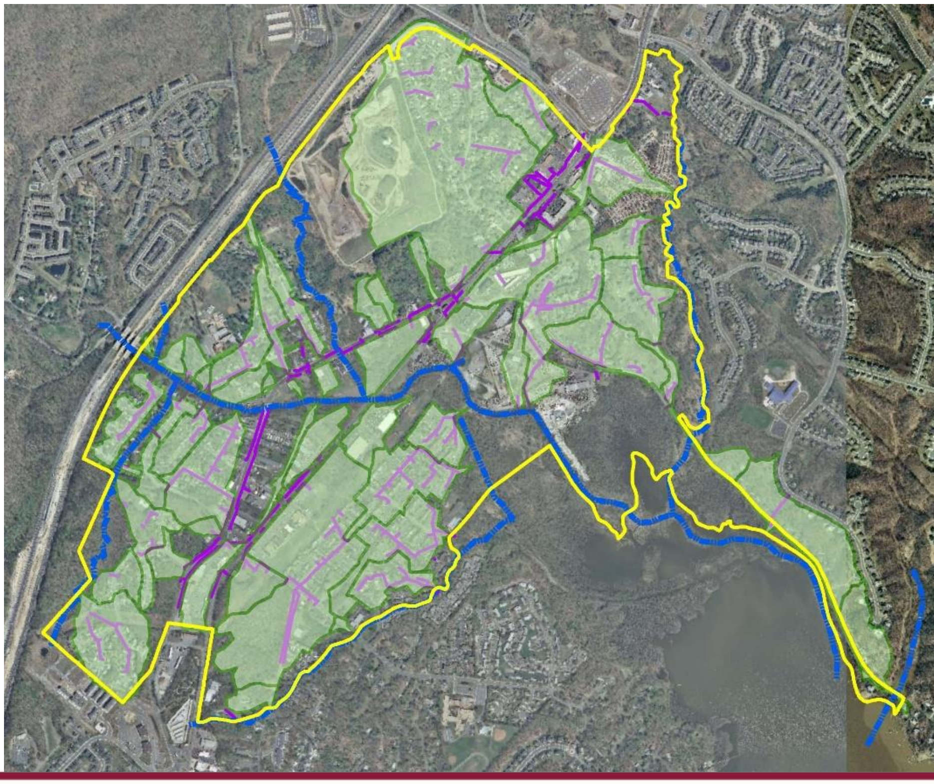
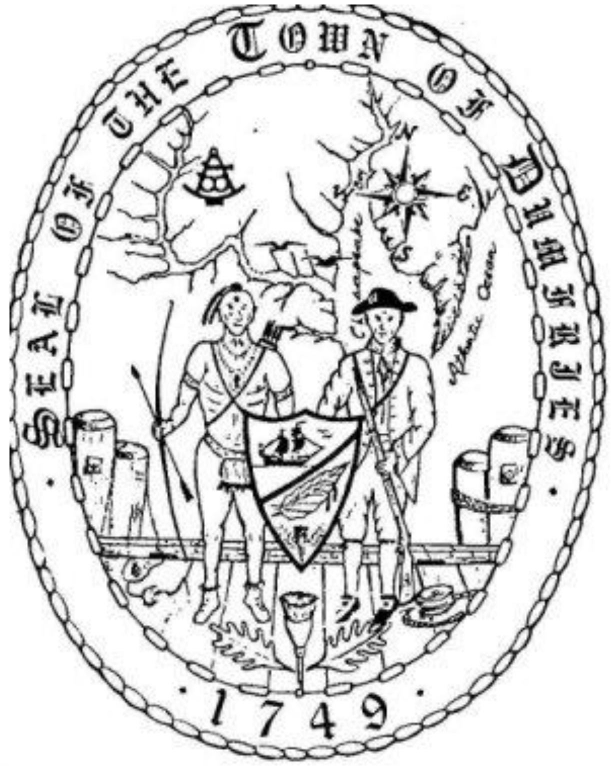
LOCAL TMDL ACTION PLAN

MS4 Permit Cycle 2013 - 2018
Town of Dumfries





PREPARED FOR:

Town of Dumfries
17755 Main Street
Dumfries, Virginia 22026

April 4, 2016

Draper Aden Associates
Engineering • Surveying • Environmental Services

DAA Project Number: **B15147-01**

3RD PARTY REVIEW

This Report has been subjected to technical and quality reviews by:

		4/4/2016
Name: Clint Pendleton, EIT Project Engineer	Signature	Date

		4/4/2016
Name: Carolyn A. Howard, PE Project Manager	Signature	Date

		4/4/2016
Name: Lindsay B. Lally, PE Quality Reviewer	Signature	Date

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1.0 INTRODUCTION

Since 2003, the Town of Dumfries (Town) has been subject to the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit). In general, the MS4 permit regulates existing storm sewer systems to reduce the potential for stormwater pollution. The permit also requires compliance for systems discharging to a waterbody with a Total Maximum Daily Load (TMDL) that assigns a Waste Load Allocation (WLA) to the permit holder. The permit holder must prepare a TMDL Action Plan to reduce the applicable pollutants of concerns (POC) through the construction of structural stormwater BMPs, non-structural operational measures, or a combination of the two.

Currently, there are two TMDLs with WLA reduction requirements for the Town – 1) the Chesapeake Bay TMDL and 2) an *E. coli* TMDL for Quantico Creek. Refer to Appendix A for the "Bacteria Total Maximum Daily Load (TMDL) Development for Tributaries to the Potomac River: Prince William and Stafford Counties" report, which includes the TMDL for Quantico Creek. This report assigned the WLA for *E. coli* to the Town and specifies that the load from the Town includes VDOT. The Chesapeake Bay TMDL Action Plan will be developed as a separate document.

DEQ issued a guidance document for compliance with local TMDLs. "Local TMDL MS4 Guidance" was issued May 29, 2015 as a draft; refer to Appendix B.

2.0 WATERSHED ANALYSIS

The Quantico Creek watershed and its relation to the Town is shown in Figure 1.

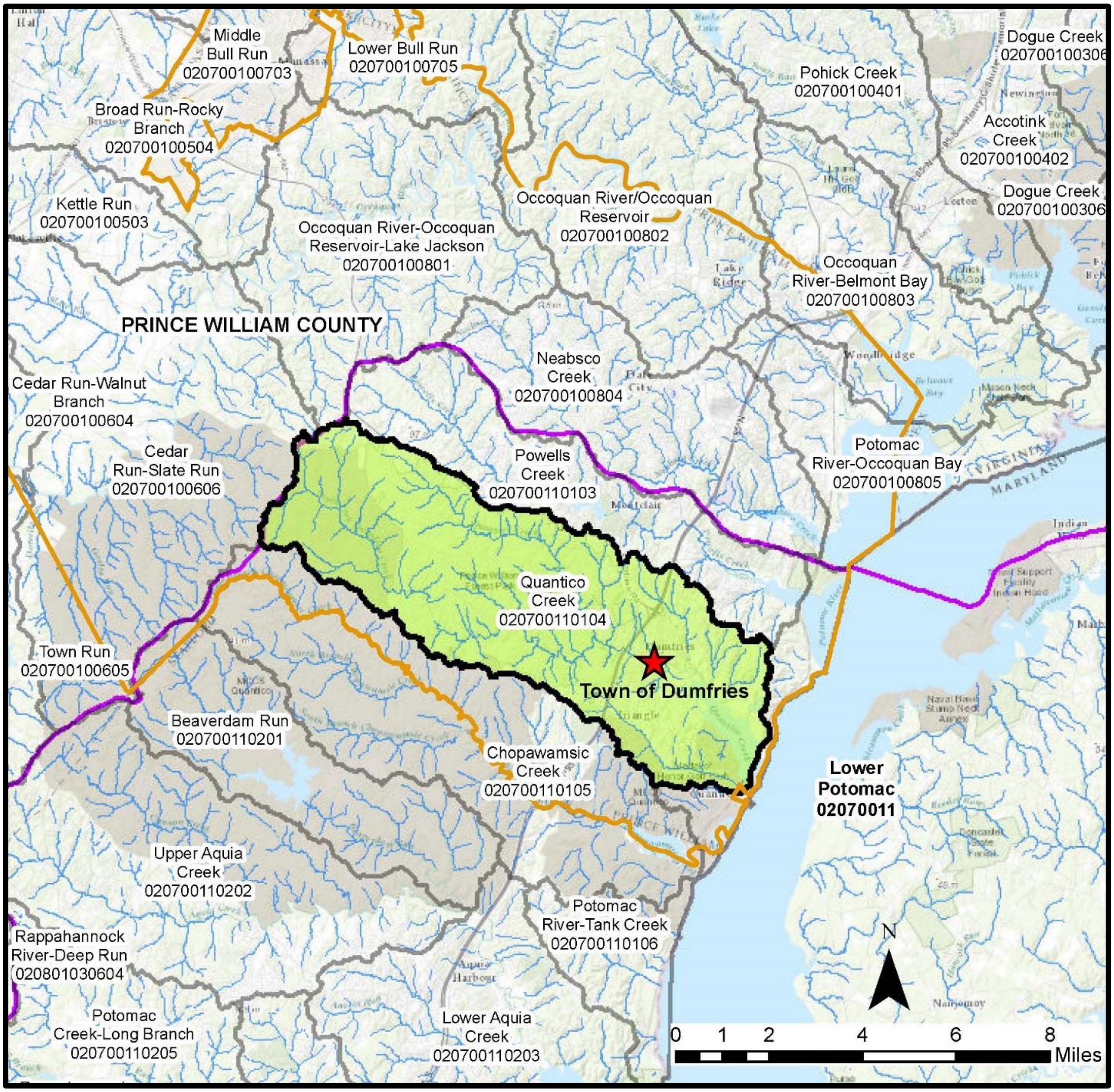

Figure 1: Quantico Creek Watershed

A map of the Town and MS4 service area within the TMDL watershed is attached in Appendix C. Approximately 986.93 acres of the Quantico Creek Watershed lies within the Town's boundary, of which 575.57 acres is within the Town's MS4 service area.

3.0 SOURCE ANALYSIS

The TMDL included data from one (1) sampling point - Station1aQUA004.46 - located at the Route 1 (Business) bridge crossing of Quantico Creek. 27 samples were taken at this station from January 1, 2003 – December 31, 2008; 7 out of 27 samples (26%) exceeded the maximum water quality assessment criterion (235 cfu/100ml) for E. coli.

According to the TMDL Report Section 1.4.2.2, the primary sources of E. coli are wildlife and residential waste under both wet weather, high flow and dry weather, low flow conditions. Therefore, the Action Plan must address both conditions.

3.1 Local E. Coli Sampling

The Prince William County Soil & Water Conservation District collects and reports the results of E. coli sampling along Quantico Creek. There are four (4) sampling locations adjacent to or within the Town limits; refer to Figure 1 taken from page 15 of the Town of Dumfries MS4 Annual Report dated November 10, 2014.

- D1: Upstream of I-95
- D2: Downstream of I-95
- D3: Downstream of southbound US Route 1
- D4: Downstream of northbound US Route 1

Of the 100 samples taken from July 1, 2013 to June 22, 2014, 24 (16 from D3 and D4) exceeded the maximum water quality assessment criterion (235 cfu/100ml) for E. coli.

Coliscan Sampling Results

Site	D1	D2	D3	D4	Rainfall past 24 Hours (")
Lat	38.56861	38.56775	38.56586	38.5661	
Long	-77.33592	-77.33481	-77.329	-77.32437	
	E coli Colony Forming Units per 100 mL				
7/1/2013	125	100	950	775	0.53
7/17/2013	175	125	325	850	none
8/5/2013	25	50	50	50	none
8/19/2013	200	350	150	100	0.84
9/2/2013	20	20	20	20	0.1
9/7/2013	25	50	300	275	none
10/11/2013	1950	1750	3200	3050	0.9
10/28/2013	20	20	20	25	none
11/17/2013	50	20	25	20	0.3
12/15/2013	50	50	75	175	0.3
12/29/2013	1200	750	1125	975	1.31
1/15/2014	50	20	75	25	0.2
1/26/2014	20	20	20	20	0.02
2/1/2014	20	20	20	20	none
2/17/2014	20	25	20	20	none
3/16/2014	20	20	25	75	none
3/29/2014	50	20	100	25	0.22
4/14/2014	25	20	20	50	0.16
4/15/2014	950	650	925	975	0.67
4/29/2014	100	75	150	600	0.38
4/30/2014	350	20	325	375	2.6
5/21/2014	75	75	25	25	0.02
6/3/2014	50	25	50	20	none
6/14/2014	75	75	200	250	0.56
6/22/2014	20	20	25	25	0.16

Figure 1

3.2 Residential Waste

Leaks, overflows, and illicit connections from sanitary sewers are a potential source of observed bacteria. There are no known overflows or illicit discharges within the Town limits; Prince William County Health Department does not have information regarding properties with septic systems or illicit discharges.

Additionally, improper disposal of pet waste can be a potential source of observed bacteria in the watershed. The Town has a detailed Public Education and Outreach Program (Appendix D) specifically designed to address and minimize impacts of pet waste on Quantico Creek. The plan incorporates written material and active engagement of citizens.

> *The brochure will address pet waste as a major source of the bacteria found in waters within the Town that needs to be reduced. Topics that will be addressed: Why pet waste is a concern; how it can impact local water by affecting bacteria levels; and simple ways to keep pet waste out of water. Local contact information and sources for additional information will be included.*
>
> *Brochures will be distributed to HOAs within the MS4 permit area along with a cover letter explaining the importance of the brochure and its intended use. Follow-up with communication with HOA points of contact will be critical to ensuring effectiveness.*

3.3 Wildlife

The TMDL specifically cites wildlife as a potential source of observed bacteria in the watershed. There are no known elimination programs through DEQ or EPA to eliminate the wildlife source of E. coli. Therefore, this Action Plan will focus on reducing residential / pet waste sources.

4.0 ACTION PLAN COMPONENTS

4.1 General

The following is a summary of the required Local TMDL Action Plan components as provided in the latest DEQ guidance document; refer to Appendix B.

4.1.1 The name(s) of the Final TMDL report(s)

Bacteria Total Maximum Daily Load (TMDL) Development for Tributaries to the Potomac River: Prince William and Stafford Counties

4.1.2 The pollutant(s) causing the impairment(s): E coli.

4.1.3 The WLA(s) assigned to the MS4 as aggregate or individual WLAs:

3.37E+09 cfu/day or 1.23E+12 cfu/year for E. coli shared by the Town and the Virginia Department of Transportation (VDOT)

4.1.4 Significant sources of POC(s) from facilities of concern owned or operated by the MS4 operator that are not covered under a separate VPDES permit. A significant source of pollutant(s) from a facility of concern means a discharge where the expected pollutant loading is greater than the average pollutant loading for the land use identified in the TMDL.

Based on an analysis of the Town's property located within the TMDL watershed, there are no significant sources where the expected pollutant loading is greater than the average pollutant loading for the land use identified in the TMDL.

4.1.5 Existing or new management practices, control techniques, and system design and engineering methods, that have been or will be implemented as part of the MS4 Program Plan that are applicable to reducing the pollutant identified in the WLA.

Refer to section 3.1 of this Action Plan. Additionally, the Town tests for E. coli a minimum of once per month at four (4) sampling points within the Town. Sampling results are found in the Town's MS4 Annual Report.

4.1.6 Legal authorities such as ordinances, state and other permits, orders, specific contract language, and interjurisdictional agreements applicable to reducing the POCs identified in each respective TMDL

The Town currently has no additional legal authorities applicable to reducing E. coli within the Quantico Creek watershed.

4.1.7 Enhancements to public education, outreach, and employee training programs to also promote methods to eliminate and reduce discharges of the POC(s) for which a WLA has been assigned.

Refer to Section 3.1 of this Action Plan.

4.1.8 A schedule of interim milestones and implementation of the items in 4.1.5, 4.1.6, and 4.1.7.

Refer to Appendix E – Town of Dumfries MS4 Program Plan dated 12-01-15.

4.1.9 Methods to assess TMDL Action Plans for their effectiveness in reducing the pollutants identified in the WLAs.

Refer to Appendix D – Town of Dumfries Public Education Outreach Program dated 12-01-15, Section 5.5.

4.1.10 Measurable goals and the metrics that the permittee and Department will use to track those goals (and the milestones required by the permit). Evaluation metrics other than monitoring may be used to determine compliance with the TMDL(s).

The TMDL aggregates Town's WLA with that of VDOT; there is no practical way to determine a numerical load assigned to the Town as part of the total WLA. Compliance with the TMDL will be measured by the continuation of the programs described in this document.

APPENDIX A – BACTERIAL TOTAL MAXIMUM DAILY LOAD (TMDL) DEVELOPMENT FOR TRIBUTATRIES TO THE POTOMAC RIVER: PRINCE WILLIAM AND STAFFORD COUNTIES

Bacteria Total Maximum Daily Load (TMDL) Development for Tributaries to the Potomac River: Prince William and Stafford Counties

Submitted by:

Virginia Department of Environmental Quality

Prepared by:

THE Louis Berger Group, INC.
1250 23rd Street, NW
Washington, DC 20037

Final Report

August 2013

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Executive Summary

This report presents the development of the bacteria TMDL for the Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek and Potomac Run watersheds. These waterbodies were listed as impaired on Virginia's 303(d) Total Maximum Daily Load Priority List and Reports (VADEQ, 2010) because of violations of the state's water quality standards for *E. coli* bacteria.

Description of the Study Area

The Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek, and Potomac Run watersheds are located within the borders of Stafford County and Prince William County. All streams are tributaries to the Potomac River. These watersheds occupy a combined drainage area of 137 square miles.

Impairment Description

Powells Creek (TMDL ID: VAN-A26R-02) was first identified as impaired on VADEQ's 2004303 (d) Total Maximum Daily Load Priority List due to exceedances for the state's water quality criteria for fecal coliform bacteria. In 2006, Powells Creek was listed as impaired due to exceedances of the state's water quality criterion for *E. coli* bacteria. The segment extends for 4.62 miles, beginning approximately 0.2 river miles below Lake Montclair and continuing downstream until the end of the free-flowing waters of Powells Creek.

Quantico Creek (TMDL ID: VAN-A26R-03) was first identified as impaired on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List (VADEQ, 2004) due to exceedances for the state's water quality criteria for fecal coliform bacteria. In 2006, Quantico Creek was listed as impaired due to exceedances of the state's water quality criterion for *E. coli* bacteria. The bacteria impaired portion of Quantico Creek is 1.45 river miles in length, beginning at the confluence with South Fork Quantico Creek, approximately 0.75 river miles upstream from I-95, and continuing downstream until the start of the tidal waters of Quantico Bay. Quantico Creek is located in Prince William County.

South Fork Quantico Creek (TMDL ID: VAN-A26R-03) was first identified as impaired on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List (VADEQ, 2004) due to exceedances for the state's water quality criterion for *E. coli* bacteria. The bacteria impaired portion of South Fork Quantico Creek is 4.63 miles in length, beginning at the headwaters of the South Fork Quantico Creek and continuing downstream until the start of the impounded waters, adjacent to what is labeled as Mawavi Camp No. 2 on the Joplin quad. South Fork Quantico Creek is located in Prince William County.

North Branch Chopawamsic Creek segment (TMDL ID: VAN-A26R-04) was first identified as impaired for bacteria on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for *E. coli* bacteria. The impaired segment is 6.9 miles long, beginning at the headwaters of North Branch Chopawamsic Creek and continuing downstream until the confluence with Middle Branch. The North Branch Chopawamsic Creek watershed is located in Prince William and Stafford Counties.

The Unnamed Tributary to Potomac River (TMDL ID: A26R-07-BAC) was first identified as impaired for bacteria on VADEQ's 2010 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for *E. coli* bacteria. The segment is 2.9 miles long, beginning at the headwaters of the Unnamed Tributary (Stream Code XLF) and continuing downstream until its confluence with the Potomac River. The Unnamed Tributary to the Potomac River is located in Stafford County.

Austin Run (TMDL ID: VAN-A28R-01) was first identified as impaired for bacteria on VADEQ's 2004 303 (d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for fecal coliform bacteria. The bacteria impaired portion of Aquia Creek extends from river mile 4.28 to river mile 3.28 in Aquia Creek, encompassing a 0.5-mile radius around station 1aAUA003.71. This impairment is located in estuarine waters. The impaired portion of Austin Run is 0.79 miles long, beginning at the confluence with an unnamed tributary to Austin Run (streamcode XGQ) and continuing downstream until the confluence with Aquia Creek. Austin Run is located in Stafford County.

A portion of Accokeek Creek (TMDL ID: VAN-A29R-01) was first identified as impaired for bacteria on VADEQ's 2002 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criteria for fecal coliform criteria. In 2006, Accokeek

Creek was listed as impaired due to exceedances of the state's water quality criterion for *E. coli* bacteria. The impaired portion of Accokeek Creek is approximately 4.21 river miles long, beginning at the confluence with an unnamed tributary to Accokeek Creek, approximately 0.33 river miles downstream from Route 1 at river mile 8.62, and continuing downstream until the end of the free-flowing waters. Accokeek Creek is located in Stafford County.

Potomac Creek (TMDL ID: VAN-A29R-02) was first identified as impaired for bacteria on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for fecal coliform bacteria. In 2006, Potomac Creek was listed as impaired due to exceedances of the state's water quality criterion for *E. coli* bacteria. The impaired portion of Potomac Creek is approximately 2.18 river miles long, beginning at the railroad crossing at the west end of swamp upstream from Route 608, and continuing downstream until the east end of the swamp. Potomac Creek is located in Stafford County.

Potomac Run (TMDL ID: 60073) was first identified as impaired on VADEQ's 2006 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for *E. coli* bacteria. The impaired portion of Potomac Run is approximately 6.13 miles long, beginning at the headwaters of Potomac Run and continuing downstream until the confluence with Long Branch. Potomac Run is located in Stafford County.

Applicable Water Quality Standards

Virginia's bacteria water quality standard currently states that *E. coli* bacteria shall not exceed a geometric mean of 126 *E. coli* counts per 100 mL of water for four weekly samples over a calendar month or an *E. coli* concentration of 235 counts per 100 mL of water at any time. However, the loading rates for watershed-based modeling are available only in terms of the previous standard, fecal coliform bacteria. Therefore, the TMDL was expressed in *E. coli* by converting modeled daily fecal coliform concentrations to daily *E. coli* concentrations using an instream translator. This TMDL was required to meet both the geometric mean and instantaneous *E. coli* water quality criteria.

Watershed Characterization

The land use characterization for the Tributaries to the Potomac River: Prince William and Stafford County watersheds were based on land cover data from the 2006 National Land Cover Database (NLCD). Dominant land uses in the watersheds are Forest (64%) and Developed (12%).

The potential sources of bacteria in the watershed were identified and characterized. Potential key sources of bacteria include run-off from point source dischargers, pet waste, residential waste, and wildlife sources.

Data obtained from the VADEQ's Northern Regional Office indicate that there are two individually permitted facilities currently active within the Austin Run watershed (VA0092479 and VA0060968), two individually permitted facilities currently active in the Accokeek Creek watershed (VA0089630 and VAG406207) and one individually permitted facility within the Unnamed Tributary to Potomac River watershed (VAG406114). The available flow data and water quality for the permitted facilities was retrieved and analyzed. Average flows for the permitted facilities were used in the HSPF model set-up and calibration. In addition to VPDES permits, there are also 7 MS4 (Municipal Separate Storm Sewer System) permits with the watersheds addressed by these TMDLs.

TMDL Technical Approach

The Hydrologic Simulation Program-Fortran (HSPF) model was selected and used as a tool to predict the instream water quality conditions of the delineated watershed under varying scenarios of rainfall and fecal coliform loading. HSPF is a hydrologic, watershed-based water quality model. The results from the model were used to develop the TMDL allocations based on the existing fecal coliform load. Basically, this means that HSPF can explicitly account for the specific watershed conditions, the seasonal variations in rainfall and climate conditions, and activities and uses related to fecal coliform loading.

The modeling process in HSPF starts with the following steps:

- delineating the watershed into smaller subwatersheds
- entering the physical data that describe each subwatershed and stream segment
- entering values for the rates and constants that describe the sources and the activities related to the fecal coliform loading in the watershed

The Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek and Potomac Run watersheds were delineated into 64 smaller subwatersheds to represent the watershed characteristics and to improve the accuracy of the HSPF model. This delineation was based on a Digital Elevation Model (DEM), stream reaches obtained from the National Hydrography Dataset (NHD), and stream flow and instream water quality data. Stream flow data were available from the U.S. Geological Survey (USGS). Weather data were obtained from the National Climatic Data Center (NCDC).

The period of 2002 to 2005 was used for HSPF hydraulic calibration and 2006 to 2010 was used to validate the HSPF model. The hydrologic calibration parameters were adjusted until there was a good agreement between the observed and simulated stream flow, thereby indicating that the model parameterization is representative of the hydrologic characteristics of the watershed. The model results closely matched the observed flows during low flow conditions, base flow recession and storm peaks.

Instream water quality data for the calibration was retrieved from VADEQ, and was evaluated for potential use in the set-up, calibration, and validation of the water quality model. The existing *E. coli* loading was calculated based on current watershed conditions.

TMDL Calculations

The TMDL represents the maximum amount of a pollutant that the stream can receive without exceeding the water quality standard. The load allocation for the selected scenarios was calculated using the following equation:

$$TMDL = \sum WLA + \sum LA + MOS$$

Where,

WLA = wasteload allocation (point source contributions);

LA = load allocation (non-point source allocation); and

MOS = margin of safety.

The margin of safety (MOS) is a required component of the TMDL to account for any lack of knowledge concerning the relationship between effluent limitations and water quality. The MOS was implicitly incorporated in this TMDL. Implicitly incorporating the MOS required that allocation scenarios be designed to meet a calendar-month geometric mean *E. coli* criterion of 126 cfu/100 mL and the instantaneous *E. coli* criterion of 235 cfu/100 mL with no more than a 10% exceedance rate.

Typically, there are several potential allocation strategies that would achieve the TMDL endpoint and water quality standards. A number of load allocation scenarios were developed to determine the final TMDL load allocation scenario.

Based on the load-allocation scenario analyses, the TMDL allocation plans that will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 mL and the instantaneous *E. coli* water quality criterion of 235 cfu/100 mL are presented in **Table E-1** to **E-9**.

Table E-1: Powells Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	2.52E+12	2.49E+12	1.0%
Cropland	2.74E+12	1.00E+11	96.3%
Pasture	6.04E+12	2.21E+11	96.3%
Urban/Non-MS4[1]	2.65E+13	9.72E+11	96.3%
Cattle-Direct Deposition	2.09E+12	0.00E+00	100.0%
Wildlife-Direct Deposition	2.68E+12	2.68E+12	0.0%
Failing Sewage Disposal Systems	4.04E+11	0.00E+00	100.0%
Future Growth[2]	0.00E+00	9.64E+10	-
SSOs	4.24E+09	0.00E+00	100.0%
MS4s	8.40E+13	3.08E+12	96.3%
Total	**1.27E+14**	**9.64E+12**	**92.4%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

Table E-2: Quantico Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	8.61E+11	8.53E+11	1.0%
Cropland	4.34E+10	3.44E+09	92.1%
Pasture	6.66E+11	5.27E+10	92.1%
Urban/Non-MS4[1]	2.01E+13	1.59E+12	92.1%
Cattle-Direct Deposition	2.34E+10	0.00E+00	100.0%
Wildlife-Direct Deposition	2.41E+12	2.41E+12	0.0%
Failing Sewage Disposal Systems	1.37E+11	0.00E+00	100.0%
Future Growth[2]	0.00E+00	8.66E+10	-
SSOs	7.05E+10	0.00E+00	100.0%
MS4s	4.62E+13	3.66E+12	92.1%
Total	**7.05E+13**	**8.66E+12**	**87.7%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

Table E-3: South Fork Quantico Creek Distribution of Annual Average E. coli Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	4.13E+11	4.08E+11	1.0%
Cropland	1.19E+10	8.34E+09	29.7%
Pasture	4.39E+11	3.09E+11	29.7%
Urban/Non-MS4[1]	1.70E+12	1.19E+12	29.7%

Table E-3: South Fork Quantico Creek Distribution of Annual Average E. coli Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Cattle-Direct Deposition	2.37E+11	0.00E+00	100.0%
Wildlife-Direct Deposition	1.22E+12	1.22E+12	0.0%
Failing Sewage Disposal Systems	5.52E+09	0.00E+00	100.0%
Future Growth[2]	0.00E+00	4.23E+10	-
SSOs	0.00E+00	0.00E+00	0.0%
MS4s	1.50E+12	1.05E+12	29.7%
Total	**5.52E+12**	**4.23E+12**	**23.3%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

Table E-4: North Branch Chopawamsic Creek Distribution of Annual Average E. coli Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	5.49E+11	5.43E+11	1.0%
Cropland	5.41E+12	1.61E+11	97.0%
Pasture	2.51E+13	7.45E+11	97.0%
Urban/Non-MS4[1]	3.19E+12	9.47E+10	97.0%
Cattle-Direct Deposition	0.00E+00	0.00E+00	0.0%
Wildlife-Direct Deposition	5.55E+11	5.55E+11	0.0%
Failing Sewage Disposal Systems	0.00E+00	0.00E+00	0.0%
Future Growth[2]	0.00E+00	2.50E+10	-
SSOs	1.11E+11	0.00E+00	100.00%
MS4s	1.27E+13	3.76E+11	97.0%
Total	**4.76E+13**	**2.50E+12**	**94.7%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

Table E- 5: Unnamed Tributary to Potomac River Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	3.80E+11	3.76E+11	1.0%
Cropland	9.01E+09	3.48E+09	61.4%
Pasture	2.61E+11	1.01E+11	61.4%
Urban/Non-MS4[1]	1.89E+12	7.30E+11	61.4%
Cattle-Direct Deposition	1.08E+09	0.00E+00	100.0%
Wildlife-Direct Deposition	7.06E+11	7.06E+11	0.0%
Failing Sewage Disposal Systems	7.45E+10	0.00E+00	100.0%
Permitted Point Sources	1.74E+09	1.74E+09	0.0%
Future Growth[2]	0.00E+00	2.31E+10	-

Table E- 5: Unnamed Tributary to Potomac River Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
SSOs	0.00E+00	0.00E+00	0.0%
MS4s	9.51E+11	3.67E+11	61.4%
Total	**4.27E+12**	**2.31E+12**	**46.0%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

Table E- 6: Austin Run Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	2.12E+12	2.10E+12	1.0%
Cropland	9.41E+10	9.32E+07	99.9%
Pasture	4.20E+12	4.15E+09	99.9%
Urban/Non-MS4[1]	4.73E+13	4.68E+10	99.9%
Cattle-Direct Deposition	2.48E+10	0.00E+00	100.0%
Wildlife-Direct Deposition	1.54E+12	1.54E+12	0.0%
Failing Sewage Disposal Systems	1.04E+11	0.00E+00	100.0%
Permitted Point Sources	2.09E+13	2.09E+13	0.0%
Future Growth[2]	0.00E+00	1.04E+13	-
SSOs	1.82E+10	0.00E+00	100.0%
MS4s	1.21E+14	1.20E+11	99.9%
Total	**1.97E+14**	**3.51E+13**	**82.2%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) Future Growth allocation for point sources is calculated at 6 MGD at the water quality geometric mean criterion for E. coli (126 cfu/100ml).

Table E- 7: Accokeek Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	2.59E+12	2.56E+12	1.0%
Cropland	1.52E+11	5.41E+10	64.4%
Pasture	2.10E+12	7.49E+11	64.4%
Urban/Non-MS4[1]	1.99E+13	7.09E+12	64.4%
Cattle-Direct Deposition	1.40E+12	0.00E+00	100.0%
Wildlife-Direct Deposition	2.08E+12	2.08E+12	0.0%
Failing Sewage Disposal Systems	1.33E+11	0.00E+00	100.0%
Permitted Point Sources	3.13E+09	3.13E+09	0.0%
Future Growth[2]	0.00E+00	1.57E+11	-
SSOs	4.41E+09	0.00E+00	100.0%
MS4s	8.46E+12	3.02E+12	64.4%

Table E- 7: Accokeek Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Total	**3.68E+13**	**1.57E+13**	**57.3%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

Table E- 8: Potomac Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	6.30E+12	6.30E+12	0.0%
Cropland	1.80E+11	1.78E+11	1.0%
Pasture	2.05E+12	2.03E+12	1.0%
Urban/Non-MS4[1]	1.10E+13	1.09E+13	1.0%
Cattle-Direct Deposition	5.37E+12	0.00E+00	100.0%
Wildlife-Direct Deposition	7.37E+11	7.37E+11	0.0%
Failing Sewage Disposal Systems	2.18E+11	0.00E+00	100.0%
Future Growth[2]	0.00E+00	2.09E+11	-
SSOs	6.36E+10	0.00E+00	100.0%
MS4s	5.31E+11	5.26E+11	1.0%
Total	**2.65E+13**	**2.09E+13**	**21.1%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

Table E- 9: Potomac Run Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	1.36E+12	1.35E+12	1.0%
Cropland	7.75E+11	2.30E+10	97.0%
Pasture	3.85E+13	1.14E+12	97.0%
Urban/Non-MS4[1]	7.20E+12	3.74E+11	94.8%
Cattle-Direct Deposition	2.19E+13	0.00E+00	100.0%
Wildlife-Direct Deposition	2.44E+12	2.44E+12	0.0%
Failing Sewage Disposal Systems	2.16E+11	0.00E+00	100.0%
Future Growth[2]	0.00E+00	5.51E+10	-
SSOs	0.00E+00	0.00E+00	0.0%
MS4s	9.50E+12	1.22E+11	98.7%
Total	**8.19E+13**	**5.51E+12**	**93.3%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers; the WLA includes 1 percent of the TMDL to account for Future Growth.

The summaries of the bacteria TMDL allocation plan loads are presented in the following tables. The bacteria TMDLs for Powells Creek are presented in **Tables E-10** and **E-11**.

Table E- 10: Powells Creek TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Powells Creek	**3.17E+12**	**6.47E+12**	**IMPLICIT**	**9.64E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

Table E- 11: Powells Creek TMDL (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Powells Creek	**8.69E+09**	**6.81E+10**	**IMPLICIT**	**7.68E+10**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The bacteria TMDLs for Quantico Creek are presented in **Tables E-12** and **E-13**.

Table E- 12: Quantico Creek TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Quantico Creek	**3.74E+12**	**4.91E+12**	**IMPLICIT**	**8.66E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

Table E- 13: Quantico Creek TMDL (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Quantico Creek	**1.03E+10**	**5.18E+10**	**IMPLICIT**	**6.20E+10**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The bacteria TMDLs for South Fork Quantico Creek are presented in **Tables E-14** and **E-15**.

Table E- 14: South Fork Quantico Creek TMDLs (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
South Fork Quantico Creek	**1.09E+12**	**3.14E+12**	**IMPLICIT**	**4.23E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

Table E- 15: South Fork Quantico Creek TMDLs (cfu/day) for *E. coli*				
Watershed	**WLA[1]**	**LA**	**MOS**	**TMDL**
South Fork Quantico Creek	**3.00E+09**	**3.32E+10**	**IMPLICIT**	**3.62E+10**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The bacteria TMDLs for North Branch Chopawamsic Creek are presented in **Tables E-16** and **E-17**.

Table E- 16: North Branch Chopawamsic Creek TMDLs (cfu/year) for *E. coli*				
Watershed	**WLA[1]**	**LA**	**MOS**	**TMDL**
North Branch Chopawamsic Creek	**4.01E+11**	**2.10E+12**	**IMPLICIT**	**2.50E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

Table E- 17: North Branch Chopawamsic Creek TMDLs (cfu/day) for *E. coli*				
Watershed	**WLA[1]**	**LA**	**MOS**	**TMDL**
North Branch Chopawamsic Creek	**1.10E+09**	**2.22E+10**	**IMPLICIT**	**2.33E+10**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The bacteria TMDLs for Unnamed Tributary to Potomac River are presented in **Tables E-18** and **E-19**.

Table E- 18: Unnamed Tributary to Potomac River TMDLs (cfu/year) for *E. coli*				
Watershed	**WLA[1]**	**LA**	**MOS**	**TMDL**
Unnamed Tributary to Potomac River	**3.92E+11**	**1.92E+12**	**IMPLICIT**	**2.31E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

Table E- 19: Unnamed Tributary to Potomac River TMDLs (cfu/day) for *E. coli*				
Watershed	**WLA[1]**	**LA**	**MOS**	**TMDL**
Unnamed Tributary to Potomac River	**1.07E+09**	**2.03E+10**	**IMPLICIT**	**2.14E+10**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The bacteria TMDLs for Austin Run are presented in **Tables E-20** and **E-21**.

Table E- 20: Austin Run TMDLs (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Austin Run	3.14E+13	3.69E+12	IMPLICIT	3.51E+13

[1]Wasteload allocation includes an additional load at 50% of the Aquia Creek WWTP to accommodate for future growth of point sources (VPDES and/or VSMP authorized discharges).

Table E- 21: Austin Run TMDLs (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Austin Run	8.61E+10	1.70E+10	IMPLICIT	1.03E+11

[1]Wasteload allocation includes an additional load at 50% of the Aquia Creek WWTP to accommodate for future growth of point sources (VPDES and/or VSMP authorized discharges).

The bacteria TMDLs for Accokeek Creek are presented in **Tables E-22** and **E-23**.

Table E- 22: Accokeek Creek TMDLs (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Accokeek Creek	3.18E+12	1.25E+13	IMPLICIT	1.57E+13

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

Table E- 23: Accokeek Creek TMDLs (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Accokeek Creek	8.70E+09	1.31E+11	IMPLICIT	1.39E+11

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The bacteria TMDLs for Potomac Creek are presented in **Tables E-24** and **E-25**.

Table E- 24: Potomac Creek TMDLs (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Potomac Creek	7.35E+11	2.02E+13	IMPLICIT	2.09E+13

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

Table E- 25: Potomac Creek TMDLs (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Potomac Creek	2.01E+09	2.10E+11	IMPLICIT	2.12E+11

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The bacteria TMDLs for Potomac Run are presented in **Tables E-26** and **E-27**.

Table E- 26: Potomac Run TMDLs (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Potomac Run	1.77E+11	5.33E+12	IMPLICIT	5.51E+12

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

Table E- 27: Potomac Run TMDLs (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Potomac Run	1.92E+09	5.41E+10	IMPLICIT	5.60E+10

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

TMDL Implementation

Once a TMDL is approved by EPA, measures must be taken to reduce pollutant levels from both point and non-point sources. For non-point sources, the Commonwealth intends for reductions required for this TMDL to be implemented, and pollutant loading reductions achieved, through best management practices (BMPs). Permitted point sources of bacteria, including MS4 and VPDES permits will achieve any required reductions through incorporating the TMDL results into existing permits through their respective permit programs.

Implementation for both point and non-point sources will occur in stages. The benefits of staged implementation are: 1) as stream monitoring continues to occur, it allows for water quality improvements to be recorded as they are being achieved; 2) it provides a measure of quality control, given the uncertainties that exist in any model; 3) it provides a mechanism for developing public support; 4) it helps to ensure the most cost effective practices are implemented initially, and 5) it allows for the evaluation of the TMDL's adequacy in achieving the water quality standard.

A TMDL implementation plan will be developed that addresses, at a minimum, the requirements specified in the Code of Virginia, Section 62.1-44.19.7. State law directs the State Water Control Board to "develop and implement a plan to achieve fully supporting status for impaired waters". The implementation plan "shall include the date of expected achievement of water quality objectives, measurable goals, corrective actions necessary and the associated costs, benefits and environmental impacts of addressing the impairments." EPA outlines the minimum elements of an approvable implementation plan in its 1999 "Guidance for Water Quality-Based Decisions: The TMDL Process." The listed elements include implementation actions/management measures, timelines, legal or regulatory controls, time required to attain water quality standards, monitoring plans and milestones for attaining water quality standards.

As part of the Continuing Planning Process, VADEQ staff will present EPA-approved TMDLs and TMDL implementation plans to the State Water Control Board (SWCB) for inclusion in the appropriate Water Quality Management Plan (WQMP), in accordance with the Clean Water Act's Section 303(e) and Virginia's Public Participation Guidelines for Water Quality Management Planning. VADEQ staff will also request that the SWCB adopt TMDL WLAs as part of the Water Quality Management Planning Regulation (9VAC 25-720), except in those cases when permit limitations are equivalent to numeric criteria contained in the Virginia Water Quality Standards, such as in the case for bacteria discharges resulting from treatment of municipal and industrial wastewater.

Public Participation

Two public meetings were held and an additional public comment period was allotted during the development of this TMDL. Comments were received during the public comment period on the draft report in 2012. In response to staff evaluation of the draft report and in consideration of comments received, the TMDL was revised. A second public comment period on the newly revised draft report was provided. One set of comments was received on the revised report; staff addressed comments which entailed slight revisions incorporated in this report.

1.0 Introduction

1.1 Regulatory Guidance

Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that do not meet water quality standards. TMDLs represent the total pollutant loading that a waterbody can receive without exceeding water quality standards. The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollution sources and instream water quality conditions. By following the TMDL process, states can establish water quality based controls to reduce pollution from both point and non-point sources to restore and maintain the quality of their water resources (EPA, 2001).

The Virginia Department of Environmental Quality (VADEQ) is the lead agency for the development of TMDLs statewide and focuses its efforts on all aspects of reduction and prevention of pollution to state waters. VADEQ works in coordination with the Virginia Department of Conservation and Recreation (DCR), the Department of Mines, Minerals, and Energy (DMME), and the Virginia Department of Health (VDH) to develop and regulate a more effective TMDL process. VADEQ ensures compliance with the Federal Clean Water Act and the Water Quality Planning Regulations, as well as with the Virginia Water Quality Monitoring, Information, and Restoration Act (WQMIRA), passed by the Virginia General Assembly in 1997, and coordinates public participation throughout the TMDL development process.

Within the context of the TMDL program, until recently a primary role of DCR was to regulate stormwater discharges from construction sites, and from municipal separate storm sewer systems (MS4s) through the Virginia Stormwater Management Program (VSMP). Effective July 1, 2013, these two stormwater regulatory programs are to be administered by DEQ, as well as the important role of initiating non-point source pollution control programs statewide through the use of federal grant money. DMME focuses its efforts on issuing surface mining permits and National Pollution Discharge Elimination System (NPDES) permits for industrial and mining operations. Lastly, VDH monitors waters for fecal coliform, classifies waters for shellfish growth and harvesting, and conducts surveys to determine sources of bacterial contamination (VADEQ, 2001).

As required by the Clean Water Act and WQMIRA, VADEQ develops and maintains a listing of all impaired waters in the state that details the pollutant(s) causing each impairment and the potential source(s) of each pollutant. This list is referred to as the 303(d) List of Impaired Waters (303(d) List). In addition to 303(d) List development, WQMIRA directs VADEQ to develop and implement TMDLs for listed waters (VADEQ, 2000). Once TMDLs have been developed, they are distributed for public comment and then submitted to the EPA for approval.

1.2 Impairment Listing

Segments of Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, an Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek, and Potomac Run were listed as impaired for bacteria on Virginia's 2002, 2004, 2006, 2008 and/or 2010 303(d) Total Maximum Daily Load Priority List and Reports due to exceedances of the state's water quality standard for bacteria. The impaired segments are located in hydrologic units 02070011 and include portions of Stafford and Prince William Counties.

All segments are riverine. **Table 1-1** summarizes the details of the impaired segments and **Figure 1-1** presents their location. Descriptions of the impaired segment watersheds are presented below.

1.2.1 Powells Creek

Powells Creek (TMDL ID: VAN-A26R-02) was first identified as impaired on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for fecal coliform bacteria. In 2006, Powells Creek was listed as impaired due to exceedances of the state's water quality criterion for *E. coli* bacteria. The segment extends for 4.62 miles, beginning approximately 0.2 river miles below Lake Montclair and continuing downstream until the end of the free-flowing waters of Powells Creek. During the 2010 Water Quality Integrated Assessment period (January 1, 2003 – December 31, 2008), 2 out of 13 samples (15%) exceeded the maximum water quality assessment criterion (235 cfu/100ml) for

E. coli bacteria at Station1aPOW006.11. Station 1aPOW006.11 is located at the Northgate Drive bridge crossing. Powells Creek is located in Prince William County.

1.2.2 Quantico Creek and South Fork Quantico Creek

Quantico Creek (TMDL ID: VAN-A26R-03) was first identified as impaired on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List (VADEQ, 2004) due to exceedances for the state's water quality criterion for fecal coliform bacteria. In 2006, Quantico Creek was listed as impaired due to exceedances of the state's water quality criterion for *E. coli* bacteria. South Fork Quantico Creek (TMDL ID: VAN-A26R-03) was first identified as impaired on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List (VADEQ, 2004) due to exceedances for the state's water quality criterion for *E. coli* bacteria.

The bacteria impaired portion of Quantico Creek is 1.45 river miles in length, beginning at the confluence with South Fork Quantico Creek, approximately 0.75 river miles upstream from I-95, and continuing downstream until the start of the tidal waters of Quantico Bay. During the 2010 Water Quality Integrated Assessment period (January 1, 2003 – December 31, 2008), 7 out of 27 samples (26%) exceeded the maximum water quality assessment criterion (235 cfu/100ml) for *E. coli* bacteria at Station1aQUA004.46. Station 1aQUA004.46 is located at the Route 1 (Business) bridge crossing. Quantico Creek is located in Prince William County.

The bacteria impaired portion of South Fork Quantico Creek is 4.63 miles in length, beginning at the headwaters of South Fork Quantico Creek and continuing downstream until the start of the impounded waters, adjacent to what is labeled as Mawavi Camp No. 2 on the Joplin quad. During the 2010 Water Quality Integrated Assessment period (January 1, 2003 – December 31, 2008), 7 out of 47 samples (15%) exceeded the maximum water quality criterion (235 cfu/100ml) for *E. coli* bacteria at USGS Station 01658500. South Fork Quantico Creek is located in Prince William County.

1.2.3 North Branch Chopawamsic Creek

North Branch Chopawamsic Creek segment (TMDL ID: VAN-A26R-04) was first identified as impaired for bacteria on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for *E. coli* bacteria. The impaired segment is 6.9 miles long, beginning at the headwaters of North Branch Chopawamsic Creek and continuing downstream until the confluence with Middle Branch. During the 2010 Water Quality Integrated Assessment period (January 1, 2003 – December 31, 2008), 2 out of 17 samples (12%) exceeded the maximum water quality assessment criterion (235 cfu/100ml) for *E. coli* bacteria at USGS Station 01659000. The North Branch Chopawamsic Creek watershed is located in Prince William and Stafford Counties.

1.2.4 Unnamed Tributary to the Potomac River

The Unnamed Tributary to Potomac River (TMDL ID: A26R-07-BAC) was first identified as impaired for bacteria on VADEQ's 2010 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for *E. coli* bacteria. The segment is 2.9 miles long, beginning at the headwaters of the Unnamed Tributary (Stream Code XLF) and continuing downstream until its confluence with the Potomac River. During the 2010 Water Quality Integrated Assessment period (January 1, 2003 – December 31, 2008), 2 of 11 *E. coli* samples (18%) exceeded the maximum water quality assessment criteria (235 cfu/100 ml) for *E. coli* bacteria at Station 1aXLF000.13. Station 1aXLF000.13 is located at the Route 633 bridge crossing. The Unnamed Tributary to the Potomac River is located in Stafford County.

1.2.5 Austin Run

Austin Run (TMDL ID: VAN-A28R-01) was first identified as impaired for bacteria on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for fecal coliform bacteria. The impaired portion of Austin Run is 0.79 miles long, beginning at the confluence with an unnamed tributary to Austin Run (streamcode XGQ) and continuing downstream until the confluence with Aquia Creek. Based on monitoring data for the 2006 Water Quality Assessment (January 1, 2000 to December 31, 2004) 3 of 8 samples (38%) exceeded the maximum criterion (400 MPN/100 ml) for fecal coliform bacteria at Station 1aAUS000.49 on Austin Run. Station 1aAUS000.49 is located near the end of Aquia Drive. Austin Run is located in Stafford County.

