Appendix A: Watershed Workbook

The watershed workbook is a reader-friendly document that is designed to provide the residents and stakeholders of the Sugarland Run and Horsepen Creek watersheds with information about their watersheds. The watershed workbook describes the watershed study methodology and summarizes the County-wide goals and objectives. The watershed workbook characterizes the existing state of the watersheds and describes the various methods and tools used in the evaluation of all the watershed management areas within the Sugarland Run and Horsepen Creek watersheds. The watershed workbook is a draft document that contains the information and modeling results available at the time and has not been, and will not be, updated or finalized.

Appendix B: Technical Documents

i. Subwatershed Strategies

Technical Memo 3.2 describes how initial strategies were developed for Sugarland Run and Horsepen Creek watersheds. The memo discusses the characterization of subwatershed improvement, stream restoration, and regional pond alternative strategies. The memo also describes how based on these strategies priority subwatersheds were identified and potential candidate restoration projects were selected.

ii. Prioritization

Technical Memo 3.4/3.5 describes how potential candidate projects were evaluated and the final list of projects incorporated in the watershed management plan was selected. The memo describes how candidate projects were investigated in the field to evaluate the scope, feasibility, and benefits of each candidate project. The memo also discusses the procedure by which candidate structural projects were evaluated and ranked.

iii. Modeling description

Technical Memo 3.6 describes the selection of projects to be further evaluated with hydrologic and hydraulic models. The memo discusses this assessment of potential impacts and discusses if objectives were met by implementing the modeled projects. The memo summarizes the setup, calibration and results of the hydrologic and hydraulic modeling performed. Results from the final STEPL pollution model were also summarized in this memo.

Appendix C: Public Involvement

Summaries of the initial community workshop, the draft plan forum and each of the five Watershed Advisory Group (WAG) meetings that were held through the watershed management plan development process are included in Appendix C.

i. October 30, 2008
ii. December 10, 2008
iii. March 3, 2009
iv. June 3, 2009
v. March 9, 2010
vi. July 21, 2010
vii. August 3, 2010

Appendix A: Watershed Workbook

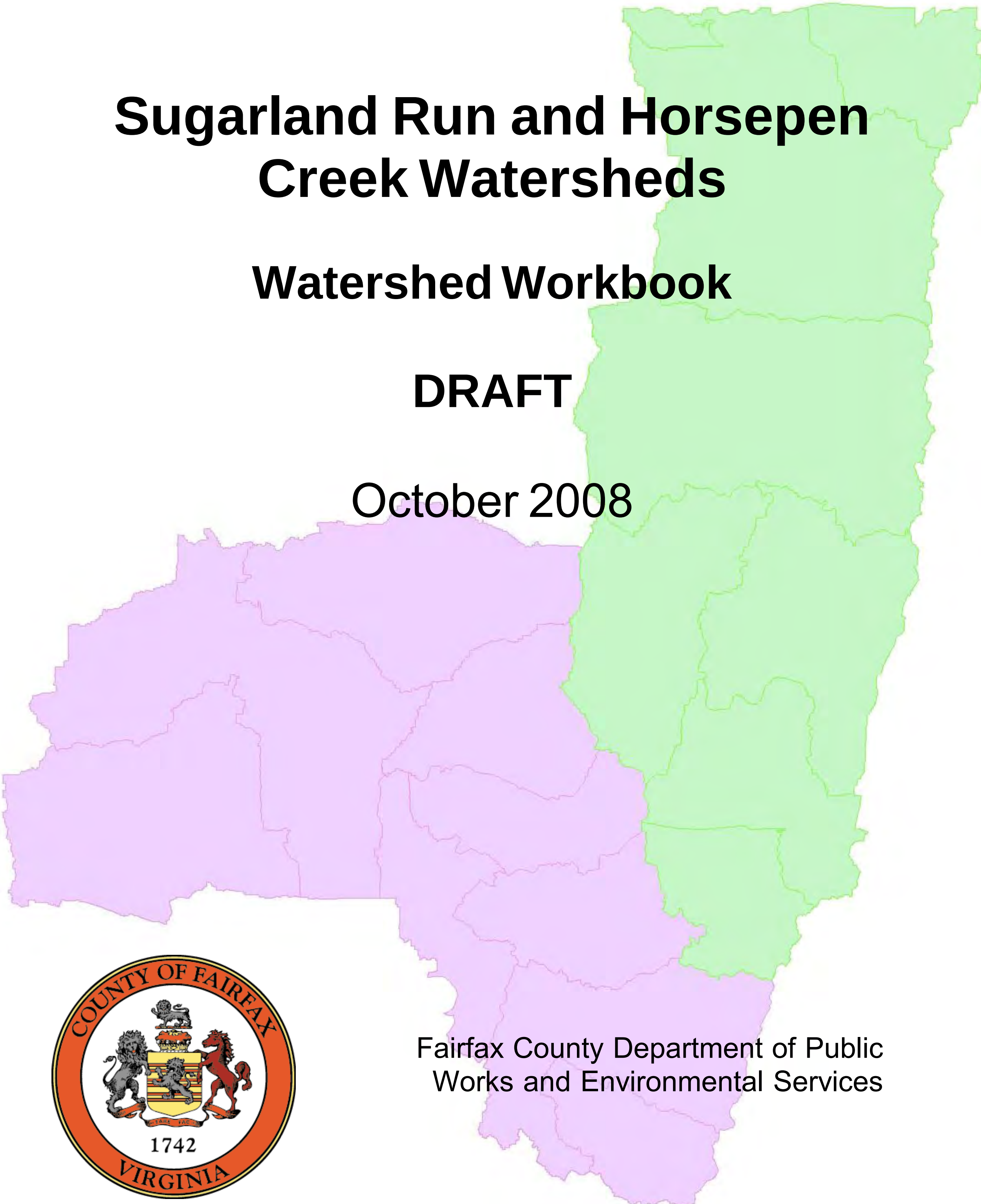
The watershed workbook is a reader-friendly document that is designed to provide the residents and stakeholders of the Sugarland Run and Horsepen Creek watersheds with information about their watersheds. The watershed workbook describes the watershed study methodology and summarizes the County-wide goals and objectives. The watershed workbook characterizes the existing state of the watersheds and describes the various methods and tools used in the evaluation of all the watershed management areas within the Sugarland Run and Horsepen Creek watersheds. The watershed workbook is a draft document that contains the information and modeling results available at the time and has not been, and will not be, updated or finalized.

Sugarland Run and Horsepen Creek Watersheds

Watershed Workbook

DRAFT

October 2008



Fairfax County Department of Public Works and Environmental Services

This page intentionally left blank.

SUGARLAND RUN
AND
HORSEPEN CREEK
WATERSHED WORKBOOK

DRAFT

October 2008

Prepared for:

County of Fairfax
Watershed Planning and Assessment Branch
Department of Public Works and Environmental Services
Stormwater Planning Division
12000 Government Center Parkway, Suite 449
Fairfax, Virginia 22035-0052

This page intentionally left blank.

Table of Contents

Table of Contents (Continued)

Section **Page**

Table of Contents (Continued)

Section **Page**

Table of Contents (Continued)

List of Figures

List of Tables

This page intentionally left blank.

1.1 Introduction

1.2 Background, Goals and Objectives

Fairfax County is located in the Northeastern part of the Commonwealth of Virginia. Thirty watersheds comprise Fairfax County, including the Sugarland Run and Horsepen Creek watersheds, as shown in Figure 1.1. In order to comply with the Chesapeake Bay 2000 Agreement, the Fairfax County Department of Public Works and Environmental Services Stormwater Planning Division is in the process of developing and implementing watershed management plans for all 30 watersheds. The watershed management plans aim to evaluate the interactions between pollutant sources, watershed stressors, and conditions within streams and other waterbodies. The county will use the information from these plans to prioritize watershed restoration and protection projects.

The county has developed goals and objectives to be applied to all watersheds during the watershed management plan development process. The countywide goals and objectives will allow plan recommendations to be linked to the Countywide Watershed Assessment. The Countywide Watershed Assessment methodology will be used to measure and track future achievement of watershed management plan goals and objectives. According to the Fairfax County WMP Subwatershed Ranking Approach (Tetra Tech, 2008), the countywide watershed planning goals are to:

1. Improve and maintain watershed functions in Fairfax County, including water quality, habitat, and hydrology.

2. Protect human health, safety, and property by reducing stormwater impacts.

3. Involve stakeholders in the protection, maintenance and restoration of county watersheds.

The county has developed countywide objectives that are linked to the above goals, as presented in Table 1.1. This table also shows how each objective is linked to the three watershed planning goals.

This page intentionally left blank.

Figure 1.1
Fairfax County Watersheds

This page intentionally left blank.

