# Chapter 2: Subwatershed Characterization

## 2.1 Introduction

A **watershed** is an area of land and an associated network of steams or drains that convey stormwater downstream, generally to a single outlet point. A watershed acts like a funnel, channeling all water that falls within its boundaries into a waterway. Each watershed is separated from other watersheds by a physical barrier such as a ridge, hill or mountain and as a result water quantity and quality in an area depend upon the land use and land cover that exists within that watershed.

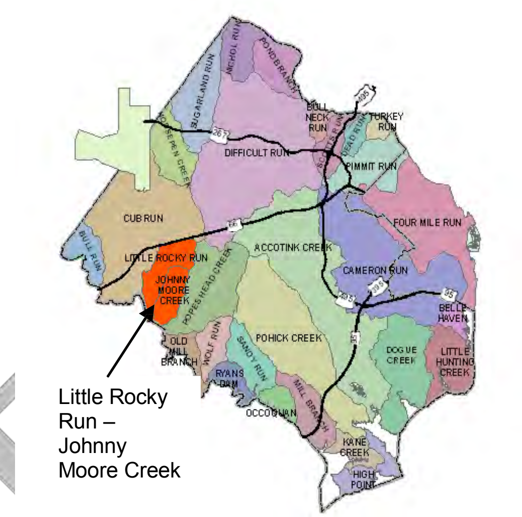



*Figure 2-1: Location of Little Rocky Run and Johnny Moore Creek Watersheds in Fairfax County*

Watersheds drain into other watersheds based on a geomorphological hierarchy, meaning that a larger watershed can be broken down into numerous subwatersheds based on the topography of an area. The Little Rocky Run watershed and the Johnny Moore Creek watershed are each divided into smaller **Watershed Management Areas** (WMAs) to make it easier to evaluate the characteristics of a portion of the watershed with similar land use and development characteristics. Using the WMAs, goals and objectives for the watershed can be refined to meet the needs of different problems and development types in the watershed.

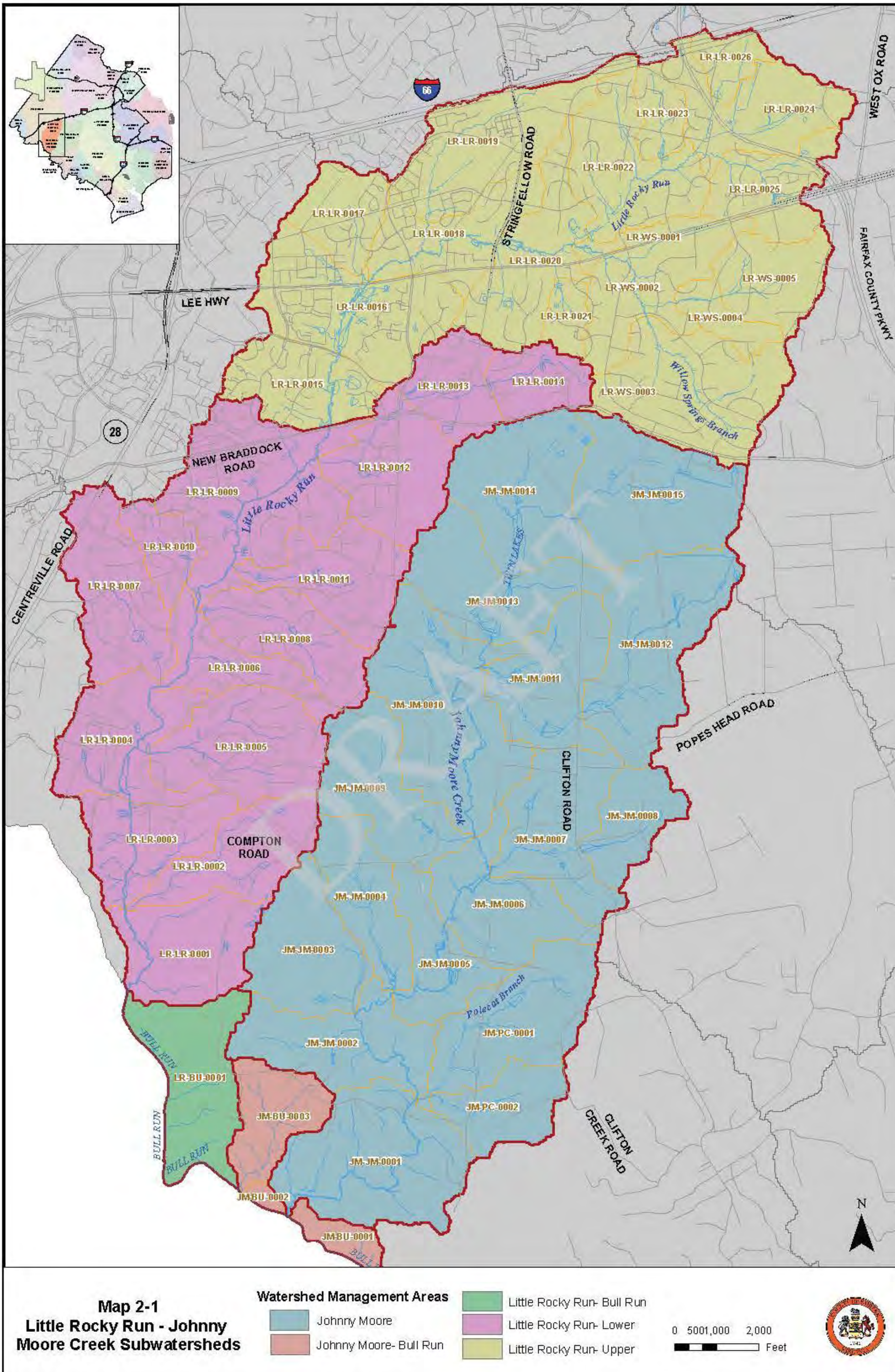
Little Rocky Run watershed is divided into three WMAs: Little Rocky Run-Upper, Little Rocky Run-Lower and Little Rocky Run-Bull Run. Johnny Moore Creek watershed is similarly divided into two WMAs, Johnny Moore and Johnny Moore-Bull Run. Both the Little Rocky Run-Bull Run and Johnny Moore-Bull Run WMAs are smaller areas that drain directly to Bull Run and are located in the southern part of the respective watersheds.

WMAs are generally about 4 square miles in area and are further broken down for this study into **subwatersheds** of between 100 and 300 acres. The subwatersheds provide further detail about the WMAs, especially the water quality and quantity issues of smaller tributaries and land use patterns that are not covered at the WMA scale. By examining data at the subwatershed level, drainage patterns, problem areas and possible solutions can be assessed in manageable work units. The information gained from the subwatershed assessment will be used to help prioritize possible future investments in water quality. Map 2-1 shows the WMAs and subwatersheds used in our water quality examination.

Sections 1-2 of this Chapter provide an introduction and a description of the methodologies used to assess the stream conditions in the watersheds. Sections 3-5 provide a summary of the stream conditions in the WMAs as follows:

- Section 3 Johnny Moore Creek and Johnny Moore Creek – Bull Run WMAs
- Section 4 Little Rocky Run – Lower and Little Rocky Run – Bull Run WMAs
- Section 5 Little Rocky Run – Upper WMA

Section 6 provides a summary of the subwatershed characterization results.




**Map 2-1**
**Little Rocky Run - Johnny Moore Creek Subwatersheds**

## 2.2 Watershed Characterization Approach

The successful development of a Watershed Management Plan (WMP) requires the assessment of the interaction between pollutant sources, watershed stressors and conditions within streams and other water bodies. Each watershed must be evaluated in light of its unique conditions. Management opportunities should then be identified based on the effects of pollutants and stressors on watershed functions, both in the immediate vicinity of these stressors, as well as farther downstream. Watershed characterization was performed using consistent methods for evaluating watershed management needs while ensuring that the WMPs are developed with appropriate attention to watershed-specific conditions.

The County has developed goals and objectives to be applied to all watersheds during the WMP development process. The countywide goals and objectives will allow WMP recommendations to be linked to a Countywide Watershed Assessment. The countywide watershed planning goals are to:

1) Improve and maintain watershed functions in Fairfax County, including water quality, habitat and hydrology.
2) Protect human health, safety and property by reducing stormwater impacts.
3) Involve stakeholders in the protection, maintenance and restoration of County watersheds.

The countywide objectives are linked to the above goals. These objectives were consolidated from a list of over 50 stakeholder-defined objectives from previous WMPs. The shorter list of objectives allows for a countywide evaluation that addresses stakeholder concerns while providing an efficient and effective means of assessment. The final objectives are presented in the Table 2-1. This table also shows how each objective is linked to the three watershed planning goals. The countywide goals and objectives will be applied to all WMP assessments and recommendations. Additional watershed-specific goals and objectives that are recommended by local stakeholders may also be incorporated into the WMP development process. The objectives listed under Category 5 (Stewardship) will be considered during countywide watershed assessment but are not addressed in the ranking approach used in development of this workbook.

**Table 2-1. 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, 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 |

| Objective | | Linked to Goal(s) |
|---|---|---|
| **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 |

### 2.2.1 Watershed Impact Indicators

The purpose of the subwatershed ranking approach is to provide a systematic means of planning management implementation countywide that will achieve the County"s watershed management goals and objectives. Since the objectives cannot be directly measured, the methods require measurable indicators that are directly linked to the objectives. One or more indicators for each objective were selected, including predictive and non-predictive, or observed, indicators. Predictive indicators, such as simulated data, can be used to compare existing and future conditions. Non-predictive indicators cannot measure future conditions but will still be useful in assessing existing watershed impacts within Fairfax County.

