
High-intensity commercial	0	0%	0	0%	0	0%
Industrial	10	1%	10	1%	0	0%
Institutional	12	1%	12	1%	0	0%
Transportation	151	9%	151	9%	0	0%
Water	8	0%	8	0%	0	0%
Total	**1,745**	**100%**	**1,745**	**100%**		**0%**

Figure 3.17 Changed Land Use



Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

According to Figure 3.17, 91 acres are projected to shift from open space in the existing land use to estate residential in the future land use. In total, 102 acres, or 68 percent of all land use changes, are projected to shift from open space to a higher intensity use. This does not guarantee that the open space will become developed – it suggests that these areas of open space can be used for development/ redevelopment in the future. Nineteen percent of the land use changes (28 acres) are projected to shift to medium-density housing from either estate residential or low-density residential land uses.

3.35.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are 14 **stormwater management facilities** within the South Fork Run subwatershed. Seventy-six percent of the South Fork Run subwatershed is not served by any stormwater management facility. Fourteen percent of the total area has quantity control only and the remaining 10 percent receives both **quantity and quality control**. A list of all stormwater management facilities in the South Fork Run subwatershed can be found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located 24 **outfall** pipes discharging into the South Fork Run subwatershed. None of these pipes were considered to be having an impact on stream character, nor were they creating any type of erosion.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of structures designed for lower flows, and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. Results from the Stream Physical Assessment identified 17 crossings in the South Fork Run subwatershed. Twenty-four percent of the crossings were either a bridge or footbridge. Most (94 percent) of the crossings did not appear to pose a threat to the instream habitat, road, or other structures.

Photo 3.116 Concrete circular crossing located in the Clarke's Landing Subdivision between Timberline Drive and the Difficult Run Stream Valley Park (DFSF0002.C001)

3.35.4 Soils

Soils found in the South Fork Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The subwatershed contains 75 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (55 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. The groundwater is fairly shallow with numerous natural springs. There are 9.5 acres of land with unclassified soils in the South Fork Run subwatershed. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.35.5 Geomorphology

There are approximately 7 miles (37,189 feet) of stream in the South Fork Run subwatershed. Most of the streams were assessed and assigned a Channel Evolution Model classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. 1,154 feet of stream were not assessed because they were characterized as wetlands with beaver dams.

Thirty-four percent of the reaches are Type III, which indicates an unstable channel that is actively widening in response to changes in stream flow. Four percent were classified as Type II, characterized by bed degradation and downcutting, and the remaining 63 percent of the reaches are Type IV, which is the bed aggradation and stabilization stage. Sixty-one percent of the stream length was identified as moderately unstable with high erosion potential during **flood** events. The dominant **substrate** of the majority (94 percent) of the reaches is gravel. The dominant substrate of the remaining 6 percent is cobble.

Photo 3.117 Eroding reach located directly south of Saint Helena Drive in the Vale Park West community (DFSF014.E001).

Photo 3.118 Located south of Photo 3.3 in Vale Park West and north of the Difficult Run Stream Valley Park (DFSF014.E002).

There were four severe erosion points of approximately 200 feet noted in the subwatershed by field crews. In all four cases, the restoration potential was high. Photos of the four points are show in Photos 3.116 to 3.119. Photo 3.116 is candidate site S121, Photo 3.118 is candidate site S119, and Photos 3.119 and 3.120 are candidate site S120.

As identified in the Stream Physical Assessment, two-thirds of the stream blockages, which can cause erosion and block fish passage, were made up of trees and debris. Some blockages had additional concrete, sediment and plywood. The remaining one third of the blockages were beaver dams.

Photo 3.118 Eroding bank located in the southern edge of the Difficult Run Stream Valley Park in the Clarke's Landing subdivision directly north of the terminus of Timberline Court (DFSF002.E001).

Photo 3.119 Heavily eroding bank on the South Fork Run mainstem, directly north of the intersection with Fox Mill Road and Deerfield Drive (DFSF007.E001).

Seventy-five percent of the obstructions appeared to be restricting fish passage. Twenty-five percent of the obstructions were causing moderate to minor impact on the stream condition.

3.35.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted the assessment in the fall of 2002.

- There are 37,189 linear feet (approximately 7 miles) of stream in the South Fork Run subwatershed. Of this length, two sections of stream (1,154 feet) were not assessed.
- Of the assessed reaches, 86 percent have as fair habitat for aquatic insects and fish, and 14 percent have good habitat.
- There are 7,670 feet of **riparian buffer** encroachment (left and right banks combined). Of this total 2,560 feet (65 percent) is a combination of **pervious** surfaces such as grass, shrubs, and forest. 275 feet (7 percent) is a combination of impervious surfaces such as buildings and roads, and the remaining 1,100 feet (28 percent) is some combination of impervious and pervious surfaces.
- Four reaches, or 37 percent of the buffer encroachment length, are having a severe impact on the stream. Examples of two of these reaches are shown below in Photos 3.120 and 3.121.
- Most (93 percent) of the impacted riparian zones have the potential for restoration through tree plantings.

Photo 3.121 Severe buffer impact on the mainstem of South Fork Run, directly north of the intersection of Fox Mill Road (SR 665) and Deerfield Drive in the Brians Hill Estates subdivision (DFSF007.B002).

Photo 3.122 Buffer impact located northwest of Timber Lake, in the Timber Lake subdivision (DFSF005.B001).

3.35.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in South Fork Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

A majority of the South Fork Run subwatershed is covered by a lower density residential land use. It contains approximately 12 percent impervious land cover. The two areas of commercial land use, located along southern Vale Road, and the industrial area on nearby West Ox Road, are likely contributors to the high **pollutant** loads in **catchments** DFSF9902 and DFSF9802. Refer to DFSF_4 for the catchment locations.

One of the highest **nitrogen**-loading rates in the subwatershed is found in catchment DFSF9701, located near the outlet of the subwatershed. This catchment is comprised mostly of low-density residential land use, but also some medium density residential land use. All catchments in the subwatershed have higher **nitrogen** and **phosphorus** loading rates. One of the highest nitrogen and phosphorus loading rates among the catchments is found in catchment DFSF9902, situated in the headwaters of South Fork Run, northeast of the intersection of West Ox Road and Vale Road. The model results in loading rates of 1.5

pounds per acre per year of nitrogen and 0.3 pounds per acre per year of phosphorus. Results can be seen in Table 3.63.

Table 3.65 Existing and Future Modeling

South Fork Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFSF0001	E	2.11	0.11	23.0	1.3	0.3
	F	2.17	0.12	23.8	1.3	0.3
	C	3%	9%	3%	0%	0%
DFSF0002	E	1.2	0.13	11.8	0.7	0.1
	F	1.51	0.1	14.9	0.8	0.2
	C	26%	-23%	26%	14%	100%
DFSF0003	E	2.48	0.08	23.6	1.3	0.3
	F	2.58	0.08	25.3	1.4	0.3
	C	4%	0%	7%	8%	0%
DFSF0004	E	2.41	0.11	22.0	1.2	0.2
	F	2.44	0.11	22.6	1.2	0.2
	C	1%	0%	3%	0%	0%
DFSF0005	E	1.66	0.11	16.3	0.9	0.2
	F	1.67	0.11	16.3	0.9	0.2
	C	1%	0%	0%	0%	0%
DFSF0006	E	1.38	0.12	15.1	0.8	0.2
	F	1.39	0.12	15.4	0.8	0.2
	C	1%	0%	2%	0%	0%
DFSF9701	E	2.59	0.12	27.5	1.5	0.3
	F	2.69	0.13	28.0	1.5	0.3
	C	4%	8%	2%	0%	0%
DFSF9802	E	2.16	0.12	24.4	1.3	0.3
	F	2.27	0.12	25.9	1.4	0.3
	C	5%	0%	6%	8%	0%
DFSF9902	E	2.64	0.09	34.7	1.9	0.3
	F	2.93	0.1	41.0	2.2	0.4
	C	11%	11%	18%	16%	33%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

Modeling results for future conditions show overall increases in runoff volume and pollutant loads. Catchment DFSF9902 has an area of low density residential land use increasing to medium density, which accounts for the increase in runoff volume and peak flow rate, while DFSF0002 shows the results of a forecast change from open space to estate residential.

3.35.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts, may occur. These culverts are over-capacity and do not allow all of the flow required to pass without flooding. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

One culvert in the subwatershed was overtopped with existing flows, as shown in Table 3.64. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.66 Culvert Hydraulic Modeling

Culvert	Crossing		Flood Year						
			100	50	25	10	5	2	1
4	Fox Mill Road (665)	E	x	x	x	x			

E – Existing conditions results, x – indicates overtopping

Culvert #4 (Photo 3.123) overtopped for the 10-year and greater events. This is classified as a primary road and should not be overtopped by storms more frequent than the 25-year event.

Photo 3.122 South Fork Run Mainstem at Fox Mill Road

3.35.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the South Fork Run subwatershed are listed below. Refer to DFSF_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S119 The Stream Physical Assessment survey indicated an area of severe erosion, along with active channel widening (Photo 3.118)

S120 This reach of South Fork Run near the crossing of Fox Mill Road is heavily eroded and has no stream buffer. (Photos 3.119, 3.120)

S121 The Stream Physical Assessment survey showed this to be a severely eroded reach of a tributary to South Fork Run. (Photo 3.116)

S122 The Stream Physical Assessment survey showed this reach of a tributary to South Fork Run is heavily eroded and has a deficient stream buffer.

<u>Hydrology and Water Quality</u>

D38 (Catchment DFSF9701) This catchment has one of the highest nitrogen and phosphorus loading rates in the subwatershed. Runoff loadings are also above average for this subwatershed. It generates one of the higher rates of runoff volume.

D40 (Catchments DFSF0001 and DFSF0002) These catchments show higher than average runoff volume and peak flows for the subwatershed, along with average pollutant loading from runoff.

D41 (Catchment DFSF9902) This catchment, in the upper part of the subwatershed, generates the highest runoff volume and pollutant loads in South Fork Run.

D79 (Catchment DFSF9802) Runoff flows, peaks, and pollutant loadings from this catchment are close to the average for the subwatershed.

<u>Flooding</u>

F04 The crossing of Fox Mill Road was overtopped for 10-year and greater events. Since it is classified as a primary road, the culvert should pass the 25-year event.

<u>Preservation</u>

All catchments showed approximately the same percentage increase in modeled pollutant loading, so no candidate sites were identified.

3.36 South Fork Run - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.65 below is a list of all projects proposed in this subwatershed.

Table 3.67 Recommendations for South Fork Run

Project #	Project Type	Candidate Site
DF9040A	Pond Retrofit	D-40
DF9040B	Pond Retrofit	D-40
DF9040C	Pond Retrofit	D-40
DF9040D	Pond Retrofit	D-40
DF9040E	Drainage Retrofits	D-40
DF9041A	Drainage Retrofits	D-41
DF9041B	Pond Retrofit	D-41
DF9041C	Pond Retrofit	D-41
DF9041D	LID Retrofit	D-41
DF9041E	Pond Retrofit	D-41
DF9079A	Drainage Retrofits	D-79
DF9079B	Culvert Retrofit	D-79
DF92120	Stream Restoration	S120

3.36.1 Regional Pond Alternative Projects

D40 (DFSF0001 and DFSF0002)

Site Investigation and Projects: The site investigation showed very few opportunities for retrofitting LID or stormwater management facilities within the drainage area. There are four existing stormwater management facilities that could be retrofitted to improve water quality, three of which are in the headwaters of the site. Streams within the drainage area are showing some signs of erosion, which could be reduced through retrofits. Outfalls from local storm drains typically show scour that could be mitigated with drainage retrofits.

Retrofit four existing dry ponds upstream and modify five outfall locations in lieu of constructing regional pond D40. In order to eliminate the need for a regional facility in this location, all nine of the identified improvements or functionally equivalent alternatives must be implemented.

> *DF9040A (Pond Retrofit)* This project is a retrofit located at the end of Nathaniel Oaks Drive. It consists of a retrofit to an existing dry pond to provide both channel protection and water quality treatment.
>
> *DF9040B (Pond Retrofit)* This project is located near Falkirk Drive. It consists of a retrofit to an existing instream dry pond to install a multi-stage control structure, create channel protection storage, and add features to improve water quality.

DF9040C (Pond Retrofit) This project is a retrofit of an existing dry pond near the intersection of Birdsboro Drive and Blair Ridge Road. It consists of a retrofit to an existing dry pond to increase channel protection storage and add water quality features such as a shallow wetland.

DF9040D (Pond Retrofit) This project is a retrofit of an existing dry pond at the end of Navy Drive. It consists of a retrofit to improve channel protection and water quality performance. Channels will be meandered through marsh areas for sediment and nutrient removal.

DF9040E (Drainage Retrofits) These five distributed projects are designed to provide energy dissipation at outfalls where the piped storm drain system discharges to a natural channel. Improvements would consist riprap, plunge pools, or bioengineered structures.

D41 (DFSF9902)

Site Investigation and Projects: The site investigation identified opportunities for LID retrofits, pond retrofits, and drainage retrofits. Erosion and scour were noted at most outfalls. Five projects were identified:

DF9041A (Drainage Retrofits) This project is intended to reduce scour and erosion at outfalls where flows from the storm drain system enter the stream. Reduction of erosive velocities will reduce the amount of sediment transported downstream. Additionally, this project includes the removal of concrete lined ditches to be replaced with grass-covered dry swales using stone to control critical high velocity areas.

DF9041B (Pond Retrofit) This project is a retrofit of an existing instream dry pond between Tilton Valley and Hickory Hills Drives. Retrofits should be designed to improve the baseflow path and provide channel protection storage using the control structure.

DF9041C (Pond Retrofit) This project is located on the south side of Vale Road, near Valewood Drive. The project consists of a retrofit of an existing dry pond to increase detention and channel protection storage.

DF9041D (LID Retrofit) The project is a rain garden demonstration site at a private residence along Brecknock at the intersection with a pipestem driveway. The location provides ideal topography and visibility.

DF9041E (Pond Retrofit) The project consists of an existing pond along a private drive on Vale Road. The facility appears to be an old farm pond that has been drained. A new riser along with outfall protection will reduce erosion in the nearby stream significantly

D79 (DFSF9802)

Site Investigation and Projects: The site investigation identified opportunities for one culvert retrofit and drainage retrofits. Erosion and scour were noted at most outfalls.

DF9079A (Drainage Retrofits) These distributed projects are designed to provide energy dissipation at outfalls where the piped storm drain system discharges to a natural channel. Improvements would consist of riprap, plunge pools, or bioengineered structures.

DF9079B (Culvert Retrofit) This project is at the intersection of Honda Road and Lariat Lane and consists of retrofitting the culvert and regrading the upstream area to provide channel protection storage and water quality treatment.

3.36.2 Catchment Improvement Projects

No sites were identified.

3.36.3 Stream Restoration Projects

S119

Site Investigation and Projects: The site investigation found one extremely erosive vertical streambank / valley wall. Further failure could result in loss of infrastructure on an adjacent residential property located on Timberline Court. The remaining portion of the stream is developing floodplains and stable streambed features and therefore appears to be recovering.

Fairfax County is addressing the restoration of this site with a current project so no additional work is proposed in this plan.

S120

Site Investigation and Projects: The site investigation found raw vertical streambanks and moderate to severe incision. The riparian area on the left side of the stream (looking downstream) is in pasture. One stream restoration project was identified.

DF92120 (Stream Restoration) The proposed restoration would involve constructing a nested channel and stabilizing and reshaping the streambanks. A forested buffer would be established in the pastured portion of the riparian zone.

S121

Site Investigation and Projects: The site investigation found one eroding streambank along an outer meander bend. The remaining portion of the reach investigated appeared to be recovering, so no project was identified.

S122

Site Investigation and Projects: The site investigation showed moderate incision and bank erosion with a stable sinuous pattern and stable riffle pool morphology and floodplain bench development. The stream appears to be recovering. Constraints associated with forest clearing and access outweighs the opportunity to reduce streambank erosion. No project was identified. Upstream culvert retrofit and roadway crossing improvements (DF9079B above and DF9402 below) would help reduce peak flows and allow the stream to recover to a stable state more quickly.

3.36.4 Preservation

No preservation candidate sites were identified for this subwatershed.

3.37 Rocky Branch – Subwatershed Condition

3.37.1 Subwatershed Characteristics

The Rocky Branch **subwatershed** has an area of approximately 2,167 **acres** (3.39 mi^2) with its eastern boundary running closely along Chain Bridge Road (Virginia 123). The southern boundary touches I-66, and the northern boundary is approximately located at the intersection of Vale Road (Virginia 672) and Hunter Mill Road (Virginia 674). The western boundary is approximately the Difficult Run Stream Valley Park.

There are almost 9 miles of stream in the Rocky Branch subwatershed. They flow in a northwesterly direction until they join with the mainstem of Difficult Run. Rocky Branch is composed of two major tributaries.

Refer to DFRB_1 for a map of the Rocky Branch subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.37.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

The development in the Rocky Branch subwatershed is moderately dense. Fifty percent is developed as low-density or estate residential while 3 percent of the subwatershed is developed for commercial or industrial uses. The most common land use in this subwatershed is low-density residential, which makes up 36 percent of the total. Much of the development is found concentrated along Chain Bridge Road (Virginia 123) in the southern portion of the subwatershed, and along Hunter Mill Road (Virginia 674).

Transportation use, such as roads and highways, make up 223 acres, or 10 percent of the overall subwatershed. Total impervious area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 376 acres, or 17 percent of the total subwatershed area.

Fifteen percent of the land in the subwatershed is preserved for open space or parks. Major parks include Tattersall Park, Oak Marr Park, Oakborough Square Park, Ashlawn Park, and a portion of Kemper Park. There are two historical sites within the subwatershed.

Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition. A summary of land use within the subwatershed can be found in Table 3.66.

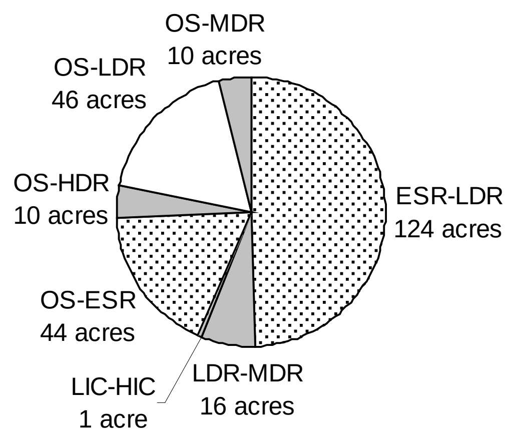
Table 3.68 Existing and Future Land Use

Land Use Type	Existing Acres	Existing Percent	Future Acres	Future Percent	Change Acres	Change Percent
Open space, parks, and recreational areas	322	15%	213	10%	-109	-5%
Golf Course	71	3%	71	3%	0	0%
Estate residential	296	14%	215	10%	-80	-4%
Low-density residential	780	36%	934	43%	154	7%
Medium-density residential	268	12%	293	14%	26	1%
High-density residential	53	2%	62	3%	10	0%
Low-intensity commercial	7	0%	6	0%	-1	0%
High-intensity commercial	64	3%	65	3%	1	0%
Industrial	0	0%	0	0%	0	0%
Institutional	84	4%	84	4%	0	0%
Transportation	223	10%	223	10%	0	0%
Water	0	0%	0	0%	0	0%
Total	**2,167**	**100%**	**2,167**	**100%**		**0%**

When comparing existing land use to future land use, there are several land use changes. The notable changes are projected in the open space, estate residential, and low-density residential land use categories. Losses projected in the open space (-5 percent) and estate residential (-4 percent) categories are balanced with gains in the low-density residential (+7 percent) and medium-density residential (+1 percent) categories. This suggests that there is a demand to increase the density of the housing base in the Rocky Branch subwatershed.

According to Figure 3.18, 124 acres are projected to shift from estate residential in the existing land use to low-density residential in the future land use. A total of 110 acres, or 44 percent of all land use changes, are projected to shift from open space in to a residential use. This open space area can be used for development/ redevelopment in the future if and when the need presents itself.

Figure 3.18 Changed Land Use



3.37.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate that there are 33 **stormwater management facilities** within the Rocky Branch subwatershed. Seventy-five percent of the Rocky Branch subwatershed is not served by any stormwater management facility. Twenty percent of the total area has quantity control only and the remaining 5 percent receives both **quantity and quality control**. A list of all stormwater management facilities in the Rocky Branch subwatershed can be found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. Field crews located seven **outfall** pipes during the Stream Physical Assessment discharging into the Rocky Branch tributaries. No pipes had significant impact, such as erosion or water quality issues, on the stream channel

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. The Stream Physical Assessment fieldwork identified 34 stream crossings in Rocky Branch, all of which were in adequate condition and have less than a moderate impact on the stream's integrity. The majority of the crossings (approximately 44 percent) were footbridges.

3.37.4 Soils

Soils found in the Rocky Branch subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes which can result in rapid **runoff** and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 42 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (28 percent). Zones with Glenelg, Manor and Elioak soils may be compatible with infiltration practices. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.37.5 Geomorphology

All 8.7 miles (46,291 feet) of stream channels in the Rocky Branch subwatershed were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. Refer to DFRB_3 for the stream classifications.

Photo 3.123 Erosion point on a tributary off of the mainstem of Rocky Branch. East of Oakton Ridge Court in the Oakton Mill Estate subdivision (DFRB010.E001)

Fifty-six percent of the reaches are Type III, which is indicative of an actively widening stream channel. Thirty-seven percent are Type II, which indicates the active incistion and the remainder of the reaches (7 percent) is Type IV, which is the stage where the stream is recovering and developing a new floodplain.The dominant substrate in the majority (78 percent) of reaches is a combination of gravel and silt. The dominant substrate types in the remaining 22 percent of reaches are sand (17 percent) and clay (4 percent).

There were 15 erosion points of approximately 12,095 feet noted in the subwatershed. Seventy-one percent of the erosion points are having a severe impact on stream condition.

Eighty-one percent of the stream length was classified as moderately unstable with high erosion potential during flood events. Seventeen percent of the stream length was moderately stable with only slight potential for erosion at flood stages. Several of the erosion points are shown in Photos 3.123 to 3.126. Photos 3.123, 3.127 and 3.130 are candidate site S127. Photos 3.125 and 3.126 are candidate site S128. Photo 3.128 is candidate site S128. Candidate site S130 is shown in Photos 3.124 and 3.131.

Photo 3.124 Erosion point on the west side of Hunter Mill Road at the intersection with Conejo Land (DFRB012.E001).

Photo 3.125 On a tributary northwest of the cul-de-sac of Westhurst Court in the Windsong community. (DFRB015.E001).

Photo 3.126 On a tributary northwest of the cul-de-sac of Westhurst Court in the Windsong community. (DFRB015.E002).

Photo 3.127 Obstruction on a tributary to Rocky Branch, directly east of Oakton Ridge Court in the Oakton Mill Estates (DFRB010.T001).

There were eight stream blockages made up mostly of trees and debris. Twenty-five percent of the obstructions appeared to be restricting fish passage. Sixty-three percent of the obstructions were causing moderate erosion to the stream. One obstruction was causing greater than moderate erosion. This one is shown above in Photo 3.127 (candidate site S128)

3.37.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one-time visual inspection. Field crews conducted that assessment in the winter of 2002/2003.

Photo 3.128 Buffer impairment south of Miller Road in the Flint Hill Lower and Middle Campus (DFRB004.B001)

Photo 3.129 Buffer encroachment on a tributary south of Marbury Road in the Hunting Hills subdivision (DFRB016.B002).

- Of the assessed reaches, 59 percent has poor habitat for aquatic insects and fish. There are 25,505 feet of **riparian buffer** encroachment (this length includes left and right banks combined). Of this, 18,800 feet (74 percent) is a combination of **pervious** surfaces, and the remaining 6,705 feet (26 percent) is some combination of impervious and pervious surfaces. Seventy-eight percent of the length has moderate to high restoration potential. Eight reaches, or 34 percent of the buffer encroachment length was severe enough that the stream conditionwas being degraded. Several buffer impacts are shown in Photos 3.128 to 3.131. Photo 3.129 is candidate site S130.
- Seventy-one percent of the stream had some channelization present. In 28 percent of the stream, there were some minor alternations to the channel, but no recent evidence of alteration activities.

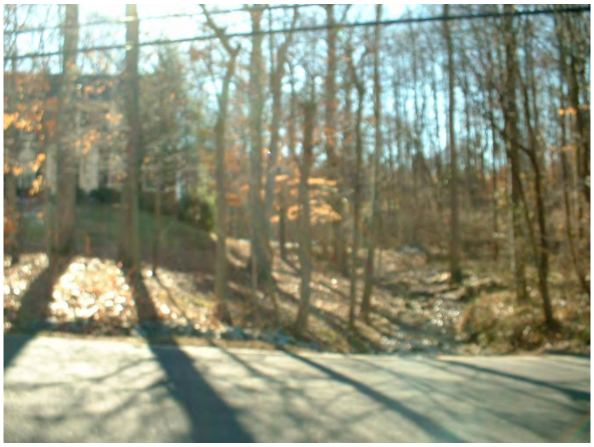


Photo 3.130 Buffer impairment south of Miller Road in the Windsong community (DFRB014.B001).

Photo 3.131 West side of Hunter Mill Road, south of intersection with Conejo Lane (DFRB012.B001)

- Forty-seven percent of the stream length had between 50 percent and 70 percent of both stream banks covered by vegetation. Typically this vegetation is scattered grasses, shrubs and forbs. Forty percent of the stream length had a variety of vegetation and covered 70 percent to 90 percent of the stream bank surface. Thirteen percent of the stream length had less than 50 percent of the stream bank covered by vegetation.

3.37.7 Hydrology and Water Quality Modeling

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Rocky Branch incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

In the Rocky Branch subwatershed, over 17 percent of the land is covered by impervious surface. More than 50 percent of the subwatershed is either low density or estate residential land use. There are also a few commercial areas located in the southern part of the subwatershed as well as high-density residential areas.

The nitrogen and phosphorus loading rates are highest in **catchment** DFRB0005, located to the east of Hunter Mill Road and Marbury Road. Refer to DFRB_4 for the catchment locations. The highest amount of nitrogen from runoff comes from this catchment, which contains mostly medium-density residential areas around Lake Vale Estates and Vienna Glen, as well as a high-density residential area along Chain Bridge Road. The phosphorus levels fluctuate with the nitrogen levels throughout the catchment. Catchment DFRB0004 has the highest runoff volume probably due to the lack of open space, along with the abundance of medium and low-density residential land use. Refer to Table 3.67 for the results.