Table 1.1 Fairfax County Watershed Planning Final Objectives

Objective		Linked to Goal(s)
CATEGORY 1. HYDROLOGY		
1A.	Minimize impacts of stormwater runoff on stream hydrology to promote stable stream morphology, protect habitat, and support biota.	1
1B.	Minimize flooding to protect property and human health and safety.	2
CATEGORY 2. HABITAT		
2A.	Provide for healthy habitat through protecting, restoring, and maintaining riparian buffers, wetlands, and instream habitat.	1
2B.	Improve and maintain diversity of native plants and animals in the county.	1
CATEGORY 3. STREAM WATER QUALITY		
3A.	Minimize impacts to stream water quality from pollutants in stormwater runoff.	1, 2
CATEGORY 4. DRINKING WATER QUALITY		
4A.	Minimize impacts to drinking water sources from pathogens, nutrients, and toxics in stormwater runoff.	2
4B.	Minimize impacts to drinking water storage capacity from sediment in stormwater runoff.	2
CATEGORY 5 STEWARDSHIP		
5A.	Encourage the public to participate in watershed stewardship.	3
5B.	Coordinate with regional jurisdictions on watershed management and restoration efforts such as Chesapeake Bay initiatives.	3
5C.	Improve watershed aesthetics in Fairfax County.	1, 3

Source: Fairfax County WMP Subwatershed Ranking Approach, Tetra Tech, 2008.

1.3 Watershed Workbook Organization

This watershed workbook is designed to provide the residents and stakeholders of the Sugarland Run and Horsepen Creek watersheds with information about their watersheds. This will help create a more informed public and encourage participation in the watershed planning and restoration process.

This watershed workbook contains the following information in each chapter.

Chapter 1 **Introduction** - Compilation of Overall Watershed Condition Data
Chapter 2 **Watershed Study Methodology** – Description of Methodologies Used
Chapter 3 **Sugarland Run Watershed Study** – Sugarland Run Preliminary Results
Chapter 4 **Horsepen Creek Watershed Study –** Horsepen Creek Preliminary Results
Chapter 5 **Glossary**

1.4 Watershed History and Condition

1.3.1 General Watershed Characteristics

The Sugarland Run and Horsepen Creek watersheds are located in the Northwestern portion of Fairfax County, as shown in Figure 1.2. Both watersheds are described in detail below.

Sugarland Run

Sugarland Run Watershed is made up of Sugarland Run, Offuts Branch, Folly Lick Branch, and Rosiers Branch. Sugarland Run flows north from its origin near Reston's Rosedown Avenue into Loudoun County, discharging to the Potomac River. Offuts Branch originates near Leesburg Pike (VA Route 7) and flows west to its confluence with Sugarland Run. Folly Lick Branch flows north from its headwaters in the town of Herndon to its confluence with Sugarland Run. Rosiers Branch is situated to the east of Sugarland Run and flows west to its confluence with Sugarland Run. About one-third of the watershed lies in Loudoun County. The portion of the Sugarland Run Watershed that lies within Fairfax County has a drainage area of approximately 15.3 square miles. There are approximately 48.6 miles of perennial streams in the entire watershed and 31.1 miles of perennial streams in Fairfax County.

Horsepen Creek

Horsepen Creek Watershed is comprised of Horsepen Run, Frying Pan Branch, Cedar Run, and Merrybrook Run. Horsepen Run flows northwest from its headwaters near Fox Mill Road towards its confluence with Broad Run in Loudoun County. Frying Pan Branch originates near Herndon's Fox Mill Road and flows west to its confluence with Horsepen Run. Cedar Run originates to the south of Horsepen Run and flows northwest to its confluence with Horsepen Run. Merrybrook Run originates to the north of Horsepen Run and flows northwest to its confluence with Horsepen Run in Loudoun County. A portion of the watershed lies in neighboring Loudoun County. The area of the Horsepen Creek Watershed that lies within Fairfax County has a drainage area of approximately 9.6 square miles. There are approximately 36.3 miles of perennial streams in the entire watershed and 19.4 miles of perennial streams in Fairfax County.

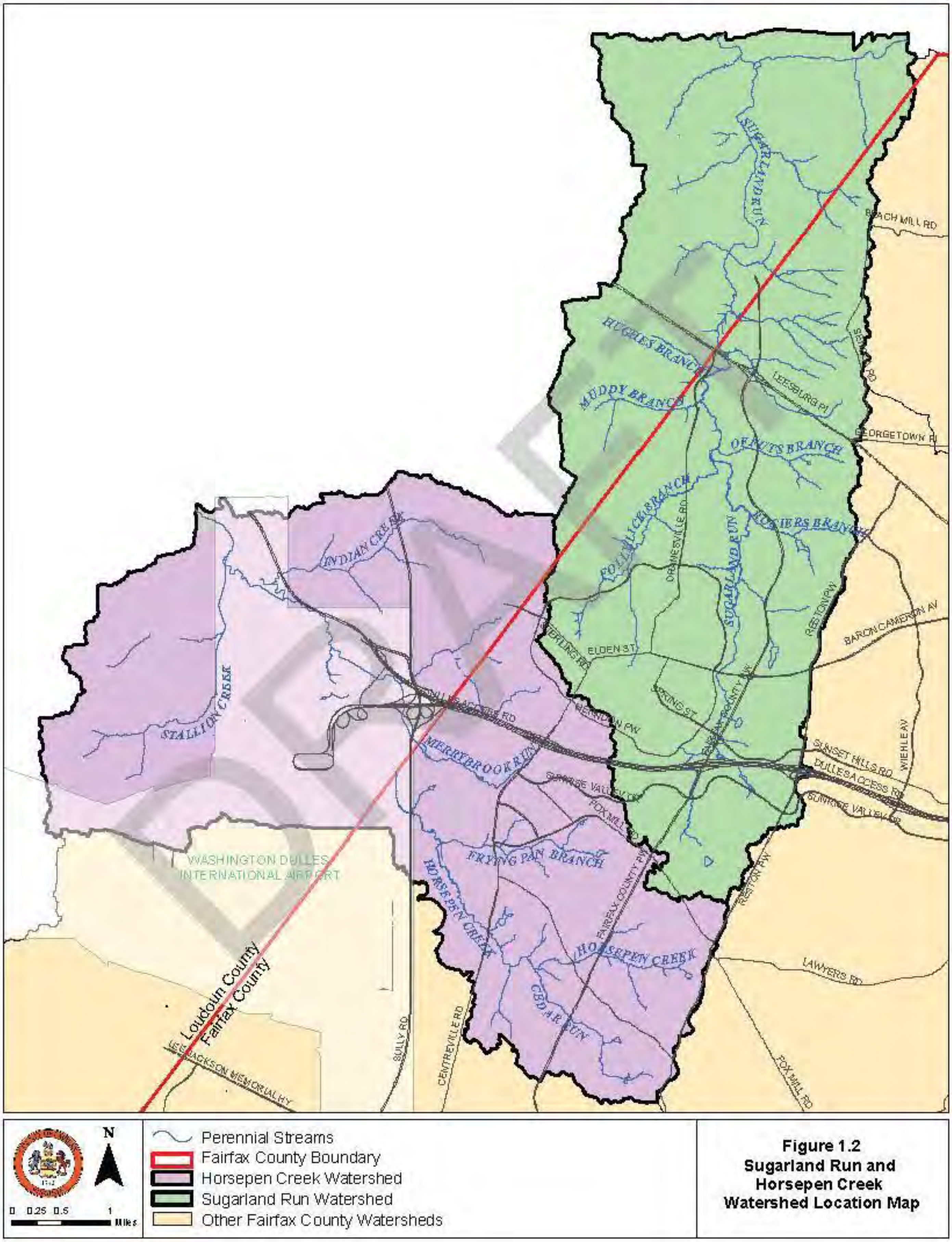


Figure 1.2
Sugarland Run and Horsepen Creek Watershed Location Map

This page intentionally left blank.

1.3.2 Watershed History and Population Growth

Watershed History

The Sugarland Run and Horsepen Creek watersheds have an interesting history. Early European rangers, who periodically scouted the area for Indians in the late 1600s to early 1700s, discovered sugar maple trees and named the nearby stream Sugarland Run. In 1709 Daniel McCarty obtained a large land grant on the west side of Sugarland Run. By 1720 he was using Sugarland Rolling Road, now Georgetown Pike, to roll hogsheads of tobacco to market. The town of Floris, once known as "Frying Pan," was situated between Horsepen Run and Frying Pan Branch. Leesburg Pike (Route 7) passes through the northern end of the Sugarland Run watershed. The road was originally known as Eastern Ridge Road, and can be traced back to 1699 when the Governor of Virginia sent a mission to the emperor of the Piscataway tribe on Conoy Island. (Parsons, Brinckerhoff, Quade, and Douglass, 1977).

