Appendix A: Watershed Workbook

The watershed workbook is a reader-friendly document that is designed to provide the residents and stakeholders of the Nichol Run and Pond Branch 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 Nichol Run and Pond Branch 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.

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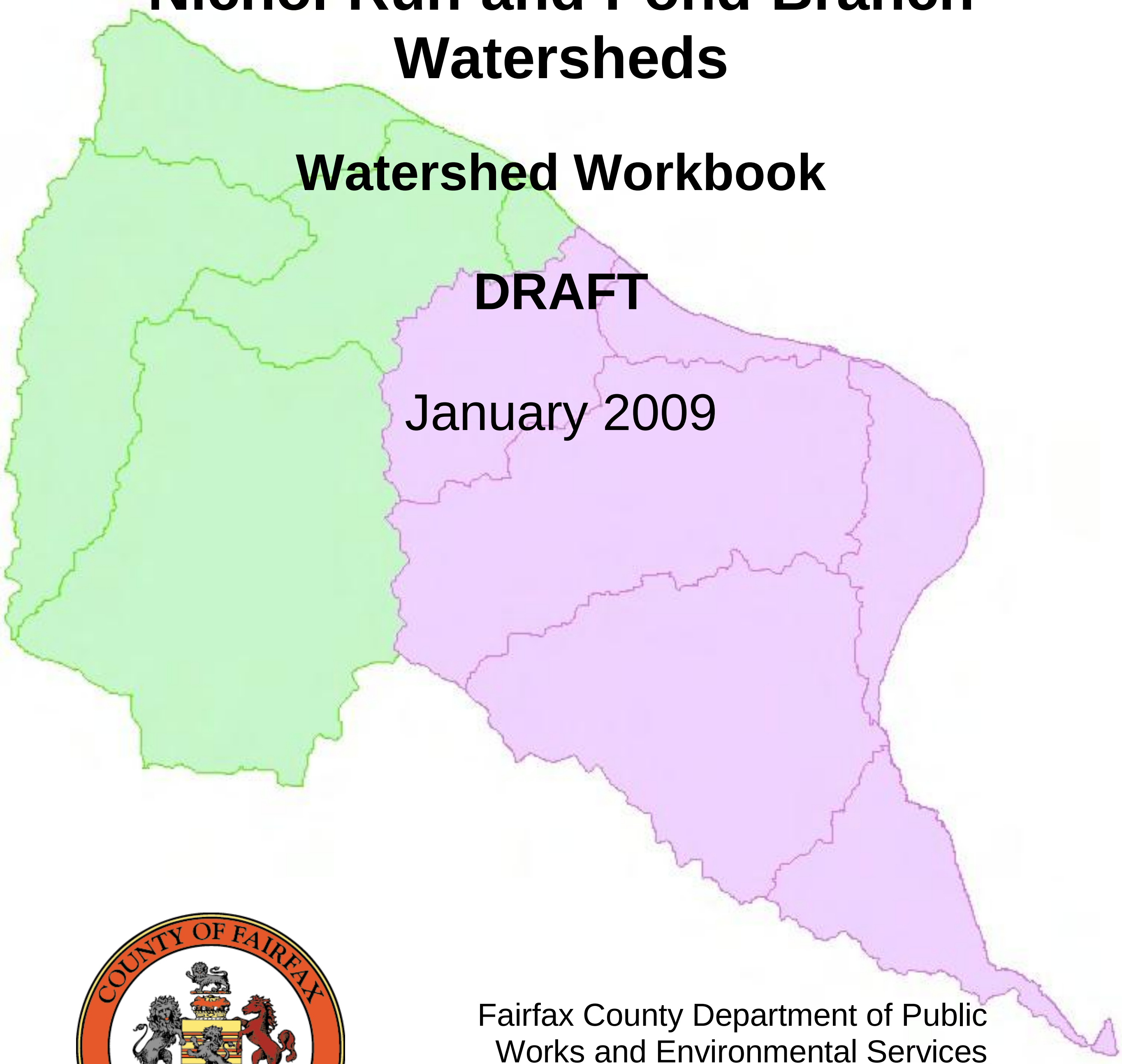
Nichol Run and Pond Branch Watersheds



Watershed Workbook

DRAFT

January 2009

Fairfax County Department of Public Works and Environmental Services

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NICHOL RUN
AND
POND BRANCH
WATERSHED WORKBOOK

DRAFT

January 2009

Prepared for:

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Watershed Planning and Assessment Branch
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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 Nichol Run and Pond Branch 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.

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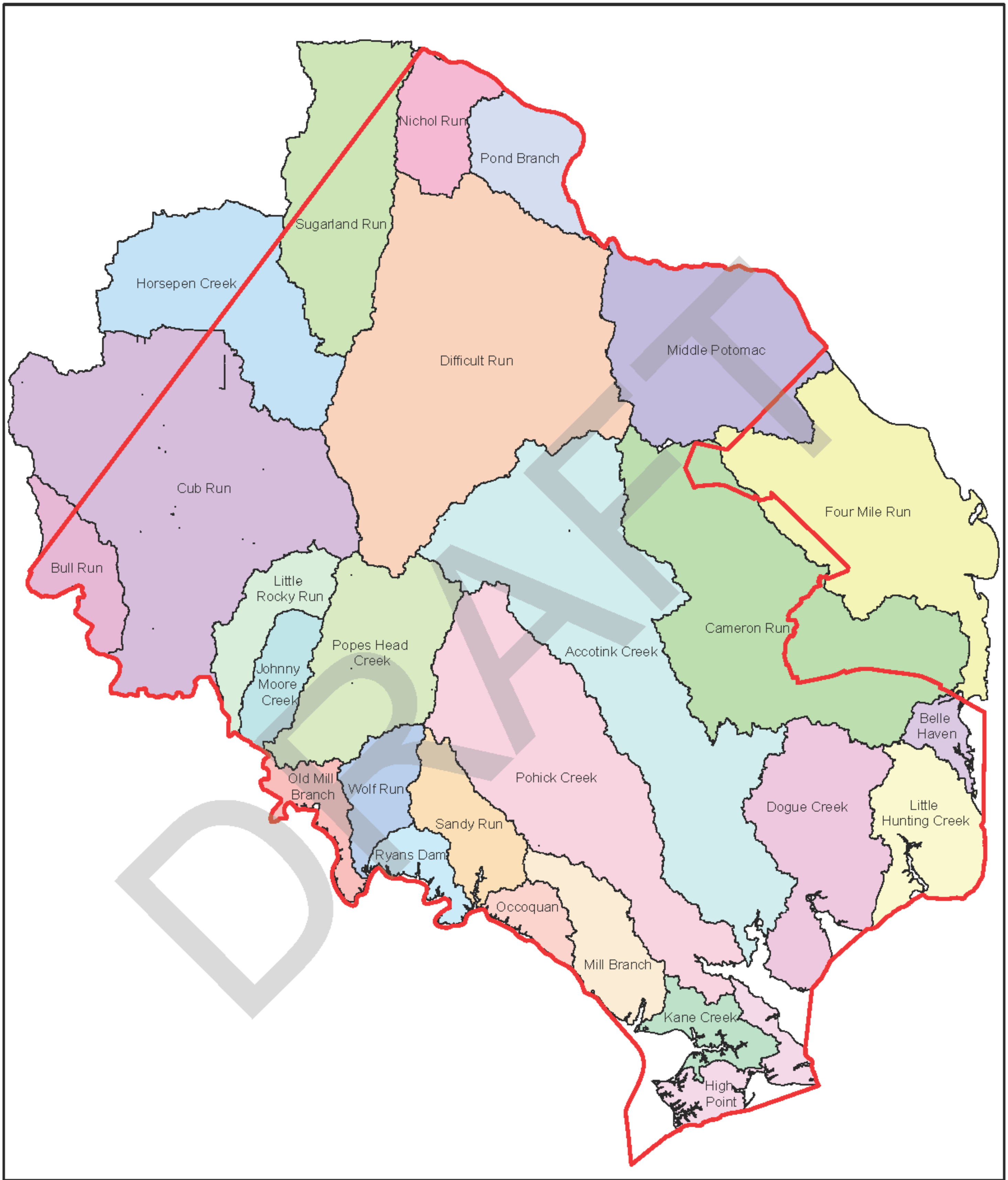

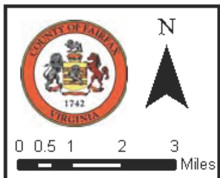

Fairfax County Boundary

Watershed Boundaries

Figure 1.1
Fairfax County Watersheds

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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 Nichol Run and Pond Branch 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 **Nichol Run Watershed Study –** Nichol Run Preliminary Results
Chapter 4 **Pond Branch Watershed Study –** Pond Branch Preliminary Results
Chapter 5 **Glossary**

1.4 Watershed History and Condition

1.4.1 General Watershed Characteristics

The Nichol Run and Pond Branch watersheds are located in the Northern portion of Fairfax County, as shown in Figure 1.2. Both watersheds are described in detail below.

Nichol Run

The Nichol Run Watershed is comprised of Nichol Run, Harkney Branch, Jefferson Branch, and the Potomac Headwaters. Nichol Run flows north from its origin near Georgetown Pike and discharges to the Potomac River. Harkney Branch originates near Beach Mill Road and flows east to its confluence with Nichol Run. Jefferson Branch originates near Seneca Road, flows north and east, and discharges into Nichol Run. The Potomac Headwaters flow northeast discharging into the Potomac River. The Nichol Run Watershed has a drainage area of approximately 8.2 square miles and a total of approximately 31.8 miles of perennial streams.

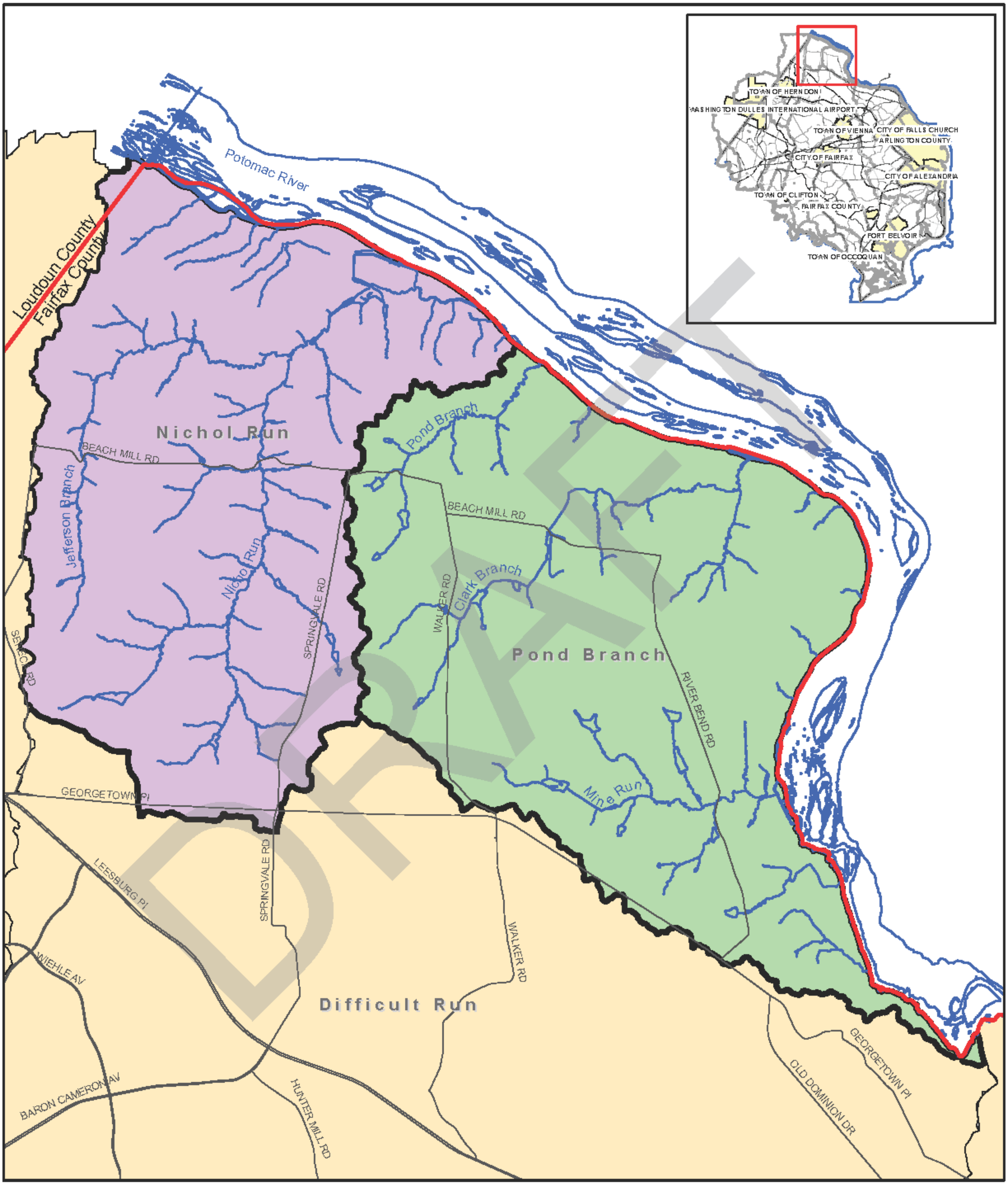
Pond Branch

Pond Branch Watershed is comprised of Pond Branch, Mine Run Branch, Clarks Branch, and Potomac Headwaters. Pond Branch flows northeast from its headwaters near Beach Mill and Springvale Roads and disperses into the Potomac River. Mine Run Branch originates near Walker Road and Georgetown Pike and flows eastwards into the Potomac River. Clarks Branch originates to the west of Walker Road and flows northeast into the Potomac River. The Pond Branch Watershed has a drainage area of approximately 8.5 square miles and a total of approximately 23.8 miles of perennial streams.

1.4.2 Watershed History and Population Growth

Watershed History

The Nichol Run and Pond Branch watersheds have an interesting history. The earliest public works project undertaken in the watersheds of northwestern Fairfax County was the construction of the “Potowmack Canal”. The proposed canal consisted of locks at Great Falls and Pond Branch. George Washington submitted the canal proposal and it was called “the first major public improvement project in the Nation’s history.” The canal was built between the years of 1785 and 1789. George Washington and his business partner, General Richard Lee, established a town strategically situated near the canal in Pond Branch watershed which would grow into a major trade center. In the late 1700’s, the settlement of Matildaville (after General Lee’s first wife) was founded near the Great Falls of the Potomac River. After commerce along the town dwindled, the town was abandoned (Parsons, Brinckerhoff, Quade, and Douglas, 1977).



Perennial Streams
Fairfax County Boundary
Pond Branch
Nichol Run
Other Fairfax County Watersheds

Figure 1.2
Nichol Run and Pond Branch Watershed Location Map

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<u>Population Growth</u>

There was very little growth within the Nichol Run and Pond Branch watersheds toward the end of the 19th century. A Bureau of topographic Engineers map from 1862 shows cultivated fields in the Pond Branch watershed and large forested areas in the Nichols Run watershed. In 1879 the Pond Branch and Nichol Run watersheds were among the least densely settled in the entire county with 0.0019 and 0.0015 houses per acre, respectively. In the 1970s there was some development of moderate and low density housing in the Nichol Run and Pond Branch watersheds (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. This dramatic suburban expansion was driven by technology-based businesses which were less dependent on urban centers than conventional industry (Fairfax County, 2001). Today, Fairfax County is the most populous jurisdiction in Virginia and the Washington D.C. metropolitan area, with the 2005 population estimated at 1,047,500, with 387,700 households (Fairfax County, 2006a).

<u>Infill Development in Fairfax County</u>

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 includes 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.

1.4.3 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 Nichol Run Watershed comprises 4,918 acres, of which 1,222 are vacant and 311 are underdeveloped. Approximately 31 percent of the watershed is not fully developed. The Pond Branch Watershed comprises 5,366 acres, 605 of which are vacant and 271 of which are underdeveloped. Approximately 16 percent of the watershed is not fully developed. Figure 1.3 shows the existing and future land use by category in the Nichol Run and Pond Branch 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 was used to evaluate future conditions. The results derived from these maps will be discussed in greater detail in future chapters.

1.4.4 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 Nichol Run and Pond Branch watersheds, with particularly high terrestrial habitat quality. 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 also very favorable. The test sites within the Nichol Run Watershed ranged from good-very good on the Jefferson Branch, Nichol Run ranked fair-good and the Pond Tributary was ranked as good. The Pond Branch sites ranged from good-very good on the Clarks Branch, ranked good on Mine Branch and along the Potomac River ranking was good-fair. Overall the ranking of the Nichol Run and Pond Branch watersheds is good.

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 three testing sites located within the Nichol Run watershed and three sites in Pond Branch watershed. All of the sites surveyed received ratings of good, with the exception of the Mine Run Branch in the Pond Branch Watershed which received a rating of excellent. The watersheds represent some of the least degraded systems in Fairfax County. Based to their exceptional nature, the Nichol Run and Pond Branch Watersheds have been designated as Watershed Protection Areas. The goal for the watersheds is to preserve biological integrity by taking active measures to identify and protect, as much as possible, the conditions responsible for current high quality ratings (Fairfax County, 2001).

Stream Physical Assessment

Fairfax County conducted a stream physical assessment in 2005 to obtain baseline data for county 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 13.7 miles of Nichol Run were assessed. Over half of the miles assessed were placed in the good category. The rest of the stream miles were categorized as poor, fair, or excellent. Nichol Run is placed in the good overall habitat category. Approximately 17 miles of the Pond Branch were assessed, and the habitat quality covered the entire range. The majority of the stream was categorized as fair, but portions of the stream were poor, very poor, and good. The Pond Branch watershed is given a fair overall habitat classification.

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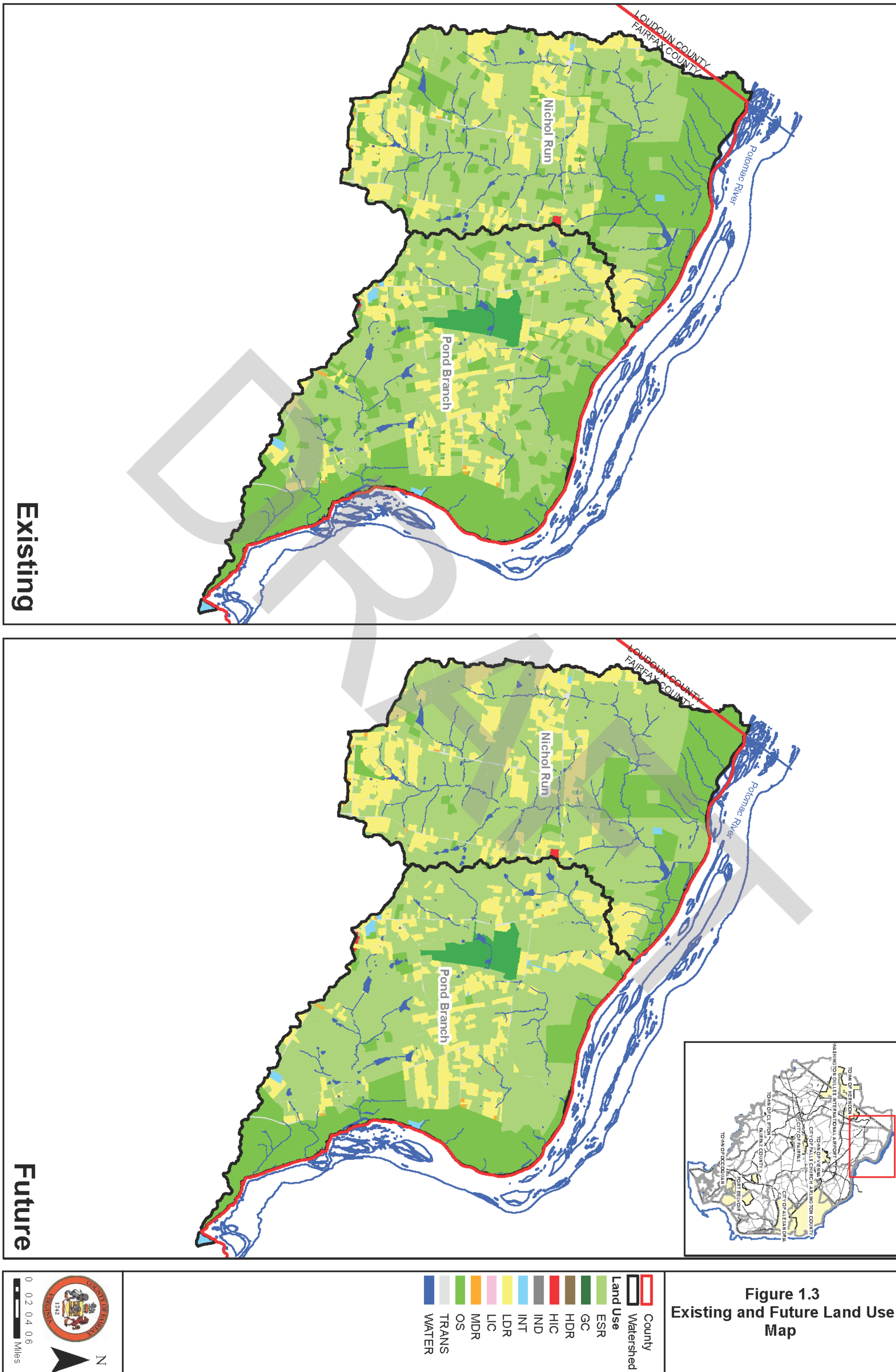

Figure 1.3
Existing and Future Land Use Map

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 over 90% of the Nichol Run Watershed to be in Evolutionary Stage 3. This is the widening stage and is characterized by streambank sloughing, erosion on insides of bends, accelerated bed migration, and exposed bedrock. The majority of channels in the Pond Branch Watershed are also in Evolutionary Stage 3.

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 the Nichol Run Watershed, 113 infrastructure points were identified with the most significant problems being headcuts and an obstruction. There were 143 infrastructure points within the Pond Branch Watershed with the most significant problems including a headcut, a deficient buffer, and an obstruction.

<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 Pond Branch watershed, based on the 2006 Integrated Report. A total of 0.9 miles of Mine Run Branch is impaired along the main stem and continues downstream until the confluence with the Potomac River. Mine Run Branch was first listed as impaired for *Escherichia coli* bacteria (*E. coli*) in 2006, and therefore did not support the recreational use goal. There are no impaired waters in the Nichol Run Watershed.

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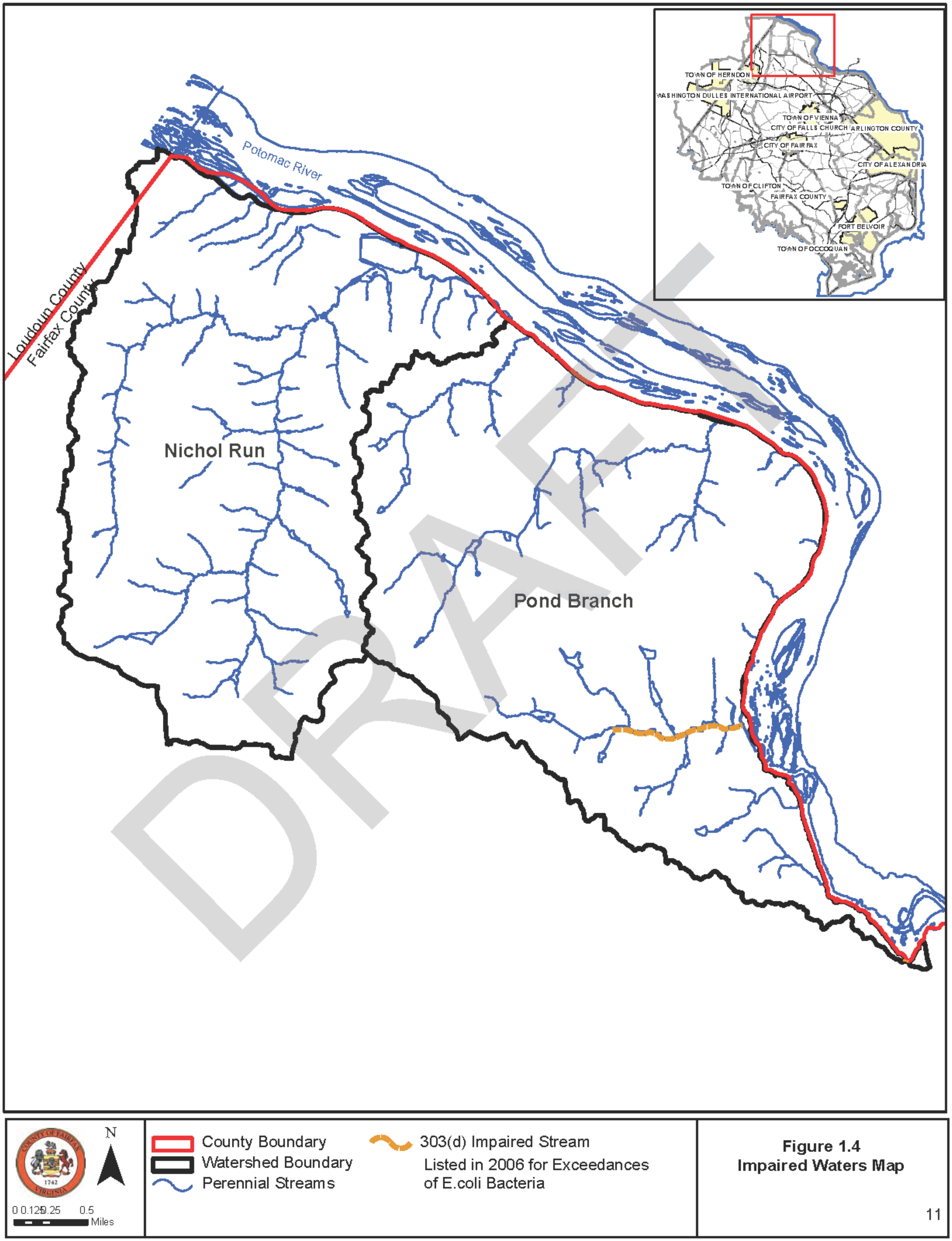

Figure 1.4
Impaired Waters Map

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Wetlands

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 portion of Nichol Run Watershed located in Fairfax County contains 204 acres of non-tidal wetlands and the portion of the Pond Branch Watershed located in Fairfax County contains 52 acres of non-tidal wetlands (U.S. Fish and Wildlife Service, 2008).