Table 3.69 Existing and Future Modeling

Rocky Branch Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFRB0001	E	1.73	0.16	20.8	1.0	0.2
	F	1.96	0.17	24.9	1.2	0.2
	C	13%	6%	20%	20%	0%
DFRB0002	E	2.22	0.15	18.9	1.0	0.2
	F	2.36	0.16	20.6	1.1	0.2
	C	6%	7%	9%	10%	0%
DFRB0004	E	3.99	0.13	50.3	2.7	0.6
	F	4.12	0.14	53.3	2.8	0.6
	C	3%	8%	6%	4%	0%
DFRB0005	E	4.19	0.13	63.1	3.2	0.6
	F	4.47	0.14	69.5	3.5	0.7
	C	7%	8%	10%	9%	17%
DFRB0006	E	3.19	0.12	42.8	2.2	0.4
	F	3.37	0.12	46.9	2.5	0.5
	C	6%	0%	10%	14%	25%
DFRB0007	E	2.67	0.1	26.9	1.4	0.3
	F	2.87	0.11	30.0	1.6	0.3
	C	7%	10%	12%	14%	0%
DFRB0008	E	2.35	0.16	16.5	0.9	0.2
	F	2.47	0.16	17.6	0.9	0.2
	C	5%	0%	7%	0%	0%
DFRB9801	E	4.78	0.12	84.0	3.4	0.5
	F	4.99	0.13	91.7	3.8	0.5
	C	4%	8%	9%	12%	0%
DFRB9802	E	2.29	0.16	22.7	1.3	0.3
	F	2.45	0.16	25.1	1.4	0.3
	C	7%	0%	11%	8%	0%
DFRB9901	E	5.72	0.15	106.6	4.3	0.5
	F	6.27	0.17	123.3	5.0	0.6
	C	10%	13%	16%	16%	20%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures.

Modeling results for future conditions show moderate increases in pollutant loads and in runoff volume in all catchments, most due to increases in residential density on already developed parcels.

3.37.8 Hydraulic Modeling Results

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts, may occur. The capacity of the culverts is not enough that flow passes without flooding. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

One culvert in the subwatershed was overtopped with existing flows, as shown in Table 3.68. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.70 Culvert Hydraulic Modeling

			Flood Year						
Culvert	Crossing		100	50	25	10	5	2	1
17	Miller Road (663)	E	x	x	x	x	x		

E – Existing conditions results, x – indicates overtopping

Culvert #17 (Photo 3.132) overtopped for events less frequent than the 5-year storm. This can be classified as a local road, which means the culvert should be able to pass the 10-year event.

Photo 3.132 Rocky Branch tributary at Miller Road

3.37.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Rocky Branch subwatershed are listed below. Refer to DFRB_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

<u>Streams</u>

S47 The Stream Physical Assessment identified the entire reach from the confluence with Difficult Run to the upstream reaches at Oakton Glen Road as having poor habitat, low bank stability, and a widening channel.

S127 The Stream Physical Assessment identified poor habitat, 2700 feet of buffer impact and over 1,000 linear feet of erosion along Miller Road (Photo 3.128).

S128 The entire length from the confluence with Difficult Run to the headwaters has a combination of bank erosion, poor habitat and a widening channel. The reach traverses the Oakton Mill Estates, Miller Heights, and Windsong Communities (Photos 3.123, 3.127 and 3.130).

S129 A small tributary to one of the major Rocky Branch tributaries with poor habitat, low bank stability, and approximately 400 linear feet of severe erosion (Photo 3.125 and 3.126).

S130 The Stream Physical Assessment located approximately 1,000 feet of buffer encroachment in the Hunter Hills community. The reach appears to be on an agricultural land use (Photo 3.129).

S131 The Stream Physical Assessment identified the reach as having poor bank stability, poor habitat, buffer impacts, eroding banks and several crossings (Photo 3.124 and 3.131).

Hydrology and Water Quality

D30 (Catchments DFRB0004 and DFRB0005) These two catchments have some of the highest levels of runoff volume, peak flows, and runoff pollutant loads in the subwatershed. While no candidate stream sites are downstream, the entire tributary through these catchments and downstream was found to have severe erosion, widening, and poor habitat.

D31 (Catchments DFRB9801 and DFRB9802) Runoff hydrology is relatively high and pollutant loadings are among the lower in the subwatershed. Streams within these catchments are undergoing erosion and widening, particularly at site S130.

D36 (Catchment DFRB0001) Runoff volume and peaks are high in this catchment. Streams within the catchment are undergoing erosion and incision, and peak flows are contributing to stream degradation downstream.

C39 (Catchment DFRB9901) Model results were about average for the subwatershed. The catchment includes highly impervious areas of Oakton built with either no stormwater management or scattered quantity control practices. Streams through the catchment are eroding, have poor habitat, and degraded buffers.

Flooding

F17 The crossing of Miller Road was overtopped for 5-year and greater events. Since it is classified as a local road, the culvert should pass the 10-year event (Photo3.132).

Preservation

P02 (DFRB0008) This catchment has the best modeled water quality in the subwatershed, but shows runoff pollutant loads more than doubling between existing and future conditions.

P03 (DFRB9901) Model results show Catchment site C39 would have the worst runoff pollutant loads of the subwatershed under future conditions.

3.38 Rocky Branch - Subwatershed Plan Action

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.69 below is a list of all projects proposed in this subwatershed.

Table 3.71 Recommendations for Rocky Branch

Project #	Project Type	Candidate Site
DF9030A	Pond Retrofit	D-30
DF9030B	Drainage Retrofits	D-30
DF9031A	Pond Retrofit	D-31
DF9031C	LID Retrofit	D-31
DF9036A3	Pond Retrofit	D-36
DF9139	Pond Retrofit	C39
DF92130	Stream Restoration	S130
DF92131	Stream Restoration	S131
DF9839	LID Retrofit	C39

3.38.1 Regional Pond Alternative Projects

D30 (DFRB0004 and DFRB0005)

Site Investigation and Projects: The field investigation showed few opportunities for onsite stormwater management retrofits because of the relatively dense residential neighborhoods in this catchment. Much of the area is managed by stormwater management facilities. One pond retrofit, a new pond, and a drainage retrofit project were proposed.

> *DF9030A (Pond Retrofit)* The existing dry pond at the end of Martinhoe Court can be converted into a shallow wetland with vegetation throughout for water quality improvement. The project would retrofit the facility to improve water quantity treatment with a modified riser structure.
>
> *DF9030B (Drainage Retrofits)* This project consists of reconfiguring outfalls or retrofitting energy dissipation structures to reduce scour and erosion where flows from the storm drainage system enter the stream. Improvements would consist of energy dissipation through riprap, plunge pools, or bioengineered structures.

D31 (DFRB9801 and DFRB9802)

Site Investigation and Projects: Two existing ponds, which could be upgraded for water quality treatment, were identified during the field investigation, along with a site for an LID retrofit.

> *DF9031A (Pond Retrofit)* There is an existing dry pond at the outlet of the drainage area, which can be retrofit for channel protection and water quality treatment, using the existing impoundment structure and a weir across the upstream side.

DF9031C (LID Retrofit) This project is located at the intersection of Oakton Ridge Circle and Oakton Ridge Court. It consists of replacing a grass swale with a bioswale designed to provide infiltration, filtration, and nutrient uptake.

D36 (DFRB0001)

Site Investigation and Projects: The site investigation identified a pond retrofit project that could improve stream conditions below the drainage area.

DF9036A3 (Pond Retrofit) This project receives direct runoff drainage from a residential community as well as draining the remainder of the catchment. The project would provide sediment settling and nutrient removal in the form of forebays and increased detention of high frequency storms.

3.38.2 Catchment Improvement Projects

C39 (DFRB9901)

Site Investigation and Projects: Field visits showed impairments from excess nutrients in the stream, along with the ones described above. Two projects are proposed to improve catchment conditions.

DF9839 (LID Retrofit) This project consists of onsite LID retrofits distributed throughout the catchment, designed to reduce runoff volume and pollutant loads as close to the source as possible. Possible improvement measures include reduction of impervious surface, bioretention, swales, and inlet filters.

DF9139 (Pond Retrofit) This project is located near the intersection of Rosehaven Street and Jermantown Road and consists of creating detention by constructing a multi-stage riser.. Focus would be on increasing storage volume for channel protection and minimizing impacts to surrounding buildings.

3.38.3 Stream Restoration Projects

S47

Site Investigation and Projects: The site investigation showed slight bank erosion, slight incision and good riffle pool morphology. The reach appears to be recovering and access, forest clearing, and wetlands are significant restraints, so no project was identified.

S127

Site Investigation and Projects: The site investigations showed moderately unstable stream banks with some widening and floodplain benching and stable bed features. Forest clearing and wetland impacts would be required for implementation. The constraints outweigh opportunities associated with streambank stabilization. No project was identified. The pond retrofit project (DF9036A3) located directly downstream should accommodate the remaining sediment until the stream fully recovers.

S128

Site Investigation and Projects: The site investigation found some bank erosion associated with outer meander bends, moderate floodplain development and stable bed features. As the channel appears to be recovering, no project was identified.

S129

Site Investigation and Projects: The site investigation found unstable and eroding banks, moderate incision and widening, and three **headcut**s at the upstream end of the reach. The stream is still actively downcutting. However, severe wetlands, forest clearing, and access constraints make a project unfeasible, so no project was identified.

S130

Site Investigation and Projects: The site investigation showed vertical eroding stream banks, moderate to severe incision, and straight plan form. The streambed was primarily one long run and lacked riffle pool morphology. One project was identified

> *DF92130 (Streambank Restoration)* The proposed restoration would involve re-meandering the stream to provide a pattern, dimension, and profile more consistent with a natural stream. A forested buffer would be established. Existing fences would have to be set back to implement the project.

S131

Site Investigation and Projects: The site investigation showed vertical eroding stream banks and moderate to severe incision. The streambed was primarily one long run and lacked riffle pool morphology. One project was identified

> *DF92131 (Streambank Restoration)* The proposed restoration would involve re-meandering the stream to provide a pattern, dimension, and profile more consistent with a natural stream. A forested buffer would be established. Existing homeowner landscaping would have to be removed to implement the project.

3.38.4 Preservation

No preservation candidate sites were identified for this subwatershed.

3.39 Upper Difficult Run – Subwatershed Condition

3.39.1 Subwatershed Characteristics

The Upper Difficult Run **subwatershed** has an area of approximately 5,683 **acres** (8.88 mi^2). Several major highways transect the subwatershed, especially in the southern portion. Lee Highway (Virginia 29) runs east-west through the southernmost section and the intersection of I-66 and Lee Jackson Memorial Highway (Virginia 50) lie directly to the north.

The southeast watershed boundary lies along and just to the east of Shirley Gate Road (Virginia 665), and the southwest watershed boundary line is approximately West Ox Road (Virginia 608). The intersection of Hunter Station Road (Virginia 677) and Hunter Mill Road (674) lies just to the northeast of the northern subwatershed extent. Hunter Mill Road (Virginia 674) lies along the northeastern boundary line, and Stuart Mill Road (Fairfax County 0900) to Vale Road (Virginia 672) provides an approximate northwestern boundary line.

There are approximately 23 miles of streams in the Upper Difficult Run subwatershed. The streams flow in a northeasterly direction. Tributaries Rocky Branch, Little Difficult Run, Angelico Branch, and Snakeden Branch join the mainstem before flowing into the Middle Difficult Run subwatershed.

Refer to DFDFU_1 for a map of the Upper Difficult Run subwatershed highlighting the Subwatershed Characteristics including, existing **land use**, **flood limit**, **wetlands**, **resource protection areas** and **stormwater management**.

3.39.2 Existing and Future Land Use

The type and density of land use in a subwatershed can affect the downstream water quality and stream condition. While each land use type introduces issues to the natural stream system, more intense land use types, such as high-density residential, commercial and industrial, can have high levels of **impervious** surface and contribute **runoff** and **pollutants** to the stream system. Less intense types such as open space and estate residential are generally less impervious, have more natural vegetation and therefore have less impact on stream quality.

Development in the Upper Difficult Run subwatershed is moderately to highly dense. It is more densely developed in the southern portions than in the northern areas, indicating a higher amount of impervious surface. Forty-six percent is developed as low-density or estate residential while 6 percent of the subwatershed is developed for commercial or industrial uses. The most common **land use** in this subwatershed is low-density residential (25 percent). Much of the development is found near the intersection of Interstate-66 with the Lee Jackson Memorial Highway (Virginia 50), and also along Lee Highway (Virginia 29).

Transportation use, such as roads and highways, make up for 633 acres, or 11 percent of the overall subwatershed. Total impervious area for the subwatershed, which includes all roads, parking lots, residential driveways and buildings, is approximately 1,043 acres, or 18 percent of the total subwatershed area.

Twenty-one percent of the land in the subwatershed is preserved for open space or parks. Major parks include Random Hills Park, Penderbrook Golf Course, a portion of Tattersall Park, a large portion of Difficult Run Stream Valley Park, Foxvale Park, a portion of Clarks Crossing Park, Kutner Park, and Gabrielson Gardens Park. Two historical sites lie within the subwatershed. A summary of land use within the subwatershed can be found in Table 3.70.

Table 3.72 Existing and Future Land Use

	Existing		Future		Change	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Open space, parks, and recreational areas	1,199	21%	870	15%	-329	-6%
Golf Course	130	2%	130	2%	0	0%
Estate residential	1,172	21%	974	17%	-197	-3%
Low-density residential	1,442	25%	1826	32%	384	7%
Medium-density residential	142	2%	189	3%	48	1%
High-density residential	457	8%	472	8%	15	0%
Low-intensity commercial	17	0%	55	1%	38	1%
High-intensity commercial	331	6%	367	6%	36	1%
Industrial	22	0%	22	0%	0	0%
Institutional	131	2%	138	2%	7	0%
Transportation	633	11%	633	11%	0	0%
Water	8	0%	8	0%	0	0%
Total	**5,683**	**100%**	**5,683**	**100%**		**0%**

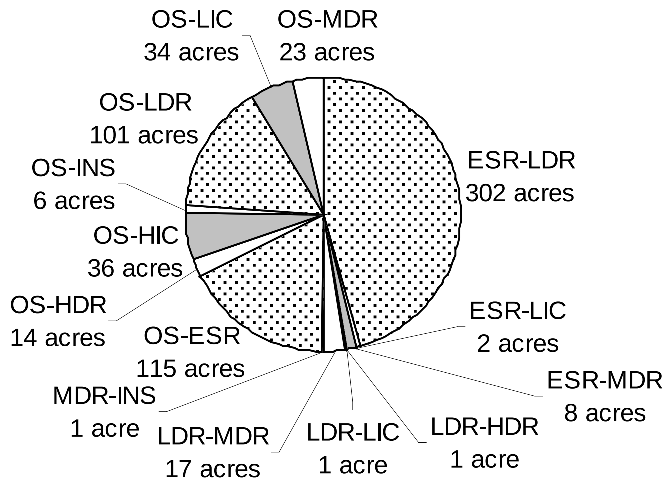
Changes in the land use that result in higher intensity uses in the future can present problems for streams. For example, if the land use shifts from open space to high-intensity commercial use, additional buildings, roadways and parking lots may replace the forest and open fields and impact stream condition.

When comparing existing land use to future land use, there are several land use changes. Notable changes are likely in the open space, estate residential, low-density residential, and low-intensity commercial land use categories. Decreases are expected in the open space (-6 percent) and estate residential (-3 percent) categories. Increases are projected in the low-density residential (+7 percent), medium-density residential (+1 percent), low-intensity commercial (+1 percent), and high-intensity commercial (+1 percent) land use categories. These shifts suggest that there is a demand to slightly increase the density of the housing base and the number of commercial activities in the Upper Difficult Run subwatershed.

Between existing and future land use, 329 acres, or 52 percent of all changed land use acreage, will shift from open space to a higher-density use. This does not guarantee that the open space will become developed – it suggests that these areas of open space can be used for development/ redevelopment in the future.

Three-hundred and two acres, or 47 percent of all land use changes, are projected to shift from an estate residential use to a lower-density residential use.

Figure 3.19 Changed Land Use



3.39.3 Existing Stormwater Management

Stormwater management provides treatment of otherwise uncontrolled runoff to reduce the harmful effects of increased stormwater flows and stormwater runoff pollution. County records indicate 60 stormwater management facilities within the Upper Difficult Run subwatershed. Seventy-six percent of the Upper Difficult Run subwatershed is not served by any **stormwater management facility**. Nineteen percent of the total area has quantity control only and the remaining 5 percent receives both **quantity and quality control**.

The difference between the amount of total developed area in the subwatershed (76 percent) and the area served by stormwater management (24 percent) indicates a possible need for additional management efforts. Areas that need more management include the low-density residential areas found throughout the subwatershed. In addition, the high-density residential and commercial areas located in the headwaters along and south of the intersection of I-66 and Lee Jackson Memorial Highway (Virginia 50) require more management. A list of all stormwater management facilities in the Upper Difficult Run subwatershed can be found in Appendix D.

Outfalls

The storm drainage system connects the developed portions of the land to the stream system. Stormwater outfalls are located where the stormwater system ends and the natural channel begins. Outfalls may be sources of pollutants and excessive stormflow from pipes can cause erosion at the outfall and downstream. During the Stream Physical Assessment, field crews located 43 outfall pipes discharging into the stream system. Most of these are in the southern portion of the subwatershed. No pipes in Upper Difficult Run were identified that have a significant impact on the stream channel.

Stream Crossings

Stream crossings, such as bridges and culverts are often locations of erosion and flooding. The combination of aging structures and frequently high stormwater levels can cause downstream stream stability problems and habitat impairment. Results of the Stream Physical Assessment identify 108 crossings in the Upper Difficult Run subwatershed. Two crossings were having a significant impact on stream condition or instream habitat. The crossings are pipe culverts that have adequate structural condition but could be improved to enhance stream integrity and avoid future problems. These are located between Blenheim Drive and Lochinver Lane and between Lochinver Lane and Lakenheath Way. Erosion at the downstream end of the culvert between Lochinver Lane and Lakenheath Way can be seen in Photo 3.133.

Photo 3.133 Pipe culvert between Lochinver Lane and Lakenheath Way.

3.39.4 Soils

Soils found in the Upper Difficult Run subwatershed belong primarily to the Glenelg – Elioak – Manor association. This association consists of rolling and hilly landscapes, which can generate rapid **runoff**, and **micaceous** soils, which are erodible. The **groundwater** is fairly shallow with numerous natural springs. The subwatershed contains 59 percent of the B hydrologic soil group with Glenelg silt loam being the dominant soil type (38 percent). B soils and the Glenelg soil type are compatible with **infiltration** practices and may provide potential stormwater management sites. Soils that cover at least 20 acres within the subwatershed can be found in Appendix A.

3.39.5 Geomorphology

There are approximately 21.8 miles of stream in the Upper Difficult Run subwatershed that were assessed and assigned a **Channel Evolution Model** classification as part of the Stream Physical Assessment. The classification indicates the stream channel's physical condition and stability as a response to disturbances such as upstream land use changes. Four stream reaches (6,397 feet), 5 percent of the total stream length, were not assessed because they were ponds or wetlands.

The majority of the assessed length in Upper Difficult Run was characterized as Type III, which is an unstable channel with eroding banks that is actively widening in response to changes in flow. Many of the tributaries within the watershed were characterized as Type II, which indicates active incision and downcutting in the stream channel. Seventy-one percent of the stream length is moderately unstable to unstable with undercut banks and high erosion potential during flood events. The channel substrate in this portion of Difficult Run is primarily comprised of a mix of gravel, sand, and silt. There are also stream sections where bedrock was noted.

There were 34 specific areas along the entire stream length where field crews noted erosion. They range in length from 75 to 3600 feet. All areas of erosion were at least moderate in severity with 20 of these having a severe impact on the channel stability and instream habitat.

Two of the more severe areas with the highest restoration potential are located in the northern portion of the subwatershed. These are shown in Photos 3.134 and 3.135. Photo 3.134 is candidate site S133. The two locations that were considered extreme erosion can be seen in Photos 3.136 and 3.137. These photos are candidate site S37.

Photo 3.134 Erosion noted by field crews just east of Hunters Crest Way (DFDF009.E001).

Photo 3.135 Erosion along Difficult Run located just east of Hunter Mill Road and south of the Washington and Old Dominion Railroad Trail (DFDF008.E002).

Photo 3.136 Area of extreme erosion with moderate restoration potential. This area is located near the end of Blenheim Drive (DFDF029.E001).

There are 37 obstructions, such as fallen trees or debris, located within the Upper Difficult Run subwatershed. All of the obstructions are thought to be restricting fish passage. Twenty-three of these obstructions were assigned an impact score of extreme, indicating that the obstruction is causing significant erosion problems or potential for **flooding** that could damage infrastructure. At these points the stream is at least 75 percent blocked, usually by trees, debris and sediment. Examples of two sites that have an extreme impact on stream integrity are shown in Photos 3.138 and 3.139 below.

Photo 3.137 Severe erosion with moderate restoration potential located near the end of Lapham Drive (DFDF028.E001).

Photo 3.138 Stream blockage located between Oakton Road and Waples Mill Road (DFDF042.T001).

Photo 3.139 Stream blockage located upstream of the area shown in Photo 3.139 (DFDF043.T002).

Eight of the most severe blockages are located on the Difficult Run mainstem in the central portion of the subwatershed. Removal of these blockages would allow easier fish passage to the more upstream portion of mainstem Difficult Run and upstream tributaries.

3.39.6 Stream Habitat and Water Quality

All stream reaches are of moderate to high slope and are generally characterized as having a predominance of **riffle** and **run** stream type. The stream reaches have the following stream habitat and water quality characteristics as taken from the Stream Physical Assessment, which provides a one time visual inspection. Field crews conducted that assessment in the fall and early winter of 2002 and 2003.

- There are 15 miles of buffer encroachment (this length includes left and right banks combined); of this total 44 percent is a combination of lawn and grasses, 41 percent is any combination of pavement and grasses/forbs/lawn, and 3 percent is pavement. Seventy-eight percent of the total length of buffer encroachment was having a severe impact and degrading the stream character. Photo 3.140 shows a roadway buffer encroachment along the mainstem. This is candidate site S38.

Photo 3.140 Roadway buffer encroachment near Waples Mill Road (DFDF034.B001).

Photo 3.141 Dumpsite located between Oakton Road and Waples Mill Road. DFDF042.M001

Fifty-eight percent of the total stream length (and just over half of mainstem Difficult Run) has poor habitat for aquatic insects and fish. Thirty-two percent has fair habitat, and 2 percent (headwater reaches) are very poor. Only 2 percent of the total length is considered good habitat for aquatic insects and fish, which is a single upstream reach that crosses under I-66 near Pender Business Park.

- There is one dumpsite, a place where trash is deposited illegally, located between Oakton Road and Waples Mill Road. The site is located along the streambank within the floodplain and was assigned an impact score of seven, indicating that the site is greater than 2,500 square feet in size and may be active (Photo 3.141). This is candidate site S132.

3.39.7 Hydrology and Water Quality Monitoring

The water quality and quantity were modeled for each subwatershed and **catchment** in the Difficult Run watershed to provide estimates that can be used for planning. The models used in Upper Difficult Run incorporate data on the amount, character and location of the land use, impervious cover, topography, vegetation, streams and stormwater management to generate estimates of water quality and quantity in the streams. Water quality modeling includes **pollutant loading** estimates for total **nitrogen** (TN), total **phosphorus** (TP) and total **suspended solids** (TSS). Because changes in land use effect the amount of runoff, streamflow, the quantity modeling estimates the amount of runoff generated by the land during rainfall and the peak streamflow or **discharge** that results.

Modeling of future conditions generally uses the same data inputs and estimates the same parameters but does so with future land use information. The future land use is a prediction of how land use would change based on the current zoning designations and the Comprehensive Plan. The difference between the existing and future model results identifies areas that will need additional management measures.

In the Upper Difficult Run subwatershed, roughly 18 percent of the land is covered by impervious surface. This imperviousness is concentrated in the headwaters of the subwatershed, along with the only areas of high density residential and most of the commercial land use. In terms of **nitrogen** and **phosphorus** runoff, the areas around I-66 and the Lee Jackson Memorial Highway (Virginia 50) have the highest loading rates per acre. The highest nitrogen and phosphorus loading rates is found in **catchment** DFDF9501, located in the area of Pender Business Park. Refer to DFDFU_4 for the catchment locations. The areas at the southern-most portion of the subwatershed also have the highest runoff volumes and peak flow rates due to the high amount of imperviousness. The catchment with the highest amount of runoff volume is DFDF9701, which contains commercial and industrial use. Refer to Table 3.71 for the results.