The Town of Herndon lies almost entirely in the headwaters of the Sugarland Run Watershed with a small portion in the Horsepen Creek Watershed. The Town of Herndon was founded in 1879 and covers 4.25 square miles. The town was originally surrounded by dairy farms, which shipped their milk daily to Washington, D.C. for processing and distribution. The town was also a vacation haven for city dwellers, who traveled to the area by railroad. The vacationers soon began building spacious summer houses throughout Herndon, which led to population growth (Town of Herndon, 2008).

Population Growth

There was very little growth within the Sugarland Run and Horsepen Creek watersheds toward the end of the 19th century. A Bureau of Topographic Engineers map from 1862 shows cultivated fields in the Horsepen Creek and Sugarland Run watersheds and large forested areas in the Sugarland Run Watershed. In 1879, the Sugarland Run Watershed had a housing density of one house per 120 acres and was the fourth most densely occupied watershed in Northern Virginia. The Horsepen Creek Watershed had a density of one house per 256 acres which was somewhat below the average of one house per 204 acres for the whole region (Parsons, Brinckerhoff, Quade, and Douglas, 1977).

In 1900 Fairfax County was largely agricultural, with dairy farming being the most important single industry. The population was just over 12,000. Four decades later, the population was still under 50,000. Beginning in the early 1940s, the county's economy shifted from agriculture to largely commercial. After World War II many people moved into Fairfax County from Washington, D.C. During this time the population grew from roughly 50,000 to 500,000. In the 1970s the population of Fairfax grew to almost 900,000 residents, driven by technology-based businesses which were less dependent on urban centers than conventional industry, resulting in suburban expansion (Fairfax County, 2001). Today, Fairfax County is the most populous jurisdiction in Virginia as well as the Washington D.C. metropolitan area, with the 2005 population estimated at 1,047,500, with 387,700 households (Fairfax County, 2006a).

The population of the Town of Herndon has also been increasing dramatically in recent years, with a 34 percent increase from 16,139 in 1990 to 21,655 in 2000 (US Census Bureau 2000, n.d.). The Sugarland Run and Horsepen Creek watersheds also experienced a population increase of over 52 percent in the 1990s. Herndon (and the unincorporated area to the south of Herndon) is part of the Dulles Technology Corridor, and is home to the headquarters of such companies as AOL, Verizon Business, Network Solutions and Airbus North America. The majority of recent development has consisted of residential infill development to meet the housing demands of corporate growth.

Infill Development in Fairfax County

In July 2000, the Fairfax County Departments of Planning and Zoning, Transportation and Public Works, and Environmental Services prepared a report that evaluated issues and provided recommendations for improving the manner in which residential infill development occurs in the county, with the primary focus being the impacts of new residential development on the immediate surroundings (Fairfax County, 2006b). "Infill development" in Fairfax County refers to activities such as demolishing an existing home and building a larger home on the same lot; subdividing a single lot into two or more building lots; developing one or more new residences on an undeveloped or underutilized site within an existing, established neighborhood; developing a relatively large subdivision that is surrounded by other recently developed subdivisions; or redeveloping an existing subdivision. The report included recommendations to address the compatibility of infill development with the existing neighborhood/area, traffic flow and cut-through traffic, tree preservation and the preservation of open space in the neighborhood, and stormwater management and erosion and sediment control.

1.3.3 Existing and Future Land Use

Fairfax County encompasses an area of approximately 395 square miles. The land use is primarily residential, with smaller areas of commercial, recreational, and open land uses. The county is largely developed, and is approaching maximum build-out conditions (Fairfax County, 2006a). According to the 1999 Demographic Reports Document, only 17.3 percent of the land area is considered underutilized residential, vacant residential or nonresidential land. (Fairfax County, 2001).

The Fairfax County Stormwater Planning Division has created standard land use categories to unify watershed management planning throughout the county. The categories are assigned a code for easy identification. The Fairfax County land use categories are presented in Table 1.2.

Table 1.2 Generalized Land Use Categories

Land Use	Code	Description
Open Space	OS	Open space, parkland, or vacant land
Estate Residential	ESR	Single-family detached greater than 2 acres per residence
Low Density Residential	LDR	Single-family detached 0.5-2 acres per residence
Medium Density Residential	MDR	Single-family detached less than 0.5 acres per residence and multifamily residential less than 8 dwelling units per acre
High Density Residential	HDR	All residential less than 0.125 acre per residence (8 or greater dwelling units per acre)
Low Intensity Commercial	LIC	Commercial uses including low rise and limited offices and neighborhood retail
High Intensity Commercial	HIC	Commercial uses including high density offices and highway retail
Industrial	IND	Industrial uses
Golf Course	GC	Golf courses, originally considered open space
Water	WATER	Perennial streams buffered 10'
Institutional	INT	School or institutions, originally considered LIC
Transportation	TRANS	Transportation, areas not represented by parcels

Source: County of Fairfax Department of Public Works, 2003

According to Technical Memorandum No. 3, prepared by County of Fairfax Department of Public Works (Fairfax County, 2003), the Horsepen Creek Watershed comprises 6,436 acres, of which 674 are vacant and 73 are underdeveloped. Approximately 11 percent of the watershed is not fully utilized. The Sugarland Run Watershed comprises 8,917 acres, 546 of which are vacant and 200 of which are underdeveloped. Approximately 8.4 percent of the watershed is not fully utilized. Figure 1.3 shows the existing and future land use by category in the Sugarland Run and Horsepen Creek watersheds.

The future land use conditions are defined by the planned land use and the zoned land use. If the planned and zoned land uses conflict, the classification with the greatest density will be used to evaluate future conditions. The results derived from these maps will be discussed in greater detail in future chapters.

This page intentionally left blank.

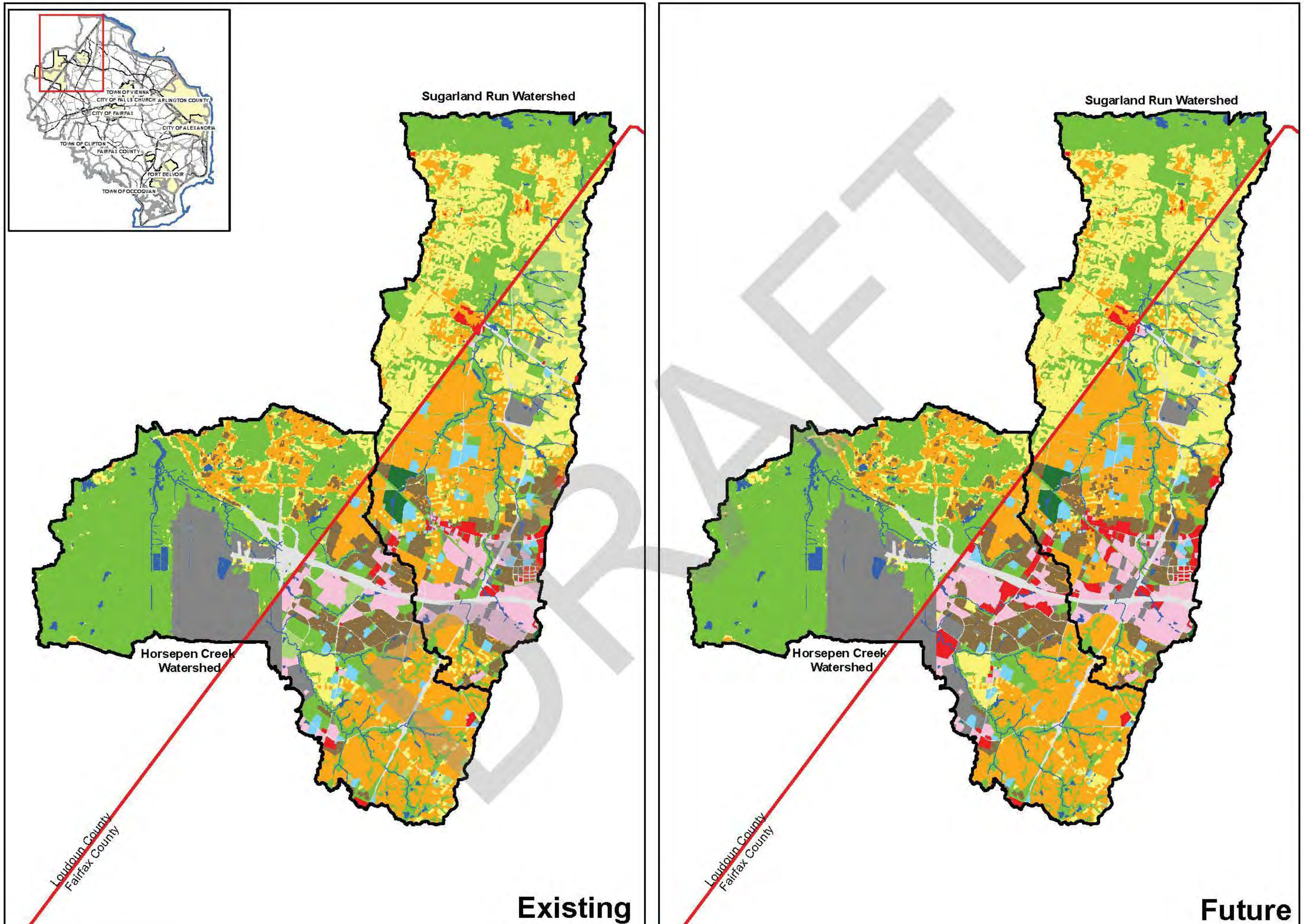


Figure 1.3
Existing and Future Land Use Map

1.3.4 Aquatic Environment

The overall quality of aquatic environments is dependent on many interconnecting factors. Major factors include water quality, stream habitat, and vegetative cover. Due to the changing relationship of these factors, the analysis of aquatic life, including benthic macroinvertebrates and fish populations, can better represent overall stream health.