In the Nichol Run Watershed, a majority of the wetlands are forested freshwater/shrub wetlands. These types of wetlands are dominant on the Potomac Headwaters, but are also found at the headwaters of Nichol Run and Jefferson Branch. Freshwater pond wetlands occur at a majority of the headwaters of all the streams in the Nichol Run Watershed.

In the Pond Branch Watershed, a majority of the wetlands are freshwater ponds and freshwater emergent wetlands forested freshwater/shrub wetlands. These types of wetlands can be found on the Pond Branch, Clarks Branch, Mine Run Branch and the Potomac Headwaters. Wetlands such as forested freshwater/shrub wetlands are located at the confluence and main stem sections.

1.4.5 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. There are 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. Commit to preserving current tree assets by fostering health and regeneration of specimen trees and urban forest.
2. Enhance the legacy for future generations by increasing the quantity and quality of trees and wooded areas.
3. 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 Nichol Run and Pond Branch watersheds, many rare, threatened and endangered species were noted. They include species such as: Regal Fritillary (*Speyeria idalia*), Stripe-winged Baskettail (*Epitheca costalis*), Midland Clubtail (*Gomphus fraternus*), Wood Turtle (*Glyptemys insculpta*), Smartweed Dodder (*Cuscuta polygonorum*), Wild Mock-cucumber (*Echinocystis lobata*) and Smooth Azalea (*Rhododendron arborescens*). See Table 1.3 for complete list of rare, threatened and endangered species within these watersheds.

Table 1.3 Rare, Threatened, and Endangered Species

Species	Occurrences Statewide	Species	Occurrences Statewide
COLEOPTERA (BEETLES)		***LEPIDOPTERA (BUTTERFLIES & MOTHS)***	
Lordithon niger (Black Lordithon Rove Beetle)	2	*Speyeria idalia* (Regal Fritillary)	34
COMMUNITIES		***NON-VASCULAR PLANTS***	
Black Mesic Forest	41	*Sphagnum subtile* (Delicate Peatmoss)	2
Black Oak-Hickory Forest	26	***ODONATA (DRAGONFLIES& DAMSELFLIES)***	
Coastal Plain/Piedmont Basic Seepage Swamp	17	*Epitheca costalis* (Stripe-winged Baskettail)	4
Eastern Hemlock-Hardwood Forest	23	*Gomphus fraternus* (Midland Clubtail)	3
Floodplain Pond / Pool	3	*Gomphus ventricosus* (Skillet Clubtail)	3
Low-elevation Boulderfield Forest / Woodland	16	*Stylurus laurae* (Laura's Clubtail)	9
Mesic Mixed Hardwood Forest	27	***REPTILES***	
Montane Mixed Oak / Oak-Hickory Forest	19	*Glyptemys insculpta* (Wood Turtle)	39
Mountain / Piedmont Acidic Woodland	14	***VASCULAR PLANTS***	
Piedmont / Mountain Floodplain Forest	7	*Amelanchier nantucketensis* (Nantucket shadbush)	1
Riverside Outcrop Barren	2	*Arabis shortii* (Short's Rockcress)	4
Riverside Prairie	10	*Carex davisii* (Davis' Sedge)	1
Rocky Bar and Shore	5	*Carex straminea* (Straw Sedge)	1
Sand / Gravel / Mud Bar and Shore	4	*Carex tenera* (Slender Sedge)	1
CRUSTACEA (AMPHIPODS, ISOPIDS & DECAPODS)		*Cerastium arvense ssp. velutinum* (A Field Chickweed)	5
Stygobromus phreaticus (Northern Virginia Well Amphipod)	3	*Cirsium altissimum* (Tall Thistle)	3
Stygobromus pizzinii (Pizzini's Amphipod)	6	*Cirsium carolinianum* (Carolina Thistle)	3
Stygobroumus sp. 15 (A Groundwater Amphipod)	3	*Cuscuta polygonorum* (Smartweed Dodder)	7

Table 1.3 Rare, Threatened, and Endangered Species (Con't)

Species	Occurrences Statewide	Species	Occurrences Statewide
VASCULAR PLANTS, cont.		***VASCULAR PLANTS, cont.***	
Desmodium cuspidatum var. cuspidatum (Toothed Tick-trefoil)	1	*Orthilia secunda (One-sided Wintergreen)*	2
Diarrhena obovata (A Beakgrain)	1	*Phacelia ranunculacea (Blue Scorpion-weed)*	3
Dichanthelium annulum	8	*Platanthera peramoena (Purple Fringeless Orchis)*	4
Echinocystis lobata (Wild Mock-cucumber)	2	*Prunus pumila var. susquehanae (Sand Cherry)*	4
Eleocharis compressa (Flat-stemmed Spike-rush)	8	*Ranunculus hederaceus (Long-stalked Crowfoot)*	6
Enemion biternatum (False Rue-anemone)	2	*Rhododendron arborescens (Smooth Azalea)*	12
Eryngium yuccifolium var. yuccifolium (Rattlesnake-master)	17	*Rorippa sessiliflora (Stalkless Yellowcress)*	9
Erythronium albidum (White Trout-lily)	7	*Sida hermaphrodita (Virginia Mallow)*	6
Hasteola suaveolens (Sweet-scented Indian-plantain)	10	*Silene nivea (Snowy Campion)*	3
Helianthus occidentalis (Mcdowell Sunflower)	1	*Solidago racemosa (Sticky Goldenrod)*	1
Hemicarpha micrantha (Dwarf Bulrush)	5	*Solidago rupestris (Rock Goldenrod)*	5
Lathyrus palustris (Vetchling)	6	*Spartina pectinata (Freshwater Cordgrass)*	15
Maianthemum stellatum (Starflower False Solomon's-seal)	6	*Triphora trianthophora (Nodding Pogonia)*	9
Matteuccia struthiopteris var. pensylvanica (Ostrich Fern)	2	*Valeriana pauciflora (Valerian)*	2
Onosmodium virginianum (Virginia False-gromwell)	13	*Vitis rupestris (Sand Grape)*	7

1.4.6 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. 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).

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, as shown in Figure 1.5 (Fairfax County, Virginia, March 23, 2007).

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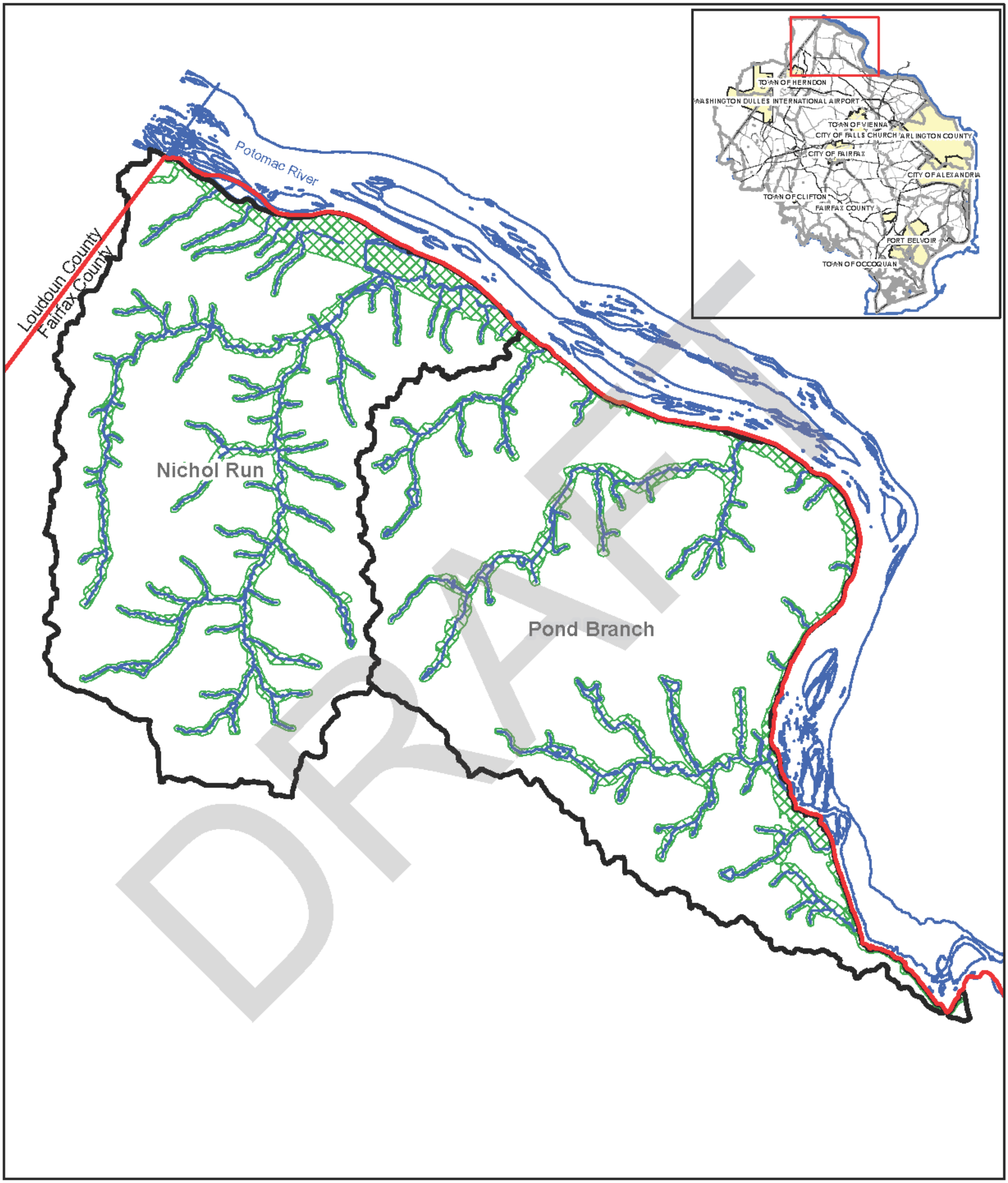

Perennial Streams
Resource Protection Areas
Watershed Boundary
County Boundary

Figure 1.5
Resource Protection Areas Map

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1.4.7 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 Nichol Run Watershed, the database lists a total of 6 projects, 1 was completed, 4 were found to be incomplete and the last was not found. The 4 projects not yet completed were all culvert replacements or repairs. Within the Pond Branch Watershed, the database lists a total of 6 proposed projects; all 6 projects were not yet completed. All 6 projects were culvert addition, replacements or repairs.

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 Watersheds consist of steep slopes (5-15 percent), with channel slopes between 1 and 3 percent. The problems identified within the Watersheds include sediment and debris accumulations, flooding of adjacent sewer lines, bank erosion, channelization, or the need for detention ponds. 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. Twelve total projects were recommended in the Nichol Run and Pond Branch Watershed, with six in each watershed. The proposed cost of the proposed projects totaled $677,000.

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.

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2.1 Watershed Study Methodology

2.2 Watershed Management Areas and Subwatersheds

Fairfax County contains 30 watersheds, including the Nichol Run and Pond Branch Watersheds. A watershed is the land area where all of the water that is under it or drains off of it goes into the same place. 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 Nichol Run and Pond Branch 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 1.3 in Chapter 1, the Nichol Run and Pond Branch watersheds are moderately 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 Nichol Run and Pond Branch watersheds were analyzed to assist with the selection of areas for field reconnaissance. The open space land use was compared to the buildings layer using the county's Geographic Information System (GIS) 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.

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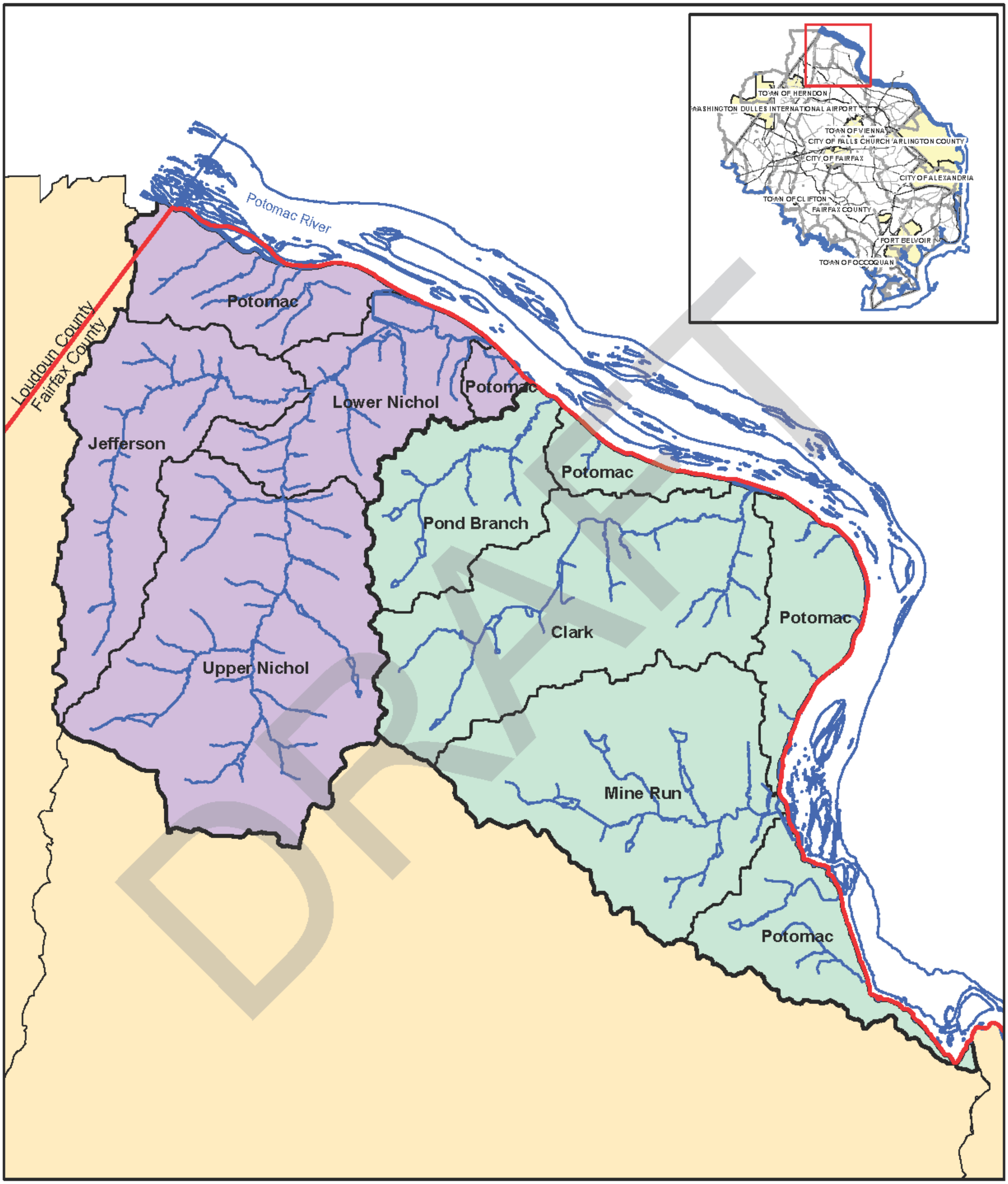

Perennial Streams
Nichol Run Watershed
Pond Branch Watershed
Other Fairfax County Watersheds
Fairfax County Boundary

Figure 2.1
Nichol Run and Pond Branch WMAs

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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. Approximately three miles of stream within the Nichol Run and Pond Branch watersheds were surveyed. The assessment included portions of Nichol Run, Harkney Branch and Mine Run Branch. The original physical stream assessment protocol was followed which included a habitat assessment, an infrastructure inventory, stream characterization, 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.

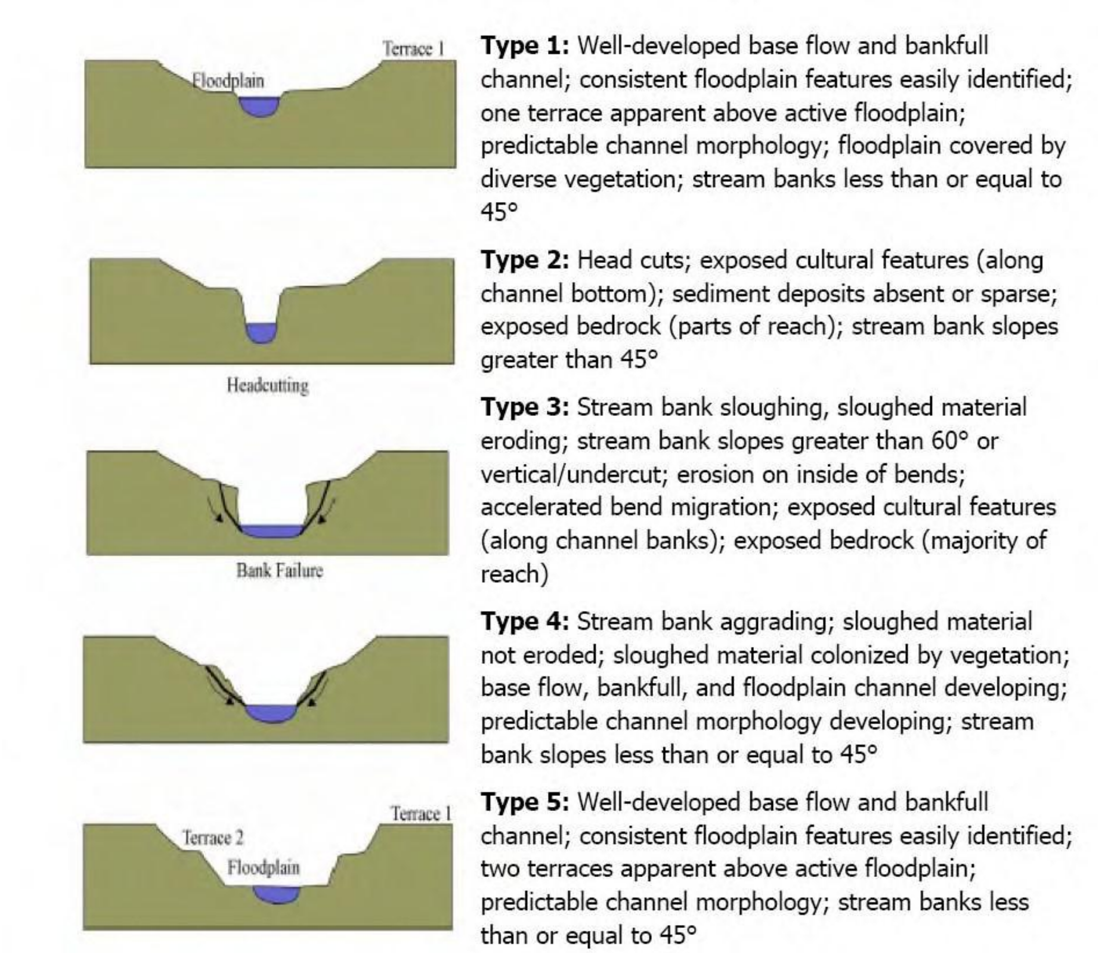

Figure 2.2 Channel Evolution Model Stages (Schumm, et al., 1984)

Along with habitat assessments, the stream reaches were placed in one of five stages of geomorphic condition in the Channel Evolution Model (CEM). Approximately 91 percent of the Nichol Run Watershed was in Evolutionary Stage 3. This is the widening stage and is characterized by streambank sloughing, erosion on insides of bends, accelerated bed migration, and exposed bedrock. The majority of channels in the Pond Branch Watershed were also determined to be in Evolutionary Stage 3 (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 are 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.

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3.1 Nichol Run Watershed

The Nichol Run Watershed consists of four watershed management areas (WMAs) as listed below:

1. Jefferson
2. Lower Nichol
3. Potomac
4. Upper Nichol

WMAs in the Nichol Run Watershed are shown in Figure 3.1. As shown in the figure, all of the WMAs are located in Fairfax County, with the exception of the Potomac WMA which has a small portion located in Loudoun County. Only areas within Fairfax County were evaluated as part of this study; however, information on stormwater structures and stream crossings near the county border was gathered and evaluated to determine how it would affect stormwater flows in Fairfax County. The following information is provided for each WMA in the subsequent sections of this chapter:

1. WMA Characteristics
2. Existing and Future Land Use Information
3. Field Reconnaissance and Stream Physical Assessment Information
4. WMA Characterization
5. STEPL Modeling
6. HEC-RAS Modeling
7. Subwatershed Ranking

Table 3.1 illustrates the total area of each WMA, the current impervious conditions and the extent and type of stormwater treatment within each WMA.

Table 3.1 Nichol Run Watershed WMA Summaries

WMA Name	Total Area (acres)	Impervious Current Condition (acres)	Percent Impervious	Current Treatment Types			
				Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Jefferson	1,184.9	51.7	4.4	12.1	-	0.4	1,172.4
Lower Nichol	820.5	25.9	3.2	4.4	-	-	816.1
Potomac	696.5	8.7	1.2	-	-	-	696.5
Upper Nichol	2,547.7	144	5.6	36.7	-	2.6	2,508.4
Watershed Totals	**5,249.6**	**230.3**	**4.4**	**53.2**	**-**	**3**	**5,193.4**

Figures for Chapter 3 are provided in the beginning of the chapter and are followed by a detailed discussion of each WMA in Sections 3.1 through Section 3.4. Section 3.5 includes a discussion of SWMM modeling results, including a SWMM Peak Flow Map for the 2-year storm event.