The watershed impact indicators used in the subwatershed ranking approach are described below:

**Benthic Communities:** Benthic communities consist of aquatic insects that are good indicators of watershed health. The scoring for this indicator is based on the 1999 *Fairfax County Stream Protection Strategy Baseline Study* that provided scoring based on the number and diversity of the benthic community at sampling sites.

**Fish Communities:** The scoring for this indicator is based on the 1999 *Fairfax County Stream Protection Strategy Baseline Study* that provided scoring based on the number and diversity of the fish community at sampling sites.

**Aquatic Habitat:** The scoring for this indicator is based on the *Fairfax County Stream Physical Assessment* that provided scoring based on a number of stream features that provide data about the diversity of the habitat and its ability to support a diverse aquatic community.

**Channel Morphology:** The scoring for this indicator is based on the *Fairfax County Stream Physical Assessment* and the *Fairfax County Stream Protection Strategy Baseline Study*. A channel evolution model (CEM)-based geomorphic assessment was performed in these studies to assess the evolutionary stage of the stream reaches. The CEM was used to identify stream successional stages from an early stable system through an unstable changing environment to a stable system.

**Instream Sediment:** The scoring for this indicator is based on bank vegetative protection and bank stability assessment from the *Fairfax County Stream Physical Assessment* and the *Fairfax County Stream Protection Strategy Baseline Study*.

**Residential Building Hazards:** The scoring for this indicator is based on the number of residential buildings in the floodplain per square mile. This number was generated using the County‟s Geographic Information System (GIS) data.

**Non-residential Building Hazards:** The scoring for this indicator is based on the number of non-residential buildings in the floodplain per square mile. This number was generated using the County‟s GIS data.

**Flood Complaints:** The scoring for this indicator is based on the number of flood complaints per square mile. This indicator was based on data from the County‟s Drainage Complaints database.

**Resource Protection Area (RPA) Riparian Habitat:** The scoring for this indicator is based on the percentage of riparian habitat in the regulated Chesapeake Bay RPA. The riparian habitat was based on the National Wetlands Inventory, George Mason tidal wetland data and the Virginia Department of Forestry‟s (VDOF) 2005 Virginia Forest Cover Map.

**Headwater Riparian Habitat:** The scoring for this indicator is based on the percentage of forest or wetland areas within 100-feet of streams for the riparian areas upstream of the RPA boundaries.

**Wetland Habitat:** The scoring for this indicator is based on the percentage of wetland habitat. The wetland habitat was based on the National Wetlands Inventory and George Mason tidal wetland data.

**Terrestrial Forested Habitat:** The scoring for this indicator is based on the percentage of forested habitat based on the VDOF forested cover classifications.

***E. Coli*:** The scoring for this indicator is based on the average of all reported *E. coli* concentrations per 100 mL. This data was based on the number of *E. coli* per 100 milliliter (#/100mL) as reported in the EPA STORET database and fecal coliform per 100 milliliter (#/100mL). Additional bacteria data were obtained from available Fairfax County Health Department data. To maximize the amount of data employed for this metric, fecal coliform data were converted to *E. coli* concentrations using the Virginia Department of Environmental Quality (VADEQ) in-stream translator equation (VDEQ, 2003).

**Upland Sediment:** The scoring for this indicator is based on the modeled average annual sediment load in tons/acre/yr.

**Nitrogen:** The scoring for this indicator is based on the modeled average annual nitrogen load in pounds/acre/yr.

**Phosphorus:** The scoring for this indicator is based on the modeled average annual phosphorus load in pounds/acre/yr.

Table 2-2 lists the selected indicators, noting the indicator type and the objective(s) each indicator is linked to.

**Table 2-2. Countywide Watershed Impact Indicators**

| Indicator | Predictive | Linked to Objectives |
|---|---|---|
| Benthic Communities | No | 1A, 2B, 3A |
| Fish Communities | No | 1A, 2B, 3A |
| Aquatic Habitat | No | 1A, 2A |
| Channel Morphology | Yes | 1A |
| Instream Sediment | No | 1A, 3A, 4B |
| Residential Building Hazards | Yes | 1B |
| Non-residential Building Hazards | Yes | 1B |
| Flood Complaints | No | 1B |
| RPA Riparian Habitat | Yes | 2A |
| Headwater Riparian Habitat | Yes | 2A |
| Wetland Habitat | Yes | 2A |
| Terrestrial Forested Habitat | Yes | 2A |
| E. Coli | No | 3A, 4A |
| Upland Sediment | Yes | 3A, 4A, 4B |
| Nitrogen | Yes | 3A, 4A |
| Phosphorus | Yes | 3A, 4A |

### 2.2.2 Source Indicators

The watershed impact indicators provide information on how endpoints of watershed processes are impacted by adverse watershed conditions. The source indicators will assist in the evaluation of the sources and stressors that impact these watershed endpoints as well. The recommended source indicators are described below:

- Channelized/Piped Streams – percent channelized/piped by stream length
- Directly Connected Impervious Area (DCIA) (predictive) - % DCIA
- Impervious Surface (predictive) - % Impervious
- Stormwater Outfalls – number of stormwater outfalls per mile of stream length
- Parcels Served by Septic Tanks – number of parcels served per square mile
- Streambank Buffer Deficiency - % buffer area disturbed (non-forest buffer area)
- Total Nitrogen Load (predictive) – see watershed impact indicator for nitrogen
- Total Phosphorus Load (predictive) – see watershed impact indicator for phosphorus

- Total Suspended Sediment Load (predictive) – see watershed impact indicator for sediment
- Total Urban Land Cover (predictive) – % urban land cover (low, medium and high density residential; low and high intensity commercial; institutional; industrial; and transportation)
- Virginia Pollutant Discharge Elimination System (VPDES) Permitted Point Sources – number of point sources per square mile

These indicators were scored and combined to determine objective composite scores and overall composite scores. These scores were used to compare the subwatersheds with respect to the objectives.

### 2.2.3 Programmatic Indicators

A third set of indicators, termed "Programmatic Indicators," will also be used to help evaluate watershed management needs. These indicators illustrate the extent and location of existing and past management efforts. The following types of management in each watershed will be inventoried in the WMA:

- Detention Facilities
- Stream Restoration
- Riparian Buffer Restoration
- BMP Facilities
- Low Impact Development
- Inspection and Maintenance of Stormwater Management Facilities
- Inspection and Repair of Stormwater Infrastructure and Outfalls
- Dumpsite Removal
- Regional Ponds
- Volunteer Monitoring
- Subarea Treatment (used in watershed modeling studies)

Data for these indicators will be considered during identification and evaluation of watershed management needs, but were not considered in the composite scoring described above.

## 2.3 Johnny Moore Creek Watershed (Johnny Moore Creek and Johnny Moore Creek – Bull Run WMAs)

### 2.3.1 WMA Characteristics

The Johnny Moore Creek and Johnny Moore Creek – Bull Run WMAs are combined in this summary. The Johnny Moore Creek –Bull Run WMA drains directly into Bull Run and is adjacent to and surrounded on three sides by the Johnny Moore Creek watershed. It is relatively undeveloped and much smaller than the Johnny Moore Creek WMA. The Johnny Moore Creek WMA has an area of approximately 3,213 acres (5.0 $mi^2$) and the Johnny Moore Creek –Bull Run WMA has an area of approximately 161 acres (0.25 $mi^2$). The Johnny Moore Creek watershed is located in southern Fairfax County and is bounded to the north by Braddock Road and to the south by Bull Run. Union Mill Road is its approximate western boundary and its eastern boundary extends from the intersection of Colchester Road and Braddock Road to the southern end of Balmoral Forest Road.

The Johnny Moore Creek WMA includes 19.0 miles of perennial streams and the Johnny Moore Creek – Bull Run WMA includes 0.7 miles of perennial streams. The streams flow generally in a southwest direction through predominantly open space and low density residential areas. Johnny Moore Creek flows into Bull Run upstream of the Norfolk Southern Railway Crossing of Bull Run.

In the *Occoquan Environmental Baseline Report (February 1978)* severe erosion was noted in one location downstream of Twin Lakes Drive, two locations downstream of Compton Road and the power line and one location near the confluence with Polecat Branch. The report also noted severe sedimentation on Polecat Branch upstream of the power line. In the erosion areas noted by the *Occoquan Environmental Baseline Report* in 1978 at Twin Lakes Drive, Compton Road and the power line, the banks remain moderately unstable with scattered vegetation; however these areas were not flagged for severe erosion in 2005. The *Stream Physical Assessment (August 2005)* data reflects erosion areas downstream of Polecat Branch and near the confluence with Bull Run. The severe sedimentation on Polecat Branch upstream of the power line noted in the 1978 *Occoquan Environmental Baseline Report* is consistent with the 2005 *Stream Physical Assessment* that also noted severe sedimentation on Polecat Branch upstream of Balmoral Forest Road and also on three other tributaries to Johnny Moore Creek.