Habitat Studies

An Environmental Baseline report was prepared by Parsons, Brinckerhoff, Quade, and Douglas in 1977 to assess changes within the Fairfax County watersheds, provide a general environmental framework for the development of the master plan for flood control, and aid in predicting the environmental effects of proposed improvements. According to the report, areas with upland hardwood forests, softwood forests, abandoned fields, floodplain forests, floodplain meadows, tidal fresh marshes, and hemlock cove forests (considered good to excellent wildlife habitats) were the most common throughout the Horsepen Creek and Sugarland Run watersheds, with particularly high terrestrial habitat quality. The exception was around the urbanized areas of Herndon and Reston. Due to the high habitat quality, animal population and diversity were high, with more wood turtles found in the area than anywhere else in the county. The aquatic field studies were less favorable. The test sites within the Horsepen Creek Watershed ranged from very good on the upper Horsepen Creek to good-fair on the lower Horsepen Creek. The Sugarland Run sites ranged from fair-poor on the lower Sugarland Run to poor-very poor on the upper Sugarland Run.

The Fairfax County Stream Protection Strategy program (Fairfax County, 2001) focused on recommendations for protection and restoration activities on a subwatershed basis, prioritization of areas for allocation of limited resources, establishment of a framework for long-term stream quality monitoring, and support for overall watershed management. Detailed biological and habitat data were collected in 2001 from five testing sites located within the Horsepen Creek and Sugarland Run watersheds. Based on the study, both Horsepen Creek and Sugarland Run watersheds were designated as Watershed Restoration Area Level II. The primary goal of the Watershed Restoration Level II areas was to prevent further degradation and implement measures to improve water quality to comply with Chesapeake Bay initiatives and other water quality initiatives and standards.

Although the 1976 data (Parsons, Brinckerhoff, Quade, and Douglas, 1977) and 2001 data (Fairfax County, 2001) cannot be directly compared due to differing methods of evaluation, it is evident that there is a general trend of decreasing quality within the Horsepen Creek Watershed. There appears to be no change in habitat quality in the Sugarland Run Watershed between 1976 and 2001. Horsepen Creek and Sugarland Run watersheds have very high percentages of impervious cover (20-46 percent), which has led to degraded stream conditions.

Stream Physical Assessment

Fairfax County conducted a stream physical assessment in 2005 to obtain baseline data for the County's streams (CH2MHill, 2005). The streams were evaluated based on habitat conditions, impacts to the stream from infrastructure and problem areas, general stream characteristics and geomorphic classification. The overall goal of the stream assessment program was to provide a consistent basis for protecting and restoring the receiving water systems and other natural resources in Fairfax County.

Approximately 17 miles of streams were assessed in the Horsepen Creek Watershed during the 2005 study. The habitat conditions for roughly 1.1 miles were classified as very poor, 3.5 miles were classified as poor, 6.1 miles were classified as fair, 6.1 miles were classified as good, and 1.3 miles were classified as excellent. The watershed received a length-weighted habitat score of 100, which represents overall fair habitat conditions. Approximately 26 miles of stream were assessed in the Sugarland Run Watershed. The habitat conditions for roughly 4.2 miles were classified as poor, 7.6 miles were classified as fair, and 13.9 miles were classified as good. Overall, the watershed was given a length-weighted habitat score of 111, or fair conditions.

Stream geomorphology was also investigated as part of the stream physical assessment in 2005 to obtain baseline data for the county's streams. Stream geomorphology is the study of forces of water as it travels through the landscape. These forces create channels, floodplains, terraces and drainage patterns. They can help explain erosion, sediment transportation and sediment deposition. Geomorphic channel classifications were based on the Channel Evolution Model (CEM) developed by Schumm et al. (1984). The CEM characterized the majority of the Horsepen Creek watershed to be in the evolutionary Stage 3, with the remainder in Stage 2. Evolutionary Stage 3 is characterized by streambank sloughing, eroded sloughed material, and bend erosion. Evolutionary Stage 2 is characterized by head cuts and deficient sediment deposits. The CEM established that 60 percent of the Sugarland Run watershed has Stage 3 channels, with the remainder in Stage 4. Evolutionary Stage 4 channels are characterized by streambank aggrading, vegetated sloughed material, and the development of base flow, bankfull, and floodplain channels.

An infrastructure inventory was conducted as part of the 2005 stream physical assessment to identify impacts on the stream from specific infrastructure and problem areas. The study identified and characterized deficient riparian buffers, ditches, dump sites, erosion areas, head cuts obstructions, road crossings and pipes. Within Horsepen Creek, 322 inventory hits were recorded, with the most significant problems being head cuts. Within Sugarland Run, 281 inventory hits were recorded, with the most significant problems including deficient riparian buffers, head cuts, a road crossing, a pipe, and an eroded area.

<u>Impaired Waters</u>

Section 305(b) of the U.S. Clean Water Act requires each state to submit a report on all information regarding its waters once every two years. Section 303(d) of the Clean Water Act requires a list of waters with impaired water quality for each state. Waters that are impaired due to human activities and pollutants require a total maximum daily load (TMDL) plan to restore their water quality. Once a TMDL is approved, a TMDL Implementation Plan is developed to restore impaired waters and maintain their improved water quality. The Virginia 2004 Integrated Water Quality Assessment Report (Virginia Department of Environmental Quality, 2004) provides information about the water quality conditions in Virginia from January 1, 1998 to December 31, 2002, and the Virginia 2006 Integrated Water Quality Assessment Report (Virginia Department of Environmental Quality, 2006) provides information about the water quality conditions in Virginia from January 1, 2000 to December 31, 2004.

The 2006 Integrated Report presents water quality assessment results for approximately 14,265 miles of free-flowing streams and rivers, or about 28.3 percent of Virginia's streams and rivers for which sufficient data were available. The leading cause of impairment of designated use was violation of the bacteria standards. Agricultural practices appear to be one of the primary sources contributing to bacteria standards violations. However, urban runoff, leaking sanitary sewers, failing septic tanks, domestic animals, and wildlife can be significant contributors. Figure 1.4 shows 303(d) impaired waters within the Sugarland Run and Horsepen Creek watersheds, based on the 2006 Integrated Report. A total of 5.75 miles of Sugarland Run is impaired beginning at the confluence with Folly Lick Branch at approximately river mile 5.75, and continuing downstream until the confluence with the Potomac River. Sugarland Run was first listed as impaired for fecal coliform in 2002 and for Escherichia coli bacteria (E. coli) in 2006, and therefore did not support the recreational use goal. It was added to the 303(d) list in 2002 and the TMDL development date is 2014.

<u>Wetlands</u>

Wetlands are vital to the watershed ecosystem because they filter pollutants and sediments from stormwater, reduce flooding, provide wildlife habitat and function as a nursery for aquatic life food chains. There are approximately 13,000 to 18,000 acres of wetlands in Fairfax County. Non-tidal wetlands comprise approximately 7,000 to 10,000 acres of Fairfax County. The Horsepen Creek Watershed contains 382 acres of non-tidal wetlands and the Sugarland Run Watershed contains 709 acres of non-tidal wetlands (U.S. Fish and Wildlife Service, 2008).

In the Sugarland Run Watershed, a majority of the wetlands are forested freshwater/shrub wetlands. These types of wetlands are dominant on the Sugarland Run Branch and Folly Lick Branch, especially in open space areas and within golf courses. Freshwater pond wetlands occur at the headwaters of all the streams in the Sugarland Run Watershed.