N

0 0.15 0.3 Miles

Perennial Streams
Roads
WMA Boundary
Nichol Run Watershed
County Boundary

Figure 3.1
Nichol Run
Watershed Management Area
Map

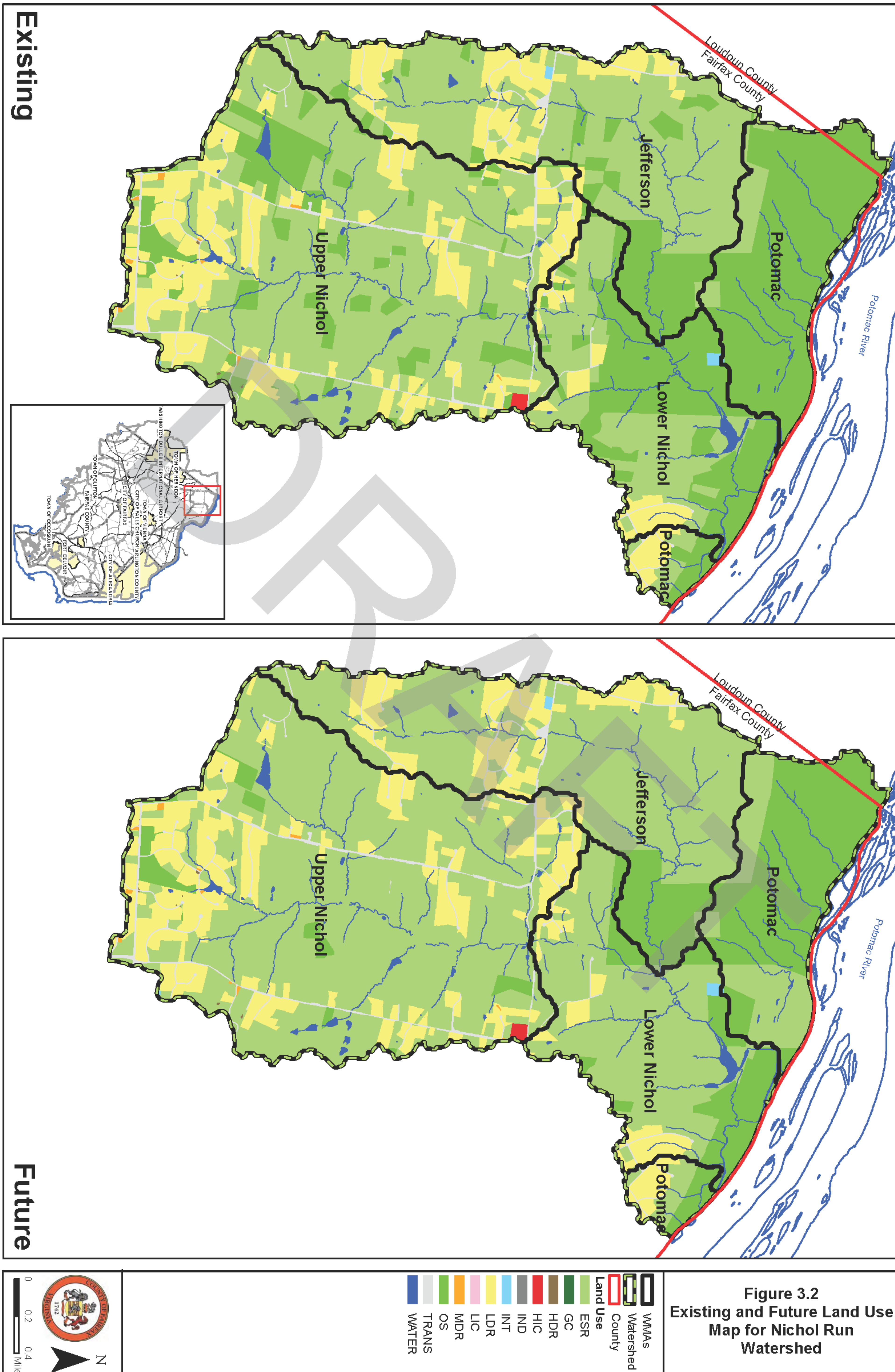

Figure 3.2 Existing and Future Land Use Map for Nichol Run Watershed

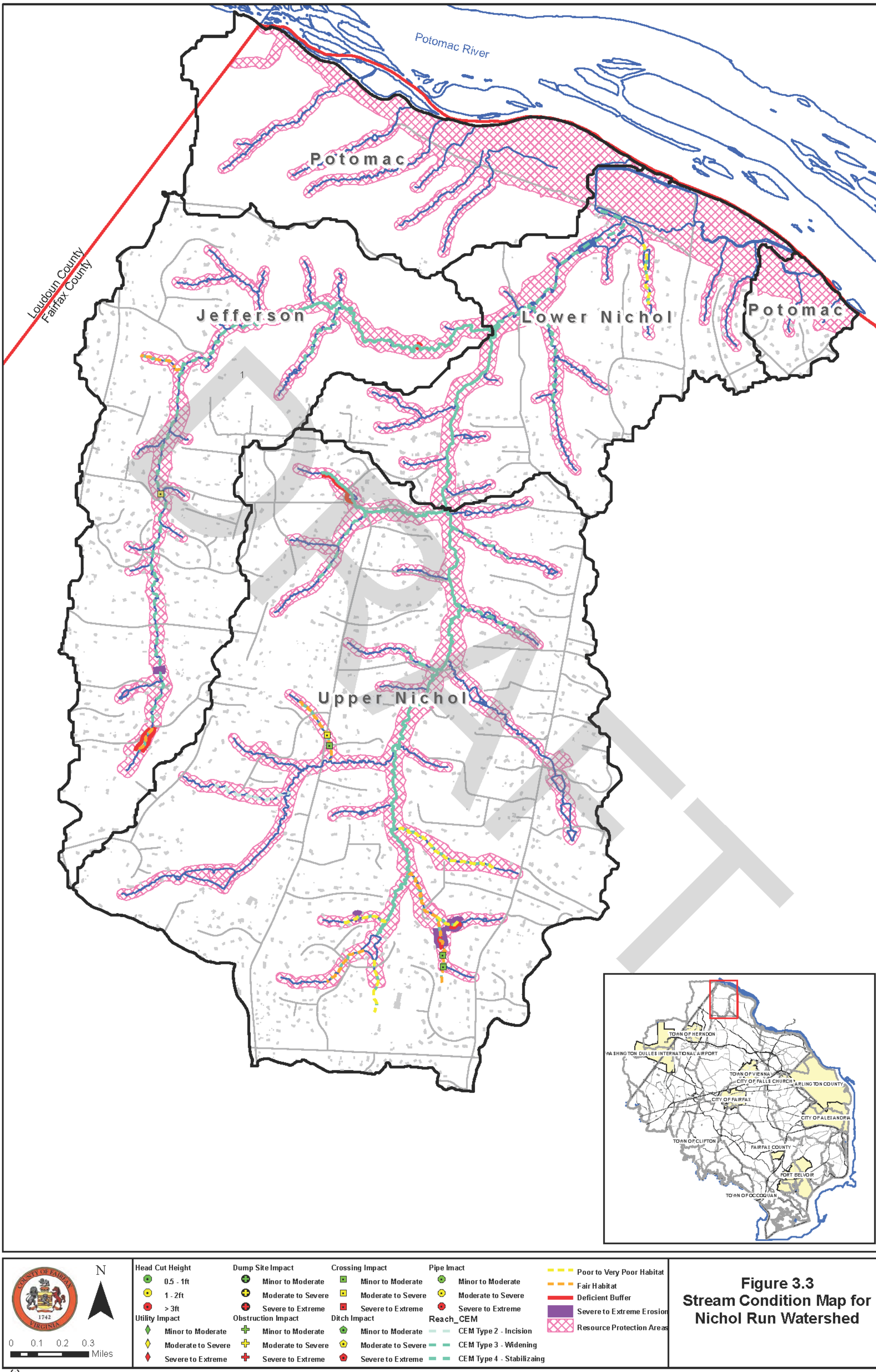

Figure 3.3
Stream Condition Map for Nichol Run Watershed

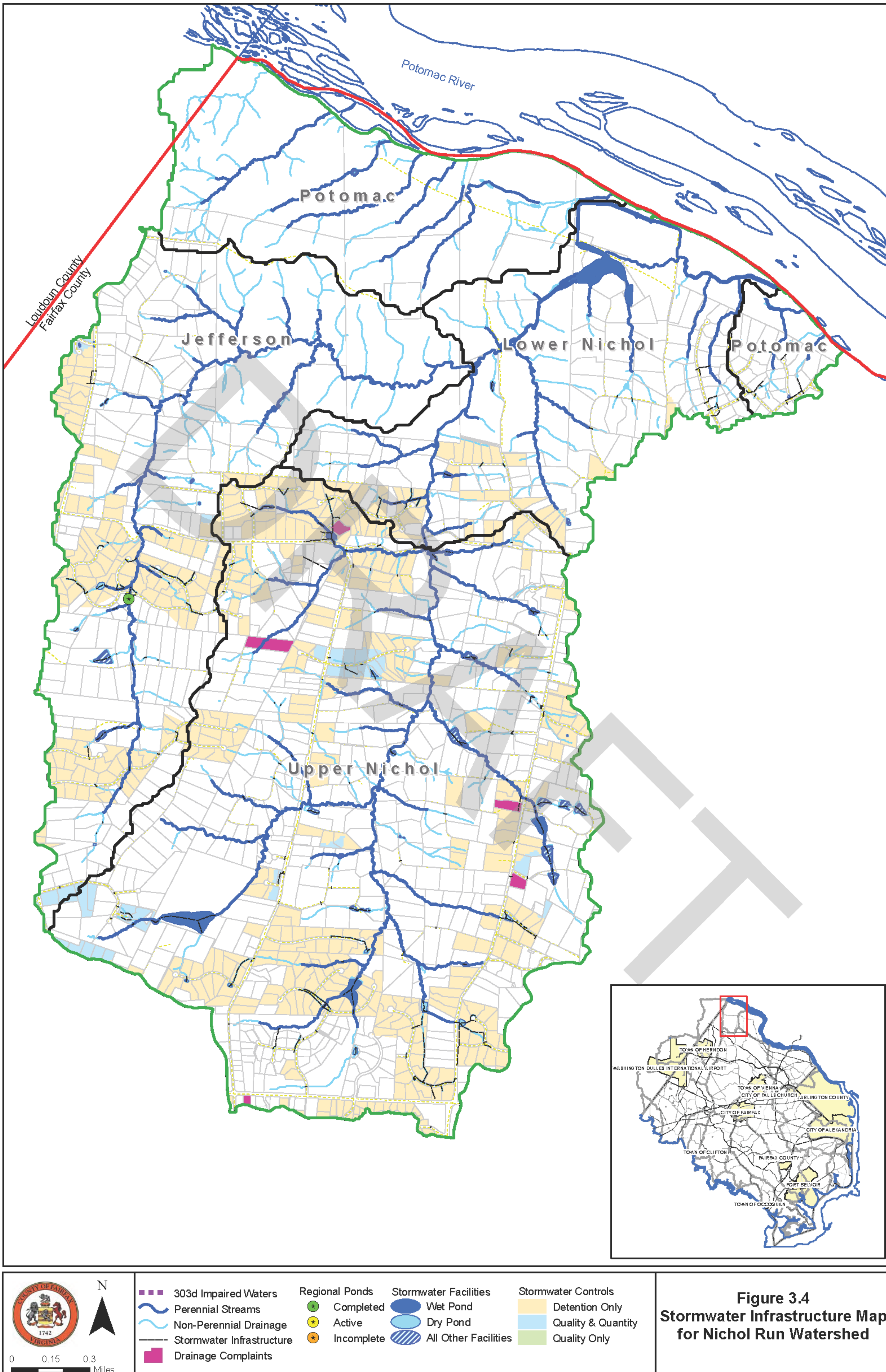

Figure 3.4
Stormwater Infrastructure Map for Nichol Run Watershed

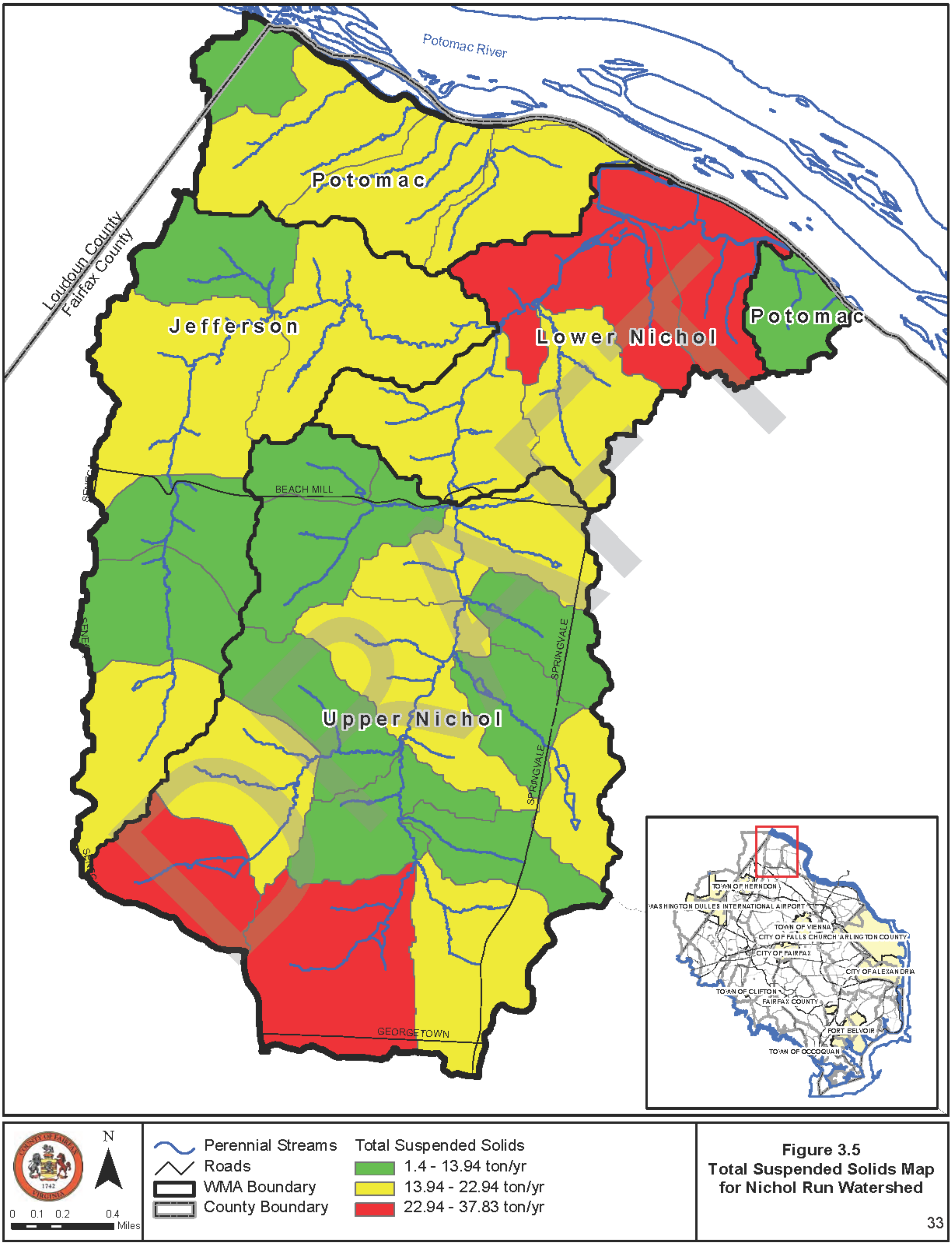

Figure 3.5
Total Suspended Solids Map for Nichol Run Watershed

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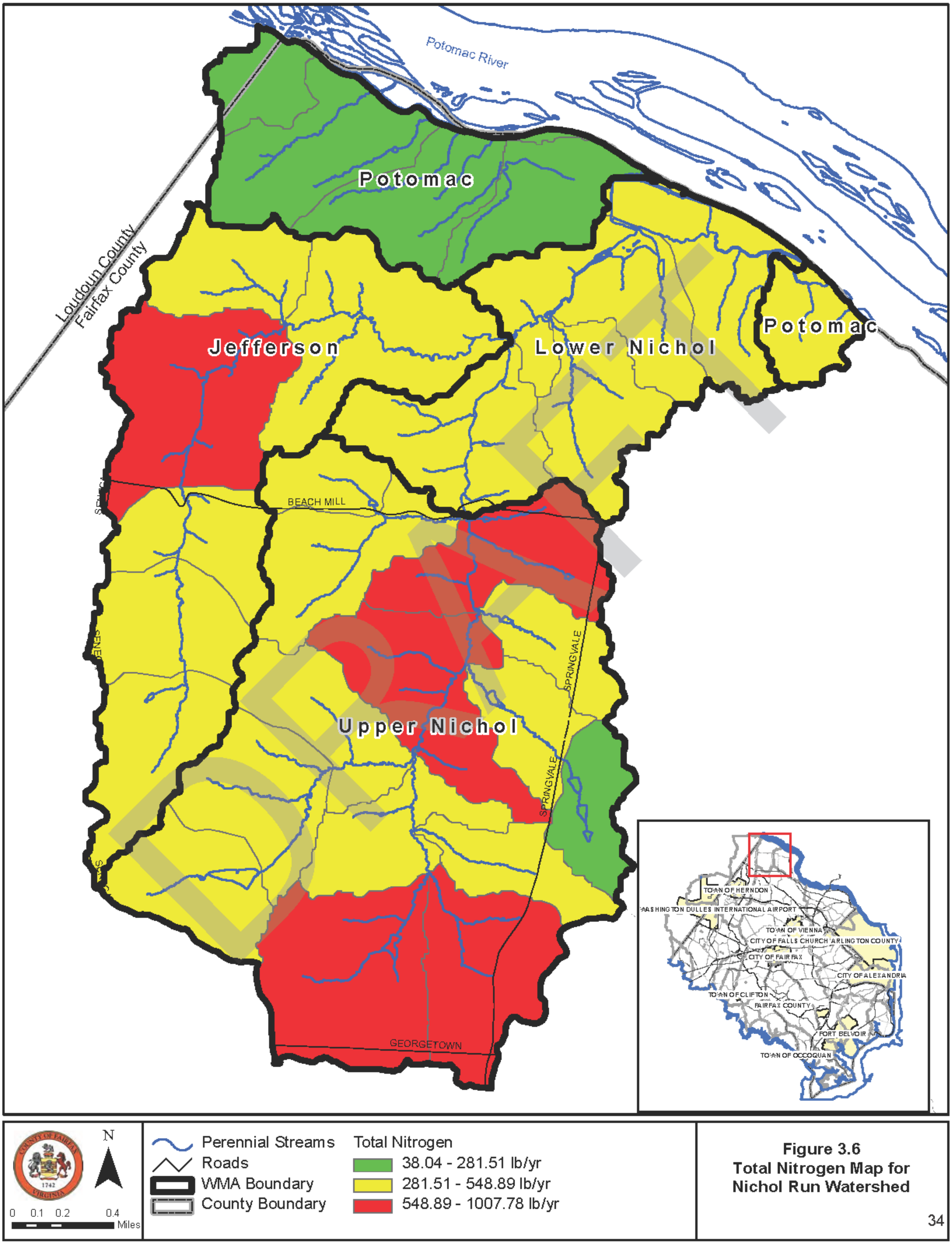

Figure 3.6
Total Nitrogen Map for Nichol Run Watershed

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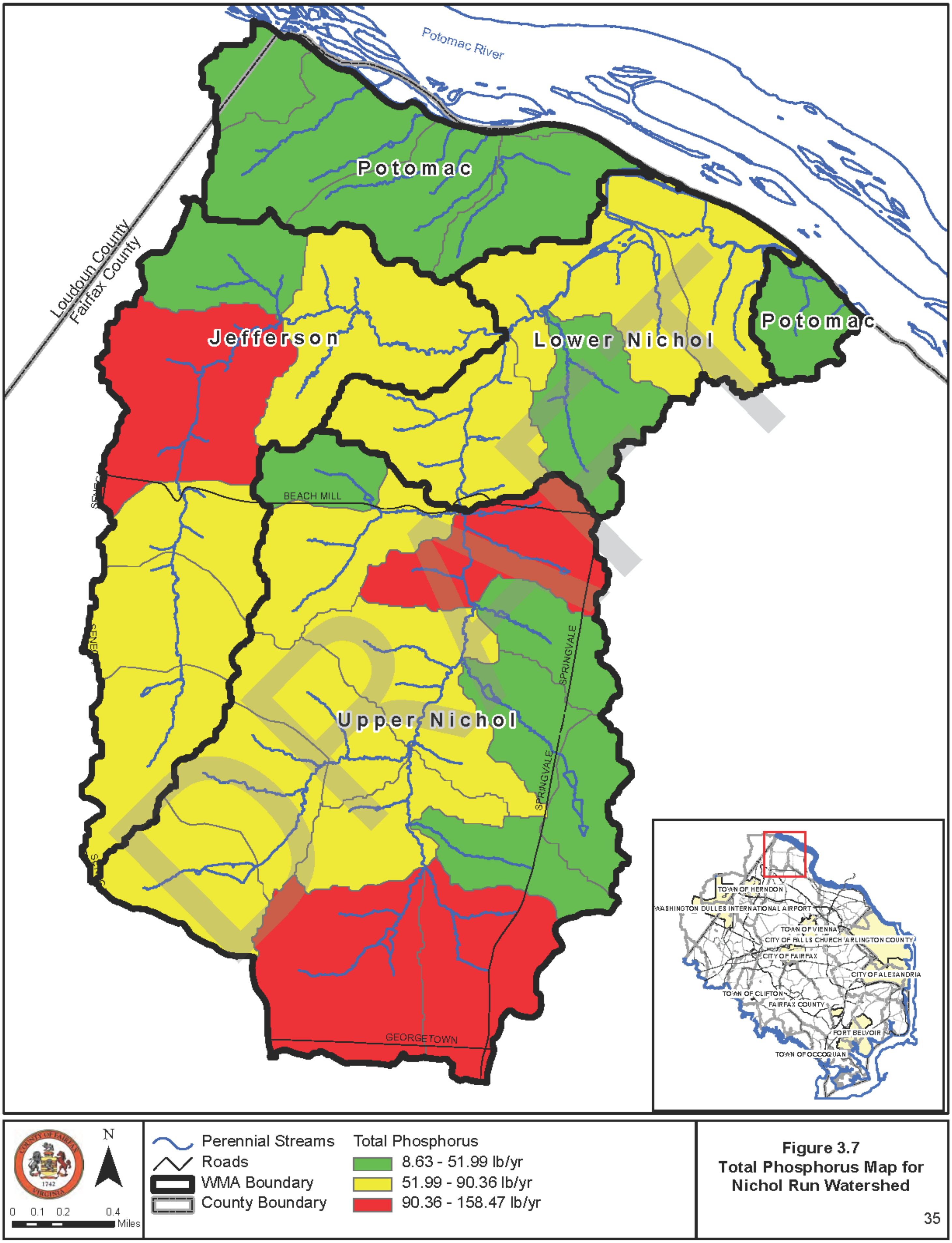

Figure 3.7
Total Phosphorus Map for Nichol Run Watershed

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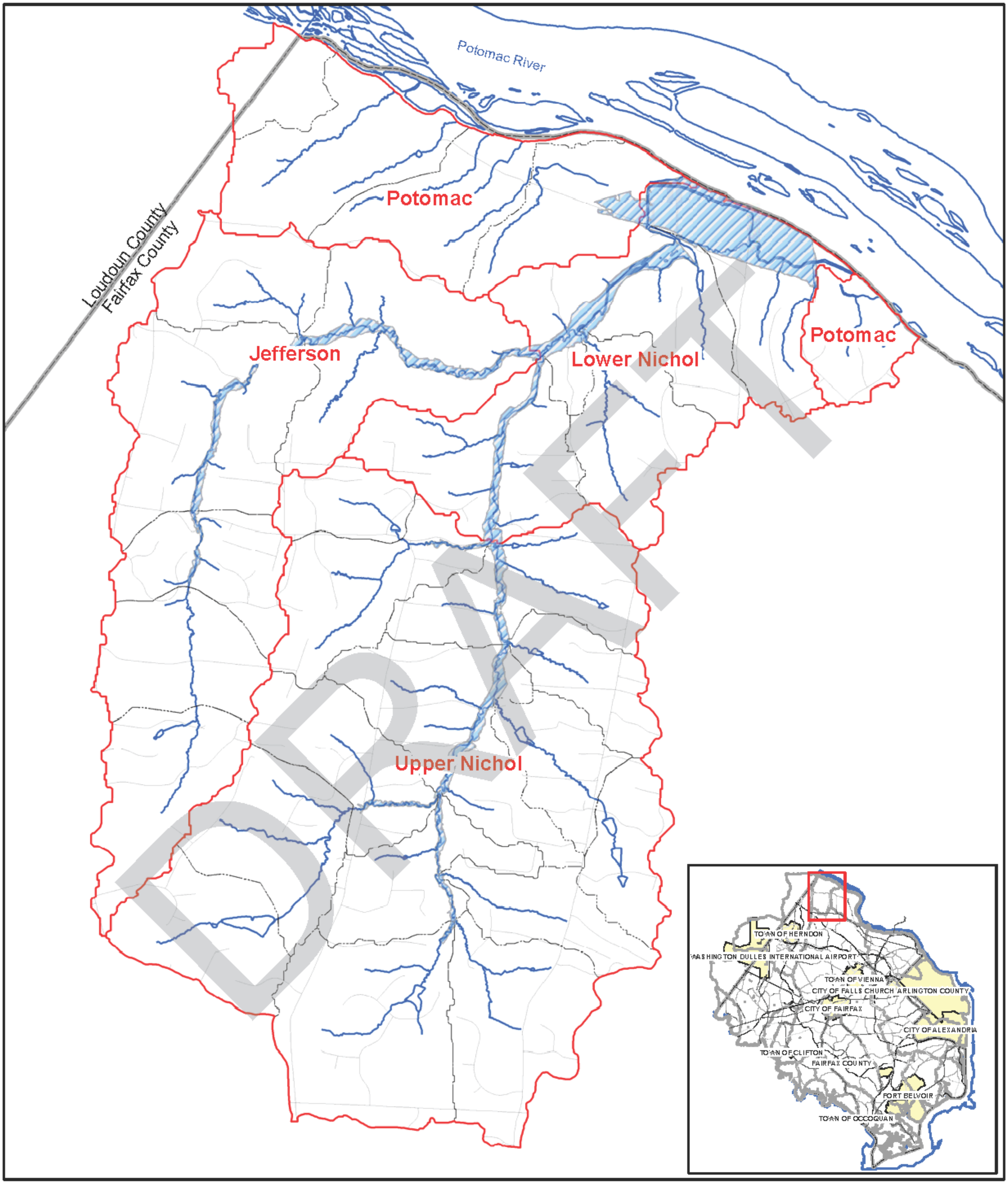

N

0 0.1 0.2 0.4 Miles

100-Year Flood Zone
Perennial Streams
Roads
Subwatershed Boundary
WMA Boundary
County Boundary

Figure 3.8
Preliminary 100-Year Storm Event Map for Nichol Run Watershed

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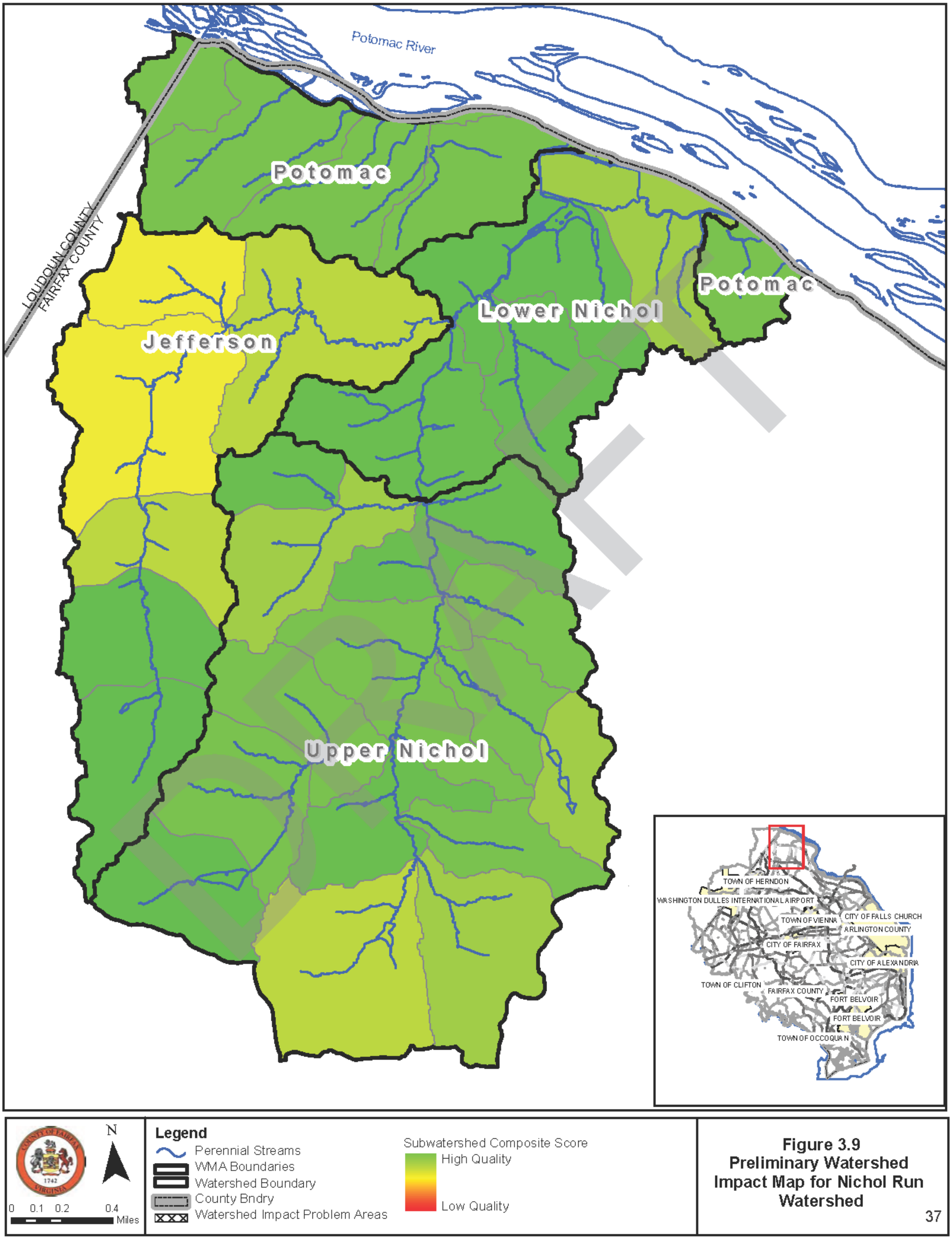