1.2.6 Accokeek Creek

A portion of Accokeek Creek (TMDL ID: VAN-A29R-01) was first identified as impaired for bacteria on VADEQ's 2002 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criteria for Fecal Coliform criteria. In 2006, Accokeek

Creek was listed as impaired due to exceedances of the state's water quality criterion for *E. coli* bacteria. The impaired portion of Accokeek Creek is approximately 4.21 river miles long, beginning at the confluence with an unnamed tributary to Accokeek Creek, approximately 0.33 river miles downstream from Route 1 at rivermile 8.62, and continuing downstream until the end of the free-flowing waters. During the 2010 Water Quality Integrated Assessment period (January 1, 2003 – December 31, 2008), 4 of 23 samples (17.4%) exceeded the maximum water quality assessment criterion (235 cfu/100 ml) for *E. coli* bacteria at Station 1aACC006.13. Station 1aACC006.13 is located at the Route 608 bridge crossing. Accokeek Creek is located in Stafford County.

1.2.7 Potomac Creek and Potomac Run

Potomac Creek (TMDL ID: VAN-A29R-02) was first identified as impaired for bacteria on VADEQ's 2004 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for fecal coliform bacteria. In 2006, Potomac Creek was listed as impaired due to exceedances of the state's water quality criterion for *E. coli* bacteria. Potomac Run (TMDL ID: 60073) was first identified as impaired on VADEQ's 2006 303(d) Total Maximum Daily Load Priority List due to exceedances of the state's water quality criterion for *E. coli* bacteria.

The impaired portion of Potomac Creek is approximately 2.18 river miles long, beginning at the railroad crossing at the west end of swamp upstream from Route 608, and continuing downstream until the east end of the swamp. During the 2010 Water Quality Integrated Assessment period (January 1, 2003 – December 31, 2008), 4 of 13 samples (31%) exceeded the maximum water quality criterion (235 cfu/100 ml) for *E. coli* bacteria at Station 1aPOM006.72. Station 1aPOM006.72 is located at the Route 608 bridge crossing. Potomac Creek is located in Stafford County.

The impaired portion of Potomac Run is approximately 6.13 miles long, beginning at the headwaters of Potomac Run and continuing downstream until the confluence with Long Branch. During the 2010 Water Quality Integrated Assessment period (January 1, 2003 – December 31, 2008), 10 of 13 samples (77%) exceeded the maximum water quality assessment criterion (235 cfu/100 ml) for *E. coli* bacteria at Station 1aPOR000.40. Station

1aPOR000.40 is located at the Route 648 bridge crossing. Potomac Run is located in Stafford County.

Table 1- 1: Impairment Summaries for Streams Included in this TMDL Report

TMDL ID	Assessment Unit	Stream Name	Length (miles)	Boundaries	Listing Station ID:	Cause:	Exceedance Rate*
VAN-A26R-02	VAN-A26R_POW01A00	Powells Creek	4.62	Approximately 0.2 rivermiles below Lake Montclair downstream until the end of the free-flowing waters of Powells Creek.	1aPOW006.11	*E. coli*	2 of 13 samples (15.4%)
VAN-A26R-03	VAN-A26R_QUA01A00	Quantico Creek	1.45	Confluence with South Fork Quantico Creek downstream until the start of the tidal waters of Quantico Bay.	1aQUA004.46	*E. coli*	7 of 27 samples (26%)
VAN-A26R-03	VAN-A26R_SOQ01B02	South Fork Quantico Creek	4.63	Headwaters of the South Fork Quantico Creek downstream until the start of the impounded waters, adjacent to what is labeled as Mawavi Camp No. 2 on the Joplin Quad.	01658500 (USGS)	*E. coli*	7 of 47 samples (15%)
VAN-A26R-04	VAN-A26R_NOR01A02	North Branch Chopawamsic Creek	6.9	Headwaters of North Branch Chopawamsic Creek downstream until the confluence with Middle Branch	01659000 (USGS)	*E. coli*	2 of 17 samples (12%)
A26R-07-BAC	VAN-A26R_XLF01A10	Unnamed tributary to Potomac River	2.9	Headwaters of the unnamed tributary downstream until its confluence with the Potomac River	1aXLF000.13	*E. coli*	2 of 11 samples (18%)
VAN-A28R-01	VAN-A28R_AUS01A04	Austin Run	0.79	Confluence with an unnamed tributary to Austin Run (streamcode XGQ) downstream until the confluence with Aquia Creek	1aAUS000.49	fecal coliform	3 of 8 samples (38%)**

*Exceedance rate listed in Virginia's 2010 305(b)/303(d) Water Quality Integrated Assessment

**Exceedance rate listed in Virginia's 2006 305(b)/303(d) Water Quality Integrated Assessment

Table 1-1: Impairment Summaries for Streams Included in this TMDL Report

TMDL ID	Assessment Unit	Stream Name	Length (miles)	Boundaries	Listing Station ID	Cause	Exceedance Rate*
VAN-A29R-01	VAN-A29R_ACC01A00	Accokeek Creek	4.21	Confluence with an unnamed tributary to Accokeek Creek (rivermile 8.62) located approximately 0.33 rivermiles downstream from Route 1, downstream until the end of the free-flowing waters.	1aACC006.13	*E. coli*	4 of 23 samples (17%)
VAN-A29R-02	VAN-A29R_POM01A00	Potomac Creek	2.18	Railroad crossing at the west end of swamp, upstream from Route 608, downstream until the east end of swamp.	1aPOM006.72	*E. coli*	4 of 13 samples (31%)
60073	VAN-A29R_POR01A06	Potomac Run	6.13	Headwaters of Potomac Run downstream until the confluence with Long Branch.	1aPOR000.40	*E. coli*	10 of 13 samples (77%)

*Exceedance rate listed in Virginia's 2010 305(b)/303(d) Water Quality Integrated Assessment

**Exceedance rate listed in Virginia's 2006 305(b)/303(d) Water Quality Integrated Assessment

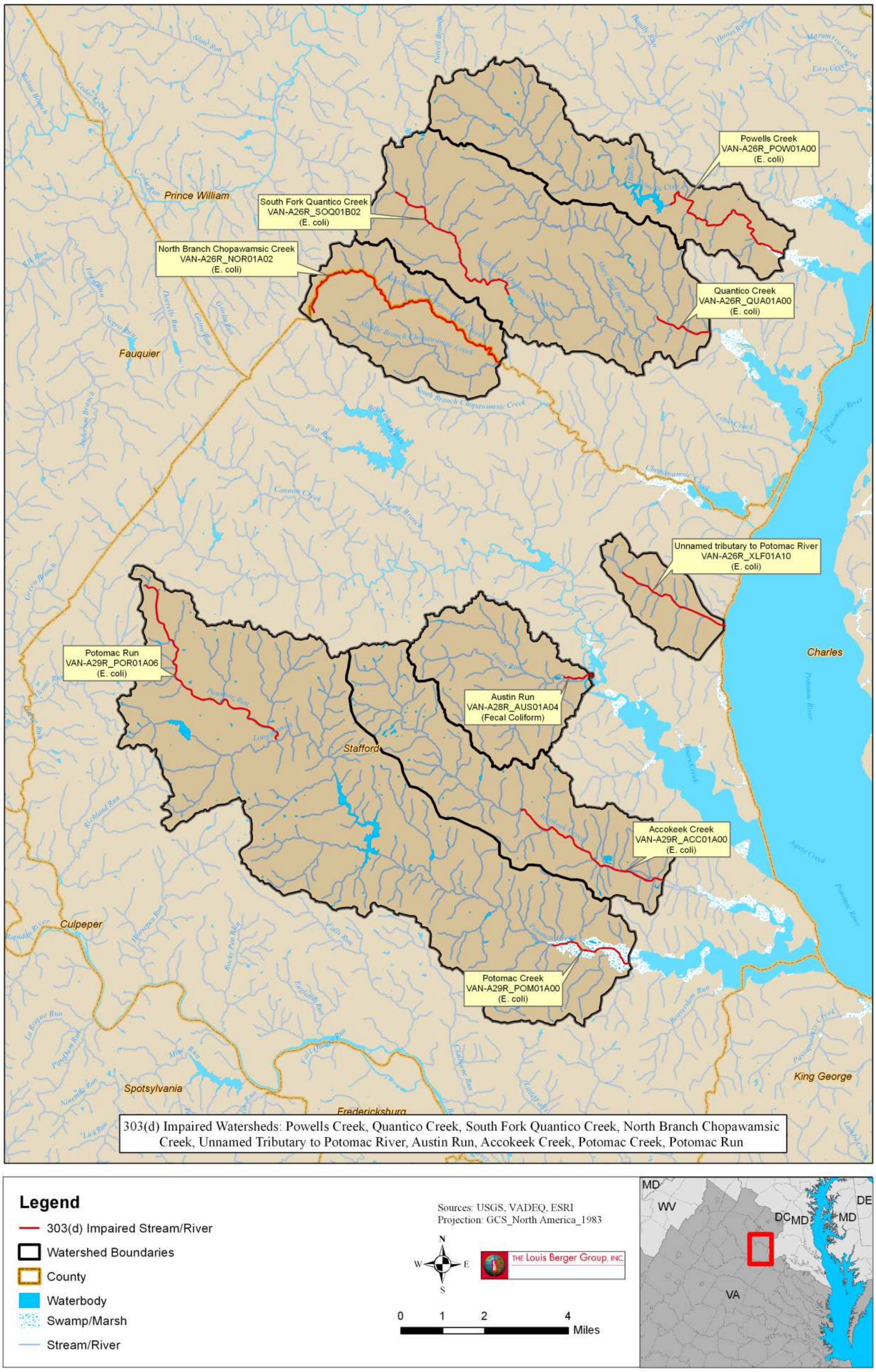


Figure 1- 1: Location of the Bacteria Impaired Segments

1.3 Applicable Water Quality Standard

Water quality standards consist of designated uses for a waterbody and water quality criteria necessary to support those designated uses. According to Virginia Water Quality Standards (9 VAC 25-260-5), the term 'water quality standards' is defined as:

"…provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."

1.3.1 Designated Uses

According to Virginia Water Quality Standards (9 VAC 25-260-10):

"…all state waters are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish)."

1.3.2 Applicable Water Quality Criteria

According to Section 9 VAC 25-260-170.A of Virginia's Water Quality Standards (Effective January 6, 2011), for a non-shellfish, freshwater waterbody to be in compliance with Virginia bacteria standards for primary contact recreation, the current criteria are as follows:

"E. coli bacteria shall not exceed a monthly geometric mean of 126 CFU/100 ml in freshwater...Geometric means shall be calculated using all data collected during any calendar month with a minimum of four weekly samples… If there are insufficient data to calculate monthly geometric means in freshwater, no more than 10% of the total samples in the assessment period shall exceed 235 E. coli CFU/100 ml."

For bacteria TMDL development after January 15, 2003, *E. coli* is the primary applicable water quality target. However, the loading rates for watershed-based modeling are available only in terms of fecal coliform. Therefore, DCR, DEQ, and EPA have agreed to apply a translator to instream fecal coliform data to determine whether reductions applied to the fecal coliform load would result in meeting instream *E. coli* criteria. The fecal coliform model and instream translator are used to calculate *E. coli* TMDLs (VADEQ, 2003). The following regression based instream translator is used to calculate *E. coli* concentrations from fecal coliform concentrations:

$$log_2 EC\ (cfu/100mL) = -0.0172 + 0.91905 * log_2 FC\ (cfu/100mL)$$

Where: EC = *E. coli* bacteria concentration
FC = Fecal coliform bacteria concentration

The modeled daily fecal coliform concentrations are converted to daily *E. coli* concentrations using the instream translator. The TMDL development process must also account for seasonal and annual variations in precipitation, flow, land use, and pollutant contributions. Such an approach ensures that TMDLs, when implemented, do not result in exceedances under a wide variety of scenarios that affect bacteria loading.

1.4 TMDL Endpoint Identification

1.4.1 Selection of TMDL Endpoint and Water Quality Targets

One of the first steps in TMDL development is to determine a numeric endpoint, or water quality target, for each impaired segment. A water quality target compares the current stream conditions to the expected restored stream conditions after TMDL load reductions are implemented. Numeric endpoints for the bacteria impaired segments of Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac Creek, Austin Run, Accokeek Creek, Potomac Creek and Potomac Run are established in Virginia Water Quality Standards (9 VAC 25-260). These standards state that all waters in Virginia should be free from any substances that can cause the water to exceed the state numeric criteria, interfere with its designated uses, or adversely affect human health and aquatic life. The current water quality target for freshwater, non-shellfish waters, as stated in 9 VAC 25-260-170, is an *E. coli* geometric mean of no greater than 126 colony-forming units (cfu) per 100 ml (minimum of four weekly samples within a calendar month necessary to calculate the geometric mean), and no more than 10% exceedance of the maximum assessment criterion of 235 cfu per 100mL.

1.4.2 Critical Condition

The critical condition refers to the “worst case scenario” of environmental conditions in the Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac Creek, Austin Run, Accokeek Creek, Potomac Creek, and Potomac Run segments. Developing TMDLs to meet the water quality targets under the critical condition will ensure that the targets would also be met under all other conditions.

EPA regulations, 40 CFR 130.7 (c)(1), require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the impaired streams is protected during times when it is most vulnerable. Critical conditions are important because they describe the combination of factors that cause an exceedance of water quality criteria. They will help in identifying the actions that may have to be undertaken to meet water quality standards.

1.4.2.1 Powells Creek

The dominant land uses in the Powells Creek watershed are forest (47%) and developed (31%). Potential key sources of *E. coli* include run-off from residential waste and wildlife sources.

E. coli loadings result from sources that can contribute during wet weather and dry weather. The critical conditions were determined from the available instream water quality data and flow data obtained from the nearby USGS flow monitoring station located on Aquia Creek.

The following figure shows the observed level of *E. coli* (**Figure 1-2**) under different flow conditions at VADEQ water quality stations 1APOW003.11 and 1APOW006.11.

The data for flow was obtained from USGS station 01660400, located on Aquia Creek near Garrisonville, VA. **Figure 1-2** depicts *E. coli* concentrations recorded between 2003 and 2010 with the available corresponding stream flow percentile.

E. coli data were available at VADEQ listing stations 1APOW003.11 and 1APOW006.11. The maximum assessment criterion is shown as a thick red line (235 *E. coli*/100 ml of water). Plotting *E. coli* data along with available stream flow data (**Figure 1-2**) revealed that exceedances occurred during high flow, dry, and low flow conditions.

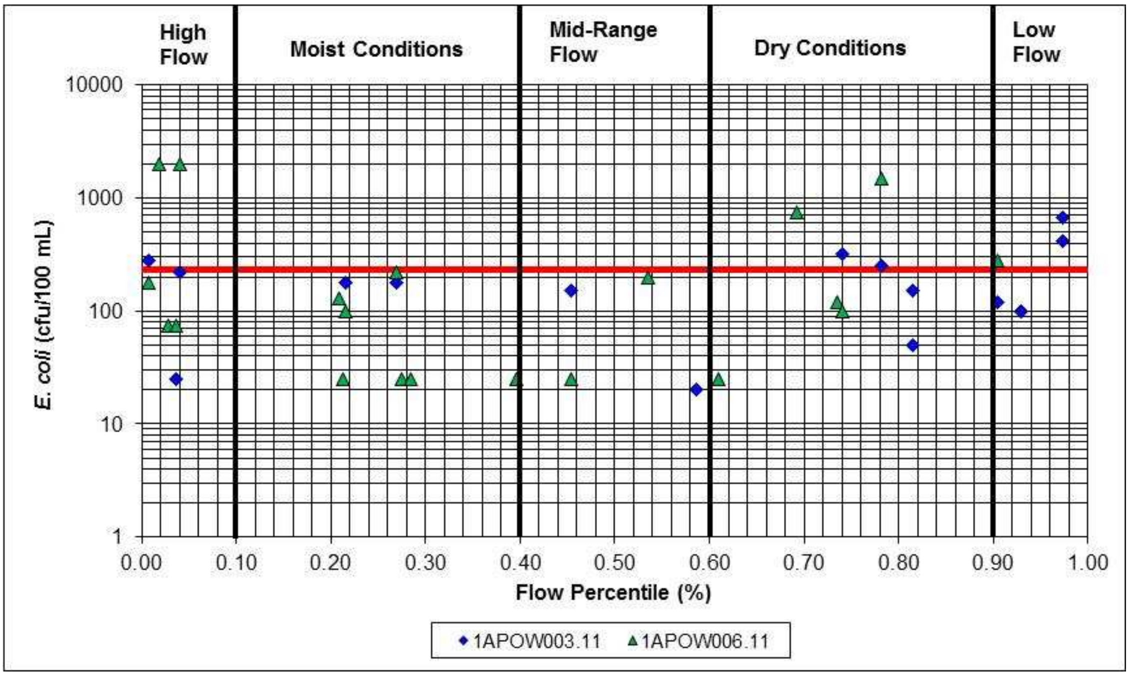


Figure 1- 2: Flow Percentile and *E. coli* Concentrations for Powells Creek at 1APOW003.11 and 1APOW006.11 (2003-2010)

While the majority of exceedances occur in dry and low flow conditions, exceedances do occur in high flow conditions, thus higher flow periods cannot be ruled out. Consequently, both higher and lower flow periods were considered as the critical conditions. Exceedances under high-flow conditions would occur from runoff based, indirect sources of bacteria, and would most likely exceed the maximum assessment criterion. Bacteria loads under low-flow conditions would likely occur from direct deposition sources of bacteria, and would most likely exceed both the maximum assessment and geometric mean criteria.

The TMDL is required to meet both the geometric mean and maximum assessment bacteria criteria. Therefore, it is necessary for the critical condition to consider both wet weather, high flow conditions, and dry weather, low flow conditions in order to comply with both bacteria criteria.

1.4.2.2 Quantico Creek and South Fork Quantico Creek

The dominant land uses in the Quantico Creek and South Fork Quantico Creek watershed are forest (85%) and developed (7%). Potential key sources of *E. coli* include run-off from residential waste and wildlife sources.

E. coli loadings result from sources that can contribute during wet weather and dry weather. The critical conditions were determined from the available instream water quality data and flow data obtained from the nearby USGS flow monitoring station located on Aquia Creek.

The following figures show the observed level of *E. coli* under different flow conditions at VADEQ water quality station 1AQUA004.46 (Quantico Creek, **Figure 1-3**) and 1ASOQ006.73 (South Fork Quantico Creek, **Figure 1-4**). The data for flow was obtained from USGS station 01660400, located on Aquia Creek near Garrisonville, VA. **Figure 1-3** depicts *E. coli* concentrations recorded in Quantico Creek between 2003 and 2010 with the available corresponding stream flow percentile. **Figure 1-4** depicts *E. coli* concentrations recorded South Fork Quantico Creek between 2003 and 2010 with the available corresponding stream flow percentile.

E. coli data were available at VADEQ stations 1AQUA004.46, 1ASOQ006.73, and USGS Station 01658500. DEQ Station 1ASOQ006.73 and USGS Station 01658500 are collocated. The maximum assessment criterion is shown as a thick red line (235 *E. coli*/100 ml of water). Plotting *E. coli* data along with available stream flow data revealed that the exceedances occurred during all flow conditions for Quantico Creek (**Figure 1-3**) and all flow conditions for South Fork Quantico Creek (**Figure 1-4**).

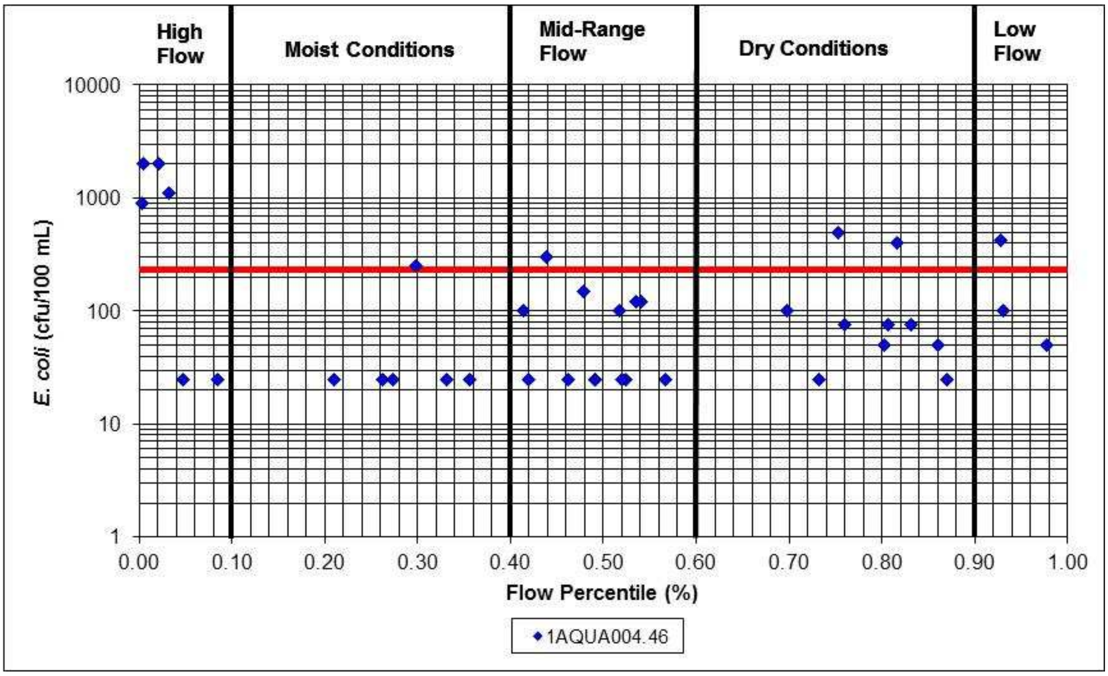


Figure 1-3: Flow Percentile and *E. coli* Concentrations for Quantico Creek at 1AQUA004.46 (2003-2010)

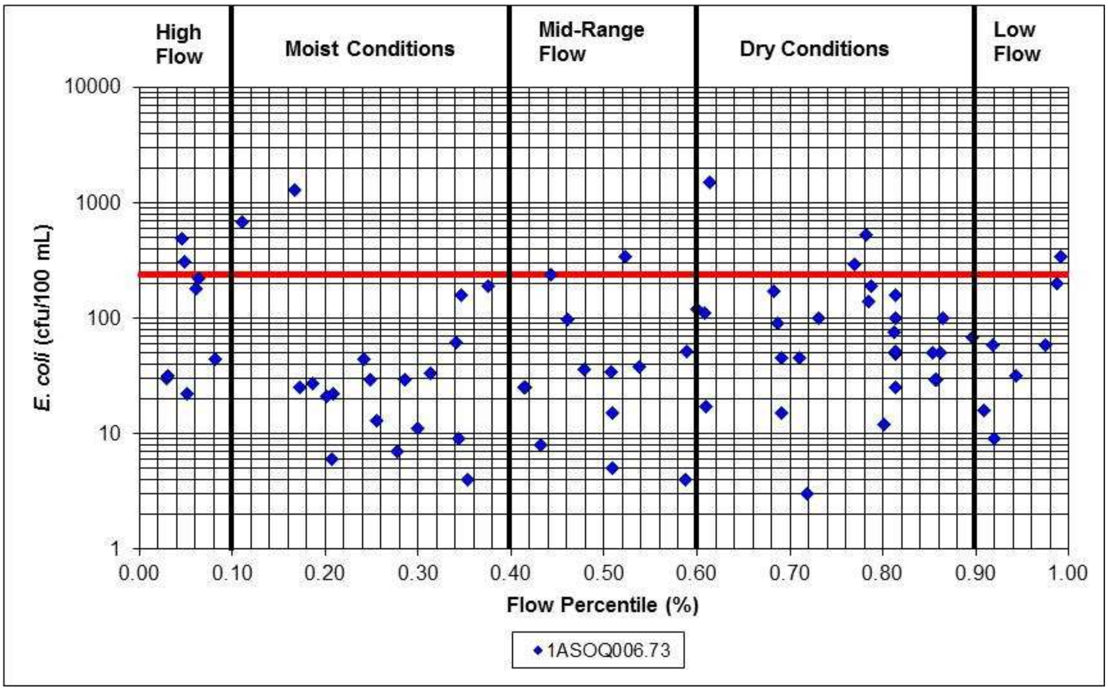


Figure 1-4: Flow Percentile and *E. coli* Concentrations for South Fork Quantico Creek at 1ASOQ006.73 and USGS Station 01658500 (2003 - 2010)

Since exceedances occur in all flow conditions for both Quantico Creek and South Fork Quantico Creek, both higher and lower flow periods were considered as the critical conditions for both impaired segments. Exceedances under high-flow conditions would occur from runoff based, indirect sources of bacteria, and would most likely exceed the maximum assessment criterion. Bacteria loads under low-flow conditions would likely occur from direct deposition sources of bacteria, and would most likely exceed both the maximum assessment and the geometric mean criteria.

The TMDL is required to meet both the bacteria criteria. Therefore, it is necessary for the critical condition to consider both wet weather, high flow conditions and dry weather, low flow conditions in order to comply with both criteria.

1.4.2.3 North Branch Chopawamsic Creek

The dominant land uses in the North Branch Chopawamsic Creek watershed are forest (84%) and wetland (12%). Potential key sources of *E. coli* include run-off from wildlife sources.

E. coli loadings result from sources that can contribute during wet weather and dry weather. The critical conditions were determined from the available instream water quality data and flow data obtained from the nearby USGS flow monitoring station located on Aquia Creek.

The following figure shows the observed level of *E. coli* under different flow conditions at VADEQ water quality station 1ANOR009.87 and USGS Station 01659000 (**Figure 1-5**). The data for flow was obtained from USGS station 01660400, located on Aquia Creek near Garrisonville, VA. **Figure 1-5** depicts *E. coli* concentrations recorded between 2007 and 2010 with the available corresponding stream flow percentile.

E. coli data were available at VADEQ station 1ANOR009.87 and USGS Station 01659000, which are collocated. The maximum assessment criterion is shown as a thick red line (235 *E. coli*/100 ml of water). Plotting *E. coli* data along with available stream flow data (**Figure 1-5**) revealed that the exceedances occurred in moist, mid-range flow, dry and low-flow conditions.

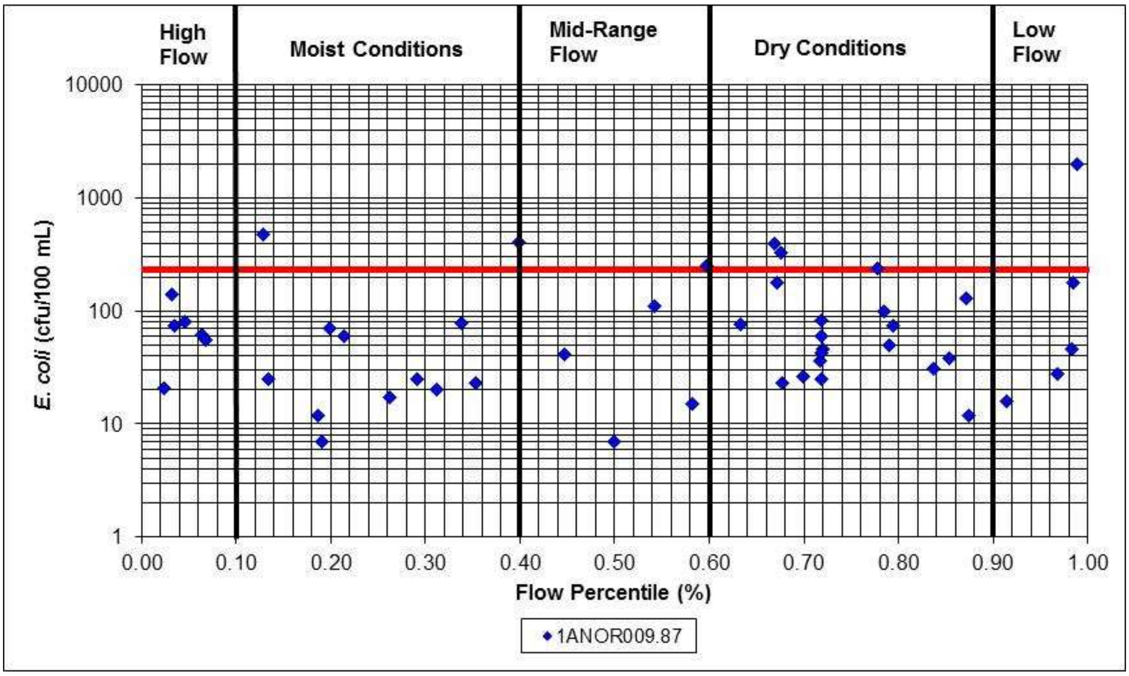


Figure 1- 5: Flow Percentile and *E. coli* Concentrations for North Branch Chopawamsic Creek at 1ANOR009.87 and USGS Station 01659000 (2007 - 2010).

With exceedances occurring in moist, mid-range, dry and low flow conditions, both higher and lower flow periods were considered as critical conditions. Exceedances under moist and mid-range flow conditions would occur from a combination of runoff based, indirect sources of bacteria, and direct depositional sources. These exceedances would most likely exceed the maximum assessment criterion. Bacteria loads under low-flow conditions would likely occur from direct deposition sources of bacteria, and would most likely exceed both bacteria criteria.

The TMDL is required to meet both the geometric mean and the maximum assessment bacteria criteria. Therefore, it is necessary for the critical condition to consider both wet weather, high flow conditions and dry weather, low flow conditions in order to comply with both bacteria criteria.

1.4.2.4 Unnamed Tributary to the Potomac River

The dominant land uses in the Unnamed Tributary to the Potomac River watershed are forest (77%) and developed (9%). Potential key sources of *E. coli* include run-off from residential waste, point source dischargers and wildlife sources.

E. coli loadings result from sources that can contribute during wet weather and dry weather. The critical conditions were determined from the available instream water quality data and flow data obtained from the nearby USGS flow monitoring station located on Aquia Creek.

The following figure shows the observed level of *E. coli* under different flow conditions at VADEQ water quality station 1AXLF000.13 (**Figure 1-6**). The data for flow was obtained from USGS station 01660400, located on Aquia Creek near Garrisonville, VA. **Figure 1-6** depicts *E. coli* concentrations recorded in 2007-2008 with the available corresponding stream flow percentile.

E. coli data were available at VADEQ listing station 1AXLF000.13. The maximum assessment criterion is shown as a thick red line (235 *E. coli*/100 ml of water). Plotting *E. coli* data along with available stream flow data (**Figure 1-6**) revealed that the exceedances occurred in dry to low-flow conditions.

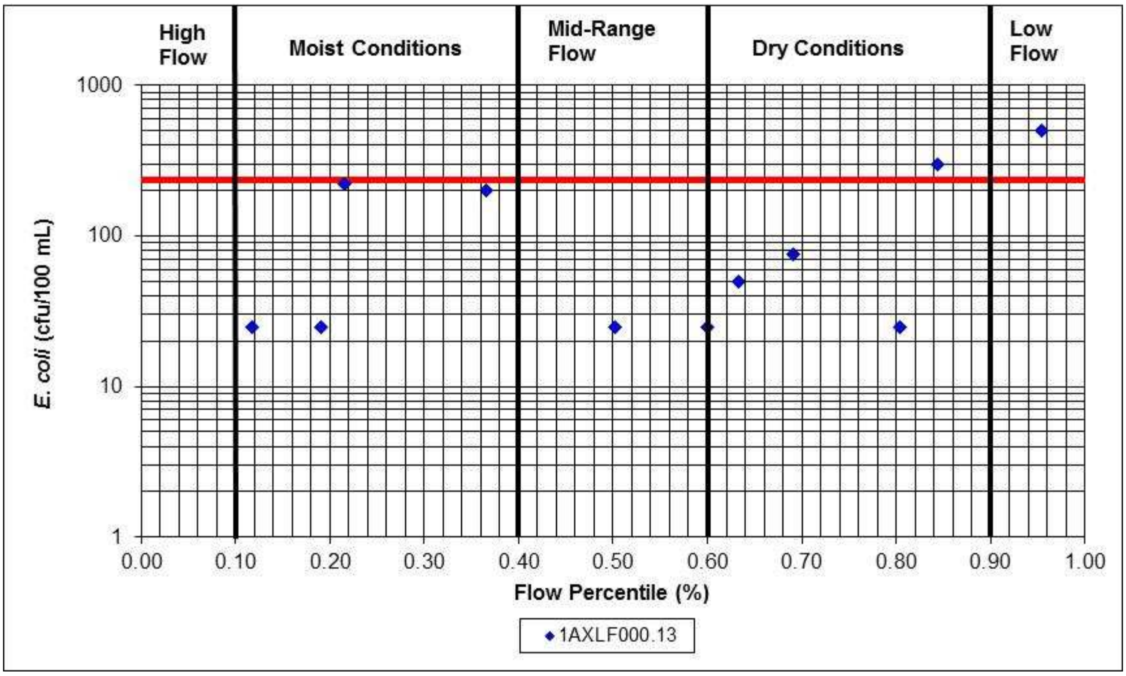


Figure 1- 6: Flow Percentile and *E. coli* Concentrations for the Unnamed Tributary to the Potomac River at 1AXLF000.13 (2007-2008)

The exceedances occurred in dry or low flow conditions. Exceedances under high-flow conditions would occur from runoff based, indirect sources of bacteria. Bacteria loads under low-flow conditions would likely occur from direct deposition sources of bacteria, and would most likely exceed the maximum assessment and geometric mean criteria.

The TMDL is required to meet both the geometric mean and maximum assessment bacteria criteria. Therefore, it is necessary for the critical condition to consider both wet weather, high flow conditions and dry weather, low flow conditions in order to comply with both bacteria criteria.

1.4.2.5 Austin Run

The dominant land uses in the Austin Run watershed are developed (45%) and forest (38%). Potential key sources of *E. coli* include run-off from point source dischargers, residential waste, and wildlife sources.

E. coli loadings result from sources that can contribute during wet weather and dry weather. The critical conditions were determined from the available instream water quality data and flow data obtained from the nearby USGS flow monitoring station located on Aquia Creek.

The following figure shows the observed level of *E. coli* under different flow conditions at VADEQ water quality station 1AAUS000.49 (**Figure 1-7**). The data for flow was obtained from USGS station USGS station 01660400, located on Aquia Creek near Garrisonville, VA. **Figure 1-7** depicts *E. coli* concentrations recorded in 2010 with the available corresponding stream flow percentile.

E. coli data were available at VADEQ listing station 1AAUS000.49. The maximum assessment criterion is shown as a thick red line (235 *E. coli*/100 ml of water). Plotting *E. coli* data along with available stream flow data (**Figure 1-7**) revealed that the exceedances occurred in high flow conditions.

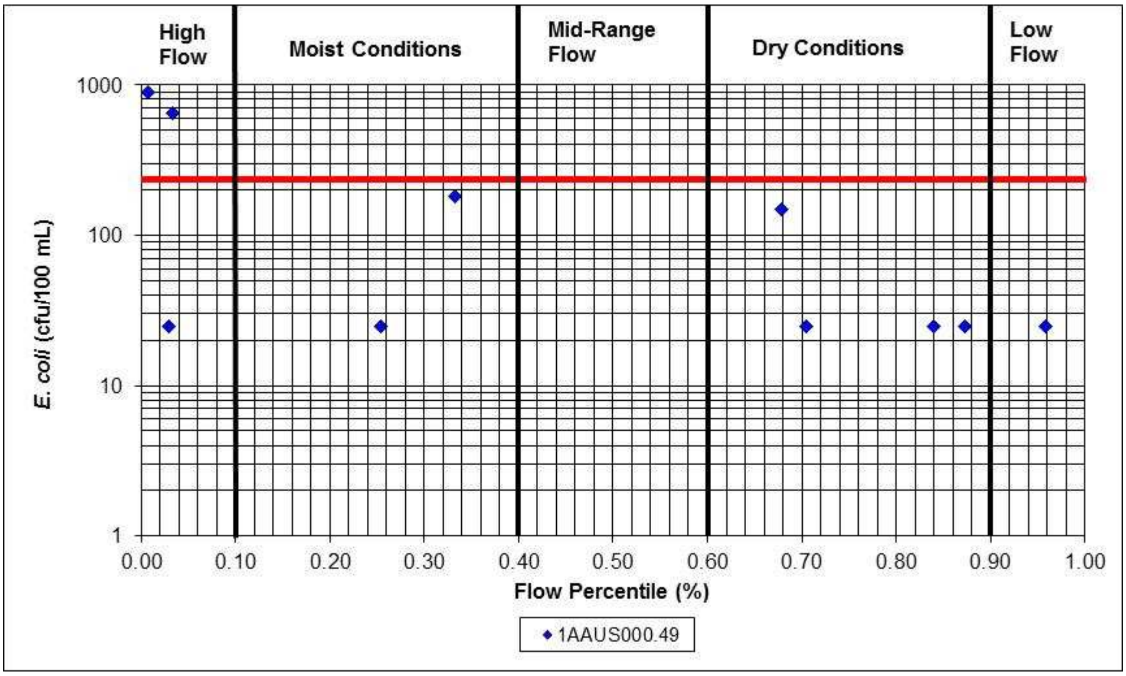


Figure 1- 7: Flow Percentile and *E. coli* Concentrations for Austin Run at 1AAUS000.49 (2010)

Exceedances under high-flow conditions would most likely occur from runoff based, indirect sources of bacteria, and would most likely exceed the maximum assessment criterion. Bacteria loads under low-flow conditions would likely occur from direct deposition sources of bacteria, and would most likely exceed both criteria.

The TMDL is required to meet both the geometric mean and maximum assessment bacteria criteria. Therefore, it is necessary for the critical condition to consider both wet weather, high flow conditions and dry weather, low flow conditions in order to comply with both criteria.

1.4.2.6 Accokeek Creek

The dominant land uses in the Accokeek Creek watershed are forest (63%) and developed (13%). Potential key sources of *E. coli* include run-off from point source dischargers, residential waste, and wildlife and agricultural sources.

E. coli loadings result from sources that can contribute during wet weather and dry weather. The critical conditions were determined from the available instream water quality data and flow data obtained from the nearby USGS flow monitoring station located on Aquia Creek.

The following figure shows the observed level of *E. coli* under different flow conditions at VADEQ water quality station 1AACC006.13 (**Figure 1-8**). The data for flow was obtained from USGS station 01660400, located on Aquia Creek near Garrisonville, VA. **Figure 1-8** depicts *E. coli* concentrations recorded between 2003 and 2010 with the available corresponding stream flow percentile.

E. coli data were available at VADEQ listing station 1AACC006.13. The maximum assessment criterion is shown as a thick red line (235 *E. coli*/100 ml of water). Plotting *E. coli* data along with available stream flow data (**Figure 1-8**) revealed that the exceedances occurred in high flow, moist, and low-flow conditions.

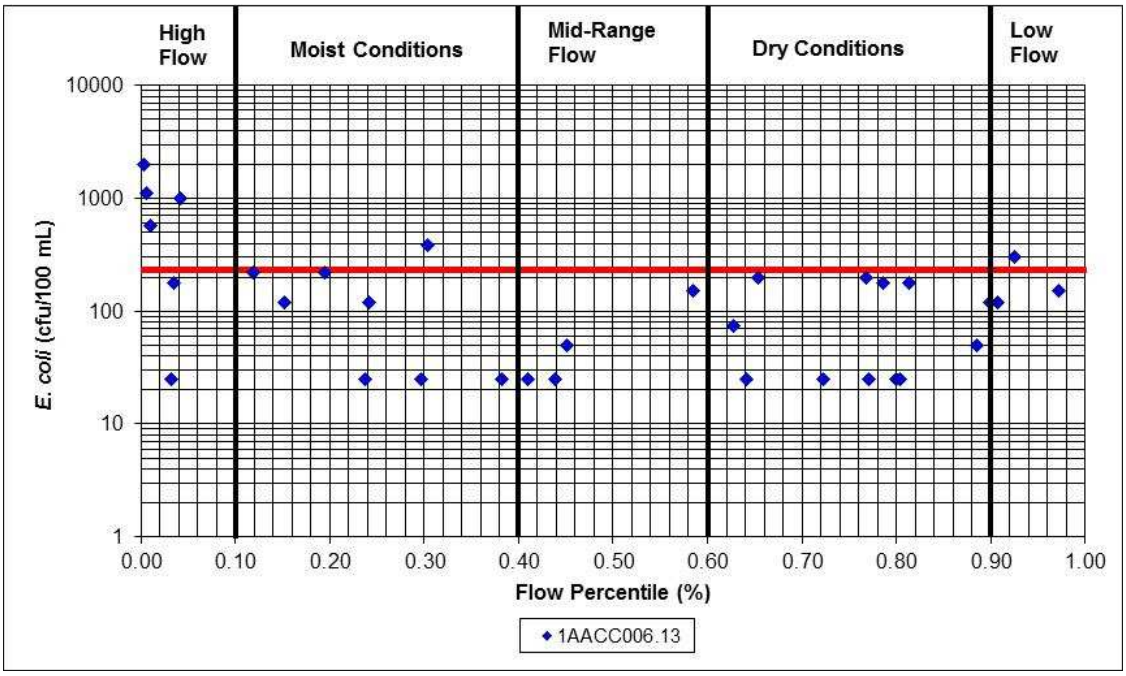


Figure 1- 8: Flow Percentile and *E. coli* Concentrations for Accokeek Creek at 1AACC006.13 (2003-2010)

With exceedances occurring in high-flow, moist and low-flow conditions, both higher and lower flow periods were considered as the critical conditions. Exceedances under high-flow conditions would most likely occur from runoff based, indirect sources of bacteria, and would most likely exceed the maximum assessment criterion. Bacteria loads under low-flow conditions would likely occur from direct deposition sources of bacteria, and would most likely exceed both criteria.

The TMDL is required to meet both the geometric mean and the maximum assessment bacteria criteria. Therefore, it is necessary for the critical condition to consider both wet weather, high flow conditions and dry weather, low flow conditions in order to comply with both criteria.

1.4.2.7 Potomac Creek and Potomac Run

The dominant land uses in the Potomac Creek and Potomac Run watershed are forest (58%) and agriculture (18%). Potential key sources of *E. coli* include run-off from wildlife and agricultural sources and residential waste.

E. coli loadings result from sources that can contribute during wet weather and dry weather. The critical conditions were determined from the available instream water quality data and flow data obtained from the nearby USGS flow monitoring station located on Aquia Creek.

The following figures show the observed levels of *E. coli* under different flow conditions at VADEQ water quality stations 1APOR000.40 (Potomac Run, **Figure 1-9**) and 1APOM006.72 (Potomac Creek, **Figure 1-10**). The data for flow was obtained from USGS station 01660400, located on Aquia Creek near Garrisonville, VA. **Figure 1-9** and **1-10** depicts *E. coli* concentrations recorded between 2003 and 2010 with the available corresponding stream flow percentile.

E. coli data were available at VADEQ listing stations 1APOR000.40 and 1APOM006.72. The maximum assessment criterion is shown as a thick red line (235 *E. coli*/100 ml of water). Plotting *E. coli* data along with available stream flow data revealed that the exceedances occurred during all flow conditions for Potomac Run (**Figure 1-9**) and during all flow conditions except low flow for Potomac Creek (**Figure 1-10**).

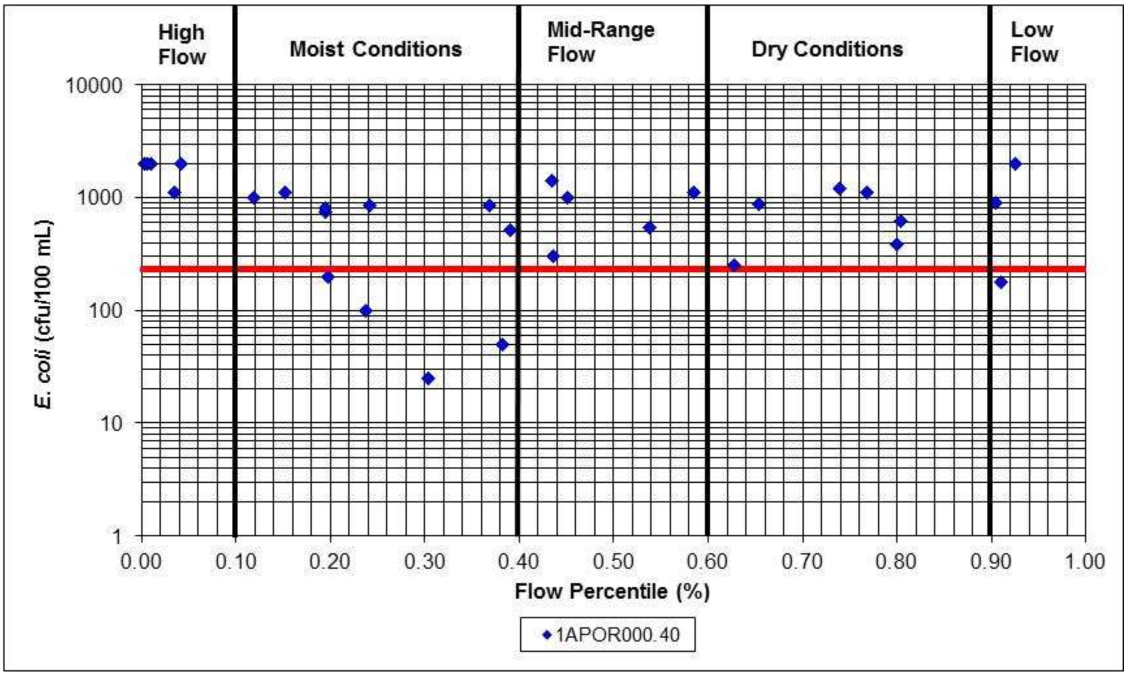


Figure 1- 9: Flow Percentile and *E. coli* Concentrations for Potomac Run at 1APOR000.40 (2003-2010)

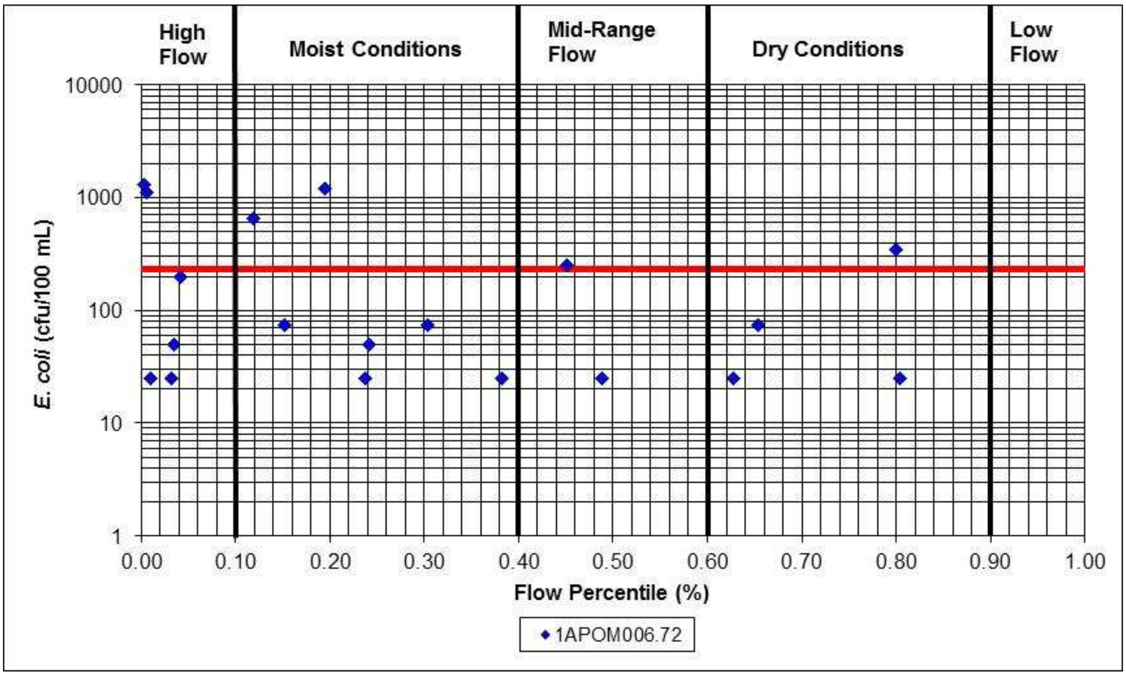


Figure 1- 10: Flow Percentile and *E. coli* Concentrations for Potomac Creek at 1APOM006.72 (2003-2010)

Since exceedances occur in all flow conditions (Potomac Run) and in all flow conditions except low flow (Potomac Creek), both higher and lower flow periods were considered as the critical conditions for both impaired segments. Exceedances under high-flow conditions would most likely occur from runoff based, indirect sources of bacteria and would most likely exceed the maximum assessment criterion. Bacteria loads under low-flow conditions would likely occur from direct deposition sources of bacteria, and would most likely exceed the maximum assessment and geometric mean criteria.