In the Horsepen Creek Watershed, a majority of the wetlands are freshwater ponds and freshwater emergent wetlands. These types of wetlands can be found on the Cedar Run Branch, Horsepen Run Branch and Frying Pan Branch. They are mainly located at the headwaters of each branch. Wetlands such as forested freshwater/shrub wetlands are located at the confluence and main stem sections.

This page intentionally left blank.

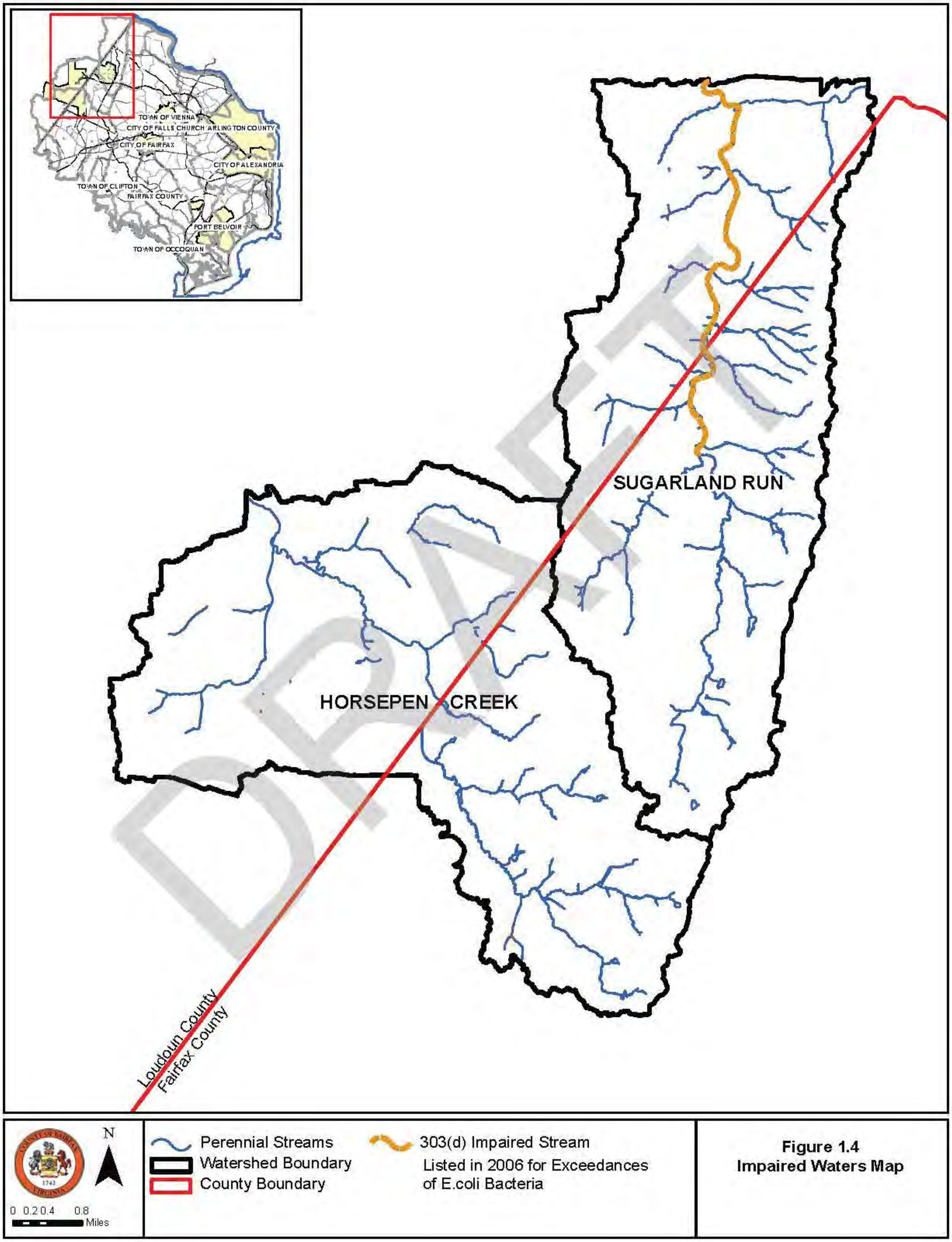


Figure 1.4
Impaired Waters Map

This page intentionally left blank.

1.3.5 Terrestrial Environment

Forest Resources

In the early 1600s, the Chesapeake Bay region was estimated to have 95 percent of its landmass covered by tree canopy. By the middle of the 19th century, historic evidence suggests that timber harvesting, agriculture, and fuel and military activities had reduced tree canopy levels to about 30 percent in Northern Virginia. With a sharp decrease in farming activities and an increase in land development in the early 1970s, Fairfax County's canopy cover rose to approximately 80 percent. Currently, the county's tree canopy cover is estimated at approximately 41 percent, or 104,000 acres of the county's 252,828 acres. The current tree canopy is comprised of 68 percent (70,720 acres) native forests, and 32 percent (33,280 acres) planted landscape trees, areas with early succession-stage tree communities, and areas dominated by invasive trees and non-native plant species. The present level of tree canopy corresponds closely to the 40 percent that is recommended by American Forests for communities east of the Mississippi River (Tree Action Plan Work Group, 2006).

The vision of the Fairfax County Tree Commission's Tree Action Plan is to leave the land, water, and air quality better than it was found. The recommended actions proposed within the plan are based on three framework goals: 1) To commit to preserving current tree assets by fostering health and regeneration of specimen trees and urban forest; 2) To enhance the legacy for future generations by increasing the quantity and quality of trees and wooded areas; and, 3) To more effectively integrate urban forestry in planning and policy making (Tree Action Plan Work Group, 2006).

Terrestrial Flora and Fauna

The Virginia Department of Conservation and Recreation's Natural Heritage Program (DCR-DNH) maintains a statewide inventory of plants, animals, natural communities, and other biological resources that are rare, threatened, endangered, or of special concern within the Commonwealth of Virginia. The database is updated annually as information becomes available to the department. In the Sugarland Run Watershed, rare, threatened and endangered species include the wood turtle (*Glyptemys insculpta*), purple milkweed (*Asclepias purpurascens*), and the white trout-lily (*Erythronium albidum*). In the Horsepen Creek Watershed, rare, threatened and endangered species include stiff goldenrod (*Oligoneuron rigidum* var. *rigidum*) (Virginia DCR-DNH, 2008).

1.3.6 Resource Protection Areas

Resource Protection Areas are vegetated riparian buffer areas that include land within a major floodplain and land within 100 feet of the water body in the floodplain. Resource Protection Areas in Sugarland Run and Horsepen Creek watersheds are shown in Figure 1.5. These buffer areas are important in the reduction of sediments and nutrients, as well as the other adverse effects of human activities. Under the county's old Chesapeake Bay Preservation Ordinance, if streams were not identified as perennial on the U.S. Geological Survey map, they did not warrant being in a Resource Protection Area (Fairfax County, Virginia, March 23, 2007).

This page intentionally left blank.