### 2.3.2 Existing and Future Land Use

The existing land use in the Johnny Moore Creek and Johnny Moore Creek – Bull Run WMAs consists primarily of open space and estate residential. This is because both of the WMAs are located in the Residential-Conservation (R-C) District where development is limited to one dwelling unit per 5 acres. This area was rezoned by the Fairfax County Board of Supervisors in 1982 to protect the Occoquan Reservoir. The Johnny Moore Creek WMA is currently 40 percent estate residential development and 36 percent open space. The Johnny Moore Creek – Bull Run WMA is currently 63 percent open space and 26 percent low density residential development. Most of the Twin Lakes Golf Course and the Westfields Golf Course at Balmoral are located in the Johnny Moore Creek WMA. A summary of the land use in the WMAs can be found in Table 2-3.

Comparing existing land use to future land use, 614 acres or 19% of the WMA shifts from open space to estate residential in Johnny Moore Creek. In the Johnny Moore Creek – Bull Run WMA, 4 acres or 2% of the WMA shifts from open space to estate residential. Map 2-2 shows the existing and future conditions land use in the Johnny Moore Creek watershed.

**Table 2-3. Existing and Future Land Use in Johnny Moore Creek**

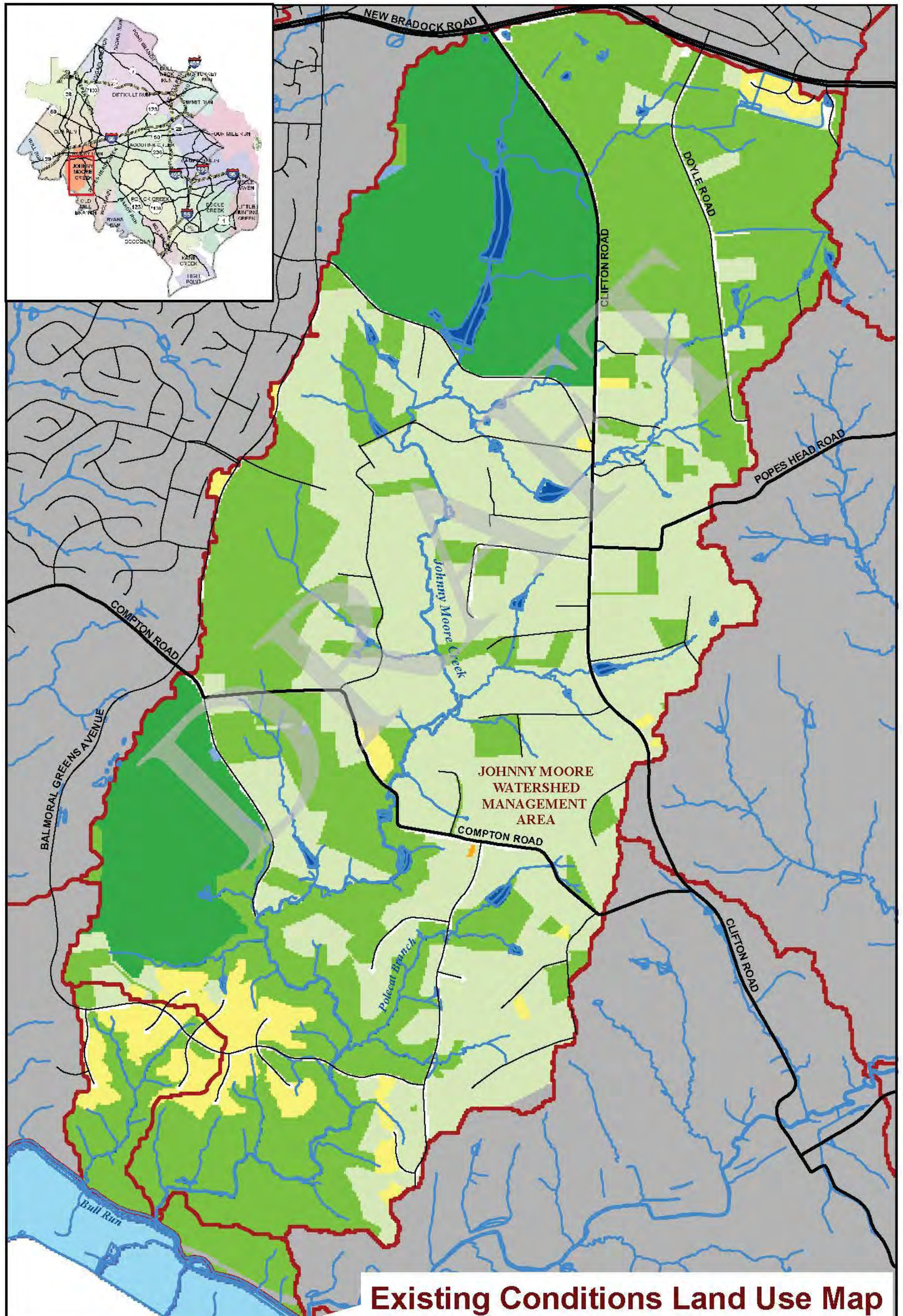
**Johnny Moore Creek WMA**

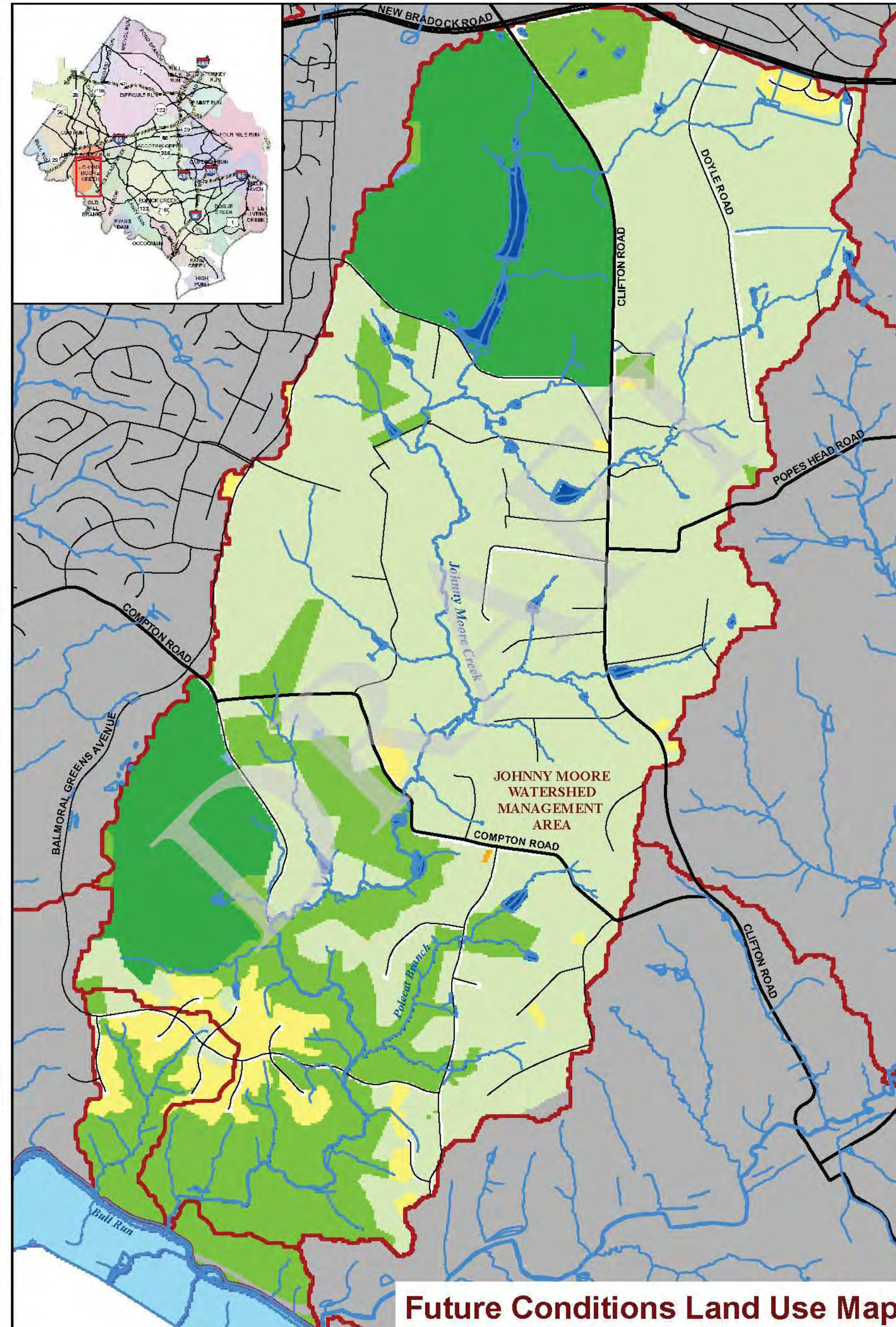
| Land Use Type | Existing | | Future | | Change | |
|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % |
| Estate Residential (ESR) | 1291 | 40% | 1905 | 60% | 614 | 19% |
| Low Density Residential (LDR) | 100 | 3% | 100 | 3% | 0 | 0% |
| Medium Density Residential (MDR) | 0 | 0% | 0 | 0% | 0 | 0% |
| High Density Residential (HDR) | 0 | 0% | 0 | 0% | 0 | 0% |
| Low Intensity Commercial (LIC) | 0 | 0% | 0 | 0% | 0 | 0% |
| High Intensity Commercial (HIC) | 0 | 0% | 0 | 0% | 0 | 0% |
| Industrial (IND) | 4 | 0% | 4 | 0% | 0 | 0% |
| Institutional (INT) | 2 | 0% | 2 | 0% | 0 | 0% |
| Golf Course (GC) | 534 | 17% | 534 | 17% | 0 | 0% |
| Open Space (OS) | 1137 | 36% | 523 | 16% | -614 | -19% |
| Water (W) | 49 | 2% | 49 | 2% | 0 | 0% |
| Transportation (T) | 79 | 2% | 79 | 2% | 0 | 0% |
| **Total** | **3200** | **100%** | **3200** | **100%** | | **0%** |