The TMDL is required to meet both the geometric mean and the maximum assessment bacteria criteria. Therefore, it is necessary for the critical condition to consider both wet weather, high flow conditions and dry weather, low flow conditions in order to comply with both bacteria criteria.

1.5 Consideration of Seasonal Variations

Seasonal variations involve changes in stream flow and water quality because of hydrologic and climatological patterns. Seasonal variations were explicitly included in the modeling approach for this TMDL. The continuous simulation model developed for this TMDL explicitly incorporates the seasonal variations of rainfall, runoff, and fecal coliform wash-off by using an hourly time-step. In addition, fecal coliform accumulation rates for each land use were developed on a monthly basis. This allowed for the consideration of temporal variability in fecal coliform loading within the watershed.

2.0 Watershed Description and Source Assessment

In this section, the types of data available and information collected for the development of TMDLs for the bacteria impaired segments of Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek and Potomac Run are presented. This information was used to characterize the waterbodies and their watersheds and to inventory and identify potential point and non-point sources of bacteria in the watershed.

2.1 Data and Information Inventory

A wide range of data and information were used in the development of these TMDLs. Categories of data that were used include the following:

(1) Physiographic data that describe physical conditions (i.e., topography, soils, and land use) within the watershed.

(2) Hydrographic data that describe the stream networks and reaches.

(3) Data related to uses of the watershed and other activities in the basin that can be used in the identification of potential bacteria sources.

Table 2-1 shows the various data types and the data sources used for TMDL development.

Table 2- 1: Inventory of Data and Information Used in TMDL Development

Data Category	Description	Source(s)
Watershed physiographic data	Watershed boundary	USGS HUC Boundaries (2007)
	Land use/land cover	NOAA (2006)
	Soil data (*Soil Data Mart*)	USDA-NRCS (2010a)
	Topographic data (USGS-30 meter DEM)	USDA-NRCS (2010b)
Hydrographic data	Stream network and reaches (1:24k resolution) – National Hydrography Dataset	USGS (2008)
Weather data	Information, data, reports, and maps that can be used to support fecal coliform source identification and loading	NCDC (2011)
Watershed activities/ uses data and information related to bacteria production	Livestock inventory	Census of Agriculture (2007), Prince William County Soil and Water Conservation District (2011), Stafford County (2011), VA DCR (2011a), Tri-County/City Soil and Water Conservation District (2011)
	Wildlife inventory	Difficult Run Bacteria TMDL (2008), VA DGIF (2011)
	Septic systems inventory and failure rates	VA DEQ, Census Bureau, Stafford County, Heath Districts (see below)
	Pet estimates	AVMA (2007)
Point sources and direct discharge data and information	Permitted facilities locations and discharge monitoring reports (DMRs)	VA DEQ (2011b)
	MS4 permits	VA DCR (2011b)
	SSO data and locations	VA DEQ (2011b)
Environmental monitoring data	Monitoring data (bacteria water quality) and station locations	VA DEQ (2011b)
	Stream flow data	USGS (2011)

Notes:
AVMA: American Veterinary Medical Association
NCDC: National Climatic Data Center
NHD: National Hydrography Dataset
NLCD: National Land Cover Database
NOAA: National Oceanic and Atmospheric Association
NRCS: Natural Resources Conservation Service
USDA: United States Department of Agriculture
USGS: United States Geological Survey
VA DCR: Virginia Department of Conservation and Recreation
VA DEQ: Virginia Department of Environmental Quality
VA DGIF: Virginia Department of Game and Inland Fisheries
VDH: Virginia Department of Health

The following agencies were specifically contacted to obtain estimates for wildlife, livestock and septic systems/straight pipes:

- Tri-County/City Soil and Water Conservation District

- Prince William County Soil and Water Conservation District
- Virginia Cooperative Extension Office – Prince William County
- Virginia Cooperative Extension Office – Fauquier
- Virginia Cooperative Extension Office – Stafford
- Prince William County Health Department
- Rappahannock Area Health District
- Virginia Department of Game and Inland Fisheries

2.2 Watershed Descriptions and Identification

The impaired streams included in this TMDL include: Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek, and Potomac Run. The watersheds of these streams occupy a combined drainage area of 137 square miles.

2.2.1 Location

The impaired watersheds addressed in this TMDL are located in the northern region of Virginia within the borders of Prince William and Stafford Counties. Additionally, all are located in Lower Potomac USGS Cataloging Unit 02070011. Watershed drainage areas and major roads within each watershed are described below.

2.2.1.1 Powells Creek

The Powells Creek watershed is located in Prince William County and occupies a drainage area of 15.2 square miles. As shown in **Figure 2-1**, the major roadways in the watershed are Interstate 95 and U.S. Highway 1, which run north-south across the eastern half of the watershed.

2.2.1.2 Quantico Creek and South Fork Quantico Creek

The Quantico Creek/South Fork Quantico Creek watershed is located in Prince William County and occupies a drainage area of 27.1 square miles. As shown in **Figure 2-1**, the major roadways in the watershed are Interstate 95 and U.S. Highway 1, which run north-south across the eastern edge; and State Highway 234, which runs east-west along the northern border between this watershed and the Powells Creek watershed. Portions of the

Quantico Creek and South Fork Quantico Creek watersheds run through the Prince William Forest Park.

2.2.1.3 North Branch Chopawamsic Creek

The North Branch Chopawamsic Creek watershed occupies a drainage area of 11 square miles, 3.9 square miles of which are in Prince William County, and the remaining 7.1 square miles are in Stafford County. There are no major roadways running through the watershed. Much of this watershed is occupied by the United States Marine Corps Base – Quantico.

2.2.1.4 Unnamed Tributary to Potomac River

The Unnamed Tributary to the Potomac River (Stream Code XLF) watershed is located in Stafford County and occupies a drainage area of 4.2 square miles. There are no major roadways in the watershed.

2.2.1.5 Austin Run

The Austin Run watershed is located in Stafford County and occupies a drainage area of 11 square miles. As shown in **Figure 2-1**, the major roadways present are Interstate 95 and U.S. Highway 1, which run north-south across the eastern portion of the watershed, and State Highway 610, which runs east-west across the northern tip of the watershed.

2.2.1.6 Accokeek Creek

Accokeek Creek is located in Stafford County and occupies a drainage area of 17.5 square miles. As shown in **Figure 2-1**, the major roadways in the watershed are Interstate 95 and U.S. Highway 1, which run north-south across the center of the watershed.

2.2.1.7 Potomac Creek and Potomac Run

The Potomac Creek/Potomac Run watershed is located in Stafford County and occupies a drainage area of 50.7 square miles. As shown in **Figure 2-1**, the major roadways in the watershed are Interstate 95 and U.S. Highway 1, which run north-south across the eastern portion of the watershed, and State Highway 616, which runs north-south across the western portion of the watershed.

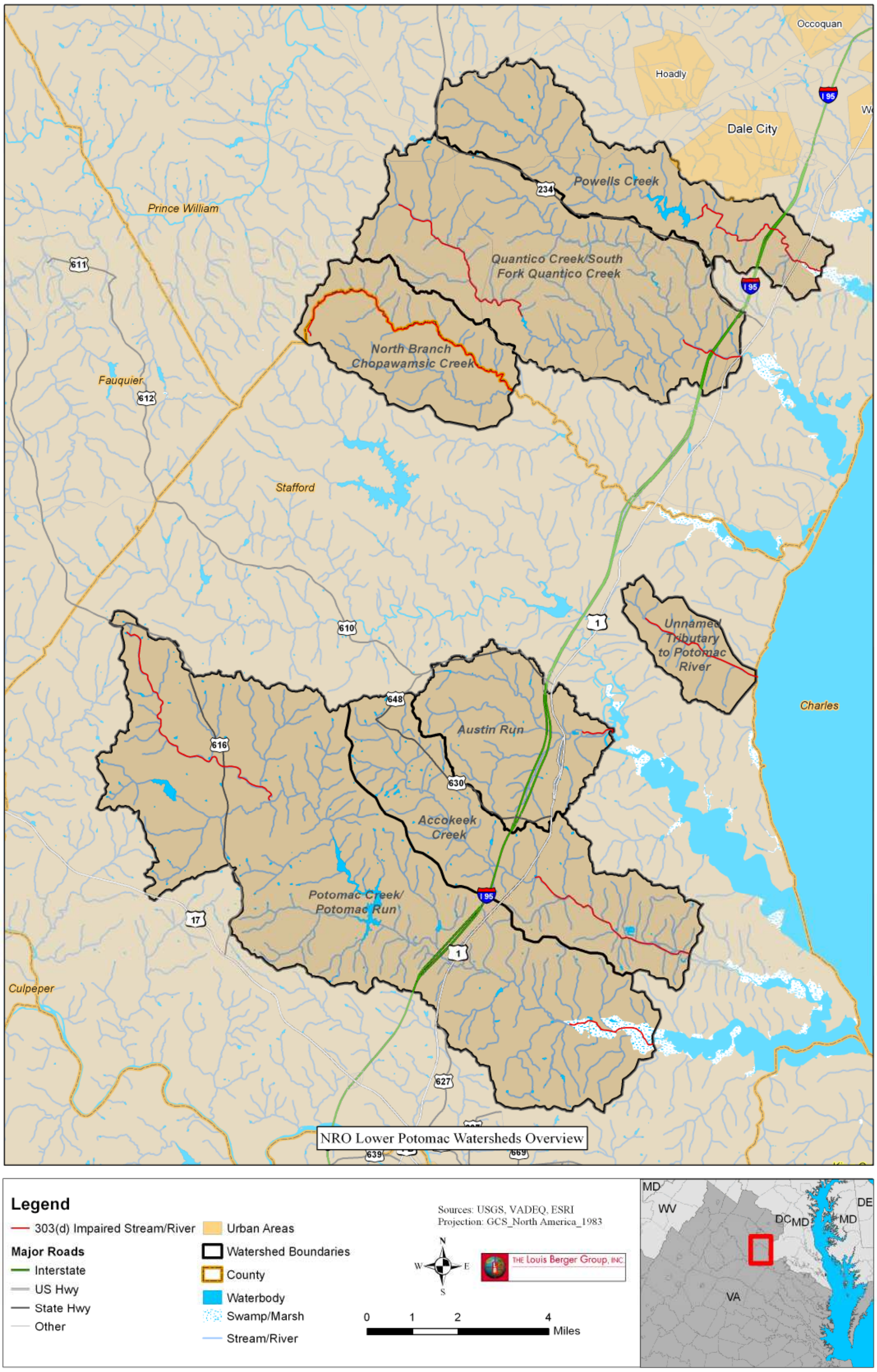


Figure 2- 1: Overview Map of Watersheds Included in TMDL Study

2.2.2 Topography

A digital elevation model (DEM) based on the USGS National Elevation Dataset (NED) was used to characterize topography in the watershed. NED data were obtained from the Geospatial Data Gateway system maintained by the USDA Natural Resources Conservation Service. Elevation within the impaired watersheds ranges from 0 to 463 feet above mean sea level.

2.2.3 Hydrologic Soil Groups and Soil Types

The following section details hydrologic soil groups for the Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek, and Potomac Run TMDL watersheds. The soil hydrologic group characterization is based on data obtained from the Soil Survey Geographic (SSURGO) Database via *Soil Data Mart*, a USGS-approved program and multi-purpose environmental analysis system integrating GIS, national watershed data, and environmental assessment and modeling tools.

The hydrologic soil groups represent different levels of infiltration capacity of the soils. Hydrologic soil group “A” designates soils that are well- to excessively well-drained, whereas hydrologic soil group “D” designates soils that are poorly drained. This means that soils in hydrologic group “A” allow a larger portion of the rainfall to infiltrate and become part of the ground water system. On the other hand, compared to the soils in hydrologic group “A,” soils in hydrologic group “D” allow a smaller portion of the rainfall to infiltrate and become part of the ground water. Consequently, more rainfall becomes part of the surface water runoff. Descriptions of the hydrologic soil groups are presented in **Table 2-2**. Distribution of hydrologic groups within the TMDL watersheds is presented in **Table 2-3**. The term “blank” in the hydrologic group breakdown refers to those classes defined as water, urban land, stony steep land, stony rolling land, sand and gravel pits, dams, and cut-and-fill lands. There are 90 general soil associations located in the watersheds, as presented in **Appendix A**. The dominant soil types in these watersheds are Nason, Caroline, Appling, Sassafras, and Elioak.

Table 2- 2: Descriptions of Hydrologic Soil Groups	
Hydrologic Soil Group	**Description**
A	High infiltration rates. Soils are deep, well-drained to excessively drained sand and gravels.
B	Moderate infiltration rates. Deep and moderately deep, moderately well- and well-drained soils with moderately coarse textures.
B/D	Combination of Hydrologic Soils Groups B and D, where drained areas are of Soil Group B and undrained areas are of Group D.
C	Moderate to slow infiltration rates. Soils with layers impeding downward movement of water or soils with moderately fine or fine textures.
C/D	Combination of Hydrologic Soil Groups C and D, where drained areas are of Soil Group C and undrained areas are of Group D.
D	Very slow infiltration rates. Soils are clayey, have high water table, or shallow to an impervious cover.

2.2.3.1 Powells Creek

The major hydrologic soil groups within the Powells Creek watershed are Group B (63%) and Group C (26%) (**Table 2-3**). The major soil series are Gaila (11%), which is deep, well drained, and found on nearly level to steep uplands; and Glenelg (10%), which is very deep, well drained and found in uplands (NRCS).

2.2.3.2 Quantico Creek and South Fork Quantico Creek

The major hydrologic soil groups within the Quantico Creek/South Fork Quantico Creek watershed are Group B (63%) and Group C (26%) (**Table 2-3**). The major soil series are Buckhall (17%), which is deep, well-drained, moderately permeable and found on ridge tops and side slopes; and Fairfax (10%), which is deep, well-drained, moderately permeable and found on level to moderately sloping uplands (NRCS).

2.2.3.3 North Branch Chopawamsic Creek

The major hydrologic soil groups within the North Branch Chopawamsic Creek watershed are Group C (55%) and Group B (30%) (Table 2-3). The major soil series are Nason (30%), which is deep, well-drained, moderately permeable and found on uplands;

and Fairfax (9%), which is deep, well-drained, moderately permeable and found on level to moderately sloping uplands (NRCS).

2.2.3.4 Unnamed Tributary to Potomac River

The major hydrologic soil groups within the Unnamed Tributary to Potomac River watershed are Group B (51%) and Group C (31%) (**Table 2-3**). The major soil series are Sassafras (45%), which is very deep, well-drained, has moderate or moderately slow permeability and is found on summits and side slopes; and Caroline (10%), which is deep, well-drained, has moderately slow or slow permeability and is found in marine and fluvial areas (NRCS).

2.2.3.5 Austin Run

The major hydrologic soil groups within the Austin Run watershed are Group C (38%) and Group B (35%) (**Table 2-3**). The major soil series are Appling (10%), which is deep, well-drained and moderately permeable, and found on ridges and side slopes; and Nason (10%), which is deep, well-drained, moderately permeable and found on uplands (NRCS).

2.2.3.6 Accokeek Creek

The major hydrologic soil groups within the Accokeek Creek watershed are Group C (42%) and Group B (33%) (**Table 2-3**). The major soil series are Caroline (26%), which is deep, well-drained, has moderately slow or slow permeability and is found in marine and fluvial areas; and Sassafras (14%), which is very deep, well-drained, has moderate or moderately slow permeability and is found on summits and side slopes (NRCS).

2.2.3.7 Potomac Creek and Potomac Run

The major hydrologic soil groups within the Potomac Creek/Potomac Run watershed are Group C (49%) and Group B (28%) (**Table 2-3**). The major soil series are Cullen (14%), which is very deep, well drained, moderately permeable and found on upland ridge tops and side slopes (NRCS); and Caroline (10%), which is deep, well-drained, has moderately slow or slow permeability and is found in marine and fluvial areas.

Table 2- 3: Distribution of Hydrologic Soil Groups within TMDL Watersheds

Soil Hydrologic Group	Powells Creek	%	Quantico Creek and South Fork Quantico Creek	%	North Branch Chopawamsic Creek	%	Unnamed Tributary to Potomac River	%	Austin Run	%	Accokeek Creek	%	Potomac Creek and Potomac Run	%	Total acres	Total %
A	-	-	-	-	-	-	137	5%	22	<1%	204	2%	155	<1%	518	1%
B	6,079	63%	10,911	63%	2,098	30%	1,368	51%	2,444	35%	3,651	33%	9,223	28%	35,774	41%
B/D	-	-	-	-	-	-	55	2%	261	4%	422	4%	562	2%	1,300	1%
C	2,488	26%	4,515	26%	3,896	55%	826	31%	2,647	38%	4,652	42%	15,909	49%	34,933	40%
C/D	-	-	143	1%	117	2%	111	4%	261	4%	776	7%	1,636	5%	3,044	3%
D	953	10%	1,356	8%	912	13%	203	7%	758	11%	1,198	11%	3,981	12%	9,361	11%
[blank]*	206	<1%	390	2%	-	-	8	<1%	616	9%	265	2%	951	3%	2,436	3%
TOTAL	9,725	100%	17,315	100%	7,023	100%	2,708	100%	7,010	100%	11,168	100%	32,417	100%	87,366	100%

* The category “blank” in the hydrologic group breakdown refers to those classes defined as water, urban land, stony steep land, stony rolling land, sand and gravel pits, dams, and cut-and-fill lands.

2.2.4 Land Use

The land use characterization for the Potomac River watersheds addressed in these TMDLs was based on the latest available land cover data from the National Land Cover Dataset, also known as NLCD 2006 Land Use Dataset. The distribution of land uses in the watershed, by land area and percentage, are presented in **Table 2-4**. Descriptions of the land use categories are presented in **Table 2-5**. Dominant land uses in the watersheds are Forest (64%) and Developed (13%). **Figure 2-2** depicts the land use distribution within the TMDL watersheds.

Table 2- 4: Land Use in the TMDL Watersheds

General Land Use Category	Specific LU Type	Powells Creek				Quantico Creek/South Fork Quantico Creek				North Branch Chopawamsic Creek				Unnamed Tributary to Potomac River				Austin Run				Accokeek Creek				Potomac Creek/Potomac Run							
		Acres*		% of Watershed		Acres*		% of Watershed		Acres*		% of Watershed		Acres*		% of Watershed		Acres*		% of Watershed		Acres*		% of Watershed		Acres*		% of Watershed		Total Acres		Total % of Watershed	
Developed	Developed High Intensity	192	3,063	2%	31%	107	1,166	1%	7%	-	8	-	<1%	0	250	<1%	9%	181	3,126	3%	45%	65	1,475	1%	13%	204	2,116	1%	7%	749	11,203	1%	13%
	Developed Medium Intensity	516		5%		220		1%		2		<1%		10		<1%		553		8%		158		1%		212		1%		1,671		2%	
	Developed Low Intensity	1,534		16%		510		3%		4		<1%		117		4%		1,616		23%		568		5%		563		2%		4,912		6%	
	Developed Open Space	821		8%		329		2%		2		<1%		122		5%		776		11%		684		6%		1,137		4%		3,871		4%	
Agricultural	Cultivated Crops	357	445	4%	5%	77	92	<1%	1%	52	61	<1%	1%	43	68	2%	3%	185	253	3%	4%	612	895	5%	8%	3,208	5,896	<1%	18%	4,534	7,710	5%	9%
	Pasture/Hay	88		1%		15		<1%		9		<1%		25		1%		68		1%		283		3%		2,688		8%		3,176		4%	
Forest	Deciduous Forest	4,179	4,559	43%	47%	10,841	14,722	63%	85%	2,594	5,897	37%	84%	1,895	2,086	<1%	77%	2,367	2,681	34%	38%	6,132	7,056	55%	63%	16,306	18,842	<1%	58%	44,314	55,844	51%	64%
	Evergreen Forest	194		2%		1,421		8%		1,435		<1%		82		3%		177		3%		516		5%		1,620		5%		5,445		6%	
	Mixed Forest	187		2%		2,461		14%		1,867		27%		109		4%		137		2%		408		4%		916		3%		6,085		7%	
Wetland	Palustrine Aquatic Bed	-	543	-	6%	-	852	-	5%	-	851	-	12%		163		6%	-	302	-	4%	-	881	-	8%	-	2,378	-	7%	-	5,970	0%	7%
	Palustrine Emergent Wetland	10		<1%		13		<1%		3		<1%		1		<1%		33		<1%		6		<1%		136		<1%		202		<1%	
	Palustrine Forested Wetland	491		5%		794		5%		782		11%		147		5%		233		3%		843		8%		2,038		6%		5,328		6%	
	Palustrine Scrub/Shrub Wetland	36		<1%		46		<1%		66		<1%		12		<1%		31		<1%		32		<1%		184		1%		407		<1%	
	Estuarine Emergent Wetland	5		<1%		0		<1%		-		-		3		<1%		5		<1%		<1		<1%		20		<1%		33		<1%	
	Estuarine Forested Wetland	-		-		-		-		-		-		-		-		-		-		-		-		-		-		-		0%	
	Estuarine Scrub/Shrub Wetland	-		-		-		-		-		-		-		-		-		-		-		-		-		-		-		0%	
Water	Open Water	87	87	1%	1%	7	7	<1%	<1%	2	2	<1%	<1%	-	-	-	-	12	12	<1%	0%	21	21	<1%	<1%	260	260	1%	1%	389	389	0%	0%
Other	Scrub/Shrub	286	1,029	3%	11%	268	476	2%	3%	143	204	2%	3%	105	141	4%	5%	227	636	3%	9%	523	840	5%	8%	1,895	2,925	6%	9%	3,447	6,251	4%	7%
	Grassland/Herbaceous	80		1%		139		1%		61		<1%		19		1%		93		1%		197		2%		486		2%		1,075		1%	
	Unconsolidated Shore	1		<1%		1		<1%		-		-		14		1%		2		<1%		2		<1%		14		<1%		34		0%	
	Bare Land	661		7%		69		<1%		-		-		3		<1%		314		4%		117		1%		531		2%		1,695		2%	
Total		**9,725**		**100%**		**17,315**		**100%**		**7,023**		**100%**		**2,708**		**100%**		**7,010**		**100%**		**11,168**		**100%**		**32,417**		**100%**		**87,366**		**100%**	

*Acreages calculated in NAD 1983 UTM Zone 18N projection

Table 2-5: Descriptions of Land Use Types	
Land Use Type	**Description**
Developed, High Intensity	Includes highly developed areas where people reside or work in high numbers. Impervious surfaces account for 80 to 100 percent of the total cover.
Developed, Medium Intensity	Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50 to 79 percent of the total cover.
Developed, Low Intensity	Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 21 to 49 percent of total cover.
Developed Open Space	Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover.
Cultivated Crops	Areas used for the production of annual crops. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle and not tilled. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.
Deciduous Forest	Areas dominated by trees generally greater than 5 meters tall and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.
Evergreen Forest	Areas dominated by trees generally greater than 5 meters tall and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
Mixed Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.
Palustrine Aquatic Bed	Includes tidal and non-tidal wetlands and deepwater habitats in which salinity due to ocean-derived salts is below 0.5 percent and which are dominated by plants that grow and form a continuous cover principally on or at the surface of the water. These include algal mats, detached floating mats, and rooted vascular plant assemblages.
Palustrine Emergent Wetland	Includes all tidal and non-tidal wetlands dominated by persistent emergent vascular plants, emergent mosses or lichens, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Plants generally remain standing until the next growing season. Total vegetation cover is greater than 80 percent.
Palustrine Forested Wetland	Includes all tidal and non-tidal wetlands dominated by woody vegetation greater than or equal to 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent.
Palustrine Scrub/Shrub Wetland	Includes all tidal and non tidal wetlands dominated by woody vegetation less than 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent. The species present could be true shrubs, young trees and shrubs, or trees that are small or stunted due to environmental conditions (Cowardin et al. 1979).
Estuarine Emergent Wetland	Includes all tidal wetlands dominated by erect, rooted, herbaceous hydrophytes (excluding mosses and lichens) and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent and that are present for most of the growing season in most years. Perennial plants usually dominate these wetlands.
Estuarine Forested Wetland	Includes all tidal wetlands dominated by woody vegetation greater than or equal to 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent. Total vegetation coverage is greater than 20 percent.
Estuarine Scrub/Shrub Wetland	Includes all tidal wetlands dominated by woody vegetation less than 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent. Total vegetation coverage is greater than 20 percent.
Open Water	All areas of open water, generally with less than 25 percent cover of vegetation or soil.
Scrub/Shrub	Areas dominated by shrubs less than 5 meters tall with shrub canopy typically greater than 20 percent of total vegetation. This class includes tree shrubs, young trees in an early successional stage, or trees stunted from environmental conditions.
Bare Land	Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earth material. Generally, vegetation accounts for less than 10 percent of total cover.
Grassland/Herbaceous	Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Unconsolidated Shore	Unconsolidated material such as silt, sand, or gravel that is subject to inundation and redistribution due to the action of water. Characterized by substrates lacking vegetation except for pioneering plants that become established during brief periods when growing conditions are favorable. Erosion and deposition by waves and currents produce a number of landforms representing this class.

Source: Coastal NLCD Classification Scheme, NOAA Coastal Services Center

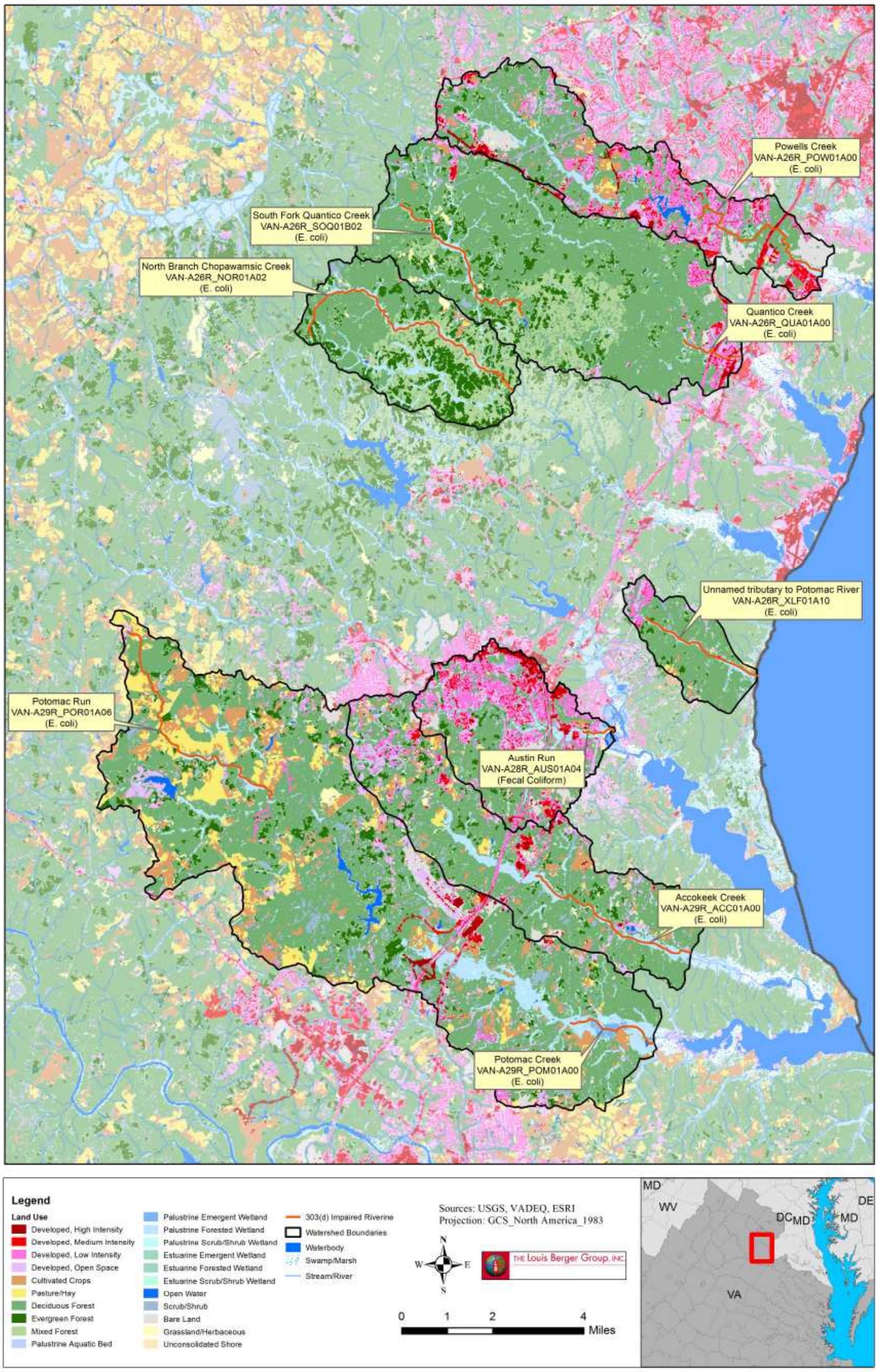


Figure 2- 2: Land Use for the TMDL watersheds

2.3 Stream Flow Data

Daily flow data were available from 10 USGS stream flow-gauging stations within the TMDL study area. Data collected at these stations are shown in **Table 2-6**. Up-to-date flow data is available from USGS station 01658500, located on the downstream end of the impaired segment of South Fork Quantico Creek; USGS stations 01659000 and 01659500, located on the downstream end of the impaired segment of North Branch Chopawamsic Creek; and USGS station 01660400, located on Aquia Creek. Locations of the USGS stations are shown in **Figure 2-3**. No historic or present USGS stream flow-gauging stations are present in the Unnamed Tributary to Potomac River, Accokeek Creek, Potomac Creek, or Potomac Run watersheds.

Table 2- 6: USGS Flow Gauges Located in the TMDL Study Area

Station	Watershed	Site Name	Period of Daily-Mean Data	
			Start Date	End Date
01657895	Powells Creek	Powells Creek near Dale City, VA	1/10/1995	07/9/1996
01658500	Quantico Creek/South Fork Quantico Creek	South Fork Quantico Creek Near Independent Hill, VA	5/1/1951	Present
01658480	Quantico Creek/South Fork Quantico Creek	Quantico Creek Near Dumfries, VA	5/19/1983	09/30/1985
01658550	Quantico Creek/South Fork Quantico Creek	South Fork Quantico Creek At Camp 5, Near Joplin, VA	6/27/1983	09/30/1985
01658650	Quantico Creek/South Fork Quantico Creek	South Fork Quantico Creek Near Dumfries, VA	5/18/1983	09/30/1985
01659000	North Branch Chopawamsic Creek	North Branch Chopawamsic Creek Near Independent Hill, VA	5/1/1951	Present
01659500	North Branch Chopawamsic Creek	Middle Branch Chopawamsic Creek Near Garrisonville VA	5/1/1951	Present
01660380	Austin Run	Cannon Creek Near Garrisonville, VA	11/23/1994	11/25/1996
01660400	Austin Run	Aquia Creek Near Garrisonville, VA	9/1/1971	Present
01660500	Austin Run	Beaverdam Run Near Garrisonville, VA	5/1/1951	12/31/2003

2.4 Ambient Water Quality Data for Bacteria

Environmental monitoring efforts for collecting bacteria data in the TMDL watersheds have been conducted by the Virginia Department of Environmental Quality (VADEQ) and U.S. Geological Survey (USGS). All available bacteria data for streams located within the TMDL watersheds were analyzed and compared to VADEQ water quality criteria for bacteria. Data extend through the end of 2010. **Table 2-7** summarizes VADEQ monitoring efforts for all bacteria indicators according to Station ID.

Table 2- 7: Summary of Instream Monitoring for Bacteria

Station ID	Stream	Indicator	Number of Samples	Sample Date		Minimum[1,2]	Maximum[1,2]
				First	Last		
Powells Creek							
1APOW003.11	Powells Creek	Fecal Coliform	11	12/16/1998	11/30/2006	25	700
		E. coli	13	2/6/2003	10/19/2010	25	420
1APOW006.11	Powells Creek	Fecal Coliform	2	10/5/2006	11/30/2006	25	50
		E. coli	23	8/7/2003	10/19/2010	25	2000
1APOW009.99	Powells Creek	Fecal Coliform	0	-	-	-	-
		E. coli	9	8/7/2003	6/14/2005	25	950
Quantico Creek/South Fork Quantico Creek							
1AQUA004.46	Quantico Creek	Fecal Coliform	60	11/17/1998	10/12/2010	25	2000
		E. coli	47	7/16/2003	10/12/2010	25	2000
1ASOQ003.17	South Fork Quantico Creek	Fecal Coliform	-				
		E. coli	13	11/20/2003	6/20/2005	25	330
1ASOQ006.73/ USGS 01658500	South Fork Quantico Creek	Fecal Coliform	-	-	-	-	-
		E. coli	75	1/14/2003	12/14/2010	3	1500
North Branch Chopawamsic Creek							
1AMIP000.40	Middle Branch Chopawamsic Creek	Fecal Coliform	-	-	-	-	-
		E. coli	9	2/25/2010	10/18/2010	25	220
1ANOR009.87/ USGS01659000	North Branch Chopawamsic Creek	Fecal Coliform	-	-	-	-	-
		E. coli	48	2/22/2007	12/14/2010	7	2000
Unnamed Tributary to Potomac River							
1AXLF000.13	Unnamed Tributary to Potomac River	Fecal Coliform	-	-	-	-	-
		E. coli	11	3/12/2007	12/9/2008	25	500
Austin Run							
1AAUS000.49	Austin Run	Fecal Coliform	8	9/12/2001	6/10/2003	100	1200
		E. coli	10	1/25/2010	10/19/2010	25	900
Accokeek Creek							
1AACC006.13	Accokeek Creek	Fecal Coliform	10	12/16/1998	6/10/2003	100	1700
		E. coli	33	7/15/2003	10/19/2010	25	2000
Potomac Creek/Potomac Run							
1APOM006.72	Potomac Creek	Fecal Coliform	10	12/16/1998	6/10/2003	100	1300

Table 2- 7: Summary of Instream Monitoring for Bacteria

Station ID	Stream	Indicator	Number of Samples	Sample Date		Minimum[1,2]	Maximum[1,2]
				First	Last		
		E. coli	19	7/15/2003	10/19/2010	25	1300
1APOM012.24	Potomac Creek	Fecal Coliform	-	-	-	-	-
		E. coli	19	9/23/2003	10/19/2010	25	950
1APOM013.02	Potomac Creek	Fecal Coliform	3	4/29/2003	6/25/2003	25	25
		E. coli	21	4/29/2003	10/14/2010	10	150
1APOM013.41	Potomac Creek	Fecal Coliform	-	-	-	-	-
		E. coli	4	7/28/2003	10/15/2003	25	25
1ALOH002.20	Able Lake	Fecal Coliform	-	-	-	-	-
		E. coli	4	7/8/2003	10/15/2003	25	25
1ALOH007.93	Long Branch	Fecal Coliform	17	4/20/1999	9/26/2007	50	100
		E. coli	18	5/20/2004	10/18/2007	25	50
1AXLB001.49	Unnamed Tributary to Long Branch	Fecal Coliform	1	4/26/2006	-	75	75
		E. coli	1	4/26/2006	-	90	90
1APOR000.40	Potomac Run	Fecal Coliform	-	-	-	-	-
		E. coli	30	7/15/2003	10/19/2010	25	2000

[1] Units for Fecal Coliform: MPN/100 ml

[2] Units for *E. coli*: CFU/100 ml

Table 2-8 shows the total number and percentage of samples exceeding the water quality maximum assessment water quality criterion for *E. coli* of 235 cfu/100 ml and the historic water quality criterion of 400 MPN/100 ml for fecal coliform bacteria. **Figure 2-3** presents the locations of VADEQ's water quality monitoring stations and USGS flow/measurement stations within the NRO Lower Potomac watersheds.

Table 2- 8: Summary of VA DEQ Bacteria Exceedances

Station ID	Stream	Cause	Exceedance Rate*
1APOW006.11	Powells Creek	*E. coli*	2/13 (15.4%)
1AQUA004.46	Quantico Creek	*E. coli*	7/27 (26%)
01658500 (USGS)	S. Fork Quantico Creek	*E. coli*	7/47 (15%)
01659000 (USGS)	North Branch Chopawamsic Creek	*E. coli*	2/7 (12%)
1AAUS000.49	Austin Run	fecal coliform	3/8 (37.5%)**
1AXLF000.13	Unnamed Tributary to Potomac River	*E. coli*	2/11 (18%)
1AACC006.13	Accokeek Creek	*E. coli*	4/23 (17%)
1APOM006.72	Potomac Creek	*E. coli*	4/13 (31%)
1APOR000.40	Potomac Run	*E. coli*	10/13 (77%)

*Exceedance rate listed in Virginia's 2010 305(b)/303(d) Water Quality Integrated Assessment

**Exceedance rate listed in Virginia's 2006 305(b)303(d) Water Quality Integrated Assessment

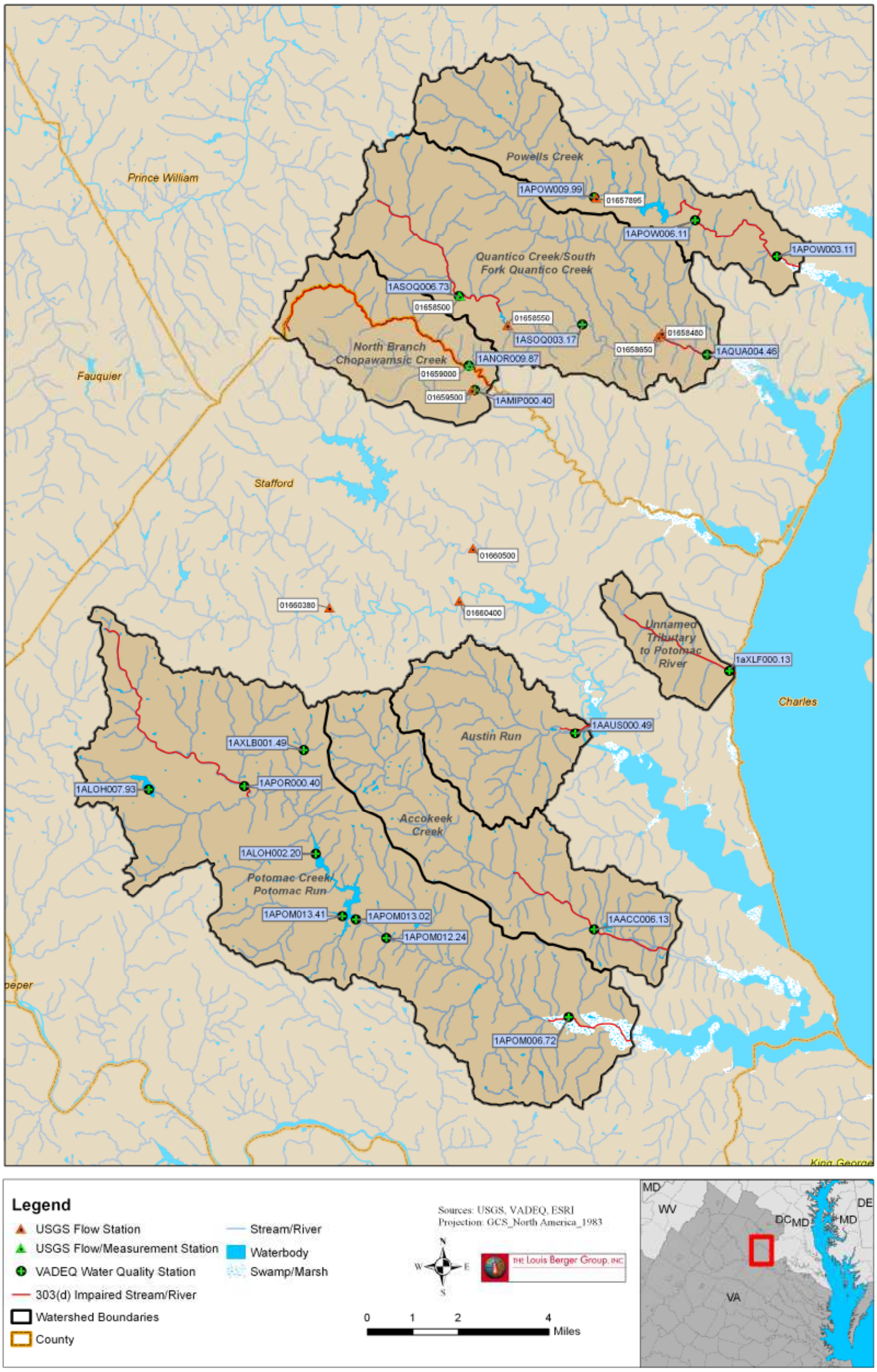


Figure 2- 3: VA DEQ Water Quality Monitoring Stations and USGS Flow Stations in the TMDL Watersheds

2.5 Bacteria Source Assessment

This section focuses on characterizing the sources that potentially contribute to the bacteria loadings in the TMDL watersheds. These sources include permitted facilities, septic systems, livestock, wildlife, and pets.

Based on data obtained from VADEQ, there are five facilities permitted by the Virginia Pollutant Discharge Elimination System (VPDES) Program that are located within the impaired watersheds and are expected to discharge the contaminant of concern. In addition to VPDES permits, Municipal Separate Storm Sewer System (MS4) permits have been issued to cities, counties and other facilities within the TMDL watersheds. Information regarding bacteria sources has been obtained from published sources as well as citizen feedback and involvement.

2.5.1 Permitted Facilities

There are three facilities holding active individual Virginia Pollutant Discharge Elimination System (VPDES) permits, issued through the VPDES permitting program, in these TMDL watersheds that are expected to discharge the contaminant of concern (bacteria). The permit number, facility name, design flow and permit concentration (cfu/100 ml) for each of these facilities are presented in **Table 2-9**. The available flow data and water quality for the permitted facilities was retrieved and analyzed. Average flows for the permitted facilities were used in the HSPF model set-up and calibration.

In addition, there are two facilities with general permits for Domestic Sewage Discharges of Less Than or Equal to 1,000 Gallons per Day (also known as “Single Family Home General Permits”) located in the TMDL watershed. Facilities holding this type of general permit are also expected to discharge the contaminant of concern and thus, are listed below in **Table 2-9,** along with their permit number, facility name, design flow and permit concentration (cfu/100 ml).

There may be other industrial process water and/or stormwater dischargers in the watershed that are authorized to discharge under the VPDES program. These facilities are not expected to discharge the pollutant of concern (bacteria). However, there may be incidental, insignificant levels of bacteria found in these discharges; the discharges are not considered to have a reasonable potential to cause or contribute to exceedances of the Virginia Water Quality Standards and the observed stream impairments. Any inadvertent bacteria discharge would be insignificant, and are not considered in this TMDL.

In addition to the VPDES permits presented above, there are currently 7 Municipal Separate Storm Sewer System (MS4) permits issued to cities, counties and other facilities within the TMDL watersheds. These permits are detailed in **Table 2-10**. For Phase I MS4 Permits (for example, Prince William County), all land-based loadings from developed land use categories (high, medium, and low intensity developed land uses) within the impaired watersheds were allocated to the MS4 permits. For Phase II Permits (i.e. Stafford County, Town of Dumfries, etc.) all land-based loadings from developed land use categories (high, medium, and low intensity developed land uses) within the most recent United States Census-defined urban areas of the permit boundaries were allocated to the MS4s. The most recent United States decennial census with defined urban areas is the 2010 Census. This approach for developing MS4 allocations is a land-use based approach. **Figure 2-4** depicts the landuse and boundaries which were used to develop the MS4 allocations.

One disadvantage to the land-use based approach is that it is not able to distinguish between urban areas that drain to regulated MS4s and those that drain to other unregulated pervious areas or directly to surface waters. At the time of TMDL development, detailed information regarding the portion of each watershed that drains to a MS4 system was not available, so a conservative, land-use based approach was used. It is important to note that the actual areas within the TMDL watersheds that are subject to a MS4 WLA are those areas that are specifically regulated under the MS4 permit. This TMDL study does not attempt or intend to define the MS4 regulatory area. Rather, the areas used to develop loadings associated with the MS4 permits in this TMDL (developed and Census defined urban areas) are only surrogates for establishing WLAs, estimating a reasonable pollutant loading that is expected to be contributed by these permitted sources. The WLAs for MS4 permittees can be revised in the future, as necessary, if additional information regarding the MS4 drainage areas becomes available or if adaptive management indicates that related loading(s) or reduction strategies would be impacted to a significant degree.

Due to the spatial overlap between MS4 entities and the resulting uncertainty of the appropriate operator of the system, the MS4 loads are aggregated by jurisdiction (Prince William County or Stafford County) in the TMDL. In most cases, the boundaries of MS4 areas are not available in enough geospatial detail to disaggregate the MS4 loads and assign individual Waste Load Allocations. EPA, DEQ, and DCR support the aggregation of MS4 WLAs for this reason. Additionally, aggregation encourages stakeholder cooperation for the implementation of appropriate BMPs to address reductions required by the TMDL.

Table 2- 9: VPDES Permitted Facilities in the TMDL Watersheds (Expected to Discharge Contaminant of Concern)

Permit Number	Permit Type	Facility Name	Watershed	Max Design Flow (MGD)	Permit Concentration (cfu/100 ml)
VA0092479	Municipal, Minor	Abrahms Ct STP*	Austin Run	0.0036	126
VA0060968	Municipal, Major	Aquia Wastewater Treatment Plant	Austin Run	12	126
VA0089630	Municipal, Minor	Randall STP	Accokeek Creek	0.0008	126
VAG406114	General Permit Domestic Sewage	Business	Unnamed Tributary to Potomac River	0.001	126
VAG406207	General Permit Domestic Sewage	Residence	Accokeek Creek	0.001	126

*This permit is still in draft form and has not been officially issued.