Figure 3.9
Preliminary Watershed Impact Map for Nichol Run Watershed

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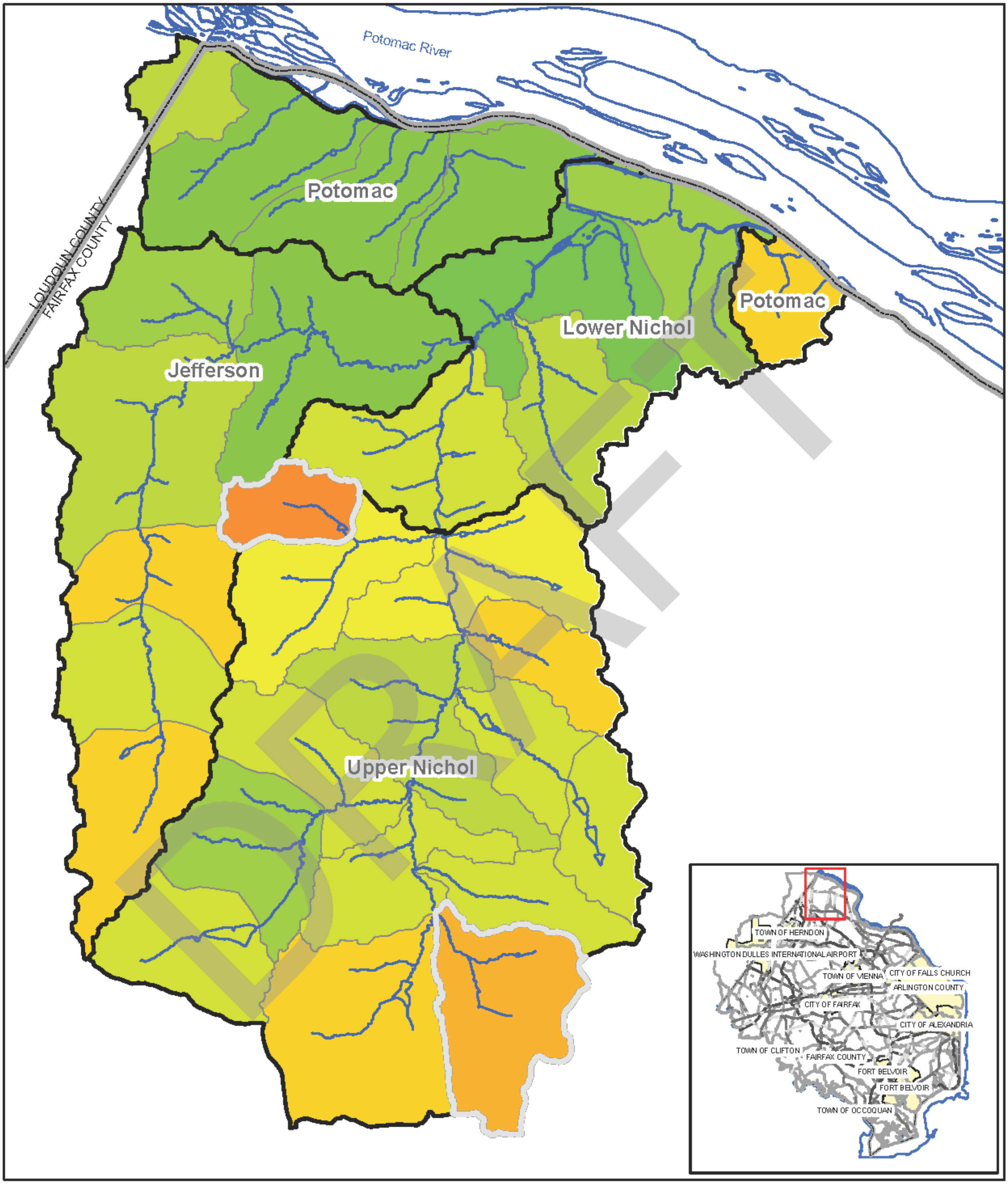

N

0 0.1 0.2 0.4 Miles

Legend

- Perennial Streams
- WMA Boundaries
- Watershed Boundary
- County Bndry
- Watershed Impact Problem Areas
- Source Indicator Problem Areas

Subwatershed Composite Score

High Quality

Low Quality

Figure 3.10
Preliminary Source Indicator Map for Nichol Run Watershed

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3.2 Jefferson WMA

3.1.1 Jefferson WMA Characteristics

The Jefferson WMA is located in the western portion of the Nichol Run Watershed. The watershed comprises 1,185 acres (1.85 square miles). The WMA is almost split in half by Beach Mill Road. Figure 3.1 shows the location of the Jefferson WMA.

Approximately 6.7 miles of perennial streams are located within the Jefferson WMA. The majority of the streams are in good to excellent condition, with a few small portions in fair condition. The streams flow northeast toward the confluence with Nichol Run, and flow primarily through estate and low density residential areas. The lower portion of the stream within the WMA travels though an expansive open space area before entering Nichol Run.

3.1.2 Existing and Future Land Use

The southern half of the Nichol Run Watershed is more developed than the northern half of the watershed, which is also true within the Jefferson WMA. Approximately 19 percent of the WMA is urbanized, primarily consisting of estate residential (63 percent), open space (17 percent) and low density residential (16 percent) land uses, as shown in Table 3.1. The open space is primarily clustered around the lower section of the stream corridor.

Table 3.2 Existing and Future Land Use for Jefferson WMA

Land Use Type	Existing Percent (%)	Future Percent (%)
Estate Residential	63.3	69.3
High Density Residential	0	0
Medium Density Residential	0	0
Low Density Residential	15.9	15.9
Industrial	0	0
Low Intensity Commercial	0	0
High Intensity Commercial	0	0
Institutional	0.1	0.1
Open Space	17.2	11.1
Golf Course	0	0
Transportation	2.7	2.7
Water	0.9	0.9
Total	100	100

Source: Fairfax County GIS, 2008

Table 3.2 and Figure 3.2 show expected changes in land use as the Jefferson WMA continues to develop. A slight decrease in open space, with a corresponding increase in estate residential areas within the Jefferson WMA is projected.

3.1.3 Field Reconnaissance and Stream Physical Assessment

Field reconnaissance was completed within the Jefferson WMA to evaluate projects proposed by the county, identify problems areas and to identify potential improvement projects. The following tasks were completed during the field reconnaissance surveys of the Jefferson WMA:

1. Evaluated existing stormwater facilities.
2. Conducted neighborhood source assessments.
3. Reviewed a stream physical assessment inventory point.

The results of each of the field reconnaissance surveys are briefly described below.

Existing Stormwater Facilities

Eight stormwater management facilities were evaluated within the Jefferson WMA to determine the need for repair or the potential for retrofit to increase the benefit of the facility. Four of the eight facilities were found to provide minimal or no stormwater management functions. The remaining facilities were functioning as designed, but most presented some opportunity for retrofit.

Neighborhood Source Assessment (NSA)

Two representative neighborhoods were chosen for the NSA to help identify potential improvement projects throughout the Jefferson WMA. The chosen neighborhoods consisted of single family attached or detached houses on one acre or larger lots. Two stormwater management facilities were identified, and they were both dry ponds. The NSA indicated that there is the potential for stormwater management facility retrofits as well as a need for better lawn and landscaping practices in the Jefferson WMA.

Stream Physical Assessment (SPA) Inventory Points

Inventory points identified during the original stream physical assessment that received an impact score of five or greater were field verified. A stream crossing was identified as impacting the stream channel. The pipes had been recently replaced, but further stabilization or improvement may be required in the future.

3.1.4 Jefferson WMA Characterization

Approximately 4.5 miles of streams were assessed within the Jefferson WMA to determine the overall stream conditions in the WMA. As shown in Figure 3.3, the stream length assessed has good habitat conditions in the upper portion and excellent habitat conditions in the lower portions. All of the perennial streams in the Jefferson WMA are protected by the resource protection areas as described in Chapter 1. The main stem was designated as protected in 1993, whereas the tributaries were not added until 2003 and 2005. The stream crossing of Beach Mill Road and the Jefferson Branch was identified as causing impairments to the stream system. The entire assessed portion of stream is in Channel Evolution Model Stage 3, which means it is an unstable channel that is experiencing significant bank erosion.

As shown in Figure 3.4, the Jefferson WMA contains a few stormwater management facilities that collect and treat stormwater runoff before it reaches the stream network. These facilities are primarily farm ponds, with a few dry ponds. Based on Table 3.3, stormwater runoff from about 24 percent of the impervious area in the WMA is treated. Which means, approximately 76 percent of the stormwater runoff generate within the Jefferson WMA is not treated. The stormwater runoff that receives treatment is primarily only treated for quantity and not water quality. Therefore, more stormwater management is needed within the Jefferson WMA.

Table 3.3 Jefferson WMA Summary

WMA Name	Total Area (acres)	Impervious Current Condition		Current Treatment Types			
		Percent (%)	Acres	Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Jefferson	1,184.9	4.4	51.7	12.1	-	0.4	1172.4

3.1.5 STEPL Modeling

The STEPL model was used to estimate nutrient loadings in each subwatershed as described in Section 2.5. Figures 3.5, 3.6 and 3.7 present the results of the STEPL model for total suspended solids, total nitrogen, and total phosphorus, respectively, which were used to estimate the pollutant loadings in each subwatershed and WMA. Table 3.4 below shows the total pollutant loading to the endpoint of Jefferson WMA. According to the STEPL model results, the Jefferson WMA contributes approximately 20 percent of the total suspended solids, 25 percent of the total nitrogen, and 24 percent of the total phosphorous annual loads to Nichol Run Watershed. Pollutant loadings normalized to the acres within the drainage area of Jefferson WMA are presented in Table 3.5. The values in this table indicate the total nutrient and sediment load that results from stormwater runoff over one acre of Jefferson WMA as compared with unit area loads for the entire watershed.

Table 3.4 Summary of Pollutant Loadings for Jefferson WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/year)	Total Nitrogen (pounds/year)	Total Phosphorus (pounds/year)
Jefferson	57.7	2,611.9	397.6
WS Totals	**286.8**	**10,410.3**	**1,629.6**

Table 3.5 Pollutant Loadings Normalized by Drainage Area for Jefferson WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/acre/year)	Total Nitrogen (pounds/acre/year)	Total Phosphorus (pounds/acre/year)
Jefferson	0.049	2.204	0.336
WS Totals	**0.055**	**1.983**	**0.310**

3.1.6 HEC-RAS Modeling

HEC-RAS hydraulic modeling was completed for a 100-year storm event in the Jefferson WMA. Channel flow capacity was analyzed to determine if the 100-year storm event would overflow the channel and flood onto the floodplain. Additionally, the elevation of the flow was determined with reference to the topographic elevations in the stream valley.

As shown in Figure 3.8, a 100-year storm in the Jefferson WMA resulted in an overflow event with flooding onto the floodplain. The modeling showed that the 100-year stormflow elevation covered the entire floodplain and reached up the valley slope.

Three culverts are located within the Jefferson WMA. The culverts were modeled to determine if the 100-year storm exceeded their capacity to carry the flow. The modeling shows that the culvert located furthest upstream on Jefferson Branch was able to carry the 100-year stormflow as well as the 10 and 2-year stormflows. The other two culverts located in this WMA were not able to carry the 100-year stormflow and water will pond upstream of the culvert structure. The existence of the ponded water will extend the time period of maximum flow through the culvert. When the ponded water is fully drained, the flow elevation will begin to drop.

3.1.7 Jefferson WMA Subwatershed Ranking

As indicated in Section 2.6, two indicator categories – watershed impact and source indicators - were used for ranking overall conditions in the subwatersheds. Figure 3.9 illustrates the results obtained for the subwatershed ranking of watershed impacts; the lowest scoring subwatersheds were identified as potential problem areas. No subwatersheds within the Jefferson WMA were identified as potential problem areas. Based upon existing conditions, the southern portion of the WMA is in good condition, but traveling north toward the confluence with Nichol Run the Jefferson Branch the conditions deteriorate slightly.

The Jefferson WMA was also evaluated using source indicators to identify potential WMA stressors or pollutant sources, as shown in Figure 3.10. The lowest ranking subwatersheds were identified as additional potential problem areas. No additional problems areas were identified within the Jefferson WMA. The southern portion of the WMA shows moderate levels of stressors and pollutant sources.

3.2 Lower Nichol WMA

3.2.1 Lower Nichol WMA Characteristics

The Lower Nichol WMA is located in the northeastern portion of the Nichol Run Watershed. The watershed is comprised of 821 acres (1.28 square miles) and is bordered on the south by Beach Mill Road, as shown in Figure 3.1.

Approximately 7.6 miles of perennial streams exist within the Lower WMA, and a majority of these streams range from good to excellent condition. The streams flow northeast towards the confluence with the Potomac River. The streams travel primarily through open space and estate residential areas. Small portions of the stream travel though low intensity commercial land use areas.

3.2.2 Existing and Future Land Use

Much of the Lower Nichol WMA is designated as parkland. Only 10 percent of the Lower Nichol WMA is urbanized, which consists of primarily open space (48 percent) and estate residential (39 percent) land uses, as shown in Table 3.6. The open space is primarily clustered in the northern areas around the Potomac River.

Table 3.6 Existing and Future Land Use for Lower Nichol WMA

Land Use Type	Existing Percent (%)	Future Percent (%)
High Density Residential	0	0
Medium Density Residential	0	0
Low Density Residential	8.6	8.6
Estate Residential	38.9	66.2
Industrial	0	0
High Intensity Commercial	0	0
Low Intensity Commercial	0	0
Institutional	0.4	0.4
Open Space	48.2	21.0
Transportation	1.4	1.4
Water	2.5	2.5
Total	100	100

Source: Fairfax County GIS, 2008

Table 3.6 and Figure 3.2 show expected changes in land use as the Lower Nichol WMA continues to develop. A decrease in open spaces areas are projected within the Lower Nichol WMA, with corresponding increases in estate residential areas.

3.2.3 Field Reconnaissance and Stream Physical Assessment

Field reconnaissance was completed within the Lower Nichol WMA to evaluate projects proposed by the county, to identify problems areas and to identify potential improvement projects. The following tasks were completed during the field reconnaissance surveys of the Lower WMA:

1. Evaluated existing stormwater facilities.
2. Conducted neighborhood source assessments.

The results of each of the above evaluations are briefly described below.

<u>Existing Stormwater Facilities</u>
Four stormwater management facilities were evaluated within the Lower Nichol WMA to determine the need for repair or the potential for retrofit to increase the benefit of the facility. Two of the four facilities were functioning as designed and both offered some opportunity for retrofit. The remaining two facilities were unable to be assessed due to access restrictions.

<u>Neighborhood Source Assessment (NSA)</u>
Three representative neighborhoods were chosen for NSAs to help identify potential improvement projects throughout the Lower Nichol WMA. The chosen neighborhoods consisted of single-family detached houses on one acre or larger lots. Within the three neighborhoods, seven stormwater management facilities were identified, all of which were wet ponds. The NSAs indicated the potential for stormwater management facility retrofits and a need for better lawn and landscaping practices.

3.2.4 Lower Nichol WMA Characterization

Approximately 2.8 miles of stream were assessed within the Lower Nichol WMA to determine the overall stream conditions in the WMA. As shown in Figure 3.3, the stream length assessed had good to excellent habitat conditions, with the exception of one tributary with poor conditions. All of the perennial streams in the Lower Nichol WMA are protected by the resource protection areas as described in Chapter 1. The Lower Nichol main stem was designated as protected in 1993, and the smaller tributaries were added in 2003. Stream crossings, headcuts, obstructions and pipes were identified during field reconnaissance. Most of the problems that were identified were considered minor to moderate. One headcut was ranked moderate to severe which was approximately two feet high. All of the Lower Nichol WMA is in Channel Evolution Model Stage 3, which indicates an unstable channel that is experiencing significant bank erosion.

As shown in Figure 3.4, the Lower Nichol WMA contains a few stormwater management facilities that collect and treat stormwater runoff before it reaches the stream network. The majority of these facilities are wet or farms ponds. Table 3.7 indicates that stormwater runoff from approximately 17 percent of the impervious area in the WMA is treated. Stormwater runoff from most of the area that does receive treatment is only treated for quantity and not water quality. Therefore, more stormwater management is needed in the Lower Nichol WMA, particularly as the WMA continues to develop.

Table 3.7 Lower Nichol WMA Summary

WMA Name	Total Area (acres)	Impervious Current Condition		Current Treatment Types			
		Percent (%)	Acres	Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Lower	820.5	3.2	25.9	4.4	-	-	816.1

3.2.5 STEPL Modeling

The STEPL model was used to estimate nutrient loadings in each subwatershed as described in Section 2.5. Figures 3.5, 3.6 and 3.7 present the results of the STEPL model for total suspended solids, total nitrogen and total phosphorus, respectively, which were used to estimate the pollutant loadings in each subwatershed and WMA. Table 3.8 below shows the total pollutant loading to the endpoint of Lower WMA. According to the STEPL model results, the Lower Nichol WMA contributes approximately 17 percent of the total suspended solids, 12 percent of the total nitrogen, and 13 percent of the total phosphorous annual loads to the Nichol Run Watershed. Pollutant loadings normalized to the acres within the drainage area of the Lower Nichol WMA are presented in Table 3.9. The values in this table indicate the total nutrient and sediment load that results from stormwater runoff over one acre of the Lower Nichol WMA as compared with unit area loads for the entire watershed.

Table 3.8 Summary of Pollutant Loadings for Lower Nichol WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/yr)	Total Nitrogen (pounds/yr)	Total Phosphorus (pounds/year)
Lower	48.5	1,249.4	207.4
WS Totals	**286.8**	**10,410.3**	**1,629.6**

Table 3.9 Pollutant Loadings Normalized by Drainage Area for Lower Nichol WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/acre/yr)	Total Nitrogen (pounds/acre/yr)	Total Phosphorus (pounds/acre/yr)
Lower	0.059	1.523	0.253
WS Totals	**0.055**	**1.983**	**0.310**

3.2.6 HEC-RAS Modeling

HEC-RAS hydraulic modeling was completed for a 100-year storm event in the Lower Nichol WMA. Channel flow capacity was analyzed to determine if the 100-year storm event would overflow the channel and flood onto the floodplain. Additionally, the elevation of the flow was determined with reference to the topographic elevations in the stream valley.

As shown in Figure 3.8, a 100-year storm in the Lower Nichol WMA resulted in an overflow event with flooding onto the floodplain. The modeling showed that the 100-year stormflow elevation covered the entire floodplain and reached up the valley slope.

One culvert and one lower water bridge are located within the Lower Nichol WMA. These structures were modeled to determine if the 100-year storm exceeded their capacity to carry the flow. The modeling shows that both the culvert and the bridge do not carry the 100-year stormflow and will overtop. Water will pond upstream of the culvert structure. The existence of the ponded water will extend the time period of maximum flow through the culverts. When the ponded water is fully drained, the flow elevations will begin to drop.

3.2.7 Lower Nichol WMA Subwatershed Ranking

As indicated in Section 2.6, two indicator categories – watershed impact and source indicators - were used for ranking overall conditions in the subwatersheds. Figure 3.9 illustrates the results obtained for the subwatershed ranking of the watershed impacts. The lowest scoring subwatersheds were identified as potential problem areas. No subwatersheds within the Lower Nichol WMA were identified as potential problem areas. Based upon existing conditions, the entirety of the WMA is in good condition.

The WMA was also evaluated using source indicators to identify potential WMA stressors or pollutant sources as shown in Figure 3.10. The lowest ranking subwatersheds were identified as additional potential problem areas. No additional problem areas were identified within the Lower Nichol WMA, with most of the WMA showing low to moderate levels of stressors and pollutant sources.

3.3 Potomac WMA

3.3.1 Potomac WMA Characteristics

The Potomac WMA is broken into two pieces, both of which lie along the northern border of the Nichol Run watershed. The watershed comprises 697 acres (1.09 square miles) and is located along the northern border of Fairfax County, flanking the Potomac River as shown in Figure 3.1. A small portion, 27.6 acres (0.04 square miles), lies within Loudoun County. Approximately 4.6 miles of perennial streams exist within the Potomac WMA. The streams flow north directly into the Potomac River, traveling primarily through and open space and park land areas.

3.3.2 Existing and Future Land Use

The eastern portion of the Potomac WMA is moderately developed, while the western portion is mostly undeveloped. Approximately 5 percent of the Potomac WMA is urbanized, which consists of open space (82 percent) and estate residential (12 percent), as shown in Table 3.10.

Table 3.10 Existing and Future Land Use for Potomac WMA

Land Use Type	Existing Percent (%)	Future Percent (%)
High Density Residential	0	0
Medium Density Residential	0	0
Low Density Residential	4.1	4.1
Estate Residential	11.6	28.5
Industrial	0	0
High Intensity Commercial	0	0
Low Intensity Commercial	0	0
Institutional	0.1	0.1
Open Space	82.1	65.3
Transportation	1.1	1.1
Water	0.9	0.9
Total	100	100

Source: Fairfax County GIS, 2008

Table 3.10 and Figure 3.2 show expected changes in land use as the Potomac WMA continues to develop. A slight decrease in open space areas and a corresponding increase in estate residential areas within the Potomac WMA are projected.

3.3.3 Field Reconnaissance and Stream Physical Assessment

Field reconnaissance was completed within the Potomac WMA to evaluate projects proposed by the county, to identify problem areas and to identify potential improvement projects. The following tasks were completed during the field reconnaissance surveys of the Potomac WMA:

1. Evaluated an existing stormwater facility. The

results of the above evaluation are briefly described below.

<u>Existing Stormwater Facilities</u>
One (1) stormwater management facility was evaluated within the Potomac WMA to determine the need for repair or the potential for retrofit to increase the benefit of the facility. The facility was not present at the indicated location.

3.3.4 Potomac WMA Characterization

Due to remote nature of the majority of the Potomac WMA and because the streams flow directly to the Potomac River, no stream assessments were completed within the Potomac WMA. As can be seen from Figure 3.3, all of the streams in the Potomac WMA are protected by the resource protection areas as described in Chapter 1. The main stems were designated as protected in 1993, and the headwaters were added in 2003.

As shown in Figure 3.4, the Potomac WMA contains only one small stormwater management facility that provides little to no stormwater treatment. Table 3.11 indicates that no stormwater runoff from the WMA is treated. Due to the undeveloped nature of the western potion of the Potomac WMA, stormwater management in this part of the WMA may not be required. In the eastern portion which contains more development, more stormwater management is needed.

Table 3.11 Potomac WMA Summary

WMA Name	Total Area (acres)	Impervious Current Condition		Current Treatment Types			
		Percent (%)	Acres	Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Potomac	696.5	1.2	8.7	-	-	-	696.5

3.3.5 STEPL Modeling

The STEPL model was used to estimate nutrient loadings in each subwatershed as described in Section 2.5. Figures 3.5, 3.6 and 3.7 present the results of the STEPL model for total suspended solids, total nitrogen, and total phosphorus, respectively, which were used to estimate the pollutant loadings in each subwatershed and WMA.. Table 3.12 below shows the total pollutant loading to the endpoint of Potomac WMA. According to the STEPL model results, the Potomac WMA contributes approximately 20 percent of the total suspended solids, seven percent of the total nitrogen, and nine percent of the total phosphorous annual loads to the Potomac Watershed.

Pollutant loadings normalized to the acres within the drainage area of the Potomac WMA are presented in Table 3.13. The values in this table indicate the total nutrient and sediment load that results from stormwater runoff over one acre of the Potomac WMA as compared with unit area loads for the entire watershed.

Table 3.12 Summary of Pollutant Loadings for Potomac WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/year)	Total Nitrogen (pounds/year)	Total Phosphorus (pounds/year)
Potomac	58.6	768.6	153.8
WS Totals	**286.8**	**10,410.3**	**1,629.6**

Table 3.13 Pollutant Loadings Normalized by Drainage Area for Potomac WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/acre/year)	Total Nitrogen (pounds/acre/year)	Total Phosphorus (pounds/acre/year)
Potomac	0.084	1.104	0.221
WS Totals	**0.055**	**1.983**	**0.310**

3.3.6 HEC-RAS Modeling

HEC-RAS hydraulic modeling was not completed for the Potomac WMA. The Potomac WMA is composed of small tributaries that drain directly to the Potomac River where stream segments and drainage areas are small and development is minimal. Hydraulic modeling of these areas would not yield any consequential information for the watershed.

3.3.7 Potomac WMA Subwatershed Ranking

As indicated in Section 2.6, two indicator categories – watershed impact and source indicators - were used for ranking overall stream conditions in the subwatersheds. Figure 3.9 illustrates the results obtained for the subwatershed ranking of watershed impacts. The lowest scoring subwatersheds were identified as potential problem areas. No subwatersheds within the Potomac WMA were identified as a potential problem area. Based upon existing conditions, the entirety of the WMA scored in good condition.

The WMA was also evaluated using source indicators to identify potential WMA stressors or pollutant sources as shown in Figure 3.10. The lowest ranking subwatersheds were identified as additional potential problem areas. No additional problems areas were identified within the Potomac WMA. All of the WMA indicates low levels of stressors and pollutant sources.