**Johnny Moore Creek - Bull Run WMA**

| | Existing | | Future | | Change | |
|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % |
| Estate Residential (ESR) | 4 | 3% | 8 | 5% | 4 | 2% |
| Low Density Residential (LDR) | 40 | 26% | 40 | 26% | 0 | 0% |
| Medium Density Residential (MDR) | 0 | 0% | 0 | 0% | 0 | 0% |
| High Density Residential (HDR) | 0 | 0% | 0 | 0% | 0 | 0% |
| Low Intensity Commercial (LIC) | 0 | 0% | 0 | 0% | 0 | 0% |
| High Intensity Commercial (HIC) | 0 | 0% | 0 | 0% | 0 | 0% |
| Industrial (IND) | 4 | 3% | 4 | 3% | 0 | 0% |
| Institutional (INT) | 0 | 0% | 0 | 0% | 0 | 0% |
| Golf Course (GC) | 0 | 0% | 0 | 0% | 0 | 0% |
| Open Space (OS) | 99 | 63% | 95 | 61% | -4 | -2% |
| Water (W) | 1 | 1% | 1 | 1% | 0 | 0% |
| Transportation (T) | 7 | 5% | 7 | 5% | 0 | 0% |
| **Total** | **156** | **100%** | **156** | **100%** | | **0%** |

The total impervious area (includes all paved areas and building rooftops) for the Johnny Moore Creek WMA is 117 acres or 3.6 percent of the WMA and for the Johnny Moore Creek – Bull Run WMA the total impervious area is 8 acres or 4.9 percent of the WMA. In general, low amounts of impervious surface indicate good stream water quality.




# Map 2-2
# Existing and Future Land Use Maps

## Johnny Moore Creek and Johnny Moore Creek - Bull Run Watershed Management Areas

### Legend

Streams

Major Roads

**Watershed Management Areas**

**WMA**

Johnny Moore WMAs

Other WMAS

### Land Use

Estate Residential

Low Density Residential

Medium Density Residential

High Density Residential

Low Intensity Commercial

High Intensity Commercial

Industrial

Institutional

Golf Course

Open Space

Water

Transportation

COUNTY OF FAIRFAX 1742 VIRGINIA

N

**Scale**

0 1,000 2,000 Feet

### 2.3.3 Stormwater Infrastructure

Stormwater infrastructure in the WMAs consists of stormwater management facilities, storm sewer and other manmade stormwater conveyances. Stormwater management facilities provide control of stormwater runoff in two ways; by reducing the quantity of stormwater runoff and providing treatment to reduce pollution and thereby improve the quality of stormwater runoff. Stormwater management facilities are designed to improve water quality by reducing the erosive effects of stormwater runoff and by filtering or capturing pollutants in the facility. Earlier facilities (prior to 1980 in the Occoquan basins and prior to 1994 in the rest of the County) provide only water quantity reduction, while facilities constructed later may provide both water quantity and quality treatment or provide quality treatment alone.

There are 47 stormwater management facilities in the County records for the Johnny Moore Creek WMAs: 10 of these are dry ponds and 3 are wet ponds. From field reconnaissance and desktop assessment, it was determined that: 2 are not stormwater facilities, 1 appears to be a constructed wetland, 5 are golf course wet ponds, 14 are small farm ponds that were not designed for stormwater management, 3 are larger wet ponds or farm ponds on private property that were not designed for stormwater management and 9 are unknown because they were inaccessible to field staff. Map 2-3 shows the location of these facilities, locations of drainage complaints and the parcels covered by stormwater management.

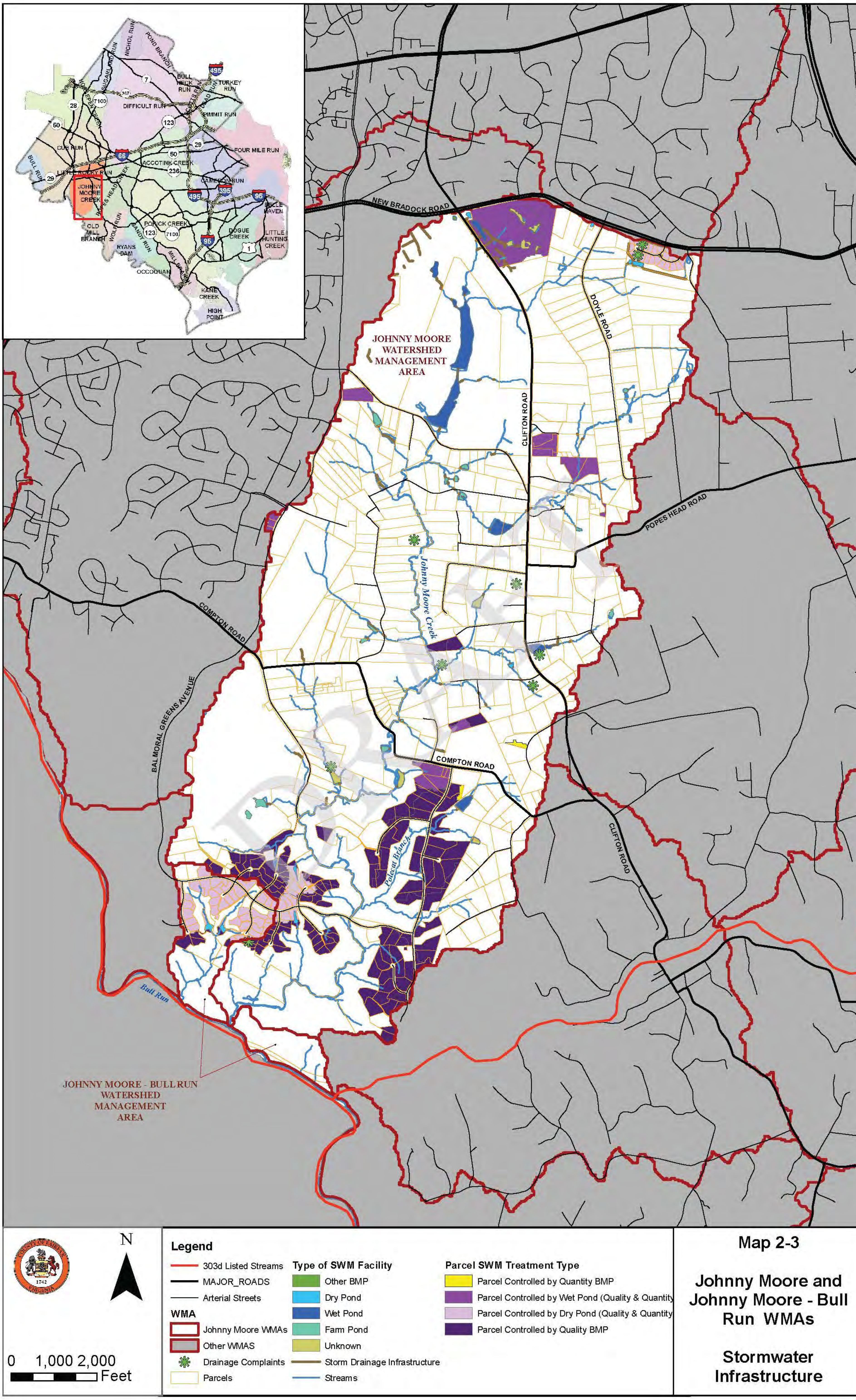
The primary land use in the WMAs is estate residential, where the lots are typically developed independently and may not have traditional stormwater management facilities. The stormwater treatment data for the WMAs is summarized in Table 2-4. Future estate residential development in the WMAs should be designed with adequate stormwater control in order to prevent water quality impacts downstream.

**Table 2-4. Stormwater Treatment Types in the Johnny Moore Creek WMAs**

| WMA Name | Current Percent Impervious | Current Treatment Types | | | |
|---|---|---|---|---|---|
| | | Quantity (acres) | Quality (acres) | Quantity/Quality (acres) | None (acres) |
| Johnny Moore | 3.6 | 2 | 188 | 114 | 2909 |
| Johnny Moore – Bull Run | 4.9 | 0 | 42 | 5 | 113 |
| **Total** | | 2 | 230 | 119 | 3022 |

There were 9 complaints related to stormwater in the County‟s complaints database in the WMAs. The classification of these complaints is summarized below:

- 8 Citizen Responsibility
- 1 Unclassified, but described as a cave-in by a pond




Map 2-3

Johnny Moore and Johnny Moore - Bull Run WMAs

Stormwater Infrastructure

### 2.3.4 Stream Condition

The County conducted a *Stream Physical Assessment* (SPA) in August 2005 that assessed the habitat, stream geomorphology and impacts to the streams from crossings, ditches, pipes, headcuts, dump sites, utilities and obstructions. Map 2-4 shows a summary of the SPA data.