Table 3.73 Existing and Future Modeling

Upper Difficult Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
DFDF0001	E	6.35	0.19	145.5	5.5	0.6
	F	7.69	0.19	220.6	8.0	0.8
	C	21%	0%	52%	45%	33%
DFDF0003	E	3.32	0.1	83.7	3.2	0.3
	F	3.93	0.1	109.0	4.2	0.4
	C	18%	0%	30%	31%	33%
DFDF0005	E	9	0.22	220.6	8.0	0.8
	F	9.7	0.25	246.1	8.8	0.9
	C	8%	14%	12%	10%	13%
DFDF0007	E	6.73	0.27	28.5	1.6	0.3
	F	7.1	0.29	36.9	2.0	0.4
	C	5%	7%	29%	25%	33%
DFDF0009	E	12.21	0.28	213.7	7.9	0.8
	F	12.75	0.3	242.4	9.0	1.0
	C	4%	7%	13%	14%	25%
DFDF0011	E	2.49	0.12	32.0	1.4	0.2
	F	3.29	0.14	45.1	2.1	0.4
	C	32%	17%	41%	50%	100%
DFDF0013	E	1.88	0.12	24.5	1.1	0.2
	F	2.8	0.14	39.9	1.9	0.3
	C	49%	17%	63%	73%	50%
DFDF0015	E	1.42	0.12	13.4	0.7	0.1
	F	1.61	0.12	15.5	0.8	0.2
	C	13%	0%	16%	14%	100%
DFDF0017	E	2.33	0.1	21.5	1.2	0.2
	F	2.4	0.1	22.2	1.2	0.3
	C	3%	0%	3%	0%	50%
DFDF0019	E	1.73	0.14	15.5	0.8	0.2
	F	1.78	0.14	15.9	0.9	0.2
	C	3%	0%	3%	13%	0%
DFDF0021	E	1.38	0.14	11.9	0.7	0.1
	F	1.5	0.14	13.2	0.7	0.1
	C	9%	0%	11%	0%	0%
DFDF0023	E	2.59	0.09	19.7	1.1	0.2

Upper Difficult Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
	F	2.6	0.09	19.8	1.1	0.2
	C	0%	0%	1%	0%	0%
DFDF0025	E	1.37	0.1	20.8	0.9	0.1
	F	1.44	0.11	22.2	1.0	0.1
	C	5%	10%	7%	11%	0%
DFDF0027	E	1.37	0.14	10.1	0.5	0.1
	F	1.4	0.14	10.4	0.6	0.1
	C	2%	0%	3%	20%	0%
DFDF0029	E	1.84	0.17	11.1	0.6	0.1
	F	1.86	0.17	11.1	0.6	0.1
	C	1%	0%	0%	0%	0%
DFDF0031	E	1.96	0.15	13.5	0.7	0.2
	F	2	0.15	13.9	0.7	0.2
	C	2%	0%	3%	0%	0%
DFDF0033	E	1.95	0.13	22.3	1.2	0.2
	F	2.16	0.14	29.7	1.5	0.2
	C	11%	8%	33%	25%	0%
DFDF7301	E	2.21	0.14	16.9	0.9	0.2
	F	2.34	0.15	18.3	1.0	0.2
	C	6%	7%	8%	11%	0%
DFDF7501	E	1.65	0.1	12.4	0.7	0.1
	F	2.32	0.12	21.3	1.2	0.2
	C	41%	20%	72%	71%	100%
DFDF7701	E	2.01	0.11	15.2	0.8	0.2
	F	2.72	0.13	23.7	1.3	0.3
	C	35%	18%	56%	63%	50%
DFDF7901	E	2.71	0.13	21.1	1.2	0.2
	F	2.78	0.13	21.8	1.2	0.2
	C	3%	0%	3%	0%	0%
DFDF8101	E	2.02	0.1	18.1	1.0	0.2
	F	2.18	0.11	20.0	1.1	0.2
	C	8%	10%	10%	10%	0%
DFDF8301	E	2.09	0.13	17.6	1.0	0.2
	F	2.29	0.14	20.6	1.1	0.2
	C	10%	8%	17%	10%	0%
DFDF8501	E	1.61	0.12	16.5	0.9	0.2
	F	2.42	0.14	25.9	1.4	0.3
	C	50%	17%	57%	56%	50%
DFDF8701	E	2.95	0.14	32.9	1.8	0.4
	F	2.95	0.14	32.8	1.8	0.4
	C	0%	0%	0%	0%	0%
DFDF8901	E	2.07	0.1	21.5	1.2	0.2

Upper Difficult Run Catchments		Runoff Volume (in/yr)	Peak (cfs/ac)	TSS (lb/ac/yr)	Runoff TN (lb/ac/yr)	Runoff TP (lb/ac/yr)
	F	2.2	0.1	23.0	1.3	0.3
	C	6%	0%	7%	8%	50%
DFDF9101	E	2.67	0.16	25.0	1.4	0.3
	F	2.73	0.16	25.0	1.4	0.3
	C	2%	0%	0%	0%	0%
DFDF9203	E	2.45	0.1	29.8	1.6	0.3
	F	2.71	0.11	34.9	1.8	0.4
	C	11%	10%	17%	13%	33%
DFDF9303	E	3.98	0.13	65.1	2.6	0.4
	F	4.27	0.14	70.3	2.9	0.4
	C	7%	8%	8%	12%	0%
DFDF9501	E	11.61	0.31	272.2	10.1	1.0
	F	13.29	0.37	310.1	11.4	1.1
	C	14%	19%	14%	13%	10%
DFDF9502	E	5.18	0.16	91.4	3.7	0.4
	F	5.26	0.16	99.5	3.9	0.5
	C	2%	0%	9%	5%	25%
DFDF9701	E	11.21	0.32	211.8	7.8	0.8
	F	11.83	0.34	253.1	9.3	0.9
	C	6%	6%	19%	19%	13%
DFDF9901	E	2.92	0.15	69.6	2.9	0.4
	F	3.5	0.16	92.1	3.8	0.5
	C	20%	7%	32%	31%	25%

E – Existing conditions results, F – Future conditions results, C – Change between existing and future shown as a percentage of the existing condition. Value is based on unrounded figures

Future modeling results show an increase in all parameters in almost every catchment. The largest percent increases were due to loss of open space or an increase in residential density.

3.39.8 Hydraulic Modeling

Hydraulic modeling combines topography with information concerning the stream system, the stream crossings and culverts to estimate the depth and speed of flow within the stream for various storm events. The model results indicate where overtopping of culverts may occur. The flows at this site exceed the capacity of the culvert. These sites can present a hazard and are considered candidate sites for improvement, further study and possibly a project to replace or retrofit the culvert.

Nine crossings in the subwatershed overtopped with existing flows, as shown in Table 3.72. Road crossings that experience overtopping are listed in Appendix F and it is anticipated that improvements will be pursued with VDOT independent of the watershed planning process.

Table 3.74 Culvert Hydraulic Modeling

			Flood Year						
Culvert	Crossing		100	50	25	10	5	2	1
21	W&OD Trail	E	x	x					
23	(West) Valley Road	E	x	x	x				
27	Hunter Mill Road	E	x	x	x	x	x	x	x
31	Pine Tree Drive	E	x	x	x	x	x	x	x
32	Waples Mill Road DS	E	x	x	x	x	x		
33	Waples Mill Road US	E	x	x	x				
34	(East) Valley Road	E	x	x	x	x	x	x	
38-A	Upstream of Vale Road	E	x	x	x	x	x		
38-B	Vale Road	E	x						
22	Hunters Valley Road	E	x	x	x	x	x	x	

E – Existing conditions results, x – indicates overtopping

Culvert #21 (Photo 3.142) overtopped for the 50 and 100-year events. As this is not a roadway traveled by cars and does not overtop more frequently, it is not considered a candidate site.

Photo 3.142 Difficult Run Mainstem at W&OD Trail

Photo 3.143 Difficult Run Tributary at Valley Road

Culvert #23 (Photo 3.143) overtopped for the 25, 50, and 100-year events. Valley Road is a local street, used by residents to access houses. Local roads are required to pass only the 10-year event, so this culvert is also not a candidate site.

Culvert #27 (Photo 3.144) overtopped for all events. Hunter Mill Road is a primary road, used for through traffic flow. Crossings classified as primary roads are required to pass the 25-year event.

Culvert #31 (Photo 3.145) overtopped for all events. Pine Tree Drive is a local road, so it is required to pass the 10-year event.

Culvert #32 (Photo 3.146) overtopped for all events except the one and two-year. As Waples Mill Road can be considered a primary road, it must pass the 25-year event.Culvert

Photo 3.144 Difficult Run Mainstem at Hunter Mill Road

Photo 3.145 Difficult Run Tributary at Pine Tree Drive

Photo 3.148 Difficult Run Mainstem at Valley Road

Photo 3.149 Difficult Run Mainstem at Vale Road

#33 (Photo 3.147) overtopped for the 25, 50, and 100-year events. Again, Waples Mill Road is considered a primary road, used for through traffic flow. It must pass the 25-year event.

Culvert #34 (Photo 3.148) overtopped for all events except the one-year. Valley Road is a

Photo 3.146 Difficult Run Mainstem at Waples Mill Road DS

Photo 3.147 Difficult Run Tributary at Waples Mill Road US

local road, not used for through traffic. Local roads are required to pass the 10-year event.

Culvert #38-A (Photo 3.149) overtopped for all events except the one and two-year. As this is a footbridge and is not a roadway traveled by cars, it is not considered a candidate site.

Culvert #38-B (Photo 3.150) overtopped for the 100-year event. Vale Road is a primary road and is thus required to pass the 25-year event. This site is not considered a candidate site.

Culvert #22 (Photo 3.151) overtopped for all events except the one-year. Hunters Valley Road is a local access road used by resident to get to abutting properties and is not used for through traffic. This is not a candidate site.

Photo 3.150 Difficult Run Mainstem at Vale Road

Photo 3.151 Difficult Run Mainstem at Hunters Valley Road

3.39.9 Candidate Sites for Improvements

Based on the review of the assessment data and modeling results, the most serious problem areas in the Upper Difficult Run subwatershed are listed below. Refer to DFDFU_4 for site numbers and locations. (S - stream sites, C - catchment sites, D – unconstructed regional pond replacement sites, F – flooding sites, and P – preservation sites).

Streams

S37 From the Stream Physical Assessment, this reach showed severe erosion and poor or very poor habitat (Photo 3.136 and 3.137).

S38 From the Stream Physical Assessment, this reach showed severe to extreme erosion, channel widening, a degraded buffer and poor or very poor habitat (Photo 3.140).

S44 From the Stream Physical Assessment, this reach was described as unstable, with a widening channel and poor or very poor habitat.

S45 The Stream Physical Assessment showed unstable banks, poor habitat, and lack of buffer through this reach.

S46 From the Stream Physical Assessment, this reach was described as unstable, with a widening channel and poor or very poor habitat.

S48 The Stream Physical Assessment showed channel widening, poor habitat, and lack of buffer through this reach.

S63 From the Stream Physical Assessment, this reach showed severe to extreme erosion, channel widening, and poor or very poor habitat.

S68 From the Stream Physical Assessment, this reach was described as unstable, with a widening channel.

S132 The Stream Physical Assessment showed channel widening, poor habitat, and lack of buffer through this reach. A large dumpsite is also present at the site (Photo 3.141).

S133 From the Stream Physical Assessment, this reach showed severe to extreme erosion, channel widening, and poor or very poor habitat (Photo 3.134).

Hydrology and Water Quality

D32 (Catchment DFDF9101) Runoff and water quality from this area are better than average for the subwatershed and about average for all of Difficult Run; however, streambanks are unstable downstream of the site.

D33 (Catchment DFDF8701) Runoff and water quality from this area are better than average for the subwatershed, and somewhat worse than average for all of Difficult Run. Streambanks are unstable and the mainstem of Difficult Run shows severe erosion impacts downstream of the site (Photo 3.133).

D34 (Catchment DFDF8501) Runoff and water quality from this area are better than average for the subwatershed, and somewhat worse than average for all of Difficult Run. Severe erosion impacts downstream of the catchment were noted in the Stream Physical Assessment survey.

D35 (Catchment DFDF8101) Runoff flows and pollutant loads for this drainage area are better than average for both the subwatershed and all of Difficult Run. The stream through the area and downstream showed evidence of active erosion and buffer degradation.

D45 (Catchment DFDF9203) In this site, runoff and pollutant loads are better than average for the subwatershed and about average for Difficult Run. The stream through the area and downstream showed severe erosion impacts.

D59 (Catchment DFDF7901) Water quality and runoff flows from this drainage area are better than average for the subwatershed, and somewhat worse than average for Difficult Run. The stream through the catchment down to the confluence with Difficult Run was rated with severe erosion impacts.

D72 (Catchment DFDF7701) This site has better than average conditions for the subwatershed and for Difficult Run as a whole. Field investigation showed no critical stream degradation within the drainage area or downstream.

C41 (Catchment DFDF0009) This area has some of the highest flows and pollutant loads in the Difficult Run watershed. It contains part of the area on and around the Fair Oaks Mall and is highly impervious. Existing stormwater management ponds treats portions. The stream below this catchment is eroded and banks are unstable.

C42 (Catchment DFDF0005) This area has some of the highest flows and pollutant loads in the Difficult Run watershed. It contains part of the Fair Oaks Mall and a portion of I-66 and is highly impervious. Portions are treated by existing stormwater management ponds. The stream below this catchment is eroded and banks are unstable.

C43 (Catchment DFDF0001) This catchment is the site of the Government Center and has a large amount of impervious surface. It has some of the highest modeled pollutant loads and flows in the entire Difficult Run watershed.

C71 (Catchment DFDF9501) This area has among the highest modeled runoff, peak flows, and pollutant loads in the Difficult Run watershed. It is highly impervious, consisting of apartments and townhouses. There are areas of unstable streams below, including S133.

C72 (Catchment DFDF9901) This area has among the highest modeled runoff, peak flows, and pollutant loads in the subwatershed. It is highly impervious, consisting of apartments and townhouses.

<u>Flooding</u>

F27 The culvert carrying the mainstem under Hunter Mill Road overtopped for all events. Since Hunter Mill Road is a primary road, the culvert must pass the 25-year event (Photo 3.144).

F31 The culvert under Pine Tree Drive overtopped for all events. Since this is a local road, the culvert required to pass the 10-year event (Photo 3.145).

F32 This culvert overtopped for all events except the one and two-year. As Waples Mill Road can be considered a primary road, it must pass the 25-year event (Photo 3.146).

F33 This culvert was overtopped for the 25, 50, and 100-year events. Again, Waples Mill Road is considered a primary road, used for through traffic flow. It must pass the 25-year event (Photo 3.147).

F34 The culvert under Valley Road overtopped for all events except the one-year. Valley Road is a local road, so the culvert must pass the 10-year event (Photo 3.148).

Preservation

No sites were identified. Several catchments are in very good condition, but model results from future development do not make them significantly worse. This means that they are essentially preserved under the current development plans and regulations.

3.40 Upper Difficult Run - Subwatershed Plan Actions

In the previous subwatershed condition section, information from stream assessments, monitoring studies, and watershed modeling was presented to identify the location and severity of watershed impairments. For the subwatershed action plan section that follows, the candidate sites for improvement are discussed in terms of the specific impairment, a description of the project, and the goal of the project. Table 3.73 below is a list of all projects proposed in this subwatershed.

Table 3.75 Recommendations for Upper Difficult Run

Project #	Project Type	Candidate Site
DF9032A	Culvert Retrofit	D-32
DF9032B	Drainage Retrofits	D-32
DF9033	Drainage Retrofits	D-33
DF9034A	Culvert Retrofit	D-34
DF9034B	Drainage Retrofits	D-34
DF9035A	Drainage Retrofits	D-35
DF9035B	LID Retrofit	D-35
DF9045A	LID Retrofit	D-45
DF9045B	Pond Retrofit	D-45
DF9045D	Stream Restoration	D-45
DF9059A	Pond Retrofit	D-59
DF9059B	Drainage Retrofit	D-59
DF9059C	Culvert Retrofit	D-59
DF9072A	Pond Retrofit	D-72
DF9141A	Pond Retrofit	C41
DF9141B	Pond Retrofit	C41
DF9142	Pond Retrofit	C42
DF9143A	Pond Retrofit	C43A
DF9143B1	Pond Retrofit	C43B
DF9143B2	Pond Retrofit	C43B
DF9143C	Pond Retrofit	C43C
DF9143D	Pond Retrofit	C43D
DF9143E	Pond Retrofit	C43E
DF9143F2	Pond Retrofit	C43F
DF9143H	Pond Retrofit	C43H
DF9171	Pond Retrofit	C71
DF9172	Pond Retrofit	C72
DF9238	Buffer Restoration	S38
DF9244	Stream Restoration	S44
DF9245	Stream Restoration	S45
DF9263	Stream Restoration	S63
DF9741	Drainage Retrofits	C41
DF9841	LID Retrofit	C41
DF9843	LID Retrofit	C43
DF9871	LID Retrofit	C71

3.40.1 Regional Pond Alternative Projects

D32 (DFDF9101)

Site Investigation and Projects:

> *DF9032A (Culvert Retrofit)* The project would consist of a culvert retrofit or roadway improvement to create a backwater storage area at the crossing of Miller Heights Road, which would provide channel protection and water quality treatment.
>
> *DF9032B (Drainage Retrofits)* The project would include improvements to reduce scour velocities at three outfalls where storm drains discharge into natural channels below Miller Heights Road.

D33 (DFDF8701)

Site Investigation and Projects: The site investigation showed very little opportunity for stormwater management retrofits. The drainage area is small, developed with single-family residential housing, and there is no room for a culvert retrofit at Miller Heights Road.

> *DF9033 (Drainage Retrofits)* The project would include improvements to reduce scour velocities at the outlet of the culvert under Miller Heights Road and another location at the bottom of the catchment. Improvements would reduce sediment loads from stream erosion.

D34 (DFDF8501)

Site Investigation and Projects: The D-34 drainage area is a small catchment of residential land use. The best opportunity for retrofit is the culvert under Miller Heights Road.

> *DF9034A (Culvert Retrofit)* The project would consist of a culvert retrofit or redundant embankment to create channel protection storage and water quality treatment at the crossing of Miller Heights Road. The project would help reduce erosive discharge rates and velocities downstream.
>
> *DF9034B (Drainage Retrofits)* The project would include improvements to reduce scour velocities at the culvert under Miller Heights Road and four other outfalls.

D35 (DFDF8101)

Site Investigation and Projects:

> *DF9035A (Drainage Retrofits)* The project would include outlet protection improvements to reduce scour velocities at the culverts under Sweetwood Court. A second phase of the retrofits would be replacing paved roadside ditches along Sweetwood with dry swales.
>
> *DF9035B (LID Retrofit)* This project consists of replacing a paved drainage swale from Young Road with a bioswale, daylighting an existing piped system, and creating a bioretention facility at the intersection of three properties where there is currently a muddy bog.

D45 (DFDF9203)

Site Investigation and Projects:

> *DF9045A (LID Retrofit)* This project is a bioretention / rain garden facility located to the left of the drive at the Oakton Swim and Racquet Club. It should provide both runoff volume reduction and water quality benefits. Public access makes it a good outreach and education site also.

DF9045B (Pond Retrofit) The location of this project is upstream of the crossing at Waples Mill Road where there is an existing dry pond. The project is a retrofit to improve channel protection and pollutant removal using the existing storage area and impoundment structure.

DF9045D (Stream Restoration) This project will create a step-pool system to lower the effective slope of the stream, and stabilize portions by regrading the banks. Stream buffers will be restored on all project reaches.

D59 (DFDF7901)

Site Investigation and Projects:

DF9059A (Pond Retrofit) The location of this project is at an existing farm pond in the center of the catchment along Center Ridge Road. The pond is eutrophic and not designed to handle the stormwater flows draining to it. The retrofit would consist of reconstruction to provide channel protection storage and the addition of water quality features such as micro-pools and wetland vegetation.

DF9059B (Drainage Retrofit) The project would include outlet protection improvements to reduce scour velocities at the storm drain outfalls throughout the drainage area. A second phase of the retrofits is to replace paved roadside ditches along Berryland Drive with grassed channels.

DF9059C (Culvert Retrofit) The project would consist of a culvert retrofit using the existing road embankment as a supplement to the pond retrofit downstream. (DF9059A). The retrofit could be designed as a sediment trap, shallow marsh, or rain garden.

D72 (DFDF7701)

Site Investigation and Projects: The site investigation showed that the streams within the drainage area were in good condition.

DF9072A (Pond Retrofit) This project is a retrofit to an existing farm pond in the center of the catchment adjacent to Vale Road. The retrofit would consist of reconstructing the embankment to current standards and providing a control structure to create detention storage. Wetland plantings and other water quality features should be added to enhance pollutant removal.

3.40.2 Catchment Improvement Projects

C41 (DFDF0009)

Site Investigation and Projects: The site investigation showed two existing ponds in the catchment with potential for retrofit, along with potential projects in the parking areas.

DF9841 (LID Retrofit) The project consists of retrofits to the impervious area on and around Fair Oaks Mall. Individual low-impact development retrofits could include inlet filtration, removal of pavement or porous pavement, green roofs, and bioretention in parking islands.

DF9141A (Pond Retrofit) The project would consist of retrofitting and possibly expanding the only existing stormwater management facility treating more than half of the mall. Retrofits could include a combination of constructed wetlands, vegetation, dry detention, and infiltration.

DF9741 (Drainage Retrofits) The project would include improvements to reduce scour velocities at outfalls to natural channels.

DF9141B (Pond Retrofit) The pond at the bottom of the catchment on the north side of US 50 could be retrofit to provide more complete channel protection or water quality treatment, especially if designed with other improvements in the catchment. .

C42 (DFDF0005)

Site Investigation and Projects: The site investigation opportunities for culvert retrofits, pond retrofits, projects in the parking areas, and a retrofit of ponds in a downstream catchment to treat the runoff from this site.

DF9142 (Pond Retrofit) The project would consist of retrofitting the stormwater management facility on the east end of the mall to provide multi-stage discharge, vegetative uptake, and extended detention volume.

C43 (DFDF0001)

Site Investigation and Projects: The site investigation showed eleven existing wet and dry ponds in the catchment, some designed for peak shaving detention and some not designed for stormwater management. Proposed projects for this catchment would be to retrofit all the ponds to provide channel protection storage and water quality treatment. An additional project would be an LID retrofit of the Government Center parking area with bioretention. Retrofit design should be done to treat the LID facilities and all the ponds as a treatment system.

DF9143A (Pond Retrofit) The two ponds at the bottom of the catchment do not appear to be designed as stormwater management facilities. If the ponds are redesigned as a system, the wet storage within these ponds is enough to meet the calculated water quality volume for not only this location, but also an additional eight dry pond facilities located upstream.

DF9143B1 (Pond Retrofit) This project, which is one of two dry ponds near the government center, collects runoff from a high-density residential site. In a systematic retrofit, these ponds would be used for channel protection volume.

DF9143B2 (Pond Retrofit) Like project DF9143B1, this project collects runoff from a high-density residential site east of the Fairfax County Government Center. It would be retrofit to detain the one-year storm for channel protection.

DF9143C (Pond Retrofit) This pond treats runoff from a high-density residential development. It should be retrofit for channel protection.

DF9143D (Pond Retrofit) This pond treats runoff from a portion of the Government Center and the parking area. It should be retrofit for channel protection.

DF9143E (Pond Retrofit) This dry pond treats runoff from a high-density residential development. It should be retrofit for channel protection .

DF9143F2 (Pond Retrofit) This pond, treats parking lot runoff from the Government Center and surrounding areas. It would be retrofit to detain higher frequency storms for channel protection.

DF9143H (Pond Retrofit) This pond treats runoff from a portion of the Herrity Building site. It has been designed as an aesthetic amenity but could be retrofit for channel protection by modifying the riser. There is enough excess wet storage volume to construct an aquatic bench around the entire perimeter of this facility for water quality treatment.

DF9843 (LID Retrofit) The project consists of retrofits to the parking area for the Fairfax County Government Center. Individual LID retrofits could include inlet filtration, removal of pavement or porous pavement, and bioretention in parking islands with interpretive signs. As an educational measure, signs describing the facilities, and a trail to tour various stormwater management features could be included at the government center complex. A PDF format “stormwater tour” map could be added to the County’s Stormwater webpage.

C71 (DFDF9501)

Site Investigation and Projects: The site investigation showed opportunities for LID retrofits and the retrofit of a pond at the outlet of the catchment. If designed together, these two systems could provide water quality and channel protection treatment.

DF9871 (LID Retrofit) The project consists of retrofits to parking areas for all of the sites east of Pender Court. Individual LID retrofits could include inlet filtration, removal of pavement or porous pavement, and bioretention in parking islands.

DF9171 (Pond Retrofit) The project would consist of retrofitting the stormwater management facility at the outlet of the catchment. The priority for retrofits would be channel storage volume.

C72 (DFDF9901)

Site Investigation and Projects: Fieldwork showed that regional pond D-77 draining the catchment has been constructed. There is a pond treating the upper part of the area south of Lee Highway.

DF9172 (Pond Retrofit) The project would consist of retrofitting the regional stormwater management facility at the outlet of the catchment to provide channel protection, and to add water quality features to improve pollutant removal.

3.40.3 Stream Restoration Projects

S37

Site Investigation and Projects: The site investigation found moderate areas of streambank erosion. The stream appears to be recovering with the development of large point bars and stable riffle pool morphology. Significant restraints with access, wetland impacts, and forest clearing outweigh the benefits of streambank stabilization. No project was identified.

S38

Site Investigation and Projects: The site investigation found that the riparian zone along the right streambank was largely in pasture. There was also slight to moderate streambank erosion along portions of the reach. One stream restoration project was identified.

DF9238 (Buffer Restoration) The proposed restoration would involve establishing a forested buffer in the pastured portion of the riparian zone.

S44

Site Investigation and Projects: The site investigation found moderate to severe incision and moderate to severe bank erosion in the upstream portion of the reach. The middle portion of the reach is a transition to the lower portion, which is stable with good floodplain access. Bed features increased in consistency and stability in the downstream direction. One project was identified.

> *DF9244 (Stream Restoration)* The proposed restoration would involve excavating a floodplain bench and reshaping the streambanks and creating stable bed features in the upper and middle portions of the reach above a pedestrian footbridge.

S45

Site Investigation and Projects: The site investigation showed moderate incision and bank erosion with some floodplain redevelopment and point bar formation. The reach appears to be recovering. Access, wetlands, and forest clearing constraints upstream of Valley Road outweigh the benefits of streambank stabilization. A project is proposed downstream of Valley Road.

> *DF9245 (Stream Restoration)* The proposed restoration would involve excavating a floodplain bench and reshaping the streambanks. The new floodplain would be planted with native woody vegetation and grasses. A forested buffer would be established.

S46

Site Investigation and Projects: The site investigation showed a straight and incised stream with a number of driveway crossings. Streambanks are slightly to moderately eroding. The constraints associated with access and tree clearing outweigh the benefits associated with streambank stabilization. No project was identified.

S48

Site Investigation and Projects: The site investigation found that most of the reach had an intact, forested riparian buffer. The portion that did not has recently been converted to a stormwater best management practice. No project was identified.

S63

Site Investigation and Projects: The site investigation found that both banks were raw and erosive upstream of Lawyers Road. The stream is slightly incised and bed features are inconsistent and not well developed. The stream appears to be historically over widened. The riparian zone is pastured along both streambanks. One project was identified.

> *DF9263 (Stream Restoration/ Buffer Restoration)* The proposed restoration would involve excavating a floodplain bench and reshaping the streambanks. The new floodplain would be planted with native woody vegetation and grasses. Instream structures would be installed to improve bed features. A forested buffer would be established.

S68

Site Investigation and Projects: The site investigation found moderate areas of streambank erosion. The stream appears to be recovering with the development of large point bars and stable riffle pool morphology. Significant restraints with access, wetland impacts, and forest clearing outweigh the benefits of streambank stabilization. No project was identified.

S132

Site Investigation and Projects: The access to this site is restricted. The site was not in poor enough condition to warrant the impacts that would be caused by gaining access. No project was identified.

S133

Site Investigation and Projects: The site investigation found moderate bank erosion. The stream is slightly incised and bed features are inconsistent and not well developed. However, constraints associated with forest clearing and wetland impacts outweigh the benefits of streambank stabilization. No project was identified.

3.40.4 Preservation

No preservation candidate sites were identified for this subwatershed.

3.38 Watershed-Wide Projects

The characterization process that resulted in candidate sites for catchment retrofits and stream restoration projects (described in Appendix G) was used to develop projects in the highest priority areas in each subwatershed. A number of problem areas were noted during the Stream Physical Assessment that may not have been included in a stream restoration project. Projects to remediate these areas are included in this section.