Table 2- 10: MS4 Permits within the TMDL Study Area

Permit Number	MS4 Permit Holder
VAR040056	Stafford County
VAR040069	United States Marine Corps, Quantico
VAR040071	Stafford County Public Schools
VAR040100	Prince William County Public Schools
VAR040115	Virginia Department of Transportation
VAR040117	Town of Dumfries
VA0088595*	Prince William County

*Phase I MS4 Permit

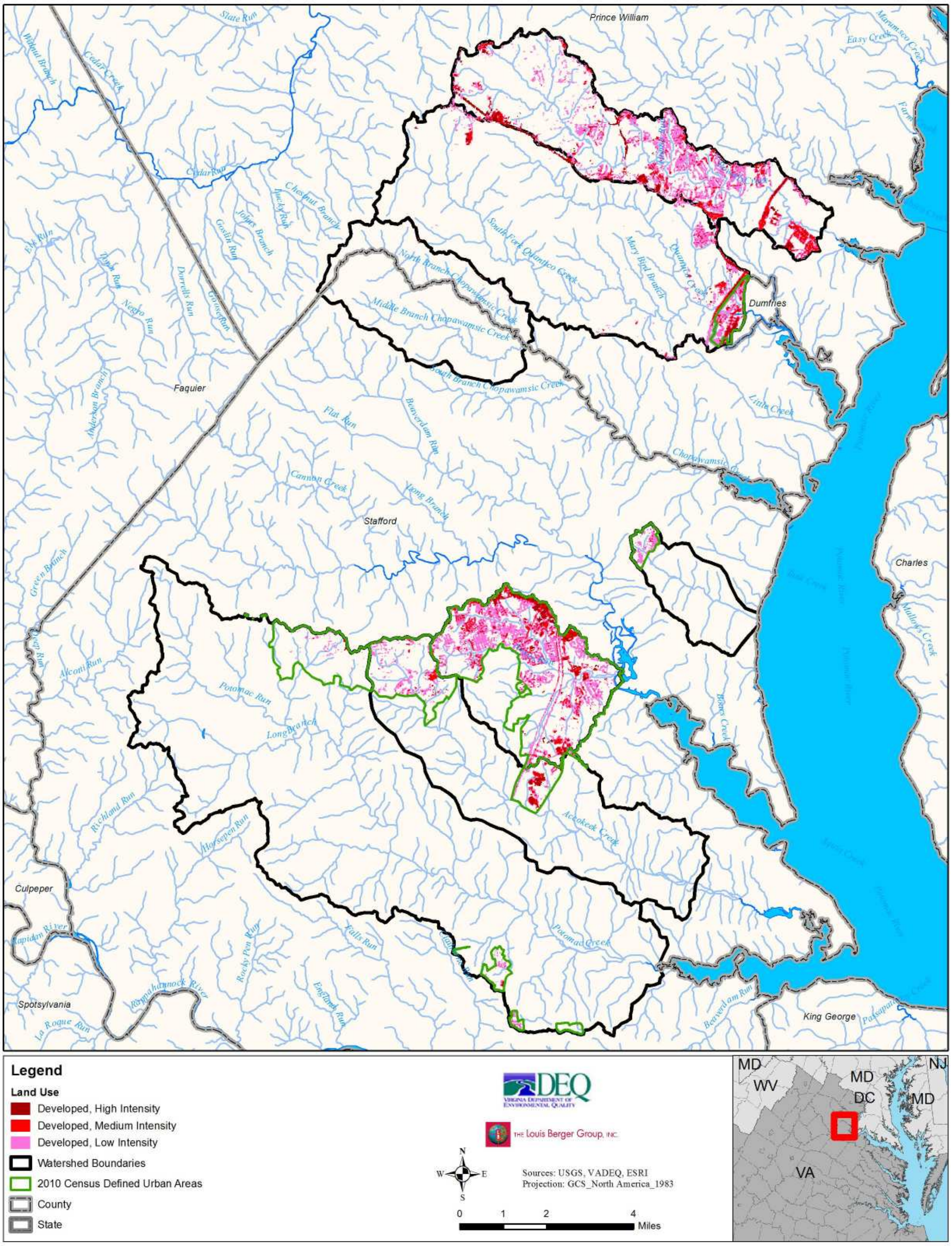


Figure 2- 4: MS4 Urban Land Use Distribution (NLCD 2006)

2.5.2 Sanitary Sewer System, Septic Tanks, and Straight Pipes

Houses can be connected to a public sanitary sewer, a septic tank, or the sewage can be disposed of by other means. Estimates of the total number of households in each impaired watershed using each type of waste disposal are presented in this section. Where homes are connected to a centralized wastewater treatment plant, the sewage collection system can be an episodic source of bacteria when there are overflows from pump stations or other sources such as manholes. These are referred to as sanitary sewer overflows (SSOs). SSOs are reported to DEQ and the events cataloged. All reported SSOs were accounted for in this source inventory.

The 2009 U.S. Census Bureau data documents population growth rates and number of houses per county. The data for Prince William and Stafford counties were reviewed to establish total population estimates and number of houses within each watershed. The last year the Census Bureau tracked the distribution of houses on sewage systems, septic systems, and other means (considered to be straight pipes) was 1990. Assuming a similar distribution in 2009, the 1990 distributions were multiplied by the 2009 population and housing unit numbers to estimate the number of houses currently on public sewers, septic tanks and other means. It was assumed that only developed areas contain houses. Thus, estimated numbers for septic, sewer, and other means were prorated to the watershed area based on the ratio of developed acres within the watershed to acres of developed area within the county. A summary of the census data and population estimates used for the TMDL watershed are presented in **Table 2-11**.

In order to determine the amount of bacteria contributed by human sources, it is necessary to estimate the failure rates of septic systems and systems classified as "other means." The 1990 U.S Census Report category "other means" includes the houses that dispose of sewage in other ways than by public sanitary sewer or a private septic system. Typically, the houses included in this category are assumed to be disposing of sewage directly via straight pipes, if located within 200 feet of a stream. In the case of these impaired watersheds, stakeholders indicated that there are currently no known straight pipes within 200 ft of the stream. This was based on information from the various county health departments, who commented that immediate action is taken whenever a straight pipe is found. However, since there are potentially some unknown straight pipes within the watershed, a 3% failure rate of homes on “other means” was used for any homes on “other means” in the impaired watersheds. The percentage of failing septic system in each TMDL watershed was calculated by multiplying the number of septic systems in each watershed by an estimated 3% septic failure rate (VADEQ, 2011). The last column in **Tables 2-11** and **2-12** show the combined number of homes with a failing sewage disposal system (includes failure rates for both homes on septic systems and homes on “other means”).

Table 2-11 also shows the estimated amount of failing septic systems per county. **Table 2-12** shows the estimated amount of population, number of houses, number of houses on public sewer, number of houses on septic systems, number of houses on other means, and number of failing sewage disposal systems by TMDL watershed.

Table 2-11: Population Estimates for Prince William and Stafford Counties

County	Population [1]	Number of Houses[1]	Number of Houses Public Sewer[2]	Number of Houses on Septic Systems	Number of Houses with Failing Septic Systems[3]	Number of Houses on “Other Means”	Estimated Number of Houses with a Failing Sewage Disposal System (Failing Septic Systems and Other Means)[3]
Prince William	379,166	137,651	115,296	21,764	653	591	671
Stafford	124,166	43,585	24,855	18,044	541	686	562

[1] Census 2009 estimates

[2] Based upon 2009 census estimate and ratio of parameter: 1990 census estimate

[3] Based on a failure rate of 3% (VADEQ 2011)

Table 2- 12: Population Estimates for the TMDL Watersheds

Watershed	Population [1]	Number of Houses[1]	Number of Houses Public Sewer[2]	Number of Houses on Septic Systems[2]	Number of Houses with Failing Septic Systems[3]	Number of Houses on "Other Means"[2]	Estimated Number of Houses with a Failing Sewage Disposal System (Failing Septic Systems and Other Means)[3]
Powells Creek	23,588	8,563	7,172	1,354	41	37	42
Quantico Creek/ South Fork Quantico Creek	2,882	3,195	2,676	505	15	14	15
North Branch Chopawamsic Creek	75	26	22	4	0	0	0
Unnamed Tributary to Potomac River	1,234	433	247	179	5	7	6
Austin Run	22,647	8,074	7,711*	238*	7	125	11
Accokeek Creek	7,636	2,680	1,528	1,110	33	42	34
Potomac Creek/ Potomac Run	9,448	3,409	1,891	1,466	41	52	43

[1] Census 2009 estimates

[2] Based upon a ratio of the 2009 Census estimate to the 1990 Census estimate

[3] Based on a failure rate of 3% (VA DEQ 2011)

*Includes information provided by Stafford County

2.5.3 Livestock

An inventory of the livestock in the TMDL watersheds was conducted using data and information provided by the United States Department of Agriculture (USDA) Census of Agriculture (2007), and stakeholders input. Livestock information was available for all counties in the watershed. These sources were was used to determine the livestock inventories per county, shown in **Table 2-13**, and per TMDL watershed, shown in **Table 2-14**.

Preliminary livestock estimates for each of the impaired watersheds were obtained by:

- Collecting information regarding the total number of livestock, as well as the total number of pastureland acres, in each of the counties included in the study area. This information was obtained from the United States Department of Agriculture (USDA) 2007 Agricultural Census.

- Determining the total amount of pastureland in each impaired watershed (calculated via GIS, with 2006 NLCD land cover).

- Incorporating this information into a ratio to determine the estimated number of each type of livestock in the impaired watershed.

Example Using Hypothetical Numbers:

$$\frac{\text{Acres of Pastureland in Impaired Watershed}^{*}}{\text{Acres of Pastureland in County}^{\#}} = \frac{\text{Number of Horses in Impaired Watershed}}{\text{Number of Horses in County}^{\#}}$$

$$\frac{20 \text{ acres}}{100 \text{ acres}} = \frac{X}{50 \text{ horses}}$$

$$X = 10 \text{ horses}$$

*****_Obtained from NLCD Land Use GIS Layer_
 # Obtained from the 2007 Agricultural Census

Table 2- 13: Livestock Present in Prince William and Stafford Counties[1]

TMDL Watershed	Beef Cows	Milk Cows	Other Cattle[2]	Hogs/Pigs	Sheep and Lambs	Chickens	Chickens (Layers)	Turkeys	Horses
Prince William	1,373	840	2,026	20	594	0	687	6	1,833
Stafford	1,117	0	1,158	0	450	0	316	74	1,405

[1] Based on USDA 2007 Agricultural Census Data (http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp)
[2] Cattle not shipped directly for slaughter

Table 2- 14: Livestock Present in TMDL Watersheds

Watershed	Beef Cows	Milk Cows	Other Cattle[3]	Hogs/Pigs	Sheep and Lambs	Chickens	Chickens (Layers)	Turkeys	Horses
Powells Creek[1]	30	20	45	0	15	0	15	0	100
Quantico Creek/South Fork Quantico Creek[1]	5	0	5	0	5	0	5	0	0

Table 2- 14: Livestock Present in TMDL Watersheds

Watershed	Beef Cows	Milk Cows	Other Cattle[3]	Hogs/Pigs	Sheep and Lambs	Chickens	Chickens (Layers)	Turkeys	Horses
North Branch Chopawamsic Creek[1]	0	0	0	0	0	0	0	0	0
Unnamed Tributary to Potomac River[2]	5	0	5	0	0	0	5	0	0
Austin Run[2]	15	0	17	0	0	0	12	0	8
Accokeek Creek[2]	50	0	50	0	20	0	15	5	65
Potomac Creek/ Potomac Run[2]	335	0	345	10	135	0	95	20	420

[1] Based on input from Prince William County SWCD and USDA 2007 Agricultural Census Data (http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp)

[2] Based on input from Stafford County, DCR and USDA 2007 Agricultural Census Data

[3] Cattle not shipped directly for slaughter

The livestock inventory was used to determine the fecal coliform loading by livestock in the watershed. **Table 2-15** shows the average fecal coliform production per animal per day contributed by each type of livestock.

Table 2- 15: Daily Fecal Coliform Production Rates for Livestock Present in TMDL Watersheds

Livestock Type	Daily Fecal Coliform Production (cfu/day)	Reference
Other Dairy Cow (including heifers)	1.16E+10	Virginia Tech, 2000
Beef Cows	3.3E+10	Virginia Tech, 2000
Dairy Cows	2.52E+10	Virginia Tech, 2000
Hogs	1.08E+10	ASAE, 1998
Sheep	2.70E+10	Virginia Tech, 2000
Horses	4.20E+08	Virginia Tech, 2000
Chickens	1.36E+08	ASAE, 1998

The impact of fecal coliform loading from livestock is dependent upon whether loadings are directly deposited into the stream, or indirectly delivered to the stream via surface runoff. For this TMDL, fecal coliform deposited while livestock were in confinement or grazing was considered indirect deposit, and fecal coliform deposited when livestock directly defecate into the stream was considered direct deposit. The distribution of daily fecal coliform loading between direct and indirect deposits was based on livestock daily schedules.

For each of the impaired watersheds, the initial estimates of the beef cattle daily schedule were based on the Difficult Run TMDL (EPA Approved, 2008).

The daily schedule for beef cattle is presented in **Table 2-16** and the daily schedule for dairy cows is presented in **Table 2-17**. The time beef cattle and dairy cows spend in the pasture or loafing was used to determine the fecal coliform load deposited indirectly. The directly deposited fecal coliform load from livestock was based on the amount of time they spend in the stream.

Table 2- 16: Daily Schedule for Beef Cattle

Month	Time Spent in	
	Pasture (Hour)	Stream (Hour)
January	24	0.50
February	24	0.50
March	24	0.75
April	24	1.00
May	24	1.00
June	24	1.25
July	24	1.25
August	24	1.25
September	24	1.00
October	24	0.75
November	24	0.75
December	24	0.50

Table 2- 17: Daily Schedule for Dairy Cows

Month	Time Spent in	
	Pasture (Hour)	Stream (Hour)
January	7.70	0.25
February	7.70	0.25
March	8.60	0.50

April	10.10	0.75
May	10.80	0.75
June	11.30	1.00
July	11.80	1.00
August	11.80	1.00
September	11.80	0.75
October	11.50	0.50
November	10.80	0.50
December	9.40	0.25

2.5.4 Land Application of Manure

Land application of the manure that cattle produce while in confinement is a typical agricultural practice. Both dairy operations and beef cattle are present in some of the watersheds. The manure produced by confined livestock was directly applied on the pasturelands, and was treated as an indirect source in the development of the TMDLs.

2.5.5 Wildlife

The wildlife inventory for the TMDL watersheds was developed based on numbers used in the Difficult Run Bacteria TMDL Report (VADEQ) and provided by the Department of Game and Inland Fisheries (DGIF). The number of wildlife in the watershed was estimated by combining typical wildlife densities with available stream wildlife habitat. Typical wildlife densities provided by the Difficult Run Bacteria TMDL Report (VADEQ), DGIF and stakeholder input are presented in **Table 2-18**. This information was used to determine the wildlife inventory for each TMDL watershed as shown in **Table 2-19.** There are significant continuous acreages of protected wilderness in Prince William Forest Park and Quantico Marine Corp Base, located in the Quantico Creek, South Fork Quantico Creek and North Branch Chopawamsic Creek watersheds.

Table 2-18: Wildlife Densities in the TMDL Watersheds[1]

Wildlife type	Land use Requirements	TMDL estimates (#/acre)
Deer	Entire watershed	0.12 animals/acre
Raccoon	Entire watershed	0.31 animals/acre
Muskrat	Within 60 feet of streams and ponds (urban, grassland, forest, wetlands)	0.23 animals/acre

Table 2-18: Wildlife Densities in the TMDL Watersheds[1]

Beaver	Per mile of rivers and streams	2 animals/mile
Goose-Summer	Within 300 feet of streams and ponds (urban, grassland, wetlands)	3.50 animals/acre
Goose-winter	Within 300 feet of streams and ponds (urban, grassland, wetlands)	3.75 animals/acre
Duck- Summer	Within 300 feet of streams and ponds (urban, grassland wetlands, forest)	0.23 animals/acre
Duck- Winter	Within 300 feet of streams and ponds (urban, grassland wetlands, forest)	0.37 animals/acre
Turkey	Entire watershed excluding urban land uses	0.01 animals/acre

[1] Source: Difficult Run Bacteria TMDL Report (VADEQ), Department of Game and Inland Fisheries (DGIF), stakeholder input

Table 2- 19: Wildlife Present Per TMDL Watershed[1]

TMDL Watershed	Acres	Deer	Raccoon	Muskrat	Beaver	Goose-Summer	Goose Winter	Duck Summer	Duck Winter	Wild Turkey
Powells Creek	9,725	1,169	3,019	95	72	3,282	3,517	298	480	66
Quantico Creek/South Fork Quantico Creek	17,315	2,081	5,375	209	141	2,745	2,941	427	687	162
North Branch Chopawamsic Creek	7,023	842	2,175	81	53	1,067	1,143	118	190	70
Unnamed Tributary to Potomac River	2,708	326	841	32	22	620	664	75	121	25
Austin Run	7,007	501	118	77	58	3,099	3,320	266	428	57
Accokeek Creek	11,168	1,340	3,461	156	110	3,775	4,045	400	644	97
Potomac Creek/Potomac Run	32,417	3,889	10,046	342	272	8,984	9,626	955	1,536	300

[1] Based on the Difficult Run Bacteria TMDL Report (VADEQ), Department of Game and Inland Fisheries (DGIF), stakeholder input

The fecal coliform production and percentage of the day in stream access for each wildlife animal is presented in **Table 2-20**.

Table 2- 20: Daily Schedule and Fecal Coliform Production for Wildlife

Wildlife Type	Daily Fecal Coliform Production (cfu/day)	Percentage of Day Spent in Stream
Ducks	2.43E+09	75%
Goose	7.99E+08	50%

Table 2- 20: Daily Schedule and Fecal Coliform Production for Wildlife		
Wildlife Type	**Daily Fecal Coliform Production (cfu/day)**	**Percentage of Day Spent in Stream**
Deer	3.47E+08	1%
Beaver	2.00E+05	90%
Raccoons	1.13E+08	10%
Wild Turkey	9.30E+07	5%
Muskrat	2.50E+07	50%
Mallard	2.43E+09	50%

2.5.6 Pets

The two types of domestic pets that were considered potential bacteria sources in this watershed were cats and dogs. As of 2007, the American Veterinary Medical Association estimates densities of 0.632 dogs per household and 0.713 cats per household. **Table 2-21** shows the number of pets per TMDL watershed based on AVMA densities. Fecal coliform loading from pets was estimated based on daily fecal coliform production rate of 5.04 $x10^2$ cfu/day per cat and 4.09 $x10^9$ cfu/day per dog (LIRPB, 1978).

Table 2- 21: Pet Inventory for the TMDL Watersheds[1]			
Watershed	**Households**	**Estimated Dog Population**	**Estimated Cat Population**
Powells Creek	8,563	5,400	6,100
Quantico Creek/South Fork Quantico Creek	3,195	2,020	2,280
North Branch Chopawamsic Creek	27	17	19
Unnamed Tributary to Potomac River	433	275	310
Austin Run	8,074	5,100	5,760
Accokeek Creek	2,680	1,700	1,910
Potomac Creek/Potomac Run	3,409	2,150	2,430

[1]Based on American Veterinary Medical Association Pet Densities

2.5.7 Bacteria Source Tracking Data from Prince William County

In past bacteria TMDLs developed by VADEQ, Bacteria Source Tracking (BST) sampling was performed in order to obtain a general overview of the types of bacteria sources (wildlife, livestock, human, or pet) present in the impaired watersheds. While DEQ did not perform BST sampling on any of the streams included in this TMDL, the Prince William County Department of Public Works did collect BST samples on multiple streams throughout Prince William County, including Powells Creek and Quantico Creek, both of which are included in this TMDL Report.

The Prince William County (PWC) and Virginia Tech (VT) study spanned a seven-year period (2003-2010) that included monitoring the bacteriological quality of water (based on enumerating fecal coliforms and/or *Escherichia coli*), and performing microbial source tracking (MST) to determine the sources of fecal pollution (Hagedorn, 2011). The results of the study indicated that wildlife and pet sources were evident in both the Powells Creek and Quantico Creek watersheds. This information complements the existing loading allocation estimates for both watersheds as is shown in Chapters 3 and 4 of this report.

3.0 Modeling Approach

This section describes the modeling approach used in TMDL development. The primary focus is on the sources represented in the model, assumptions used, model set-up, model calibration and validation, and the existing load.

3.1 Modeling Goals

The goals of the modeling approach were to develop a predictive tool for the waterbody that can:

- represent the watershed characteristics
- represent the point and non-point sources of fecal coliform and their respective contribution
- use input time series data (rainfall and flow) and kinetic data (die-off rates of fecal coliform)
- estimate the instream pollutant concentrations and loadings under the various hydrologic conditions
- allow for direct comparisons between the instream conditions and the water quality standard

3.2 Watershed Boundaries

The bacteria impaired Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek and Potomac Run watersheds share a hydrologic drainage area that is approximately 125,897 acres or 197 square miles. This area is larger than the combined area of the individual bacteria impaired watersheds because of the incorporation of the Aquia Creek drainage area, which was necessary for the hydrology calibration (Section 3-10). The hydrological drainage area is also larger due the fact that the existing water quality conditions in the impaired segments are affected by bacteria loads draining from areas upstream of the impaired segments. The hydrologic modeling area drains portions of Fauquier, Prince William, and Stafford counties. **Figure 3-1** shows both the bacteria impaired watersheds and the hydrologic modeling area.

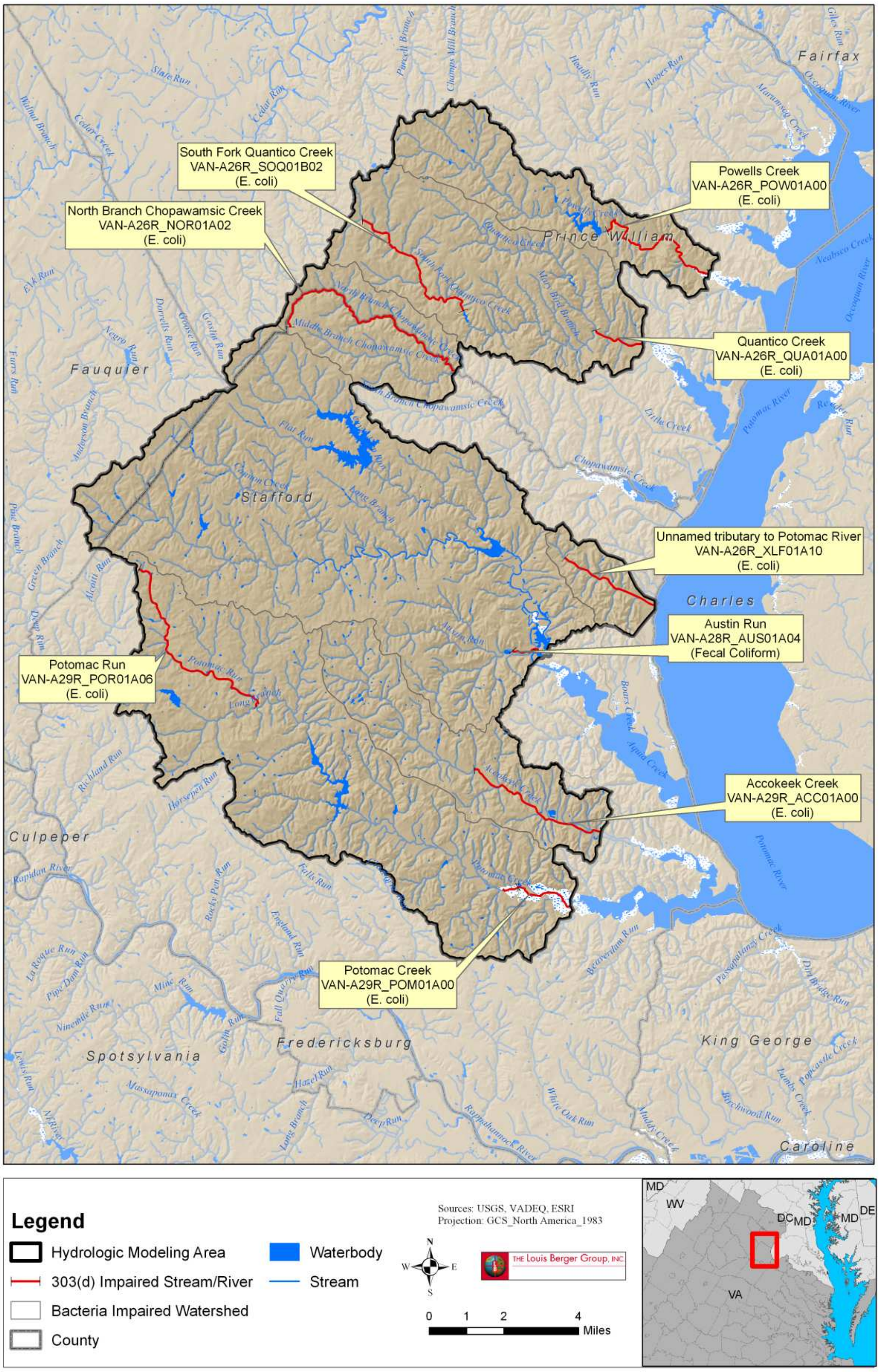


Figure 3-1: Watershed Boundaries and Hydrologic Modeling Area

3.3 Modeling Strategy

The Hydrologic Simulation Program-Fortran (HSPF) model was selected and used to predict the instream water quality conditions under varying scenarios of rainfall and fecal coliform loading. The results from the developed model are subsequently used to develop the TMDL allocations based on the existing fecal coliform load.

HSPF is a hydrologic, watershed-based water quality model. Consequently, HSPF can explicitly account for the specific watershed conditions, the seasonal variations in rainfall and climate conditions, and activities and uses related to fecal coliform loading.

The modeling process in HSPF starts with the following steps:

- delineate the watershed into smaller subwatersheds
- enter the physical data that describe each subwatershed and stream segment
- enter values for the rates and constants that describe the sources and the activities related to the fecal coliform loading in the watershed

These steps are discussed in the next sections.

3.4 Watershed Delineation

For this TMDL, the hydrologic modeling area was delineated into 125 smaller subwatersheds to represent the watershed characteristics and to improve the accuracy of the HSPF model. This delineation was created using a Digital Elevation Model (DEM), stream reaches obtained from the National Hydrography Dataset (NHD), and stream flow and instream water quality data. Size distributions of 64 subwatersheds comprising the impaired watershed area are presented in **Table 3-1. Figure 3-2** shows all delineated subwatersheds for the hydrologic modeling area. The hydrologic modeling area, including all 125 subwatersheds, was used in the hydrologic modeling.

Table 3-1: TMDL Hydrologic Modeling Area Segments In Impaired Watersheds

Modeling Segment	Drainage Area (acres)	Modeling Segment	Drainage Area (acres)
2	474.3	91	5,181.1
3	1,700.1	95	1,284.7
4	2,306.6	96	1,238.0
5	2,185.9	97	864.5
6	1,311.7	98	843.0
7	1,496.1	99	988.1
12	403.4	100	4,074.2
13	667.9	101	485.2
14	1,073.7	102	561.7
15	50.4	103	904.8
16	2,607.9	104	1,501.4
17	1,831.4	105	2,309.3
18	2,465.7	106	611.2
19	858.9	107	498.5
20	1,567.1	108	789.8
21	1,146.3	109	64.7
22	149.1	110	280.9
23	1,616.2	111	1,002.1
24	843.1	112	772.2
25	1,293.7	113	549.4
26	700.3	114	1,102.3
41	365.9	115	2,856.6
42	3,637.4	116	874.1
49	2,693.5	117	426.3
79	1,227.9	118	1,073.1
80	388.4	119	1,315.7
81	1,438.1	120	483.5
82	1,700.6	121	870.6
83	130.3	122	751.0
84	1,193.2	123	1,143.4
85	925.4	124	1,208.7
89	1,994.2	**Total**	**83,259.3**
90	3,904.6		

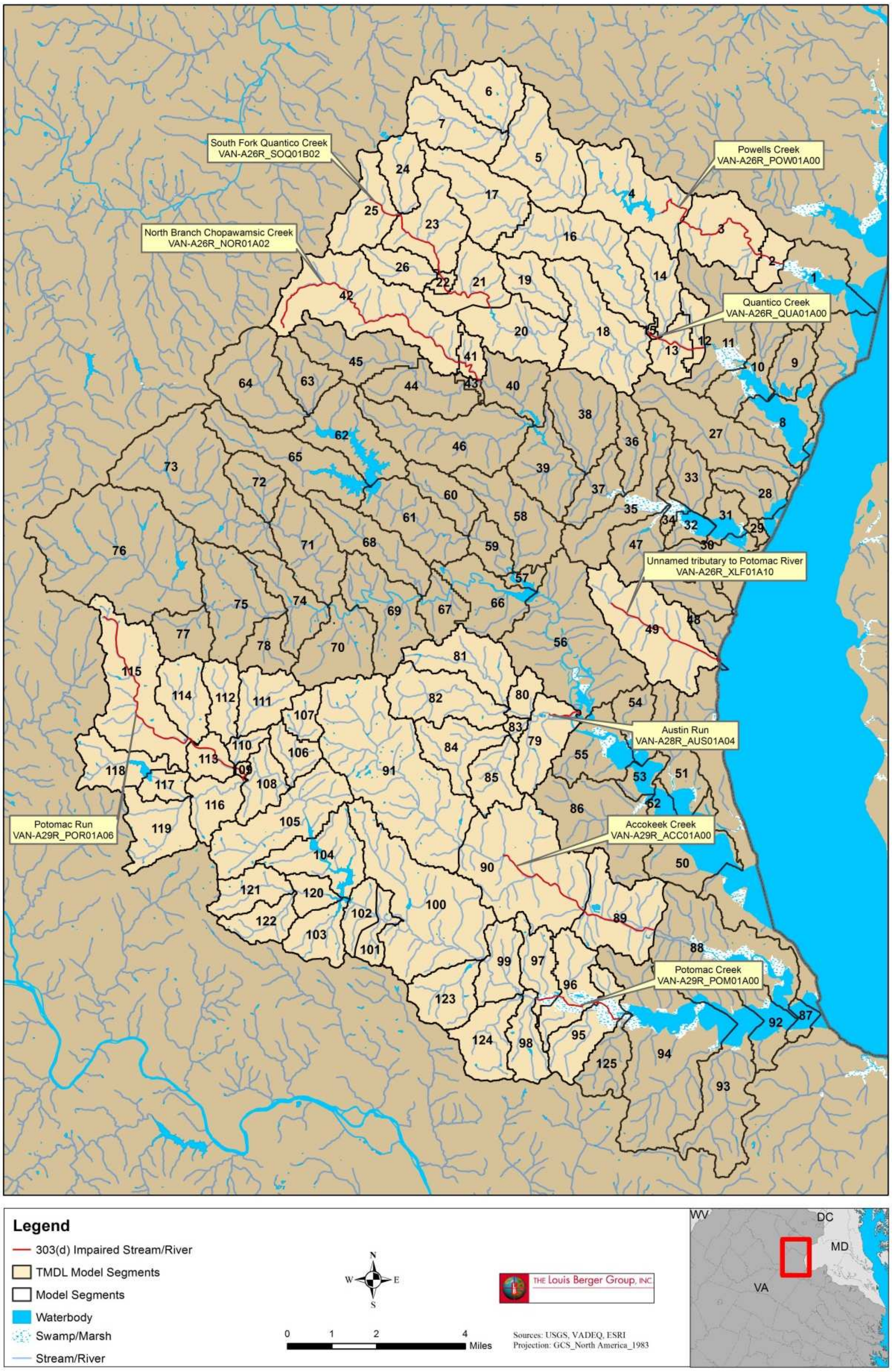


Figure 3-2: TMDL Hydrologic Modeling Area Segments

3.5 Land Use

The distribution of land uses in the impaired subwatersheds of the hydrologic modeling area, by land area and percentage, are presented in Appendix D. Dominant land uses in the modeling area are Deciduous Forest (52%), Mixed Forest (6%) and Palustrine Forested Wetland (6%).

3.6 Land Use Reclassification

There are 18 land use classes present in the hydrologic modeling area. These land use types were consolidated into eight land use categories to meet modeling goals (**Table 3-2**), facilitate model parameterization, and reduce modeling complexity. This reclassification reduced the 18 land use types to a representative number of categories that best describe conditions and the dominant fecal coliform source categories in the watersheds. Land use reclassification was based on similarities in hydrologic characteristics and potential fecal coliform production characteristics. The reclassified land uses for the impaired subwatersheds are presented in **Table 3-3**.

Table 3-2:NLCD 2006 Landuse Reclassification Scheme

NLCD 2006 Landuse	Reclassification
Deciduous Forest	Forest/Wetlands
Evergreen Forest	
Mixed Forest	
Grassland/Herbaceous	
Scrub/Shrub	
Palustrine Emergent Wetland	
Palustrine Forested Wetland	
Palustrine Scrub/Shrub Wetland	
Cultivated Crops	Cropland
Pasture/Hay	Pasture
Developed, High Intensity	Developed, High Intensity
Developed, Medium Intensity	Developed, Medium Intensity
Developed, Low Intensity	Developed, Low Intensity
Open Water	Water
Estuarine Emergent Wetland	
Bare Land	Other Urban
Developed, Open Space	
Unconsolidated Shore	

Table 3-3: Reclassified NLCD 2006 Landuse Distribution in Modeling Segments									
Model Segment	**Forest/ Wetland**	**Cropland**	**Pasture**	**Developed High Intensity**	**Developed, Medium Intensity**	**Developed Low Intensity**	**Water**	**Other Urban**	**Total**
2	104	6	2	11	81	62	0	206	473
3	897	3	13	40	123	257	0	365	1,696
4	889	38	10	29	169	741	91	334	2,301
5	1,434	206	53	41	58	246	0	143	2,182
6	1,004	60	9	6	20	79	1	128	1,307
7	1,031	38	3	45	43	60	0	273	1,493
12	106	2	0	45	78	110	0	62	403
13	339	1	1	9	71	158	0	90	668
14	790	15	0	8	39	127	0	95	1,074
15	39	4	0	0	0	3	0	5	50
16	2,541	2	0	6	10	28	1	18	2,608
17	1,689	6	2	52	14	36	0	33	1,831
18	2,406	2	0	0	3	18	0	36	2,466
19	859	0	0	0	0	0	0	0	859
20	1,543	5	2	0	0	2	5	11	1,567
21	1,145	0	0	0	0	0	0	0	1,146
22	149	0	0	0	0	0	0	0	149
23	1,607	0	0	1	5	2	0	1	1,616
24	702	30	8	4	13	29	0	55	842
25	1,271	13	0	0	1	1	0	2	1,288
26	699	0	0	0	0	1	0	0	700
41	365	0	0	0	0	1	0	0	366
42	3,571	46	9	0	2	3	0	1	3,633
49	2,332	39	24	0	10	115	13	152	2,687
79	553	78	18	16	80	264	16	203	1,228
80	152	0	0	23	58	123	0	32	388
81	332	0	4	111	233	547	0	209	1,438
82	697	26	9	9	113	484	0	363	1,700
83	75	7	0	0	5	21	0	22	130
84	926	41	31	1	10	45	0	139	1,193
85	559	33	6	20	53	131	0	122	925
89	1,731	71	50	2	4	19	11	106	1,994
90	3,081	237	13	52	77	197	1	246	3,904
91	3,707	297	220	9	75	375	10	487	5,180
95	1,144	77	20	0	0	1	38	3	1,283
96	1,038	132	27	0	0	2	0	38	1,238
97	718	87	13	0	6	7	1	32	864
98	696	65	12	0	0	10	2	55	841
99	877	66	16	2	2	5	1	18	988
100	2,637	236	36	190	149	182	8	634	4,072
101	379	48	17	5	8	8	0	20	484
102	516	11	11	0	8	5	2	8	561
103	746	41	61	0	0	11	18	25	902

Table 3-3: Reclassified NLCD 2006 Landuse Distribution in Modeling Segments									
Model Segment	**Forest/ Wetland**	**Cropland**	**Pasture**	**Developed High Intensity**	**Developed, Medium Intensity**	**Developed Low Intensity**	**Water**	**Other Urban**	**Total**
104	1,255	50	30	0	2	2	106	56	1,501
105	1,689	313	220	1	1	6	9	67	2,308
106	509	30	58	0	0	2	0	11	611
107	315	36	48	2	2	12	0	82	498
108	724	26	13	0	0	23	0	3	790
109	28	23	14	0	0	0	0	0	65
110	99	61	109	0	0	11	0	0	281
111	660	134	64	2	5	34	12	91	1,002
112	553	131	77	0	0	3	0	8	772
113	363	37	133	0	0	1	0	15	549
114	579	277	235	0	0	0	1	11	1,102
115	1,683	423	715	0	1	2	1	27	2,851
116	705	46	74	0	1	36	1	11	874
117	333	3	79	0	0	0	10	0	426
118	663	67	76	0	2	3	66	191	1,068
119	984	215	87	0	2	3	0	18	1,309
120	443	32	0	0	0	0	8	0	484
121	680	96	77	0	0	4	0	13	869
122	495	107	121	0	0	17	0	7	748
123	807	147	60	1	10	51	5	60	1,141
124	898	64	35	1	7	77	0	122	1,205
Total	**62,542**	**4,390**	**3,027**	**748**	**1,657**	**4,804**	**441**	**5,566**	**83,175**

3.7 Hydrographic Data

Hydrographic data describing the stream network were obtained from the National Hydrography Dataset (NHD). This data was used for HSPF model development and TMDL development. Stream channels in the hydrologic modeling area were represented as trapezoidal channels. The channel slopes were estimated using the reach length and the corresponding change in elevation from DEM data. The flow was calculated using the Manning's equation using a 0.05 roughness coefficient. Model representation of the stream reach segment is presented in **Appendix A.**

3.8 Fecal Coliform Sources Representation

This section demonstrates how the fecal coliform sources identified in Chapter 2 were included or represented in the model. These sources include permitted sources, human sources (failing sewage disposal systems and straight pipes), livestock, wildlife, pets, and land application of manure.

3.8.1 Permitted Facilities

Based on data obtained from VA DEQ, there are five facilities that are addressed under the Virginia Pollutant Discharge Elimination System (VPDES) Program. The permit number, facility name, design flow and permit concentration (cfu/100 ml) for the facilities are presented in **Table 2-9**.

For TMDL development, average discharge flow values were considered representative of flow conditions at the permitted facility, and were used in HSPF model set-up and calibration. For TMDL allocation development, the permitted facility was represented as a constant source discharging at its maximum permitted design flow and bacteria concentration.

Reported SSOs in any of the impaired watersheds were incorporated into the source inventory for model calibration. However, SSOs did not receive a wasteload allocation as they are unauthorized discharges.

3.8.2 Failing Sewage Disposal Systems

Failing sewage disposal system loadings to the watershed can be direct (point) or land-based (indirect or non-point), depending on the proximity of the system to the stream. As explained in Chapter 2, the total number of septic systems in the bacteria impaired watersheds was estimated at 4,763 systems.

For TMDL development, it was assumed that a 3% failure rate for septic systems would be representative of conditions in the watersheds. This corresponds to a total of 143 failed septic systems in the impaired watersheds. The number of houses on other means of sewage disposal (considered to be straight pipes or some sort of alternative disposal system) was estimated by obtaining the ratio of the 1990 “other means” number to the 1990 total households number and multiplying this ratio by the 2009 households estimate. As explained in Chapter 2, the total number of houses on other means in the impaired watersheds was estimated at 277. For TMDL development, the number of failing sewage disposal systems was represented by multiplying the septic failure rate of 3% by the sum of the number of houses on septic systems and the number of houses on "other means." This corresponds to a total of 151 failing sewage disposal systems for the TMDL watersheds.

In each subwatershed, the load from failing sewage disposal systems was calculated as the product of the total number of sewage disposal systems (septic systems and homes on "other means"), estimated failure rate, flow rate of septic discharge, typical fecal concentration in septic outflow, and the average household size in the watershed. The septic systems' design flow of 75 gallons per person per day and a fecal coliform concentration of 10,000 cfu/100mL (Horsley & Whitten, 1996) were used in the fecal coliform load calculations. Failed sewage disposal systems were represented as constant sources of fecal coliform. **Table 3-4** shows the distribution of the failed sewage disposal systems in the watershed.

Table 3-4: Failed Septic Systems and Straight Pipes Assumed in Model Development

Watershed	Modeling Segment	Septic Systems	Houses on Other Means	Estimated Number of Houses with a Failing Sewage Disposal System (Failing Septic Systems and "Other Means")
Powells Creek	2	99	3	3
	3	269	7	8
	4	602	16	19
	5	222	6	7
	6	67	2	2
	7	95	3	3
Quantico Creek	12	135	4	4
	13	137	4	4
	14	100	3	3
	15	2	0	0
	16	26	1	1
	17	59	2	2
	18	12	0	0
	19	0	0	0
	20	1	0	0
South Fork Quantico Creek	21	0	0	0
	22	0	0	0
	23	4	0	0
	24	27	1	1
	25	1	0	0
	26	1	0	0
North Branch Chopawamsic	41	1	0	0
	42	4	0	0
Unnamed Tributary	49	179	7	6
Austin Run	79	36	19	2

Table 3-4: Failed Septic Systems and Straight Pipes Assumed in Model Development				
Watershed	**Modeling Segment**	**Septic Systems**	**Houses on Other Means**	**Estimated Number of Houses with a Failing Sewage Disposal System (Failing Septic Systems and "Other Means")**
	80	21	11	1
	81	90	47	4
	82	61	32	3
	83	3	1	0
	84	6	3	0
	85	21	11	1
Accokeek Creek	89	34	1	1
	90	446	17	14
	91	630	24	19
Potomac Creek	95	2	0	0
	96	4	0	0
	97	22	1	1
	98	17	1	0
	99	15	1	0
	100	818	29	24
	101	32	1	1
	102	21	1	1
	103	17	1	1
	104	6	0	0
	105	13	0	0
	106	4	0	0
	107	27	1	1
	108	37	1	1
	116	57	2	2
	117	0	0	0
	118	7	0	0
	119	8	0	0
	120	0	0	0
	121	7	0	0
	122	28	1	1
	123	98	3	3
	124	134	5	4
Potomac Run	109	0	0	0
	110	17	1	0
	111	64	2	2
	112	5	0	0
	113	2	0	0
	114	0	0	0
	115	4	0	0

3.8.3 Livestock

Livestock contribution to the total fecal coliform load in the watershed was represented in a number of ways, which are presented in **Figure 3-3**. The model accounts for fecal coliform directly deposited in the stream, fecal coliform deposited while livestock are in confinement and later spread onto the crop and pasture lands in the watershed (land application of manure), and finally, land-based fecal coliform deposited by livestock while grazing.

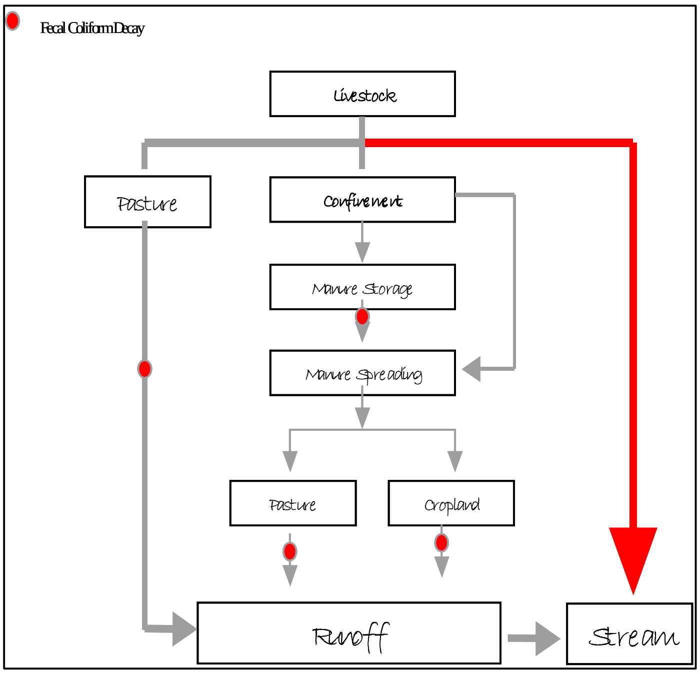


Figure 3-3: Livestock Contribution to the Impaired TMDL Watersheds

Based on the inventory of livestock in the watershed, it was determined that beef cows, cattle and horses are the predominant types of livestock, though sheep and lambs are also present in the watershed.

The distribution of the daily fecal coliform load between direct instream and indirect (land-based) loading was based on livestock daily schedules. The direct deposition load from livestock was estimated from the number of livestock in the watershed, the daily fecal coliform production per animal, and the amount of time livestock spent in the stream. The amount of time livestock spend in the stream was presented in Chapter 2.

The land-based load of fecal coliform from livestock while grazing was determined based on the number of livestock in the watershed, the daily fecal coliform production per animal, and the percent of time each animal spends in pasture. The monthly loading rates are presented in **Appendix B.**

3.8.4 Land Application of Manure

Beef cattle are present in the watershed. Because there are no feedlots or large manure storage facilities present in the watershed, the daily produced manure is applied to pastureland in the watershed, and was treated as an indirect source in the development of the TMDLs. Beef cattle spend the majority of their time on pastureland and are not confined. Thus, fecal coliform loading from beef cattle was accounted for via the methods described above. Dairy cattle do spend time in confinement, and their fecal coliform load was included in the calculation of land application of manure. Fecal coliform loading from land application of manure was estimated based on the total number of dairy cows in the watershed, the fecal coliform production per animal per day, and the percent of time dairy cows were in confinement.

3.8.5 Wildlife

Fecal loading from wildlife was estimated in the same way as loading from livestock. As with livestock, fecal coliform contributions from wildlife can be both indirect and direct. The distribution between direct and indirect loading was based on estimates of the amount of time each type of wildlife spends on the surrounding land versus in the stream.

Daily fecal coliform production per animal and the amount of time each type of wildlife spends in the stream was presented previously in the wildlife inventory (Chapter 2). The direct fecal coliform load from wildlife was calculated by multiplying the number of each type of wildlife in the watershed by the fecal coliform production per animal per day, and by the percentage of time each animal spends in the stream. The indirect (land-based) wildlife fecal coliform loading was estimated as the product of the wildlife density in each land use category or stream buffer (**Table 2-18**) and the daily fecal coliform production per wildlife animal. In summary, the indirect wildlife fecal coliform load is distributed on all land uses categories including the urban areas (High, Medium, and Low Intensity developed areas as well as the Developed Open Space land use category.

3.8.6 Pets

Pet fecal coliform loading was considered a land-based load that was primarily deposited in developed land within the watershed. The daily fecal coliform loading was calculated as the product of the number of pets in the watershed and the daily fecal coliform production per type of pet. The bacteria pet loading was distributed to all urban land uses including the Developed Open Space land use category. The pet loading was distributed proportionally using the number of houses within each land use category. Since there are no houses in the Developed Open Space land use category that can be used as a basis for the estimation of the pet bacteria loading, it was assumed that dog owners walk their dogs 40% of the time in the Open Space land use category. Therefore, the Developed Open Space land use category received 40% of all the pet loads in the watershed. This 40% assumption is conservative, since a survey of dog owners in the Chesapeake Bay indicates that 56% of dog owners walk their dog (Swann, 1999). The estimated bacteria pet loading on each urban land use category was then reduced by 50%, assuming that that pet owners pick up after their dogs 50 percent of the time (Swann, 1999).

3.9 Fecal Coliform Die-off Rates

Representative fecal coliform decay rates were included in the HSPF model developed for the watershed. Three fecal coliform die-off rates required by the model to accurately represent watershed conditions included:

1. **In-storage fecal coliform die-off**. Fecal coliform concentrations are reduced while manure is in storage facilities.

2. **On-surface fecal coliform die-off**. Fecal coliform deposited on the land surfaces undergoes decay prior to being washed into streams.

3. **In-stream fecal coliform die-off**. Fecal coliform directly deposited into the stream, as well as fecal coliform entering the stream from indirect sources, will also undergo decay.

For the TMDL, in-storage die-off was not included in the model because there is no manure storage facility located in the watershed. Decay rates of 1.37 and 1.152 per day were used to estimate die-off rates for on surface and instream fecal coliform, respectively (EPA, 1985).

3.10 Model Set-up, Hydrology Calibration, and Validation

Hydrologic calibration of the HSPF model involves the adjustment of model parameters to control various flow components (e.g. surface runoff, interflow and base flow, and the shape of the hydrographs) and make simulated values match observed flow conditions during the desired calibration period.

The model credibility and stakeholder faith in the outcome hinges on developing a model that has been calibrated and validated. Model calibration is a reality check. The calibration process compares the model results with observed data to ensure the model output is accurate for a given set of conditions. Model validation establishes the credibility of the model. The validation process compares the model output to the observed data set, which is different from the one used in the calibration process, and estimates the prediction accuracy of the model. Water quality processes were calibrated following calibration of the hydrologic processes of the model.

3.10.1 Model Set-Up

The HSPF model was set up and calibrated for hydrology based on the flow measured at the USGS Station 01660400, Aquia Creek near Garrisonville, VA (**Table 3-5**). The USGS Station 01660400 was selected for the hydrology calibration and validation because it drains a significantly larger area than the other USGS stations in the area and is therefore more amenable to mimic the hydrology in the study area. Following the hydrology calibration and validation, all the derived hydrologic parameters were assigned to the other modeling segments for the water quality calibrations and the development of

TMDLs. Details on the selected flow monitoring station are presented in **Table 3-4**. **Figure 3-5** depicts the location of USGS Station 01660400 along with the model segments and the weather station used in hydrology modeling.