11.7 miles of stream habitat in the Johnny Moore WMAs were assessed for the SPA. The results for this study are summarized below:

- Very Poor: 0.1 miles or 1%
- Poor: 1.8 miles or 15%
- Fair: 7 miles or 60%
- Good: 2.8 miles or 24%
- Excellent: 0 miles

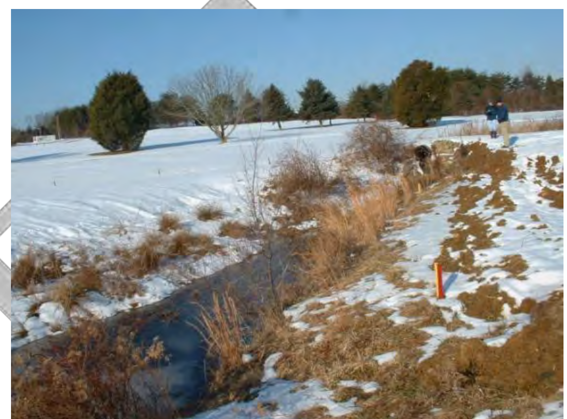
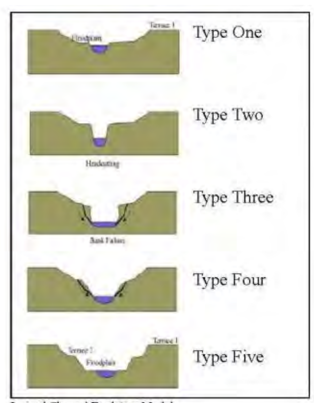


Figure 2-2: Very poor stream habitat segment – Twin Lakes Golf Course

The stream habitat segment classified as very poor in the above list (shown in Figure 2-2) is located within the Twin Lakes Golf Course and is an altered channel with little to no vegetated buffer. Stream segments with sections classified as "poor" for stream habitat are located on various tributaries to Johnny Moore Creek, but none are on the Johnny Moore Creek main stem.

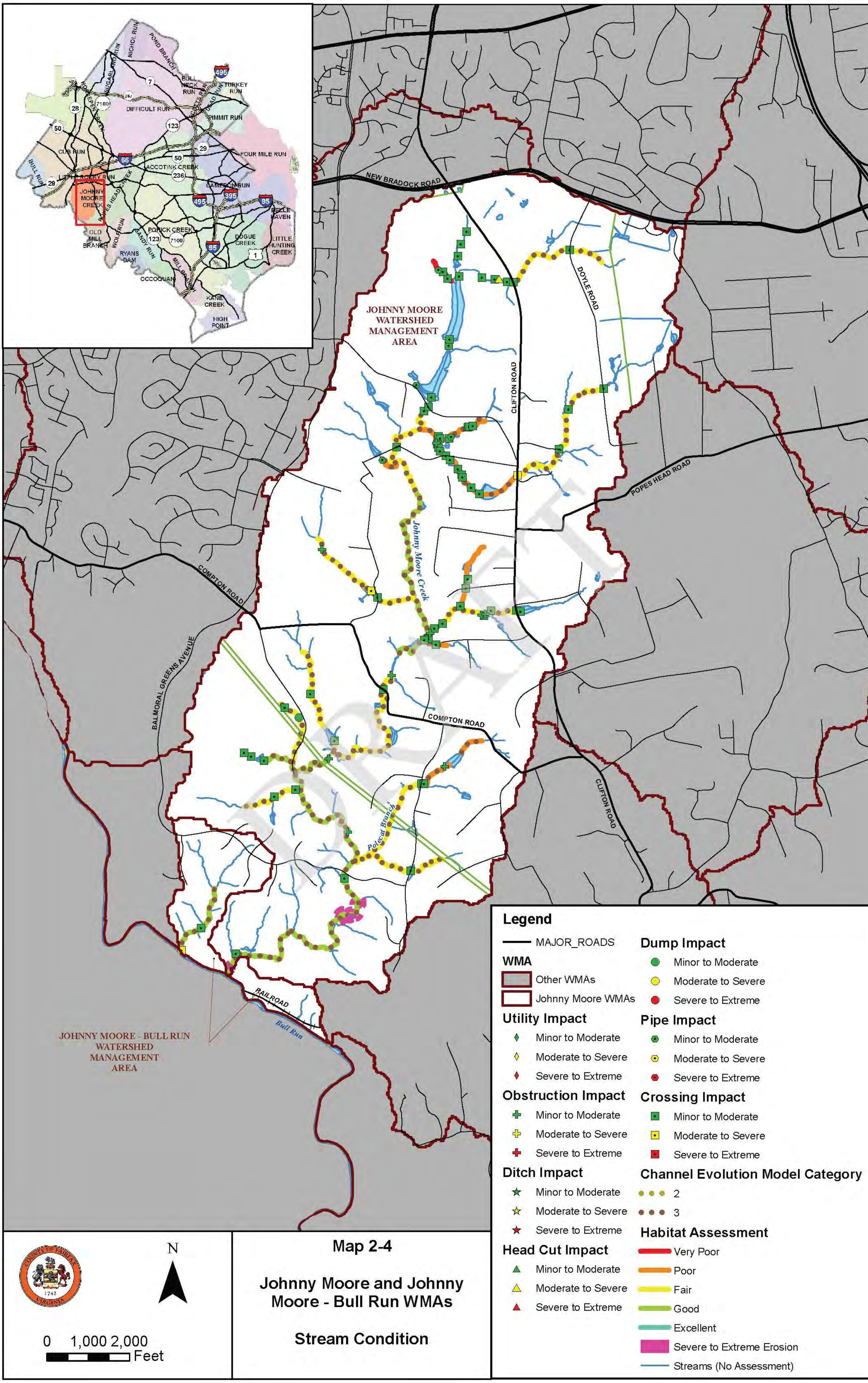
The geomorphological assessment of the stream channels in the WMAs were performed in 2003 and was based on the conceptual incised channel evolution model (CEM) developed by Schumm et al (1984). The CEM provides information about the evolution of a stream channel in response to disturbance. Based on visual observation of the channel cross section and other morphological observations of the channel segment, the CEM type was assigned for the channel segment. The CEM types are summarized below.

| CEM Type | Description |
|---|---|
| 1 | Stable stream banks and developed channel |
| 2 | Deep incised channel |
| 3 | Unstable stream banks and actively widening channel |
| 4 | Stream bank stabilizing and channel developing |
| 5 | Stable stream banks and widened channel |




Incised Channel Evolution Model (Schumm, Harvey, and Watson, 1984)

The CEM Types 2 and 3 are shown on the stream condition map because these types are considered the most unstable. In the WMAs, all of the assessed reaches are CEM Type 3, except for the tributary that crosses Fox Shadow Lane, which is a CEM Type 4.




**Map 2-4**

**Johnny Moore and Johnny Moore - Bull Run WMAs**

**Stream Condition**

The SPA noted two areas of moderate to extreme erosion on Johnny Moore Creek. One near the confluence with Bull Run and one approximately 800 feet downstream of Balmoral Greens Avenue. Photos of the two areas are shown in Figures 2-3 and 2-4 below.

Figure 2-3: Erosion area near confluence with Bull Run

Figure 2-4: Erosion area downstream of Balmoral Greens Avenue

The other impacts found in the SPA are summarized in Table 2-5.

**Table 2-5. SPA Impacts in the Johnny Moore Creek WMAs**

| Impact Type | Number | Comment |
|---|---|---|
| Utility | 0 | |
| Obstruction | 9 | All minor to moderate, includes 4 beaver dams |
| Ditch | 0 | |
| Headcut | 1 | 2" Headcut on tributary in Twin Lakes Golf Course |
| Dump | 1 | Appliances, Trash on tributary along Union Mill Rd (minor to moderate) |
| Pipes | 4 | Minor to Moderate |
| Crossings | 67 | 3 bridges, 4 box culverts, 32 circular culverts, 2 fords and 26 foot bridges<br>3 have moderate to severe impact (one ford, one box culvert and one circular pipe) |

The following pictures show some of the impacts found in the WMAs during the 2005 SPA.

Figure 2-5: Headcut on tributary located on Twin Lakes Golf Course

Figure 2-6: Dump Site on tributary along Union Mill Road (no longer there – see below)

Figure 2-7: Pipe Impact near confluence with Bull Run

### 2.3.5 Field Reconnaissance

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

During the field reconnaissance performed in June 2008, several areas of concern from 2005 were re-visited and were found to no longer exist. Most of the debris obstructions noted in 2005 had been removed or washed out. Prior to the 2008 field reconnaissance the area received unusually heavy rainfall. The rainfall likely contributed to the washing out of many beaver dams and natural stream obstructions that had previously existed. Evidence of this was observed throughout the watershed with large piles of branches and debris pushed to the side of channels. No evidence of dump sites observed in 2005 existed in 2008. A dump site identified in 2005 on a tributary along Union Mill Road where a hot tub was abandoned is no longer present.

Additionally, many new areas of concern were identified and inspected during the field reconnaissance. Bank erosion was one of the most common and significant impact types identified. Bank erosion was found to occur throughout the watershed and ranged from minor to severe in condition.