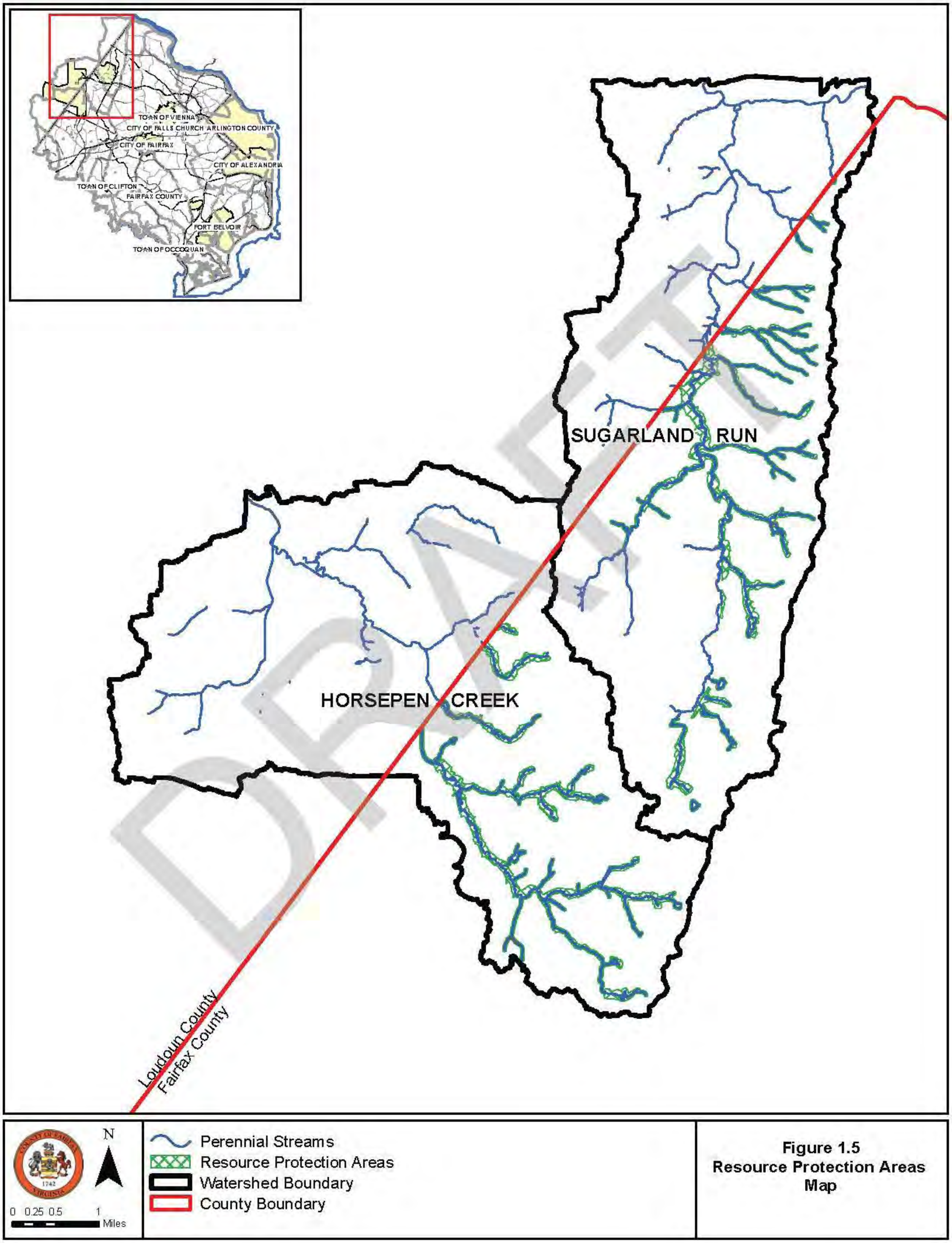


Figure 1.5
Resource Protection Areas Map

This page intentionally left blank.

The Perennial Stream Mapping Project was initiated to address concerns that all perennial streams were not being protected under the county's Chesapeake Bay Preservation Ordinance. At that time, the county's ordinance only listed perennial streams as those streams which were depicted as perennial on the U.S. Geological Survey topographical maps. To ensure compliance with the state's revised Chesapeake Bay Preservation Area Designation and Management Regulations, Fairfax County began the process of accurately mapping all streams in the county in 2002. By October 2003, the field work was completed and the new Resource Protection Area maps were generated (Fairfax County, Virginia, March 23, 2007).

1.3.7 Stormwater Management

Regional stormwater management prior to the late 1970s, had been achieved in Fairfax County through developer cooperation, rezoning proffers and joint county/developer projects. The Fairfax County Regional Stormwater Management Plan (Camp Dresser & McKee, Inc., 1989) was developed to identify the most appropriate locations for regional stormwater detention facilities. The recommended regional basin network for the plan was developed through a multi- step process with criteria that included land availability, topography and available storage. Once sited, the detention basins were modeled using hydrologic models to determine watershed-wide impacts.

The Fairfax County Drainage Master Plan (Fairfax County, January 2007) is a database of stormwater and drainage projects that are derived from the following sources: basin drainage plans by Parsons, Brinkerhoff, Quade and Douglas from the late 1970s, a Regional Pond Plan by Camp, Dresser, and McKee from 1989, citizen drainage complaints, recorded maintenance problems, and localized drainage studies. Within the Horsepen Creek Watershed, the database lists a total of 27 projects, 22 of which are listed as inactive (not an actively funded county project), one is listed as deleted because it was not a drainage project, two are listed as partially funded active county projects, and the remaining two are listed as fully funded county projects. Within the Sugarland Run Watershed, the database lists a total of 30 projects, 26 of which are listed as inactive, three are partially funded active county projects, and one is a completed basin project that is not fully a regional pond as constructed. A majority of the inactive projects are stream restorations and stormwater pipe and culvert work. The actively funded projects are all regional detention ponds

The Basin Plan (Parsons, Brinckerhoff, Quade, and Douglas, 1979) was created as a part of the overall stormwater management program for Fairfax County. The plan includes an analysis of stormwater problems throughout the watersheds and recommended solutions. The solutions were weighted according to cost, construction feasibility, and environmental and aesthetic considerations. The problems identified within the watersheds included sediment and debris accumulations, flooding of adjacent sewer lines, bank erosion, channelization, or the need for detention ponds. Thirty-two projects were recommended in the Horsepen Creek Watershed at a total cost of $3,032,000 and 29 projects were recommended in the Sugarland Run Watershed at a total cost of $2,938,000.

Fairfax County approved the use of stormwater detention ponds (Regional Ponds) in 1987. This idea of regional ponds was reviewed by the Fairfax County Board of Supervisors and was adopted in 1989 as the Regional Stormwater Management Plan (Fairfax County, 2003). The plan was to provide regional detention for rapidly developing areas of Fairfax County. The purpose was to promote safety and reduce the county's liability exposure for stormwater management facilities within residential areas. The implementation of 134 regional ponds was proposed as a preferred type of stormwater management. A Regional Pond Subcommittee was developed in 2002 to re-evaluate this type of stormwater management practice. This subcommittee compiled a comprehensive list of issues and organized them into categories. They then considered what would be an ideal stormwater program within the subject area. The subcommittee determined that although regional ponds are not the preferred stormwater management alternative, they should be considered one of many tools that can be used to manage stormwater in Fairfax County. (Fairfax County, 2003).

A Forested Wetland Committee was also developed to determine methods to minimize the disturbance of wetlands, primarily forested wetlands, during the implementation of regional stormwater management ponds. The following are the recommendations of the subcommittee regarding wetlands and regional stormwater management facilities.

1. A regional pond wetlands protection policy should be instituted which will examine all regional sites for wetland impacts and will locate stormwater facilities strategically to avoid wetland areas.
2. The design and construction of innovative and state-of-the-art Best Management Practices (BMPs) should be encouraged.
3. The maintenance and efficiency of BMPs should be a top priority.
4. Protection must be addressed for stream channels and associated riparian wetlands before the stormwater facilities are built.
5. Each site should be evaluated on a case-by-case basis to determine the appropriate BMP.
6. The Fairfax County BMP program should be re-evaluated every four years.
7. Regional ponds located in the Chesapeake Protection Areas should be moved outside the major floodplain.

The watershed management plan that is developed as a result of this project will be used by Fairfax County to select watershed management projects for future construction. These watershed management practices will be carefully selected to make the best use of county resources and at the same time provide the most benefit to the largest area of the county.

1.4 References

Camp Dresser & McKee, Inc. (1989). Regional Stormwater Management Plan. Prepared for County of Fairfax Department of Public Works.

CH2MHILL. (2005). Fairfax County Stream Physical Assessment. Prepared for the Fairfax County Department of Public Works and Environmental Services.

County of Fairfax Department of Public Works. (June 2003). Technical Memorandum No. 3.

Fairfax County Environmental Coordinating Committee and Regional Pond Subcommittee. (2003). The Role of Regional Ponds in Fairfax County's Watershed Management.

Fairfax County Stormwater Management Branch, Stormwater Planning Division, and Department of Public Works and Environmental Services. (2001). Fairfax County Stream Protection Strategy Baseline Study.

Fairfax County Stormwater Planning Division and Department of Public Works and Environmental Services. (2006a). Annual Report on Fairfax County's Streams.

Fairfax County Department of Public Works and Environmental Services, Department of Planning and Zoning, and Department of Transportation. (2006b). Infill and Residential Development Study.

Fairfax County. (January 2007). Fairfax County Drainage Master Plan and Project Database.

Fairfax County, Virginia. (March 23, 2007). Perennial Streams Mapping Project, Project Background. Retrieved from http://www.fairfaxcounty.gov/dpwes/watersheds/perennial.htm on August 20, 2008.

Parsons, Brinckerhoff, Quade, and Douglas. (1977). Pond Nichol Sugarland Horsepen Environmental Baseline. Prepared for Fairfax County, Virginia for the Master Plan for Flood Control and Storm Drainage in Fairfax County.

Parsons, Brinckerhoff, Quade & Douglas. (1979). Proposed Drainage Plan, Basin Plan. Horsepen Creek, Sugarland Run, Nichol Run, and Pond Branch Watersheds. Prepared for Fairfax County, Virginia.

Tetra Tech. (2008). Fairfax County WMP Subwatershed Ranking Approach. Prepared for the Fairfax County Department of Public Works and Environmental Services, Stormwater Planning Division.