Table 3-5: USGS Flow Station used for the Hydrology Calibration and Validation

Station ID	Station Name	Drainage Area (mi^2)	Begin Date	End Date
01660400	Aquia Creek near Garrisonville, VA	35	9/1/1971	10/16/2011

3.10.1.1 Stream Flow Data

A 4-year period (2002-2005) was selected as the calibration period for the hydrologic model. The validation period selected was from 2006 to 2010. Observed flow data for the period of 2002 to 2010 for this station is plotted in **Figure 3-4**.

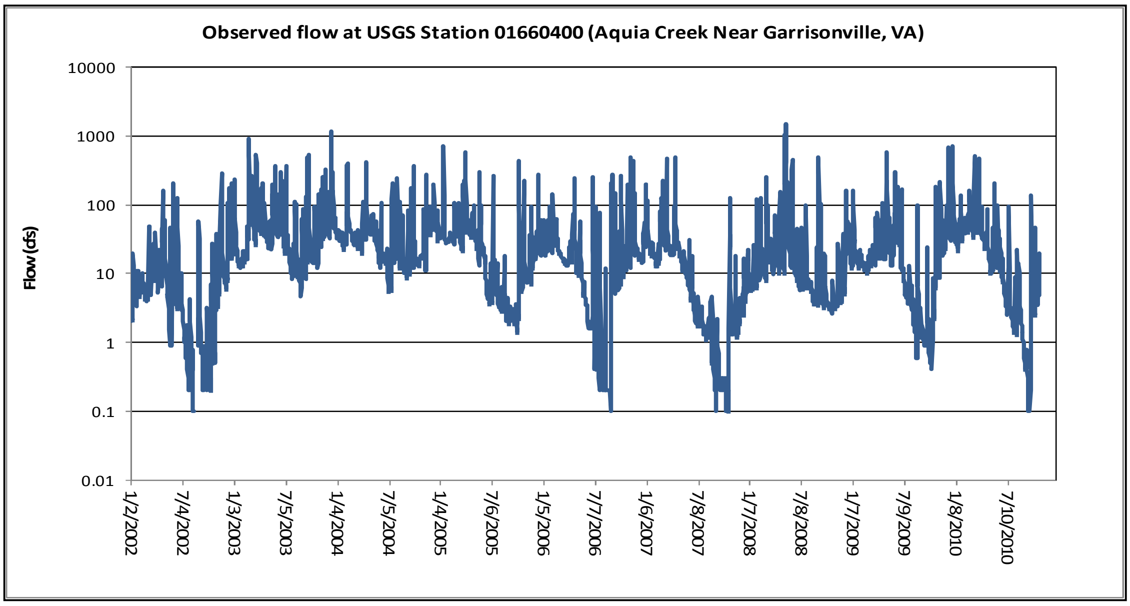


Figure 3-4: Daily Mean Flow at USGS Station 01660400 (Aquia Creek near Garrisonville, VA)

3.10.1.2 Rainfall and Climate Data

Weather data from the Reagan National Airport station were obtained from NCDC. The data include meteorological (hourly precipitation) and surface airways data (including wind speed/direction, ceiling height, dry bulb temperature, dew point temperature, and solar radiation). **Figure 3-5** depicts the location of the NCDC meteorological station used in modeling.

Figure 3-5: Locations of NCDC Weather Station and USGS Flow Calibration Station

3.10.2 Model Hydrologic Calibration Results

The Expert System for Calibration of the Hydrological Simulation Program-FORTRAN (HSPEXP) software was used to calibrate the hydrology of the hydrologic modeling area. After each model's iteration, summary statistics were calculated to compare model results with observed values, in order to provide guidance on parameter adjustment according to built-in rules. The rules were derived from the experience of expert modelers and listed in the HSPEXP user manual (Lumb and Kittle, 1993).

Using the recommended default criteria as target values for an acceptable hydrologic calibration, the hydrologic model was calibrated from January 2002 to December 2005 at the USGS flow station 01660400 (Aquia Creek near Garrisonville, VA). Calibration results at USGS station 01660400 are presented in **Table 3-6**, showing the simulated and observed values for seven flow characteristics. The error statistics summary for five flow conditions is presented in **Table 3-7**. The error statistics indicate that the validation results were within the recommended ranges except for the seasonal volume error. The model results and the observed daily average flow at the calibration station are plotted in **Figure 3-6**. The cumulative flow frequency distribution for the calibration period is plotted in **Figure 3-7**.

Table 3-6: USGS 01660400 (Aquia Creek near Garrisonville, VA) Model Calibration Results

Category	Simulated	Observed
Total runoff, in inches	53.490	55.530
Total of highest 10% flows, in inches	24.930	25.151
Total of lowest 50% flows, in inches	8.040	8.757
Total storm volume, in inches	4.020	3.047
Baseflow recession rate	0.910	0.920
Summer flow volume, in inches	11.190	8.658
Winter flow volume, in inches	15.770	17.246

Table 3-7: USGS 01660400 (Aquia Creek near Garrisonville, VA) Model Calibration Error Statistics

Category	Current	Criterion
Error in total volume	-3.700	± 10.000
Error in low flow recession	0.010	± 0.010
Error in 50% lowest flows	-8.200	± 10.000
Error in 10% highest Flow	-0.900	± 15.000
Seasonal volume error	37.8	± 10.000

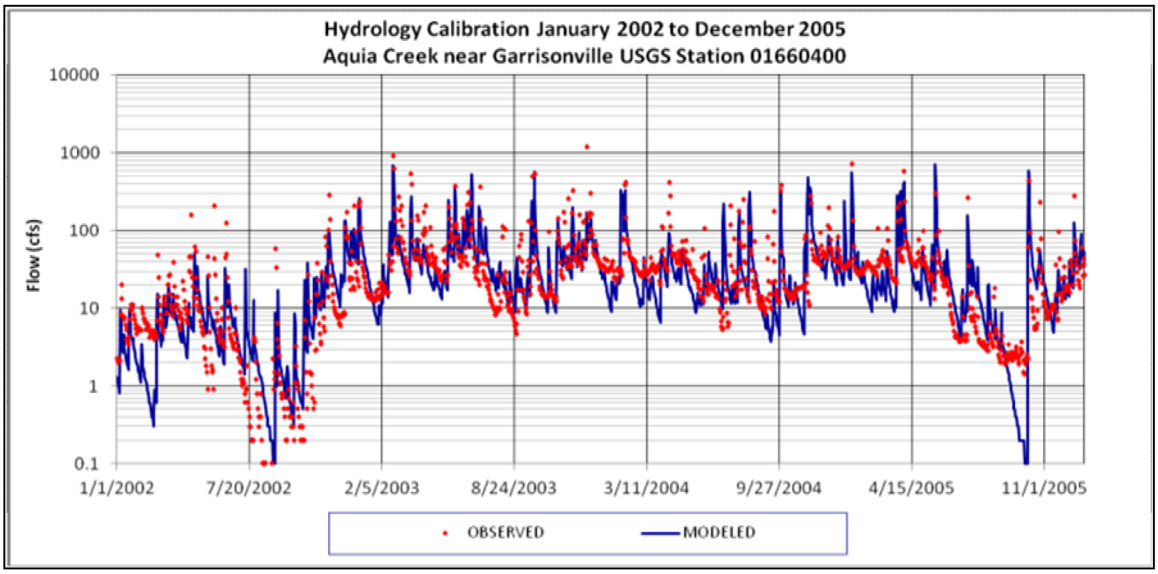


Figure 3-6: USGS 01660400 (Aquia Creek near Garrisonville, VA) Model Hydrologic Calibration Results

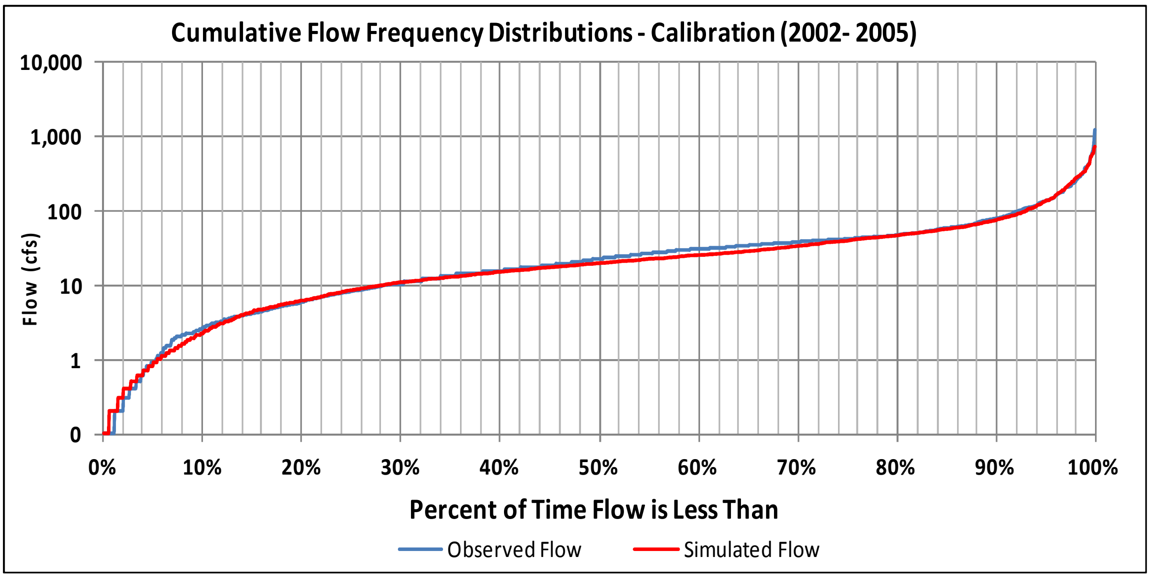


Figure 3-7: USGS 01660400 (Aquia Creek near Garrisonville, VA) Cumulative Flow Frequency Distribution for Model Hydrologic Calibration Results

3.10.3 Model Hydrologic Validation Results

The period of January 2006 to December 2010 was used to validate the HSPF model. Validation results at USGS Station 01660400 are presented in **Table 3-8**, which shows the simulated and observed values for seven flow characteristics. The error statistics summary for five flow conditions is presented in **Table 3-9**. The model results and the observed daily average flow at the calibration station are plotted in **Figure 3-8**. The cumulative flow frequency distribution for the validation period is plotted in **Figure 3-9**.

Table 3-8: USGS 01660400 (Aquia Creek near Garrisonville, VA) Model Validation Results

Category	Simulated	Observed
Total runoff, in inches	42.890	43.14
Total of highest 10% flows, in inches	21.410	24.38
Total of lowest 50% flows, in inches	4.120	3.85
Total storm volume, in inches	4.640	5.38
Baseflow recession rate	0.920	0.91
Summer flow volume, in inches	6.280	5.55
Winter flow volume, in inches	10.380	12.07

Table 3-9: USGS 01660400 (Aquia Creek near Garrisonville, VA) Model Validation Error Statistics

Category	Current	Criterion
Error in total volume	-0.600	± 10.000
Error in low flow recession	-0.010	± 0.010
Error in 50% lowest flows	7.100	± 10.000
Error in 10% highest Flow	-12.20	± 15.000
Seasonal volume error	27.20	± 10.000

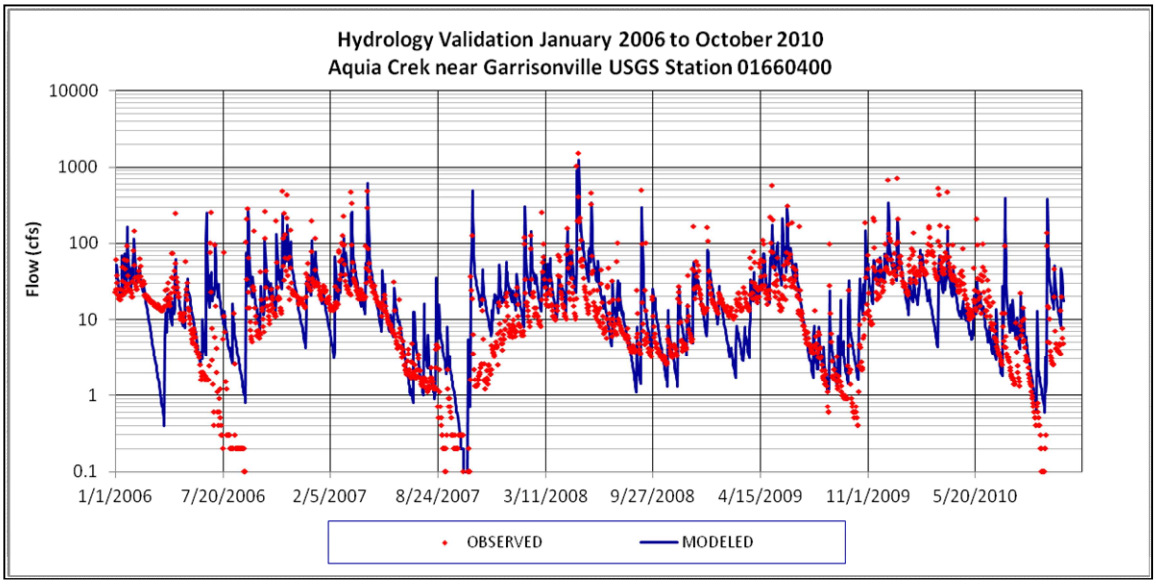


Figure 3-8: USGS 01660400 (Aquia Creek near Garrisonville, VA) Model Hydrologic Validation Results

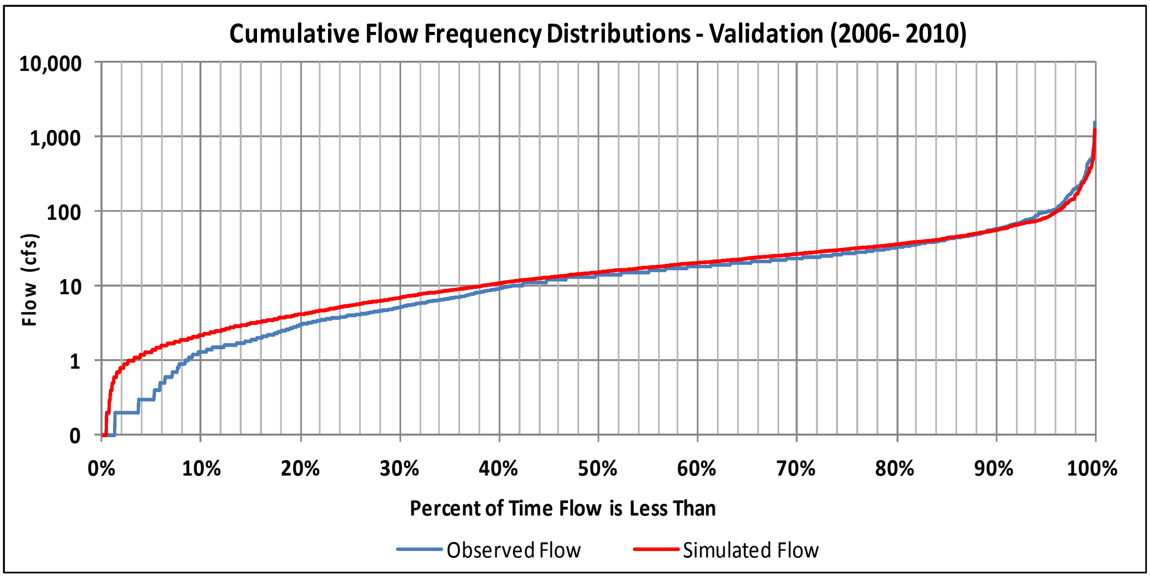


Figure 3-9: USGS 01660400 (Aquia Creek near Garrisonville, VA) Cumulative Flow Frequency Distribution for Model Hydrologic Validation Results

Overall, there is good agreement between the observed and simulated stream flow, indicating that the model parameterization is representative of the hydrologic characteristics of the watershed. Model results closely match the observed flows during low flow conditions, base flow recession, and storm peaks.

The error statistics indicate that the calibration and validation results were within the recommended ranges except for the seasonal volume error (**Tables 3-7 and 3-9**). In HSPEXP the seasonal volume error is defined as the summer (June-August) runoff volume percent error minus the winter (December-February) runoff volume error. This relatively high seasonal volume error is caused by the summer flow volume error. In fact, the observed summer flow is extremely low (as low as 0.1 cfs) and an extremely small difference between the computed summer flow and the observed summer flow results in a significantly high summer flow percent error. The final parameter values of the calibrated hydrology model are listed in **Table 3-10**.

Table 3-10: TMDL HSPF Calibration Parameters (Typical, Possible and Final Values)							
Parameter	Definition	Units	Typical		Possible		Tributaries to the Potomac River: Prince William and Stafford County
			Min	Max	Min	Max	
FOREST	Fraction forest cover	None	0.00	0.5	0	1.0	0 - 1
LZSN	Lower zone nominal soils moisture	inch	3	8	0.01	100	8.0 - 9.3
INFILT	Index to infiltration capacity	Inch/hour	0.01	0.25	0.0001	100	0.05 - 0.11
LSUR	Length of overland flow	ft	200	500	1	None	300
SLSUR	Slope of overland flowpath	None	0.01	0.15	0.00001	10	0.012
KVARY	Groundwater recession variable	1/inch	0	3	0	None	0
AGWRC	Basic groundwater recession	None	0.92	0.99	0.001	0.999	0.88 - 0.905
PETMAX	Air temp below which ET is reduced	Deg F	35	45	None	None	40
PETMIN	Air temp below which ET is set to zero	Deg F	30	35	None	None	35
INFEXP	Exponent in infiltration equation	None	2	2	0	10	2
INFILD	Ratio of max/mean infiltration capacities	None	2	2	1	2	2
DEEPER	Fraction of groundwater inflow to deep recharge	None	0	0.2	0	1.0	0.25
BASETP	Fraction of remaining ET from base flow	None	0	0.05	0	1.0	0
AGWETP	Fraction of remaining ET from active groundwater	None	0	0.05	0	1.0	0
CEPSC	Interception storage capacity	Inch	0.03	0.2	0.00	10.0	0.06
UZSN	Upper zone nominal soils moisture	inch	0.10	1	0.01	10.0	0.3
NSUR	Manning’s n	None	0.15	0.35	0.001	1.0	0.1 - 0.35
INTFW	Interflow/surface runoff partition parameter	None	1	3	0	None	3 - 4
IRC	Interflow recession parameter	None	0.5	0.7	0.001	0.999	0.3

LZETP	Lower zone ET parameter	None	0.2	0.7	0.0	0.999	0.3 - 0.66
ACQOP*	Rate of accumulation of constituent	#/ac day					1.09E05 - 1.10E11
SQOLIM*	Maximum accumulation of constituent	#					1.96E05 - 1.98E11
WSQOP*	Wash-off rate	Inch/hour					0.45 - 1
IOQC*	Constituent concentration in interflow	#/CF					1416
AOQC*	Constituent concentration in active groundwater	#/CF					283
KS*	Weighing factor for hydraulic routing		0.5				0.5
FSTDEC*	First order decay rate of the constituent	1/day	1.152 (FC)				1.152
THFST*	Temperature correction coefficient for FSTDEC	none	1.07				1.07

*Typical values. These parameters are unavailable because they are site-specific and determined through model calibration.

3.10.4 Water Quality Calibration

Calibrating the water quality component of the HSPF model involves setting up the build-up, wash-off, and kinetic rates for fecal coliform that best describe fecal coliform sources and environmental conditions in the watershed. It is an iterative process in which the model results are compared to the available instream fecal coliform data, and the model parameters are adjusted until there is an acceptable agreement between the observed and simulated instream concentrations and the build-up and wash-off rates are within the acceptable ranges.

The availability of water quality data is a major factor in determining calibration and validation periods for the model. In Chapter 2, instream monitoring stations on the impaired segments were listed and sampling events conducted on Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek and

Potomac Run were summarized and presented. **Table 3-11** lists the stations used in the water quality calibration for each impaired segment.

Table 3-11: Water Quality Stations used in the HSPF Fecal Coliform Simulations

Stream	Water Quality Station	HSPF Model Segment
Powells Creek	1APOW003.11	3
Quantico Creek	1AQUA004.46	13
South Fork Quantico Creek	1ASOQ006.73	22
North Branch Chopawamsic Creek	1ANOR009.87	41
Unnamed Tributary to Potomac River	1AXLF000.13	49
Austin Run	1AAUS000.49	79
Accokeek Creek	1AACC006.13	90
Potomac Creek	1APOM006.72	97
Potomac Run	1APOR000.40	109

The period used for water quality calibration of the model, and the period used for model validation depended on the time the water quality observations were collected. In fact, the observed *E. coli* concentrations are instantaneous values that are highly dependent on the time and location the sample was collected. The model-simulated fecal coliform concentrations represent the average daily values. The simulated *E. coli* concentrations were derived from the simulated fecal coliform concentrations using a regression-based instream translator, which is presented below:

$$E.\ coli\ concentration\ (cfu/100\ ml) = 2^{-0.0172}\ x\ (FC\ concentration\ (cfu/100ml))^{0.91905}$$

These *E. coli* concentrations were then compared to the *E. coli* concentrations measured at the various VADEQ monitoring stations in each of the impaired segment. **Figures 3-10 through 3-18** summarize the calibration results of the HSPF *E. coli* simulations.

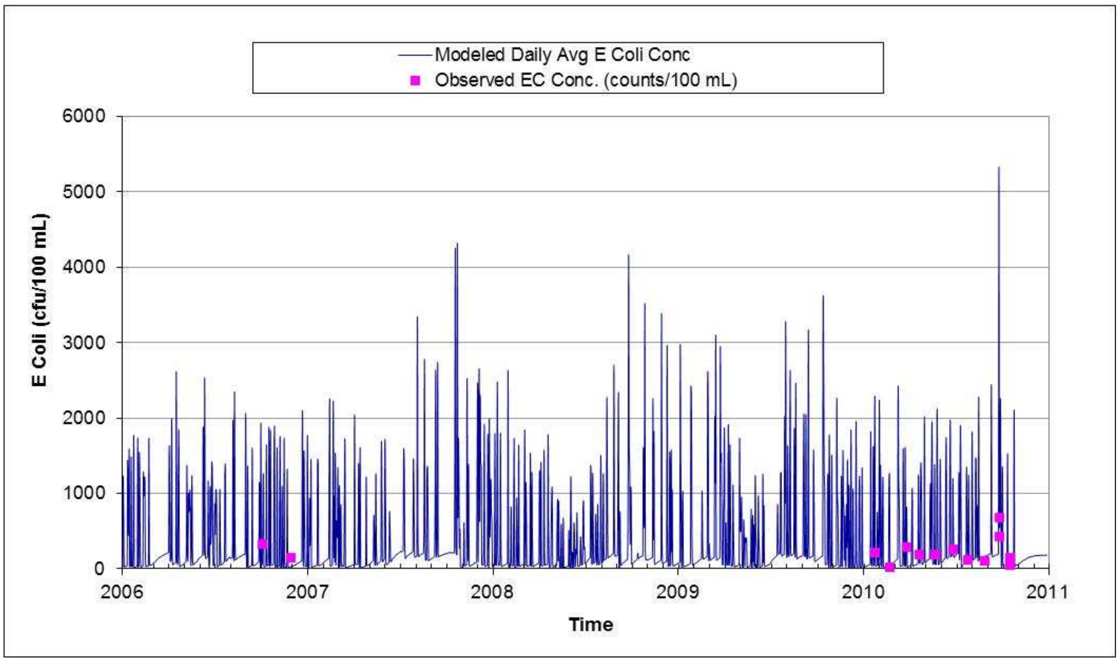


Figure 3-10: ***E. coli*** **Calibration for Powells Creek - 1APOW003.11 (Reach 3)**

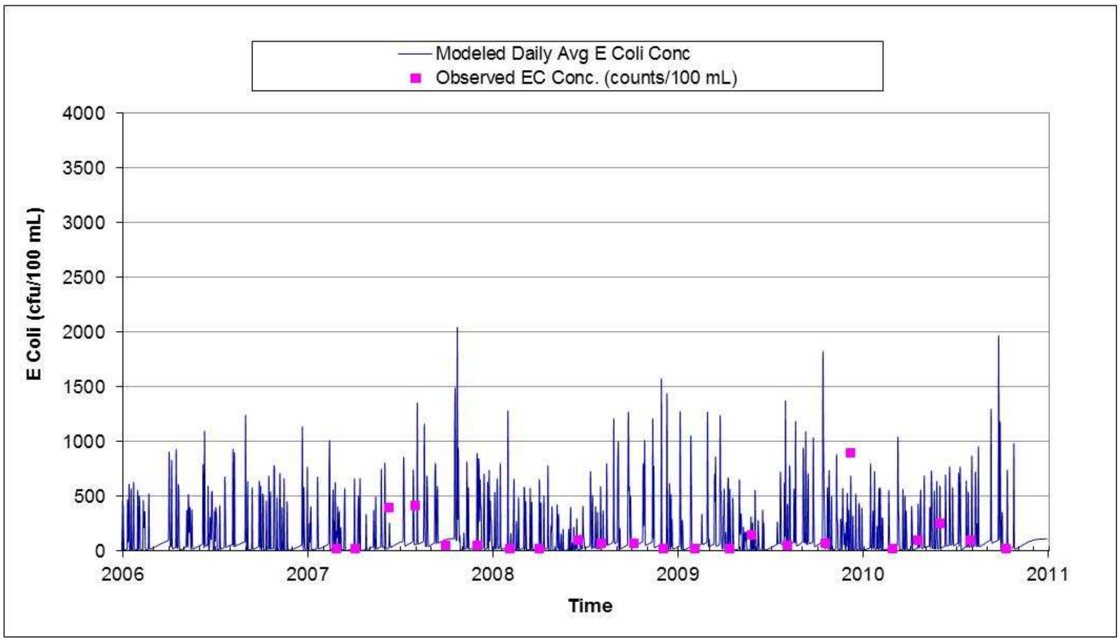


Figure 3-11: ***E. coli*** **Calibration for Quantico Creek - 1AQUA004.46 (Reach 13)**

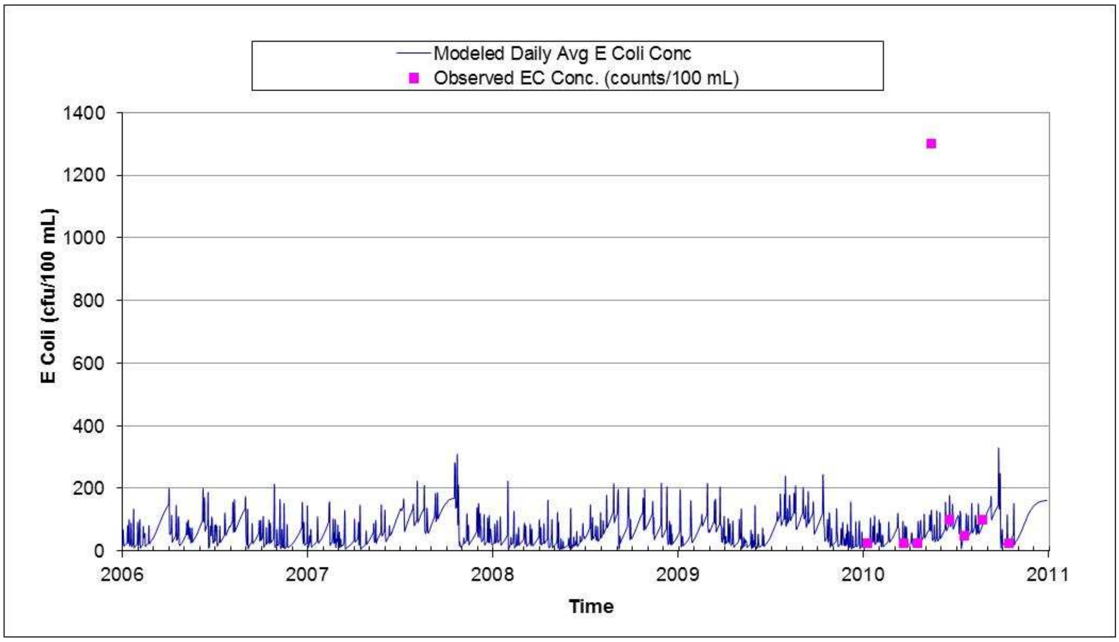


Figure 3-12: *E. coli* Calibration for South Fork Quantico Creek - 1ASOQ006.73 (Reach 22)

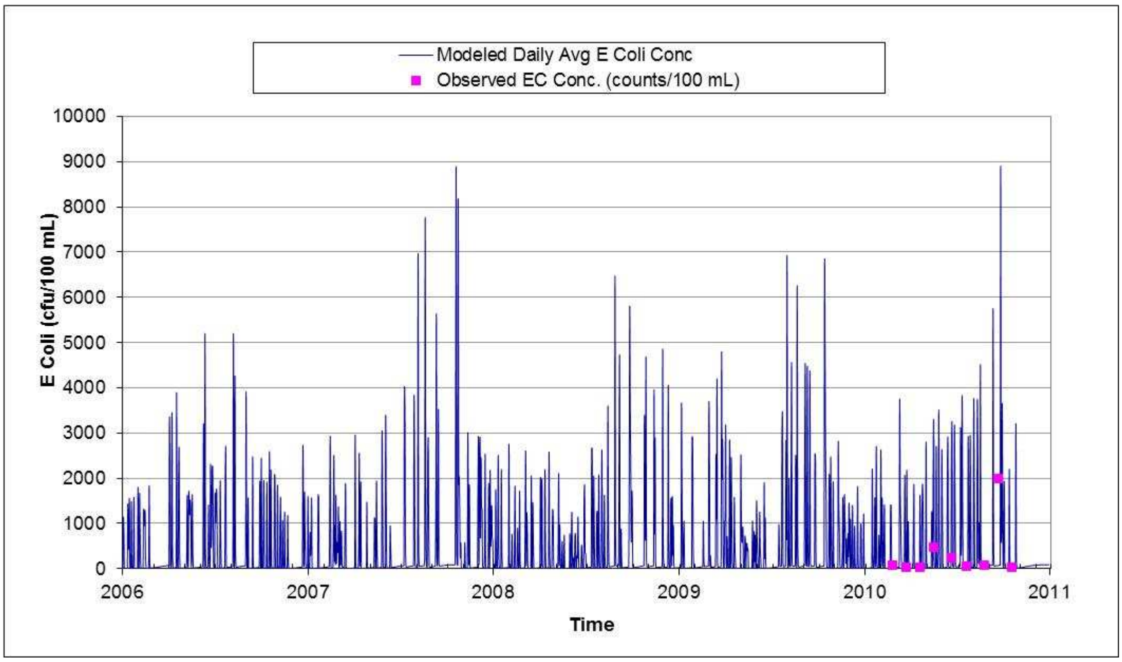


Figure 3-13: *E. coli* Calibration for North Branch Chopawamsic Creek - 1ANOR009.87 (Reach 41)

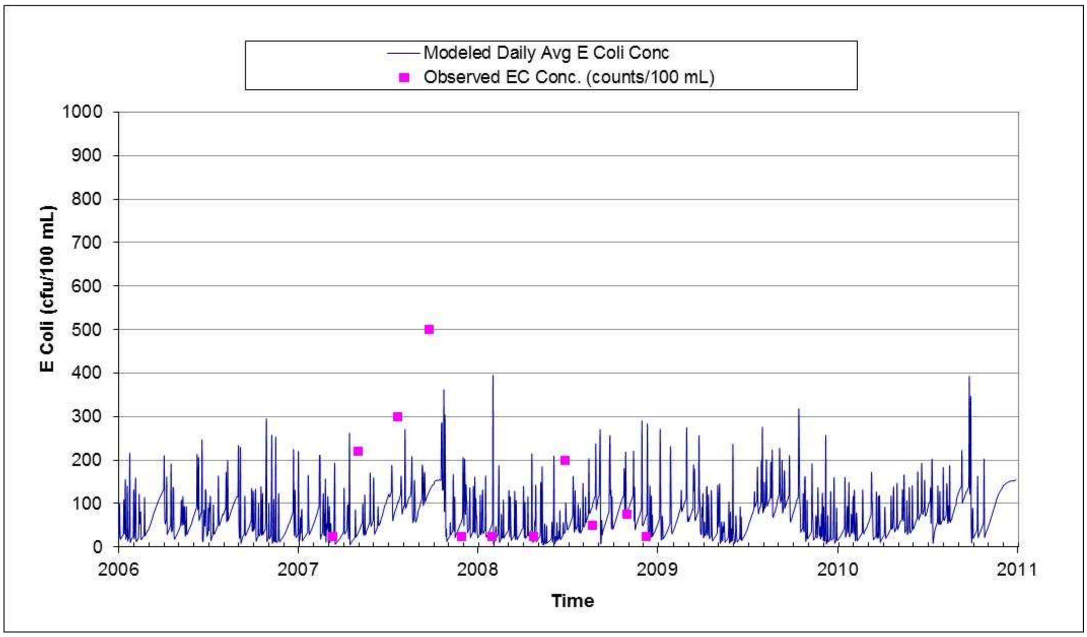


Figure 3-14: *E. coli* Calibration for an Unnamed Tributary to Potomac River - 1AXLF000.13 (Reach 49)

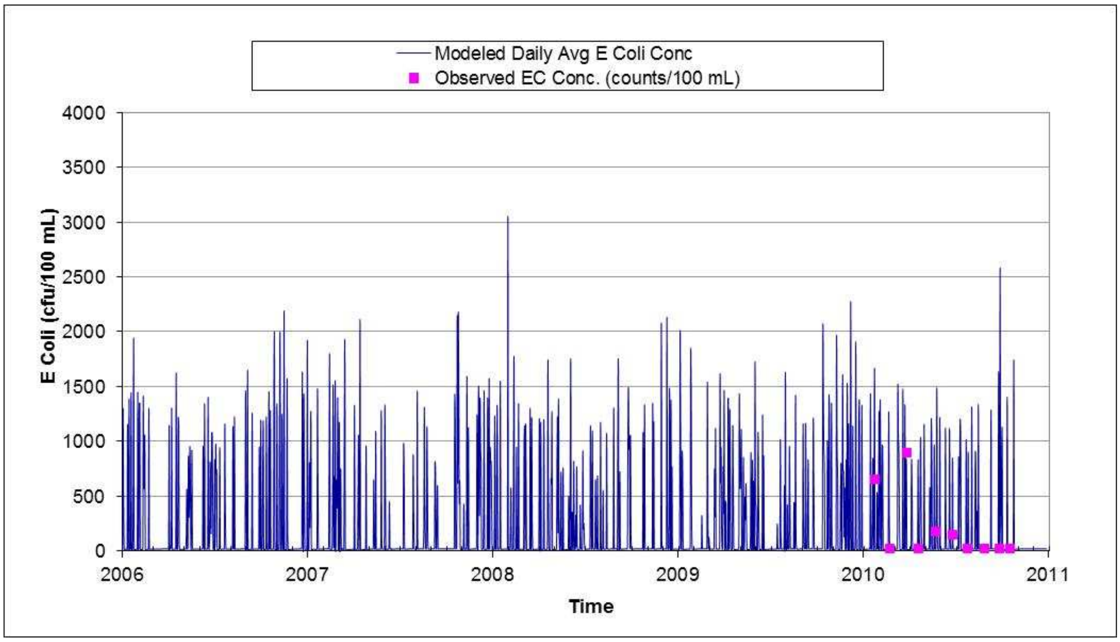


Figure 3-15: *E. coli* Calibration for Austin Run - 1AAUS000.49 (Reach 79)

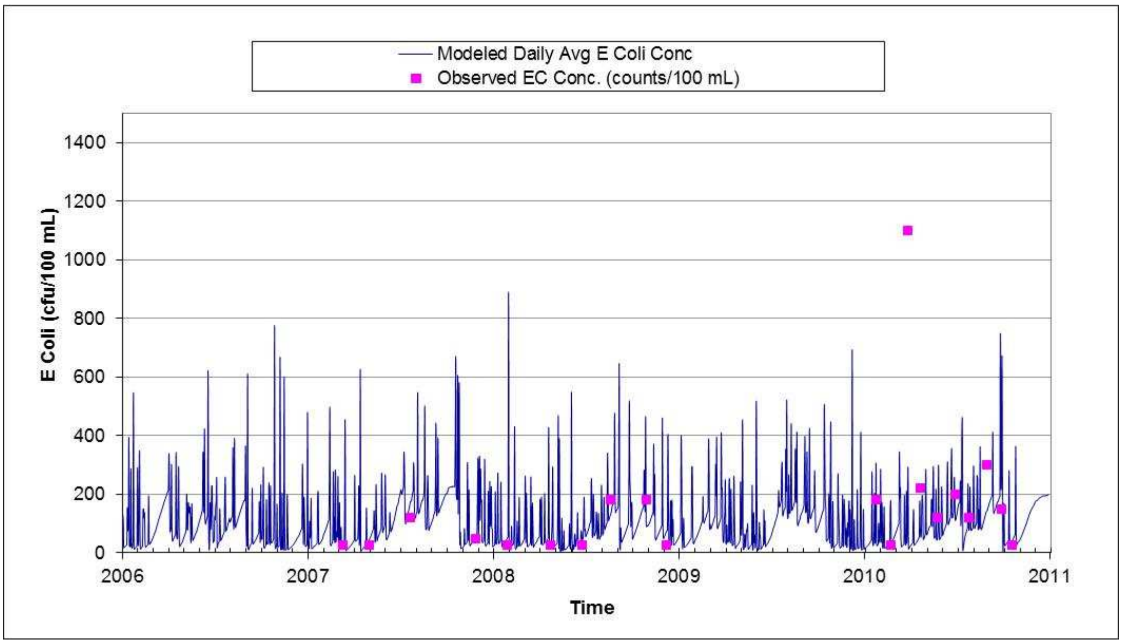


Figure 3-16: *E. coli* Calibration for Accokeek Creek - 1AACC006.13 (Reach 90)

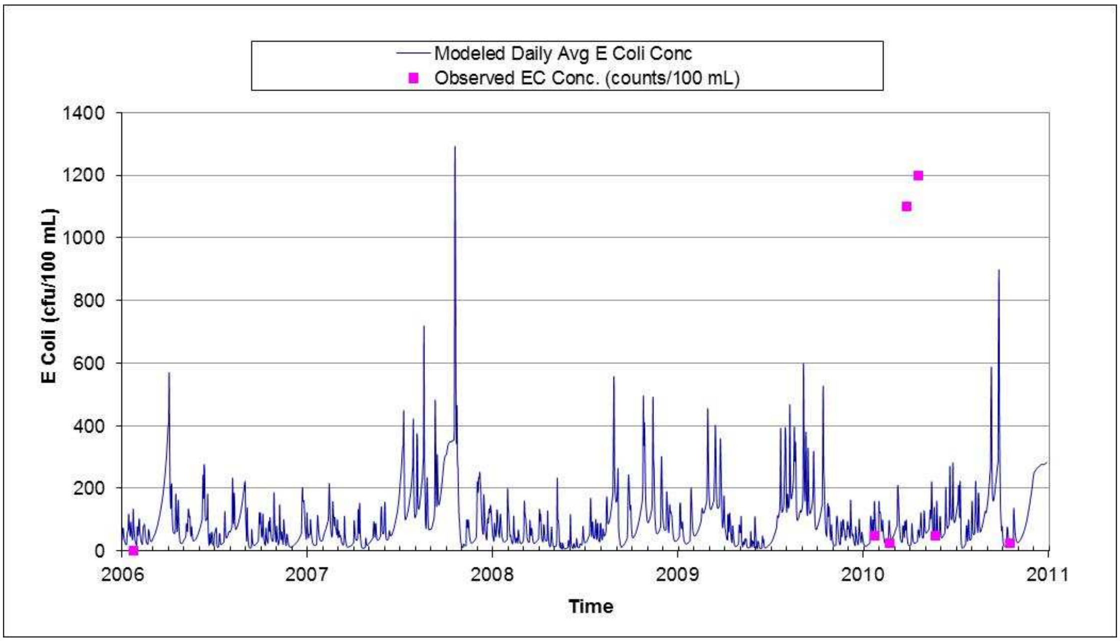


Figure 3-17: *E. coli* Calibration for Potomac Creek - 1APOM006.72 (Reach 97)

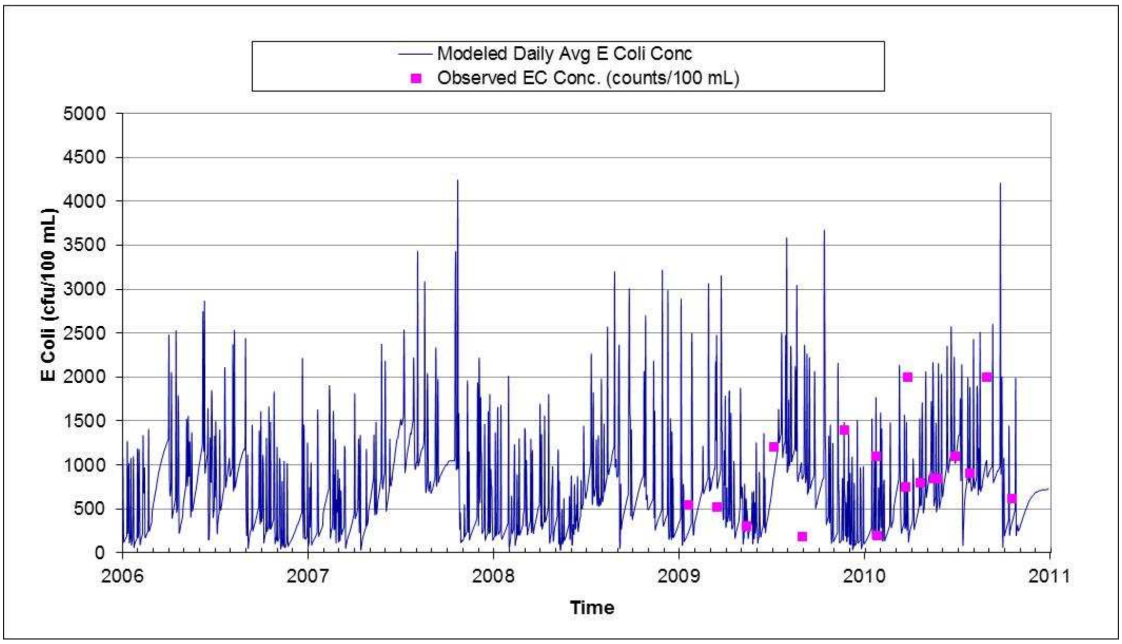


Figure 3-18: *E. coli* Calibration for Potomac Run - 1APOR000.40 (Reach 109)

The goodness of fit for the water quality calibration was evaluated visually. Analysis of the model results indicated that the model was capable of predicting the range of fecal coliform concentrations under both wet and dry weather conditions, and thus was well-calibrated. **Table 3-12** shows the observed and simulated geometric mean *E. coli* concentrations spanning the period from 2002 to 2010. Similarly, **Table 3-13** shows the observed and simulated exceedance rates of the 235 cfu/100 ml maximum *E. coli* criterion.

Table 3-12: Observed and Simulated Geometric Mean *E. coli* Concentration (2002-2010)

Station	Reach	Geometric Mean	
		Simulated	Observed
Powells Creek - 1APOW003.11	3	131	143
Quantico Creek - 1AQUA004.46	13	53	82
South Fork Quantico Creek - 1ASOQ006.73	22	45	63
North Branch Chopawamsic Creek - 1ANOR009.87	41	73	101
Unnamed Tributary to Potomac River - 1AXLF000.13	49	50	71
Austin Run - 1AAUS000.49	79	42	72
Accokeek Creek - 1AACC006.13	90	69	104
Potomac Creek - 1APOM006.72	97	61	101
Potomac Run - 1APOR000.40	109	501	621

Table 3-13: Observed and Simulated Exceedance Rates of the 235 cfu/100ml Maximum Assessment Criterion for *E. coli* Bacteria (2002-2010).

Station	Reach	Exceedances of the Maximum Assessment Criterion*	
		Simulated	Observed
Powells Creek - 1APOW003.11	3	30%	31%
Quantico Creek - 1AQUA004.46	13	24%	24%
South Fork Quantico Creek - 1ASOQ006.73	22	14%	13%
North Branch Chopawamsic Creek - 1ANOR009.87	41	26%	33%
Unnamed Tributary to Potomac River - 1AXLF000.13	49	17%	18%
Austin Run - 1AAUS000.49	79	24%	20%
Accokeek Creek - 1AACC006.13	90	21%	18%
Potomac Creek - 1APOM006.72	97	17%	32%
Potomac Run - 1APOR000.40	109	83%	83%
*235 cfu/100ml			

3.11 Existing Bacteria Loading

The existing bacteria loading for each of the impaired watershed was calculated based on current watershed conditions represented by the water quality calibrations.

3.11.1 Powells Creek

The instream concentrations of bacteria under existing conditions in the Powells Creek mainstem are above the *E. coli* geometric mean and maximum assessment criteria for the majority of the time period. **Figure 3-19** shows the *E. coli* geometric mean concentrations under existing conditions and **Figure 3-20** shows the modeled daily *E. coli* concentrations under existing conditions.

Distribution of the existing fecal coliform load by source in Powells Creek (Segment VAN-A26R_POW01A00) is presented in **Table 3-14**. *E. coli* concentrations in the impaired Powells Run segment were calculated from fecal coliform concentrations using the instream translator. **Table 3-14** shows that loadings from developed areas (which includes bacteria loads from pets and wildlife), as well as indirect loading pasture (which includes the bacteria load from wildlife and cattle), are the predominant sources of bacteria in the Powells Creek watershed. However, both wet weather and dry weather conditions were identified as the critical condition. Under wet weather conditions, the indirect deposition loads from pets and wildlife will dominate. Under dry weather conditions, direct deposition loads from wildlife and cattle will dominate.