Severe erosion was observed on tributaries as well as the main stem of Johnny Moore Creek. The tributary located near the intersection of Clifton Road and Cedar Ridge Drive is experiencing severe erosion and headcuts. The following pictures show the erosion near the intersection.

Figure 2-8: Bank erosion in excess of 3ft on small tributary near Cedar Ridge Drive

Figure 2-9: Bank erosion in excess of 3ft on small tributary near Cedar Ridge Drive



Severe bank erosion was also observed along the main channel of Johnny Moore Creek near the Balmoral Greens neighborhood in the same location as noted in the 2005 SPA. The following pictures show an update of erosion occurring in this area.

Figure 2-10: Bank erosion in excess of 3ft on Johnny Moore Creek near Balmoral Greens Subdivision

Figure 2-11: Bank erosion in excess of 3ft on Johnny Moore Creek near Balmoral Greens Subdivision

A summary of the new impacts found in the 2008 field reconnaissance are displayed in Table 2-6.

**Table 2-6. New Impacts Identified in 2008 Field Reconnaissance**

| Impact Type | Number of Sites | Comment |
|---|---|---|
| Bank Erosion | 7 | Minor to sever erosion throughout watershed, effecting small tributaries to main channels |
| Obstruction | 4 | Minor to moderate, three man made and one natural, causing erosion and head cuts |
| Headcut | 1 | Minor cause by natural debris blockage |
| Wet Ponds | 25+ | Primarily privately owned, several in poor health due to overgrown vegetation, over fertilization and heavy sedimentation |
| Pipes | 2 | Minor to Moderate |
| Encroachments | 2 | Standing water is encroaching on Compton Rd and Doyle Rd at tributary crossings, these areas also provides a mosquito habitat |

The following pictures show examples of other significant impacts found in the watershed.

Figure 2-12: Standing water encroachment along Compton Rd.

Figure 2-13: Debris obstruction and headcut near Clifton Rd. and Cedar Ridge Dr.

Figure 2-14: Manmade obstruction near Clifton Rd. and Cedar Ridge Dr.

Figure 2-15: Pipe Impact near Clifton Rd. and Cedar Ridge Dr.

### 2.3.6 Modeling Results

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

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

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

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

The table below shows three storm events and the rationale for being modeled:

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

The County is using a customized version of the Environmental Protection Agency‟s (EPA‟s) Spreadsheet Tool for the Estimation of Pollutant Loads (STEPL). This customized program (STEPL-FFX) was built in Microsoft (MS) Excel Visual Basic for Application (VBA). It provides a user-friendly interface to create a customized spreadsheet-based model in MS Excel. It 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 (BMPs), including Low Impact Development (LID) practices for urban areas. It computes surface runoff; nutrient loads, including nitrogen, phosphorus and 5-day biological oxygen demand (BOD); and sediment delivery based on various land uses and management practices. The land uses considered are user-defined land uses from Fairfax County. For each watershed, the annual 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. The annual sediment load (from sheet and rill erosion only) is 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 BMP efficiencies.

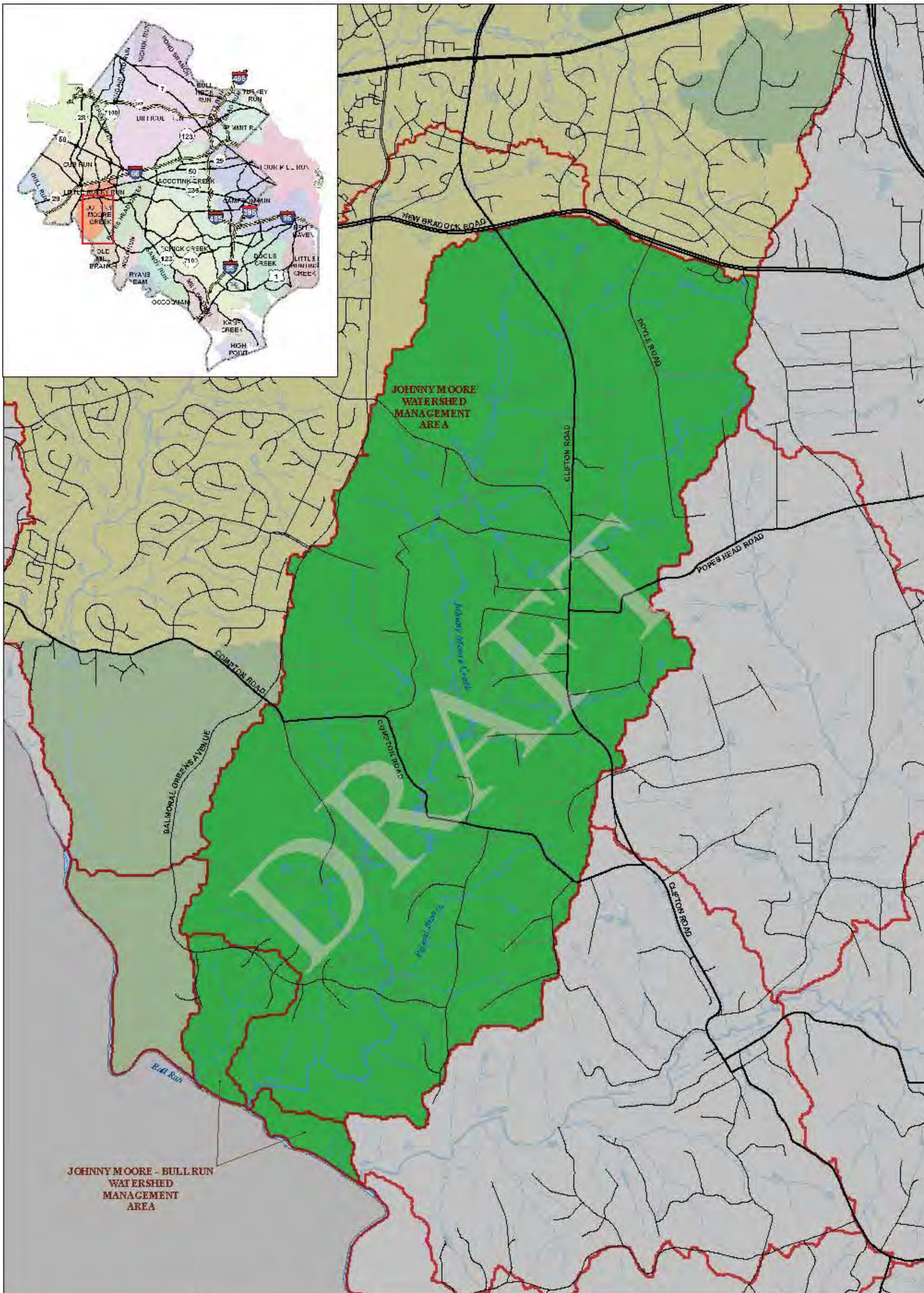
Existing Conditions water-quality data from the STEPL-FFX is shown on Maps 2-5, 2-6 and 2-7. The color gradient map symbols for pollutant loadings are the same for both the Johnny Moore and Little Rocky Run watersheds. Therefore, for Total Nitrogen (TN), Total Phosphorous (TP) and Total Suspended Solids (TSS), the Johnny Moore subwatersheds are producing relatively low loads. The water-quality analysis is driven by land use and the watershed is predominantly open space and low density/estate residential. With less impervious areas and more natural cover, the results are consistent with expectations. One item to note is that the field reconnaissance effort identified several gulley formations throughout the Johnny Moore Creek watershed, which will be included in an updated STEPL analysis for more accurate TSS loadings. While some open space will be converted to estate residential in the future, no changes associated with the County‟s 25-yr Comprehensive Plan will significantly impact pollutant loadings for this watershed.

Table 2-7 provides a summary of runoff peak values and pollutant loadings at the outlet of the WMA. The second table is normalized by contributing drainage area.

**Table 2-7. Johnny Moore Creek Stormwater Peak Values and Pollutant Loadings**

| WMA | Stormwater Runoff Peak Values | | Pollutant Loadings | | |
|---|---|---|---|---|---|
| | 2-yr storm (cfs) | 10-yr storm (cfs) | TSS (tons/yr) | TN (lbs/yr) | TP (lbs/yr) |
| Johnny Moore Creek | 542 | 1591 | 249.6 | 7102.5 | 1255.7 |
| **NORMALIZED BY DRAINAGE AREA** | | | | | |
| **WMA** | **Stormwater Runoff Peak Values** | | **Pollutant Loadings** | | |
| | **2-yr storm (cfs/acre)** | **10-yr storm (cfs/acre)** | **TSS (tons/acre/ yr)** | **TN (lbs/acre/ yr)** | **TP (lbs/acre /yr)** |
| Johnny Moore Creek | 0.169 | 0.495 | 0.078 | 2.211 | 0.391 |

The preliminary hydraulic model for Johnny Moore was developed using United States Army Corps of Engineers (USACE) Hydrologic Engineering Centers River Analysis System (HEC-RAS) to compute water surface profiles. The preliminary model results were used to analyze the water surface elevation and flooding of inline structures.