Tree Action Plan Work Group. (2006). Tree Action Plan. Prepared for Fairfax County as a 20-year strategic plan to conserve and manage Fairfax County's urban forest.

Town of Herndon. (2008). Herndon's History. Retrieved from http://www.herndon-va.gov/Content/AboutHerndon/History.aspx?cnlid=21

U.S. Census Bureau, Census 2000. (n.d..1990 Census for Town of Herndon. Retrieved fromhttp://factfinder.census.gov/servlet/SAFFPopulation?_event=Search&geo_id=01000US&_geoContext=01000US&_street=&_county=herndon&_cityTown=herndon&_state=04000US51&_zip=&_lang=en&_sse=on&ActiveGeoDiv=geoSelect&_useEV=&pctxt=fph&pgsl=010&_submenuId=population_0&ds_name=null&_ci_nbr=&qr_name=&reg=%3A&_keyword=&_industry=

U.S. Fish and Wildlife Service. (2008). Classification of Wetlands and Deepwater Habitats of the United States [Vector digital data]. Available from U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. FWS/OBS-79/31
http://www.fws.gov/wetlands/

Virginia Department of Conservation and Recreation. (2006). National Heritage Program. Retrieved from: http://www.dcr.virginia.gov/natural_heritage on August 25, 2008.

Virginia Department of Environmental Quality (DEQ) and Virginia Department of Conservation and Recreation (DCR). (2004). Virginia Water Quality Assessment Integrated Report. Prepared for U.S. Environmental Protection Agency (EPA) and the U.S. Congress.

Virginia Department of Environmental Quality (DEQ) and Virginia Department of Conservation and Recreation (DCR). (2006). Virginia Water Quality Assessment Integrated Report. Prepared for U.S. Environmental Protection Agency (EPA) and the U.S. Congress.

2.1 Watershed Study Methodology

2.2 Watershed Management Areas and Subwatersheds

Fairfax County contains 30 watersheds, including the Horsepen Creek and Sugarland Run Watersheds. A watershed is the land area that drains into a stream. They are defined by the topography of the area and do not follow county, state or national boundaries. The size of a watershed can vary from a few acres for a small stream to many square miles for a large river. The watersheds within Fairfax County are part of the larger Potomac River basin. The Potomac River, in turn, is part of the even larger Chesapeake Bay Watershed, which drains 64,000 square miles and extends from New York through Pennsylvania, Delaware, West Virginia, Maryland, Virginia and the District of Columbia.

For management and planning purposes, watersheds are further broken down into watershed management areas (WMAs) and subwatersheds. A WMA is generally four square miles (2,560 acres) in size and is the contributing drainage area to a major tributary or a group of subwatersheds with similar characteristics. A subwatershed ranges in size from 100 to 300 acres. Due to their smaller size, WMAs and subwatersheds are easier to target for specific watershed management and restoration strategies. The WMAs in the Sugarland Run and Horsepen Creek watersheds are shown in Figure 2.1.

2.3 Existing and Future Land Use

One of the leading causes of stream degradation, including water quality impairments and habitat decline, is changes in land use. As shown in Figure 1.4 in Chapter 1, the Sugarland Run and Horsepen Creek watersheds are highly developed. Monitoring changes in land use will provide critical information to the overall health of the watersheds. For example, high density residential, commercial and industrial land uses generally produce higher stormwater runoff volumes and pollutant loads, whereas open space and estate residential land uses have a much lower impact on the health of the watershed.

For this study, the existing and future land use within the Sugarland Run and Horsepen Creek watersheds were analyzed to assist with the selection of areas for field reconnaissance. Open space land use data was compared to building footprint data provided by the county to determine areas of new construction. The areas thought to be newly constructed were field-verified to ensure accuracy. The land use GIS was updated to reflect changes found during the field reconnaissance. The land use GIS was also used to identify neighborhoods and other development areas for the Neighborhood Source Assessments (NSA), which are described further in Chapters 3 and 4. At least one representative neighborhood was chosen per WMA, based upon the land use within the area. The existing and future land use data will be further utilized to identify current and future management opportunities and project areas to better achieve the county's goals and objectives.

This page intentionally left blank.

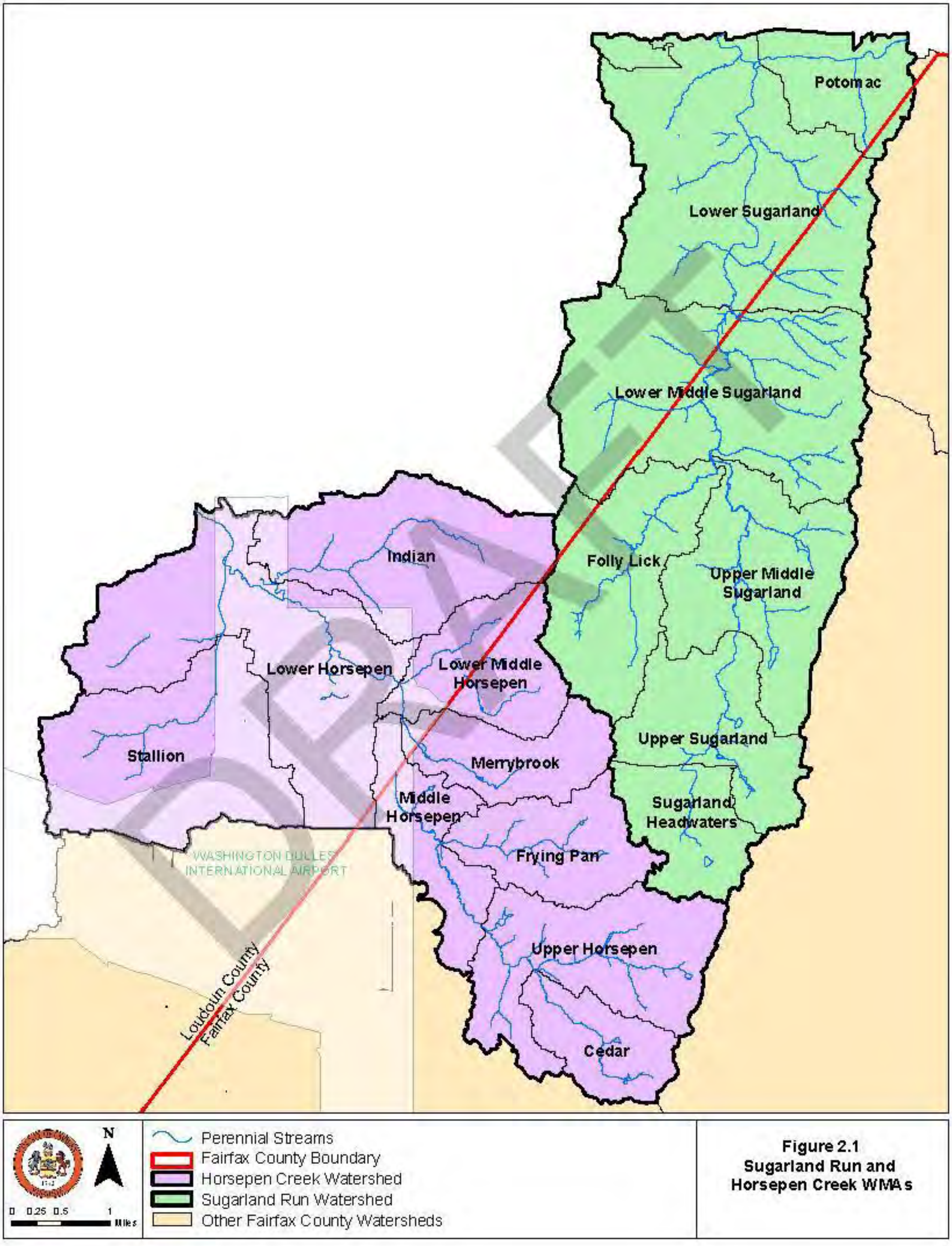


Figure 2.1
Sugarland Run and Horsepen Creek WMAs

This page intentionally left blank.