3.4 Upper Nichol WMA

3.4.1 Upper Nichol WMA Characteristics

The Upper Nichol WMA is located in the southern portion of the Nichol Run Watershed. The Upper Nichol WMA is the largest in the watershed, comprising 2,549 acres (3.98 square miles). The WMA is border on the north by Beach Mill Road, to the east by Springvale Road and to the south by Georgetown Pike as shown in Figure 3.1.

Approximately 12.9 miles of perennial streams exist within the Upper Nichol WMA. These streams range from good to poor condition. The streams flow north into the Lower Nichol WMA. The streams travel primarily through estate and low density residential areas.

3.4.2 Existing and Future Land Use

The Upper Nichol WMA is moderately developed, and represents the typical development style within the Nichol Run Watershed. Approximately 22 percent of the Upper Nichol WMA is urbanized, consisting of estate residential (62 percent), low density residential (21 percent) and open space (11 percent), as shown in Table 3.14.

Table 3.14 Existing and Future Land Use for Upper Nichol WMA

Land Use Type	Existing Percent (%)	Future Percent (%)
Estate Residential	61.6	69.7
High Density Residential	0	0
Medium Density Residential	0.2	0.2
Low Density Residential	20.9	21.0
Low Intensity Commercial	0	0
High Intensity Commercial	0.2	0.2
Industrial	0	0
Institutional	0	0
Open Space	11.2	3.0
Transportation	4.5	4.5
Water	1.4	1.4
Total	100	100

Source: Fairfax County GIS, 2008

Table 3.14 and Figure 3.2 show expected changes in land use as the Upper Nichol WMA continues to develop. A decrease in open space areas, with a corresponding increase in estate and low density residential areas within the Upper Nichol WMA are projected.

3.4.3 Field Reconnaissance and Stream Physical Assessment

Field reconnaissance was completed within the Upper Nichol WMA to evaluate projects proposed by the county, to identify problem areas and to identify potential improvement projects.

The following tasks were completed during the field reconnaissance surveys of the Upper Nichol WMA:

1. Evaluated drainage complaints.
2. Evaluated projects proposed by the county.
3. Evaluated existing stormwater facilities.
4. Conducted neighborhood source assessments.
5. Reviewed stream physical assessment inventory points.
6. Conducted a stream physical assessment

The results of each of the above evaluations are briefly described below.

<u>Drainage Complaints</u>
Thirty five (35) drainage complaints have been documented within the Upper Nichol WMA between 2001 and 2006. Of those, seven representative complaints were chosen for field investigation. The complaints included road and yard flooding, channel and drainage erosion and infrastructure issues. All of the complaints were validated, with the exception of one area of streambank erosion which had previously been fixed.

<u>Proposed County Projects</u>
Based upon past evaluations and reports, multiple stormwater projects have been proposed within the Upper Nichol WMA. Field investigations were used to determine whether the projects were still needed. The projects included six culvert replacement projects and one stream restoration and stabilization project. One of the culvert projects was not reviewed due to the inability to locate the project location and another one had already been completed. The other three culvert projects and the stream restoration project were validated.

<u>Existing Stormwater Facilities</u>
Twenty-five (25) stormwater management facilities were evaluated within the Upper Nichol WMA to determine the need for repairs or the potential for retrofits to increase the benefit of the facilities. Of the 25 facilities, three were not evaluated due to the inability to access property or the facility did not exist. The remaining facilities were functioning as designed, with the exception of one dry pond which was not providing stormwater management. Most of the evaluated facilities provided some opportunity for retrofit.

<u>Neighborhood Source Assessment (NSA)</u>
Two representative neighborhoods were chosen for the NSA to help identify potential improvement projects throughout the Upper Nichol WMA. Both of the chosen neighborhoods consisted of single-family detached houses on one acre and larger lots. Eight stormwater management facilities were located within the neighborhoods, consisting of wet and dry ponds. The NSA indicated the potential for stormwater management facility retrofit, as well as a need for better lawn and landscaping practices.

<u>Stream Physical Assessment (SPA) Inventory Points</u>
Inventory points identified during the original stream physical assessment that received an impact score of five or greater were field verified. Four stream crossings were identified as

impacting the stream channel. One of the problems are already been corrected, but the other three warranted further evaluation and repair.

Stream Physical Assessment (SPA)
A supplemental stream physical assessment was conducted on 2 miles of stream within the Upper Nichol WMA. One of the stream segments was chosen for re-assessment because a county stream restoration and stabilization project and a culvert replacement project were located on the stream. The other two sections were chosen because they were not included in the original stream physical assessment and because they included two county culvert replacement projects. The stream was found to be in good habitat condition. The SPA identified 16 bank erosion problems, seven obstructions, three pipes/drainage ditch erosion problems, one utility line and two stream crossings.

3.4.4 Upper Nichol WMA Characterization

Approximately 6.3 miles of streams were assessed within the Upper Nichol WMA to determine the overall stream conditions. As shown in Figure 3.3, the assessed stream segment had poor to good habitat conditions. Most of the streams in the Upper Nichol WMA are protected by the resource protection areas as described in Chapter 1. The main stem and some of the tributaries were designated as protected in 1993 and the other tributaries and headwater sections were added in 2003 and 2005. Several pipes, deficient riparian buffer areas, obstructions, stream crossings, erosion, and a utility and headcut were identified during field reconnaissance, although the majority of the problems were considered minor to moderate. Three of the deficient riparian buffers and three of the erosion areas were considered moderate to severe; however the restoration potential for this area was moderate to low. There was one moderate to severe crossing, headcut and obstruction. The crossing was under Utterback Store Road, the headcut was two feet high and the obstruction is caused by riprap. Most of the assessed stream within the Upper Nichol WMA is in Channel Evolution Model Stage 3, which indicates an unstable channel that is experiencing significant bank erosion. The remaining portions are in Stage 4, which indicates that the stream is attempting to stabilize by developing a bankfull and floodplain channel, or Stage 2, which indicates the channel is cutting down and experiencing significant bed erosion.

As shown in Figure 3.4, the Upper Nichol WMA contains multiple stormwater management facilities that collect and treat stormwater runoff before it reaches the stream network. The majority of these facilities are farm or ornamental ponds. Based on Table 3.15, stormwater runoff from approximately 27 percent of the impervious area in this WMA is treated. Stormwater runoff from most of the area that does receive treatment is treated for only quantity, and does not incorporate water quality. As development continues in the Upper Nichol WMA, additional stormwater facilities should be installed, particularly in the central portion of the WMA where no treatment exists.

Table 3.15 Upper Nichol WMA Summary

WMA Name	Total Area (acres)	Impervious Current Condition		Current Treatment Types			
		Percent (%)	Acres	Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Upper Nichol	2,547.7	5.6	144	36.7	-	2.6	2,508.4

3.4.5 STEPL Modeling

The STEPL model was used to estimate nutrient loadings in each subwatershed as described in Section 2.5. Figures 3.5, 3.6 and 3.7 present the results of the STEPL model for total suspended solids, total nitrogen, and total phosphorus, respectively, which were used to estimate the pollutant loadings in each subwatershed and WMA. Table 3.16 below shows the total pollutant loading to the endpoint of Upper Nichol WMA. According to the STEPL model results, the Upper Nichol WMA contributes approximately 43 percent of the total suspended solids, 56 percent of the total nitrogen, and 53 percent of the total phosphorous annual loads to the Nichol Run Watershed. Pollutant loadings normalized to the acres within the drainage area of Upper Nichol WMA are presented in Table 3.17. The values in this table indicate the total nutrient and sediment load that results from stormwater runoff over one acre of the Upper Nichol WMA as compared with unit area loads for the entire watershed.

Table 3.16 Summary of Pollutant Loadings for Upper Nichol WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/year)	Total Nitrogen (pounds/year)	Total Phosphorus (pounds/year)
Upper Nichol	122	5,780.4	870.8
WS Totals	**286.8**	**10,410.3**	**1,629.6**

Table 3.17 Pollutant Loadings Normalized by Drainage Area for Upper Nichol WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/acre/year)	Total Nitrogen (pounds/acre/year)	Total Phosphorus (pounds/acre/year)
Upper Nichol	0.048	2.269	0.342
WS Totals	**0.055**	**1.983**	**0.310**

3.4.6 HEC-RAS Modeling

HEC-RAS hydraulic modeling was completed for a 100-year storm event in the Upper Nichol WMA. Channel flow capacity was analyzed to determine if the 100-year storm event would overflow the channel and flood onto the floodplain. Additionally, the elevation of the flow was determined with reference to the topographic elevations in the stream valley.

As shown in Figure 3.8, a 100-year storm in the Upper Nichol WMA resulted in an overflow event with flooding onto the floodplain. The modeling showed that the 100-year stormflow elevation covered the entire floodplain and reached up the valley slope.

There are three culverts located within the Upper Nichol WMA. All three of the culverts located in the Upper Nichol WMA do not carry the 100-year stormflow and water will pond upstream of the culvert structures. The existence of the ponded water will extend the time period of maximum flow through the culvert. When the ponded water is fully drained, the flow elevation will begin to drop. The two other culverts carry the 100-year stormflow.

3.4.7 Upper Nichol WMA Subwatershed Ranking

As indicated in Section 2.6, two indicator categories – watershed impact and source indicators - were used for ranking overall stream conditions in the subwatersheds. Figure 3.9 illustrates the results obtained for the subwatershed ranking of watershed impacts. The lowest scoring subwatersheds were identified as potential problem areas. No subwatersheds within the Upper Nichol WMA were identified as potential problem areas. Based upon the evaluation, the WMA is in good condition.

The WMA was also evaluated using source indicators to identify potential WMA stressors or pollutant sources as shown in Figure 3.10. The lowest ranking subwatersheds were identified as additional potential problem areas. Two additional problem areas were identified within the Upper Nichol WMA. The WMA has a range of stressors and pollutant sources, ranging from low to moderate levels of stressors and pollutant sources.

3.5 SWMM Modeling for Nichol Run Watershed

The Stormwater Management Model (SWMM) was used to determine the peak rate (maximum volume of water per second) of stormwater flows in stream channels during a storm. The 2-year and 10-year storm flows were modeled; these are the storm flows that, on average, occur once every 2-years or 10-years. Figure 3.11 shows peak rates of flow for the 2-year storm across the watershed. As shown in Figure 3.11, peak flows are the highest within the Upper Nichol WMA for both the 2-year and 10-year storms. The Potomac WMA has the lowest peak flows during the 2-year storm, but the Lower Nichol WMA has the lowest peak flows during the 10-year storm.

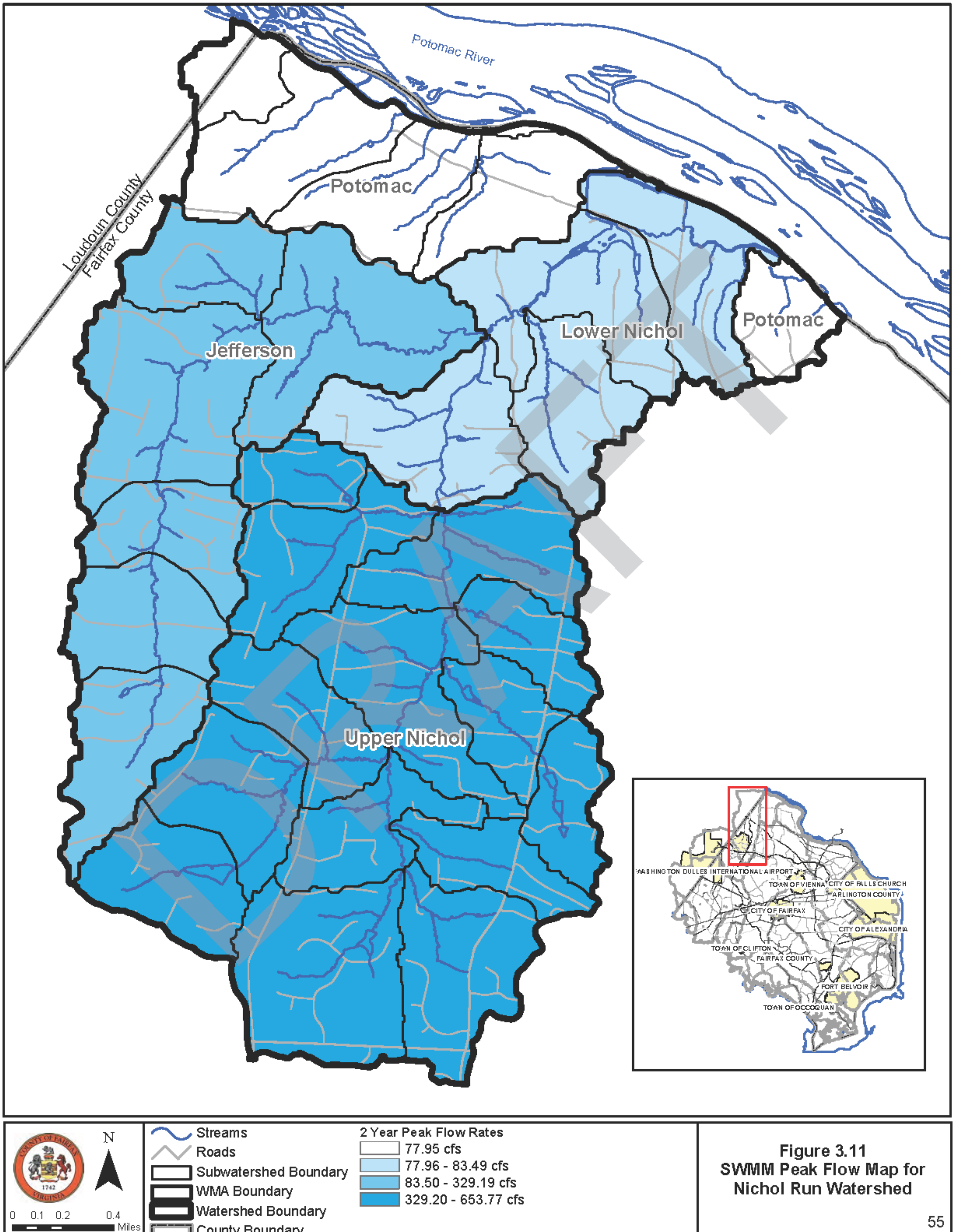

Figure 3.11
SWMM Peak Flow Map for Nichol Run Watershed

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Table 3.18 shows peak flows for the 2-year and 10-year storms in the WMAs in the Nichol Run Watershed. The SWMM model shows that peak flows are the highest within the Upper Nichol WMA for both the 2-year and 10-year storms. The Potomac WMA has the lowest peak flows during the 2-year storm, but the Lower Nichol WMA has the lowest during the 10-year storm. This change can be attributed to the lack of stormwater treatment within the Potomac WMA. Peak flows for the 10-year storm are approximately two to four times as large as the flows for the 2-year storm.

Table 3.18 Summary of SWMM and STEPL Results

WMA Name[1]	Stormwater Runoff Peak Flow Values		Pollutant Loadings		
	2-yr storm (cubic ft/sec)	10-yr storm (cubic ft/sec)	Total Suspended Solids (tons/yr)	Total Nitrogen (pounds/yr)	Total Phosphorus (pounds/yr)
Jefferson	329.19	703.18	57.7	2,611.9	397.6
Lower Nichol	83.49	236.06	48.5	1,249.4	207.4
Potomac	77.95	305.70	58.6	768.6	153.8
Upper Nichol	653.77	1,402.79	122.0	5,780.4	870.8
WS Totals	**1,063.60**	**2,499.53**	**286.8**	**10,410.3**	**1,629.6**

1. The "WMA Name" is the WMA for which there is a node that has the individual, cumulative peak flows (2 and 10 year) for the entire upstream drainage area.

To determine which WMA has the greatest flows, the peak flows in Table 3.18 were recalculated based on WMA drainage area. Table 3.19 shows these flows normalized by WMA drainage area. The Jefferson and Upper Nichol WMAs have the most stormwater runoff during the 2-year storm and the Lower Nichol WMA has the least; the same was seen during the 10-year storm.

The STEPL model was used to estimate the pollutant loadings for total suspended solids (sediments), total nitrogen, and total phosphorus for each WMA and the results are shown in Table 3.18. As stormwater flows accumulate downstream, so do the pollutant loadings carried by the flows. Pollutant loads pass from the upstream contributing WMAs to downstream WMAs. The cumulative downstream loadings may increase or decrease depending on the presence and magnitude of new sources and the relative increase in drainage area and associated flows. The Upper and Lower Nichol WMAs have the greatest cumulative pollutant loadings and the Potomac WMA has the least. The Potomac WMA drains directly into the Potomac River and the pollutant loading resulting from this area do not contribute to the Nichol Run Watershed stormflows.

Table 3.19 SWMM and STEPL Results Normalized by Drainage Area

WMA Name[1]	Drainage Area (Acres)	Stormwater Runoff Peak Flow Values		Pollutant Loadings		
		2-yr storm (cubic ft/sec)	10-yr storm (cubic ft/sec)	Total Suspended Solids (tons/yr)	Total Nitrogen (pounds/yr)	Total Phosphorus (pounds/yr)
Jefferson	1,184.9	0.278	0.593	0.049	2.204	0.336
Lower Nichol	820.5	0.102	0.288	0.059	1.523	0.253
Potomac	696.5	0.112	0.439	0.084	1.104	0.221
Upper Nichol	2,547.7	0.257	0.551	0.048	2.269	0.342
WS Totals	**5,249.6**	**0.203**	**0.476**	**0.055**	**1.983**	**0.310**

1. The "WMA Name" is the WMA for which there is a node that has the individual, cumulative peak flows (2 and 10 year) for the entire upstream drainage area.

4.1 Pond Branch Watershed

The Pond Branch Watershed consists of four watershed management areas (WMAs) as listed below:

1. Clark
2. Mine Run
3. Pond
4. Potomac

WMAs in the Pond Branch Watershed are shown in Figure 4.1. As shown in the figure, all of the WMAs are located in Fairfax County. The following information is provided for each WMA in the subsequent sections of this chapter:

1. WMA Characteristics
2. Existing and Future Land Use Information
3. Field Reconnaissance and Stream Physical Assessment Information
4. WMA Characterization
5. STEPL Modeling
6. HEC-RAS Modeling
7. Subwatershed Ranking

Table 4.1 illustrates the total area of each WMA, the current impervious conditions and the extent and type of stormwater treatment within each WMA.

Table 4.1 Pond Branch Watershed WMA Summaries

WMA Name	Total Area (acres)	Impervious Current Condition (acres)	Percent Impervious	Current Treatment Types			
				Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Clark	1,759.4	98.8	5.6	13.6	0.5	6.5	1,738.8
Mine Run	1,633.4	103.7	6.3	15.5	0.3	-	1,617.6
Pond	741.6	48.1	6.5	5.9	0.7	-	735
Potomac	1,269.7	38.4	3	0.4	0.2	0.8	1,268.3
Watershed Totals	**5,404.1**	**289**	**5.3**	**35.4**	**1.7**	**7.3**	**5,359.7**

Figures for Chapter 4 are provided in the beginning of the chapter and are followed by a detailed discussion of each WMA in Sections 4.1 through Section 4.4. Section 4.5 includes a discussion of SWMM modeling results, including a SWMM Peak Flow Map for the 2-year and 10-year storm event.

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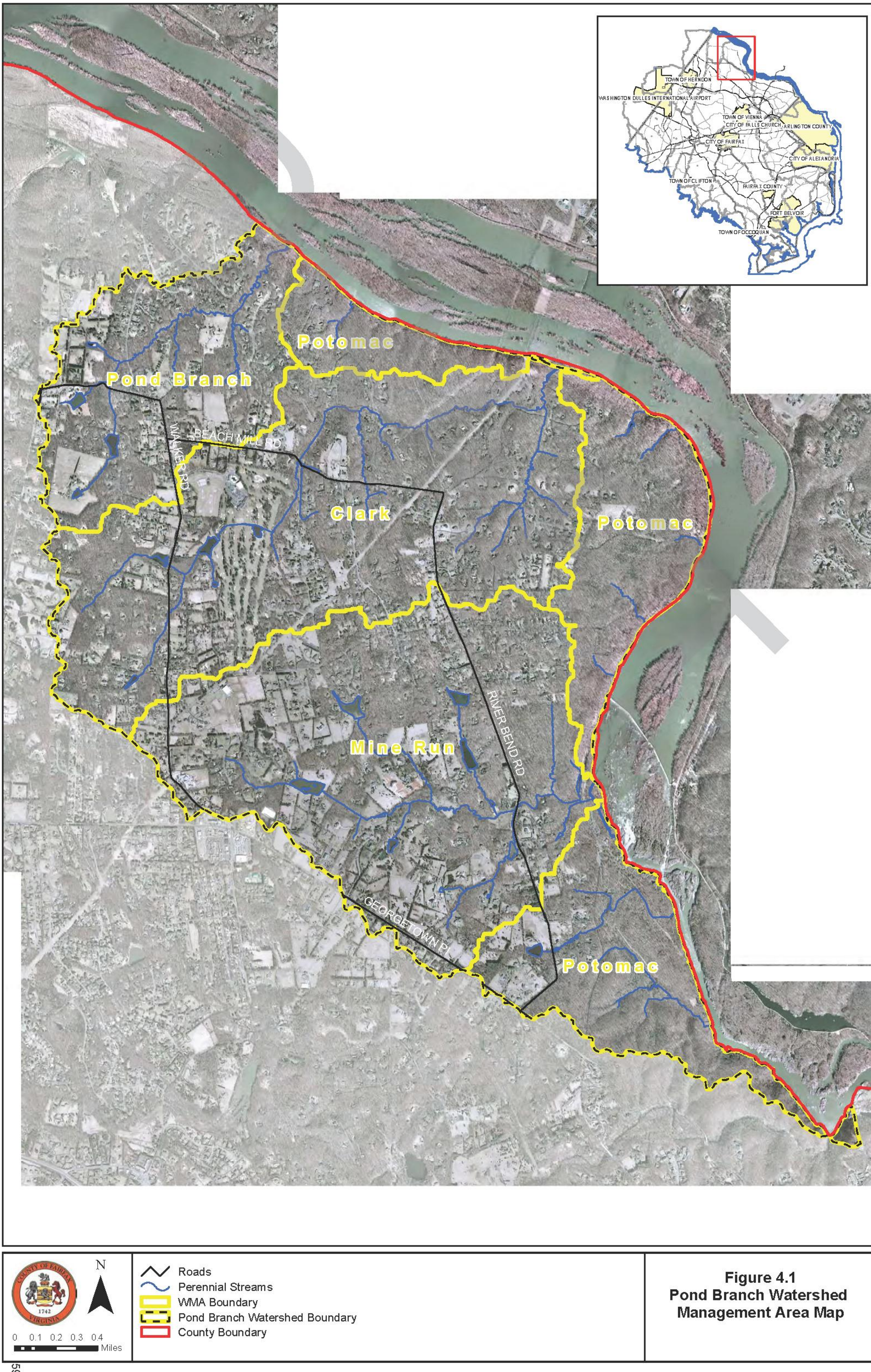