N

0 1,000 2,000 Feet

**Legend**

MAJOR_ROADS
Arterial Streets

**WMA**

Johnny Moore WMAs
Other WMAS
Streams

**STEPL Existing**

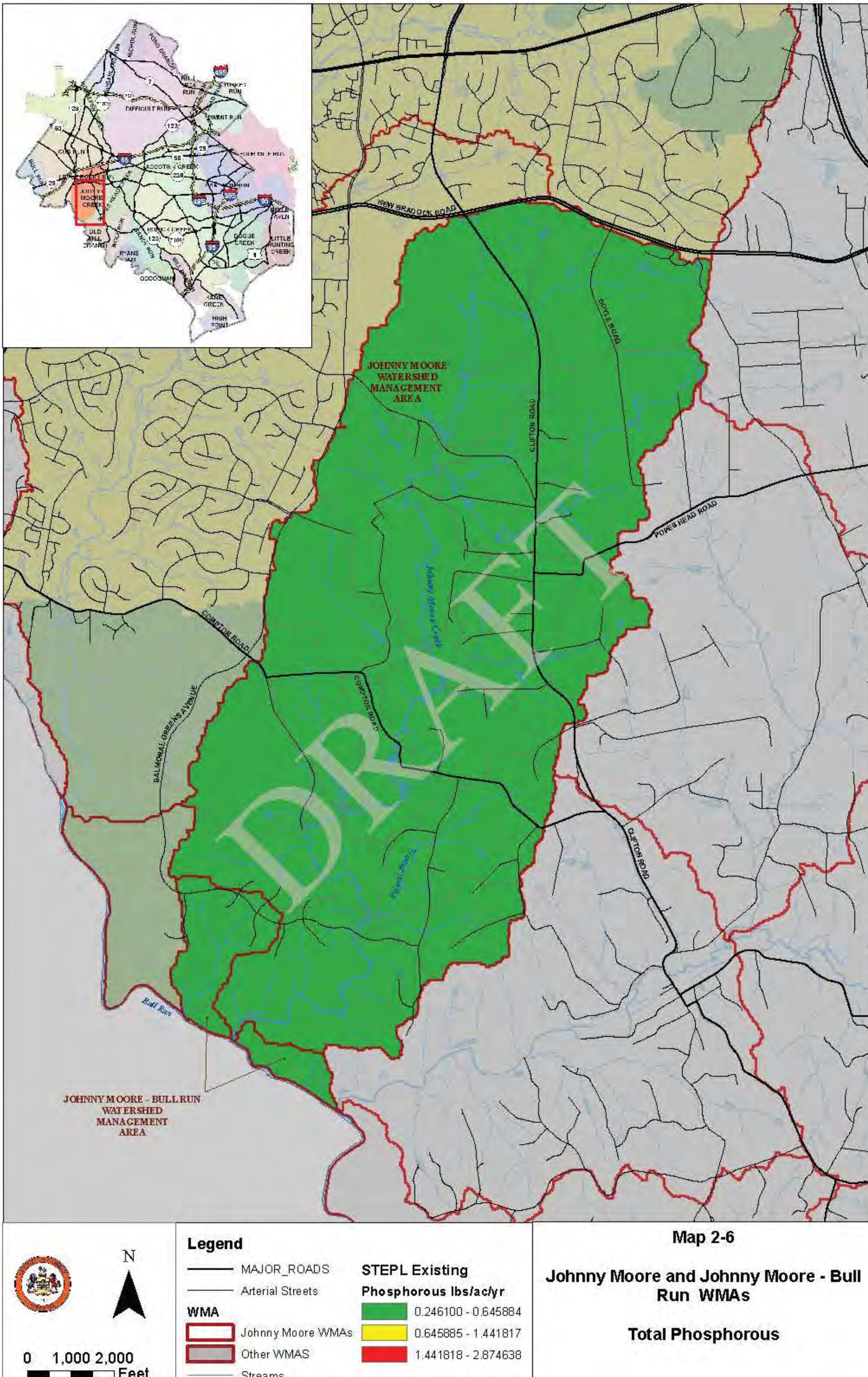
**Total Nitrogen lbs/ac/yr**

0.987500 - 4.287116
4.287117 - 9.069964
9.069965 - 17.802404

**Map 2-5**

**Johnny Moore and Johnny Moore - Bull Run WMAs**

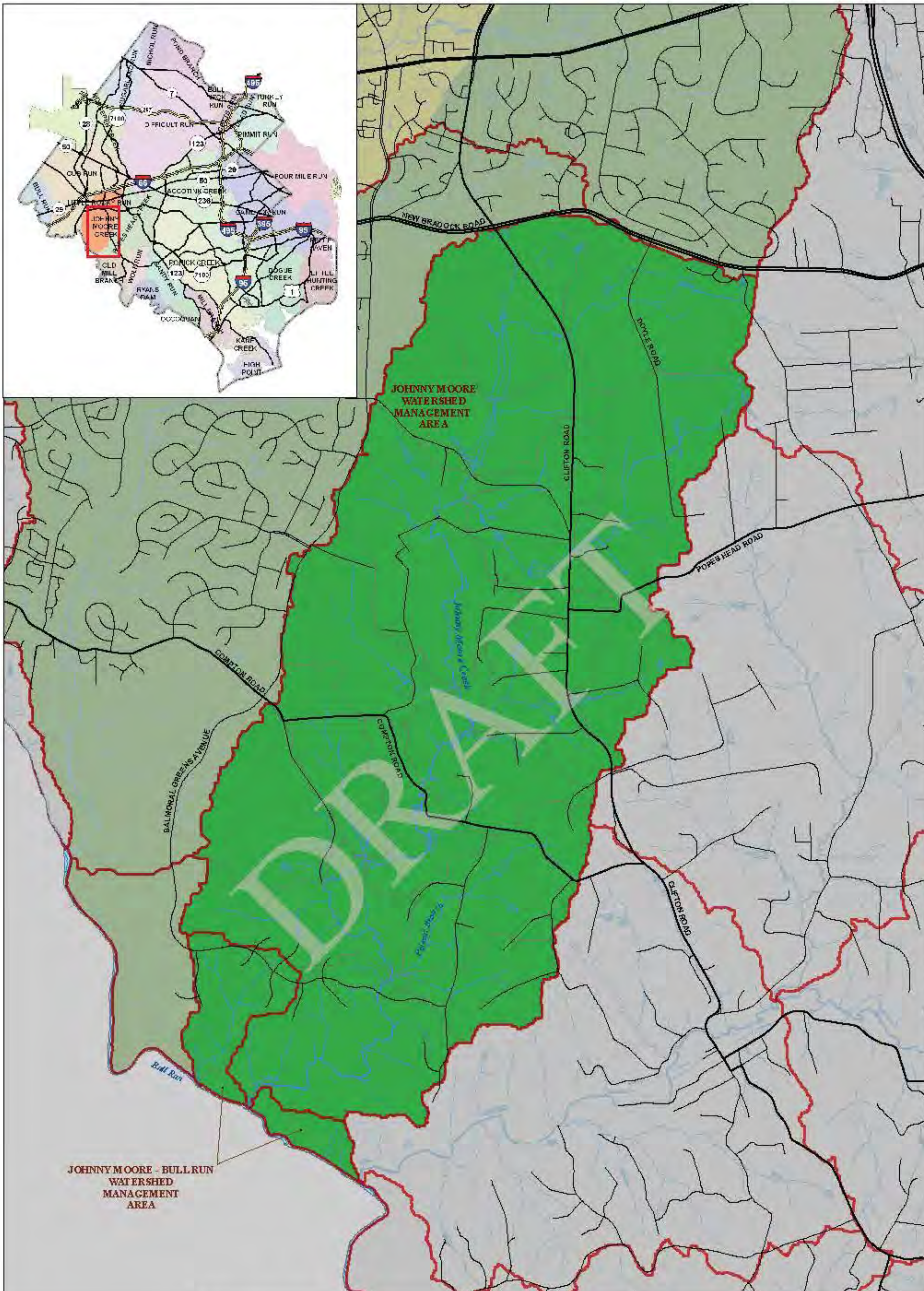
**Total Nitrogen**




**Map 2-6**

**Johnny Moore and Johnny Moore - Bull Run WMAs**

**Total Phosphorous**




N

0 1,000 2,000 Feet

**Legend**

MAJOR_ROADS

Arterial Streets

**WMA**

Johnny Moore WMAs

Other WMAS

Streams

**STEPL Existing**

**TSS t/ac/yr**

0.045347 - 0.180933

0.180934 - 0.316520

0.316521 - 0.452106

**Map 2-7**

**Johnny Moore and Johnny Moore - Bull Run WMAs**

**Total Suspended Solids**

The input data for the HEC-RAS model was extracted using HEC-GeoRAS. HEC-GeoRAS is a tool that processes the geospatial data within the County‟s GIS, specifically as it pertains to physical features such as stream geometry and flowpath so that these features can be represented in the model. HEC-RAS models were developed for study streams within Johnny Moore watershed using a naming convention unique for each reach. The study streams were defined as having a drainage area of at least 200 acres.

Bridge and Culvert crossings were coded according to available County or Virginia Department of Transportation (VDOT) engineering documents that depict the facility as it was actually built. Where not available, limited field reconnaissance was performed to obtain the crossing data. The crossing elevation data was determined relative to a point where the elevation could be estimated accurately from the County‟s topographic data.

Manning‟s „n‟ values, which represent surface roughness, were assigned to the channel and overbank portions of the studied streams based on field visits and aerial photographs.