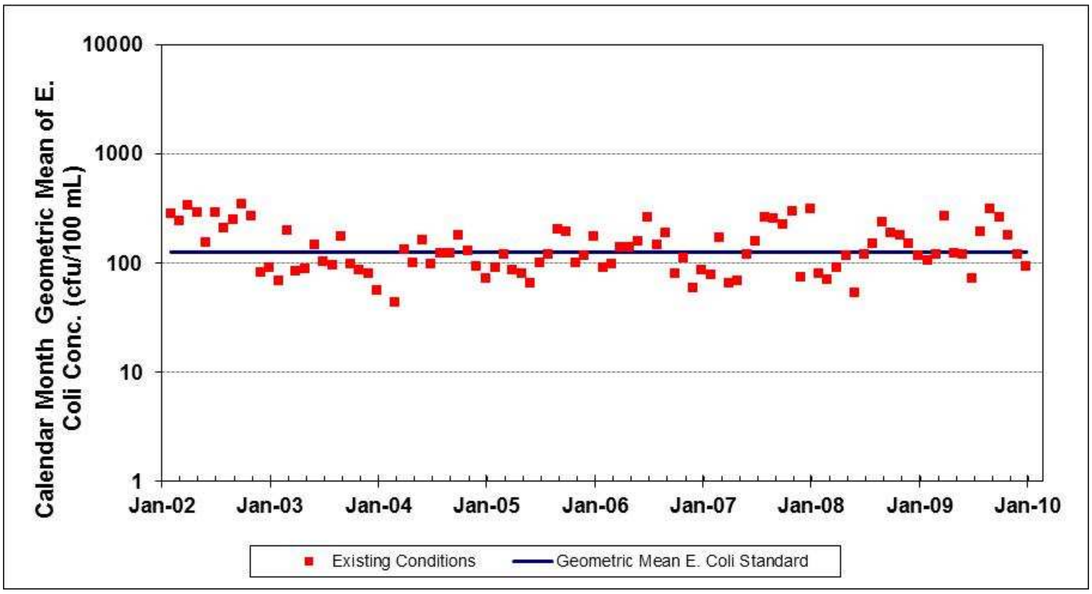


Figure 3-19: **Powells Creek *E. coli* Geometric Mean Existing Conditions**

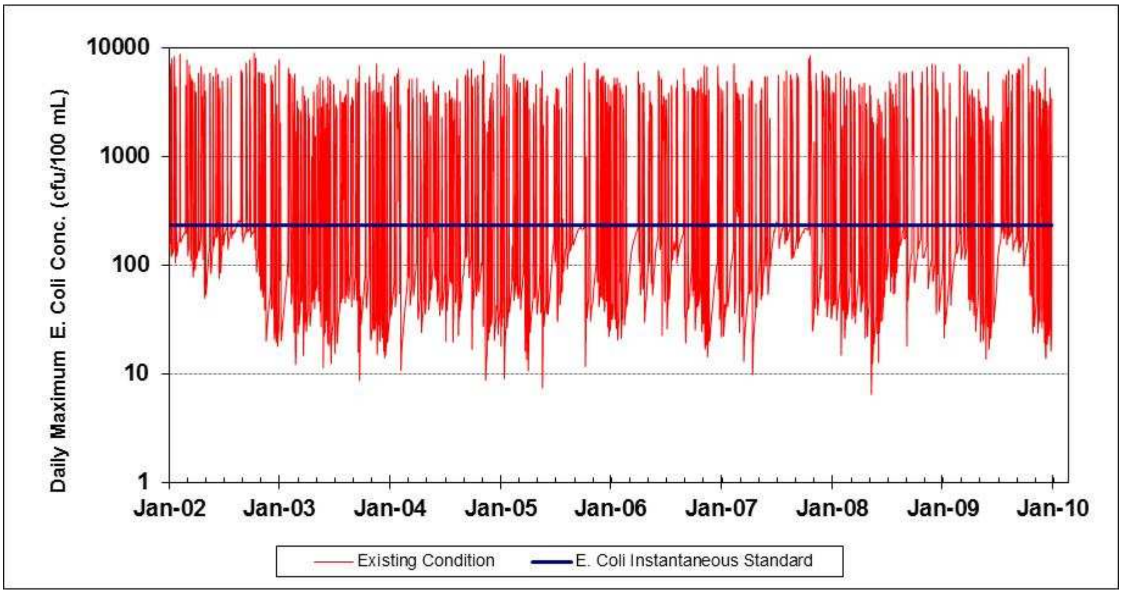


Figure 3-20: Modeled Daily *E. coli* Concentrations for Powells Creek under Existing Conditions

Table 3-14: Powells Creek (Segment VAN-A26R_POW01A00) *E. coli* Existing Load Distribution

Source	Annual Average *E. Coli* Loads	
	cfu/year	**%**
Forest and Wetland	2.52E+12	2.0%
Cropland	2.74E+12	2.2%
Pasture	6.04E+12	4.8%
Urban – Developed Land*	1.11E+14	87.0%
Cattle - Direct Deposition	2.09E+12	1.6%
Wildlife-Direct Deposition	2.68E+12	2.1%
Failed Septics	4.04E+11	0.3%
Point Source	0.00E+00	0.0%
SSOs	4.24E+09	0.0%
Total	**1.27E+14**	**100.0%**
*Loads from pets and wildlife		

3.11.2 Quantico Creek

The instream concentrations of bacteria under existing conditions in the Quantico Creek mainstem are above and the *E. coli* geometric mean a few times during the simulation period and above the *E. coli* maximum assessment criteria for the majority of the time period**. Figure 3-21** shows the *E. coli* geometric mean concentrations under existing conditions and **Figure 3-22** shows the modeled daily *E. coli* concentrations under existing conditions.

Distribution of the existing *E. coli* load by source in Quantico Creek (segment VAN-A26R_QUA01A00) is presented in **Table 3-15**. *E. coli* concentrations in the impaired Quantico Creek segment were calculated from fecal coliform concentrations using the instream translator. **Table 3-15** shows that loadings from developed areas (which includes bacteria loads from pets and wildlife), and direct loads from wildlife, are the predominant sources of bacteria in Quantico Creek watershed. However, both wet weather and dry weather conditions were identified as the critical condition. Under wet weather conditions, the indirect deposition loads from pets and wildlife will dominate. Under dry weather conditions, the direct deposition loads from wildlife will dominate.

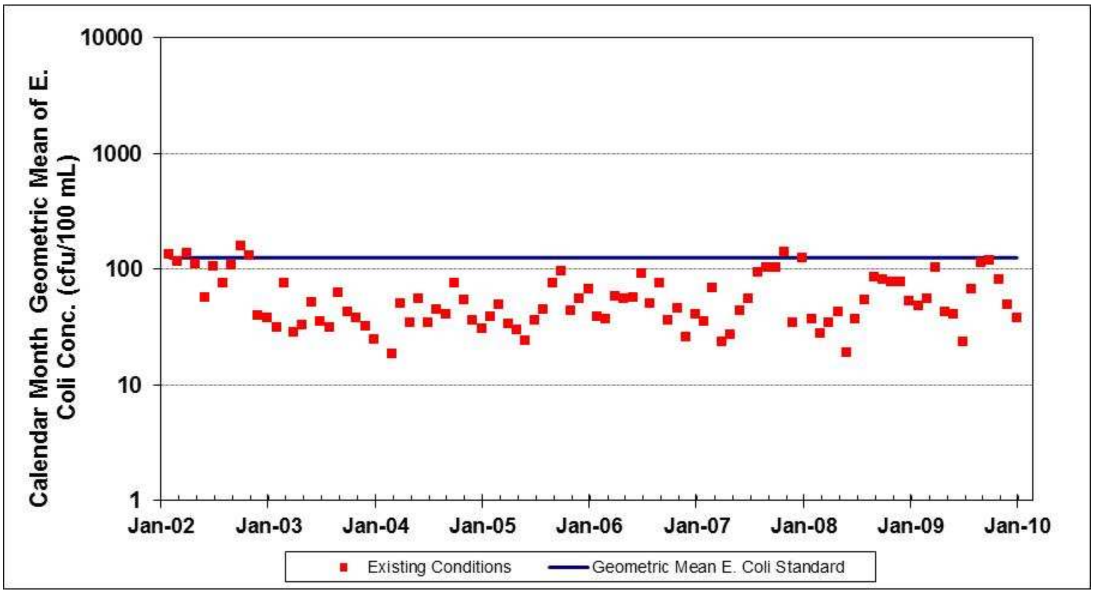


Figure 3-21: Quantico Creek *E. coli* Geometric Mean Existing Conditions

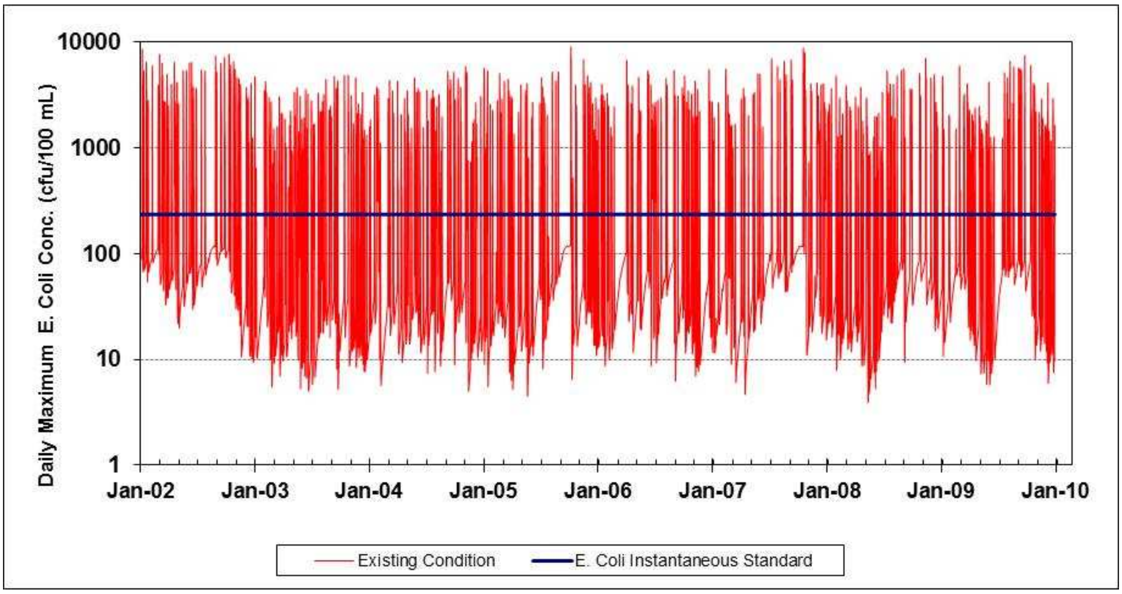


Figure 3-22: Modeled Daily *E. coli* Concentrations for Quantico Creek under Existing Conditions

Table 3-15: Quantico Creek (Segment VAN-A26R_QUA01A00) *E. coli* Existing Load Distribution

Source	Annual Average *E. coli* Loads	
	cfu/year	%
Forest and Wetland	8.61E+11	1.2%
Cropland	4.34E+10	0.1%
Pasture	6.66E+11	0.9%
Urban – Developed Land*	6.63E+13	94.0%
Cattle - Direct Deposition	2.34E+10	0.0%
Wildlife-Direct Deposition	2.41E+12	3.4%
Failed Septics	1.37E+11	0.2%
Point Source	0.00E+00	0.0%
SSOs	7.05E+10	0.1%
Total	**7.05E+13**	**100.0%**
*Loads from pets and wildlife		

3.11.3 South Fork Quantico Creek

The instream concentrations of bacteria under existing conditions in the South Fork Quantico Creek mainstem are above the *E. coli* geometric mean and maximum assessment criteria periodically during the simulation period. **Figure 3-23** shows the *E. coli* geometric mean concentrations under existing conditions and **Figure 3-24** shows the modeled daily *E. coli* concentrations under existing conditions.

Distribution of the existing *E. coli* load by source in South Fork Quantico Creek (segment VAN-A26R_SOQ01B02) is presented in **Table 3-16**. *E. coli* concentrations in the impaired South Fork Quantico Creek segment were calculated from fecal coliform concentrations using the instream translator. **Table 3-16** shows that loadings from developed areas (which includes bacteria loads from pets and wildlife) and direct loadings from wildlife are the predominant sources of bacteria in South Fork Quantico Creek watershed. However, both wet weather and dry weather conditions were identified as the critical condition. Under wet weather conditions, the indirect deposition loads from pets and wildlife will dominate. Under dry weather conditions, the direct deposition loads from wildlife will dominate.

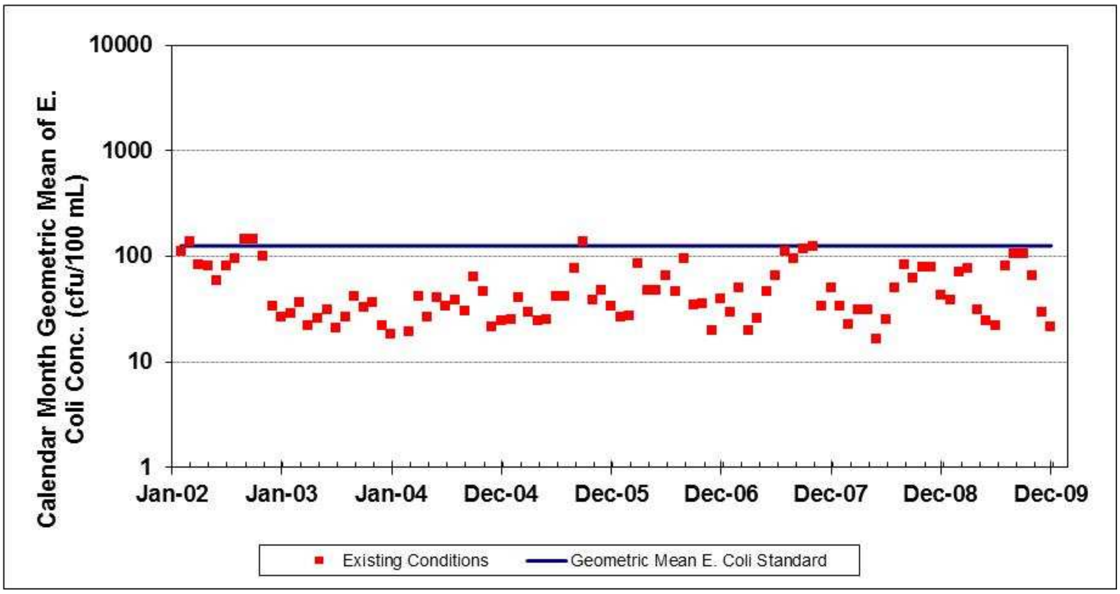


Figure 3-23: South Fork Quantico Creek *E. coli* Geometric Mean Existing Conditions

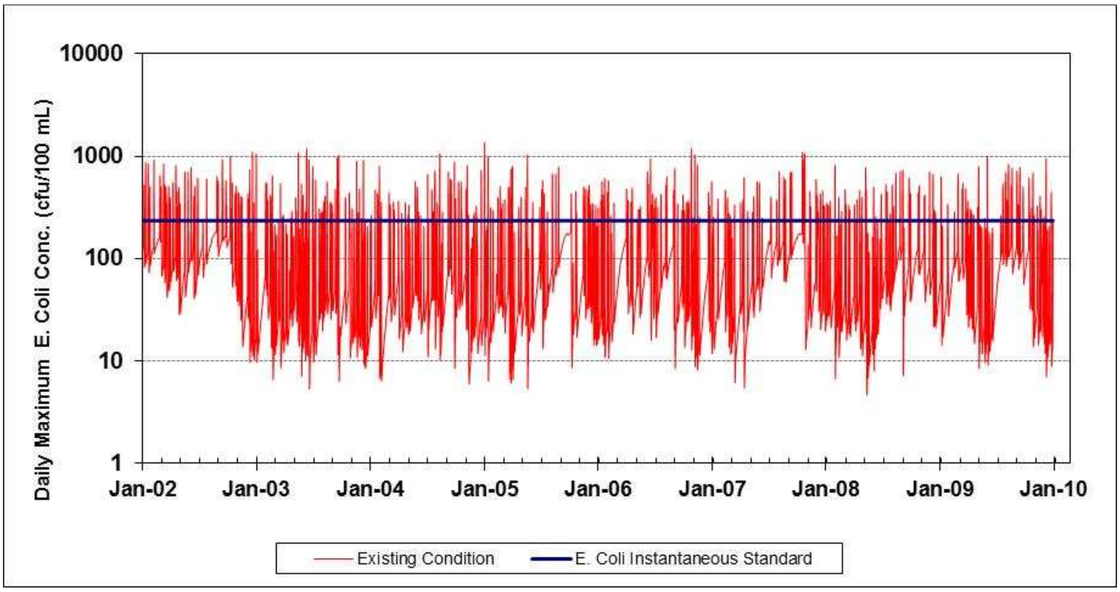


Figure 3-24: Modeled Daily *E. coli* Concentrations for South Fork Quantico Creek under Existing Conditions

Table 3-16: South Fork Quantico Creek (Segment VAN-A26R_SOQ01B02) *E. coli* Existing Load Distribution

Table 3-16: South Fork Quantico Creek (Segment VAN-A26R_SOQ01B02) *E. coli* Existing Load Distribution

Source	Annual Average *E. coli* Loads	
	cfu/year	**%**
Forest and Wetland	4.13E+11	7.5%
Cropland	1.19E+10	0.2%
Pasture	4.39E+11	8.0%
Urban – Developed Land*	3.19E+12	57.9%
Cattle - Direct Deposition	2.37E+11	4.3%
Wildlife-Direct Deposition	1.22E+12	22.0%
Failed Septics	5.52E+09	0.1%
Point Source	0.00E+00	0.0%
SSOs	0.00E+00	0.0%
Total	**5.52E+12**	**100.0%**

*Loads from pets and wildlife

3.11.4 North Branch Chopawamsic Creek

The instream concentrations of bacteria under existing conditions in the North Branch Chopawamsic Creek mainstem are above the *E. coli* geometric mean a number of times during the simulation period and above the *E. coli* maximum assessment criteria for the majority of the time period. **Figure 3-25** shows the *E. coli* geometric mean concentrations under existing conditions and **Figure 3-26** shows the modeled daily *E. coli* concentrations under existing conditions.

Distribution of the existing *E. coli* load by source in North Branch Chopawamsic Creek (segment VAN-A26R_NOR01A02) is presented in **Table 3-17**. *E. coli* concentrations in the impaired North Branch Chopawamsic Creek segment were calculated from fecal coliform concentrations using the instream translator. **Table 3-17** shows that indirect loadings from forest (which includes bacteria load from wildlife) as well as direct loadings from wildlife are the predominant sources of bacteria in North Branch Chopawamsic Creek watershed. However, both wet weather and dry weather conditions were identified as the critical condition. Under wet weather conditions, the indirect deposition loads from wildlife will dominate. Under dry weather conditions, the direct deposition loads from wildlife will dominate.

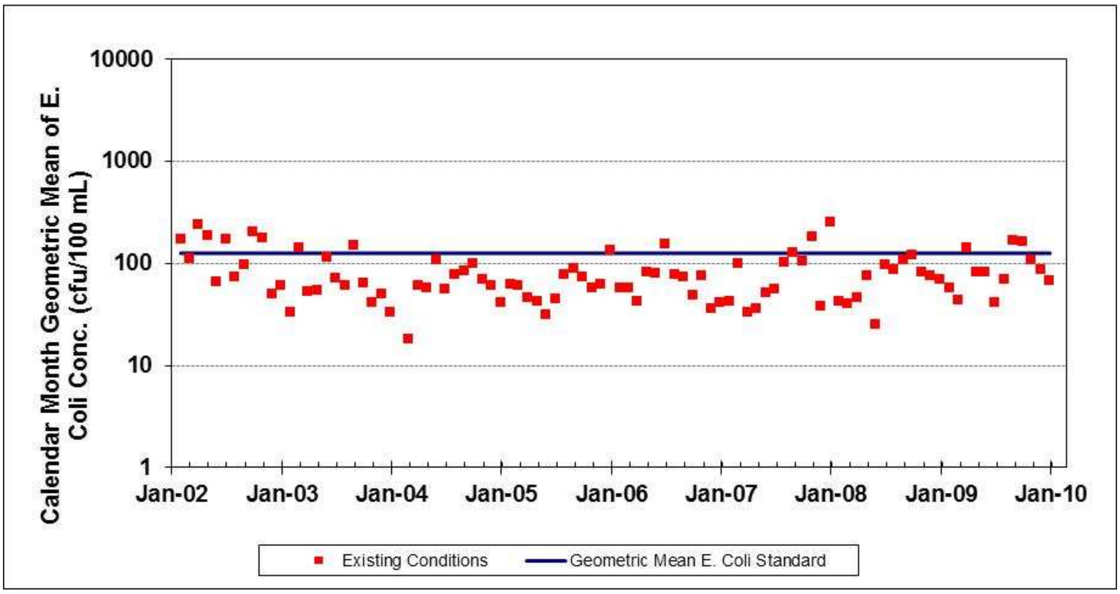


Figure 3-25: North Branch Chopawamsic Creek *E. coli* Geometric Mean Existing Conditions

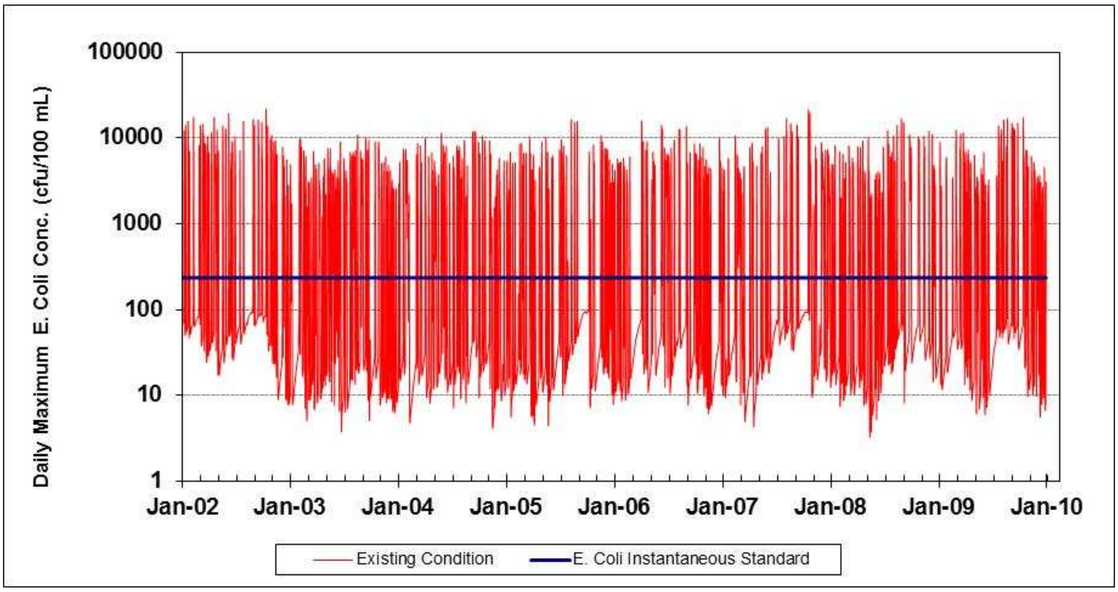


Figure 3-26: Modeled Daily *E. coli* Concentrations for North Branch Chopawamsic Creek under Existing Conditions

Table 3-17: North Branch Chopawamsic Creek (Segment VAN-A26R_NOR01A02) *E. coli* Existing Load Distribution

Source	Annual Average *E. coli* Loads	
	cfu/year	**%**
Forest and Wetland	5.49E+11	1.2%
Cropland	5.41E+12	11.4%
Pasture	2.51E+13	52.7%
Urban – Developed Land*	1.59E+13	33.4%
Cattle - Direct Deposition	0.00E+00	0.0%
Wildlife-Direct Deposition	5.55E+11	1.2%
Failed Septics	0.00E+00	0.0%
Point Source	0.00E+00	0.0%
SSOs	1.11E+11	0.2%
Total	**4.76E+13**	**100.0%**

*Loads from pets and wildlife

3.11.5 Unnamed Tributary to Potomac River

The instream concentrations of bacteria under existing conditions in the Unnamed Tributary to Potomac River mainstem are above the *E. coli* geometric mean and maximum assessment criteria periodically during the simulation period. **Figure 3-27** shows the *E. coli* geometric mean concentrations under existing conditions and **Figure 3-28** shows the modeled daily *E. coli* concentrations under existing conditions.

Distribution of the existing *E. coli* load by source in Unnamed Tributary to Potomac River (segment VAN-A26R_XLF01A10) is presented in **Table 3-18**. *E. coli* concentrations in the impaired South Fork Quantico Creek segment were calculated from fecal coliform concentrations using the instream translator. **Table 3-18** shows that loadings from developed areas (which includes the bacteria loads from pets and wildlife) and direct deposition from wildlife, as well as indirect loadings from forest (which includes bacteria load from wildlife) are the predominant sources of bacteria in Unnamed Tributary to Potomac River watershed. Dry weather conditions were identified as the critical condition. Under dry weather conditions, the direct deposition loads from wildlife will dominate.

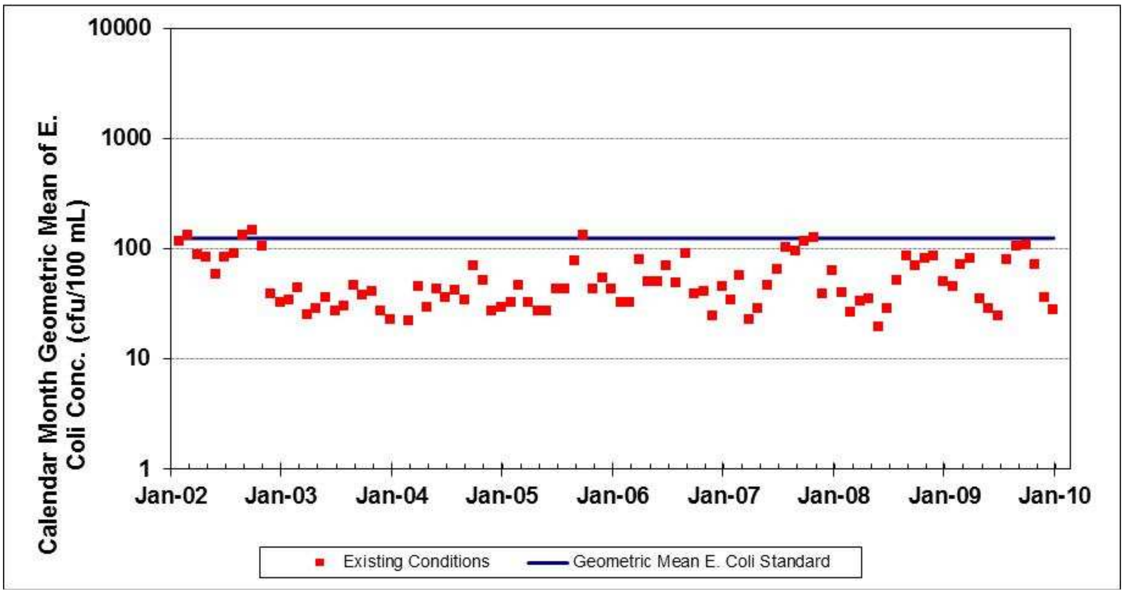


Figure 3-27: Unnamed Tributary to Potomac River *E. coli* Geometric Mean Existing Conditions

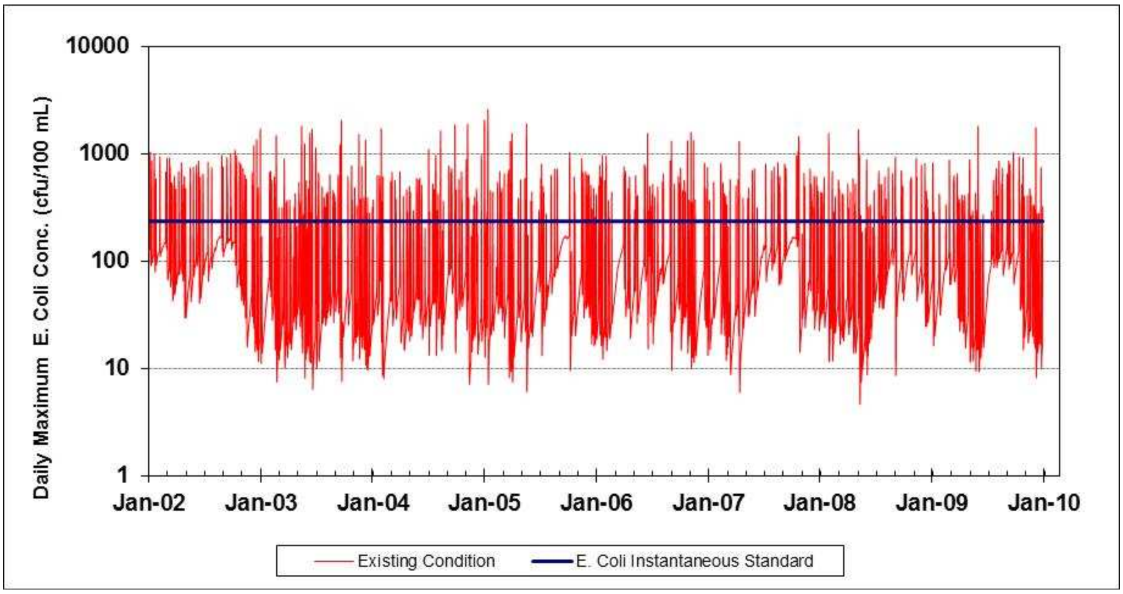


Figure 3-28: Modeled Daily *E. coli* Concentrations for Unnamed Tributary to Potomac River under Existing Conditions

Table 3-18: Unnamed Tributary to Potomac River (Segment VAN-A26R_XLF01A10) *E. coli* Existing Load Distribution

Source	Annual Average *E. coli* Loads	
	cfu/year	**%**
Forest and Wetland	3.80E+11	8.9%
Cropland	9.01E+09	0.2%
Pasture	2.61E+11	6.1%
Urban – Developed Land*	2.84E+12	66.5%
Cattle - Direct Deposition	1.08E+09	0.0%
Wildlife-Direct Deposition	7.06E+11	16.5%
Failed Septics	7.45E+10	1.7%
Point Source	1.74E+09	0.0%
SSOs	0.00E+00	0.0%
Total	**4.27E+12**	**100.0%**
*Loads from pets and wildlife		

3.11.6 Austin Run

The instream concentrations of bacteria under existing conditions in the Austin Run mainstem are above the *E. coli* geometric mean once during the simulation period and above the *E. coli* maximum assessment criteria for more than half of the time period. **Figure 3-29** shows the *E. coli* geometric mean concentrations under existing conditions and **Figure 3-30** shows the modeled daily *E. coli* concentrations under existing conditions.

Distribution of the existing *E. coli* load by source in Austin Run (segment VAN-A28R_AUS01A04) is presented in **Table 3-19** and indicates that loadings from developed areas (which includes bacteria loads from pets and wildlife) and point source loading are the predominant sources of bacteria in Austin Run watershed. Wet weather conditions were identified as the critical condition. Under wet weather conditions, the indirect deposition loads from pets and wildlife will dominate.

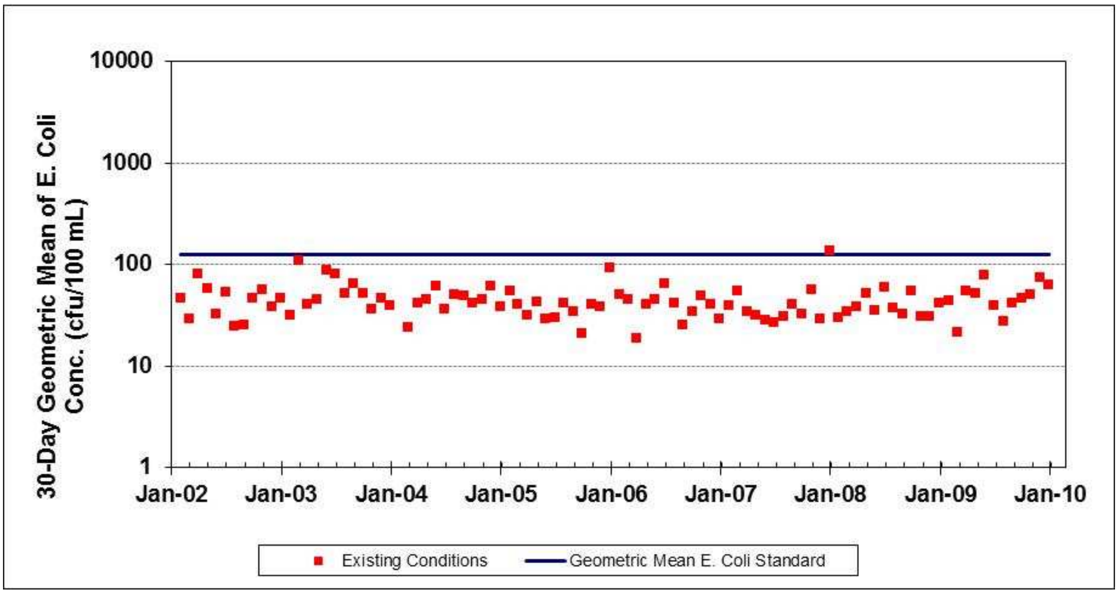


Figure 3-29: Austin Run *E. coli* Geometric Mean Existing Conditions

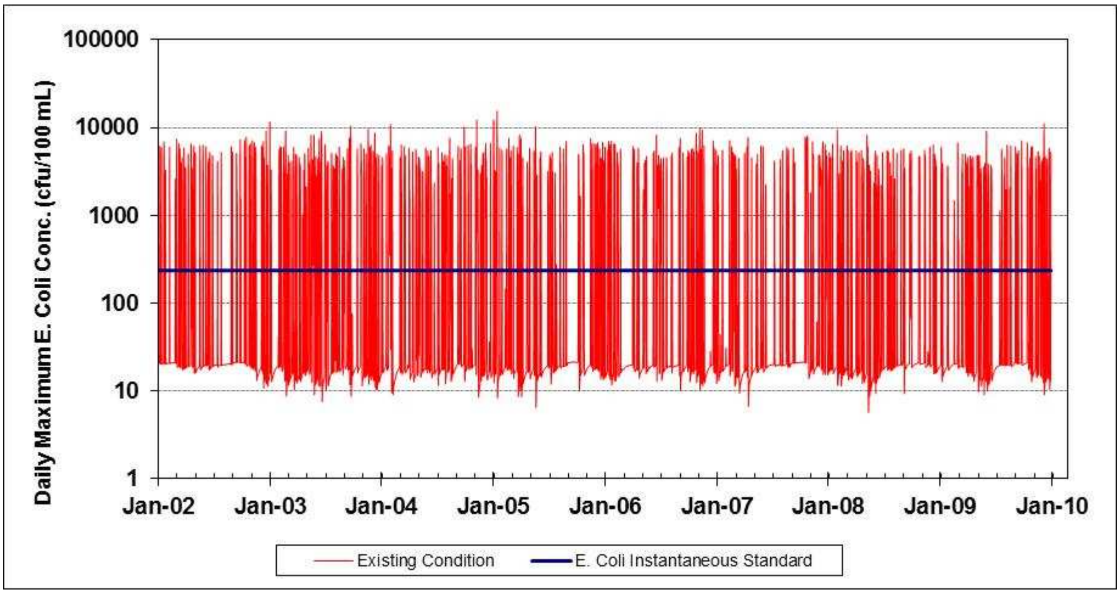


Figure 3-30: Modeled Daily *E. coli* Concentrations for Austin Run under Existing Conditions

Table 3-19: Austin Run (Segment VAN-A28R_AUS01A04) *E. coli* Existing Load Distribution

Source	Annual Average *E. coli* Loads	
	cfu/year	%
Forest and Wetland	2.12E+12	1.1%
Cropland	9.41E+10	0.0%
Pasture	4.20E+12	2.1%
Urban – Developed Land*	1.68E+14	85.3%
Cattle - Direct Deposition	2.48E+10	<0.1%
Wildlife-Direct Deposition	1.54E+12	0.8%
Failed Septics	1.04E+11	0.1%
Point Source	2.09E+13	10.6%
SSOs	1.82E+10	<0.1%
Total	**1.97E+14**	**100.0%**
*Loads from pets and wildlife		

3.11.7 Accokeek Creek

The instream concentrations of bacteria under existing conditions in the Accokeek Creek mainstem are above the *E. coli* geometric mean and maximum assessment criteria periodically during the simulation period. **Figure 3-31** shows the *E. coli* geometric mean concentrations under existing conditions and **Figure 3-32** shows the modeled daily *E. coli* concentrations under existing conditions.

Distribution of the existing *E. coli* load by source in Accokeek Creek (segment VAN-A29R_ACC01A00) is presented in **Table 3-20**. *E. coli* concentrations in the impaired Accokeek Creek segment were calculated from fecal coliform concentrations using the instream translator. **Table 3-20** shows that loading from developed areas (which includes bacteria loads from pets and wildlife) as well as indirect deposition from forest (which includes bacteria load from wildlife) are the predominant sources of bacteria in the Accokeek Creek watershed. However, both wet weather and dry weather conditions were identified as the critical condition. Under wet weather conditions, the indirect deposition loads from pets, wildlife and cattle will dominate. Under dry weather conditions, the direct deposition loads from wildlife will dominate.

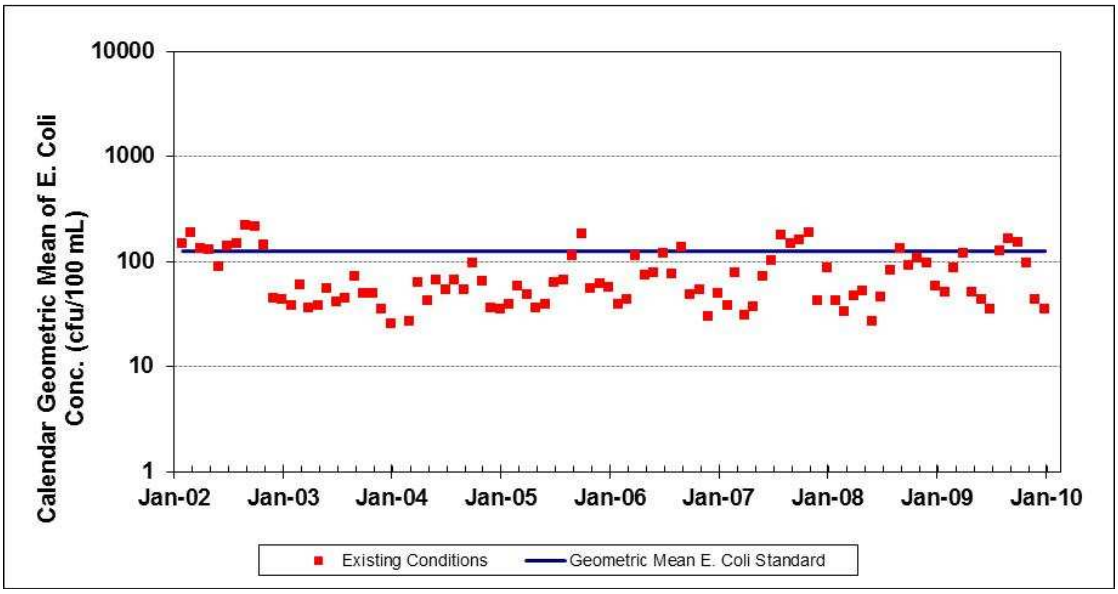


Figure 3-31: Accokeek Creek *E. coli* Geometric Mean Existing Conditions

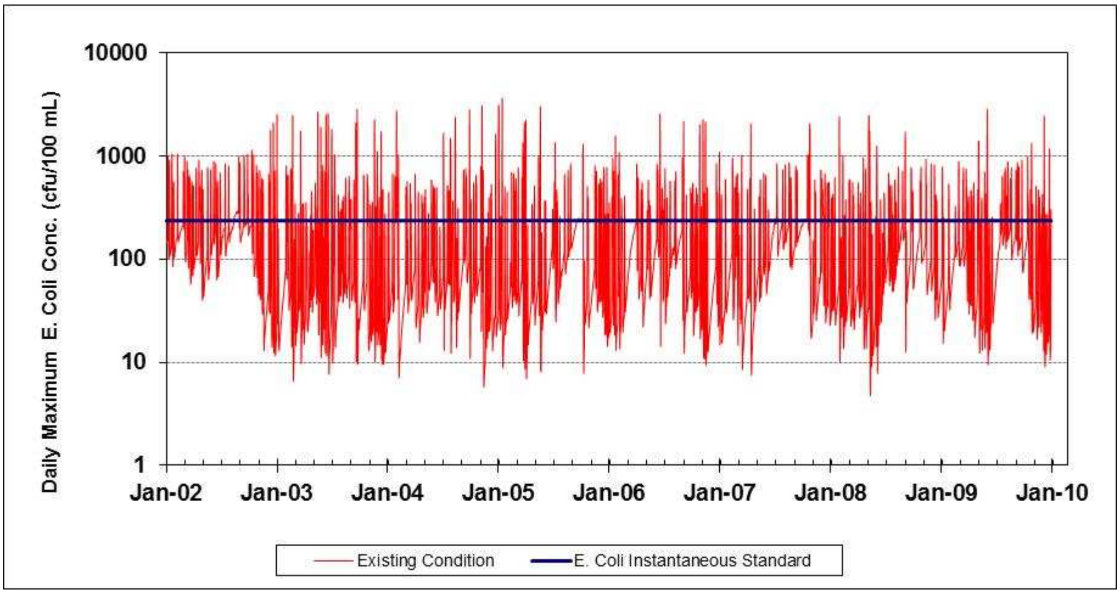


Figure 3-32: Modeled Daily *E. coli* Concentrations for Accokeek Creek under Existing Conditions

Table 3-20:Accokeek Creek (Segment VAN-A29R_ACC01A00) *E. coli* Existing Load Distribution

Source	Annual Average *E. coli* Loads	
	cfu/year	%
Forest and Wetland	2.59E+12	7.0%
Cropland	1.52E+11	0.4%
Pasture	2.10E+12	5.7%
Urban – Developed Land*	2.84E+13	77.0%
Cattle - Direct Deposition	1.40E+12	3.8%
Wildlife-Direct Deposition	2.08E+12	5.7%
Failed Septics	1.33E+11	0.4%
Point Source	3.13E+09	0.0%
SSOs	4.41E+09	0.0%
Total	**3.68E+13**	**100.0%**

*Loads from pets and wildlife

3.11.8 Potomac Creek

The instream concentrations of bacteria under existing conditions in the Potomac Creek mainstem are above the *E. coli* geometric mean and maximum assessment criteria periodically during the simulation period. **Figure 3-33** shows the *E. coli* geometric mean concentrations under existing conditions and **Figure 3-34** shows the modeled daily *E. coli* concentrations under existing conditions.

Distribution of the existing *E. coli* load by source in Potomac Creek (segment VAN-A29R_POM01A00) is presented in **Table 3-21**. *E. coli* concentrations in the impaired Potomac Creek segment were calculated from fecal coliform concentrations using the instream translator. **Table 3-21** shows that loading from developed areas (which includes bacteria loads from pets and wildlife), as well as indirect deposition from forest (which includes bacteria load from wildlife) and direct deposition by cattle are the predominant sources of bacteria in Potomac Creek watershed. However, both wet weather and dry weather conditions were identified as the critical condition. Under wet weather conditions, the indirect deposition loads from wildlife and pets will dominate. Under dry weather conditions, the direct deposition loads from cattle will dominate.

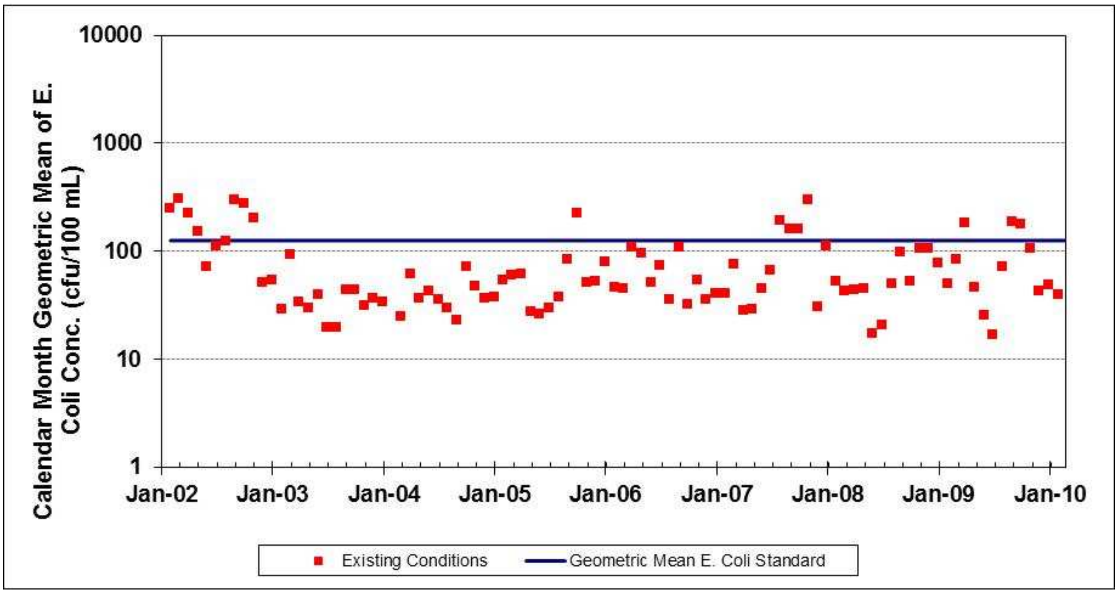


Figure 3-33: Potomac Creek *E. coli* Geometric Mean Existing Conditions

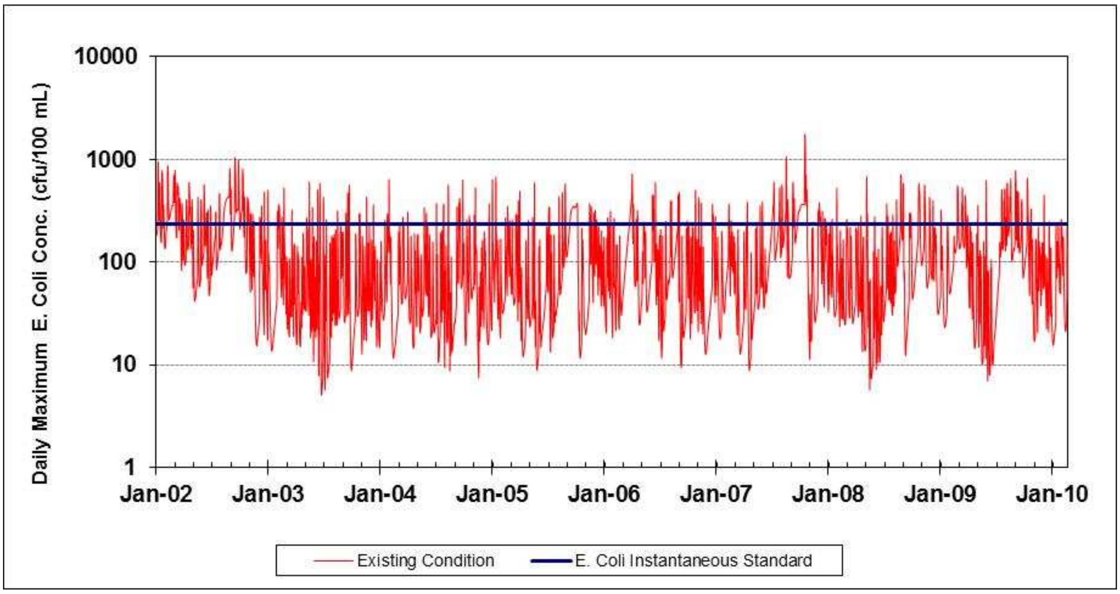


Figure 3-34: Modeled Daily *E. coli* Concentrations for Potomac Creek under Existing Conditions

Table 3-21:Potomac Creek (Segment VAN-A29R_POM01A00) *E. coli* Existing Load Distribution

Source	Annual Average Fecal Coliform Loads	
	cfu/year	%
Forest and Wetland	6.30E+12	23.8%
Cropland	1.80E+11	0.7%
Pasture	2.05E+12	7.8%
Urban – Developed Land*	1.16E+13	43.7%
Cattle - Direct Deposition	5.37E+12	20.3%
Wildlife-Direct Deposition	7.37E+11	2.8%
Failed Septics	2.18E+11	0.8%
Point Source	0.00E+00	0.0%
SSOs	6.36E+10	0.2%
Total	**2.65E+13**	**100.0%**

*Loads from pets and wildlife

3.11.9 Potomac Run

The instream concentrations of bacteria under existing conditions in the Potomac Run mainstem are above the *E. coli* geometric mean and maximum assessment criteria for the majority of the time period. **Figure 3-35** shows the *E. coli* geometric mean concentrations under existing conditions and **Figure 3-36** shows the modeled daily *E. coli* concentrations under existing conditions.

Distribution of the existing *E. coli* load by source in Potomac Run (segment VAN-A29R_POR01A06) is presented in **Table 3-22**. *E. coli* concentrations in the impaired Potomac Run segment were calculated from fecal coliform concentrations using the instream translator. **Table 3-22** shows that indirect deposition from pasture (which includes bacteria loads from wildlife and cattle) and the direct loading from cattle are the predominant sources of bacteria in Potomac Run watershed. However, both wet weather and dry weather conditions were identified as the critical condition. Under wet weather conditions, the indirect deposition loads from wildlife and cattle will dominate. Under dry weather conditions, the direct deposition loads from cattle will dominate.