Figure 4.1
Pond Branch Watershed Management Area Map

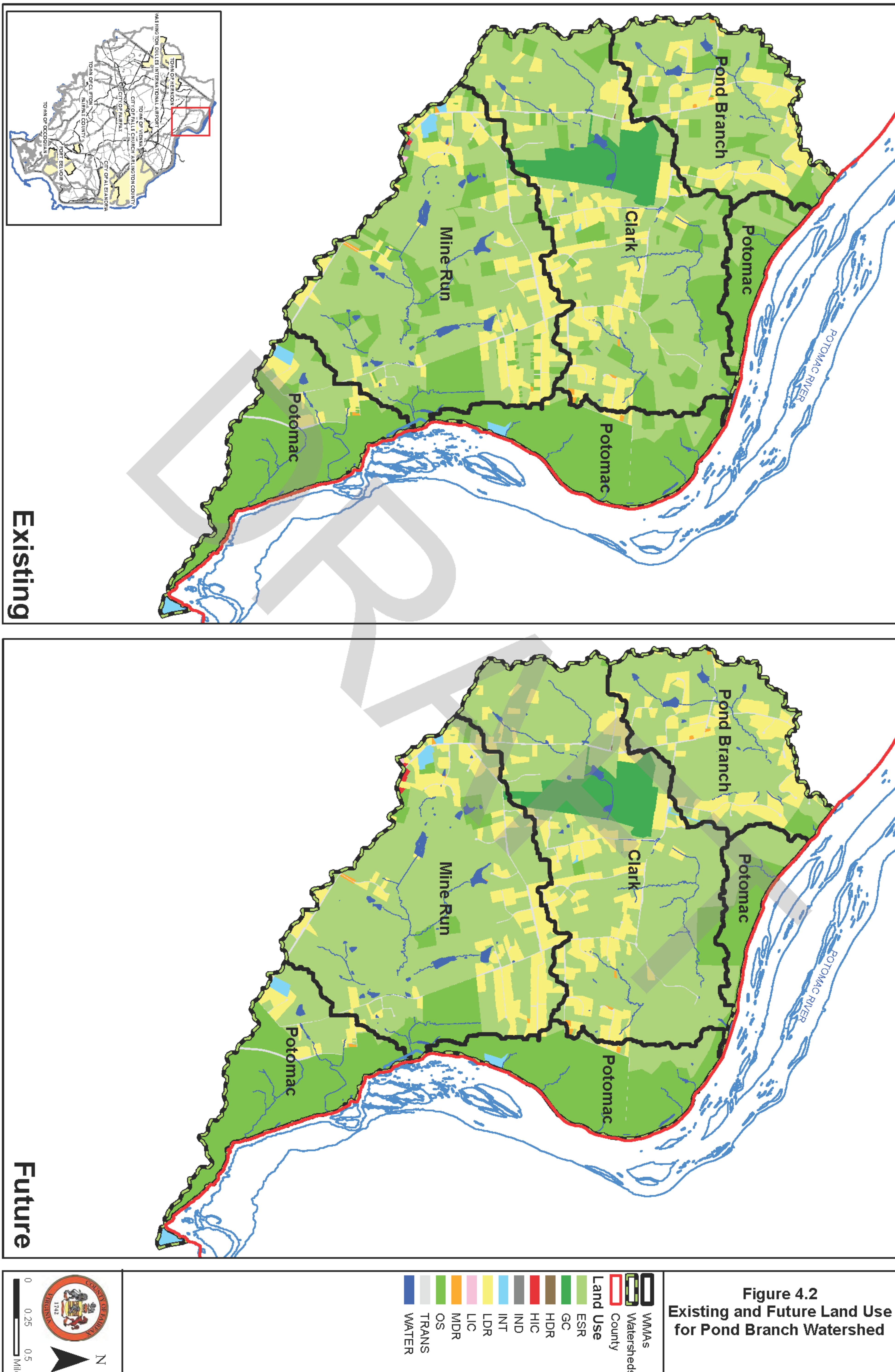

Figure 4.2
Existing and Future Land Use for Pond Branch Watershed

60

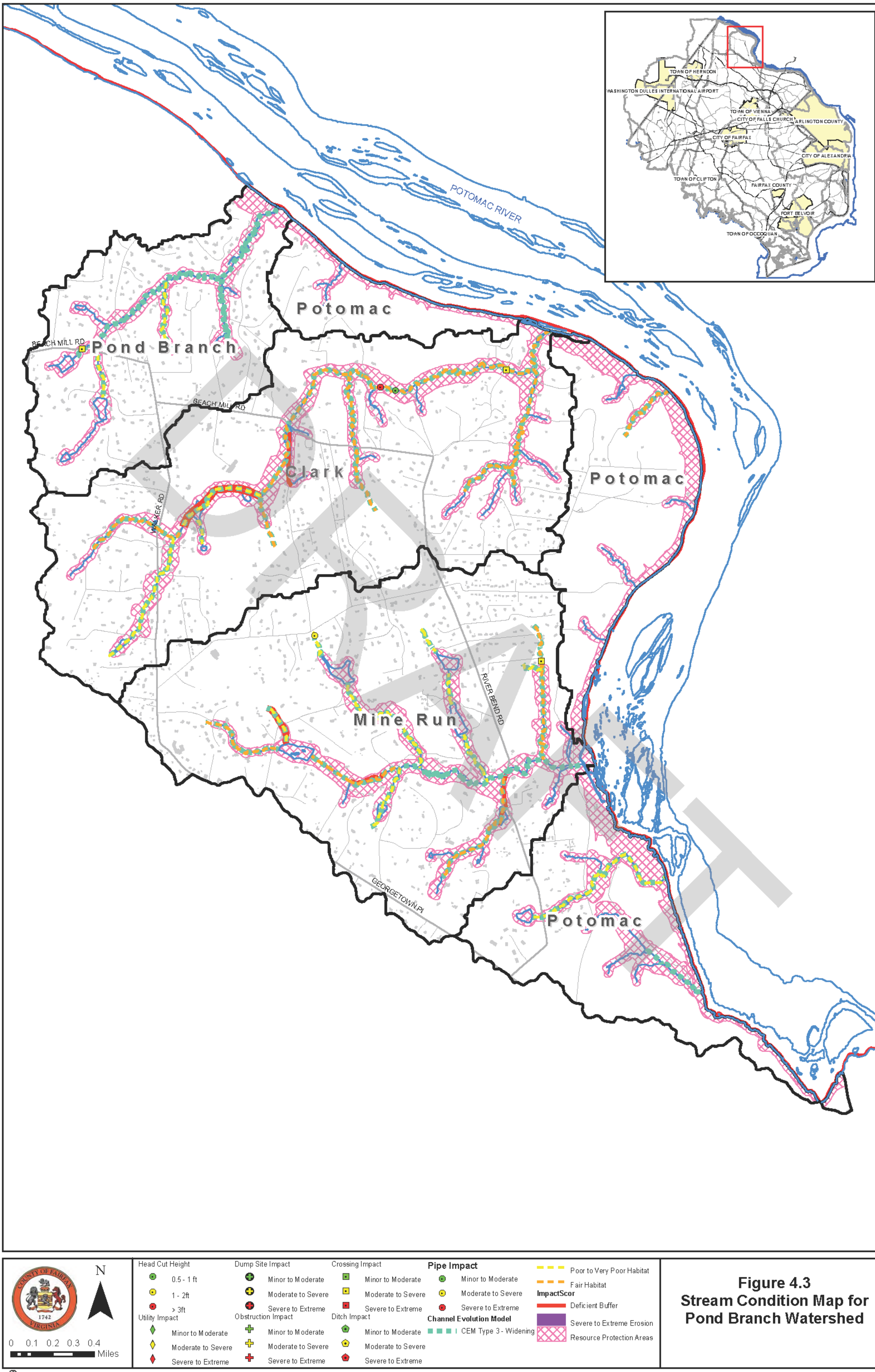

Figure 4.3
Stream Condition Map for Pond Branch Watershed

N

0 0.2 0.4 Miles

303d Impaired Waters
Perennial Streams
Non-Perennial Drainage
Stormwater Infrastructure
Drainage Complaints

Regional Ponds
Completed
Active
Incomplete

Stormwater Facilities
Wet Pond
Dry Pond
All Other Facilities

Stormwater Controls
Detention Only
Quality & Quantity
Quality Only

Figure 4.4
Stormwater Infrastructure Map for Pond Branch Watershed

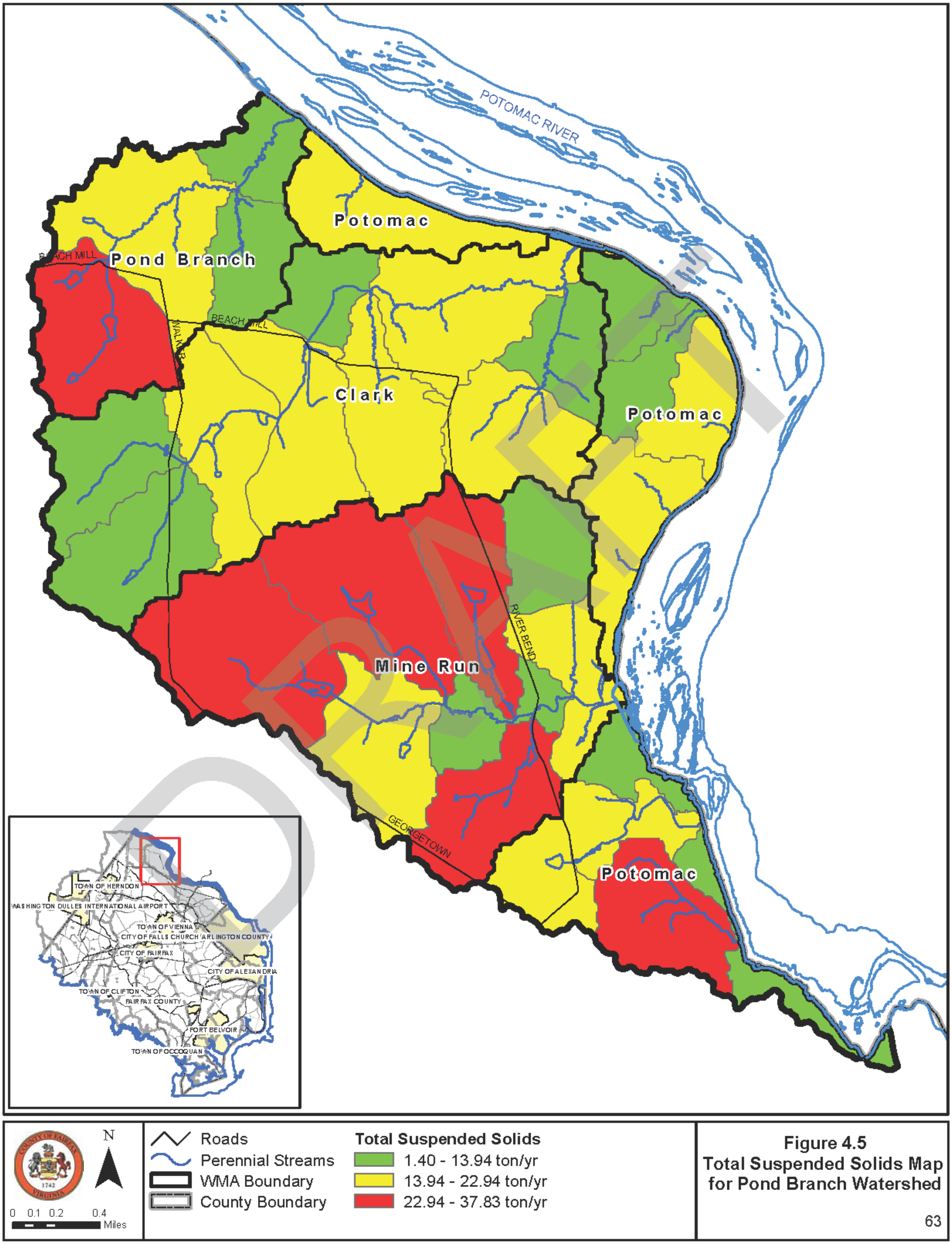

Figure 4.5
Total Suspended Solids Map for Pond Branch Watershed

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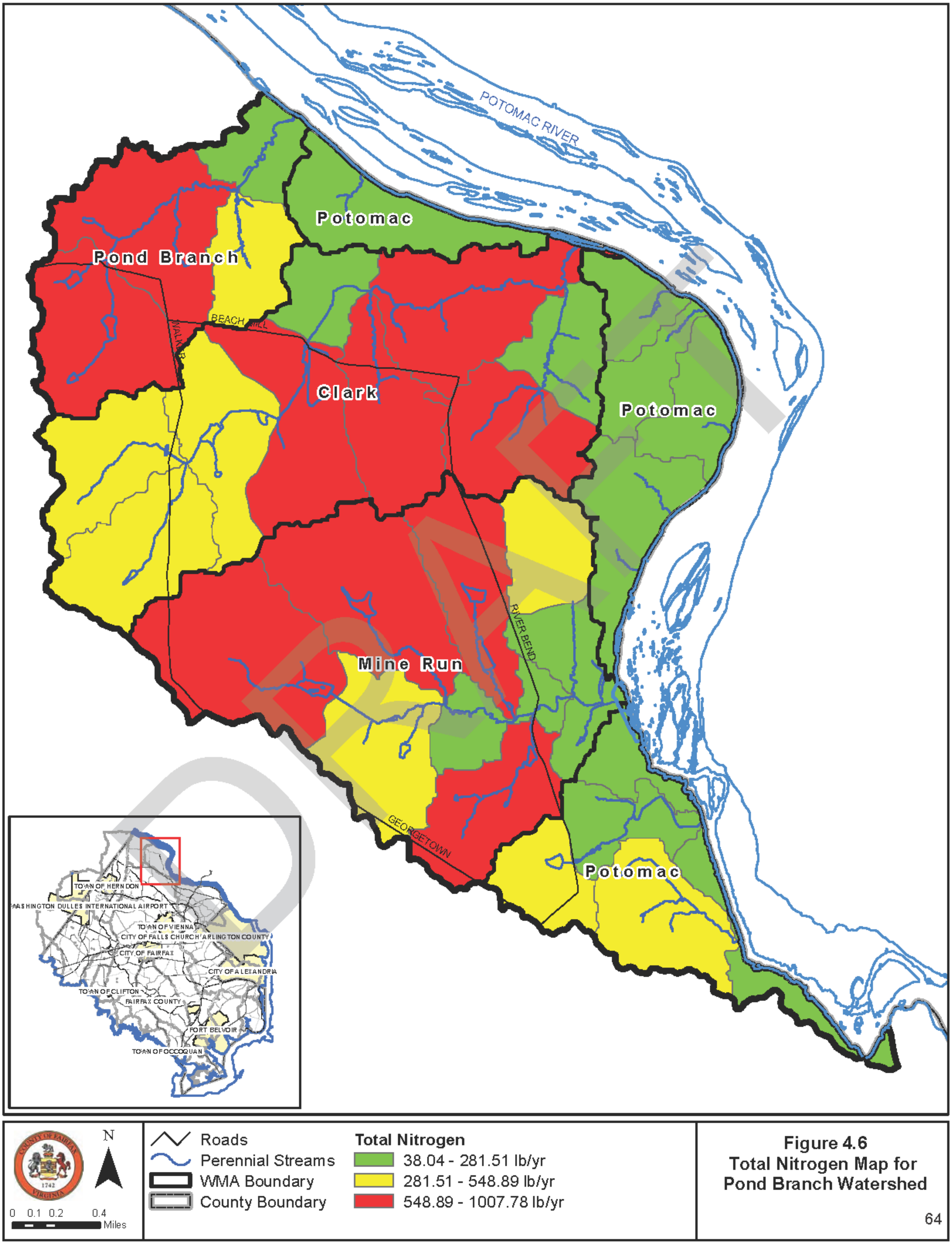

Figure 4.6
Total Nitrogen Map for Pond Branch Watershed

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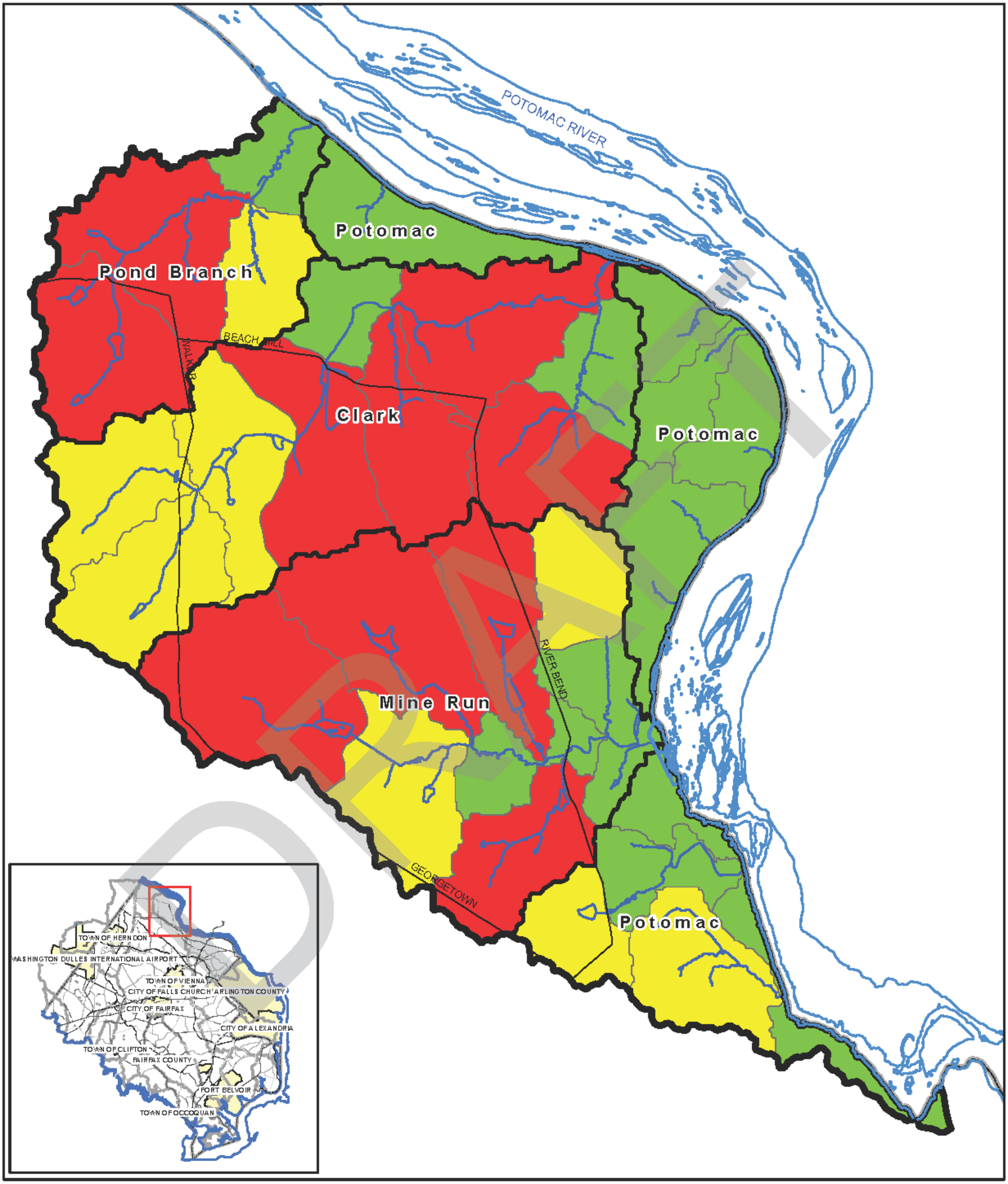

Figure 4.7
Total Phosphorus Map for Pond Branch Watershed

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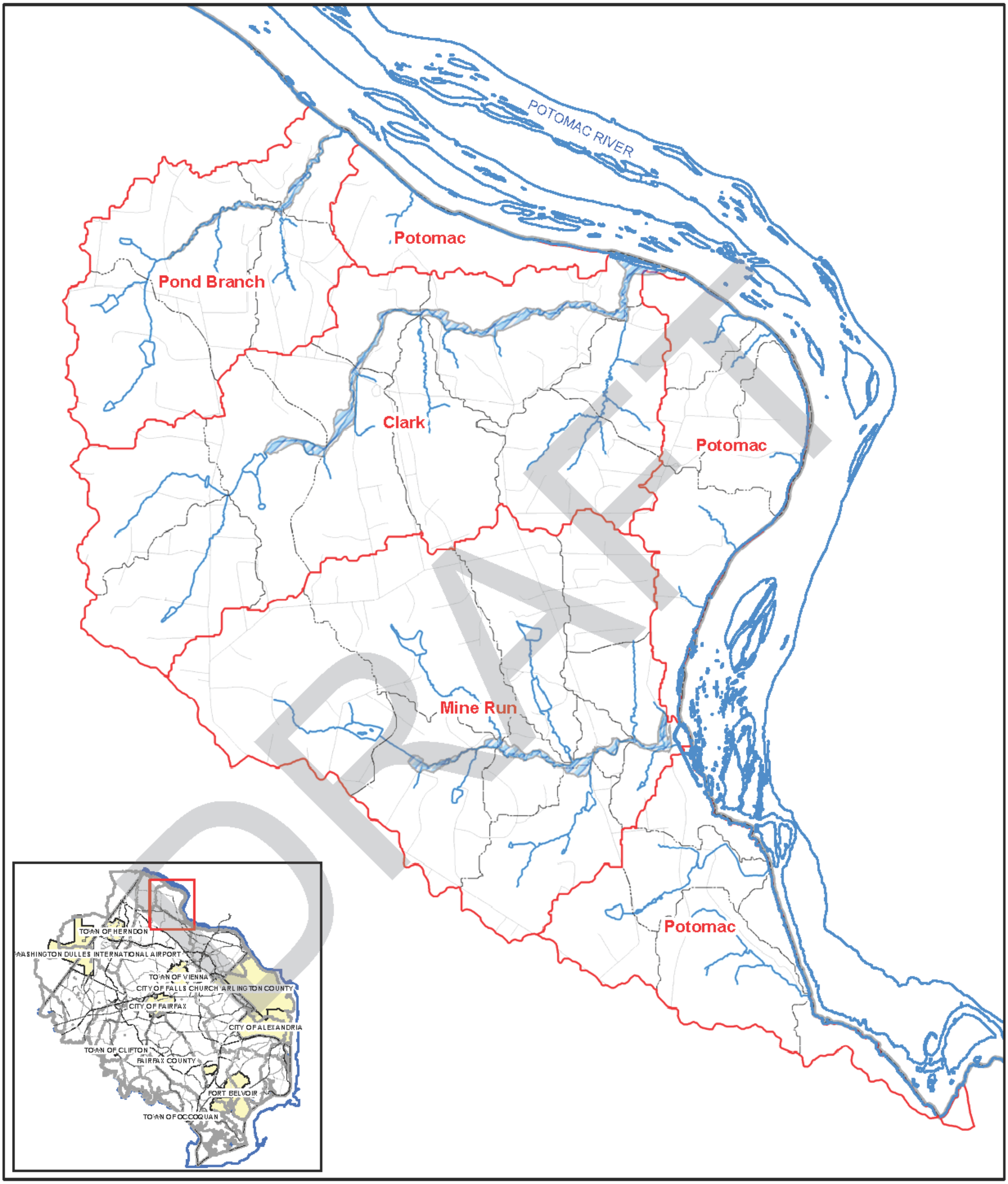

Figure 4.8
Preliminary 100-Year Storm Event Map for Pond Branch Watershed

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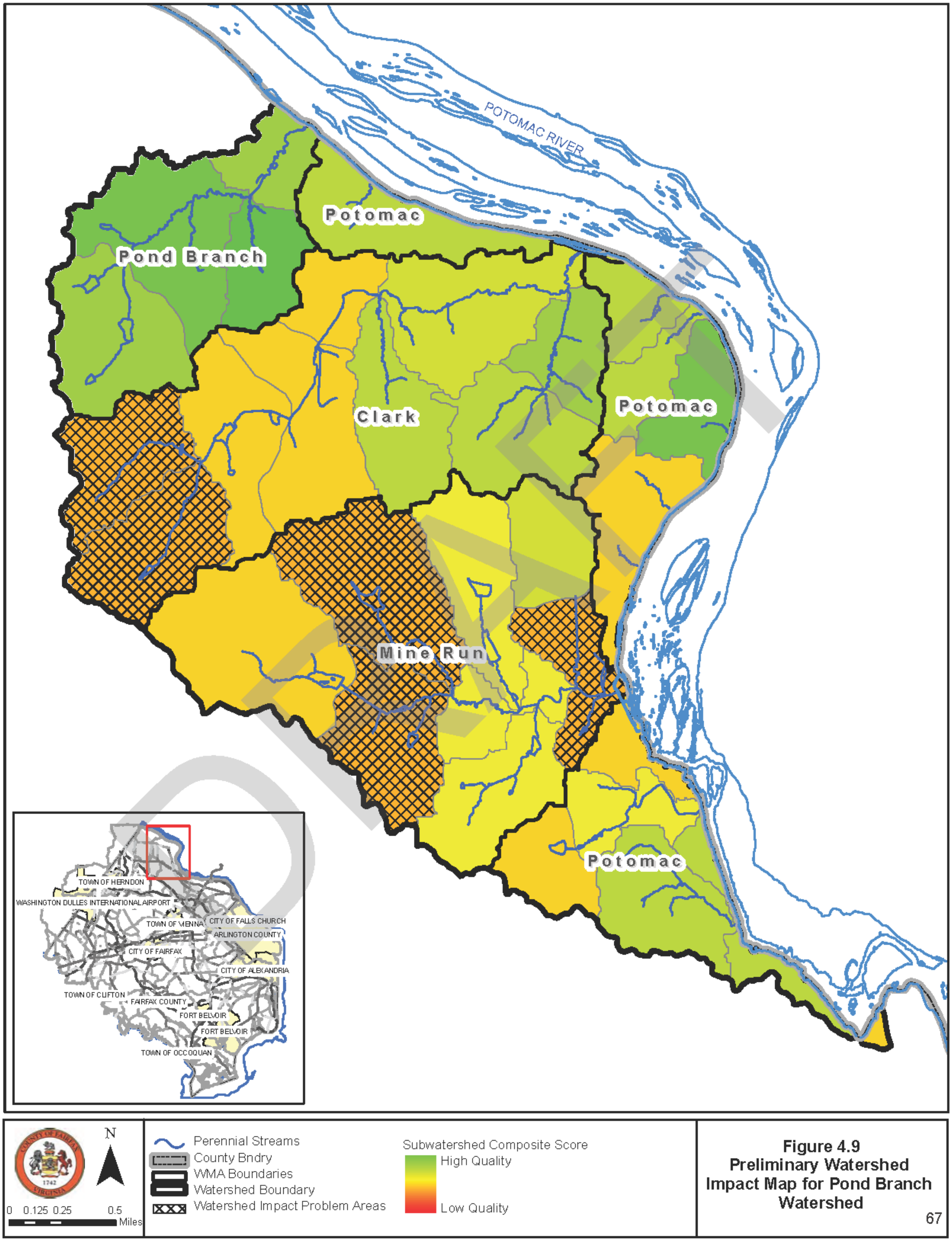

Figure 4.9
Preliminary Watershed Impact Map for Pond Branch Watershed

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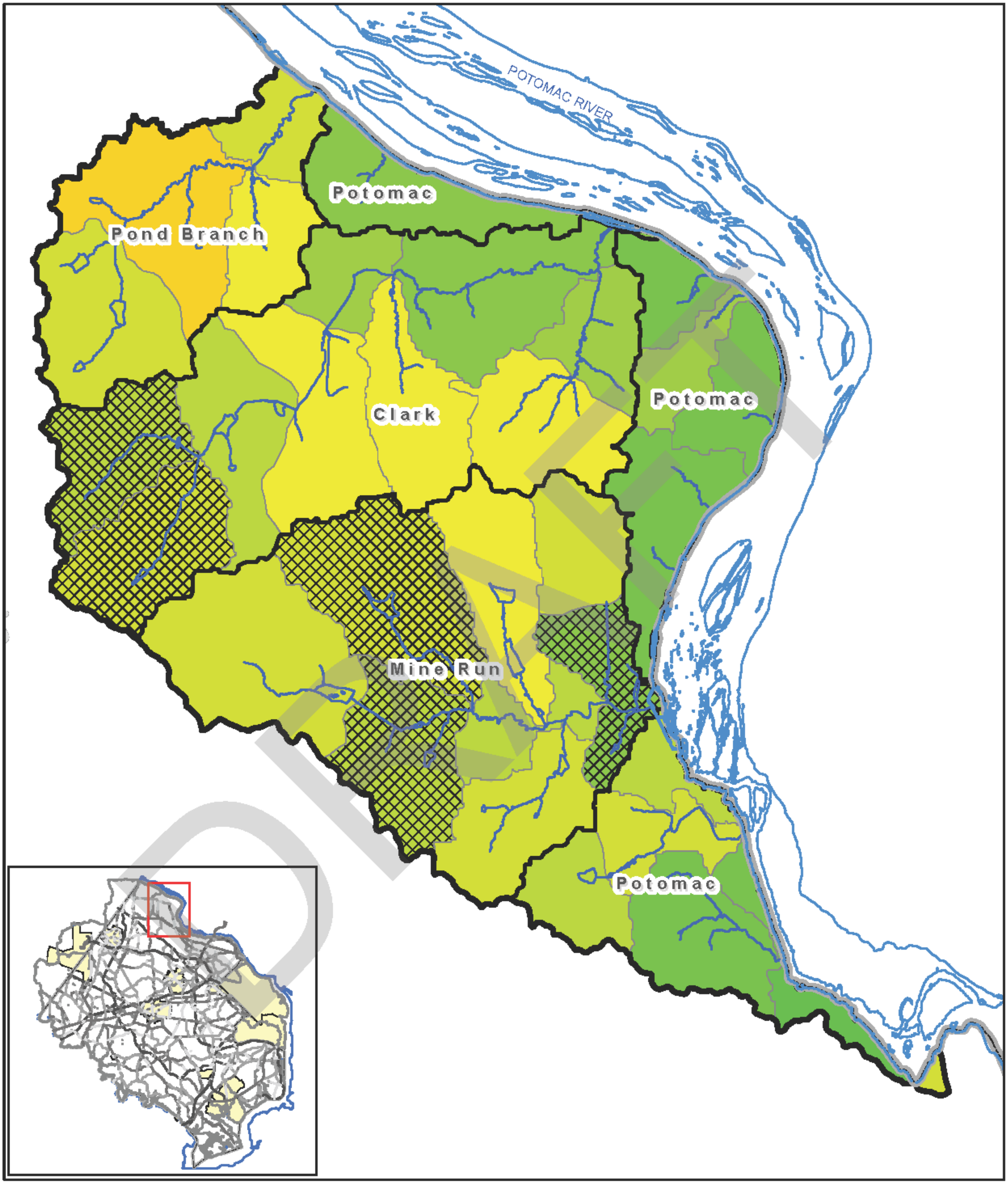

Figure 4.10
Preliminary Source Impact Map for Pond Branch Watershed

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4.2 Clark WMA

4.1.1 Clark WMA Characteristics

The Clark WMA is located in the central portion of the Pond Branch Watershed. It is the largest WMA in the watershed and comprises 1,759 acres (2.7 square miles). This WMA is transversed on the west by Walker Road, on the east by River Bend Road, and through the middle by Beach Mill Road. See Figure 4.1 for the location of the Clark WMA.