The flow change locations were extracted from the EPA Storm Water Management Model (SWMM) developed to estimate preliminary stormwater runoff flow values. The 2-yr, 10-yr and 100-yr storm flows were determined at several locations in order to provide a detailed flow profile for the hydraulic model. Map 2-8 provides a graphical representation of the SWMM results for the 10-year storm discharge.

The 2-year storm discharge is regarded as the channel-forming or dominant discharge for the purposes of this study. This discharge is the flow value that transports the majority of a stream‟s sediment load and therefore actively forms and maintains the channel. A comparison of stream dynamics and channel geometry for the 2-year discharge provides insight regarding the relative stability of the system and helps to identify areas in need of restoration.

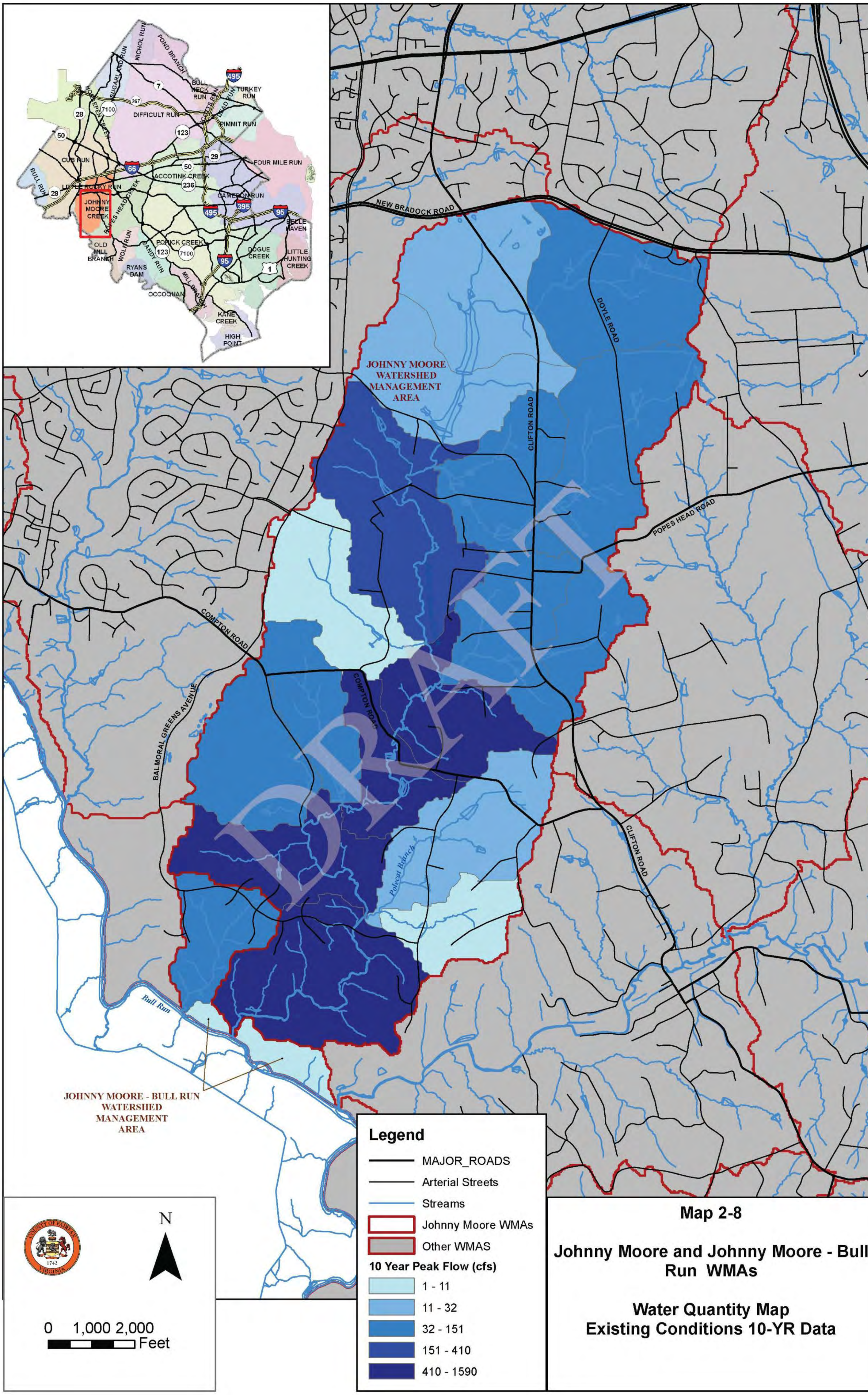
The 10-year storm discharge is being included to analyze the level of service of stream crossings. Occurring less frequently than the 2-year storm, the flood stage associated with this storm can result in more significant safety hazards to residents. All stream crossings (bridges and culverts) will be analyzed against this storm to see if they are performing at a level that safely passes this storm.

The 100-year storm discharge is used by the Federal Emergency Management Agency (FEMA) to map floodplain inundation zones and establish flood insurance rates. This provides a means to assess which properties are at risk to flooding and determine the appropriate insurance requirements for these at risk properties. The models developed to analyze the system for watershed planning have been built in compliance with FEMA standards in order to update the Flood Insurance Rate Maps for Fairfax County where appropriate.

In summary, the preliminary results for HEC-RAS are as follows:

- 3 stream road crossings in the watershed do not have the capacity to pass the 10-year storm without the road being over topped.
- The 2-year storm exceeds the channel banks in several locations.
- No residential structures are within the modeled 100-year flood inundation zone.

The limit of the 100-year flood is graphically represented in Map 2-9.


DULLES TOLL RD
SUGARLAND RUN
NICHOL RUN
POND BRANCH
HORSEPEN CREEK
BULL NECK RUN
TURKEY RUN
DIFFICULT RUN
DEAD RUN
SCOTTS RUN
PIMMIT RUN
CUB RUN
FOUR MILE RUN
ACCOTINK CREEK
BULL RUN
LITTLE ROCKY RUN
CAMERON RUN
JOHNNY MOORE CREEK
POPES HEAD CREEK
BELLE HAVEN
OLD MILL BRANCH
WOLF RUN
POHICK CREEK
SANDY RUN
DOGUE CREEK
LITTLE HUNTING CREEK
RYANS DAM
MILL BRANCH
OCCOQUAN
KANE CREEK
HIGH POINT
NEW BRADOCK ROAD
DOYLE ROAD
JOHNNY MOORE WATERSHED MANAGEMENT AREA
CLIFTON ROAD
POPES HEAD ROAD
COMPTON ROAD
BALMORAL GREENS AVENUE
Polecat Branch
Bull Run
JOHNNY MOORE - BULL RUN WATERSHED MANAGEMENT AREA
DRAFT
N
0 1,000 2,000 Feet
Legend
MAJOR_ROADS
Arterial Streets
Streams
Johnny Moore WMAs
Other WMAS
10 Year Peak Flow (cfs)
1 - 11
11 - 32
32 - 151
151 - 410
410 - 1590
Map 2-8
Johnny Moore and Johnny Moore - Bull Run WMAs
Water Quantity Map
Existing Conditions 10-YR Data


N

0 1,000 2,000 Feet

**Legend**

- Preliminary 100 YR Floodplain Boundary
- Major Roads
- Arterial Streets

**WMA**

- Johnny Moore WMAs
- Other WMAS
- Streams

**Map 2-9**

**Johnny Moore and Johnny Moore - Bull Run WMAs**

**Preliminary 1% Annual Chance Floodplain Boundary**

### 2.3.7 Subwatershed Ranking

It should be noted that all designations of the preliminary ranking results are relative to the area studied for this report. In other words, a „low quality" designation does not necessarily indicate a poor quality subwatershed, only relative to the 51 other subwatersheds in the Little Rocky Run/Johnny Moore Creek watersheds.

The Johnny Moore Creek WMA contains mostly high quality subwatersheds as summarized on maps 2-33 (Objective Composite Score) and 2-34 (Source Composite Score). Maps 2-26 to 2-32 describe more specific objective criteria, which have been weighted to determine the objective composite score. Please refer to section 2.2 for a more detailed description of impact, source and programmatic indicators and how they are being used to characterize the subwatersheds.

The main stressors in this WMA come from two golf courses, which tend to result in higher pollutant loadings while also having a negative impact on natural stream buffers. Also, noted in the SPA and in the field reconnaissance, there are many gulley formations and unstable banks throughout this watershed, which will increase sediment load, impacting aquatic life throughout the watershed. Otherwise, this watershed is of higher quality than its Little Rocky Run counterparts because of significant land use differences. The predominant Low Density Residential/Open Space watershed results in more natural measures protecting watershed health.

More specifically, the color gradient for Map 2-26 reflects that Lower Little Rocky is rated higher for „Stormwater Runoff" than Johnny Moore, which is atypical. Stormwater Runoff is determined from equal weights of 5 indicators, including Benthic Communities, Fish Communities, Aquatic Habitat, ICEM Class and Instream Sediment Loading. One item contributing to this WMA scale anomaly is the Fish Communities Indicator. Though community values were similar (ranging from 25 to 31 across 5 sites), the threshold value of 28 used in the ranking gave the Johnny Moore sites a lower score than Little Rocky Run Lower. Also, as noted previously, the SPS/SPA study revealed several reaches in Johnny Moore are experiencing streambank sloughing and are in an active erosive state. Lower scores for ICEM and Instream Sediment are recorded as a result. The remaining two attributes (Benthic Communities and Aquatic Habitat) were comparable.