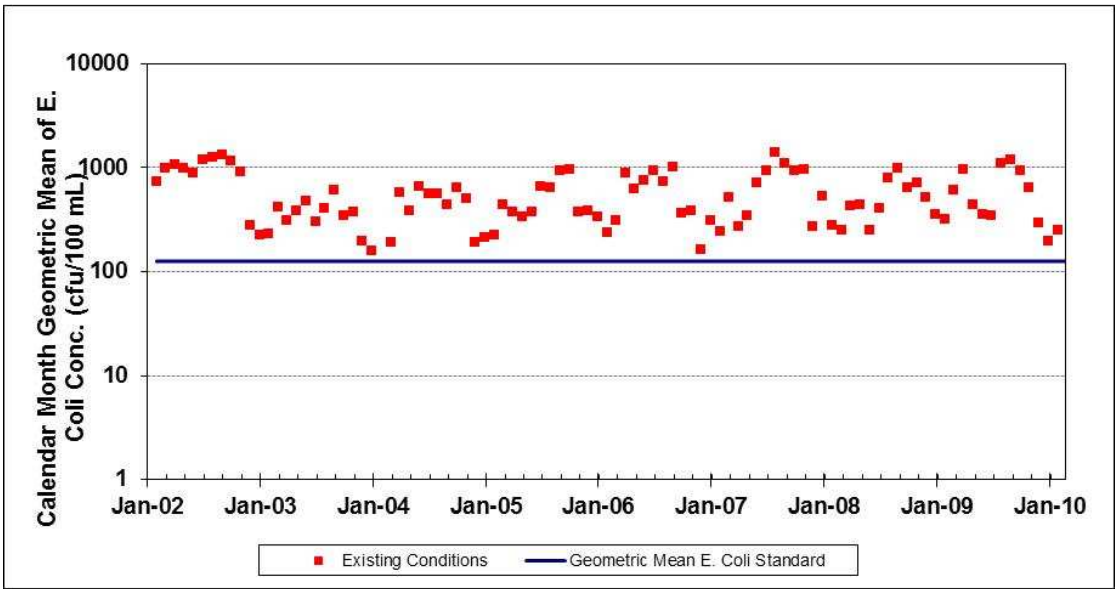


Figure 3-35: **Potomac Run *E. coli* Geometric Mean Existing Conditions**

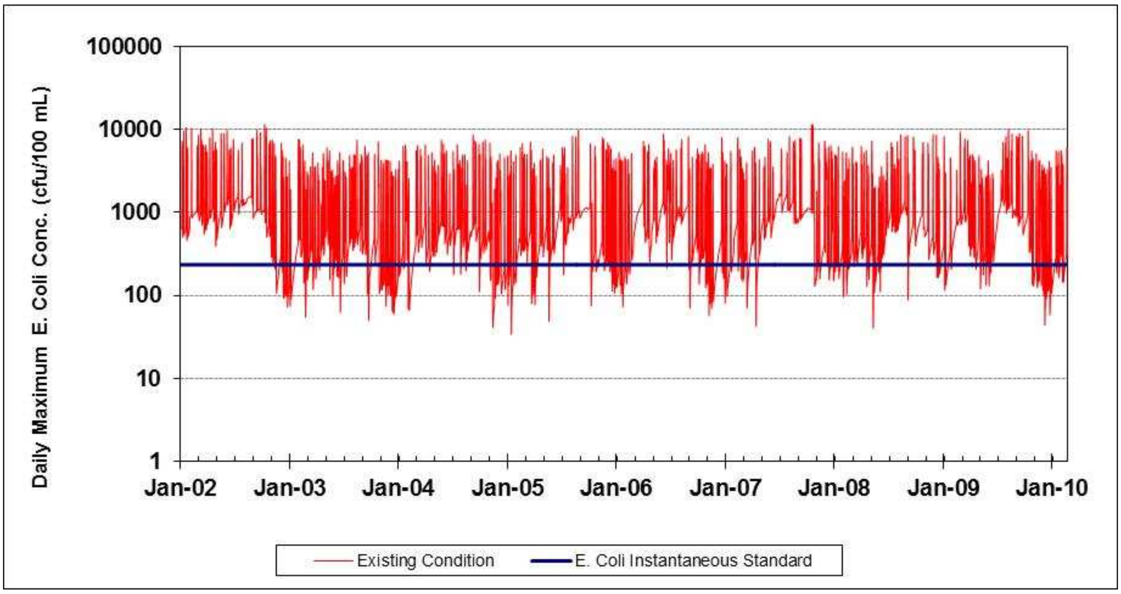


Figure 3-36: **Modeled Daily *E. coli* Concentrations for Potomac Run under Existing Conditions**

Table 3-22: Potomac Run (Segment VAN-A29R_POR01A06) *E. coli* Existing Load Distribution

Source	Annual Average Fecal Coliform Loads cfu/year	%
Forest and Wetland	1.36E+12	1.7%
Cropland	7.75E+11	0.9%
Pasture	3.85E+13	47.0%
Urban – Developed Land*	1.67E+13	20.4%
Cattle - Direct Deposition	2.19E+13	26.7%
Wildlife-Direct Deposition	2.44E+12	3.0%
Failed Septics	2.16E+11	0.3%
Point Source	0.00E+00	0.0%
SSOs	0.00E+00	0.0%
Total	**8.19E+13**	**100.0%**

*Loads from pets and wildlife

4.0 Allocation

Allocation analysis was the third stage in the development of the Tributaries to the Potomac River: Prince William and Stafford Counties Bacteria TMDLs. The purpose of this third stage was to develop the framework for reducing bacteria loading under the existing watershed conditions so that water quality standards may be met. The TMDLs represents the maximum amount of pollutant that the stream can receive without exceeding the water quality criteria. The load allocations for the selected scenarios were calculated using the following equation:

$$TMDL = \sum WLA + \sum LA + MOS$$

Where,

WLA = waste load allocation (point source contributions);

LA = load allocation (non-point source allocation); and

MOS = margin of safety.

Typically, several potential allocation strategies would achieve the TMDL endpoint and water quality standards. Available control options depend on the number, location, and character of pollutant sources.

4.1 Incorporation of Margin of Safety

The margin of safety (MOS) is a required component of the TMDL to account for any lack of knowledge concerning the relationship between effluent limitations and water quality. According to EPA guidance (*Guidance for Water Quality-Based Decisions: The TMDL Process, 1991*), the MOS can be incorporated into the TMDL using one of two methods:

- Implicitly incorporating the MOS using conservative model assumptions to develop allocations.
- Explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations.

The MOS will be implicitly incorporated into this TMDL. Implicitly incorporating the MOS will require that allocation scenarios be designed to meet the monthly geometric mean criterion of 126 cfu/100 mL for *E. coli* bacteria. In addition, it is required that final allocation scenarios be designed so that there is no more than a 10% exceedance rate of the maximum assessment criterion for *E. coli* of 235 cfu/100 mL.

4.2 Allocation Scenario Development

Allocation scenarios were modeled using the calibrated HSPF model to adjust the existing conditions until the water quality criteria were attained. The Tributaries to the Potomac River: Prince William and Stafford Counties TMDLs were based on the Virginia water quality criteria for *E. coli*. As detailed in Section 1.3, the *E. coli* criterion states that the calendar-month geometric mean concentration shall not exceed 126 cfu/100 mL, and that a maximum single sample concentration of *E. coli* shall not exceed 235 cfu/100 mL more than 10 percent of the time. According to the guidelines put forth by VADEQ (VADEQ, 2011) for modeling *E. coli* with HSPF, the model was set up to estimate loads of fecal coliform, and then the model output was converted to concentrations of *E. coli* with the following equation:

$$\log_2 EC\ (cfu/100mL) = -0.0172 + 0.91905 * \log_2 FC\ (cfu/100mL)$$

Where: EC = *E. coli* bacteria concentration
FC = Fecal coliform bacteria concentration

The pollutant concentrations were simulated over the entire duration of a representative modeling period, and pollutant loads were adjusted until the criteria was met. The pollutant loads were calculated at the outlet of the impaired segments. The development of the allocation scenarios was an iterative process requiring numerous runs where each run was followed by an assessment of source reduction against the water quality target. The long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the following equation (*USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*):

$$MDL = LTA \times Exp[z\sigma - 0.5\sigma^2]$$

Where:

MDL = maximum daily limit (cfu/day)

LTA = long-term average (cfu/day)

z = z statistic of the probability of occurrence

$\sigma^2 = \ln(CV^2+1)$

CV = coefficient of variation

Daily expressions for aggregate WLAs and LAs were calculated using the above method. The daily expression of individual WLAs, presented in Tables 4-1 through 4-4, were calculated based on the average annual individual WLAs divided by 365 days in a year. These daily average values are not intended to represent maximum allowable daily loads. Rather, they represent the average daily loadings that may be expected to occur over the long term.

The following sections present the waste load allocation (WLA) and load allocations (LA) for the impaired segment.

4.3 Wasteload Allocation

This section outlines the wasteload allocations (WLA) for the impaired segments. It presents the existing and allocated loads for each permitted (VPDES and MS4) facility contributing to the impaired segments. There may be other industrial process water and/or stormwater dischargers in the watershed that are authorized to discharge under the VPDES program. These facilities are not expected to discharge the pollutant of concern (bacteria). However, there may be incidental, insignificant levels of bacteria found in these discharges; the discharges are not considered to have a reasonable potential to cause or contribute to exceedances of the Virginia Water Quality Standards and the observed stream impairments. Any inadvertent bacteria discharge would be insignificant, and are not considered in this TMDL. Additionally, it should be noted that reported SSOs in any of the impaired watersheds were incorporated into the source inventory for model calibration. However, SSOs did not receive a wasteload allocation as they are unauthorized discharges.

For Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to the Potomac River, Accokeek Creek, Potomac Creek and Potomac Run, an explicit allocation equivalent to 1% of the total TMDL for each of the watersheds was provided for future growth of permitted point sources in the watershed. The 1% of the total TMDL allocation for future growth in each watershed was determined to be sufficient to cover the estimated failing sewage disposal systems and straight pipes presented in Section 2.5.2. In cases where replacement septic systems or alternative systems are not suitable for failing sewage disposal systems and/or straight pipes, there is adequate future growth in each TMDL watershed to issue discharge permits as needed. The allocation for future growth in Austin Run is presented in Section 4.3.6. In each of the TMDL watersheds, the future growth will be allocated to both new and existing permits as needed on a first-come, first-serve basis through the VADEQ permitting process. Allocation of bacteria loadings set aside under the WLA as future growth shall be determined at the discretion of DEQ staff.

4.3.1 Wasteload Allocations for VPDES Permitted Discharges

4.3.1.1 Powells Creek

There are no municipal VPDES permitted facilities which discharge into the Powells Creek bacteria impaired watershed. However, an explicit allocation (equivalent to 1% of the total TMDL load for the watershed) was provided for the future growth of permitted point sources in the watershed. The future growth allocation for point sources in the Powells Creek watershed is 9.64E+10 cfu/year.

4.3.1.2 Quantico Creek

There are no municipal VPDES permitted facilities which discharge into the Quantico Creek bacteria impaired watershed. However, an explicit allocation (equivalent to 1% of the total TMDL load for the watershed) was provided for the future growth of permitted point sources in the watershed. The future growth allocation for point sources in the Quantico Creek watershed is 8.66E+10 cfu/year.

4.3.1.3 South Fork Quantico Creek

There are no municipal VPDES permitted facilities which discharge into the South Fork Quantico Creek bacteria impaired watershed. However, an explicit allocation (equivalent to 1% of the total TMDL load for the watershed) was provided for the future growth of permitted point sources in the watershed. The future growth allocation for point sources in the South Fork Quantico Creek watershed is 4.23E+10 cfu/year.

4.3.1.4 North Branch Chopawamsic Creek

There are no municipal VPDES permitted facilities which discharge into the North Branch Chopawamsic Creek bacteria impaired watershed. However, an explicit allocation (equivalent to 1% of the total TMDL load for the watershed) was provided for the future growth of permitted point sources in the watershed. The future growth allocation for point sources in the North Branch Chopawamsic Creek watershed is 2.50E+10 cfu/year.

4.3.1.5 Unnamed Tributary to Potomac River

There is one VPDES permitted facility which discharges into the Unnamed Tributary to Potomac River bacteria impaired watershed (Permit VAG406114). It has been assigned a waste load allocation equal to its maximum permitted design flow (0.001 MGD) multiplied by the geometric mean *E. coli* criterion of 126 CFU/100mL and the appropriate conversion factors, resulting in a allocation of 1.74E+09 CFU/year. In addition, an explicit allocation (equivalent to 1% of the total TMDL load for the watershed) was provided for the future growth of permitted point sources in the watershed. The TMDL allocation plan for the permit in the Unnamed Tributary to Potomac River is presented in **Table 4-1**.

Table 4-1: WLA for VPDES Permitted Facilities in the Unnamed Tributary to Potomac River Watershed					
Permit Number	**Facility Type**	**Design Flow (MGD)**	**Effluent Limit (cfu/100ml)**	**Wasteload Allocation (cfu/day)**	**Wasteload Allocation (cfu/year)**
VAG406114	General Domestic Sewage	0.001	126	4.77E+06	1.74E+09
			Future Growth Allocation:	6.33E+07	2.30E+10
			Total WLA:	**6.81E+07**	**2.48E+10**

4.3.1.6 Austin Run

There are two VPDES permitted facilities which discharge into the Austin Run bacteria impaired watershed (Individual, VPDES Municipal Permits VA0092479 and VA0060968). Each has been assigned a wasteload allocation equal to its maximum design flow multiplied by the geometric mean *E. coli* criterion of 126 CFU/100mL and the appropriate conversion factors, resulting in a combined allocation of 2.09E+13 CFU/year. In addition, an allocation equivalent to 6 MGD at the water quality geometric mean criterion for *E. coli* (126 CFU/100mL) was included to accommodate future growth and expansion of point sources in the watershed. TMDL allocations for the VPDES permits in Austin Run are presented in **Table 4-2**.

Table 4-2: WLA for VPDES Permitted Facilities in the Austin Run Watershed					
Permit Number	**Facility Name**	**Maximum Design Flow (MGD)**	**Effluent Limit (cfu/100ml)**	**Wasteload Allocation (cfu/day)**	**Wasteload Allocation (cfu/year)**
VA0092479	Abrahms Ct STP	0.0036*	126	1.72E+07	6.27E+09
VA0060968	Aquia Wastewater Treatment Plant	12	126	5.73E+10	2.09E+13
Future Growth Allocation[#]		6	126	2.85E+10	1.04E+13
			Total WLA:	**8.58E+10**	**3.13E+13**

*This permit is still in draft form and has not been officially issued.
The future growth allocation was modeled as though it were coming from the Aquia WWTP; however, the future growth will be allocated to any VPDES or VSMP permitted facility (either current or future) in the watershed based on the discretion of DEQ staff.

4.3.1.7 Accokeek Creek

There are two VPDES permitted facilities which discharge into the Accokeek Creek bacteria impaired watershed (Permits VA0089630 and VAG406279). Each has been assigned a waste load allocation equal to its maximum permitted design flow multiplied by the geometric mean *E. coli* criterion of 126 CFU/100mL and the appropriate conversion factors, resulting in a allocation of 3.13E+09 CFU/year. In addition, an explicit allocation (equivalent to 1% of the total TMDL load for the watershed) was provided for the future growth of permitted point sources in the watershed. The TMDL allocation plan for the permits in Accokeek Creek is presented in **Table 4-3**.

Table 4-3: WLA for VPDES Permitted Facilities in the Accokeek Creek Watershed

Permit Number	Facility	Design Flow (MGD)	Effluent Limit (cfu/100ml)	Wasteload Allocation (cfu/day)	Wasteload Allocation (cfu/year)
VA0089630	Randall STP	0.0008	126	3.81E+06	1.39E+09
VAG406207	Residence	0.001	126	4.77E+06	1.74E+09
			Future Growth Allocation:	4.30E+08	1.57E+11
			Total WLA:	4.39E+08	1.60E+11

4.3.1.8 Potomac Creek

There are no municipal VPDES permitted facilities which discharge into the Potomac Creek bacteria impaired watershed. However, an explicit allocation (equivalent to 1% of the total TMDL load for the watershed) was provided for the future growth of permitted point sources in the watershed. The future growth allocation for point sources in the Potomac Creek watershed is 2.09E+11 cfu/year.

4.3.1.9 Potomac Run

There are no municipal VPDES permitted facilities which discharge into the Potomac Run bacteria impaired watershed. However, an explicit allocation (equivalent to 1% of the total TMDL load for the watershed) was provided for the future growth of permitted point sources in the watershed. The future growth allocation for point sources in the Potomac Run watershed is 5.51E+10 cfu/year.

4.3.2 Wasteload Allocations for MS4 Discharges

As discussed in Chapter 2 of this report, loads associated with MS4 areas are considered part of the wasteload allocation. Seven MS4 permits have been issued in the Tributaries to the Potomac River: Prince William and Stafford Counties Bacteria TMDL watersheds. For Phase I MS4 Permits (for example, Prince William County), all land-based loadings from developed land use categories (high, medium, and low intensity developed land uses) within the impaired watersheds were allocated to the MS4 permits. For Phase II Permits (i.e. Stafford County, Town of Dumfries, etc.) all land-based loadings from developed land use categories (high, medium, and low intensity developed land uses) within the most recent United States Census-defined urban areas of the permit boundaries were allocated to the MS4s. The most recent United States decennial census with defined urban areas is the 2010 Census. This approach for developing MS4 allocations is a land-use based approach.

One disadvantage to the land-use based approach is that it is not able to distinguish between urban areas that drain to regulated MS4s and those that drain to other unregulated pervious areas or directly to surface waters. At the time of TMDL development, detailed information regarding the portion of each watershed that drains to a MS4 system was not available, so a conservative, land-use based approach was used. It is important to note that the actual areas within the TMDL watersheds that are subject to a MS4 WLA are those areas that are specifically regulated under the MS4 permit. This TMDL study does not attempt or intend to define the MS4 regulatory area. Rather, the areas used to develop loadings associated with the MS4 permits in this TMDL (developed and Census defined urban areas) are only surrogates for establishing WLAs, estimating a reasonable pollutant loading that is expected to be contributed by these permitted sources. The WLAs for MS4 permittees can be revised in the future, as necessary, if additional information regarding the MS4 drainage areas becomes available or if adaptive management indicates that related loading(s) or reduction strategies would be impacted to a significant degree. Additionally, the future growth allocations available under the respective WLAs for each TMDL watershed may be assigned to MS4 loadings, as warranted.

Due to the spatial overlap between MS4 entities and the resulting uncertainty of the appropriate operator of the system, the MS4 loads are aggregated by jurisdiction (Prince William County or Stafford County) in the TMDL. In most cases, the boundaries of MS4 areas are not available in enough geospatial detail to disaggregate the MS4 loads and assign individual Waste Load Allocations. EPA, DEQ, and DCR support the aggregation of MS4 WLAs for this reason. Additionally, aggregation encourages stakeholder cooperation for the implementation of appropriate BMPs to address reductions required by the TMDL.

Table 4-4 lists the wasteload allocations associated with each MS4 jurisdiction within each subwatershed. The allocated *E. coli* load from MS4 sources in the Powells Creek watershed is 3.08E+12 cfu/year; 4.71E+12 cfu/year in Quantico Creek/South Fork Quantico Creek; 3.76E+11 cfu/year in North Branch Chopawamsic Creek; 3.67E+11 in the Unnamed Tributary to Potomac River; 1.20E+11 cfu/year in Austin Run; 3.02E+12 cfu/year in Accokeek Creek; and 6.48E+11 cfu/year in Potomac Creek/Potomac Run.

Table 4-4: MS4 Wasteload Allocation for *E. coli*

Permit Number	MS4 Permit	MS4 Geographical Area	Developed Acres	Overall MS4 Allocation (cfu/year)	MS4 Allocation by Jurisdiction (cfu/day)	MS4 Allocation by Jurisdiction (cfu/year)
Powells Creek (A26R-02-BAC)						
VA0088595	Prince William County	Prince William County	2,214	3.08E+12	8.44E+09	3.08E+12
VAR040100	Prince William County Public Schools					
VAR040115	Virginia Department of Transportation					
		Total MS4 WLA	2,214	3.08E+12	8.44E+09	3.08E+12
Quantico Creek (A26R-03-BAC) & South Fork Quantico Creek (A26R-05-BAC)						
VA0088595	Prince William County	Prince William County	563	4.71E+12	9.54E+09	3.48E+12
VAR040100	Prince William County Public Schools					
VAR040115	Virginia Department of Transportation					
VAR040117	Town of Dumfries	Town of Dumfries	257		3.37E+09	1.23E+12
VAR040115	Virginia Department of Transportation					
		Total MS4 WLA	820	4.71E+12	1.29E+10	4.71E+12
North Branch Chopawamsic Creek (A26R-04-BAC)						
VA0088595	Prince William County	Prince William County	6	3.76E+11	1.03E+09	3.76E+11
		Total MS4 WLA	6	3.76E+11	1.03E+09	3.76E+11
Unnamed Tributary to Potomac River (A26R-07-BAC)						
VAR040056	Stafford County	Stafford County	85	3.67E+11	1.00E+09	3.67E+11
VAR040071	Stafford County Public Schools					
VAR040115	Virginia Department of Transportation					
		Total MS4 WLA	85	3.67E+11	1.00E+09	3.67E+11
Austin Run (A28R-01-BAC)						
VAR040056	Stafford County	Stafford County	2,244	1.20E+11	3.28E+08	1.20E+11
VAR040071	Stafford County Public Schools					
VAR040115	Virginia Department of Transportation					
		Total MS4 WLA	2,244	1.20E+11	3.28E+08	1.20E+11

Table 4-4: MS4 Wasteload Allocation for *E. coli*

Permit Number	MS4 Permit	MS4 Geographical Area	Developed Acres	Overall MS4 Allocation (cfu/year)	MS4 Allocation by Jurisdiction (cfu/day)	MS4 Allocation by Jurisdiction (cfu/year)
Accokeek Creek (A29R-01-BAC)						
VAR040056	Stafford County	Stafford County	456	3.02E+12	8.27E+09	3.02E+12
VAR040071	Stafford County Public Schools					
VAR040115	Virginia Department of Transportation					
		Total MS4 WLA	456	3.02E+12	8.27E+09	3.02E+12
Potomac Creek (A29R-02-BAC) & Potomac Run (A29R-03-BAC)						
VAR040056	Stafford County	Stafford County	133	6.48E+11	1.78E+09	6.48E+11
VAR040115	Virginia Department of Transportation					
		Total MS4 WLA	133	6.48E+11	1.78E+09	6.48E+11

4.4 Load Allocation Development

The reduction of loadings from non-point sources, including livestock and wildlife direct deposition, is incorporated into the load allocation. A number of load allocation scenarios were developed in order to determine the final TMDL load allocation. Fecal coliform loading and instream fecal coliform concentrations were estimated for each potential scenario using the HSPF model for the hydrologic period of January 2006 to December 2010. The following is a list of load allocation scenarios that were implemented to arrive at the final TMDL allocations. Additional scenarios deemed necessary were also implemented to attain the final TMDL. The following is a brief summary of the key scenarios:

- Scenario 0 is the existing load, no reduction of any of the sources.
- Scenario 1 represents elimination of human sources (failing sewage disposal systems).
- Scenario 2 represents the elimination of human sources (failing sewage disposal systems) as well as half the direct instream loading from livestock.
- Scenario 3 represents the elimination of the human sources (failing sewage disposal systems) as well as the direct instream loading from livestock.
- Scenario 4 represents the elimination of all non-point sources and direct instream loading from livestock.

- Scenario 5 represents the elimination of the human sources (failing sewage disposal systems) and direct instream loading from livestock as well as half of the direct wildlife contribution.
- Scenario 6 represents the elimination of the human sources (failing sewage disposal systems) and direct instream loading from livestock as well as 75% of the direct wildlife contribution.
- Scenario 7 represents the elimination of the human sources (failing sewage disposal systems), direct instream loading from livestock, 95% of the loading from agricultural non-point sources, 95% of the loading from urban non-point sources, and 95% of the indirect wildlife contribution.
- Scenario 8 represents the elimination of the human sources (failing sewage disposal systems), direct instream loading from livestock, 85% of the loading from agricultural non-point sources, 85% of the loading from urban non-point sources, and 85% of the non-point source wildlife contribution.

Additional scenarios were necessary in order to reach the assigned endpoints. The following section discusses the scenario implementation for each TMDL.

4.4.1 Powells Creek

The TMDL load allocation scenario that resulted in no exceedances of the *E. coli* geometric mean criterion and not more than 10% exceedance of the maximum assessment criterion was Scenario 13. Under this scenario, complete elimination of the human sources (failing sewage disposal systems) and livestock direct deposition, 96.3 percent reduction of agricultural and urban non-point sources, and a 1% percent reduction of indirect wildlife deposition are required.

Table 4-5: Powells Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
0							46%	31%
1	100						44%	31%

Table 4-5: Powells Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
2	100	50					34%	30%
3	100	100					24%	30%
4	100	100	100	100	100		0%	0%
5	100	100				50	8%	30%
6	100	100				75	1%	30%
7	100	100	95	95	95		1%	13%
8	100	100	85	85	85		4%	23%
9	100	100	90	90	90		1%	21%
10	100	50	50	50	50		28%	28%
11	100	75	75	75	75		18%	26%
12	100	100				100	0%	30%
13	**100**	**100**	**96.3**	**96.3**	**1**	**0**	**0%**	**9%**

**Urban runoff by nature is non-point source runoff. It includes regulated stormwater under the MS4 program, and non-regulated stormwater (e.g. non-MS4).*

4.4.2 Quantico Creek

The TMDL load allocation scenario that resulted in no exceedances of the *E. coli* geometric mean criterion and not more than 10% exceedance of the maximum assessment criterion was Scenario 13. Under this scenario, complete elimination of the human sources (failing sewage disposal systems) and livestock direct deposition, a 92 percent reduction of agricultural and urban non-point sources and a 1% percent reduction of indirect wildlife deposition are required.

Table 4-6: Quantico Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
0							5%	25%
1	100						5%	25%
2	100	50					5%	25%
3	100	100					4%	25%
4	100	100	100	100	100		0%	0%

Table 4-6: Quantico Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
5	100	100				50	0%	25%
6	100	100				75	0%	25%
7	100	100	95	95	95		0%	5%
8	100	100	85	85	85	0	0%	16%
9	100	100	90	90	90	0	0%	12%
10	100	50	50	50	50	0	1%	22%
11	100	75	75	75	75	0	0%	19%
12	100	100				100	0%	25%
13	**100**	**100**	**92.1**	**92.1**	**1**	**0**	**0%**	**10%**

**Urban runoff by nature is non-point source runoff. It includes regulated stormwater under the MS4 program, and non-regulated stormwater (e.g. non-MS4).*

4.4.3 South Fork Quantico Creek

The TMDL load allocation scenario that resulted in no exceedances of the *E. coli* geometric mean criterion and not more than 10% exceedance of the maximum assessment criterion was Scenario 13. Under this scenario, complete elimination of the human sources (failing sewage disposal systems) and livestock direct deposition, a 29 percent reduction of agricultural and urban non-point sources, and a 1 percent reduction of indirect wildlife deposition are required.

Table 4-7: South Fork Quantico Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
0							4%	15%
1	100						4%	15%
2	100	50					4%	15%
3	100	100					1%	15%
4	100	100	100	100			0%	0%
5	100	100				50	0%	14%
6	100	100				75	0%	14%
7	100	100	95	95	95		0%	0%

Table 4-7: South Fork Quantico Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
8	100	100	85	85	85	0	0%	0%
9	100	100	90	90	90	0	0%	0%
10	100	50	50	50	50	0	4%	6%
11	100	75	75	75	75	0	0%	1%
12	100	100				100	0%	14%
13	**100**	**100**	**29.7**	**29.7**	**1**	**0**	**0%**	**10%**

**Urban runoff by nature is non-point source runoff. It includes regulated stormwater under the MS4 program, and non-regulated stormwater (e.g. non-MS4).*

4.4.4 North Branch Chopawamsic Creek

The TMDL load allocation scenario that resulted in no exceedances of the *E. coli* geometric mean criterion and not more than 10% exceedance of the maximum assessment criterion was Scenario 13. Under this scenario, complete elimination of the human sources (failing sewage disposal systems) and livestock direct deposition, 97 percent reduction of agricultural and urban non-point sources, and a 1 percent reduction of indirect wildlife deposition are required.

Table 4-8: North Branch Chopawamsic Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
0							17%	32%
1	100						17%	32%
2	100	50					17%	32%
3	100	100					17%	32%
4	100	100	100	100			0%	0%
5	100	100				50	5%	32%
6	100	100				75	2%	32%
7	100	100	95	95	95	0	0%	16%
8	100	100	85	85	85	0	1%	24%

Table 4-8: North Branch Chopawamsic Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
9	100	100	90	90	90	0	0%	22%
10	100	50	50	50	50	0	10%	29%
11	100	75	75	75	75	0	2%	26%
12	100	100				100	0%	32%
13	**100**	**100**	**97**	**97**	**1**	**0**	**0%**	**10%**

**Urban runoff by nature is non-point source runoff. It includes regulated stormwater under the MS4 program, and non-regulated stormwater (e.g. non-MS4).*

4.4.5 Unnamed Tributary to Potomac River

The TMDL load allocation scenario that resulted in no exceedances of the *E. coli* geometric mean criterion and not more than 10% exceedance of the maximum assessment criterion was Scenario 13. Under this scenario, complete elimination of the human sources (failing sewage disposal systems) and livestock direct deposition, 61 percent reduction of agricultural and urban non-point sources, and a 1 percent reduction of indirect wildlife deposition are required.

Table 4-9: Unnamed Tributary to Potomac River Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
0							4%	18%
1	100						1%	18%
2	100	50					1%	18%
3	100	100					1%	18%
4	100	100	100	100			0%	0%
5	100	100				50	0%	17%
6	100	100				75	0%	17%
7	100	100	95	95	95	0	0%	0%
8	100	100	85	85	85	0	0%	1%
9	100	100	90	90	90	0	0%	1%
10	100	50	50	50	50	0	1%	11%

Table 4-9: Unnamed Tributary to Potomac River Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
11	100	75	75	75	75	0	0%	4%
12	100	100				100	0%	17%
13	**100**	**100**	**61.4**	**61.4**	**1**	**0**	**0%**	**8%**

**Urban runoff by nature is non-point source runoff. It includes regulated stormwater under the MS4 program, and non-regulated stormwater (e.g. non-MS4).*

4.4.6 Austin Run

The TMDL load allocation scenario that resulted in no exceedances of the *E. coli* geometric mean criterion and not more than 10% exceedance of the maximum assessment criterion was Scenario 12. Under this scenario, complete elimination of the human sources (failing sewage disposal systems) and livestock direct deposition, 99.9 percent reduction of agricultural and urban non-point sources, and a 1 percent reduction of indirect wildlife deposition are required.

Table 4-10: Austin Run Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
0							95%	25%
1	100						95%	25%
2	100	50					95%	25%
3	100	100					95%	25%
4	100	100	100	100			0%	0%
5	100	100				50	95%	25%
6	100	100				75	95%	25%
7	100	100	95	95	95	0	14%	16%
8	100	100	85	85	85	0	49%	22%
9	100	50	90	90	90	0	28%	21%
10	100	75	50	50	50	0	93%	24%
11	100	100	75	75	75	0	72%	23%
12	**100**	**100**	**99.9**	**99.9**	**1**	**0**	**0%**	**10%**

**Urban runoff by nature is non-point source runoff. It includes regulated stormwater under the MS4 program, and non-regulated stormwater (e.g. non-MS4).*

4.4.7 Accokeek Creek

The TMDL load allocation scenario that resulted in no exceedances of the *E. coli* geometric mean criterion and not more than 10% exceedance of the maximum assessment criterion was Scenario 13. Under this scenario, complete elimination of the human sources (failing sewage disposal systems) and livestock direct deposition, 64 percent reduction of agricultural and urban non-point sources, and a 1 percent reduction of indirect wildlife deposition are required.

Table 4-11: Accokeek Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
0							20%	22%
1	100						19%	21%
2	100	50					10%	20%
3	100	100					2%	20%
4	100	100	100	100			0%	0%
5	100	100				50	0%	20%
6	100	100				75	0%	20%
7	100	100	95	95	95	0	0%	1%
8	100	100	85	85	85	0	0%	2%
9	100	100	90	90	90	0	0%	1%
10	100	50	50	50	50	0	6%	12%
11	100	75	75	75	75	0	4%	4%
12	100	100				100	0%	20%
13	**100**	**100**	**64.4**	**64.4**	**1**	**0**	**0%**	**8%**

**Urban runoff by nature is non-point source runoff. It includes regulated stormwater under the MS4 program, and non-regulated stormwater (e.g. non-MS4).*

4.4.8 Potomac Creek

The TMDL load allocation scenario that resulted in no exceedances of the *E. coli* geometric mean criterion and not more than 10% exceedance of the maximum assessment criterion was Scenario 13. Under this scenario, complete elimination of the human sources (failing sewage disposal systems) and livestock direct deposition are required.

Table 4-12: Potomac Creek Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E. coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
0							16%	16%
1	100						16%	16%
2	100	50					10%	12%
3	100	100					0%	10%
4	100	100	100	100			0%	0%
5	100	100				50	0%	10%
6	100	100				75	0%	10%
7	100	100	95	95	95	0	0%	0%
8	100	100	85	85	85	0	0%	0%
9	100	100	90	90	90	0	0%	0%
10	100	50	50	50	50	0	6%	5%
11	100	75	75	75	75	0	0%	1%
12	100	100				100	0%	10%
13	**100**	**100**	**1**	**1**	**0**	**0**	**0%**	**10%**

**Urban runoff by nature is non-point source runoff. It includes regulated stormwater under the MS4 program, and non-regulated stormwater (e.g. non-MS4).*

4.4.9 Potomac Run

The TMDL load allocation scenario that resulted in no exceedances of the *E. coli* geometric mean criterion and not more than 10% exceedance of the maximum assessment criterion was Scenario 13. Under this scenario, complete elimination of the human sources (failing sewage disposal systems) and livestock direct deposition, 97 percent reduction of agricultural and urban non-point sources and a 1 percent reduction of indirect wildlife deposition are required.

Table 4-13: Potomac Run Load Reductions Under 30-Day Geometric Mean and Maximum Assessment Criteria for *E. coli*

Scenario	Failing Sewage Disposal Systems	Direct Deposition from Cattle	Non-Point Source Agriculture	Urban*	Forest (Indirect Wildlife)	Direct Deposition from Wildlife	Percent Exceedance of the *E .coli* Geometric Mean Criterion	Percent Exceedance of the *E. coli* Maximum Assessment Criterion
0							100%	82%
1	100						100%	81%
2	100	50					97%	65%
3	100	100					23%	27%
4	100	100	100	100			0%	0%
5	100	100				50	4%	26%
6	100	100				75	1%	26%
7	100	100	95	95	95	0	1%	15%
8	100	100	85	85	85	0	3%	22%
9	100	100	90	90	90	0	1%	20%
10	100	50	50	50	50	0	92%	64%
11	100	75	75	75	75	0	64%	47%
12	100	100				100	0%	27%
13	**100**	**100**	**97**	**97**	**1**	**0**	**0%**	**10%**

**Urban runoff by nature is non-point source runoff. It includes regulated stormwater under the MS4 program, and non-regulated stormwater (e.g. non-MS4).*

4.5 Powells Creek Allocation Plan and TMDL Summary

As shown in **Table 4-5**, Scenario 13 will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 ml and the maximum assessment water quality criterion of 235 cfu/100 ml for Powells Creek. The requirements for this scenario are:

- 100 percent reduction of the human sources (failing sewage disposal systems).
- 100 percent reduction of the direct instream loading from livestock.
- 96.3 percent reduction of bacteria loading from agricultural and urban non-point sources.
- 1 percent reduction of the indirect loading from wildlife.

Table 4-14 shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source.

Table 4-14: Powells Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	**Allocation**	
Forest and Wetland	2.52E+12	2.49E+12	1.0%
Cropland	2.74E+12	1.00E+11	96.3%
Pasture	6.04E+12	2.21E+11	96.3%
Urban/Non-MS4[1]	2.65E+13	9.72E+11	96.3%
Cattle-Direct Deposition	2.09E+12	0.00E+00	100.0%
Wildlife-Direct Deposition	2.68E+12	2.68E+12	0.0%
Failing Sewage Disposal Systems	4.04E+11	0.00E+00	100.0%
Future Growth[2]	0.00E+00	9.64E+10	-
SSOs	4.24E+09	0.00E+00	100.0%
MS4s	8.40E+13	3.08E+12	96.3%
Total	**1.27E+14**	**9.64E+12**	**92.4%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

The TMDL for Powells Creek is presented in **Table 4-15.**

Table 4-15: Powells Creek TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Powells Creek	**3.17E+12**	**6.47E+12**	**IMPLICIT**	**9.64E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

As mentioned in Section 4-3, the long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the approach outlined in the *USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*. In reference to the daily expression equation presented in Section 4.2, the coefficient of variation in Powells Creek watershed is 3.09.

A summary of the daily TMDL allocation plan loads for Powells Creek is presented in **Table 4-16**.

Table 4-16: Powells Creek TMDL (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Powells Creek	8.69E+09	6.81E+10	IMPLICIT	7.68E+10

[1] The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The resulting geometric mean and maximum assessment criteria for *E. coli* concentrations under the TMDL allocation plan are presented in **Figures 4-1** and **Figure 4-2**. **Figure 4-1** shows the calendar month geometric mean *E. coli* concentrations after applying the allocations of Scenario 13, as well as geometric mean loading under existing conditions. **Figure 4-2** shows the instantaneous *E. coli* concentrations also under the allocations of Scenario 13 as well as the loading under existing conditions. For Powells Creek, allocation Scenario 13 results in bacteria concentrations that are consistently below both the geometric mean and maximum assessment criterion for *E. coli*.

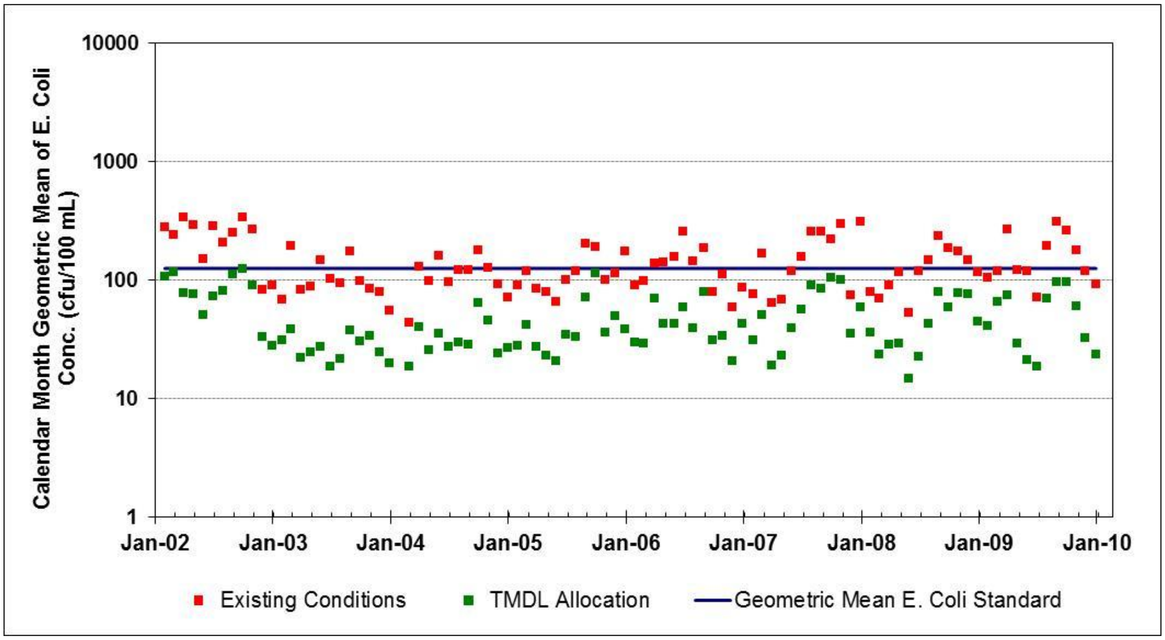


Figure 4-1: Powells Creek Geometric Mean *E. coli* Concentrations under Existing Conditions and Allocation Scenario 13

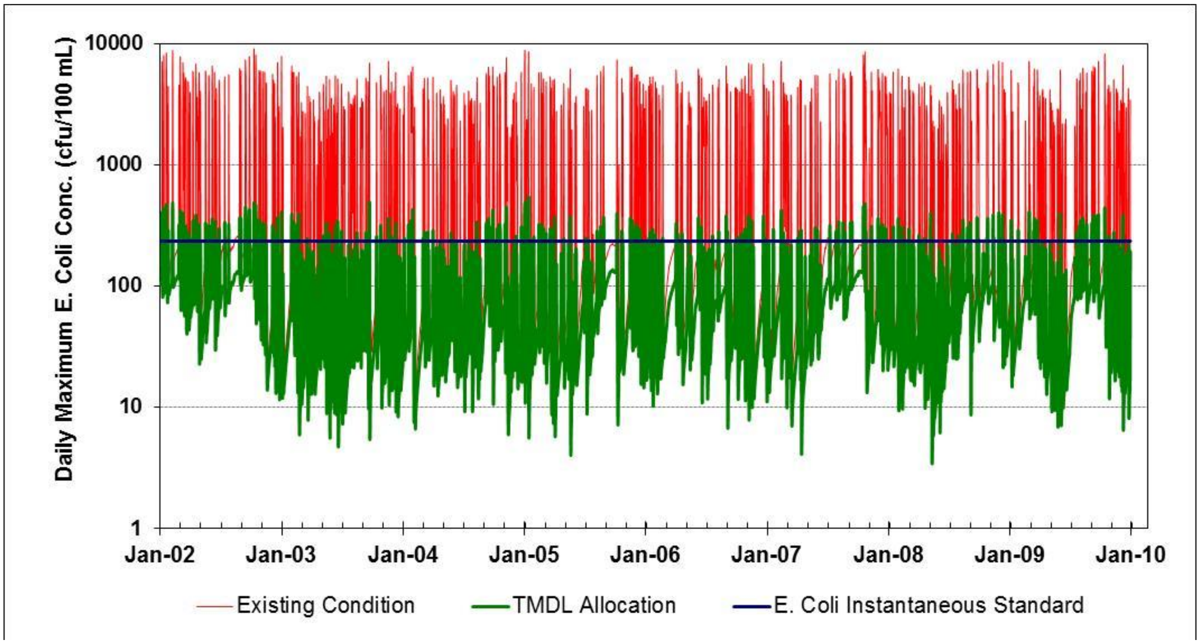


Figure 4-2: Powells Creek Instantaneous *E. coli* Concentrations under Allocation Scenario 13

4.6 Quantico Creek Allocation Plan and TMDL Summary

As shown in **Table 4-6**, Scenario 13 will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 ml and the maximum assessment water quality criterion of 235 cfu/100ml for Quantico Creek. The requirements for this scenario are:

- 100 percent reduction of the human sources (failing sewage disposal systems).
- 100 percent reduction of the direct instream loading from livestock.
- 92 percent reduction of bacteria loading from agricultural and urban non-point sources.
- 1 percent reduction of the indirect loading from wildlife.

Table 4-17 shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source.

Table 4-17: Quantico Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	8.61E+11	8.53E+11	1.0%
Cropland	4.34E+10	3.44E+09	92.1%
Pasture	6.66E+11	5.27E+10	92.1%
Urban/Non-MS4[1]	2.01E+13	1.59E+12	92.1%
Cattle-Direct Deposition	2.34E+10	0.00E+00	100.0%
Wildlife-Direct Deposition	2.41E+12	2.41E+12	0.0%
Failing Sewage Disposal Systems	1.37E+11	0.00E+00	100.0%
Future Growth[2]	0.00E+00	8.66E+10	-
SSOs	7.05E+10	0.00E+00	100.0%
MS4s	4.62E+13	3.66E+12	92.1%
Total	**7.05E+13**	**8.66E+12**	**87.7%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

The TMDL for Quantico Creek is presented in **Table 4-18.**

Table 4-18: Quantico Creek TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Quantico Creek	**3.74E+12**	**4.91E+12**	**IMPLICIT**	**8.66E+12**

[1] The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

As mentioned in Section 4-3, the long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the approach outlined in the *USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*. In reference to the daily expression equation presented in Section 4.2, the coefficient of variation in Quantico Creek watershed is 3.13.

A summary of the daily TMDL allocation plan loads for Quantico Creek is presented in **Table 4-19**.

Table 4-19: Quantico Creek TMDL (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Quantico Creek	1.03E+10	5.18E+10	IMPLICIT	6.20E+10

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The resulting geometric mean and instantaneous *E. coli* concentrations under the TMDL allocation plan are presented in **Figures 4-3** and **Figure 4-4**. **Figure 4-3** shows the calendar month geometric mean *E. coli* concentrations after applying the allocations of Scenario 13, as well as geometric mean loading under existing conditions. **Figure 4-4** shows the instantaneous *E. coli* concentrations also under the allocations of Scenario 13 as well as the loading under existing conditions. For Quantico Creek, allocation Scenario 13 results in bacteria concentrations that are consistently below both the geometric mean and maximum assessment criterion for *E. coli*.

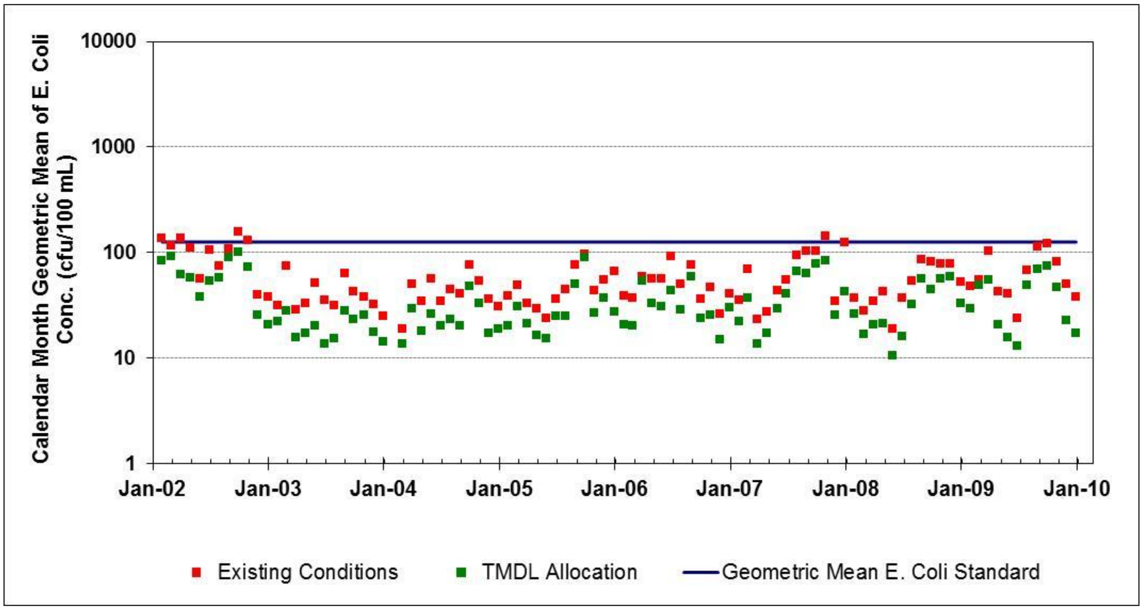


Figure 4-3: Quantico Creek Geometric Mean *E. coli* Concentrations under Existing Conditions and Allocation Scenario 13

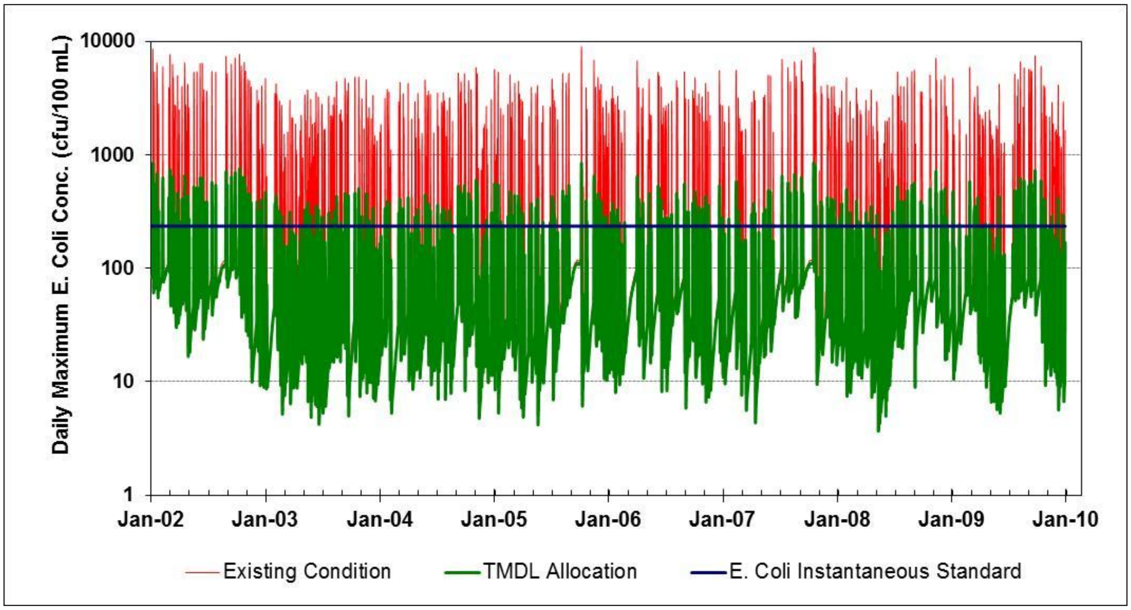


Figure 4-4: Quantico Creek Instantaneous *E. coli* Concentrations under Allocation Scenario 13

4.7 South Fork Quantico Creek Allocation Plan and TMDL Summary

As shown in **Table 4-7**, Scenario 13 will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 ml and the maximum assessment water quality criterion of 235 cfu/100 ml for South Fork Quantico Creek. The requirements for this scenario are:

- 100 percent reduction of the human sources (failing sewage disposal systems).
- 100 percent reduction of the direct instream loading from livestock.
- 29.7 percent reduction of bacteria loading from agricultural and urban non-point sources.
- 1 percent reduction of the indirect loading from wildlife.