Approximately 8.4 miles of perennial streams are located within the Clark WMA. Most of these streams are in fair condition, with portions of the headwaters in poor and very poor condition. The streams flow in a northeast direction toward the Potomac River and travels through primarily estate residential and open space areas, including a golf course.

4.1.2 Existing and Future Land Use

The Clark WMA is moderately developed. Approximately 18 percent of the WMA is urbanized, consisting primarily of estate residential (58 percent), open space (13 percent) and golf course (10 percent) land uses, as shown in Table 4.2. Open space is clustered throughout the WMA, with a portion including the River Bend Golf and Country Club.

Table 4.2 Existing and Future Land Use in Clark WMA

Land Use Type	Existing Percent (%)	Future Percent (%)
Estate Residential	57.5	67.7
High Density Residential	0	0
Medium Density Residential	0.1	0.1
Low Density Residential	15.2	15.2
High Intensity Commercial	0	0
Low Intensity Commercial	0	0
Industrial	0	0
Institutional	0	0.1
Open Space	13.4	3.2
Golf Course	9.7	9.7
Transportation	3.1	3.1
Water	1.0	1.0
Total	100	100

Source: Fairfax County GIS, 2008

Table 4.2 and Figure 4.2 show the expected change in land use as the Clark WMA continues to develop. A decrease in open space land use is projected, with a corresponding increase in estate residential and institutional areas within the Clark WMA.

4.1.3 Field Reconnaissance

Field reconnaissance was completed within the Clark WMA to evaluate projects proposed by the county, to identify problems areas and to identify potential improvement projects. The following tasks were completed during the field reconnaissance surveys of the Clark WMA:

1. Evaluated drainage complaints.
2. Evaluated projects proposed by the county.
3. Evaluated existing stormwater facilities.
4. Conducted neighborhood source assessments.
5. Conducted hot spot investigations.
6. Reviewed stream physical assessment inventory points.

The results of each of the field reconnaissance surveys are briefly described below:

Drainage Complaints
Twenty-two (22) drainage complaints have been documented within the Clark WMA during 2001. Of those, three representative complaints were chosen for field investigation. The complaints included erosion around a stormwater management facility, streambank erosion and a cave in near Club View Drive. The facility and streambank erosion had already been stabilized, and no cave in was identified.

Proposed County Projects
Based upon past evaluations and reports, one stormwater project had been proposed within the Clark WMA. Field investigations were conducted to determine whether this project was still viable. The project involved replacing the culvert under Walker Road. Field investigations verified the project is still viable.

Existing Stormwater Facilities
Sixteen (16) stormwater management facilities were evaluated within the Clark WMA to determine the need for repair or the potential for retrofit to increase the benefit of the facility. The majority of the facilities were farm and ornamental ponds, and all were functioning as designed. Most of the facilities presented some opportunity for retrofit.

Neighborhood Source Assessment (NSA)
Two representative neighborhoods were chosen for an NSA to help identify potential improvement projects throughout the Clark WMA. The chosen neighborhoods consisted of single family detached houses on one acre or larger lots. Three stormwater management facilities were identified, including one wet pond and two dry ponds. The NSA indicated the potential for stormwater management facility retrofit potential and a need for better lawn and landscaping practices.

Hot Spot Investigation (HSI)
Two representative facilities with the potential to generate concentrated stormwater pollution were chosen within the Clark WMA for the HSI. An investigation was conducted of each facility and the corresponding property to identify sources of pollution. The River Bend Golf and

Country Club and a disposal company were targeted for the HIS. The golf course indicated a confirmed hot spot, while the disposal company was no longer in business. A review of the stormwater pollution plan is recommended along with an onsite visit for that facility.

Stream Physical Assessment (SPA) Inventory Points
Inventory points identified during the original stream physical assessment that received an impact score of five or greater were field verified. A stream crossing, headcut and pipe were identified as impacting the stream channel. The pipes should be removed, although they are not threatening to the system, the crossing is undersized to carry the streams capacity, and the headcut was unable to be located.

4.1.4 Clark Run WMA Characterization

Approximately 6.7 miles of streams were assessed within the Clark WMA to determine the overall stream conditions in the WMA. As shown in Figure 4.3, the majority of stream length assessed has fair habitat conditions, with the exception of two headwater sections which have poor and very poor habitat conditions. Most of the streams in the Clark WMA are protected by resource protection areas, as described in Chapter 1. The main stem was designated as protected in 1993, whereas the tributaries were not added until 2003 and 2005. Several erosion areas, pipes, deficient riparian buffers, obstructions, stream crossings, a dump and a headcut were identified during field reconnaissance, although the majority of the problems were considered minor to moderate. Two areas of deficient riparian buffer were considered moderate to severe and one severe to extreme, but that area has a very low restoration potential. Two crossings were considered moderate to severe and a headcut severe to extreme. The crossings were under Walker Road and Potomac Forest Drive and the headcut was four feet high. The assessed sections of Clark WMA are in Channel Evolution Model Stage 3, which indicates an unstable channel that is experiencing significant bank erosion.

As shown in Figure 4.4, the Clark WMA contains multiple stormwater management facilities that collect and treat stormwater runoff before it reaches the stream network, including dry ponds, wet ponds and farm ponds. Table 4.3 indicates that stormwater runoff from approximately 21 percent of the impervious area in this WMA is treated, and stormwater runoff from approximately 79 percent of the area in this WMA is not treated by any means. The stormwater runoff is primarily treated for quantity, and only a small portion receives quality control. Approximately 6 percent of this WMA is impervious. All of these factors illustrate that increased stormwater management facilities are needed in the Clark WMA.

Table 4.3 Clark WMA Summary

WMA Name	Total Area (acres)	Impervious Current Condition		Current Treatment Types			
		Percent (%)	Acres	Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Clark	1,759.4	5.6	98.8	13.6	0.5	6.5	1,738.8

4.1.5 STEPL Modeling

The STEPL model was used to estimate nutrient loadings in each subwatershed as described in Section 2.5. Figures 4.5, 4.6, and 4.7 present the results of the STEPL model for total suspended solids, total nitrogen, and total phosphorus, respectively, which were used to estimate the pollutant loadings in each subwatershed and WMA. Table 4.4 below shows the total pollutant loading to the endpoint of Clark WMA. According to the STEPL model results, the Clark WMA contributes approximately 28 percent of the total suspended solids, 34 percent of the total nitrogen, and 34 percent of the total phosphorous annual loads to the Pond Branch Watershed. Pollutant loadings normalized to the acres within the drainage area of the Clark WMA are presented in Table 4.5. The values in this table indicate the total nutrient and sediment loads that result from stormwater runoff over one acre of the Clark WMA as compared with unit area loads for the entire watershed.

Table 4.4 Summary of Pollutant Loadings for Clark WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/year)	Total Nitrogen (pounds/year)	Total Phosphorus (pounds/year)
Clark	97.9	3,932.2	628.2
WS Totals	**347.9**	**11,526.3**	**1,865.4**

Table 4.5 Pollutant Loadings Normalized by Drainage Area for Clark WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/acre/year)	Total Nitrogen (pounds/acre/year)	Total Phosphorus (pounds/acre/year)
Clark	0.056	2.235	0.357
WS Totals	**0.064**	**2.133**	**0.345**

4.1.6 HEC-RAS Modeling

HEC-RAS hydraulic modeling was completed for a 100-year storm event in the Clark WMA. Channel flow capacity was analyzed to determine if the 100-year storm event would overflow the channel and flood onto the floodplain. Additionally, the elevation of the flow was determined with reference to the topographic elevations in the stream valley.

As shown in Figure 4.8, a 100-year storm in the Clark WMA resulted in an overflow event with flooding onto the floodplain. The modeling showed that the 100-year stormflow elevation covered the entire floodplain and reached up the valley slope.

Two culverts are located within the Clark WMA. The culverts were modeled to determine if the 100-year storm exceeded their capacity to carry the flow. The modeling shows that both culverts do not carry the 100-year stormflow and water will pond in the culvert and upstream of the culvert structure. The existence of the ponded water will extend the time period of maximum flow through the culvert. When the ponded water is fully drained, the flow elevation will begin to drop. The second culvert does carry the 100-year stormflow.

4.1.7 Clark WMA Subwatershed Ranking

As indicated in Section 2.6, two indicator categories – watershed impact and source indicators - were used for ranking overall stream conditions in the subwatersheds. Figure 4.9 illustrates the results obtained for subwatershed ranking of the watershed impacts. The lowest scoring subwatersheds were identified as potential problem areas. Two subwatersheds within the Clark WMA were identified as potential problem areas. Based upon existing conditions, the upper portion of the WMA is in fair condition, while the lower portion is in good condition.

The Clark WMA was also evaluated using source indicators to identify potential WMA stressors or pollutant sources as shown in Figure 4.10. The lowest ranking subwatersheds were identified as additional potential problem areas. No additional subwatersheds within the Clark WMA have been identified as additional problem areas. The WMA was ranked as having low to moderate levels of stressors and pollutant sources.

4.2 Mine Run WMA

4.2.1 Mine Run WMA Characteristics

The Mine Run WMA makes up the majority of the southern border of the Pond Branch Watershed, and is bordered by the Difficult Run Watershed. It is the second largest WMA in the Pond Branch Watershed and consists of 1,634 acres (2.6 square miles). The WMA is bordered on the west by Walker Road, bordered on the south by Georgetown Pike, and River Bend Road runs through the eastern portion. See Figure 4.1 for the location of the Mine Run WMA.

There are approximately 6.9 miles of perennial streams within the Mine Run WMA, with habitat conditions ranging from good to very poor. The streams flow in an eastern direction toward the Potomac River. The streams travel through a combination of estate residential and open space areas. The open space along the Potomac River is designated as parkland.

4.2.2 Existing and Future Land Use

Approximately 20 percent of the Mine Run WMA is urbanized, consisting primarily of estate residential (60 percent), open space (18 percent) and low density residential (15 percent) land uses, as shown in Table 4.6. The areas of open space are scattered throughout the WMA and along the Potomac River, which is designated as parkland.

Table 4.6 Existing and Future Land Use in Mine Run WMA

Land Use Type	Existing Percent (%)	Future Percent (%)
Estate Residential	59.9	67.2
High Density Residential	0	0
Medium Density Residential	0.1	0.1
Low Density Residential	15.5	15.9
High Intensity Commercial	0.1	0.2
Low Intensity Commercial	0.1	0.1
Industrial	0.1	0
Institutional	0.6	0.6
Open Space	17.9	10.0
Golf Course	0.1	0.1
Transportation	3.6	3.6
Water	2.1	2.1
Total	100	100

Source: Fairfax County GIS, 2008

Table 4.6 and Figure 4.2, show the expected change in land use as the Mine Run WMA continues to develop. A decrease in open space land use, with a corresponding increase in estate residential areas is projected within the Mine Run WMA.

4.2.3 Field Reconnaissance and Stream Physical Assessment

Field reconnaissance was completed within the Mine Run WMA to evaluate projects proposed by the county, to identify problems areas and to identify potential improvement projects. The following tasks were completed during the field reconnaissance surveys of the Mine Run WMA:

1. Evaluated drainage complaints.
2. Evaluated projects proposed by the county.
3. Evaluated existing stormwater facilities.
4. Conducted neighborhood source assessments.
5. Conducted hot spot investigations.
6. Investigated stream physical assessment inventory points.
7. Conducted supplemental stream physical assessments.

The results of each of the field reconnaissance surveys are briefly described below.

<u>Drainage Complaints</u>
Thirty four (34) drainage complaints were documented within the Mine Run WMA during 2001. Of those, seven representative complaints were chosen for field investigation. The complaints included yard flooding and drainage problems, as well as channel erosion. One of the complaints was found to not be an issue, but the others warrant further investigation and/or repair.

Proposed County Projects

Based upon past evaluations and reports, two stormwater projects have been proposed within the Mine Run WMA. Field investigations were conducted to determine whether these projects were still viable. Field investigations were completed for two culvert replacement projects, one under Arnon Chapel Road and the other under Weant Drive. Field investigation showed no evidence of a need for replacement, but the Arnon Chapel culvert could use some maintenance.

Existing Stormwater Facilities

Fifteen (15) stormwater management facilities were evaluated within the Mine Run WMA to determine the need for repair or the potential for retrofit to increase the benefit of the facility. Three of the 15 facilities were found to not exist, and the remaining facilities were functioning as designed, although most presented some opportunity for retrofit.

Neighborhood Source Assessment (NSA)

Four representative neighborhoods were chosen for an NSA to help identify potential improvement projects throughout the Mine Run WMA. All of the chosen neighborhoods consisted of single-family detached houses on lot sizes ranging from a half-acre to over an acre. The neighborhood conditions, as well as the stormwater management facilities, were evaluated. The NSAs indicated the potential for stormwater management facility and conveyance system retrofit and a need for better lawn and landscaping practices.

Hot Spot Investigation (HSI)

Two representative facilities with the potential to generate concentrated stormwater pollution were chosen within the Mine Run WMA for the HSI. An investigation was conducted of the facility and the corresponding property to identify sources of pollution. A school and an auto repair center were targeted for the HSI within the Mine Run WMA. The garage was identified as a potential hotspot, while the school was a confirmed hot spot. This indicated the need for future education efforts and the need for a follow-up on-site inspection.

Stream Physical Assessment (SPA) Inventory Points

Inventory points identified during the original stream physical assessment that received an impact score of five or greater were field verified. A pipe was identified that is undersized to carry the streams flows during larger storm events. A headcut was also identified, which is currently being held in place by tree roots and non-erosive soils.

Stream Physical Assessment (SPA)

A supplemental stream physical assessment was conducted on 1.2 miles of stream within the Mine Run WMA. The stream was found to have good to excellent habitat conditions. Multiple inventory points were identified with impact scores of five or higher including ten erosion areas, nine obstructions, one headcut, one ditch, one utility line and one stream crossing.

4.2.4 Mine Run WMA Characterization

Approximately 6.6 miles of streams were assessed within the Mine Run WMA to determine the overall stream conditions in the WMA. As shown in Figure 4.3, the majority of the main stem of Mine Run has good to fair habitat conditions. The tributaries range from fair to very poor habitat conditions. All of the perennial streams in the Mine Run WMA are protected by the resource protection area, as described in Chapter 1. The main stem was designated as protected in 1993, whereas the headwaters and tributaries were not added until 2003. Several pipes, deficient riparian buffer areas, obstructions, stream crossings and a headcut were identified during field reconnaissance, although the majority of the problems were considered minor to moderate. A few areas of deficient riparian buffer were considered moderate to severe; however, the restoration potential for these areas is considered low. The crossing under Deer Park Road was considered moderate to severe, as well as a two foot headcut and a wood obstruction. The surveyed channels in this WMA are in Channel Evolution Model Stage 3. This indicates an unstable channel that is experiencing significant bank erosion.

As shown in Figure 4.4, the Mine Run Pan WMA contains multiple stormwater management facilities that collect and treat stormwater runoff before it reaches the stream network. These facilities include dry ponds, wet ponds and farm ponds. Based on Table 4.7, stormwater runoff from approximately 15 percent of the impervious area in the WMA is treated. Stormwater runoff from the areas that do receive treatment is treated for both primarily only quantity, no water quality control. Approximately six percent of the area in this WMA is impervious. More stormwater management facilities are needed in the Mine Run WMA to control and treat stormwater.

Table 4.7 Mine Run WMA Summary

WMA Name	Total Area (acres)	Impervious Current Condition		Current Treatment Types			
		Percent (%)	Acres	Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Mine Run	1,633.4	6.3	103.7	15.5	0.3	-	1,617.6

4.2.5 STEPL Modeling

The STEPL model was used to estimate nutrient loadings in each subwatershed as described in Section 2.5. Figures 4.5, 4.6, and 4.7 present the results of the STEPL model, respectively, which were used to estimate the pollutant loadings in each subwatershed and WMA. Table 4.8 shows the total pollutant loading to the endpoint of Mine Run WMA. According to the STEPL model results, the Mine Run WMA contributes approximately 26 percent of the total suspended solids, 34 percent of the total nitrogen, and 32 percent of the total phosphorous annual loads to the Pond Branch Watershed. Pollutant loadings normalized to the acres within the drainage area of the Mine Run WMA are presented in Table 4.9. The values in this table indicate the total nutrient and sediment load that results from stormwater runoff over one acre of the Mine Run WMA as compared with unit area loads for the entire watershed.

Table 4.8 Summary of Pollutant Loadings for Mine Run WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/year)	Total Nitrogen (pounds/year)	Total Phosphorus (pounds/year)
Mine Run	91.7	3,897.9	601.2
WS Totals	**347.9**	**11,526.3**	**1,865.4**

Table 4.9 Pollutant Loadings Normalized by Drainage Area for Mine Run WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/acre/year)	Total Nitrogen (pounds/acre/year)	Total Phosphorus (pounds/acre/year)
Mine Run	0.056	2.386	0.368
WS Totals	**0.064**	**2.133**	**0.345**

4.2.6 HEC-RAS Modeling

HEC-RAS hydraulic modeling was completed for a 100-year storm event in the Mine Run WMA. Channel flow capacity was analyzed to determine if the 100-year storm event would overflow the channel and flood onto the floodplain. Additionally, the elevation of the flow was determined with reference to the topographic elevations in the stream valley.

As shown in Figure 4.8, a 100-year storm in the Mine Run WMA resulted in an overflow event with flooding onto the floodplain. The modeling showed that the 100-year stormflow elevation covered the entire floodplain and reached up the valley slope.

Three culverts are located within the Mine Run WMA. The culverts were modeled to determine if the 100-year storm exceeded their capacity to carry the flow. The modeling shows that all three of the culverts in the Mine Run WMA do not carry the 100-year stormflow and water will pond in the culvert and upstream of the culvert structure. The existence of the ponded water will extend the time period of maximum flow through the culvert. When the ponded water is fully drained, the flow elevation will begin to drop. The second culvert does carry the 100-year stormflow.

4.2.7 Mine Run WMA Subwatershed Ranking

As indicated in Section 2.6, two indicator categories – watershed impact and source indicators - were used for ranking overall stream conditions in the subwatersheds. Figure 4.9 illustrates the results obtained for subwatershed ranking of the watershed impacts. The lowest scoring subwatersheds were identified as potential problem areas. Three subwatersheds within the Mine

Run WMA have been identified as potential problem areas. Based upon the existing conditions, the WMA has fair conditions.

The Mine Run WMA was also evaluated using source indicators to identify potential WMA stressors or pollutant sources as shown in Figure 4.10. The lowest ranking subwatersheds were identified as additional potential problem areas. No additional subwatersheds within the Mine Run WMA have been identified as additional problem areas. The Mine Run WMA was ranked as having low to moderate levels of stressors and pollutant sources.

4.3 Pond WMA

4.3.1 Pond WMA Characteristics

The Pond WMA is located in the northwestern corner of the Pond Branch Watershed and bordered is on the west by Nichol Run Watershed. The Pond WMA is the smallest WMA, encompassing 741 acres (1.2 square miles). The WMA is transversed by Beach Mill Road and Walker Road in the southern half of the WMA. See Figure 4.1 for the location of Pond WMA.

There are approximately 4.1 miles of perennial streams within the Pond WMA. The streams flow in a northeast direction toward the confluence with the Potomac River. The stream flows through a combination of low density and estate residential and open space areas.

4.3.2 Existing and Future Land Use

Approximately 28 percent of the Pond WMA is urbanized, consisting primarily of estate residential (59 percent), low density residential (23 percent) and open space (12 percent) land uses, as shown in Table 4.10. A portion of open space has been designated as parkland along the Potomac River.

Table 4.10 Existing and Future Land Use

Land Use Type	Existing Percent (%)	Future Percent (%)
Estate Residential	58.7	68.0
High Density Residential	0	0
Medium Density Residential	0.2	0.2
Low Density Residential	23.3	23.3
High Intensity Commercial	0	0
Low Intensity Commercial	0	0
Industrial	0	0
Institutional	0	0.1
Open Space	12.0	2.7
Transportation	4.2	4.2
Water	1.5	1.5
Total	100	100

Source: Fairfax County GIS, 2008

Table 4.10 and Figure 4.2 show the expected change in land use as the Pond WMA continues to develop. A decrease in open space land use, with a corresponding increase in estate residential areas is projected within the Pond WMA.

4.3.3 Field Reconnaissance and Stream Physical Assessment

Field reconnaissance was completed within the Pond WMA to evaluate projects proposed by the county, to identify problems areas and to identify potential improvement projects. The following tasks were completed during the field reconnaissance surveys of the Pond WMA:

1. Evaluated projects proposed by the county.
2. Evaluated existing stormwater facilities.
3. Reviewed a stream physical assessment inventory point.
4. Conducted a neighborhood source assessment.

The results of each of the above evaluations are briefly described in the following sections.

<u>Proposed County Projects</u>
Based upon past evaluations and reports, two stormwater projects have been proposed within the Pond WMA. Field investigations were conducted to determine whether the projects were still viable. The projects included two culvert replacement projects under Beach Mill Road. Both of the culverts are undersized to carry the higher flows experienced during larger storm events, and need to be addressed.

<u>Existing Stormwater Facilities</u>
Seven stormwater management facilities were evaluated within the Pond WMA to determine the need for repair or the potential for retrofit to increase the benefit of the facility. One of the seven facilities was found to not exist, but the remaining facilities were functioning as designed, although most presented some opportunity for retrofit.

<u>Stream Physical Assessment (SPA) Inventory Points</u>
Inventory points identified during the original stream physical assessment that received an impact score of five or greater were field verified. A stream crossing was identified that was negatively impacting the stream. An undersize culvert under Beach Mill Road needs investigated further and/or repaired.

<u>Neighborhood Source Assessment (NSA)</u>
One representative neighborhood was chosen for a NSA to help identify potential improvement projects throughout the Pond WMA. The neighborhood consisted of single family detached houses on one acre or larger lots. The neighborhood conditions, as well as the stormwater management facilities, were evaluated. The NSA indicated the potential for more stormwater management facilities and a need for better lawn and landscaping practices.

4.3.4 Pond WMA Characterization

Approximately 2.9 miles of stream was assessed within the Pond WMA to determine the overall stream conditions. As shown in Figure 4.3, the main stem and one of the tributaries has good habitat conditions. The other tributaries have poor habitat conditions. All of the perennial streams within the Pond WMA are protected by the resource protection area, as described in Chapter 1. Most of the stream network was designated as protected in 1993, although headwater and tributary streams were added in 2003 and 2005. Several deficient riparian buffer areas, stream crossings, and a utility and erosional area were identified during field reconnaissance, although the majority of the problems were considered minor to moderate. One of the stream crossings and the erosional area were considered moderate to severe; however the restoration potential for this area was low. The surveyed channels in this WMA are in Channel Evolution Model Stage 3. This indicates an unstable channel that is experiencing significant bank erosion.

As shown in Figure 4.4, the Pond WMA contains a handful of stormwater management facilities that collect and treat stormwater runoff before it reaches the stream network, including dry ponds, wet ponds and farm ponds. Based on Table 4.11, stormwater runoff from approximately 14 percent of the impervious area in the WMA is treated. Stormwater runoff from the areas that do receive treatment is treated for primarily only quantity, no water quality control. Approximately seven percent of the area in this WMA is impervious. More stormwater management facilities are needed in the Pond WMA to control and treat stormwater.