Watershed-Wide Action 3.38.1: Remove dumpsites from stream corridors.

This project would consist of cleaning up dumpsites identified by the Stream Physical Assessment and disposing of the items. Two of these sites were addressed with the stream restoration projects. One site in Middle Difficult Run (DFDF055.M001) consisted of a discarded residential oil tank and was investigated by a field crew as Candidate Site S107. The oil tank was not found and presumably had been removed. The site in Little Difficult Run (DFLD013.M001) has been included with stream restoration project DF92114. Two large dumpsites containing appliances, concrete pipes, tires, and trucks were included with candidate sites S82 and S132, however no project was proposed at these sites, so the cleanup effort remains to be completed (DFPR005.M001 and DFDF042.M001). There are also three small dumpsites containing a section of CMP pipe, lawn waste and tree trimmings to be cleaned up (DFDF071.M001, DFSF008.M001, and DFDF023.M001). It is anticipated that all 5 sites will be addressed as part of an ongoing Countywide initiative.

Table 3.76: Dumpsite Projects

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Small Dumpsite	3	EA	$3,000.00	$9,000
Large Dumpsite	2	EA	$8,000.00	$16,000
			Base Cost	**$25,000**
			Mobilization (5%)	$1,250
			Subtotal 1	**$26,250**
			Contingency (25%)	$6,563
			Subtotal 2	**$32,813**
			Estimated Project Cost	**$33,000**

Watershed-Wide Action 3.38.2: Remove obstructions from stream corridors.

This project consists of removing items obstructing streamflow identified by the Stream Physical Assessment and disposing of them. There were 191 such sites in Difficult Run. Of these, 12 will be addressed with one of the proposed stream restoration projects.

Of the remaining 179 sites, 113 had an impact score of 5 or higher (moderate to severe), which indicated that the blockage was causing at least moderate erosion and should be removed. Ninety-nine of these sites consist of some combination of trees, debris, or sediment. Thirteen sites will involve removal of concrete or other man-made structures, and will require more effort than tree and debris clearing. One site is a beaver dam.

Table 3.77: Obstruction Removal Projects

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Remove trees and debris	99	EA	$3,000.00	$297,000
Remove concrete debris	8	EA	$8,000.00	$64,000
Remove man-made obstructions	5	EA	$8,000.00	$40,000
Remove beaver dams	1	EA	$3,000.00	$3,000
			Base Construction Cost	**$404,000**
			Mobilization (5%)	$20,200
			Subtotal 1	**$424,200**
			Contingency (25%)	$106,050
			Subtotal 2	**$530,250**
			Estimated Project Cost	**$530,000**

Watershed-Wide Action 3.38.3: Remove fish passage obstructions

The Stream Physical Assessment further classified obstructions by whether or not they blocked fish passage. Many of these obstructions will be cleared either through stream restoration projects or removal of higher severity obstructions. Of the remainng 66 low severity obstructions, 43 were identified as fish passage obstructions. This project is intended to remediate these sites.

Table 3.78: Fish Passage Restoration Projects

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Remove trees and debris	21	EA	$3,000.00	$63,000
Remove concrete debris	2	EA	$8,000.00	$16,000
Remove man-made obstructions	6	EA	$8,000.00	$48,000
Remove beaver dams	14	EA	$3,000.00	$42,000
			Base Construction Cost	**$169,000**
			Mobilization (5%)	$8,450
			Subtotal 1	**$177,450**
			Contingency (25%)	$44,363
			Subtotal 2	**$221,813**
			Estimated Project Cost	**$222,000**

Watershed-Wide Action 3.38.4: Repair utility crossings.

This project consists of repairing or replacing exposed or failing utility crossings. Thirty-nine sites were identified by the Stream Physical Assessment. Of these, 10 are within the limits of a proposed stream restoration project and will be addressed as part of the project.

Five of the remaining 29 utility crossings were rated moderate or severe, which means the utility is over half exposed, identifying significant erosion problems, or appears to be about to fail. There were four sanitary sewer crossings and one cable crossing that fell into this category.

Table 3.79: Utility Crossings

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Water / Sewer	4	EA	$10,000.00	$40,000
Cable / Telephone / Electric	1	EA	$5,000.00	$5,000
			Base Construction Cost	**$45,000**
			Mobilization (5%)	$2,250
			Subtotal 1	**$47,250**
			Contingency (25%)	$11,813
			Subtotal 2	**$59,063**
			Estimated Project Cost	**$59,000**

Watershed-Wide Action 3.38.5: Restore riparian buffers

This project consists of replanting riparian buffers in areas where they were determined to be deficient. Four hundred seventy-one sites comprising approximately 439,000 linear feet were identified by the Stream Physical Assessment. Of these, 97 are within the limits of the proposed stream restoration projects and will be addressed as part of the projects.

Restoration is recommended for buffer areas that are rated with a moderate or severe deficiency, and for which the restoration potential is moderate to high. Two hundred sixty-five of the 374 sites not within stream restoration projects met the severity rating, and of these, 29 had a high restoration potential, for a total of 17,650 LF.

Table 3.80: Buffer Restoration

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL
Restore buffer	17,650	LF	$25.00	$441,250
			Base Construction Cost	**$441,250**
			Mobilization (5%)	$22,063
			Subtotal 1	**$463,313**
			Contingency (25%)	$115,828
			Subtotal 2	**$579,141**
			Estimated Project Cost	**$579,000**

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4 Watershed-wide Policy and Non-Structural Recommendations

4.1 Introduction

Chapter 4 describes structural projects for the improvement of the Difficult Run watershed that can be implemented through the County's Capital Improvement Program. During meetings with the Difficult Run resident-based Steering Committee and Advisory Committee, a series of policy and land use recommendations were identified that would complement the structural measures in restoring and preserving the watershed.

Most of these recommendations are appropriate for all County watersheds and could be implemented throughout Fairfax County. They include various proposals that would typically involve amendments to the County Code and other supporting documents such as the *Public Facilities Manual*. The current approach for processing the policy recommendations from the *Difficult Run Watershed Management Plan* is to integrate these recommendations with others developed from the watershed management plans for Little Hunting Creek, Popes Head Creek, Cameron Run, Bull Run and Cub Run.

Specific ordinance amendments would then be drafted that factor in other County initiatives and address the common recommendations from all five watershed plans.

The approach used in describing candidate sites for improvements in Chapter 4 has been used below in developing the recommendations. These include recommendations to improve stream conditions, reduce runoff volume or peak flow rates, improve water quality, reduce the potential for flooding, and help preserve areas currently in good condition.

4.2 Stream Restoration

Impairment: Some streams in the Difficult Run watershed are degraded as a result of increased stormwater flow, pollutant loads, channelization, deficient buffers and other causes.

Improvement Goals: The goals of the recommendations in this section are to reduce the direct impacts of disturbances that negatively affect the stream system. Measures that have an indirect effect on streams by changing watershed runoff characteristics are described below in sections 4.3 and 4.4.

Non-Structural Measures:

> *Non-Structural Measure 4.2.1 Enhance outfall inspections and other interfaces between the man-made and natural drainage systems for scour and erosion and make repairs as necessary*. Field work completed during the Difficult Run study showed that existing outfall protection has degraded in many locations. This recommendation if implemented would result in a comprehensive inspection and improvement program to upgrade outfalls and eliminate further scour and erosion.

> *Non-Structural Measure 4.2.2 Continue and enhance the volunteer monitoring program.* Continue supporting training and using volunteers for bioassessments. Look for opportunities to expand the use of volunteers to monitor other measures of stream health, such as reporting flood stages, geomorphic measurements, or water quality testing.

4.3 Hydrology

Impairment: In many areas of the Difficult Run watershed, there are examples of the negative impacts from excessive stormwater runoff caused by impervious surfaces, which include increased volume of runoff, reduced infiltration to groundwater, reduced baseflow in streams, and higher peak flows. Streams may dry up more often, erosion of stream banks may increase, and overall habitat quality may go down.

Improvement Goals: The goal for the policies recommended below is to reduce the amount of imperviousness, or reduce the effects of impervious surfaces on streamflow. These policies should also have a beneficial effect on stormwater runoff quality.

Policy Recommendations:

Policy Action 4.3.1 Evaluate land development regulations to consider setting a maximum impervious percentage for each type of development. Current regulations focus on many aspects of development, but do not specify standards for impervious area. This proposal would set a maximum imperviousness value, depending on the type of development and/or zoning.

Policy Action 4.3.2 Evaluate requesting road widening projects to manage stormwater runoff from the entire roadway, not just the added lane widths. Current standards require that stormwater management for 2- and 10-year detention needs to be provided for any additional imperviousness created in a road reconstruction project. This approach does not mitigate any impacts from older roads built before stormwater management regulations. The recommendation is to request that reconstruction include stormwater management facilities that can manage the entire roadway in the construction zone at a lower volume storm interval such as the 1- or 2-year event for channel protection storage.

Policy Action 4.3.3 Evaluate and implement incentives for the use of porous pavers for seasonal or overflow parking, where appropriate. Many parking areas are designed for peak conditions but remain partially empty for most of the year. This recommendation proposes incentives in the development review process to encourage developers to use pavement systems that allow infiltration for the lightly-used portions of the parking lot.

Policy Action 4.3.4 Evaluate and implement incentives into County ordinances to consider establishing more stringent stormwater quality control standards for redevelopment Ideally, predevelopment conditions for redevelopment would be set at forested or open space conditions, which is similar to the standard for new development However, the new standard should ensure that redevelopment in the County's revitalization Areas and Districts is not precluded or impeded. Further study of this issue is recommended. This proposal would study a revision to the current redevelopment regulations so that redevelopment sites would manage stormwater to the same degree as new development. The long-term effect would be to bring all development in the County to current standards of stormwater management, without reducing opportunities for redevelopment.

Policy Action 4.3.5 Continue efforts to add LID design criteria and keep PFM up to date. The Public Facilities Manual (PFM), which provides design criteria for stormwater management in new development, is in the process of being updated to add LID criteria. This action recommends that updates continue as stormwater management technologies and procedures evolve in the future.

Impairment: While much of Fairfax County was developed prior to stormwater management regulations, a substantial amount of the County is treated by stormwater management facilities. These systems become less effective over time, and may fail completely, if they are not maintained.

Improvement Goals: The policies recommended below will help restore a more natural balance between baseflow and stormwater flow in the streams, increasing the effectiveness of existing stormwater management facilities by enhancing maintenance of publicly-owned systems and increasing inspections of private systems\. While not the primary goal, these policies will also bring about improvements in stormwater quality.

Non-Structural Measures:

> *Non-Structural Measure 4.3.5 Update and expand the County's database of all public and private stormwater management facilities.* Although an enhancement of the database is currently underway, this effort should be sustained on a longterm basis. The first step to enhancing the inspection program is to expand the database of stormwater management facilities to include all facilities in the County. This recommendation will involve research into development plans and stormwater management computations to build a GIS database of stormwater management facilities and the information needed to carry out inspections and estimate their effectiveness.

> *Non-Structural Measure 4.3.6 Enhance stormwater management inspection, maintenance, and enforcement programs.* Although an enhancement of the inspection program is currently underway, this effort should be sustained on a longterm basis. This action item involves reviewing current inspection standards and improving the County's procedures to increase the frequency of inspections, change the way inspections are done, create maintenance agreements, educate residential and property owners, or provide other assistance in maintaining the existing stock of stormwater management facilities.

Impairment: Two catchments comprising the right fork of Dog Run showed problems of stream erosion found during the stream assessment, high pollutant loads estimated from model results, and flooding identified through public input.

Improvement Goals: The goal for the measure recommended below is to outline a comprehensive drainage study to address all of the issues in the area.

Non-Structural Measures:

> *Non-Structural Measure 4.3.7: Conduct a drainage study and develop an improvement plan for the area.* The drainage study would include hydrologic, hydraulic, and water quality modeling to determine the frequency and cause of stream erosion and flooding, and propose solutions for upstream stormwater management. Upon completion of the study and the selection of feasible alternatives, improvement projects would be initiated to mitigate the existing drainage problems.

4.4 Water Quality

Impairment: Based on field observations, it appears that poor lawn management is contributing excess nitrogen and phosphorus to certain streams through improper fertilizer application.

Improvement Goals: Reduction of nutrient pollutant loads through education and outreach to homeowners and lawn care companies.

Policy Recommendations:

Policy Action 4.4.1 Evaluate and implement incentives that could be applied locally to encourage lawn care companies in Fairfax County to enroll in the Virginia Water Quality Improvement Program. This project would help educate lawn care companies to practice more environmentaly friendly lawn management. Education should include proper application techniques of fertilizer, and other chemicals, to reduce excess chemicals that run the risk of being washed off into streams.

Non-Structural Measures:

Non-Structural Measure 4.4.2 Education and outreach for lawn care. The project would consist of outreach to homeowners to insure that soil nutrients are tested and no more fertilizer is applied than can be taken up by vegetation.

Non-Structural Measure 4.4.3 Golf course nutrient management. Work with golf course managers within the watershed to evaluate turf management practices.

Impairment: Potentially harmful bacteria levels in urban streams are measurably higher than those in less developed areas. There are a number of sources of bacteria, including wildlife, domestic animals, and human sources from leaking sewers, or sewage bypasses and overflows.

Improvement Goals: These policies are intended to reduce the amount of harmful bacteria that reach the waterways.

Non-Structural Measures:

Non-Structural Measure 4.4.4 Enhance illicit discharge and sewer infiltration / inflow removal program to eliminate potential sewer leaks, overflows and illegal cross-connections. Of the harmful bacteria sources mentioned above, human sewage is one that is more controllable than others. This program will help reduce leaks and overflows through a more intensive program to find the sources.

4.5 Flooding

Impairment Areas of the Town of Vienna experience frequent flooding where the mainstem of Wolftrap Creek flows through a developed area bounded by Route 123, Follin Lane, Echols St, and Branch Rd.

Improvement Goals: This measure would provide a more detailed study of the causes and potential solutions for a specific area in the Wolftrap Creek subwatershed, which is beyond the scope of this watershed plan. Based on additional coordination with the Town of Vienna, other drainage problem areas may also be studied.

Non-Structural Measures:

Non-Structural Measure 4.5.1 Conduct a drainage study and develop an improvement plan to reduce flooding. The drainage study would include hydrologic and hydraulic modeling to determine the frequency and cause of flooding, and propose solutions for upstream stormwater management and/or capacity improvements to reduce the frequency and amount of flooding. The final area will be determined via coordination with Vienna. Upon completion of the study and the selection of feasible alternatives, an improvement project would be initiated to mitigate the existing drainage problems.

No other policies or non-structural measures are proposed specifically to improve or reduce flooding conditions. Many of the recommendations that improve stream hydrology are expected to reduce downstream flooding also. Chapter 4 also outlines many other recommendations to improve or reduce flooding conditions in specific subwatersheds.

4.6 Preservation

Impairment: Streams located in parcels that are undeveloped or slated for redevelopment should be protected because there is a potential that they will be degraded by the effects of urbanization.

Improvement Goals: The goal of these policies is to preserve areas in good condition and minimize the potential to be negatively affected by new development.

Policy Recommendations:

Action 4.6.1 Continue efforts to develop a forest conservation ordinance that will preserve existing woodlands. The County's tree preservation ordinance requires one-for-one replacement of trees removed during development. This policy would work toward a more effective forest ordinance that would preserve the existing woodlands rather than replace them.

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5 Summary of Watershed Plan Actions

5.1 Watershed Plan Goals, Issues, and Recommended Actions

Chapter 1 described the goals of the *Difficult Run Watershed Management Plan:*

5. To restore and protect the County's streams, 70 percent of which are in fair to very poor condition.
6. To position the County to meet state and federal water quality standards, including listed impairments for Difficult Run.
7. To support Virginia's commitment to the Chesapeake 2000 Agreement to clean the Chesapeake Bay.
8. To develop alternatives, where feasible, to the unbuilt regional ponds.

The goals were developed in partnership with Fairfax County staff and the Difficult Run Steering Committee. The plan provides a strategy to meet these goals, by identifying the watershed impairments and presenting solutions for restoration and preservation. This chapter describes the projects and policies recommended to achieve the goals of the watershed plan.

The goals and issues for the watershed were based on the project team's analysis of watershed conditions, and reviewed by the community in Steering Committee meetings and public forums, as described in Section 1.3 of this plan. The recommendations are those, which were developed for both capital improvements and Countywide policy implementation. Table 5.1 provides the list of proposed structural projects in the Difficult Run watershed. The project number, type, description and location are listed. If the project is part of a regional pond alternative, the regional pond number is also given.

The issues identified during the watershed management plan development process have been addressed in the plan as follows:

Issue 1: Stormwater runoff pollution

Structural Project Action: Carry out preliminary engineering, design, and construction of LID retrofit projects recommended in Table 5.1 below. Culvert retrofit, pond retrofit, and new pond projects will also have a positive effect on this issue.

Policy Action 4.3.5 Continue efforts to add LID design criteria and keep PFM up to date.

Issue 2: Increased stormwater runoff

Structural Project Action: Carry out preliminary engineering, design, and construction of culvert retrofit and pond retrofit projects recommended in Table 5.1 below.

Policy Action 4.3.1 Evaluate revising land development regulations to set a maximum impervious percentage for each type of development.

Policy Action 4.3.2 Evaluate requesting road construction projects to manage the whole roadway, not just the added lane widths.

Policy Action 4.3.3 Evaluate and implement incentives where appropriate for the use of pavers or porous pavement for seasonal or overflow parking.

Policy Action 4.3.4 Evaluate and implement incentives into County ordinances to consider establishing more stringent stormwater quality control standards for redevelopment.

Issue 3: Uncontrolled stormwater

Structural Project Action: Carry out preliminary engineering, design, and construction of new pond projects recommended in Table 5.1 below.

Non-Structural Measure 4.3.7 Conduct a drainage study and develop an improvement plan for the right fork of Dog Run.

Non-Structural Measure 4.5.1 In partnership with the Town of Vienna, conduct a drainage study and develop an improvement plan to reduce flooding in Vienna near Echols Street.

Issue 4: Erosion and streambank stability

Structural Project Action: Carry out preliminary engineering, design, and construction of stream restoration and drainage retrofit projects recommended in Table 5.1 below.

Non-Structural Measure 4.2.2 Enhance inspections of all outfalls and other interfaces between the man-made and natural drainage systems for scour and erosion and make repairs as necessary.

Watershed-Wide Action 3.38.2: Remove obstructions from stream corridors.

Watershed-Wide Action 3.38.4: Repair utility crossings.

Issue 5: Stream water quality

Structural Project Action: Carry out preliminary engineering, design, and construction of buffer restoration projects recommended in Table 5.1 below.

Non-Structural Measure 4.2.3 Continue and enhance the volunteer monitoring program.

Policy Action 4.4.1 Evaluate and implement incentives that could be applied locally to encourage lawn care companies in Fairfax to enroll in the Virginia Water Quality Improvement Program.

Non-Structural Measure 4.4.2 Education and outreach for proper lawn care.

Non-Structural Measure4.4.3 Golf course nutrient management. Work with golf course managers within the watershed to evaluate turf management practices.

Non-Structural Measure 4.4.4 Develop an enhanced illicit discharge and sewer infiltration / inflow removal program to eliminate potential sewer leaks, overflows and illegal cross-connections.

Watershed-Wide Action 3.38.1: Remove dumpsites from stream corridors.

Issue 6: Stream habitat loss

Structural Project Action: Carry out preliminary engineering, design, and construction of stream restoration projects recommended in Table 5.1 below.

Watershed-Wide Action 3.38.3: Remove fish passage obstructions

Watershed-Wide Action 3.38.5: Restore riparian buffers

Issue 7: Natural resource protection measures

Policy Action 4.6.2 Continue efforts to develop a forest conservation ordinance that would preserve existing woodlands.

Issue 8: Stormwater regulatory compliance

Policy Action 4.3.5 Update and improve the County's database of all public and private SWM facilities.

Policy Action 4.3.6 Enhance SWM inspection, maintenance, and enforcement programs.

Table 5.81 Proposed Improvement Projects by Subwatershed

Project	Project Type	Description	Location	Site
		Angelico Branch		
DF9051D	Culvert Retrofit	Redesign to allow for sediment transport and fish passage	Upstream of Cedar Pond Road	D-51
DF9051E	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-51
DF92117	Stream Restoration	2754 feet of stream regrading, buffer replanted	South of Whippoorwill Rd and north of Lawyers Rd	S117
		Captain Hickory Run		
DF9005B	Culvert Retrofit	Additional storage volume	At Polo Place	D-05
DF9006B	Drainage Retrofit	Riprap outlet protection	At outfalls within this drainage area	D-06
DF9007A	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-07
DF9007C	Culvert Retrofit	Use floodplain storage to settle out sediment and allow nutrient uptake	Upstream of Sunnybrook Drive	D-07
DF9007D	LID Retrofit	Reduce runoff pollutant loads	Commercial area west of Walker Road	D-07
DF9106A	Pond Retrofit	Create more storage for channel protection and water quality improvements	At Georgetown Pike	C06
DF9106B	Pond Retrofit	Create more storage for detention and water quality improvements	Downstream of Columbine Street	C06
DF9274	Stream Restoration	Excavating a new floodplain, re-meandering the stream	At end of Walker Glen Court	S74
DF9706	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C06
DF9806	LID Retrofit	A bioswale, biofiltration retention/detention facility and natural channel improvement	North of Georgetown Pike	C06
		Colvin Run		
DF9012	Pond Retrofit	Increase detention for peak flow reduction	Private property off of Crowell Road	D-12
DF9013	Pond Retrofit	Reduce peak flow rates and improve water quality treatment	In business development on Business Center Drive	D-13

Project	Project Type	Description	Location	Site
DF9013A	Pond Retrofit	Increase detention and water quality treatment	In business development on Business Center Drive	D-13
DF9014A	Culvert Retrofit	Peak flow detention and increase nutrient removal	Upstream side of Little Run Court	D-14
DF9014B	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-14
DF9118A	Pond Retrofit	Increase detention and water quality improvements	Culvert under Sunset Hills Road	C18
DF9118B	Pond Retrofit	Improve water quality treatment	Facility on south side of Dulles Toll Road	C18
DF9151	New Pond	Pond Retrofit	Improve water quality treatment and manage peak flows	C51
DF9152	Pond Retrofit	Increase detention and attenuate discharges, pollutant removal	Between Bennington Woods Road and Baron Cameron Avenue	C52
DF9213	Stream Restoration	2200 feet of streambank stabilization and trees replanted in riparian zone	In Lake Fairfax Park, west of Hunter Mill Road	S13
DF92135	Stream Restoration	1600 feet of bank stabilization and protection	South of North Shore Drive	S135
DF92136	Stream Restoration	1850 feet of bank stabilization and remove stream blockage	East of Wiehle Avenue and south of Yellowwood Court	S136
DF9249	Stream Restoration	700 feet of bank stabilization and trees replanted in riparian zone	South of Fairway Drive and west of Westbriar Drive	S49
DF9295	Stream Restoration	Adjust pattern and profile; bank protection	Mainstem, near confluence with Difficult Run	S95
DF9507B	Culvert Retrofit	Increase detention and water quality treatment	Culvert under Wiehle Avenue	C07
DF9508A	Culvert Retrofit	Induce ponding and time of concentration	Along Village Road and Baron Cameron Avenue	C08
DF9508B	Culvert Retrofit	Water quality improvements	Culvert under Baron Cameron Avenue	C08
DF9512A	Culvert Retrofit	Increase detention and water quality treatment	Culvert under North Shore Drive	C12
DF9512B	Culvert Retrofit	Increase detention and reduce peak flows	Culvert under North Shore Drive	C12
DF9512C	Culvert Retrofit	Stormwater detention and vegetative uptake	Culvert under Wiehle Avenue	C12
DF9550A	Culvert Retrofit	Provide channel protection storage	Culvert under Baron Cameron Avenue	C50
DF9551	Culvert Retrofit	Allow solids to settle and regulate flow	Upstream of Gates Meadow Way	C51

Project	Project Type	Description	Location	Site
DF9552A	Culvert Retrofit	Peak flow attenuation, sediment removal	Upstream of Bennington Woods Road	C52
DF9552B	Culvert Retrofit	Settle out solids and vegetative uptake	Upstream of North Shore Drive	C52
DF9707	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C07
DF9712	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C12
DF9750	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C50
DF9751	Drainage Retrofit	Energy dissipation at outlets to reduce scour and erosion	At outfalls within this drainage area	C51
DF9807	LID Retrofit	Rain garden	Wiehle Ave and North Shore Dr	C07
DF9808	LID Retrofit	Reduce impervious area and increase water quality	Intersection of Village Drive and North Shore Drive	C08
DF9809	LID Retrofit	Reduce imperviousness, increase flow path, improve water quality and quantity	South of the intersection of Village Drive and North Shore Drive	C09
DF9812	LID Retrofit	Reduce imperviousness, increase flow path, and plant vegetation for uptake	Between Isaac Newton Square and Wiehle Avenue	C12
DF9818	LID Retrofit	Reduce imperviousness, increase flow path, improve water quality and quantity	Throughout catchment north of the Dulles Toll Road	C18
		Difficult Run, Lower		
DF9009A	Pond Retrofit	Increase detention and improve water quality	End of Lyons Street	D-09
DF9009B	Pond Retrofit	Increase detention and improve water quality	Near Wood Glade Drive	D-09
DF9009C	Drainage Retrofit	2424 feet of paved ditch and outlet protection	At outfalls within this drainage area	D-09
DF9010A	Culvert Retrofit	Increase time of concentration and decrease peak flows	Upstream side of Forestville Drive	D-10
DF9010B	Culvert Retrofit	Increase time of concentration and decrease peak flows	Upstream side of Trotting Horse Lane	D-10
DF9010C	Pond Retrofit	Reduce peak flow rates and scour	Upstream side of Tackroom Lane	D-10
DF9010D	Drainage Retrofit	Reduce sediment load and outfall protection	At outfalls within this drainage area	D-10
DF9010E	Stream Restoration	Restore incised stream	Upstream of Tackroom Lane	D-10
DF9076A	Culvert Retrofit	Reduce erosion and the peak flow rate	Culvert under Falls Run Road	D-76