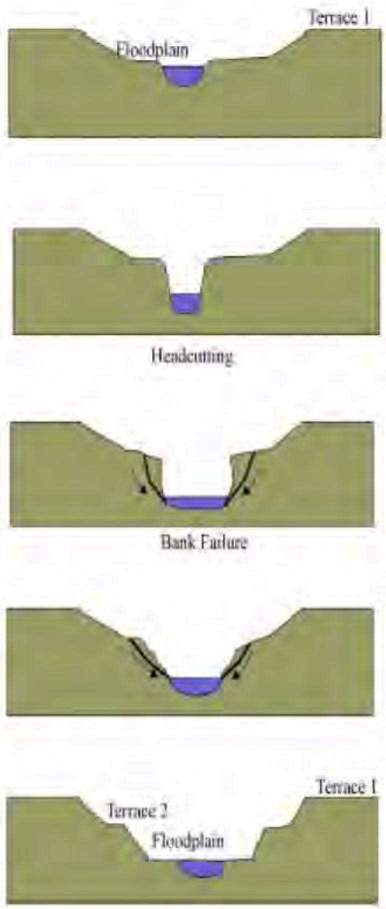
2.4 Field Reconnaissance and Stream Physical Assessment

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

Fairfax County conducted a physical stream assessment in 2005 to obtain baseline data for the County's streams, as described in Chapter 1. A supplemental physical stream assessment was completed during the summer of 2008, in which approximately nine miles of stream within the Sugarland Run and Horsepen Creek watersheds were surveyed. The assessment included portions of Sugarland Run, Offuts Branch, Folly Lick Branch, Horsepen Creek and Merrybrook Run. The original physical stream assessment protocol was followed which included an infrastructure inventory, a habitat assessment, stream characterizations, and a Channel Evolution Model assessment. The infrastructure inventory identified and characterized the following:

- Ditches
- Dump sites
- Erosion areas
- Head cuts
- Obstructions
- Pipes
- Road and other stream crossings
- Utility lines

The habitat assessment and stream characterization served to document the stream physical conditions, while the Channel Evolution Model assessment evaluated the stability of the stream. The Channel Evolution Model can define the stages the stream channel geomorphology will take after a disturbance, and can be used to predict future conditions. Geomorphology is the process by which stream channels adjust to changes within the associated watershed. Stream geomorphology is a natural process that occurs slowly over time. The features of a stream channel are determined by the type of soil, the slope, and the flow experienced by the channel. Alterations to the watershed will lead to changes in the stream channel; the channel will rework itself to meet the new watershed conditions. Figure 2.2 shows the five stages of geomorphic condition in the Channel Evolution Model.



Type 1: Well-developed base flow and bankfull channel; consistent floodplain features easily identified; one terrace apparent above active floodplain; predictable channel morphology; floodplain covered by diverse vegetation; stream banks less than or equal to 45°

Type 2: Head cuts; exposed cultural features (along channel bottom); sediment deposits absent or sparse; exposed bedrock (parts of reach); stream bank slopes greater than 45°

Type 3: Stream bank sloughing, sloughed material eroding; stream bank slopes greater than 60° or vertical/undercut; erosion on inside of bends; accelerated bend migration; exposed cultural features (along channel banks); exposed bedrock (majority of reach)

Type 4: Stream bank aggrading; sloughed material not eroded; sloughed material colonized by vegetation; base flow, bankfull, and floodplain channel developing; predictable channel morphology developing; stream bank slopes less than or equal to 45°

Type 5: Well-developed base flow and bankfull channel; consistent floodplain features easily identified; two terraces apparent above active floodplain; predictable channel morphology; stream banks less than or equal to 45°

Figure 2.2 Channel Evolution Model Stages (Schumm, et al., 1984)

Along with habitat assessments, the stream reaches were placed in one of five stages of geomorphic condition in the Channel Evolution Model (CEM). Approximately 60 percent of the Sugarland Run Watershed was in Evolutionary Stage 3, with the remainder in Evolutionary Stage 4. Stage 3 is the widening stage and is characterized by streambank sloughing, erosion on insides of bends, accelerated bed migration, and exposed bedrock. Stage 4 is the stabilizing stage which is characterized by streambank aggrading, base flow, bankfull, and floodplain channel developing, and a predictable channel morphology developing. The majority of channels in the Horsepen Creek Watershed are in Evolutionary Stage 3, with the rest in Stage 2. Stage 2 is the incision stage which is characterized by head cuts, absent sediment deposits, and exposed bedrock (Fairfax County, 2001).

2.5 Watershed Characterization

Successful management of a watershed requires the assessment of the interactions between pollutant sources, watershed stressors, and conditions within streams and other waterbodies. The goal is to identify existing and potential problem areas and evaluate subwatershed restoration opportunities. This requires a direct evaluation of the existing stream conditions and stormwater infrastructure, streambank erosion, flooding, unique watershed conditions, water quality problems, and other factors relating to the ecosystem and stormwater drainage network.

The watershed characterization data obtained from previous studies and provided by the county were used to create maps to characterize the watersheds. Two types of maps were developed: stream condition maps and stormwater infrastructure maps. The stream condition maps display the overall health and stability of the streams within the watersheds and the stormwater infrastructure maps display the extent and type of stormwater management facilities within the watersheds. Chapters 3 and 4 provide more detailed information on a WMA scale.

2.6 Modeling

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

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

- Hydrologic models take into account several factors: the particular rainfall event of interest, the physical nature of the land area where the rainfall occurs and how quickly the resulting stormwater runoff drains this given land area. Hydrologic models can describe both the quantity of stormwater runoff and the resulting pollution, such as nutrients (nitrogen and phosphorus) and sediment, that is transported by the runoff.

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

Table 2.1 shows three storm events and the rationale for modeling.

Table 2.1 Rationale for Storm Event Modeling

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

For this study, the Storm Water Management Model (SWMM), a hydrologic model developed by the U. S. Environmental Protection Agency (EPA), was used to quantify stormwater runoff. SWMM is a dynamic rainfall-runoff simulation model that can simulate runoff quantity and quality for single rain event or long-term conditions in primarily urban areas. It was used in this project to estimate the quantity of stormwater runoff at specific pre-determined locations within the watershed and calculate the peak rate of those flows at these locations as well. Specifically, the runoff component of SWMM operates on a collection of treatment areas within subwatersheds on which rain falls and runoff is generated. The routing portion of SWMM transports this runoff through a conveyance system of pipes, channels and storage/treatment devices. SWMM tracks the quantity of runoff generated within each treatment area, and the flow rate and flow depth of water in each pipe and channel during a simulation period comprised of multiple time steps

The Spreadsheet Tool for Estimating Pollutant Loading (STEPL) developed by the U. S. EPA Office of Water is another hydrologic model used to estimate the quantity of pollution and sediment transported by stormwater runoff. The STEPL model employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices. The nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. Sediment loads are calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using known BMP efficiencies.

The hydraulic model used in this project is the Hydrologic Engineering Centers River Analysis System (HEC-RAS) model developed by the United States Army Corps of Engineers (USACE) to manage rivers and harbors under their jurisdiction. The model is a one dimensional program that provides no direct modeling of the hydraulic effect of cross section shape changes, bends, and other two- and three-dimensional aspects of flow. Aside from this limitation, the model has found wide acceptance in simulating the hydraulics of water flow through natural and/or manmade channels and rivers. HEC-RAS is commonly used for modeling water flowing through a system of open channels with the objective of computing water surface profiles. The computed surface profiles are then used to predict and evaluate conveyance capability of culverts and bridges and determine the spatial extent of potential flooding dependent on the specific topography in the area of interest.

2.7 Subwatershed Ranking

The purpose of the subwatershed ranking is to provide a systematic means of compiling available water quality and natural resources information. Ranking subwatersheds based on watershed characterization and modeling results provides a tool for planners and managers to set priorities and to use as they consider which subwatersheds should undergo further study.

Three basic indicator categories are used to rank subwatershed conditions including watershed impact indicators, source indicators, and programmatic indicators. These indicator categories are described below.

Watershed impact composite scores are calculated by analyzing a variety of indicators including channel morphology, flooding hazards, aquatic/terrestrial habitat and water quality.

Source indicator composite scores were calculated by analyzing a variety of pollutant sources and environmental stressors, including urban land cover, channelized streams, industrial and stormwater outfalls, septic systems and water quality. They provide information on the source of watershed impacts and stressors.

Programmatic indicators describe the existence or benefits of stormwater management facilities and programs. There is no scoring associated with programmatic indicators; however, a data inventory will be compiled in order to help determine where stormwater management is needed most during candidate project identification.

The scores from these indicators are rolled up into composite scores which are used in the prioritization and subwatershed ranking process. In cases where a subwatershed did not have any reported data for a particular indicator, or data was only geographically available for a portion of the subwatershed (e.g., headwaters only), the metric value from another subwatershed with reported data ("reference subwatershed") was used. Several factors were considered when assigning surrogate metric values. These factors are listed in priority order below:

1. Land use and land cover distribution based on the Virginia Department of Forestry's 2005 Virginia Forest Cover Map
2. Location of reference subwatershed (within the same WMA was preferable)
3. Similar drainage area
4. Proximity of reference subwatershed
5. Similar stream order (e.g., headwater, major waterway stem, main stem outlet)
6. Hydrologic connectivity

This page intentionally left blank.