Table 4.11 Pond WMA Summary

WMA Name	Total Area (acres)	Impervious Current Condition		Current Treatment Types			
		Percent (%)	Acres	Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Pond	741.6	6.5	48.1	5.9	0.7	-	735

4.3.5 STEPL Modeling

Figures 4.5, 4.6 and 4.7 present the results of the STEPL model for total suspended solids, total nitrogen, and total phosphorus, respectively, which were used to estimate the pollutant loadings in each subwatershed and WMA. Table 4.12 shows the total pollutant loading to the endpoint of Pond WMA. According to the STEPL model results, the Pond WMA contributes approximately 12 percent of the total suspended solids, 17 percent of the total nitrogen, and 16 percent of the total phosphorous annual loads to the Pond Branch Watershed. Pollutant loadings normalized to the acres within the drainage area of the Pond WMA are presented in Table 4.13. The values in this table indicate the total nutrient and sediment load that results from stormwater runoff over one acre of the Pond WMA as compared with unit area loads for the entire watershed.

Table 4.12 Summary of Pollutant Loadings for Pond WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/year)	Total Nitrogen (pounds/year)	Total Phosphorus (pounds/year)
Pond	42.3	1,944.7	298.1
WS Totals	**347.9**	**11,526.3**	**1,865.4**

Table 4.13 Pollutant Loadings Normalized by Drainage Area for Pond WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/acre/year)	Total Nitrogen (pounds/acre/year)	Total Phosphorus (pounds/acre/year)
Pond	0.057	2.622	0.402
WS Totals	**0.064**	**2.133**	**0.345**

4.3.6 HEC-RAS Modeling

HEC-RAS hydraulic modeling was completed for a 100-year storm event in the Pond WMA. Channel flow capacity was analyzed to determine if the 100-year storm event would overflow the channel and flood onto the floodplain. Additionally, the elevation of the flow was determined with reference to the topographic elevations in the stream valley.

As shown in Figure 4.8, a 100-year storm in the Pond WMA resulted in an overflow event with flooding onto the floodplain. The modeling showed that the 100-year stormflow elevation covered the entire floodplain and reached up the valley slope.

There are two culverts located in the Pond WMA. These culverts were modeled to determine if the 100-year storm exceeded the capacity of the culvert to carry the flow. The modeling shows that the culvert located further upstream in Pond WMA was able to carry the 100-year and smaller stormflows. The other culvert located downstream in the WMA does not carry the 100-year stormflow and water will pond upstream of the culvert structure. The existence of the ponded water will extend the time period of maximum flow through the culvert. When the ponded water is fully drained, the flow elevation will begin to drop.

4.3.7 Pond Subwatershed Ranking

As indicated in Section 2.6, two indicator categories – watershed impact and source indicators - were used for ranking overall stream conditions in the subwatersheds. Figure 4.9 illustrates the results obtained for subwatershed ranking of the watershed impacts. The lowest scoring subwatersheds were identified as potential problem areas. No subwatersheds within the Pond WMA were identified as potential problem areas. Based upon existing conditions, the conditions of the Pond WMA are excellent.

The Pond WMA was also evaluated using source indicators to identify potential WMA stressors or pollutant sources as shown in Figure 4.10. The lowest ranking subwatersheds were identified as additional potential problem areas. No additional subwatersheds within the Pond WMA have been identified as additional problem areas. The stressor levels and pollutant sources range from low to moderate within the Pond WMA.

4.4 Potomac WMA

4.4.1 Potomac WMA Characteristics

The Potomac WMA is broken into three pieces, all of which lie along the Potomac River. Two are along the northern border of the WMA and the third encompasses the southeastern tip. The Potomac WMA is the second smallest WMA in the Pond Branch Watershed and consists of 1,269 acres (2 square miles). See Figure 4.1 for the location of the Potomac WMA.

There are approximately 4.4 miles of perennial streams within the Potomac WMA. The streams flow in a north/northeastern direction into the Potomac River, depending on the location within the watershed. The streams flow through primarily open space and estate residential areas. Most of the Potomac WMA is designated as parkland including the Northern Virginia Regional Park, River Bend Regional Park and the Great Falls National Park.

4.4.2 Existing and Future Land Use

Only approximately seven percent of the Potomac WMA is urbanized, consisting primarily of open space (76 percent) and estate residential (17 percent), as shown in Table 4.14. The majority of open space within the Potomac WMA is parkland along the Potomac River, as described above.

Table 4.14 Existing and Future Land Use

Land Use Type	Existing Percent (%)	Future Percent (%)
Estate Residential	16.6	21.7
High Density Residential	0	0
Medium Density Residential	0.1	0.1
Low Density Residential	3.4	3.4
High Intensity Commercial	0	0
Low Intensity Commercial	0	0
Industrial	0	0
Institutional	1.7	1.7
Open Space	75.7	70.6
Transportation	1.7	1.7
Water	0.8	0.8
Total	100	100

Source: Fairfax County GIS, 2008

Table 4.14 and Figure 4.2 show the expected change in land use as the Potomac WMA continues to develop. A decrease in open space land use, with a corresponding increase in estate residential areas is projected within the Potomac WMA.

4.4.3 Field Reconnaissance and Stream Physical Assessment

Field reconnaissance was completed in the Potomac WMA to evaluate projects proposed by the county, to identify problems areas and to identify potential improvement projects. The following tasks were completed during the field reconnaissance surveys of the Potomac WMA:

1. Evaluated a drainage complaint.
2. Evaluated a project proposed by the county.
3. Evaluated existing stormwater facilities.
4. Conducted neighborhood source assessments.

The results of each of the above evaluations are briefly described in the following sections.

<u>Drainage Complaints</u>
Four drainage complaints have been documented within the Potomac WMA between 2001 and 2002. Of those, one representative complaint was chosen for field investigation. The complaint included road flooding along River Bend Road. Field reconnaissance indicated the culvert is undersized and warrants further investigation and/or repair.

<u>Proposed County Projects</u>
Based upon past evaluations and reports, one stormwater project has been proposed within the Potomac WMA. Field investigations were conducted to determine whether the project was still viable. The project involved replacing a culvert under River Bend Road. Field investigation verified the project is still valid and should be completed to prevent further road flooding.

<u>Existing Stormwater Facilities</u>
Eight stormwater management facilities were evaluated within the Potomac WMA to determine the need for repair or the potential for retrofit to increase the benefit of the facility. Two of the eight facilities were ornamental ponds and are inadequate to provide stormwater management function. The remaining facilities were functioning as designed, although most presented some opportunity for retrofit.

<u>Neighborhood Source Assessment (NSA)</u>
Two representative neighborhoods were chosen for a NSA to help identify potential improvement projects throughout the Potomac WMA. The neighborhoods consisted of single family detached houses on half-acre or larger lots. The neighborhood conditions, as well as the stormwater management facilities, were evaluated. The NSAs indicated the potential for stormwater management facility retrofit and a need for better lawn and landscaping practices.

4.4.4 Potomac WMA Characterization

Approximately 1.7 miles of stream was assessed within the Potomac WMA to determine the overall stream conditions in the WMA. As shown in Figure 4.3, the tributaries range from good to poor habitat conditions. All of the perennial streams in the WMA are protected by the resource protection area, as described in Chapter 1. The area along the Potomac River and a few of the tributaries were designated as protected in 1993, and the other tributaries were added in 2003. Several stream crossings and a deficient buffer area were identified during field reconnaissance, although the problems were considered minor to moderate. The surveyed channels in the WMA are in Channel Evolution Model Stage 3. This indicates an unstable channel that is experiencing significant bank erosion.

As shown in Figure 4.4, the Potomac WMA contains multiple stormwater management facilities that collect and treat stormwater runoff before it reaches the stream network, including dry ponds, wet ponds and farm ponds. Table 4.15 indicates that stormwater runoff from approximately four percent of the impervious area in this WMA is treated. Stormwater runoff from the areas that do receive treatment are treated for both quantity and water quality. Approximately three percent of the area in the WMA is impervious. More stormwater management facilities are needed in the Potomac WMA, particularly the southern piece which is more developed.

Table 4.15 Potomac WMA Summary

WMA Name	Total Area (acres)	Impervious Current Condition		Current Treatment Types			
		Percent (%)	Acres	Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Potomac	1,269.7	3	38.4	0.4	0.2	0.8	1,268.3

4.4.5 STEPL Modeling

Figures 4.5, 4.6 and 4.7 present the results of the STEPL model for total suspended solids, total nitrogen and total phosphorus, respectively, which were used to estimate the pollutant loadings in each subwatershed and WMA. Table 4.16 shows the total pollutant loading to the endpoint of the Potomac WMA. According to the STEPL model results, the Potomac WMA contributes approximately 33 percent of the total suspended solids, 15 percent of the total nitrogen, and 18 percent of the total phosphorous annual loads to the Pond Branch Watershed. Pollutant loadings normalized to the acres within the drainage area of the Potomac WMA are presented in Table 4.17. The values in this table indicate the total nutrient and sediment load that results from stormwater runoff over one acre of the Potomac WMA as compared with unit area loads for the entire watershed.

Table 4.16 Summary of Pollutant Loadings for Potomac WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/year)	Total Nitrogen (pounds/year)	Total Phosphorus (pounds/year)
Potomac	116.1	1,751.5	337.9
WS Totals	**347.9**	**11,526.3**	**1,865.4**

Table 4.17 Pollutant Loadings Normalized by Drainage Area for Potomac WMA

WMA Name	Pollutant Loadings		
	Total Suspended Solids (tons/acre/year)	Total Nitrogen (pounds/acre/year)	Total Phosphorus (pounds/acre/year)
Potomac	0.091	1.380	0.266
WS Totals	**0.064**	**2.133**	**0.345**

4.4.6 HEC-RAS Modeling

HEC-RAS hydraulic modeling was not completed for the Potomac WMA. The Potomac WMA is composed of small tributaries that drain directly to the Potomac River where stream segments and drainage areas are small and development is minimal. Hydraulic modeling of these areas would not yield any consequential information for the watershed.

4.4.7 Potomac WMA Subwatershed Ranking

As indicated in Section 2.6, two indicator categories – watershed impact and source indicators - were used for ranking overall stream conditions in the subwatersheds. Figure 4.9 illustrates the results obtained for subwatershed ranking of the watershed impacts. The lowest scoring subwatersheds were identified as potential problem areas. No subwatersheds within the Pond WMA were identified as potential problem areas. Based upon existing conditions, the environment ranges within the Potomac WMA from good to poor.

The Potomac WMA was also evaluated using source indicators to identify potential WMA stressors or pollutant sources as shown in Figure 4.10. The lowest ranking subwatersheds were identified as additional potential problem areas. No additional subwatersheds within the Potomac WMA have been identified as additional problem areas. The Potomac WMA was ranked as having low levels of stressors and pollutant sources

4.5 SWMM Modeling for Pond Branch Watershed

The Stormwater Management Model (SWMM) was used to determine the peak rate (maximum volume of water per second) of stormwater flows in stream channels during a storm. The 2-year and 10-year storm flows were modeled; these are the storm flows that, on average, occur once every 2 or 10 years. Figure 4.11 shows peak rates of flow for the 2-year storm across the watershed. As shown in Figure 4.11, within each WMA, peak flows tend to increase downstream as more drainage area contributes more stormwater runoff to the stream channel. In a similar manner, an upstream, contributing WMA augments the flow in a downstream, receiving WMA. Because stormwater runoff flow carries pollutants, pollutant loadings also increase downstream within a WMA and from one WMA to the next.

Table 4.18 shows peak flows for the 2-year and 10-year storms in the WMAs in the Pond Branch watershed. The SWMM model shows that peak flows are the highest within the Potomac WMA for both the 2-year and 10-year storms. The Pond WMA has the lowest peak flows during the 2-year and 10-year storms. Peak flows for the 10-year storm are approximately twice as large as the flows for the 2-year storm.

Table 4.18 Summary of SWMM and STEPL Results

WMA Name[1]	Stormwater Runoff Peak Flow Values		Pollutant Loadings		
	2-yr storm (cubic ft/sec)	10-yr storm (cubic ft/sec)	Total Suspended Solids (tons/yr)	Total Nitrogen (pounds/yr)	Total Phosphorus (pounds/yr)
Clark	518.42	1,177.18	97.9	3,932.2	628.2
Mine Run	545.17	1,193.82	91.7	3,897.9	601.2
Pond Branch	267.93	604.40	42.3	1,944.7	298.1
Potomac	556.64	1,538.33	116.1	1,751.5	337.9
WS Totals	**1,514.76**	**3,551.68**	**347.9**	**11,526.3**	**1,865.4**

1. The "WMA Name" is the WMA for which there is a modeled cumulative peak flow (2 and 10 year) for the entire upstream drainage area.

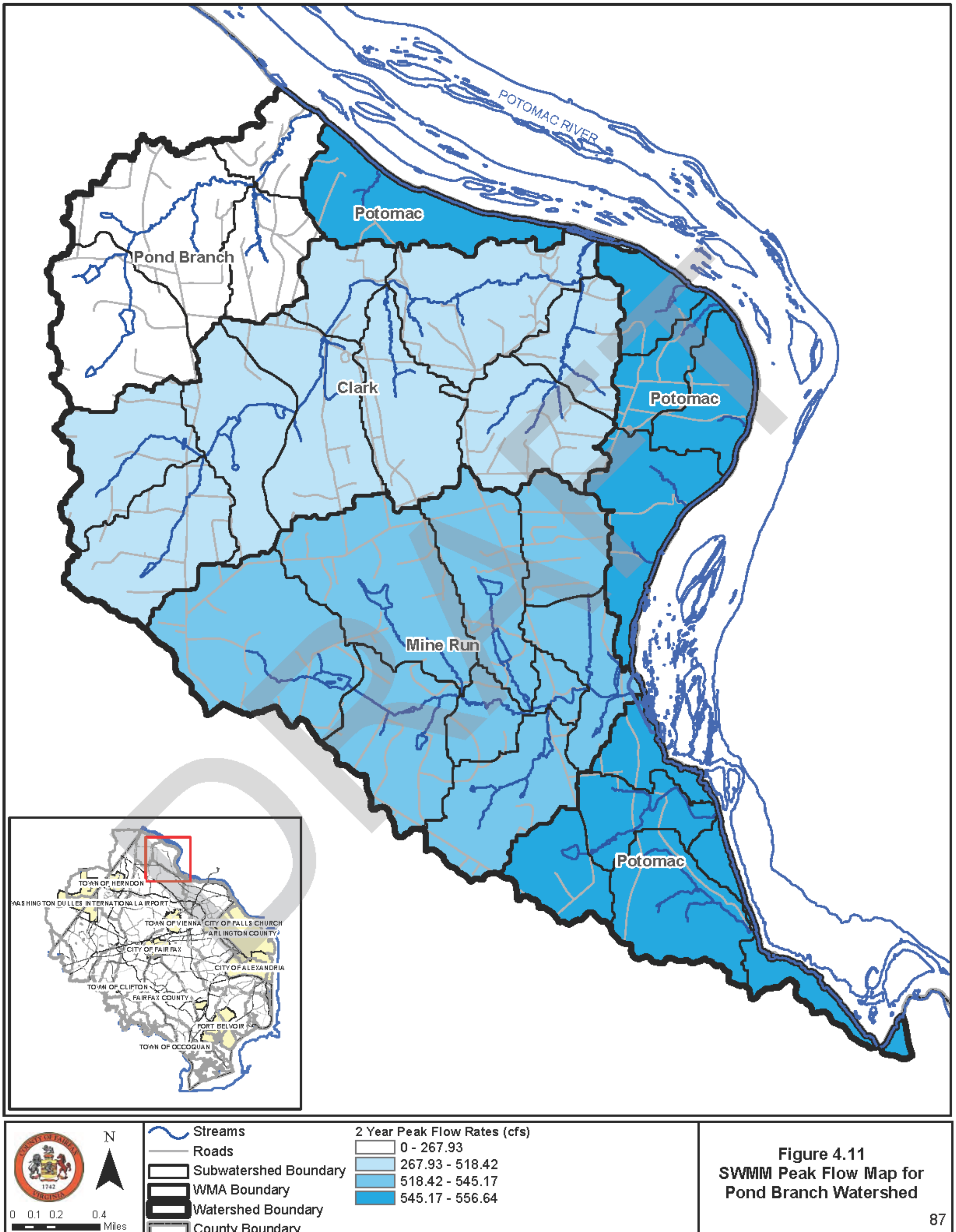

Figure 4.11
SWMM Peak Flow Map for Pond Branch Watershed

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To determine which WMA contributes the greatest flows, the peak flows in Table 4.18 were recalculated based on WMA drainage area. Table 4.19 shows these flows normalized by WMA drainage area. The Potomac WMA contributes the most stormwater runoff during the 2-year storm and the Clark WMA contributes the least; the same results were seen during the 10-year storm.

The STEPL model was used to estimate the pollutant loadings for total suspended solids, total nitrogen and total phosphorus for each WMA, as shown in Table 4.18. The Pond WMA has the greatest cumulative pollutant loading and the Potomac WMA has the least. The WMAs within the Pond Branch Watershed drain directly into the Potomac River. To determine if the pollutant loadings shown in Table 4.18 are increasing or decreasing with downstream flow, the pollutant loadings in Table 4.18 were recalculated based on WMA drainage area. Table 4.19 shows pollutant loadings normalized by the contributing drainage area.

Table 4.19 SWMM and STEPL Results Normalized by Drainage Area

WMA Name[1]	Drainage Area (acres)	Stormwater Runoff Peak Flow Values		Pollutant Loadings		
		2-yr storm (cubic ft/sec)	10-yr storm (cubic ft/sec)	Total Suspended Solids (tons/yr)	Total Nitrogen (pounds/yr)	Total Phosphorus (pounds/yr)
Clark	1,759.4	0.295	0.669	0.056	2.235	0.357
Mine Run	1,633.4	0.334	0.731	0.056	2.386	0.368
Pond Branch	741.6	0.361	0.815	0.057	2.622	0.402
Potomac	1,269.7	0.438	1.212	0.091	1.380	0.266
WS Totals	**5,404.1**	**0.280**	**0657**	**0.064**	**2.133**	**0.345**

1. The "WMA Name" is the WMA for which there is a modeled cumulative peak flow (2 and 10 year) for the entire upstream drainage area.

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5.0 Glossary of Terms

Acre – A measure of land equating to 43,560 square feet.

Aquatic Habitat – The wetlands, streams, lakes, ponds, estuaries, and streamside (riparian) environments where aquatic organisms (e.g., fish, benthic macroinvertebrates) live and reproduce; includes the water, soils, vegetation, and other physical substrate (rocks, sediment) upon and within which the organisms occur.

Benthic Macroinvertebrate – An aquatic animal lacking a backbone and generally visible to the unaided eye.

Best Management Practice (BMP) – A structural or nonstructural practice that is designed to minimize the impacts of changes in land use on surface and groundwater systems. Structural best management practices refer to basins or facilities engineered for the purpose of reducing the pollutant load in stormwater runoff, such as bioretention, constructed stormwater wetlands, etc. Nonstructural best management practices refer to land use or development practices that are determined to be effective in minimizing the impact on receiving stream systems such as the preservation of open space and stream buffers, disconnection of impervious surfaces, etc.

Bioengineering – Combines biological (live plants) and engineering (structural) methods to provide a streambank stabilization method that performs natural stream functions without habitat destruction.

Channel Evolution Model (CEM) – The geomorphologic assessment of the incised stream channels developed by Schumm et. al.

Channel – A natural or manmade waterway.

Confluence – The joining point where two or more stream create a combined, larger stream.

Design Storm – A selected rainfall hyetograph of specified amount, intensity, duration, and frequency that is used as a basin for design.

Detention – The temporary impoundment or holding of stormwater runoff.

Ecosystem – All the component organisms of a community and their environment that together form an interacting system.

Erosion - The natural process by which a stream channel adjusts to changes within its watershed. Increased development within a watershed can accelerate the erosion process, resulting in the loss of residential yards, threatened infrastructure, siltation of aquatic habitat, and decreased water quality.

Floodplain - Area of land on each side of a stream channel that is inundated periodically by flood waters; important zone for dissipating the energy of peak storm flow discharges and for storing waters that otherwise might damage in-stream habitat and/or cause downstream flood damage; typically includes high-quality riparian habitat (if undisturbed); waters flowing in incised (down-cut) streams may not be able to access the adjacent floodplain area to dissipate the volume and energy of higher storm flow events.

Geographic Information System (GIS) – A method of overlaying spatial land and land use data of different kinds. The data are referenced to a set of geographical coordinates and encoded in a computer software system. GIS is used by many localities to map utilities and sewer lines and to delineate zoning areas.

Geomorphology – A science that deals with the land and submarine relief features of the earth's surface.

Headcut – The geomorphologic incision of the stream due to the hydraulic effect of a channel from head forces. One example is the accelerated cutting of a stream due to a manmade or natural constriction where water velocities are increased substantially. Another example is the outlet of a dam, where extreme velocities can occur due to the high static head forces created by the build-up of water from the dam structure.

Headwater – The source of a stream or watershed.

Hot Spot – A problem area that may contain significant stressors or pollutant sources that can affect watershed conditions within the immediate subwatershed and may be having an impact on downstream areas.

Hydraulics – The physical science and technology of the static and dynamic behavior of fluids.

Hydrograph – A plot showing the rate of discharge, depth, or velocity of flow versus time for a given point on a stream or drainage system.

Hydrology – The science of dealing with the distribution and movement of water.

Hyetograph – A graph of time distribution of rainfall over a watershed.

Impervious Surface – A surface composed of any material that significantly impedes or prevents natural infiltration of water into the soil. Impervious surfaces include, but are not limited to, roofs, buildings, streets, parking areas, any concrete, asphalt, or compacted gravel surface.

Modeling - Use of conceptual and/or computer models to simulate the response (e.g., pollutant loading to streams) of a natural system (e.g., watershed) to various management scenarios; useful in assessing which types of watershed protection techniques will yield the greatest benefit to water quality, habitat, or flooding conditions, and in determining which locations within the watershed are optimal for such practices or project sites.

Open Space – The area within the boundaries of a lot that is intended to provide light and air, and is designed for either scenic or recreational purposes. Open space shall, in general, be available for entry and use by residents or occupants of the development. Open space may include, but is not limited to, lawns, decorative planting, walkways, recreation areas, playgrounds, undisturbed natural areas and wooded areas.

Peak Discharge – The maximum rate of flow at an associated point within a given rainfall event or channel condition.

Perennial Stream – A body of water that normally flows year-round in a defined channel or bed, and is capable, in the absence of pollution or other manmade stream disturbances, of supporting bottom-dwelling aquatic animals.

Pipes – Pipes carry water from various sources to a stream. Because of this, the discharge may contain pollutants such as oil from roadway runoff, sewage, nutrients from lawn fertilization, etc. The high volume and flow delivered to the stream, particularly during storm events, can result in erosion of the stream channel and banks.

Redevelopment – The substantial alteration, rehabilitation, or rebuilding of a property for residential, commercial, industrial, or other purposes.

Resource Protection Area (RPA) – Vegetated riparian buffer areas, which include land within a major floodplain and land within 100 feet of a water body. These buffer areas are important in the reduction of sediments, nutrients, as well as the other adverse effects of human activities, which could potentially degrade these systems and those downstream.

Restoration - The re-establishment of wetlands or stream hydrology and wetlands vegetation into an area where wetland conditions (or stable streambank and stream channel conditions) have been lost.

Retention – The permanent storage of stormwater.

Retrofit – The modification of stormwater management systems through the construction and/or enhancement 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 volume and duration. If a storm has a one percent chance of occurring in any given year, then it has a return period of 100 years.

Riparian Buffer - An area adjacent to a stream, wetland, or shoreline where development activities (e.g., buildings, logging) are typically restricted or prohibited; may be managed as streamside (riparian) zones where undisturbed vegetation and soils act as filters of pollutants in stormwater runoff; buffer zone widths vary depending on state and local rules, but are typically a minimum of 25 to 50 feet on each side of perennial streams.

Road Crossing – Crossings are structures that span the width of a stream, usually road or foot bridges. The structures constrict the flow within a stream which can result in detrimental effects including erosion, flooding, and decreased water quality. In addition, structures may block fish and wildlife passage preventing migration to feeding/spawning areas.

Runoff – The portion of precipitation, snow melt, or irrigation water that runs off the land into surface waters.

Stormwater - Precipitation that is often routed into drain systems in order to prevent flooding.

Stormwater Management Facility – A device that controls stormwater runoff and changes the characteristics of that runoff including, but not limited to, the quantity and quality, the period of release or the velocity of flow.

Stream Restoration – The reestablishment of the general structure, function, and dynamic, but self-sustaining, behavior of the ecosystem.

Subwatershed – A subdivision of a watershed used for planning and management purposes, usually ranges in size from 100 to 300 acres.

Tree Cover – The area directly beneath the crown and within the dripline of a tree.

Watercourse – A stream with incised channel (bed and banks) over which water are conveyed.

Watershed – A defined land area drained by a river, stream, or drainage way, or system of connecting rivers, streams, or drainage ways such that all surface water within the area flows through a single outlet.

Watershed Management Area (WMA) – A subdivision of a watershed used for planning and management purposes, usually four square miles in size.

Watershed Planning - The development of basin wide Watershed Restoration Plans; planning typically includes (1) an assessment of watershed conditions and functional impacts at progressively smaller scales of study, and (2) the development of land use management strategies and optimal watershed restoration, enhancement and protection/preservation projects designed to address the identified watershed needs & opportunities.

Wetland - Habitats where the influence of surface water or groundwater has resulted in the development of plant or animal communities adapted to aquatic or intermittently wet conditions. Wetlands include tidal flats, shallow sub-tidal areas, swamps, marshes, wet meadows, bogs, and similar areas.