Project	Project Type	Description	Location	Site
DF9076B	Pond Retrofit	Reduce erosion and the peak flow rate	Farm pond below Falls Run Road	D-76
DF9284	Stream Restoration	918 feet of streambank stabilization and reshaping	East of Old Dominion Drive	S84
DF9285	Stream Restoration	1101 feet of stream relocation and stabilization	Where Colvin Run Road intersects Leesburg Pike	S85
DF9289	Stream Restoration	Moderate regrading, bank protection on meanders	Confluence with Captain Hickory Run	S85
DF9515A	Culvert Retrofit	Increase detention and increase settling and nutrient uptake	Under Leesburg Pike	C15
DF9515B	Culvert Retrofit	Increase detention and allow pollutants to settle out	Upstream of Locust Hill Drive	C15
		Difficult Run, Middle		
DF9011A	Pond Retrofit	Increase detention and reduce peak flow rate	Upstream of Windstone Drive	D-11
DF9011C	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-11
DF9122	Pond Retrofit	Redesign dry pond for channel protection and water quality improvements	Between Brittenford Drive and Hunt Country Lane	C22
DF92106	Stream Restoration	Stabilize streambanks and replant riparian area	Mainstem, north of Dulles Toll Road	S106
DF92108	Buffer Restoration	668 feet, replanting floodplain	South of Dulles Toll Road, east of Hunter Mill Road	S108
DF9522A	Culvert Retrofit	Increase detention time and allowing settlement of sediment and pollutants	Driveway off of Willow Crest Court	C22
DF9522B	Culvert Retrofit	Reduce peak discharges and settle out pollutants and sediment	Upstream of Brittenford Drive	C22
DF9522C	Culvert Retrofit	Increase detention time, settle out pollutants and sediment	At Brittenford Drive, east of Raleigh Hill Road	C22
DF9522D	Culvert Retrofit	Reduce peak discharges and settle out pollutants and sediment	At Brittenford Drive, east of Landon Hill Road	C22
DF9555A	Culvert Retrofit	Store runoff and settle out sediment	Upstream of Hunter Mill Road	C55
DF9555B	Culvert Retrofit	Store runoff and settle out sediment	Upstream of Dulles Toll Road	C55
DF9555C	Culvert Retrofit	Reduce peak discharges and settle out pollutants and sediment	At Brittenford Drive, east of Rosaleigh Court	C55
DF9722	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C22
DF9755	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C55
		Difficult Run, Upper		

Project	Project Type	Description	Location	Site
DF9032A	Culvert Retrofit	Create storage, reduce peak flows	Upstream side of Miller Heights Road	D-32
DF9032B	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-32
DF9033	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-33
DF9034A	Culvert Retrofit	Reduce peak discharges, reduce erosion	Upstream side of Miller Heights Road	D-34
DF9034B	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-34
DF9035A	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-35
DF9035B	LID Retrofit	Replace paved drainage swale with bioswale, create a bioretention facility	East side of Young Drive	D-35
DF9045A	LID Retrofit	Educational demonstration site for biofiltration facilities	Left of the drive at the Oakton Swim and Racquet Club	D-45
DF9045B	Pond Retrofit	Retrofit of dry facility for peak flows	By Waples Mill Road and Bronzedale Drive	D-45
DF9045D	Stream Restoration	Stabilize streambanks and replant riparian area	By Waples Mill Road	D-45
DF9059A	Pond Retrofit	Provide adequate detention for stormwater flows	Along Center Ridge Road	D-59
DF9059B	Drainage Retrofit	Energy dissipation at outlets, remove concrete ditches	At outfalls within this drainage area	D-59
DF9059C	Pond Retrofit	Increase detention, include water quality improvements	Upstream of Berryland Drive	D-59
DF9072A	Pond Retrofit	Re-build embankment, provide greater detention, nutrient uptake	Across Vale Road from Chris Wood Court	D-72
DF9141A	Pond Retrofit	Peak flow attenuation	On Fair Oaks Mall property, next to Lee Jackson Mem. Hwy	C41
DF9141B	Pond Retrofit	Provide more channel protection, water quality treatment	North side of US 50	C41
DF9142	Pond Retrofit	Enhance water quality, additional detention	East end of the Fair Oaks Mall property	C42
DF9143A	Pond Retrofit	Water quality iomprovements for this and 8 other ponds	Eastern boundary of the Fairfax County Government Center	C43
DF9143B1	Pond Retrofit	Channel protection measures	South of project DF9143A and north of Rockaway Lane	C43
DF9143B2	Pond Retrofit	Increase detention, reduce peak flows	South of project DF9143A and north of Rockaway Lane	C43
DF9143C	Pond Retrofit	Increase available volume for storage	North of Government Center Parkway	C43

Project	Project Type	Description	Location	Site
DF9143D	Pond Retrofit	Sediment forebays, remove concrete channels, increase detention volume	North side of the stream from project DF9143C	C43
DF9143E	Pond Retrofit	Retrofit for increased detention time, remove concrete channels, grass ditches	Between Glen Alden Road and Government Center Parkway	C43
DF9143F2	Pond Retrofit	Maximize detention time, create natural channels, water quality improvements	North of the Government Center building	C43
DF9143H	Pond Retrofit	Enhance water quality, additional detention s	Between Government Center Parkway and Legato Road	C43
DF9171	Pond Retrofit	Increase detention and attenuate discharges, pollutant removal	East of Pender Drive	C52
DF9172	New Pond	Increase detention time, enhance water quality feaztures	East of Lower Park Drive	C57
DF9238	Buffer Restoration	593 feet of planting a forested buffer	North of intersection of Waples Mill Road and Fox Mill Road	S38
DF9244	Stream Restoration	1016 feet of reshaping streambanks and creating stable features	North of Government Center Parkway	S44
DF9245	Stream Restoration	587 feet of reshaping streambanks, plant floodplain with native trees and grasses	North of intersection of Fairfax Farms Road and Valley Road	S45
DF9263	Stream Restoration	255 feet of excavating floodplain bench, reshape streambanks, replant floodplain	Southwest of Lawyers Road before Hunters Crest Way	S63
DF9741	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C41
DF9841	LID Retrofit	Reduce imperviousness, lengthen flow times, and improve water quality	On and around Fair Oaks Mall	C41
DF9842	LID Retrofit	Reduce imperviousness, lengthen flow times, and improve water quality	Throughout the Fair Oaks Mall property	C42
DF9843	LID Retrofit	Inlet filtration, removal of pavement or porous pavement, bioretention	Entire parking area for the Government Center	C43
DF9871	LID Retrofit	Inlet filtration, removal of pavement or porous pavement, and bioretention	East of Pender Drive	C71
		Dog Run		
DF9001A	Drainage Retrofit	Provide outfall protection	At outfalls within this drainage area	D-01
DF9001B	Pond Retrofit	Expand detention period, improve the water quality	End of Branton Lane	D-01
DF91135	Pond Retrofit	Increase the storage and the amount of treatment	Between Water Pointe Lane and the Reston Parkway	C135

Project	Project Type	Description	Location	Site
DF9202	Stream Restoration	484' of stream restoration and bank stabilization	Southwest of Leesburg Pike and east of Reston Pkwy	S02
DF9278	Stream Restoration	558' of stream restoration and bank stabilization	By Georgetown Pike and Kimberly Place	S78
DF9279	Buffer Restoration	Restore buffer	E of Stones Throw Drive	S79
DF9501B	Culvert Retrofit	Dry detention facility with water quality improvements	Upstream of Stones Throw Drive	C01
DF9501C	Culvert Retrofit	Store and treat streamflow	End of Bright Pond Lane	C01
DF9701	Drainage Retrofit	Provide energy dissipation with outlet protection	At outfalls within this drainage area	C01
		The Glade		
DF92104	Stream Restoration	Remove stormwater pipe in stream and stabilize banks	Southwest of Stirrup Road	S104
DF9540A	Culvert Retrofit	Increase the time of concentration, provide attenuation, settling solids	Upstream side of Steeplechase Drive	C40
DF9540B	Culvert Retrofit	Increase the time of concentration, settling solids	Upstream side of Colts Neck Road	C40
DF9740	Drainage Retrofit	Remove ditch channels, outfall protection	At outfalls within this drainage area	C40
		Little Difficult Run		
DF9023A	Pond Retrofit.	Retrofit of dry facility for extended detention and water quality	Between Birdfoot Lane and Raccoon Ridge Court	D-23
DF9039A	Culvert Retrofit	Discharge control and water quality improvements	Upstream side of Westwood Hills Drive	D-38
DF9039B	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-39
DF9043A	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-43
DF9043B	Pond Retrofit	Retrofit of dry facility for peak flows and water quality	Between Wild Cherry Place and Black Fir Court	D-43
DF9043C	LID Retrofit	Biofiltration swale	Next to parking lot of Fox Mill Swim and Tennis Club	D-43
DF9058A	Culvert Retrofit	Provide detention	Upstream side of Thoroughbred Road	D-58
DF9058B	Culvert Retrofit	Provide detention to reduce erosion, increase vegetative uptake	Upstream side of Folkstone Road	D-58
DF9061A	Culvert Retrofit	Provide detention and address water quality issues	At Stuart Mill Road	D-61
DF9061B	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-61

Project	Project Type	Description	Location	Site
DF9061C	Culvert Retrofit	Reduce peak discharges, increase vegetative uptake	Upstream of Foxclove Road	D-61
DF9061D	Pond Retrofit	Create storage to reduce peak discharges	Along Foxclove Road	D-61
DF92114	Stream Restoration	1115 feet of bank regrading, replant native vegetation	East of Colt Run Road before Stuart Mill Road	S114
DF9236	Stream Restoration	Excavating new floodplain, re-meandering the stream	West of intersection of Stuart Mill Road and Birdfoot Lane	S36
DF9265	Stream Restoration	Minor grading, revegetate buffer	West of Fox Mill Rd	S65
		Old Courthouse Branch		
DF9119	New Pond	Dry facility design for channel protection	West of Gosnell Road	C19
DF9157	New Pond	Reduce peak flows	At Leesburg Pike and Laurel Hill Road	C57
DF9557	Culvert Retrofit	Water quality and channel protection improvements	Upstream of Laurel Hill Road	C57
DF9157A	Pond Retrofit	Dry retrofit of D-107	Crossing of Jarrett Valley Drive	C57
DF9757	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C57
DF9819	LID Retrofit	Porous pavement, inlet filters, bioretention parking medians	Intersection of Leesburg Pike and Chain Bridge Road	C19
		Piney Branch		
DF9027A	Culvert Retrofit	Increase detention, water quality improvements	Two culverts upstream of Batten Hollow and Brookhill Roads	D-27
DF9027B	Drainage Retrofit	233 feet of ditch removal, energy dissipation at outfalls	At outfalls within this drainage area	D-27
DF9029A	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-29
DF9029B	New Pond	Modified regional pond	At site of original D-29	D-29
DF9073A	LID Retrofit	Reduce the runoff rate and volume	Madison High School and Flint Hill Elementary School	D-73
DF9073B	Drainage Retrofit	1389 feet of stream naturalization, ditch removal	At outfalls within this drainage area	D-73
DF9073C	Pond Retrofit	Redirect stream into existing farm pond	Along Riviera Drive	D-73
DF9074A	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-74
DF9129	Pond Retrofit	Increase the storage and improve water quality treatment	At the bend in Liberty Tree Lane	C29

Project	Project Type	Description	Location	Site
DF92110	Stream Restoration	Relocate the stream to the center of the natural valley	South off Fosbak Drive	S110
DF9729	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C29
DF9730	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C30
DF9830	LID Retrofit	Reduce runoff volume and pollutant loads	Along Maple Avenue and the W&OD Trail	C30
		Piney Run		
DF9002A	Culvert Retrofit	Create a storage area to decrease peak velocities	Upstream of Riva Ridge Drive	D-02
DF9002B	Drainage Retrofit	Provide outfall protection	At outfalls within this drainage area	D-02
DF9003AA	Pond Retrofit	Facility retrofit for detention, channel protection	Near Tottenham Court	D-03
DF9003AB	Pond Retrofit	Create channel protection, storage volume	Near Tottenham Court	D-03
DF9003B	Drainage Retrofit	Improvements at manmade and natural channel interfaces	At outfalls within this drainage area	D-03
DF9064A	Pond Retrofit	Increase the detention volume, water quality improvements	Behind private residences by Challedon Road	D-64
DF9064B	Culvert Retrofit	Create storage area to reduce peak discharges	North of Brevity Drive	D-64
DF9064C	Pond Retrofit	Increase detention volume and water quality function	The end of Artemel Court	D-64
DF9064D	Drainage Retrofit	Improvements at manmade and natural channel interfaces	At outfalls within this drainage area	D-64
DF9103	Pond Retrofit	Modify outflow orifice for channel protection, reduce peak flows	Between Bright Pond Lane and Fieldview Drive	C03
DF9205	Stream Restoration	Reshape streambanks, plant native trees and shrubs	South of Walker Mill Road	S05
DF9280	Buffer Restoration	684' of stream to be replanted with native trees and shrubs	On either side of Bishops Gate Road	S80
DF9503	Culvert Retrofit	Longer detention period, vegetative uptake of nutrients	Intersection of Hawthorne Court and Reston Parkway	C03
DF9504A	Culvert Retrofit	Increase detention time, reduction in the peak flows	Upstream side of Tiverton Circle	C04
DF9504B	Culvert Retrofit	Increase detention, reduce peak flows and pollutant loads	Culvert under Wiehle Avenue	C04
		Rocky Branch		
DF9030A	Pond Retrofit	Retrofit of dry facility for water quality and channel protection	End of Martinhoe Court	D-30
DF9030B	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-30

Project	Project Type	Description	Location	Site
DF9031A	Pond Retrofit	Retrofit of dry facility for peak flows and water quality	Intersection of Oakton Ridge Circle and Oakton Ridge Court	D-31
DF9031C	LID Retrofit	Replace a grassed swale with a bioswale	Intersection of Oakton Ridge Circle and Oakton Ridge Court	D-31
DF9036A3	Pond Retrofit	Provide stormwater management	Near Miller Road	D-36
DF9139	Pond Retrofit	Increase the detention volume	Intersection of Rosehaven and Jermantown Roads	C39
DF92130	Stream Restoration	918 feet of stream naturalization	West of Mystic Meadow Road, south of Hunter Mill Road	S130
DF92131	Stream Restoration	1265 feet of stream naturalization, restore buffer	West of Hunter Mill Road before intersection with Vale Road	S131
DF9839	LID Retrofit	Reducing volume and peak rates of runoff, water quality improvements, restore natural regime	Around intersection of Jermantown and Route 123	C39
		Rocky Run		
DF9019A	Drainage Retrofit	Reduce erosion at outfalls	At outfalls within this drainage area	D-19
DF9066A	Pond Retrofit	Peak flow reduction, enhance water quality treatment	Upstream of Daviswood Drive	D-66
DF9121	Pond Retrofit	Water quality retrofit	Regional pond D-67	C21
DF9291	Stream Restoration	1760 feet of streambank stabilization and buffer restoration	North of Bellview Road, south of Galium Court	S91
		Sharpers Run		
DF9020B	Drainage Retrofit	Energy dissipaters	At outfalls within this drainage area	D-20
DF9290	Stream Restoration	Stabilize streambanks and replant riparian area	Downstream of Bellview Road	S90
		Snakeden Branch		
DF9024A	Pond Retrofit	Channel protection and water quality improvements	Existing facility near Clovermeadow Drive	D-24
DF9024B	Culvert Retrofit	Detention storage and pollutant removal	Upstream of the W&OD Trail	D-24
DF9024C	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-24
DF9123B	Pond Retrofit	Peak flow reduction	Existing pond on upstream side of Sugarberry Court	C23
DF9124A	Pond Retrofit	Sediment removal, nutrient uptake	East of Barton Hill Road	C24
DF9124C	Pond Retrofit	Increase detention volume	Intersection of the Dulles Toll Road with W&OD Trail	C24

Project	Project Type	Description	Location	Site
DF92101	Stream Restoration	1160 feet of bank stabilization, outfall reconfiguration, protect utility lines	North of Sunrise Valley Road	S101
DF92102	Stream Restoration	1404 feet of bank stabilization, buffer restoration	North of Sunrise Valley Road	S102
DF9225	Stream Restoration	2597 feet of bank stabilization and floodplain reconnection	East and west of Soapstone Drive	S25
DF9523	Culvert Retrofit	Extend detention, settle solids and vegetative uptake	Upstream side of Soapstone Drive	C23
DF9524	Culvert Retrofit	Channel protection for D/S project	N of Sunrise Valley Dr, E of Preston White Dr	C24
DF9535A	Culvert Retrofit	Detention storage and peak flow reduction	Upstream side of Colts Neck Road	C35
DF9535B1	Culvert Retrofit	Increase detention storage	Culvert under Glade Drive	C35
DF9535B2	Culvert Retrofit	Increase detention storage	Culvert under Glade Drive	C35
DF9723	Drainage Retrofit	Energy dissipation and stabilization at outlets	At outfalls within this drainage area	C23
DF9724	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C24
DF9728	Drainage Retrofit	Remove concrete ditches	Along Purple Beech Drive and Ridge Heights Road	C28
DF9735	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C35
DF9835	LID Retrofit	Reduce imperviousness, increase flow paths, reduce runoff by increasing infiltration	In and around Hunters Woods Village Shopping Ctr	C35
		South Fork Run		
DF9040A	Pond Retrofit	Increase the level of stormwater management	End of Nathaniel Oaks Drive	D-40
DF9040B	Pond Retrofit	Retrofit of dry facility for peak flows and water quality	Near Falkirk Drive	D-40
DF9040C	Pond Retrofit	Retrofit of dry facility for peak flows and water quality	Near intersection of Birdsboro Drive and Country Ridge Lane	D-40
DF9040D	Pond Retrofit	Retrofit of dry facility for peak flows and water quality	End of Navy Drive	D-40
DF9040E	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-40
DF9041A	Drainage Retrofit	Energy dissipation at outlets, remove concrete ditched	At outfalls within this drainage area	D-41
DF9041B	Pond Retrofit	Retrofit of facility for peak flows	Between Tilton Valley Drive and Hickory Hills Drive	D-41
DF9041C	Pond Retrofit	Retrofit of facility for peak flows	South Vale Road, east of Valewood	D-41

Project	Project Type	Description	Location	Site
			Drive	
DF9041D	LID Retrofit	Rain garden demonstration site	Along Brecknock Street	D-41
DF9041E	Pond Retrofit	Reduce erosive flows at outfall, manage peak flows	Along a private drive off Vale Road	D-41
DF9079A	Drainage Retrofit	Reduce scour and erosion at outfalls	At outfalls within this drainage area	D-79
DF9079B	Culvert Retrofit	Increase detention	Near the intersection of Honda Road and Lariat Lane	D-79
DF92120	Stream Restoration	446 feet of reshaping banks, establish forested buffer	East of Fox Mill Road, north of Deerfield Drive	S120
		Wolftrap Creek		
DF9017A	Pond Retrofit	Increase detention and water quality features	Existing pond along Spring Ridge Lane	D-17
DF9017B	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-17
DF9028A	Drainage Retrofit	Energy dissipation at outlets, 1685 feet of ditches removed	At outfalls within this drainage area	D-28
DF9028B	Culvert Retrofit	Eliminate larger discharges, add water quality measures	End of Ashgrove Lane	D-28
DF9028C	Pond Retrofit	Include more detention and water quality improvements	Along Lupine Den Road	D-28
DF9054A	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-54
DF9054B	New Pond	Modified regional pond	Site of original D-54	D-54
DF9065A	New Pond	Implementation of planned regional facility	Near Pinstripe Court	D-65
DF9065B	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	D-65
DF9116A	Pond Retrofit	Improve channel protection and water quality treatment	Between Kilby Glen Drive and Shouse Drive	C16
DF9116B	Pond Retrofit	Improve channel protection and water quality treatment	Along Deramus Farm Drive	C16
DF9117	Pond Retrofit	Manage peak flows, plant vegetation	Between Shouse Drive and Towlston Road	C17
DF9133A	Pond Retrofit	Pollutant removal, additional detention	At the outlet to Catchment 33	C33
DF9133B	Pond Retrofit	Peak flow reduction, pollutant load removal	Upstream side of Silentree Drive	C33
DF92124	Stream Restoration	Plant native trees and shrubs in riparian zone, create nested channel, agreement with homeowners	South of Chain Bridge Road, west of Westwood Forest Road	S124

Project	Project Type	Description	Location	Site
DF92125	Buffer Restoration	Plant the riparian zone with woody trees and shrubs	Within the Westbriar Country Club golf course	S125
DF92126	Stream Restoration	Bank stabilization, replant riparian area	West of Foxstone Drive	S126
DF9520A	Culvert Retrofit	Reduce peak flows, settle solids	Culvert under Dulles Toll Road	C20
DF9520B	Culvert Retrofit	Improve channel protection	Culvert under Dulles Toll Road	C20
DF9531B	Culvert Retrofit	Increase storage, eliminate road overtopping	Above Creek Crossing Road	C31
DF9532A	Culvert Retrofit	Increase detention, use floodplain to settle solids	Upstream side of Follin Lane	C32
DF9532B	Culvert Retrofit	Increase detention, use floodplain to settle solids	Upstream side of Woodford Road	C32
DF9558	Culvert Retrofit	Extend detention, improve water quality	Upstream side of Old Courthouse Road	C58
DF9716	Drainage Retrofit	Remove concrete ditches, outlet protection	Along Tuba and Laurlin Courts	C16
DF9731	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C31
DF9758	Drainage Retrofit	Energy dissipation at outlets	At outfalls within this drainage area	C58
DF9831	LID Retrofit	Removal or renovation of parking lot	Rear parking lot on Follin Lane	C31
DF9831B	LID Retrofit	Reduce imperviousness, bioretention, rooftop detention, or green roofs	On both sides of Maple Street	C31
DF9832	LID Retrofit	Reduce imperviousness	Notre Dame and Our Lady of Good Counsel Catholic Church	C32
DF9833	LID Retrofit	Increase infiltration, reduce imperviousness	Upper third of Catchment 33	C33

5.2 Regional Ponds

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-two regional ponds were planned for eventual construction in Difficult Run. Only 10 of these were constructed leaving 52 planned facilities still unbuilt as of the date of this plan. In the areas that were to be treated by these 52 facilities, most on-site SWM facilities were waived for new development. As a result, these areas are similar to those developed before 1974, in that they have no stormwater controls.

One of the goals of the *Difficult Run Watershed Management Plan* is to find alternatives to the 52 unbuilt regional ponds in the watershed. At the beginning of the study, the drainage areas for these ponds were delineated as a catchment so that they could be assessed and modeled individually.

Each unbuilt regional pond site was treated as a candidate site for improvements. Site visits were made and alternative projects were developed where feasible. Projects were selected to provide water quality or channel protection improvements based on the type of impairment found at the site. At a number of sites, the stream system was found to be in good condition, and the drainage area to the pond was either forested or relatively undeveloped. For these locations, the recommendation was made to delete the proposed regional pond without alternatives.

The outcome of the projects is shown in Table 5.2

Table 5.82 Disposition of Unbuilt Regional Ponds

Disposition	No. of Ponds	Pond Sites
Recommend deletion of the proposed regional pond and implementation of a group of alternative projects.	10	D13, D23, D27, D32, D33, D34, D39, D41, D43, D59,
Recommend deletion of the proposed regional pond and no alternative projects are necessary.	8	D06, D16, D18, D20, D21, D69, D71, D151
Recommend deferral of the proposed regional pond and implementation of a group of alternative projects. If the alternative projects cannot be implemented, then a modified scope regional pond may be considered at a future date.	23	D01, D02, D05, D07, D09, D10, D11, D12, D14, D19, D24, D28, D30, D31, D35, D38, D40, D51, D58, D61, D66, D72, D74, D79
Recommend implementation of a reduced-size or modified regional pond. If the pond still cannot be implemented, then pursue implementation of a group of alternative projects. If an agreement has been executed to construct the pond, then the facility should be implemented as designed.	11	D03, D17, D29, D36, D45, D54, D64, D65, D73, D76

5.3 The Reston Watershed Plan

The *Reston Watershed Plan* (GKY, 2002) was completed in April 2002 by a team of consultants working with staff from the Reston Association and Fairfax County, assisted by the Reston Watershed Action Group (ResWAG), an ad hoc stakeholders group specifically established to oversee development of the Plan. ResWAG volunteers assisted in public outreach, data collection, fieldwork, and document review.

The Plan had its beginning with the report of the Reston Association's 2000 Watershed Subcommittee, entitled *Reston's Watersheds: An Assessment of Conditions and Management Strategies*, which recognized the need for a watershed management plan as a high priority to improve the quality and condition of Reston's watersheds. The report identified two significant problems throughout the watersheds:

- System-wide stream channel incision which effectively disconnects stream from their floodplains, in turn causing more stream erosion.
- High sediment loads from erosion, which are deposited in Reston's lakes, gradually filling them in.

In general, the study found that biological conditions were poor, and were caused primarily by poor habitat instead of water quality problems. The driving factor causing the habitat impairment was high stream flows from uncontrolled stormwater.

Methods

The technical approach to the Reston watershed analysis involved physical, biological, and water quality assessments of stream and lake conditions and hydraulic modeling of targeted stream reaches. Within the Difficult Run watershed, streams in the Colvin Run, Snakeden Branch, and The Glade subwatersheds were studied.

<u>Physical Assessment</u> The physical assessment of the streams was conducted in two phases. A broad-level stream assessment provided an inventory of general stream channel characteristics based on field observations, assessing the riparian zone, the stream channel, and stream banks.

The second phase was a characterization of stream condition, which was a more detailed assessment of stream stability, erosion potential, and sediment supply and deposition. Erosion potential was assessed using a modified version of the Bank Erosion Hazard Index developed in *Applied River Morphology* (Rosgen, 1996). Stream condition was also assessed by evaluating aquatic habitat using the United States Environmental Protection Agency's Rapid Bioassessment Protocols. This method is a qualitative rating performed concurrently with the stream assessments, resulting in a numerical score for habitat quality.

<u>Hydraulic Modeling</u> Computer models of rainfall, runoff, and streamflow were developed for several of the stream reaches under study, identified by ResWAG as the ones most impaired by urbanization. Modeling was performed by the consultant team. Model results provided information on the depth and velocity of flow in the reaches studied, which in turn allowed the modelers to estimate the degree of incision and the erosion potential for each reach.

<u>Biological Assessment</u> The health of the biological communities in streams can be an indicator of long-term or chronic problems with habitat or water quality. Reston began a systematic biological monitoring program in the fall of 2000, using the Virginia Save Our Streams protocol, which was developed for use by volunteers. In the spring of 2001, it was modified to improve the accuracy of the results. The protocol included macro-invertebrate sampling, measurements of nitrate, nitrite, and turbidity, and general observations related to water appearance, odor, and flow.

Comparisons were made between the Save Our Streams results and the County's Stream Protection Strategy Countywide monitoring results, which uses a more detailed macroinvertebrate analysis. The modified Save Our Streams ranking scheme correlated reasonably closely. Where sites did not correlate, the County protocols consistently ranked good or excellent while the Save Our Streams rankings were fair or poor.

The biological assessment performed for the Plan was a snap-shot of stream conditions, with only about 1.5 years of data at the time the Plan was developed.

<u>Lake Water Quality</u> The Reston Association has been collecting water quality information on three of the four lakes in Reston (Lake Anne, Lake Audubon and Lake Thoreau) since 1982,

with the fourth (Lake Newport) added in 1992. The plan analysis integrated results of stream assessments with lake quality to provide an overall perspective on watershed conditions.

Incorporation of Reston Assessment Data in the Difficult Run Watershed Plan

The results of the Reston watershed analysis were used to check and validate the findings from the Fairfax County Stream Physical Assessment and to corroborate the selection of candidate sites for stream restoration projects. Reston information came from the published Plan, and no review of raw data or field notes was made.

A short description of the Reston stream assessment is included in the Colvin Run, Snakeden and The Glade subwatershed condition descriptions in Chapter 3, immediately following the discussion of candidate sites for improvements.

Reston Watershed Plan Recommendations

The *Reston Watershed Plan* (GKY, 2002) addressed improvements to eight tributaries of Difficult Run in the Colvin Run, Snakeden Branch, and The Glade subwatersheds, which are in many ways complementary to the projects and programs developed for Difficult Run. This section describes the measures recommended in the Plan to reduce the impacts of uncontrolled stormwater on the stream system. The recommendations took four forms:

- Demonstration projects: Three sites were chosen to demonstrate the coordinated application of all of the recommendations.
- Reston-wide measures: Several measures were recommended to be carried out throughout the community without site-specific descriptions. These included outreach and education programs such as watershed advocacy programs, stream assessment and monitoring, coordination with Fairfax County development reviewers, and pollution prevention education.
- On-site stormwater controls: Recommendations were made to apply LID techniques to reduce the impacts of imperviousness and land development as close to the source as possible. For new development and redevelopment, the Plan recommends that design criteria for these types of controls be incorporated into the Reston Association's covenants. All the measures proposed are also effective for retrofit of existing sites without stormwater management controls; however, no specific retrofit projects were recommended in the Plan.
- Structural measures: The Plan recommended improvements for each of the eight tributaries assessed. These included stormwater attenuation structures and floodplain spreaders to improve conditions in the riparian zone. Check dams were proposed to reduce erosion and gully creation in intermittent streams, and stream restoration projects were recommended for perennial streams.

More information on these projects is included in the subwatershed sections for Colvin Run, Snakeden Branch, and The Glade in Chapter 3.

5.4 Monitoring Program

This section describes the monitoring actions and targets for determining the success of failure of the future structural and non-structural plan actions. The monitoring will help to determine if the plan actions should be modified in the future because of a low success rate, or as watershed conditions change.

Structural Projects: Carry out preliminary engineering, design, and construction of culvert retrofit projects

Monitor: Number of projects designed and completed.

Target: 100% of Implementation Group A projects designed and 50% of Group A projects completed within 5 years. 100% of Group B projects designed within 10 years.

Structural Projects: Carry out preliminary engineering, design, and construction of pond retrofit projects

Monitor: Number of projects designed and completed.

Target: 100% of Implementation Group A projects designed and 50% of Group A projects completed within 5 years. 100% of Group B projects designed within 10 years.

Structural Projects: Carry out preliminary engineering, design, and construction of new pond projects.

Monitor: Number of projects designed and completed.

Target: 100% of Implementation Group A projects designed and 50% of Group A projects completed within 5 years. 100% of Group B projects designed within 10 years.

Structural Projects: Carry out preliminary engineering, design, and construction of LID retrofit projects

Monitor: Number of projects designed and completed.

Target: 100% of Implementation Group A project sites reviewed with private landowners within 2 years. Agreements reached and design completed on 50% of Group A project sites within 5 years.

Structural Projects: Carry out preliminary engineering, design, and construction of drainage retrofit projects.

Monitor: Number of projects designed and completed.

Target: 100% of Implementation Group A projects completed within 5 years. 100% of Group B projects completed within 10 years.

Structural Projects: Carry out preliminary engineering, design, and construction of buffer restoration projects.

Monitor: Number of projects designed and completed.

Target: 100% of Implementation Group A projects completed within 5 years. 100% of Group B projects completed within 10 years.

Structural Projects: Carry out preliminary engineering, design, and construction of stream restoration projects.

Monitor: Number of projects designed and completed.

Target: 100% of Implementation Group A projects designed and 50% of Group A projects completed within 5 years. 100% of Group B projects designed within 10 years. Both targets contingent on completion of upstream quantity reduction measures.

Non-Structural Measure 4.2.2 Inspect all outfalls and other interfaces between the man-made and natural drainage systems for scour and erosion and make repairs as necessary.

Monitor: Number of outfalls inspected.

Target: Inspect 20% of all outfalls each year for the next 5 years. Complete necessary repairs within 2 years of inspection.

Non-Structural Measure 4.4.2 Education and outreach for lawn care.

Monitor: Number of brochures distributed.

Target: Distribute brochures to 20% of the homeowners in the watershed each year for the next 5 years, beginning in the highest priority catchments.

Non-Structural Measure 4.4.3 Golf course nutrient management. Work with golf course managers to evaluate turf management practices with a watershed perspective.

Monitor: Review maintenance and landscaping plans to encourage watershed-friendly use of fertilizers and other materials for landscaping.

Target: Reduce amount of fertilizer used by 5% in the next 5 years.

Non-Structural Measure 4.4.4 Develop a stronger illicit discharge and sewer infiltration / inflow removal program to eliminate sewer leaks, overflows and illegal cross-connections.

Monitor: Number of outfalls inspected. (can be combined with Measure 4.2.2 above.)

Target: Visually inspect 20% of outfalls each year for the next 5 years. Complete any necessary repairs within 2 years of inspection.

Non-Structural Measure 4.5.1 In partnership with the Town of Vienna, conduct a drainage study and develop an improvement plan to reduce flooding in Vienna near Echols Street.

Monitor: Completed drainage study.

Target: Develop an improvement plan within the next 5 years.

6 Project Prioritization and Implementation

6.1 Introduction

Chapters 3, 4, and 5 described and summarized the structural projects, policy actions, and non-structural measures considered for implementation in Difficult Run. The recommended actions will potentially be implemented over the 25-year life of the *Difficult Run Watershed Management Plan*. This section prioritizes the projects, develops an initial implementation program and provides an estimate of the costs improvements proposed by the Plan.

This Plan will be a guide for all County agencies and officials in protecting and maintaining the health of the watershed. It will be an active or “living” document that will be revisited and updated regularly throughout the implementation phase.

The final scope and design of each project will be determined during implementation, in collaboration with all parties affected, including the Fairfax County Park Authority, homeowners associations, adjacent landowners and others.

The following “tracks” have been identified for the implementation of watershed management plan recommendations throughout the County:

1. Structural and Non-structural Projects:
    - County-initiated Projects via the Capital Improvement Program
    - Developer-initiated via the Zoning Approval Process (proffers and/or development conditions) or waiver approval process
    - Volunteer Group Implementation
2. “Policy” Recommendations

The policy actions and many of the nonstructural actions will be considered with similar recommendations from other watershed plans and will potentially be implemented across all watersheds. Also, many of the actions involve coordination with other agencies such as the Northern Virginia Soil and Water Conservation Service, Fairfax County Health Department and Virginia Department of Conservation and Recreation.

The Plan identifies the projects to be evaluated and implemented within each of the following five-year implementation phases:

A - Year 1 – 5

B - Year 6 – 10

C - Year 11 – 15

D - Year 16 – 20

E - Year 21 - 25

The identification of the projects to be included in each phase is based primarily on the project priority developed as described in Section 6.2, although other factors are considered when phasing the projects for implementation. Phase A includes higher priority projects and Phase E includes lower-priority projects. While not completed at this time, a comprehensive County-wide project prioritization method is forthcoming. This ranking process will affect the actual implementation sequence and annual funding analysis.

6.2 Prioritization Methodology

The prioritization methodology presented in this section is based on interim procedures developed by the Fairfax County Stormwater Planning Division which have been applied in other watershed management plans. Although this report provides a recommended schedule for implementation of the actions included in the Plan, additional factors, which may affect the individual projects and the implementation schedule, include:

- Projects, programs and policy items will first undergo review by County staff and the Board of Supervisors before implementation. Board adoption of the watershed plan will not set into motion the automatic implementation of the plan recommendations.
- The watershed plan is a master list of recommended non-structural actions and structural projects. Each fiscal year, staff will prepare and submit to the Board a detailed spending plan that will describe the projects and explain their ranking, benefit, and need to meet a defined watershed or water quality goal.
- The watershed plan considers visions, goals, issues and needs only within the Difficult Run watershed. Fairfax County will consider stormwater needs and priorities across the entire County when implementing the recommendations included in this and other watershed plans.
- Availability of funding and other resources will affect the implementation of projects identified in this watershed plan.
- The initial project implementation phases will include outreach to the community near the proposed projects. The recommended plan elements may become infeasible or need to be modified based on comments received from the local residents during this outreach.
- Projects will be value-engineered at the time of implementation to ensure cost-effectiveness. Alternatives such as enlisting volunteers or alternative funding sources will be considered for each project to reduce the costs to the County.
- Stream crossing improvements not related to protection of streambeds or banks or prevention of structure flooding will not be funded out of the County budget for stormwater improvements.
- Stream restoration and other projects on private land will be evaluated to determine means for cost sharing with the landowners.

For the interim prioritization process, a weighted set of five categories was applied to each plan action. The weighting factor assigned is indicated in parentheses:

1. Board Adopted Stormwater Control Project Prioritization Categories (40%).

- Projects that are mandated by state or federal regulations for immediate implementation and projects that address critical/emergency dam safety issues.
- Projects that alleviate structures from damage by flood waters or by being undermined by severe erosion.
- Projects that achieve stormwater quality improvement in specific conformance with the County's obligation under the Chesapeake Bay initiatives and/or the VPDES permit for storm sewer system discharges.
- Projects that alleviate severe streambank and channel erosion.
- Projects that alleviate moderate and minor streambank and channel erosion.
- Projects that alleviate yard flooding.
- Projects that alleviate road flooding.

2. Direct Regulatory Contribution (10%)

- Hybrid projects that accomplish multiple objectives.
- Projects that contribute directly to MS4 and Virginia Tributary Strategies compliance.

- Projects that contribute to TMDL compliance only.
- Projects that have indirect water quality benefits
- Projects that mitigate flooding.

3. Public Support (10%)

- Steering Committee support.
- Support for projects by affected residents.

4. Effectiveness / Location (25%)

- Quantity control projects are more desirable in headwater areas that lack stormwater management controls
- Quality control projects are more desirable in areas that lack existing controls
- Projects that address peak flows and velocities should be implemented before downstream stream erosion control projects
- Project effectiveness in removing pollutants, eliminating stream erosion, meeting project goals, etc.

5. Ease of Implementation (15%)

- Project complexity
- Land acquisition requirements

The plan actions are given a score from 1 to 5 for each prioritization category with 5 being the highest score and 1 the lowest. The assigned scores are based on both qualitative and quantitative measures. The weighting factors are then applied to a total score used to rank the projects.

6.3 Nonstructural Project Prioritization and Implementation Program

Table 6-1 shows the priority rankings, based on the procedures described in Section 6.2, for the nonstructural actions listed in Chapter 4. This table provides the implementation phase, assuming that all nonstructural actions are considered for implementation within the first 15 years of the 25-year program. Projects with a score of 4.0 or higher were assigned Implementation Phase A. Scores between 3.5 and 4.0 were assigned to Phase B, with lower scores in Phase C.

Table 6.1: Nonstructural Project Prioritization and Implementation Program

Action	Description	Score	Phase
4.2.3	Continue and enhance the volunteer monitoring program	4.3	A
4.5.1	Conduct a drainage study to reduce flooding in Vienna	4.2	A
4.3.5	Update the County's database of SWM facilities	4.2	A
4.3.6	Enhance SWM inspection and maintenance, programs	4.2	A
4.3.7	Conduct a drainage study for the right fork of Dog Run	4.2	A
4.4.4	Enhance illicit discharge and I/I program	4.2	A
4.4.2	Education and outreach for lawn care	4.1	A
4.4.3	Golf course nutrient management	4.1	A
4.2.2	Enhance outfall inspections and make repairs as necessary	3.3	C

6.4 Policy Recommendation Prioritization and Implementation Program

Policy recommendations described in Chapter 4 are ranked and sorted by their assigned priority in Table 6.2. This table also provides the implementation phase for these projects with all recommendations being considered within the first 15 years of the 25-year program. Implementation phases were determined in the same manner for policies as they were for non-structural projects.

Table 6.2 Policy Recommendation Prioritization and Implementation Program

Action	Description	Score	Phase
4.3.5	Continue efforts to add LID design criteria and keep PFM up to date.	4.2	A
4.3.1	Evaluate land development regulations to consider setting a maximum impervious percentage for each type of development.	4.0	A
4.3.3	Evaluate and implement incentives where appropriate for the use of porous pavers for seasonal or overflow parking	4.0	A
4.3.2	Request road widening projects to manage stormwater runoff from the entire roadway, not just the added lane widths	3.9	B
4.3.4	Evaluate and implement incentives into County ordinances to consider establishing more stringent stormwater quality control standards for redevelopment.	3.8	B
4.4.1	Evaluate and implement incentives that could be applied locally to encourage lawn care companies in Fairfax to enroll in the Virginia Water Quality Improvement Program	3.7	B
4.6.2	Continue efforts to obtain legal authority and develop a forest conservation ordinance that will preserve existing woodlands	3.4	C

6.5 Structural Project Implementation Program

Structural projects were sorted by implementation phase, priority score, and project number in Table 6.3 below. This table also provides the cost estimate for each project and the assigned implementation phase.

Structural projects were grouped into phases to maximize the benefit to the watershed by implementing projects as a group wherever possible. This approach can reduce neighborhood impacts and also reduce costs associated with the public outreach when the projects are implemented. Finally, by implementing projects in a geographic area at one time, the net benefit to the stream may be greater than the sum of the benefits provided by the individual projects.

The reasoning used to prepare the project implementation program were as follows:

- Projects were grouped based on a percentage of the total cost of watershed improvements. Projects in Groups A and B each represented about 25% of the total cost of the proposed improvents. Group C represented about 20%, and groups D and E, 15% each.
- Construction of alternatives to the unbuilt regional ponds was a high priority in the Difficult Run watershed. These alternatives were assigned to implementation groups A and B based on priority score, each group with an equal total cost. Fifty-eight of these projects were assigned to group A and 47 to group B.
- Projects recommended for inclusion in the County's FY 2007 Stormwater Implementation program were assigned to implementation group A. These were for the most part either regional pond replacement projects, or high priority projects with significant public support or interest. There were 16 additional group A projects from this category:

  - LID retrofit DF9843, and the group of pond retrofits at the Government Center, DF9143A through DF9143H in Upper Difficult Run.
  - Stream restoration DF92136 and upstream culvert retrofit DF9507B, which addresses a severely eroding stream next to Wiehle Avenue in Colvin Run.
  - Three stream restoration projects, DF9249, DF92104, and DF9284.
- Watershed-wide stream projects, including dumpsite cleanup, removal of obstructions, repair of utility crossings, and buffer restoration.
- The remainder of Group A projects were selected from among the highest scoring projects based on the project team's evaluation of priorities. Factors included stream restoration projects where severe erosion is active, and projects that should be grouped for reasons of construction or function. These included:
  - DF9285, a stream restoration of the mainstem of Colvin Run which is undermining Leesburg Pike.
  - DF92117, a stream restoration project in Angelico Branch, one of the most severe cases of erosion in the watershed. Erosion has worked upstream and excessive stormwater does not appear to be the cause.
  - DF92119, stream restoration in South Fork Run which is undermining residential property. An existing regional pond is upstream of the project.
  - DF92135, a stream restoration in Colvin Run where erosion is threatening a major sewer line. This project should be built simultaneously with upstream culvert retrofits DF9550A and DF9550B.
  - DF92101 and DF9524, a stream restoration and culvert retrofit in Snakeden Branch where active erosion is beginning to undermine an adjacent commercial parking lot.
  - DF9278, a stream restoration in Dog Run which would help improve water quality and habitat in the drainage area of regional pond D-01.
  - DF9106A, DF9106B, DF9806, DF9706, and DF9274, all high priority projects which would complete the restoration projects for Captain Hickory Run.
- The remainder of projects in Group B were selected using the same criteria.
  - All projects in Courthouse Spring Branch, which had the highest levels of modeled runoff water quality of all the subwatersheds.
  - Stream restoration DF9225 and associated culvert retrofit DF9523 in Snakeden Branch, where the mainstem is eroding.
  - Culvert retrofit and LID projects upstream of DF9225 including DF9535A and B, DF9835, and DF9123B. This would complete the retrofit of the upstream tributaries of Snakeden Branch.
  - A series of projects in the three most upstream and developed catchments of Wolftrap Creek: Pond retrofit DF9133, LID projects DF9831, DF9831B, DF9833 and DF9832, and culvert retrofits DF9532A and B.
  - Two culvert retrofits where the mainstem of Wolftrap Creek crosses under the Dulles Toll Road: DF9520A and DF9520B.
  - Seven of the next highest scoring pond retrofit projects, which are in headwater areas and designed for both peak flow reduction and water quality improvements, along with stream restoration project DF9213 in Lake Fairfax Park.
- Projects in Groups C, D, and E were selected based on order of priority from the remaining projects.

The total cost of projects in each implementation group are shown in Table 6.4, along with an estimate of the County staff effort in Staff Year Equivalents (SYE) required to manage the program implementation.

Projects are listed and sorted by project number in the Executive Summary and in each subwatershed section in Chapter 3.

Table 6.3 Structural Project Prioritization

Project_No	Type	Subwaterhed	Location	Score	Phase	Estimate
DF9001B	Pond Retrofit	Dog Run	End of Branton Lane	3.95	A	$224,000
DF9003AA	Pond Retrofit	Piney Run	Near Tottenham Court	3.95	A	$110,000
DF9003AB	Pond Retrofit	Piney Run	Near Tottenham Court	3.95	A	$90,000
DF9007D	LID Retrofit	Captain Hickory Run	Commercial area W of Walker Road	3.95	A	$170,000
DF9011A	Pond Retrofit	Middle Difficult Run	Upstream of Windstone Road	3.95	A	$205,000
DF9030A	Pond Retrofit	Rocky Branch	End of Martinhoe Court	3.95	A	$55,000
DF9031A	Pond Retrofit	Rocky Branch	Oakton Ridge Circle and Oakton Ridge Court	3.95	A	$32,000
DF9031C	LID Retrofit	Rocky Branch	Oakton Ridge Circle and Oakton Ridge Court	3.95	A	$14,000
DF9035B	LID Retrofit	Upper Difficult Run	E side of Young Road	3.95	A	$100,000
DF9041B	Pond Retrofit	South Fork Run	Tilton Valley Drive and Hickory Hills Drive	3.95	A	$43,000
DF9041C	Pond Retrofit	South Fork Run	S Vale Road, E of Valewood Drive	3.95	A	$35,000
DF9041D	LID Retrofit	South Fork Run	Along Brecknock Street	3.95	A	$2,000
DF9041E	Pond Retrofit	South Fork Run	Along a private drive off Vale Road	3.95	A	$107,000
DF9043C	LID Retrofit	Little Difficult Run	Parking lot of Fox Mill Swim and Tennis Club	3.95	A	$107,000
DF9045A	LID Retrofit	Upper Difficult Run	Left of drive at Oakton Swim and Racquet Club	3.95	A	$46,000
DF9073A	LID Retrofit	Piney Branch	Madison HS and Flint Hill ES	3.95	A	$221,000
DF9073C	Pond Retrofit	Piney Branch	Along Riviera Drive	3.95	A	$63,000
DF9106A	Pond Retrofit	Captain Hickory Run	At Georgetown Pike	3.95	A	$112,000
DF9106B	Pond Retrofit	Captain Hickory Run	Downstream of Columbine Street	3.95	A	$44,000
DF9143E	Pond Retrofit	Upper Difficult Run	Glen Alden Road and Government Center Pkwy	3.95	A	$24,000
DF9143H	Pond Retrofit	Upper Difficult Run	Government Center Parkway and Legato Road	3.95	A	$147,000
DF9806	LID Retrofit	Captain Hickory Run	N of Georgetown Pike	3.95	A	$145,000
DF9843	LID Retrofit	Upper Difficult Run	Entire parking area for the Government Center	3.95	A	$333,000
DF9010E	Stream Restoration	Lower Difficult Run	Upstream side of Tackroom Road	3.90	A	$964,000
DF9045D	Stream Restoration	Upper Difficult Run	E side of Valeview Drive	3.90	A	$375,000
DF92101	Stream Restoration	Snakeden Branch	N of Sunrise Valley Road	3.90	A	$573,000
DF92104	Stream Restoration	The Glade	SW of Stirrup Road	3.90	A	$628,000
DF92117	Stream Restoration	Angelico Branch	S of Whippoorwill Road and N of Lawyers Road	3.90	A	$1,358,000
DF92135	Stream Restoration	Colvin Run	S of N Shore Drive	3.90	A	$861,000
DF9249	Stream Restoration	Colvin Run	S of Fairway Drive and W of Westbriar Drive	3.90	A	$424,000
DF9274	Stream Restoration	Captain Hickory Run	At end of Walker Glen Court	3.90	A	$683,000
DF9284	Stream Restoration	Lower Difficult Run	E of Old Dominion Drive	3.90	A	$583,000
DF9285	Stream Restoration	Lower Difficult Run	Where Colvin Run Road intersects Leesburg Pike	3.90	A	$609,000

Project_No	Type	Subwaterhed	Location	Score	Phase	Estimate
DF9012	Pond Retrofit	Colvin Run	Private property off of Crowell Road	3.85	A	$54,000
DF9017A	Pond Retrofit	Wolftrap Creek	Existing pond along Spring Ridge Road	3.85	A	$217,000
DF9024B	Culvert Retrofit	Snakeden Branch	Upstream of the W&OD Trail	3.85	A	$135,000
DF9028B	Culvert Retrofit	Wolftrap Creek	End of Ashgrove Lane	3.85	A	$105,000
DF9028C	Pond Retrofit	Wolftrap Creek	Along Lupine Den Road	3.85	A	$46,000
DF9040A	Pond Retrofit	South Fork Run	End of Nathaniel Oaks Drive	3.85	A	$178,000
DF9040B	Pond Retrofit	South Fork Run	Near Falkirk Road	3.85	A	$48,000
DF9040C	Pond Retrofit	South Fork Run	Birdsboro Drive and Country Ridge Lane	3.85	A	$96,000
DF9040D	Pond Retrofit	South Fork Run	End of Navy Road	3.85	A	$84,000
DF9058A	Culvert Retrofit	Little Difficult Run	Upstream side of Thoroughbred Road	3.85	A	$27,000
DF9059A	Pond Retrofit	Upper Difficult Run	Along Center Ridge Road	3.85	A	$49,000
DF9059C	Pond Retrofit	Upper Difficult Run	Upstream of Berryland Drive	3.85	A	$183,000
DF9066A	Pond Retrofit	Rocky Run	Woodlea Mill and Orlo Road	3.85	A	$96,000
DF9072A	Pond Retrofit	Upper Difficult Run	Across Vale Road from Chris Wood Drive	3.85	A	$111,000
DF9079B	Culvert Retrofit	South Fork Run	Honda Road and Lariat Lane	3.85	A	$63,000
DF9143B1	Pond Retrofit	Upper Difficult Run	S of DF9143A and N of Rockaway Lane	3.85	A	$20,000
DF9143B2	Pond Retrofit	Upper Difficult Run	S of DF9143A and N of Rockaway Lane	3.85	A	$36,000
DF9143C	Pond Retrofit	Upper Difficult Run	N of Government Center Parkway	3.85	A	$162,000
DF9045B	Pond Retrofit	Upper Difficult Run	Waples Mill Road and Bronzedale Drive	3.70	A	$23,000
DF9064C	Pond Retrofit	Piney Run	The end of Artemel Lane	3.70	A	$22,000
DF9065A	New Pond	Wolftrap Creek	Near Pinstripe Court	3.70	A	$1,456,000
DF9029B	New Pond	Piney Branch	Site of D-29	3.60	A	$499,000
DF9036A3	Pond Retrofit	Rocky Branch	Near Miller Road	3.60	A	$77,000
DF9054B	New Pond	Wolftrap Creek	At Site of D-54	3.60	A	$333,000
DF9007C	Culvert Retrofit	Captain Hickory Run	Upstream of Sunnybrook Drive	3.45	A	$79,000
DF9009A	Pond Retrofit	Lower Difficult Run	End of Lyons Road	3.45	A	$105,000
DF9009B	Pond Retrofit	Lower Difficult Run	Near Wood Glade Drive	3.45	A	$132,000
DF9013	Pond Retrofit	Colvin Run	Business Center Drive	3.45	A	$111,000
DF9013A	Pond Retrofit	Colvin Run	Business Center Drive	3.45	A	$268,000
DF9023A	Pond Retrofit	Little Difficult Run	Birdfoot Ct and Raccoon Ridge Ct	3.45	A	$20,000
DF9024A	Pond Retrofit	Snakeden Branch	Existing facility near Clovermeadow Road	3.45	A	$150,000
DF9027A	Culvert Retrofit	Piney Branch	Upstream of Batten Hollow and Brookhill Roads	3.45	A	$91,000
DF9043B	Pond Retrofit	Little Difficult Run	Wild Cherry Place and Black Fir Court	3.45	A	$42,000
DF9061A	Culvert Retrofit	Little Difficult Run	At Stuart Mill Road	3.45	A	$30,000
DF9061D	Pond Retrofit	Little Difficult Run	Along Foxclove Road	3.45	A	$401,000
DF9064A	Pond Retrofit	Piney Run	Behind private residences by Challedon Road	3.45	A	$96,000
DF9076A	Culvert Retrofit	Lower Difficult Run	Culvert under Falls Run Road	3.45	A	$294,000
DF9076B	Pond Retrofit	Lower Difficult Run	Pond below Falls Run Road	3.45	A	$369,000
DF9143D	Pond Retrofit	Upper Difficult Run	N side of the stream from project DF9143C	3.45	A	$47,000
DF9143F2	Pond Retrofit	Upper Difficult Run	N of the Government Center building	3.45	A	$24,000
DF9003B	Drainage Retrofit	Piney Run	Distributed	3.25	A	$91,000
DF9040E	Drainage Retrofit	South Fork Run	Distributed	3.25	A	$76,000
DF9706	Drainage Retrofit	Captain Hickory Run	Distributed	3.25	A	$213,000

Project_No	Type	Subwaterhed	Location	Score	Phase	Estimate
DF9143A	Pond Retrofit	Upper Difficult Run	E of the Fairfax Government Center	3.20	A	$50,000
DF9507B	Culvert Retrofit	Colvin Run	Culvert under Wiehle Avenue	3.05	A	$146,000
DF9524	Culvert Retrofit	Snakeden Branch	N of Sunrise Valley Dr, E of Preston White Dr	3.05	A	$218,000
DF9550A	Culvert Retrofit	Colvin Run	Culvert under Baron Cameron Avenue	3.05	A	$22,000
DF92136	Stream Restoration	Colvin Run	E of Wiehle Avenue and S of Yellowwood Court	2.70	A	$1,038,000
DF9278	Stream Restoration	Dog Run	By Georgetown Pike and Kimberly Place	2.70	A	$419,000
DF9133A	Pond Retrofit	Wolftrap Creek	At the outlet to Catchment 33	3.95	B	$43,000
DF9133B	Pond Retrofit	Wolftrap Creek	At the outlet to Catchment 33	3.95	B	$534,000
DF9157	New Pond	Old Courthouse	At Leesburg Pike and Laurel Hill Road	3.95	B	$499,000
DF9535A	Culvert Retrofit	Snakeden Branch	Upstream side of Colts Neck Road	3.95	B	$98,000
DF9819	LID Retrofit	Old Courthouse	S of intersection of Village Drive and N Shore Drive	3.95	B	$1,721,000
DF9831	LID Retrofit	Wolftrap Creek	Rear parking lot on Follin Lane	3.95	B	$309,000
DF9831B	LID Retrofit	Wolftrap Creek	Rear parking lot on Follin Lane	3.95	B	$723,000
DF9832	LID Retrofit	Wolftrap Creek	Notre Dame and Our Lady of Good Counsel Catholic Church	3.95	B	$120,000
DF9833	LID Retrofit	Wolftrap Creek	Upper third of Catchment 33	3.95	B	$1,256,000
DF9835	LID Retrofit	Snakeden Branch	In and around Hunters Woods Village Shopping Center	3.95	B	$292,000
DF9535B1	Culvert Retrofit	Snakeden Branch	Culvert under Glade Drive	3.85	B	$28,000
DF9535B2	Culvert Retrofit	Snakeden Branch	Culvert under Glade Drive	3.85	B	$16,000
DF9123B	Pond Retrofit	Snakeden Branch	Existing pond on upstream side of Sugarberry Court	3.70	B	$23,000
DF9157A	Pond Retrofit	Old Courthouse	At the corssing of Jarrett Valley Drive	3.70	B	$332,000
DF9051D	Culvert Retrofit	Angelico Branch	Upstream of Cedar Pond Road	3.45	B	$65,000
DF9119	New Pond	Old Courthouse	Village Road and Baron Cameron Avenue	3.45	B	$212,000
DF9002A	Culvert Retrofit	Piney Run	Upstream of Great Passage Boulevard	3.35	B	$47,000
DF9014A	Culvert Retrofit	Colvin Run	Upstream side of Little Run Court	3.35	B	$26,000
DF9520A	Culvert Retrofit	Wolftrap Creek	Culvert under Dulles Toll Road	3.35	B	$88,000
DF9520B	Culvert Retrofit	Wolftrap Creek	Culvert under Dulles Toll Road	3.35	B	$188,000
DF9523	Culvert Retrofit	Snakeden Branch	Upstream side of Soapstone Road	3.35	B	$212,000
DF9532A	Culvert Retrofit	Wolftrap Creek	Upstream side of Follin Lane	3.35	B	$98,000
DF9532B	Culvert Retrofit	Wolftrap Creek	Upstream side of Woodford Road	3.35	B	$27,000
DF9001A	Drainage Retrofit	Dog Run	Distributed at outfalls throughout the drainage area	3.25	B	$228,000
DF9002B	Drainage Retrofit	Piney Run	Distributed at outfalls throughout the drainage area	3.25	B	$137,000
DF9006B	Drainage Retrofit	Captain Hickory Run	Distributed at outfalls throughout the drainage area	3.25	B	$61,000
DF9007A	Drainage Retrofit	Captain Hickory Run	Distributed at outfalls throughout the drainage area	3.25	B	$122,000
DF9009C	Drainage Retrofit	Lower Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$496,000
DF9010D	Drainage Retrofit	Lower Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$91,000
DF9011C	Drainage Retrofit	Middle Difficult Run	Distributed at outfalls throughout the	3.25	B	$137,000

Project_No	Type	Subwaterhed	Location	Score	Phase	Estimate
			drainage area			
DF9014B	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	3.25	B	$107,000
DF9017B	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	3.25	B	$61,000
DF9019A	Drainage Retrofit	Rocky Run	Distributed at outfalls throughout the drainage area	3.25	B	$137,000
DF9020B	Drainage Retrofit	Sharpers Run	Distributed at outfalls throughout the drainage area	3.25	B	$91,000
DF9024C	Drainage Retrofit	Snakeden Branch	Distributed at outfalls throughout the drainage area	3.25	B	$91,000
DF9027B	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	3.25	B	$106,000
DF9028A	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	3.25	B	$370,000
DF9029A	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	3.25	B	$213,000
DF9030B	Drainage Retrofit	Rocky Branch	Distributed at outfalls throughout the drainage area	3.25	B	$167,000
DF9032B	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$107,000
DF9033	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$30,000
DF9034B	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$76,000
DF9035A	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$203,000
DF9039B	Drainage Retrofit	Little Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$183,000
DF9039B	Drainage Retrofit	Little Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$183,000
DF9041A	Drainage Retrofit	South Fork Run	Distributed at outfalls throughout the drainage area	3.25	B	$583,000
DF9043A	Drainage Retrofit	Little Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$76,000
DF9051E	Drainage Retrofit	Angelico Branch	Distributed at outfalls throughout the drainage area	3.25	B	$244,000
DF9054A	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	3.25	B	$46,000
DF9059B	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$344,000
DF9061B	Drainage Retrofit	Little Difficult Run	Distributed at outfalls throughout the drainage area	3.25	B	$122,000
DF9064D	Drainage Retrofit	Piney Run	Distributed at outfalls throughout the drainage area	3.25	B	$91,000
DF9065B	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	3.25	B	$46,000
DF9073B	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	3.25	B	$673,000
DF9074A	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	3.25	B	$61,000
DF9079A	Drainage Retrofit	South Fork Run	At Fox Mill Road	3.25	B	$152,000

Project_No	Type	Subwaterhed	Location	Score	Phase	Estimate
DF9723	Drainage Retrofit	Snakeden Branch	Distributed at outfalls throughout the drainage area	3.25	B	$183,000
DF9735	Drainage Retrofit	Snakeden Branch	Distributed at outfalls throughout the drainage area	3.25	B	$259,000
DF9757	Drainage Retrofit	Old Courthouse	Distributed at outfalls throughout the drainage area	3.25	B	$61,000
DF9005B	Culvert Retrofit	Captain Hickory Run	At Polo Place	3.05	B	$47,000
DF9010A	Culvert Retrofit	Lower Difficult Run	Upstream side of Forestville Road	3.05	B	$19,000
DF9032A	Culvert Retrofit	Upper Difficult Run	Upstream side of Miller Heights Road	3.05	B	$136,000
DF9034A	Culvert Retrofit	Upper Difficult Run	Upstream side of Miller Heights Road	3.05	B	$40,000
DF9039A	Culvert Retrofit	Little Difficult Run	Upstream side of Timberline Road	3.05	B	$118,000
DF9061C	Culvert Retrofit	Little Difficult Run	Upstream of Foxclove Road	3.05	B	$29,000
DF9225	Stream Restoration	Snakeden Branch	E and W of Soapstone Road	2.70	B	$1,125,000
DF9010B	Culvert Retrofit	Lower Difficult Run	Upstream side of Trotting Horse Road	2.55	B	$22,000
DF9010C	Culvert Retrofit	Lower Difficult Run	Upstream side of Tackroom Road	2.55	B	$255,000
DF9058B	Culvert Retrofit	Little Difficult Run	Upstream side of Folkstone Road	2.55	B	$41,000
DF9064B	Culvert Retrofit	Piney Run	N of Brevity Drive	2.55	B	$143,000
DF9557	Culvert Retrofit	Old Courthouse	Upstream of Laurel Hill Road	2.55	B	$97,000
DF9103	Pond Retrofit	Piney Run	Bright Pond Lane and Fieldview Drive	3.95	C	$20,000
DF91135	Pond Retrofit	Dog Run	Water Pointe Lane and the Reston Parkway	3.95	C	$532,000
DF9121	Pond Retrofit	Rocky Run	Retrofit regional pond D-67	3.95	C	$151,000
DF9139	Pond Retrofit	Rocky Branch	Intersection of Rosehaven and Jermantown Roads	3.95	C	$20,000
DF9141A	Pond Retrofit	Upper Difficult Run	Fair Oaks Mall property, near Lee Jackson Hwy	3.95	C	$90,000
DF9142	Pond Retrofit	Upper Difficult Run	E end of the Fair Oaks Mall property	3.95	C	$250,000
DF9171	Pond Retrofit	Upper Difficult Run	Bennington Woods Road and Baron Cameron Avenue	3.95	C	$100,000
DF9172	Pond Retrofit	Upper Difficult Run	At Leesburg Pike and Laurel Hill Road	3.95	C	$63,000
DF9540B	Culvert Retrofit	The Glade	Upstream side of Colts Neck Road	3.95	C	$119,000
DF9807	LID Retrofit	Colvin Run	Rain garden at Wiehle Rd and N Shore Dr	3.95	C	$43,000
DF9808	LID Retrofit	Colvin Run	Intersection of Village Drive and N Shore Drive	3.95	C	$60,000
DF9809	LID Retrofit	Colvin Run	S of the intersection of Village Drive and N Shore Drive	3.95	C	$1,546,000
DF9812	LID Retrofit	Colvin Run	Isaac Newton Square and Wiehle Avenue	3.95	C	$628,000
DF9818	LID Retrofit	Colvin Run	Throughout catchment N of the Dulles Toll Road	3.95	C	$2,520,000
DF9830	LID Retrofit	Piney Branch	Along Maple Avenue and the W&OD Trail	3.95	C	$1,961,000
DF9839	LID Retrofit	Rocky Branch	Around intersection of Jermantown and Route 123	3.95	C	$1,069,000
DF9841	LID Retrofit	Upper Difficult Run	On and around Fair Oaks Mall	3.95	C	$2,216,000
DF9842	LID Retrofit	Upper Difficult Run	Throughout the Fair Oaks Mall property	3.95	C	$904,000
DF9871	LID Retrofit	Upper Difficult Run	E of Pender Court	3.95	C	$1,207,000
DF9213	Stream Restoration	Colvin Run	In Lake Fairfax Park, W of Hunter Mill Road	3.90	C	$1,118,000

Project_No	Type	Subwaterhed	Location	Score	Phase	Estimate
DF9205	Stream Restoration	Piney Run	S of Walker Mill Road	3.90	D	$875,000
DF92106	Stream Restoration	Middle Difficult Run	Mainstem N of Toll Road	3.90	D	$1,089,000
DF92110	Stream Restoration	Piney Branch	S off Fosbak Drive	3.90	D	$203,000
DF92114	Stream Restoration	Little Difficult Run	E of Colt Run before Stuart Mill Road	3.90	D	$721,000
DF92120	Stream Restoration	South Fork Run	E of Fox Mill Road, N of Deerfield Drive	3.90	D	$563,000
DF92124	Stream Restoration	Wolftrap Creek	S of Chain Bridge Road, W of Westwood Forest Road	3.90	D	$409,000
DF92126	Stream Restoration	Wolftrap Creek	W of Foxstone Drive	3.90	D	$874,000
DF92130	Stream Restoration	Rocky Branch	W of Mystic Meadow Road, S of Hunter Mill Road	3.90	D	$627,000
DF92131	Stream Restoration	Rocky Branch	W of Hunter Mill Road before intersection with Vale Road	3.90	D	$792,000
DF9236	Stream Restoration	Little Difficult Run	W of intersection of Stuart Mill Road and Birdfoot Lane	3.90	D	$1,926,000
DF9263	Stream Restoration	Upper Difficult Run	SW of Lawyers Road before Hunters Crest Way	3.90	D	$194,000
DF9265	Stream Restoration	Little Difficult Run	S of Thoroughbred Rd, E of Fox Mill Rd	3.90	D	$742,000
DF9289	Stream Restoration	Lower Difficult Run	Confluence with Captain Hickory Run	3.90	D	$964,000
DF9290	Stream Restoration	Sharpers Run	Downstream of Bellview Road	3.90	D	$558,000
DF9291	Stream Restoration	Rocky Run	N of Bellview Road, S of Galium Road	3.90	D	$1,006,000
DF9295	Stream Restoration	Colvin Run	S of Colvin Forest Dr, W of Leesburg Pike	3.90	D	$1,384,000
DF9116A	Pond Retrofit	Wolftrap Creek	Kilby Glen Drive and South Courthouse Drive	3.85	D	$45,000
DF9116B	Pond Retrofit	Wolftrap Creek	Along Deramus Farm Drive	3.85	D	$59,000
DF9118B	Pond Retrofit	Colvin Run	Facility on S side of Dulles Toll Road	3.85	D	$317,000
DF9151	Pond Retrofit	Colvin Run	S of Baron Cameron Avenue	3.85	D	$75,000
DF9503	Culvert Retrofit	Piney Run	Intersection of Hawthorne Court and Reston Parkway	3.85	D	$41,000
DF9508A	Culvert Retrofit	Colvin Run	Along Village Road and Baron Cameron Avenue	3.85	D	$38,000
DF9512A	Culvert Retrofit	Colvin Run	Culvert under N Shore Drive	3.85	D	$25,000
DF9512B	Culvert Retrofit	Colvin Run	Culvert under N Shore Drive	3.85	D	$218,000
DF9515A	Culvert Retrofit	Lower Difficult Run	Under Leesburg Pike	3.85	D	$20,000
DF9551	Culvert Retrofit	Colvin Run	Upstream of Gates Meadow Way	3.85	D	$19,000
DF9552A	Culvert Retrofit	Colvin Run	Upstream of Bennington Woods Road	3.85	D	$24,000
DF9118A	Pond Retrofit	Colvin Run	Culvert under Sunset Hills Road	3.70	D	$166,000
DF9141B	Pond Retrofit	Upper Difficult Run	N side of US 50	3.70	D	$381,000
DF9124A	Pond Retrofit	Snakeden Branch	End of Red Leaf Court	3.60	D	$35,000
DF9152	Pond Retrofit	Colvin Run	Bennington Woods Road and Baron Cameron Avenue	3.60	D	$46,000
DF9117	Pond Retrofit	Wolftrap Creek	S Courthouse Drive and Towlston Road	3.45	E	$149,000
DF9122	Pond Retrofit	Middle Difficult Run	Brittenford Drive and Hunt Country Lane	3.45	E	$404,000
DF9124C	Pond Retrofit	Snakeden Branch	Intersection of the Dulles Toll Road with W&OD Trail	3.45	E	$128,000
DF9129	Pond Retrofit	Piney Branch	At the bend in Liberty Tree Lane	3.45	E	$96,000
DF9531B	Culvert Retrofit	Wolftrap Creek	Above Creek Crossing Road	3.45	E	$115,000
DF9540A	Culvert Retrofit	The Glade	Upstream side of Steeplechase Road	3.45	E	$103,000
DF9501B	Culvert Retrofit	Dog Run	Upstream of Stones Throw Drive	3.35	E	$53,000

Project_No	Type	Subwaterhed	Location	Score	Phase	Estimate
DF9501C	Culvert Retrofit	Dog Run	End of Bright Pond Lane	3.35	E	$126,000
DF9508B	Culvert Retrofit	Colvin Run	Culvert under Baron Cameron Avenue	3.35	E	$17,000
DF9515B	Culvert Retrofit	Lower Difficult Run	Upstream of Locust Hill Drive	3.35	E	$27,000
DF9552B	Culvert Retrofit	Colvin Run	Upstream of N Shore Drive	3.35	E	$44,000
DF9558	Culvert Retrofit	Wolftrap Creek	Upstream side of Old Courthouse Road	3.35	E	$212,000
DF9701	Drainage Retrofit	Dog Run	Distributed at outfalls throughout the drainage area	3.25	E	$91,000
DF9707	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	3.25	E	$91,000
DF9712	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	3.25	E	$61,000
DF9716	Drainage Retrofit	Wolftrap Creek	Along Tuba and Laurlin Court	3.25	E	$183,000
DF9722	Drainage Retrofit	Middle Difficult Run	Distributed at outfalls throughout the drainage area	3.25	E	$61,000
DF9724	Drainage Retrofit	Snakeden Branch	Distributed at outfalls throughout the drainage area	3.25	E	$167,000
DF9728	Drainage Retrofit	Snakeden Branch	Along Purple Beech Drive and Ridge Heights Road	3.25	E	$230,000
DF9729	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	3.25	E	$46,000
DF9730	Drainage Retrofit	Piney Branch	Distributed at outfalls throughout the drainage area	3.25	E	$30,000
DF9731	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	3.25	E	$122,000
DF9740	Drainage Retrofit	The Glade	Distributed at outfalls throughout the drainage area	3.25	E	$1,410,000
DF9741	Drainage Retrofit	Upper Difficult Run	Distributed at outfalls throughout the drainage area	3.25	E	$91,000
DF9750	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	3.25	E	$46,000
DF9751	Drainage Retrofit	Colvin Run	Distributed at outfalls throughout the drainage area	3.25	E	$46,000
DF9755	Drainage Retrofit	Middle Difficult Run	Distributed at outfalls throughout the drainage area	3.25	E	$61,000
DF9758	Drainage Retrofit	Wolftrap Creek	Distributed at outfalls throughout the drainage area	3.25	E	$167,000
DF9504A	Culvert Retrofit	Piney Run	Upstream side of Tiverton Circle	3.05	E	$41,000
DF9522A	Culvert Retrofit	Middle Difficult Run	Driveway off of Willow Crest Court	3.05	E	$117,000
DF9522B	Culvert Retrofit	Middle Difficult Run	Upstream of Brittenford Drive	3.05	E	$37,000
DF9522C	Culvert Retrofit	Middle Difficult Run	At Brittenford Drive, E of Raleigh Hill Road	3.05	E	$43,000
DF9522D	Culvert Retrofit	Middle Difficult Run	At Brittenford Drive, E of Landon Hill Road	3.05	E	$31,000
DF9555A	Culvert Retrofit	Middle Difficult Run	Upstream of Hunter Mill Road	3.05	E	$66,000
DF9555B	Culvert Retrofit	Middle Difficult Run	Upstream of Dulles Toll Road	3.05	E	$72,000
DF92108	Buffer Restoration	Middle Difficult Run	S of Dulles Toll Road, E of Hunter Mill Road	3.00	E	$32,000
DF92125	Buffer Restoration	Wolftrap Creek	Within the Westbriar Country Club golf course	3.00	E	$36,000
DF9238	Buffer Restoration	Upper Difficult Run	N of intersection of Waples Mill Road and Fox Mill Road	3.00	E	$28,000

Project_No	Type	Subwaterhed	Location	Score	Phase	Estimate
DF9279	Buffer Restoration	Dog Run	E of Stones Throw Road	3.00	E	$39,000
DF9280	Buffer Restoration	Piney Run	On either side of Bishops Gate Way	3.00	E	$33,000
DF9202	Stream Restoration	Dog Run	SW of Leesburg Pike and E of Reston Parkway	2.70	E	$368,000
DF92102	Stream Restoration	Snakeden Branch	S of N Shore Dr and E of Barton Hill Rd	2.70	E	$786,000
DF9244	Stream Restoration	Upper Difficult Run	N of Government Center Parkway	2.70	E	$577,000
DF9245	Stream Restoration	Upper Difficult Run	N of intersection of Fairfax Farms Road and Valley Road	2.70	E	$442,000
DF9504B	Culvert Retrofit	Piney Run	Culvert under Wiehle Avenue	2.55	E	$128,000
DF9512C	Culvert Retrofit	Colvin Run	Culvert under Wiehle Avenue	2.55	E	$94,000
DF9555C	Culvert Retrofit	Middle Difficult Run	At Brittenford Drive, E of Rosaleigh Court	2.55	E	$70,000
DF9001B	Pond Retrofit	Dog Run	End of Branton Lane	3.95	A	$224,000
DF9003AB	Pond Retrofit	Piney Run	Near Tottenham Court	3.95	A	$90,000

Table 6.4: Project Cost by Implementation Group

Implementation Group	Cost	Percent	SYE
A	$19,562,000	27%	
B	$17,528,000	25%	
C	$14,199,000	20%	
D	$9,995,000	14%	
E	$9,932,000	14%	
Total	$71,216,000	100%	4.9

6.6 Watershed Plan Benefits

Plan benefits were estimated with the watershed model developed during the project. Proposed conditions were compared to future conditions to determine the benefits of the proposed projects.

Proposed stormwater BMPs, including pond retrofits, culvert retrofits, LID retrofits, and new ponds were modeled based on the amount of runoff each was capable of treating, and literature values for pollutant removal efficiency. Peak flow reductions were also modeled, again based on the amount of area draining to each retrofit project and its size. The majority of the proposed projects were designed to improve both water quality and water quantity control, and should help to reduce pollutant loads, but also to reduce the erosive peak flows that damage streambeds and scour stream crossings.

The watershed plan includes many nonstructural actions and policy recommendations. Many of the nonstructural actions are education and outreach that would reduce the impact on Difficult Run and its tributary streams. Policy actions also modify the impacts that new impervious area would have on the watershed. While these actions would improve the watershed health and reduce nutrient loads, these benefits are difficult to quantify.

6.6.1 Water Quality Improvements

Results of the modeling showed improvements in pollutant loads, throughout the entire Difficult Run watershed. Table 6.5 below compares the existing and future conditions model results for each subwatershed to the results of the projects proposed in this watershed plan. The modeling shows an 8 percent decrease in Total Suspended Solids (TSS), an 11percent decrease in Total Nitrogen (TN), and a 17 percent decrease in Total Phosphorus (TP) throughout the watershed.

Table 6.5: Pollutant Loads and Reductions

Subwatershed	Area	Scenario	Runoff Volume (in/yr)	Peak Flow (cfs/ac)	TSS (lb/ac/yr)	TN (lb/ac/yr)	TP (lb/ac/yr)
Angelico Branch	483	Existing	2.1	1.6	19.1	1.00	0.20
		Future	2.5	1.8	25.5	1.35	0.27
		Proposed	2.5	1.7	25.4	1.28	0.24
		Reduction	-2.6%	-5.8%	-0.5%	-5.0%	-12.5%
Captain Hickory Run	1,695	Existing	2.1	1.2	24.5	1.2	0.21
		Future	2.3	1.2	26.5	1.3	0.24
		Proposed	2.3	1.1	24.9	1.1	0.18
		Reduction	-2.6%	-8.1%	-6.1%	-13.4%	-23.6%
Colvin Run	3,876	Existing	5.1	2.1	108.6	4.3	0.52
		Future	5.7	2.2	119.4	4.6	0.55
		Proposed	5.3	1.8	103.1	3.9	0.44
		Reduction	-6.7%	-14.4%	-13.7%	-16.2%	-20.2%
Dog Run	516	Existing	3.0	1.5	35.7	1.8	0.32
		Future	3.4	1.6	43.0	2.1	0.40
		Proposed	3.3	1.4	42.8	1.8	0.25
		Reduction	-1.8%	-17.0%	-0.7%	-13.9%	-36.4%
The Glade	853	Existing	3.3	1.6	45.5	2.3	0.44
		Future	3.3	1.6	46.0	2.3	0.45
		Proposed	3.3	1.4	46.0	2.2	0.39
		Reduction	-1.4%	-13.0%	-0.1%	-4.9%	-12.2%
Little Difficult Run	2,590	Existing	2.0	1.4	20.2	1.1	0.21
		Future	2.2	1.5	23.5	1.3	0.25
		Proposed	2.2	1.3	23.5	1.2	0.23
		Reduction	-2.8%	-10.9%	0.0%	-3.2%	-8.6%
Old Courthouse Spring	981	Existing	9.3	2.7	192.9	7.7	0.88
		Future	9.5	2.8	197.9	8.0	0.93
		Proposed	9.4	2.7	191.8	7.6	0.86
		Reduction	-1.1%	-3.1%	-3.1%	-5.1%	-7.7%
Piney Branch	2,475	Existing	4.6	2.1	73.7	3.6	0.63
		Future	4.9	2.2	85.6	4.2	0.72
		Proposed	4.8	2.1	84.7	4.0	0.64
		Reduction	-3.0%	-7.5%	-1.0%	-4.8%	-11.5%
Piney Run	2,100	Existing	3.2	1.6	48.8	2.1	0.32
		Future	3.5	1.6	56.8	2.5	0.37
		Proposed	3.5	1.3	57.0	2.4	0.33
		Reduction	-2.0%	-19.0%	0.5%	-4.8%	-12.7%
Rocky Branch	2,167	Existing	3.4	1.6	47.9	2.3	0.39
		Future	3.7	1.7	53.2	2.5	0.44
		Proposed	3.6	1.6	53.2	2.3	0.36

Subwatershed	Area	Scenario	Runoff Volume (in/yr)	Peak Flow (cfs/ac)	TSS (lb/ac/yr)	TN (lb/ac/yr)	TP (lb/ac/yr)
		Reduction	-2.3%	-10.1%	0.1%	-7.0%	-17.7%
Rocky Run	1,673	Existing	4.0	1.9	64.5	2.9	0.36
		Future	4.2	2.0	66.2	3.1	0.40
		Proposed	4.1	1.8	65.5	3.0	0.40
		Reduction	-2.1%	-9.2%	-1.2%	-1.5%	-2.3%
Snakeden Branch	2,239	Existing	6.1	2.1	126.5	5.0	0.66
		Future	6.4	2.1	132.9	5.1	0.66
		Proposed	6.3	1.8	130.3	4.9	0.60
		Reduction	-2.4%	-12.9%	-1.9%	-4.7%	-9.4%
South Fork Run	1,745	Existing	2.1	1.3	23.4	1.3	0.25
		Future	2.3	1.3	25.4	1.4	0.27
		Proposed	2.2	1.2	25.3	1.3	0.23
		Reduction	-2.1%	-10.4%	-0.2%	-6.2%	-15.7%
Sharpers Run	415	Existing	1.7	1.2	21.3	1.2	0.18
		Future	2.2	1.2	30.0	1.6	0.23
		Proposed	2.1	1.1	29.8	1.6	0.23
		Reduction	-3.1%	-10.9%	-0.7%	-0.4%	-0.5%
Wolftrap Creek	3,631	Existing	5.1	2.3	80.8	3.7	0.60
		Future	5.6	2.5	95.4	4.5	0.74
		Proposed	5.3	2.0	84.4	3.8	0.58
		Reduction	-5.0%	-20.2%	-11.5%	-15.8%	-22.7%
Upper Difficult Run	5,684	Existing	3.7	1.8	60.6	2.5	0.34
		Future	4.1	1.9	73.1	3.0	0.39
		Proposed	4.0	1.5	60.5	2.3	0.30
		Reduction	-2.2%	-20.4%	-17.3%	-20.9%	-24.8%
Middle Difficult Run	1,721	Existing	3.3	1.7	41.2	1.9	0.31
		Future	3.5	1.8	45.1	2.1	0.33
		Proposed	3.3	1.5	42.8	1.9	0.26
		Reduction	-5.6%	-14.0%	-5.1%	-11.8%	-20.8%
Lower Difficult Run	2,450	Existing	1.9	1.4	17.5	0.9	0.17
		Future	2.0	1.5	19.0	1.0	0.19
		Proposed	1.9	1.4	18.9	0.9	0.16
		Reduction	-1.5%	-5.1%	-0.5%	-4.7%	-12.6%
Difficult Run Total	37,924	Existing	3.8	1.8	63.1	2.7	0.41
		Future	4.2	1.9	70.6	3.1	0.46
		Proposed	4.0	1.6	65.4	2.7	0.38
		Reduction	-3.3%	-13.6%	-7.5%	-10.9%	-16.6%

Glossary

A

Acre: A measure of land area equal to 43,560 square feet.

Acre-Foot: A measure of water volume equal to a land area of one acre with a depth of one foot.

Algae: Simple plants that grow in sunlit waters. Too much algal growth can lower water quality by reducing the oxygen necessary to support *aquatic* life. Excessive algal growth can be triggered by high amounts of *nutrients* such as *nitrogen*.

Aquatic: Growing or living in, or often found in water.

Aquatic Bench: A ten to fifteen foot wide bench around the inside perimeter of a stormwater pond that ranges in depth from zero to twelve inches. Normally planted with wetland vegetation, the bench provides safety, habitat, and additional pollutant removal.

Aquifer: A water-bearing layer of rock, sand, or gravel capable of absorbing water. An aquifer supplies *groundwater* to wells and springs.

B

Bankfull Flow: The flow at which a stream begins to overflow its banks.

Baseflow: Streamflow coming from *groundwater* seeping into a stream.

Benthic Macroinvertebrate: An *aquatic* animal with no backbone and generally visible to the unaided eye, living at the bottom of streams. The number and types of these animals is used as a measure of water quality.

Berm: A mound of earth formed to control the flow of surface water. (Also called, *earthen berm*.)

Best Management Practice (BMP): A practice designed to lessen the impacts of changes in land use on surface water and *groundwater*. Structural best management practices refer to techniques such as *stormwater ponds* designed to reduce pollutants in stormwater runoff. Nonstructural best management practices refer to land-use practices designed to reduce the impact of stormwater runoff on streams, such as the preservation of open space and stream buffers.

Biofiltration: see *Bioretention*.

Bioretention: A water quality practice that uses landscaping and soils to collect and treat urban stormwater runoff. Water is collected in shallow depressions in the ground and allowed to slowly filter through a layer of plants and soil.

Build-out: The total potential land development area based on current and future land development and zoning plans.

Buffer: An area of plant cover next to shorelines, wetlands, or streams. See also, *Resource Protection Area* and *Riparian Buffer*.

C

Catchment: The smallest *watershed* management unit, defined as the area contributing water to a stream, usually through a pipe or open channel.

Channel: A natural or manmade waterway.

Channel Evolution Model: A classification system based on a stream channel's response to human activity such as changes in land use. Channel types are categorized based on streambed and bank characteristics that represent stages in a stream channel's response to land disturbance. See section 3.1.6 for more details.

Chesapeake 2000 Agreement: A voluntary agreement that jurisdictions around the Chesapeake Bay, including the Commonwealth of Virginia, have signed to form a partnership to restore the Chesapeake Bay.

Chesapeake Bay Preservation Areas: Any land designated by Fairfax County in accordance to Part III of the Chesapeake Bay Preservation Area Designation and Management Regulations and Code of Virginia, Section 10.1-2107. A Chesapeake Bay Preservation Area consists of a *Resource Protection Area* (RPA) and a *Resource Management Area* (RMA).

Confluence: The point where two or more streams join to create a combined, larger stream.

D

Deposition: The process in which particles (e.g., silt, sand, gravel) in the water settle to the stream bottom. Too much deposition can create a thick layer of particles on the stream bottom causing a loss of habitat and spawning areas for *aquatic* insects and fish. Stream bank erosion is a common source for the particles.

Detention: The temporary storage of stormwater runoff used to control peak runoff amounts and provide time for the gradual settling of pollutants.

Detention Basin: A stormwater management pond that temporarily holds runoff and slowly releases it to a downstream stormwater system. Since a detention basin holds runoff only temporarily, it is normally dry during periods of no rainfall. (Also called a *Dry Pond*.)

Discharge: The volume of water that passes a given location within a given period of time, usually expressed in cubic feet per second.

Dissolved Oxygen (DO): The amount of oxygen that is present in a liquid**.** An adequate supply of oxygen is necessary to support life in a body of water. Measuring the amount of dissolved oxygen in water provides a means of determining the water quality.

Drainage: The removal of excess surface water or *groundwater* from land.

Drainage Area: The area of land draining to a single outlet point.

Dry Pond: See *Detention Basin*.

Dwelling Unit: A residential building or part of a building intended for use as a complete, independent living facility.

E

Ecosystem: All of the organisms in an ecological community and their environment that together function as a unit.

Effluent: Water that flows from a sewage or other type of treatment plant after it has been treated.

Erodibility: The susceptibility of soil to erosion.

Erosion: The wearing away of the land surface by running water, wind, ice, or other geological agents. In streams, erosion is the removal of soil from the stream banks or streambed by rapid flows.

Estuary: A partially enclosed body of water where freshwater from rivers and streams flows into the ocean, mixing with the salty seawater. Although influenced by the tides, estuaries are protected from the full force of ocean waves, winds, and storms by the reefs, barrier islands, or fingers of land, mud, or sand.

Eutrophication: The process of over-enrichment of waterbodies by nutrients, often resulting in excess *algae*. Excess algae reduces the oxygen in water, required for living organisms.

Evapotranspiration: The loss of water to the atmosphere from the earth's surface by evaporation and by *transpiration* through plants.

F

Farm Pond: A still body of water found on farmland.

Fecal Coliform Bacteria: A group of organisms that live in the intestinal tracts of humans and animals. The presence of fecal coliform bacteria in water is an indicator of pollution from human and/or animal excrement.

Filter Strips: A vegetated area that treats *sheet flow* and/or *interflow* by removing sediment and other pollutants. The area may be grass-covered, forested or of mixed vegetative cover (e.g., wildflower meadow).

First Flush: The first portion of stormwater runoff usually containing the highest pollutant concentration resulting from a rainfall event.

Fish Passage: Unobstructed movement of fish within the stream system. Fish require the ability to move between various habitat types and during migration.

Flood limit: Those land areas in and adjacent to streams subject to continuous or periodic inundation from flood events. A 100-year flood limit is an area with a 1 percent chance of inundation in any given year. Also called *floodplain*.

Flooding: The inundation of land next to streams and waterbodies.

Forb: A small, non-woody plant that is not grass, commonly called weeds.

Forebay: A small storage area near the inlet of a stormwater pond to trap incoming sediment where it can be removed easily before it can accumulate in the pond.

G

Gabion: A wire basket or cage that is filled with rock, used to stabilize stream banks, change flow patterns, or prevent erosion.

Geographic Information System (GIS): A computer system for mapping and spatial analysis.

Geomorphology: A science that deals with the land and underwater relief features of the earth's surface. In streams (fluvial geomorphology), it is the study of stream and river channel physical characteristics and evolution over time.

Grassed (Grassy) Swale: An open, vegetated natural depression or wide shallow ditch used to temporarily store, route, or filter out pollutants and sediments from runoff.

Greywater: Wastewater from washing machines, showers, bathtubs, hand washing, lavatories and sinks, which does not contain sewage.

Groundwater: Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturated zone is called the water table.

Groundwater Discharge: The flow of water from the ground to a receiving waterbody such as a stream or lake. See also *Baseflow*.

H

Headcut: An erosional feature in which a sudden change in stream bed elevation occurs resulting in a small waterfall. Flow over the headcut results in a lowering of the stream bed elevation on the downstream side. The headcut will migrate upstream creating a deeper channel as it porgresses.

Headwater: The source of a stream or *watercourse*.

Herbicides: Chemicals used to control or kill plants.

Hydraulics: The physical science and technology of the stationary and active behavior of fluids.

Hydrograph: A plot showing the rate of discharge, depth, or velocity of flow over time for a given point on a stream or drainage system.

Hydrologic Cycle: The cycling of water from the atmosphere, onto and through the landscape and eventually back into the atmosphere.

Hydrology: The science dealing with the distribution and movement of water.

Hyetograph: A graphical display of the distribution of rainfall over time.

I

Impervious Surface: A surface composed of any material that impedes or prevents *infiltration* of water into the soil. Impervious surfaces include roofs, buildings, streets, and parking areas. Also called impervious cover.

Infill: A residential development that has occurred near, or within, an already established neighborhood.

Infiltration: The process by which water drains into the ground. Some of this water will remain in the shallow soil layer, where it will gradually move through the soil and subsurface material. Eventually, it might enter a stream by seepage out of a stream bank or it may penetrate deeper, recharging *ground-water aquifers*.

Infiltration Facility: A stormwater management facility that temporarily stores runoff so it can be absorbed into the surrounding soil. Since an infiltration facility confines runoff only temporarily, it is normally dry during periods of no rainfall. Infiltration ponds, infiltration trenches, infiltration dry wells, and porous pavement are considered infiltration facilities.

Intensely Developed Area: A term related to Fairfax County's Chesapeake Bay Preservation ordinance, describing an area of existing development and *infill* sites where development is concentrated and little of the natural environment remains.

L

Land Development: A man-made change to, or construction on, the land surface.

Land Disturbing Activity: Land change including clearing, grading, excavating, permanent flooding associated with the impoundment of water, and filling of land. These land changes can result in soil erosion from water or wind and the movement of sediments into waters or onto lands.

Land Use: Describes the type of activity on the land such as commercial or residential. The county zoning requirements dictates the type of land use allowed for a given area.

Leaching: The process by which water-soluble materials in the soil, such as salts, nutrients, pesticides or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

Low-Impact Development (LID): A stormwater management technique that reduces the stormwater impacts from new development or redevelopment. There are many options for including low impact development in a design. For example, reducing the amount of *impervious* surfaces and designing the site to take advantage of the natural conditions can reduce the amount of runoff produced by a development area. Techniques such as *grassy swales* and *bioretention* facilities may also be included to reduce runoff rates and promote *infiltration*.

M

Marsh: A wet land area, periodically inundated with water.

Micaceous: General term for mica-rich rocks. Mica is a group of minerals with a sheet-like crystal structure that easily separate into thin, transparent leaves. Micas can be found in the rocks of the Piedmont and Blue Ridge provinces of Virginia.

Micropool: A small permanent pool in a larger stormwater pond system, usually at the pond outlet to provide additional settling of pollutants.

Mitigation: To make a development scenario less harmful than the original plan; or to provide a habitat in another more conducive, larger, or better-suited area, typically in a different location from the original.

Municipal Separate Storm Sewer (MS4) Permit: An NPDES (National Pollutant Discharge Elimination System) permit issued to municipalities requiring the reduction in pollutants contributing to the discharges from the municipality's storm sewer system outfalls.

N

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, monitoring, and enforcing permits under Sections 307, 402, 318 and 405 of the Clean Water Act. The NPDES permits regulate wastewater and stormwater discharges to the waters of the United States, and are administered by the Virginia Department of Environmental Quality and Virginia Department of Conservation and Recreation.

Nitrogen: A chemical element that occurs naturally as a gas and makes up 78 percent of the atmosphere. It is required by plants for growth and is found in most fertilizers. Too much nitrogen in the water can cause *eutrophication* and result in excess algal blooms, reducing the amount of oxygen available to aquatic life.

Nonpoint Source (NPS) Pollution: Contaminants such as sediment, nitrogen, phosphorous, hydrocarbons, heavy metals, and other toxins whose origins cannot be pinpointed to a specific source. These contaminants are generally washed from the land surface by stormwater runoff.

Nutrient: A substance that provides food or nourishment. In the *aquatic* environment, nutrient refers to compounds of phosphorus, nitrogen, and potassium that contribute to *eutrophication*.

Nutrient Uptake: The biological process in which plants absorb nutrients through their roots, removing these compounds from the *aquatic* environment.

O

On-Site Stormwater Management: A stormwater management facility designed to control runoff from a small area, such as a lot, block, or subdivision.

Open Space: A portion of a development site that is permanently set aside for public or private use and will not be developed. The space may be used for recreation, or may be reserved to protect or buffer natural areas.

Outfall: Defined in the *NPDES* program as the point where discharge from a regulated system flows into waters of the United States.

Outlet: The point at which water flows from one waterbody to another, such as a stream or river to a lake or larger river.

P

Peak Discharge: The maximum flow rate at a given location during a rainfall event. Peak discharge is a primary design factor for the design of stormwater runoff facilities such as pipe systems, storm inlets and culverts, and swales.

Perennial Streams: A body of water that normally flows year-round, supporting a variety of *aquatic* life.

Pervious: Any material that allows for the passage of liquid through it. Any surface area that allows *infiltration*.

Phosphorus: An element found in fertilizers and sediment runoff that can contribute to the *eutrophication* of waterbodies. It is the keystone pollutant in determining pollutant removal efficiencies for various *best management practices* as defined by the Virginia Stormwater Management Regulations.

Point Source: Any discernible, confined conveyance, including but not limited to, any pipe, ditch, channel, tunnel, well, concentrated animal feeding operation, landfill leachate collection system, or floating craft from which pollutants are discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Pollutant: Any substance introduced to water that degrades its physical, chemical, or biological quality.

Pollutant Loading: The rate at which a pollutant enters a surface water or *groundwater* system. This is typically determined by water quality modeling and expressed in terms such as pounds per acre, per year.

Pollution Prevention: Any activity intended to reduce or eliminate pollutants from entering a waterbody (e.g., spill response, minimizing fertilizer or pesticide use, etc.)

Pool: The reach of a stream between two *riffles*; a small and relatively deep body of quiet water in a stream or river. Natural streams often consist of a succession of pools and riffles.

Post-Development: Refers to conditions that exist after completion of a land development activity on a specific site or tract of land.

Pre-Development: Refers to the conditions that exist at the time that plans for land development of a tract of land are approved by the plan approval authority.

Q

Quantity Control: *Stormwater management facilities* designed to reduce *post-development peak discharge* to the peak *discharge* that occurred in the *pre-development* conditions.

Quality Controls: *Stormwater management facilities* designed to remove *pollutants* from *runoff* and improve water quality.

R

Rain Barrel: A storage container connected to a roof downspout, typically including a hose attachment to allow for reuse of rooftop runoff.

Reach: General term used to describe a length of stream.

Recharge: The downward movement of water through the soil into *groundwater*; for example, rainfall that seeps into a *groundwater aquifer*.

Redevelopment: The substantial alteration, rehabilitation, or rebuilding of a property for residential, commercial, industrial, or other purposes.

Regional Ponds: Larger stormwater management facilities designed to treat the runoff from drainage areas of 100 to 300 acres.

Resource Management Area (RMA): An area defined in Fairfax County's Chesapeake Bay Preservation Ordinance comprised of lands that, if improperly used or developed, have a potential for causing significant water quality degradation. RMAs typically include floodplains, highly erodible or permeable soils, and other land as designated by the locality.

Resource Protection Area (RPA): As established in accordance with Chapter 118 of the Code of County of Fairfax, Virginia, that component of the Chesapeake Bay Preservation Area comprised of lands at or near the shoreline or water's edge that have an intrinsic water quality value due to the ecological and biological processes they perform or are sensitive to impacts that may result in significant degradation of the quality of state waters. In their natural condition, these lands provide for the removal, reduction, or assimilation of sediments, nutrients, and potentially harmful or toxic substances from runoff entering the Bay and its tributaries, and minimize the adverse effects of human activities on state waters and aquatic resources.

Resource protection areas filter pollutants out of stormwater runoff, reduce the volume of stormwater runoff, prevent erosion, and perform other important biological and ecological functions. A resource management area is a Chesapeake Bay Preservation Area, whose land features generally include tidal wetlands, nontidal wetlands contiguous to tidal wetlands, tidal shores, tributary streams, a buffer area (of not less than 100 feet), and other lands as designated by the locality.

Retention: The permanent storage of stormwater.

Retention Basin: A stormwater management pond that permanently stores water for the purpose of improving water quality. It is normally wet, even during periods without rainfall. Stormwater runoff may be temporarily stored above this impoundment for the purpose of reducing flooding or stream channel erosion. Also called a *Wet Pond*.

Retrofit: The modification of stormwater quantity control systems through the modification of wet ponds, wetland plantings, or other *best management practices* designed to improve water quality.

Return Period: The average length of time between events having the same characteristics. For example, if a storm has a 1 percent chance of occurring in any given year, then it has a return period of 100 years.

Riparian Buffer: Strips of grass, shrubs, and/or trees along the banks of rivers and streams that filter polluted runoff. These buffers provide a transition zone between water and human land use. Buffers are also complex ecosystems that provide habitat and improve the stream communities they shelter.

Riprap: A protective layer of large stones placed on a streambank to prevent erosion.

Riffle: A reach of stream that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.

Riffle/Run: Streams that are generally characterized by a high slope (gradient), and a mixture of riffle and run habitat.

Runoff: The portion of precipitation, snowmelt, or irrigation water that flows off the land into surface waters instead of *infiltrating*.

Run: A segment of stream length that is characterized by moderate depths, smooth flowing water at a moderate pace. A run is intermediate between a *riffle* and a *pool*.

S

Scour: Removal of sediment from the streambed and banks caused by fast moving water. See also *Erosion*.

Sediment: Organic materials and/or minerals that have been moved from their original site by water or wind. Sediment accumulates in reservoirs, rivers and streams, reducing channel depth, impeding navigability, destroying wildlife habitat and clouding water so that sunlight cannot reach *aquatic* plants.

Sedimentation (Settling): The processes whereby particles of rock material accumulate to form deposits. Sedimentation also refers to a pollutant removal method to treat stormwater in which pollutants are removed by gravity as sediment settles out of the water column. An example of a *best management practice* using sedimentation is a *detention pond/wet pond*.

Sheet Flow: Runoff that flows over the ground surface as a thin, even layer, not concentrated in a channel.

Site Plan: Detailed engineering drawings of the proposed uses and improvements required in the development of a given lot.

Source Controls: A group of stormwater management techniques designed to remove pollutants before they enter a downstream waterbody. They include non-structural best management practices, pollution prevention techniques, and housekeeping measures such as street sweeping, litter and trash pickup, or storm sewer cleaning.

Stakeholder: Stakeholders include groups of people within the Difficult Run watershed (e.g., residents, industry, local government, agencies, and community groups), as well as those who work in the *watershed*.

Storm Drain: See *Storm Sewer*.

Storm Sewer: A man-made drainage system that carries only surface runoff, street wash, and snow melt from the land. In a separate storm sewer system, storm sewers are completely separate from sanitary sewers that carry wastewater. In a combined sewer, a single conveyance system carries both stormwater and wastewater.

Stormwater: Surface water flow that results from rainfall.

Stormwater Management (SWM) Facility: A structure, such as a pond, that controls the quantity and quality of stormwater runoff.

Stormwater Outfall: A single location, pipe discharge, or outlet structure that releases stormwater into a stream, river, or pond.

Stormwater Ponds: A depression or dammed area with an outlet device that controls stormwater outflow. Stormwater ponds retain water from upstream areas, thereby reducing peak flows downstream. In Fairfax County, stormwater ponds are either dry (*dry pond*) or contain a permanent pool of water (*wet pond*) and are typically designed to control the peak runoff rate for selected storm events.

Stormwater Wetlands: Areas intentionally designed to emulate the water quality improvement function of wetlands for the primary purpose of removing pollutants from stormwater.

Stream Flow: Surface water flowing in a natural channel.

Stream Rehabilitation: The recovery of ecosystem functions and processes in a degraded *aquatic* habitat. Rehabilitation does not necessarily reestablish the pre-existing condition of the ecosystem, but does involve establishing geologically and hydrologically stable landscapes that support the natural ecosystem.

Stream Restoration: The reestablishment of the structure and function of a stream, as closely as possible to its pre-existing condition.

Subdivision: A new development that splits an existing tract, parcel or lot into two or more parts.

Subdivision Code: A set of local requirements that govern the dimensions of a particular zoning category and also specify the types of roads, drainage, waste disposal and other community services that must be constructed to serve the development.

Substantial Alteration: Expansion or modification of a structure or development that would result in disturbance of any land within a *Resource Protection Area.* It also refers to land exceeding an area of 2,500 square feet within a *Resource Management Area*.

Substrate: The material forming the bottom of a stream channel. Channel materials are generally broken into categories (listed smallest to largest) such as clay, silt, sand, gravel, cobble and boulder.

Subwatershed: A smaller subsection of a larger *watershed*, delineated to describe a particular tributary to a larger waterbody. A subwatershed may contain several *catchments*.

Suspended solids: Particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles as well as solids in wastewater.

Swale: A natural depression or wide shallow ditch used to temporarily store, route, or filter runoff.

T

Tidal Shores or Shore: The land next to a tidal body of water between the mean low water level and the mean high water level.

Total Maximum Daily Load (TMDL): A calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards.

Transpiration: The process by which water vapor escapes from living plants and enters the atmosphere. Studies have shown that about 10 percent of the moisture found in the atmosphere is released by plants through transpiration.

Tree Canopy Cover: The area directly beneath the crown and within the dripline of a tree.

Turbidity: The amount of solid particles that are suspended in water, making it cloudy or even opaque in extreme cases.

U

Ultra-Urban: A type of land use dominated by highly developed areas in which very little *pervious* surface exists.

Uncontrolled Stormwater: Stormwater that is not treated by *stormwater management* systems.

Urban Runoff: Stormwater from developed areas, including streets and adjacent residential or commercial/industrial properties. This runoff can carry road salt, trash, chemicals, oil, and other pollutants into local streams and waterbodies.

W

Water Body with Perennial Flow: A body of water flowing in a natural or manmade channel year-round, except during periods of drought. These include *perennial streams*, *estuaries*, and tidal bays.

Water Quality Standards: State-adopted and USEPA-approved standards for waterbodies. The standards prescribe the use of the waterbody and establish the water quality criteria that must be met to protect designated uses.

Watershed: An area of land that drains directly, or through tributary streams, into a particular river or waterbody. A watershed includes its associated groundwater. Elevated landforms, such as ridges or even roads can serve as watershed divides.

Wetlands: Areas where the soil or substrate is saturated with water during at least a part of the growing season. These saturated conditions determine the types of plants and animals that live in these areas.

Wet Pond: See *Retention Basin*.

Acronyms

ac	Acre
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
cfs	Cubic Feet per Second
CEM	Channel Evolution Model
CBPA	Chesapeake Bay Preservation Area
COD	Chemical Oxygen Demand
CMP	Corrugated Metal Pipe
CWA	Clean Water Act
DCR	Virginia Department of Conservation and Recreation
DEM	Digital Elevation Model
DEQ	Virginia Department of Environmental Quality
DO	Dissolved Oxygen
DPWES	Fairfax County Department of Public Works and Environmental Services
DPZ	Fairfax County Department of Planning and Zoning
E&SC	Erosion and Sediment Control
FEMA	Federal Emergency Management Agency
fps	Feet per Second
FBP	Future Basin Plan
GIS	Geographic Information System
GP	General Permit
IAP	Immediate Action Plan
IDA	Intensely Developed Area
IMBI	Index of Macro-Biotic Integrity
IMP	Integrated Management Practices
JPA	Joint Permit Application
LF	Linear Foot
LID	Low Impact Development
mg/l	Milligrams per Liter
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NRCS	U.S. Natural Resources Conservation Service

NWP	Nationwide Permit
OSDS	Fairfax County Office of Site Development Services
PFM	Fairfax County Public Facilities Manual
ppb	Parts per Billion
ppm	Parts per Million
ppt	Parts per Thousand
PRS	Pro Rata Share
RBP	Rapid Bioassessment Protocol
RCP	Reinforced Concrete Pipe
RMA	Resource Management Area
RPA	Resource Protection Area
SCS	U.S. Soil Conservation Service
SOS	Save Our Streams
SPA	Stream Physical Assessment
SPS	Stream Protection Strategy
STATSGO	NRCS State Soil Geographic Database
SWM	Stormwater Management
TMDL	Total Maximum Daily Load
TR-55	Technical Release 55
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VDH	Virginia Department of Health
VDOT	Virginia Department of Transportation
VPDES	Virginia Pollutant Discharge Elimination System
VWPP	Virginia Water Protection Permit

References

CDM, 2003. *Technical Memorandum No. 3, Stormwater Model and GIS Interface Guidelines*, CDM, Annandale, VA.

Center for Watershed Protection, 2003. *Impacts of Impervious Cover on Aquatic Systems*. CWP, Ellicott City, MD.

Fairfax County Environmental Coordinating Committee, 2003. *The Role of Regional Ponds In Fairfax County's Watershed Management.* Fairfax County, Fairfax VA.

Fairfax County Office of Comprehensive Planning, 1978. *Difficult Run Headwaters Land Use Study*, Fairfax County, Fairfax VA.

Fairfax County Soil Science Office, 1990. *Fairfax County Soil Survey*. Fairfax, VA.

Fairfax County Stormwater Management Branch, 2001. *Fairfax County Stream Protection Strategy (SPS) Baseline Study.* Fairfax, VA.

Metropolitan Washington Council of Governments, 2006. *Growth Trends to 2030: Cooperative Forecasting in the Washington Region*. MWCOG, Washington DC.

Parsons Brinkerhoff Quade and Douglas, 1976. *Difficult Run Environmental Baseline*. PBQ&D, Fairfax, VA.

Schueler, T.S., 2000. "Irreducible Pollutant Concentrations Discharged from Stormwater Practices*."* Article 65 in *The Practice of Watershed Protection.* Center for Watershed Protection, Ellicott City, MD.

Schumm, S.A., Harvey, M.D., and Watson, C.C., 1984. *Incised Channels: Morphology, Dynamics, and Control*. Water Resources Publications, Littleton, CO.