Table 4-20 shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source.

Table 4-20: South Fork Quantico Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	4.13E+11	4.08E+11	1.0%
Cropland	1.19E+10	8.34E+09	29.7%
Pasture	4.39E+11	3.09E+11	29.7%
Urban/Non-MS4[1]	1.70E+12	1.19E+12	29.7%
Cattle-Direct Deposition	2.37E+11	0.00E+00	100.0%
Wildlife-Direct Deposition	1.22E+12	1.22E+12	0.0%
Failing Sewage Disposal Systems	5.52E+09	0.00E+00	100.0%
Future Growth[2]	0.00E+00	4.23E+10	-
SSOs	0.00E+00	0.00E+00	0.0%
MS4s	1.50E+12	1.05E+12	29.7%
Total	**5.52E+12**	**4.23E+12**	**23.3%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

The TMDL for South Fork Quantico Creek is presented in **Table 4-21.**

Table 4-21: South Fork Quantico Creek TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
South Fork Quantico Creek	**1.09E+12**	**3.14E+12**	**IMPLICIT**	**4.23E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

As mentioned in Section 4-3, the long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the approach outlined in the *USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*. In reference to the daily expression equation presented in Section 4.2, the coefficient of variation in South Fork Quantico Creek watershed is 3.13.

A summary of the daily TMDL allocation plan loads for South Fork Quantico Creek is presented in **Table 4-22**.

Table 4-22: South Fork Quantico Creek TMDL (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
South Fork Quantico Creek	3.00E+09	3.32E+10	IMPLICIT	3.62E+10

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The resulting geometric mean and instantaneous *E. coli* concentrations under the TMDL allocation plan are presented in **Figures 4-5** and **Figure 4-6**. **Figure 4-5** shows the calendar month geometric mean *E. coli* concentrations after applying the allocations of Scenario 13, as well as geometric mean loading under existing conditions. **Figure 4-6** shows the instantaneous *E. coli* concentrations also under the allocations of Scenario 13 as well as the loading under existing conditions. For South Fork Quantico Creek, allocation Scenario 13 results in bacteria concentrations that are consistently below both the geometric mean and maximum assessment criterion for *E. coli*.

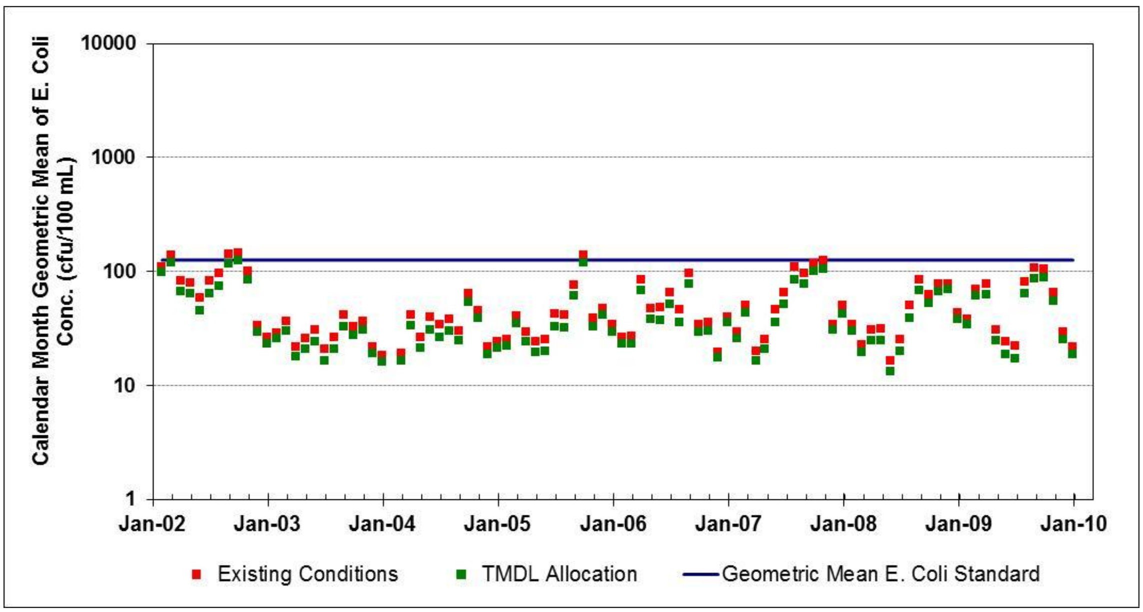


Figure 4-5: South Fork Quantico Creek Geometric Mean *E. coli* Concentrations under Existing Conditions and Allocation Scenario 13

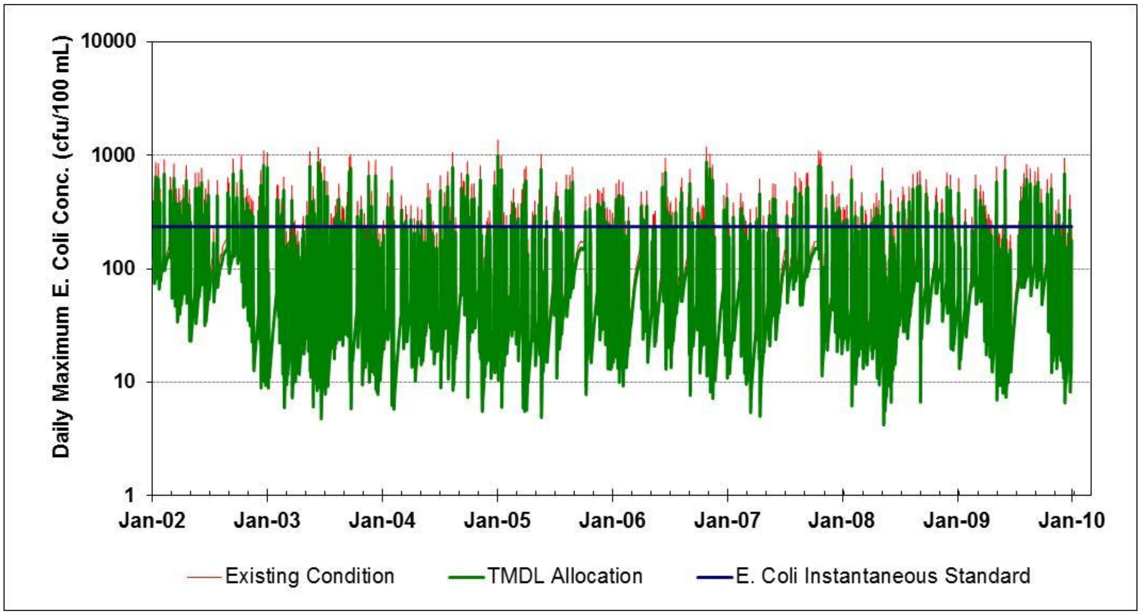


Figure 4-6: South Fork Quantico Creek Instantaneous *E. coli* Concentrations under Allocation Scenario 13

4.8 North Branch Chopawamsic Creek Allocation Plan and TMDL Summary

As shown in **Table 4-8**, Scenario 13 will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 ml and the maximum assessment water quality criterion of 235 cfu/100ml for North Branch Chopawamsic Creek. The requirements for this scenario are:

- 100 percent reduction of the human sources (failing sewage disposal systems).
- 100 percent reduction of the direct instream loading from livestock.
- 97 percent reduction of bacteria loading from agricultural and urban non-point sources.
- 1 percent reduction of the indirect loading from wildlife.

Table 4-23 shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source.

Table 4-23: North Branch Chopawamsic Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	5.49E+11	5.43E+11	1.0%
Cropland	5.41E+12	1.61E+11	97.0%
Pasture	2.51E+13	7.45E+11	97.0%
Urban/Non-MS4[1]	3.19E+12	9.47E+10	97.0%
Cattle-Direct Deposition	0.00E+00	0.00E+00	0.0%
Wildlife-Direct Deposition	5.55E+11	5.55E+11	0.0%
Failing Sewage Disposal Systems	0.00E+00	0.00E+00	0.0%
Future Growth[2]	0.00E+00	2.50E+10	-
MS4s	1.27E+13	3.76E+11	97.0%
SSOs	1.11E+11	0.00E+00	100.0%
Total	**4.74E+13**	**2.50E+12**	**94.7%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

The TMDL for North Branch Chopawamsic Creek is presented in **Table 4-24.**

Table 4-24: North Branch Chopawamsic Creek TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
North Branch Chopawamsic Creek	**4.01E+11**	**2.10E+12**	**IMPLICIT**	**2.50E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

As mentioned in Section 4-3, the long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the approach outlined in the *USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*. In reference to the daily expression equation presented in Section 4.2, the coefficient of variation in North Branch Chopawamsic Creek watershed is 3.44.

A summary of the daily TMDL allocation plan loads for North Branch Chopawamsic Creek is presented in **Table 4-25**.

Table 4-25: North Branch Chopawamsic Creek TMDL (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
North Branch Chopawamsic Creek	1.10E+09	2.22E+10	IMPLICIT	2.33E+10

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The resulting geometric mean and instantaneous *E. coli* concentrations under the TMDL allocation plan are presented in **Figures 4-7** and **Figure 4-8**. **Figure 4-7** shows the calendar month geometric mean *E. coli* concentrations after applying the allocations of Scenario 13, as well as geometric mean loading under existing conditions. **Figure 4-8** shows the instantaneous *E. coli* concentrations also under the allocations of Scenario 13 as well as the loading under existing conditions. For North Branch Chopawamsic Creek, allocation Scenario 13 results in bacteria concentrations that are consistently below both the geometric mean and maximum assessment criterion for *E. coli*.

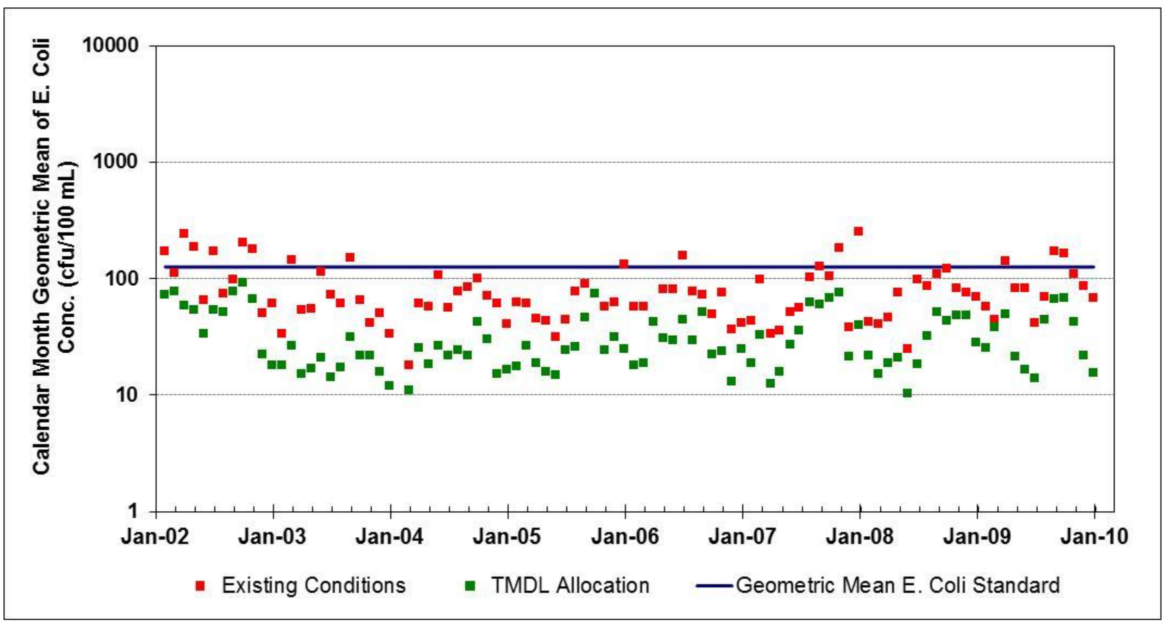


Figure 4-7: North Branch Chopawamsic Creek Geometric Mean *E. coli* Concentrations under Existing Conditions and Allocation Scenario 13

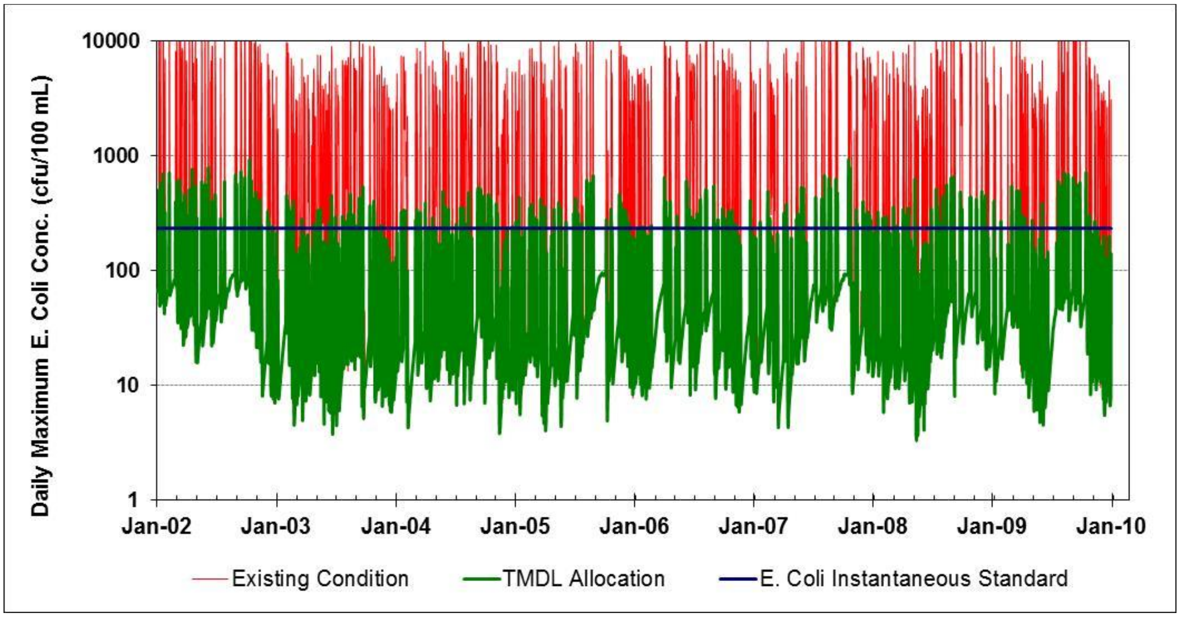


Figure 4-8: North Branch Chopawamsic Creek Instantaneous *E. coli* Concentrations under Allocation Scenario 13

4.9 Unnamed Tributary to Potomac River Allocation Plan and TMDL Summary

As shown in **Table 4-9**, Scenario 13 will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 ml and the maximum assessment water quality criterion of 235 cfu/100ml for Unnamed Tributary to Potomac River. The requirements for this scenario are:

- 100 percent reduction of the human sources (failing sewage disposal systems).
- 100 percent reduction of the direct instream loading from livestock.
- 61 percent reduction of bacteria loading from agricultural and urban non-point sources.
- 1 percent reduction of the indirect loading from wildlife.

Table 4-26 shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source.

Table 4-26: Unnamed Tributary to Potomac River Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest	3.80E+11	3.76E+11	1.0%
Cropland	9.01E+09	3.48E+09	61.4%
Pasture	2.61E+11	1.01E+11	61.4%
Urban/Non-MS4[1]	1.89E+12	7.31E+11	61.4%
Cattle-Direct Deposition	1.08E+09	0.00E+00	100.0%
Wildlife-Direct Deposition	7.06E+11	7.06E+11	0.0%
Failing Sewage Disposal Systems	7.45E+10	0.00E+00	100.0%
Permitted Point Sources	1.74E+09	1.74E+09	0.0%
Future Growth[2]	0.00E+00	2.31E+10	-
SSOs	0.00E+00	0.00E+00	0.0%
MS4s	9.51E+11	3.67E+11	61.4%
Total	**4.27E+12**	**2.31E+12**	**46.0%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

The TMDL for Unnamed Tributary to Potomac River is presented in **Table 4-27.**

Table 4-27: Unnamed Tributary to Potomac River TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Unnamed Tributary to Potomac River	**3.92E+11**	**1.92E+12**	**IMPLICIT**	**2.31E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

As mentioned in Section 4-3, the long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the approach outlined in the *USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*. In reference to the daily expression equation presented in Section 4.2, the coefficient of variation in Unnamed Tributary to Potomac River watershed is 3.54.

A summary of the daily TMDL allocation plan loads for the Unnamed Tributary to Potomac River is presented in **Table 4-28**.

Table 4-28: Unnamed Tributary to Potomac River TMDL (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Unnamed Tributary to Potomac River	**1.07E+09**	**2.03E+10**	**IMPLICIT**	**2.14E+10**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The resulting geometric mean and instantaneous *E. coli* concentrations under the TMDL allocation plan are presented in **Figures 4-9** and **Figure 4-10**. **Figure 4-9** shows the calendar month geometric mean *E. coli* concentrations after applying the allocations of Scenario 13, as well as geometric mean loading under existing conditions. **Figure 4-10** shows the instantaneous *E. coli* concentrations also under the allocations of Scenario 13 as well as the loading under existing conditions. For Unnamed Tributary to Potomac River, allocation Scenario 13 results in bacteria concentrations that are consistently below both the geometric mean and maximum assessment criterion for *E. coli*.

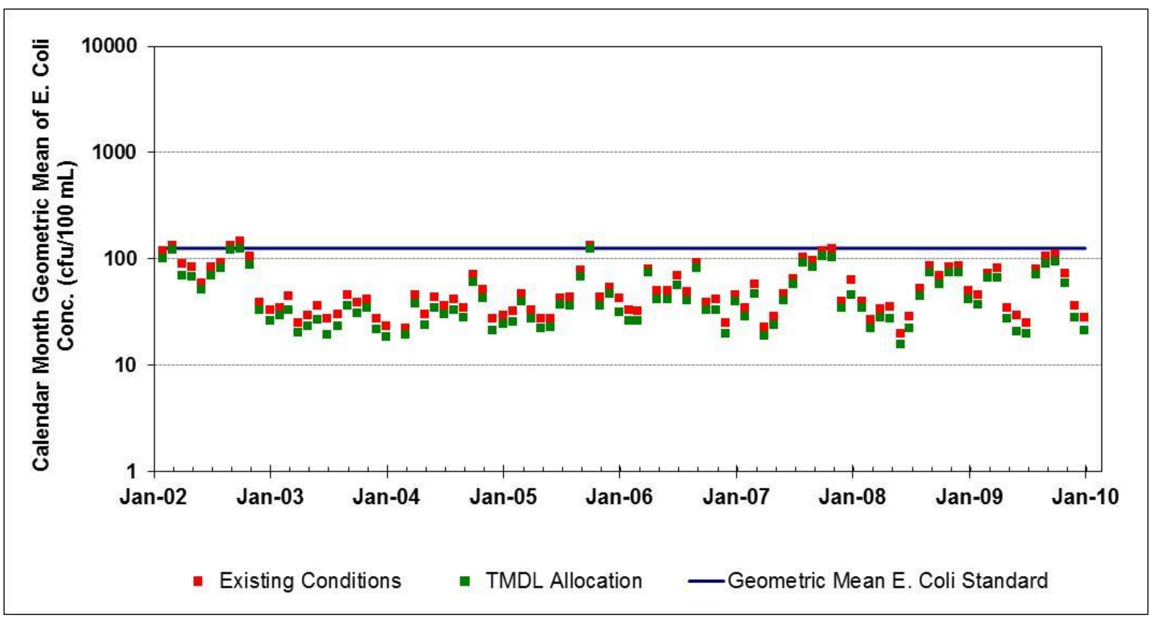


Figure 4-9: Unnamed Tributary to Potomac River Geometric Mean *E. coli* Concentrations under Existing Conditions and Allocation Scenario 13

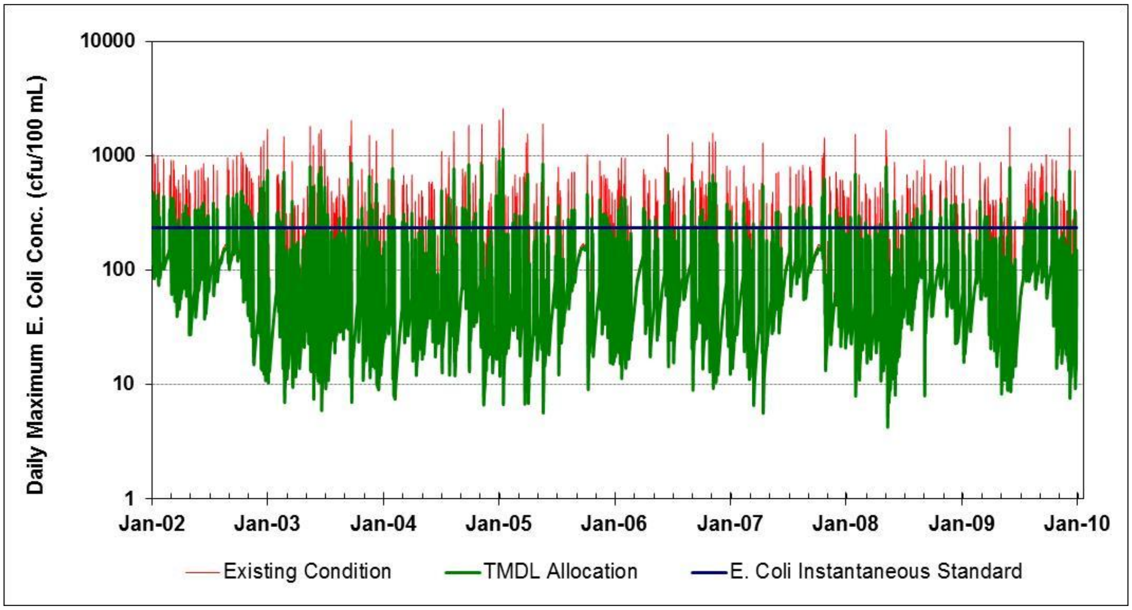


Figure 4-10: Unnamed Tributary to Potomac River Instantaneous *E. coli* Concentrations under Allocation Scenario 13

4.10 Austin Run Allocation Plan and TMDL Summary

As shown in **Table 4-10**, Scenario 12 will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 ml and the maximum assessment water quality criterion of 235 cfu/100ml for Austin Run. The requirements for this scenario are:

- 100 percent reduction of the human sources (failing sewage disposal systems).
- 100 percent reduction of the direct instream loading from livestock.
- 99.9 percent reduction of bacteria loading from agricultural and urban non-point sources.
- 1 percent reduction of the indirect loading from wildlife.

Table 4-29 shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source.

Table 4-29: Austin Run Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	2.12E+12	2.10E+12	1.0%
Cropland	9.41E+10	9.32E+07	99.9%
Pasture	4.20E+12	4.15E+09	99.9%
Urban/Non-MS4[1]	4.73E+13	4.68E+10	99.9%
Cattle-Direct Deposition	2.48E+10	0.00E+00	100.0%
Wildlife-Direct Deposition	1.54E+12	1.54E+12	0.0%
Failing Sewage Disposal Systems	1.04E+11	0.00E+00	100.0%
Permitted Point Sources	2.09E+13	3.13E+13	0.0%
Future Growth[2]	0.00E+00	1.04E+13	-
SSOs	1.82E+10	0.00E+00	100.0%
MS4s	1.21E+14	1.20E+11	99.9%
Total	**1.97E+14**	**3.51E+13**	**82.2%**

(1) *The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.*
(2) *Future Growth allocation for point sources is calculated at 6 MGD at the water quality geometric mean criterion for E. coli (126 cfu/100ml).*

The TMDL for Austin Run is presented in **Table 4-30.**

Table 4-30: Austin Run TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Austin Run	**3.14E+13**	**3.69E+12**	**IMPLICIT**	**3.51E+13**

[1]Wasteload allocation includes an additional load at 50% of the Aquia Creek WWTP to accommodate for future growth of point sources (VPDES and/or VSMP authorized discharges).

As mentioned in Section 4-3, the long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the approach outlined in the *USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*. In reference to the daily expression equation presented in Section 4.2, the coefficient of variation in Austin Run watershed is 0.36. A summary of the daily TMDL allocation plan loads for Austin Run is presented in **Table 4-31**.

Table 4-31: Austin Run TMDL (cfu/day) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Austin Run	8.61E+10	1.70E+10	IMPLICIT	1.03E+11

[1]Wasteload allocation includes an additional load at 50% of the Aquia Creek WWTP to accommodate for future growth of point sources (VPDES and/or VSMP authorized discharges).

The resulting geometric mean and instantaneous *E. coli* concentrations under the TMDL allocation plan are presented in **Figures 4-11** and **Figure 4-12**. **Figure 4-11** shows the calendar month geometric mean *E. coli* concentrations after applying the allocations of Scenario 12, as well as geometric mean loading under existing conditions. **Figure 4-12** shows the instantaneous *E. coli* concentrations also under the allocations of Scenario 12 as well as the loading under existing conditions. For Austin Run, allocation Scenario 12 results in bacteria concentrations that are consistently below both the geometric mean and maximum assessment criterion for *E. coli*.

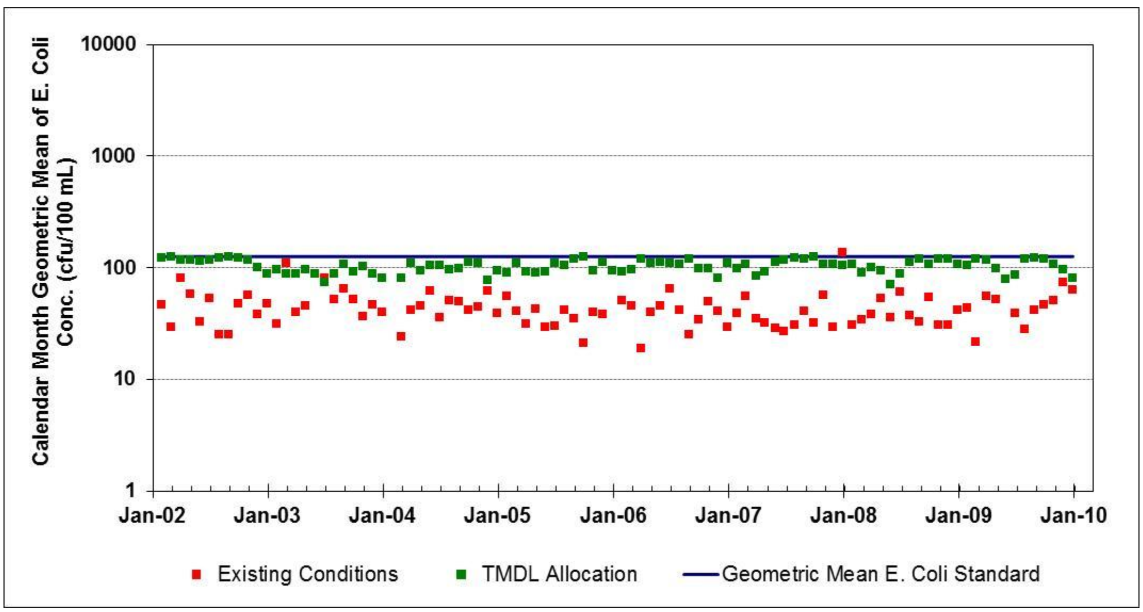


Figure 4-11: Austin Run Geometric Mean *E. coli* Concentrations under Existing Conditions and Allocation Scenario 12

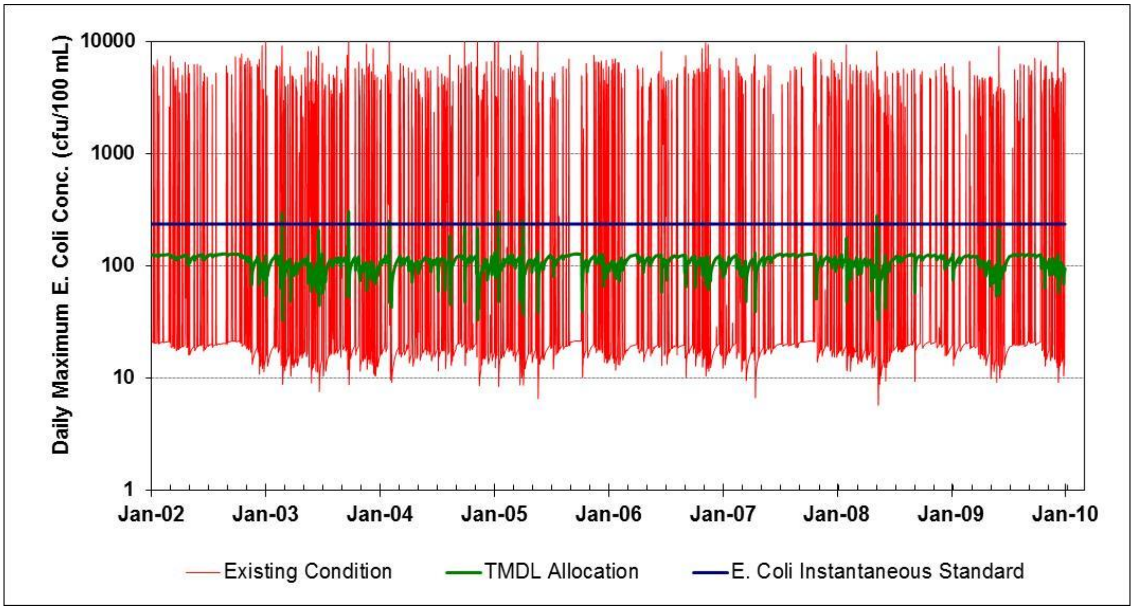


Figure 4-12: Austin Run Instantaneous *E. coli* Concentrations under Allocation Scenario 12

4.11 Accokeek Creek Allocation Plan and TMDL Summary

As shown in **Table 4-11**, Scenario 13 will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 ml and the maximum assessment water quality criterion of 235 cfu/100ml for Accokeek Creek. The requirements for this scenario are:

- 100 percent reduction of the human sources (failing sewage disposal systems).
- 100 percent reduction of the direct instream loading from livestock.
- 64 percent reduction of bacteria loading from agricultural and urban non-point sources.
- 1 percent reduction of the indirect loading from wildlife.

Table 4-32 shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source.

Table 4-32: Accokeek Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	2.59E+12	2.56E+12	1.0%
Cropland	1.52E+11	5.41E+10	64.4%
Pasture	2.10E+12	7.49E+11	64.4%
Urban/Non-MS4[1]	1.99E+13	7.09E+12	64.4%
Cattle-Direct Deposition	1.40E+12	0.00E+00	100.0%
Wildlife-Direct Deposition	2.08E+12	2.08E+12	0.0%
Failing Sewage Disposal Systems	1.33E+11	0.00E+00	100.0%
Permitted Point Sources	3.13E+09	3.13E+09	0.0%
Future Growth[2]	0.00E+00	1.57E+11	-
SSOs	4.41E+09	0.00E+00	100.0%
MS4s	8.46E+12	3.02E+12	64.4%
Total	**3.68E+13**	**1.57E+13**	**57.3%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.
(2) Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

The TMDL for Accokeek Creek is presented in **Table 4-33.**

Table 4-33: Accokeek Creek TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Accokeek Creek	**3.18E+12**	**1.25E+13**	**IMPLICIT**	**1.57E+13**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

As mentioned in Section 4-3, the long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the approach outlined in the *USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*. In reference to the daily expression equation presented in Section 4.2, the coefficient of variation in Unnamed Tributary to Potomac River watershed is 5.17.

A summary of the daily TMDL allocation plan loads for Accokeek Creek is presented in **Table 4-34**.

Table 4-34: Accokeek Creek TMDL (cfu/day) for *E. coli*				
Watershed	**WLA[1]**	**LA**	**MOS**	**TMDL**
Accokeek Creek	**8.70E+09**	**1.31E+11**	**IMPLICIT**	**1.39E+11**
[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.				

The resulting geometric mean and instantaneous *E. coli* concentrations under the TMDL allocation plan are presented in **Figures 4-13** and **Figure 4-14**. **Figure 4-13** shows the calendar month geometric mean *E. coli* concentrations after applying the allocations of Scenario 13, as well as geometric mean loading under existing conditions. **Figure 4-14** shows the instantaneous *E. coli* concentrations also under the allocations of Scenario 13 as well as the loading under existing conditions. For Accokeek Creek, allocation Scenario 13 results in bacteria concentrations that are consistently below both the geometric mean and maximum assessment criterion for *E. coli*.

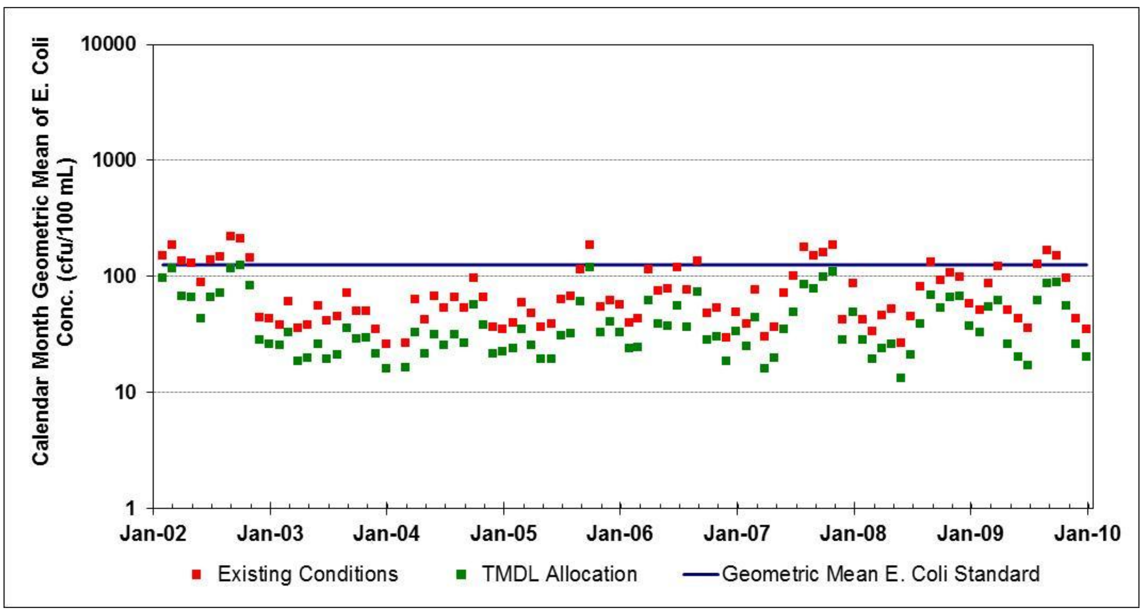


Figure 4-13: Accokeek Creek Geometric Mean *E. coli* Concentrations under Existing Conditions and Allocation Scenario 13

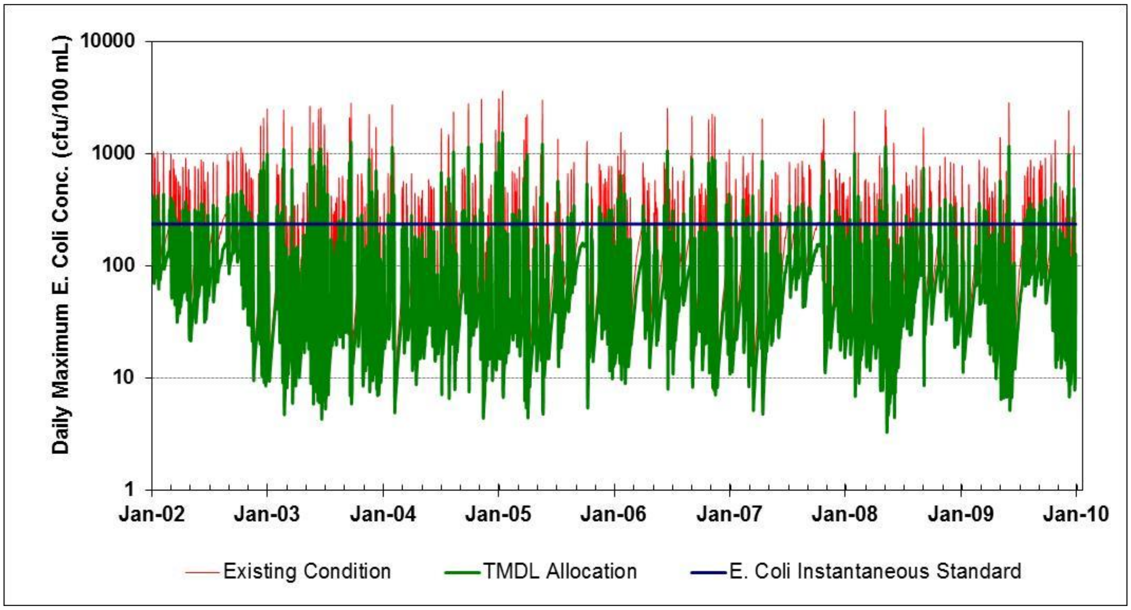


Figure 4-14: Accokeek Creek Instantaneous *E. coli* Concentrations under Allocation Scenario 13

4.12 Potomac Creek Allocation Plan and TMDL Summary

As shown in **Table 4-12**, Scenario 13 will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 ml and the maximum assessment water quality criterion of 235 cfu/100ml for Potomac Creek. The requirements for this scenario are:

- 100 percent reduction of the human sources (failing sewage disposal systems).
- 100 percent reduction of the direct instream loading from livestock.
- 1 percent reduction of the bacteria loading from agricultural and urban non-point sources.

Table 4-35 shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source.

Table 4-35: Potomac Creek Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Percent Reduction (%)
	Existing	Allocation	
Forest and Wetland	6.30E+12	6.30E+12	0.0%
Cropland	1.80E+11	1.78E+11	1.0%
Pasture	2.05E+12	2.03E+12	1.0%
Urban/Non-MS4[1]	1.10E+13	1.09E+13	1.0%
Cattle-Direct Deposition	5.37E+12	0.00E+00	100.0%
Wildlife-Direct Deposition	7.37E+11	7.37E+11	0.0%
Failing Sewage Disposal Systems	2.18E+11	0.00E+00	100.0%
Future Growth[2]	0.00E+00	2.09E+11	-
SSOs	6.36E+10	0.00E+00	100.0%
MS4s	5.31E+11	5.26E+11	1.0%
Total	**2.65E+13**	**2.09E+13**	**21.1%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers. The Future Growth allocation for point sources is calculated at 1 percent of the TMDL.

The TMDL for Potomac Creek is presented in **Table 4-36.**

Table 4-36: Potomac Creek TMDL (cfu/year) for *E. coli*

Watershed	WLA[1]	LA	MOS	TMDL
Potomac Creek	**7.35E+11**	**2.02E+13**	**IMPLICIT**	**2.09E+13**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

As mentioned in Section 4-3, the long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the approach outlined in the *USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*. In reference to the daily expression equation presented in Section 4.2, the coefficient of variation in Potomac Creek watershed is 2.68.

A summary of the daily TMDL allocation plan loads for Potomac Creek is presented in **Table 4-37**.

Table 4-37: Potomac Creek TMDL (cfu/day) for *E. coli*				
Watershed	**WLA[1]**	**LA**	**MOS**	**TMDL**
Potomac Creek	**2.01E+09**	**2.10E+11**	**IMPLICIT**	**2.12E+11**
[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.				

The resulting geometric mean and instantaneous *E. coli* concentrations under the TMDL allocation plan are presented in **Figures 4-15** and **Figure 4-16**. **Figure 4-15** shows the calendar month geometric mean *E. coli* concentrations after applying the allocations of Scenario 13, as well as geometric mean loading under existing conditions. **Figure 4-16** shows the instantaneous *E. coli* concentrations also under the allocations of Scenario 13 as well as the loading under existing conditions. For Potomac Creek, allocation Scenario 13 results in bacteria concentrations that are consistently below both the geometric mean and maximum assessment criterion for *E. coli*.

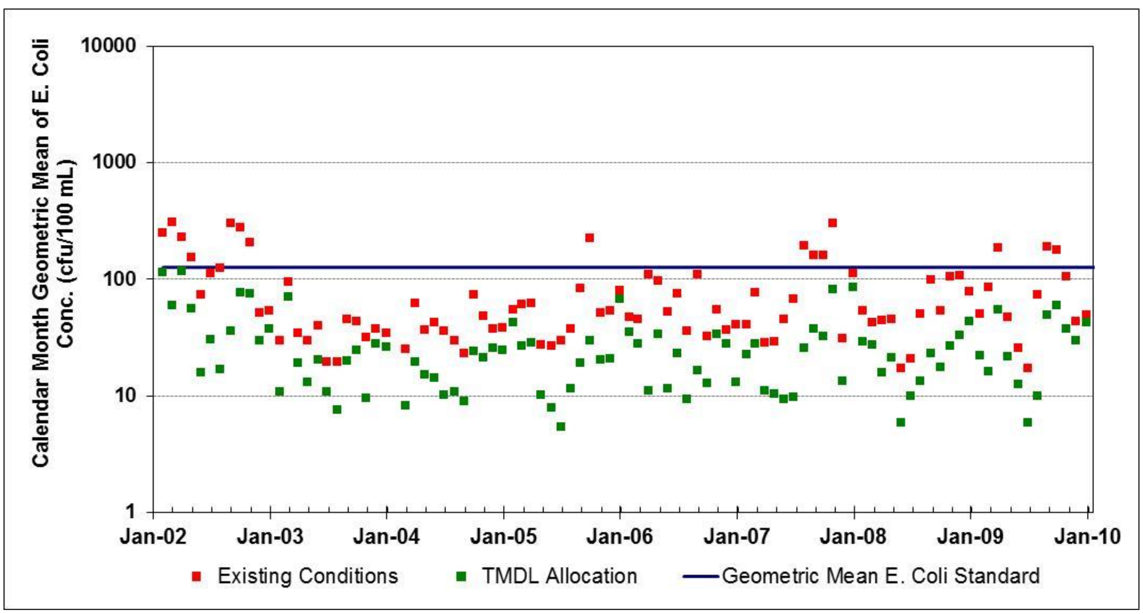


Figure 4-15: Potomac Creek Geometric Mean *E. coli* Concentrations under Existing Conditions and Allocation Scenario 13

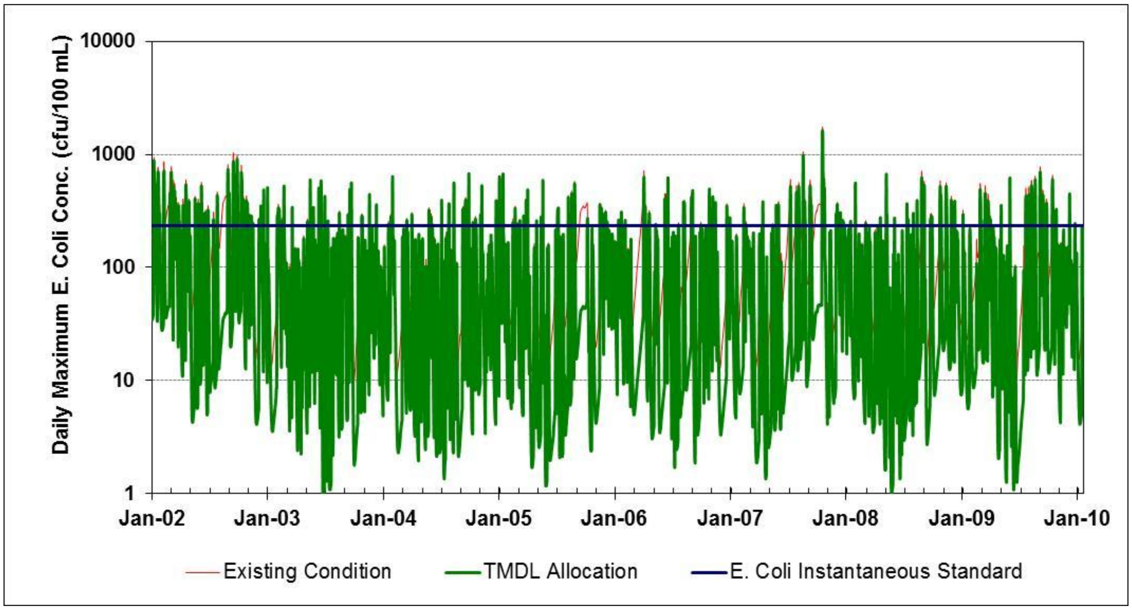


Figure 4-16: Potomac Creek Instantaneous *E. coli* Concentrations under Allocation Scenario 13

4.13 Potomac Run Allocation Plan and TMDL Summary

As shown in **Table 4-13**, Scenario 13 will meet the calendar-month *E. coli* geometric mean water quality criterion of 126 cfu/100 ml and the maximum assessment water quality criterion of 235 cfu/100ml for Potomac Run. The requirements for this scenario are:

- 100 percent reduction of the human sources (failing sewage disposal systems).
- 100 percent reduction of the direct instream loading from livestock.
- 97 percent reduction of bacteria loading from agricultural and urban non-point sources.
- 1 percent reduction of the indirect loading from wildlife.

Table 4-38 shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source.

Table 4-38: Potomac Run Distribution of Annual Average *E. coli* Load under Existing Conditions and TMDL Allocation			
Land Use/Source	**Average *E. coli* Loads (cfu/yr)**		**Percent Reduction (%)**
	Existing	**Allocation**	
Forest and Wetland	1.36E+12	1.35E+12	1.0%
Cropland	7.75E+11	2.30E+10	97.0%
Pasture	3.85E+13	1.14E+12	97.0%
Urban/Non-MS4[1]	7.20E+12	3.74E+11	94.8%
Cattle-Direct Deposition	2.19E+13	0.00E+00	100.0%
Wildlife-Direct Deposition	2.44E+12	2.44E+12	0.0%
Failing Sewage Disposal Systems	2.16E+11	0.00E+00	100.0%
Future Growth[2]	0.00E+00	5.51E+10	-
SSOs	0.00E+00	0.00E+00	0.0%
MS4s	9.50E+12	1.22E+11	98.7%
Total	**8.19E+13**	**5.51E+12**	**93.3%**

(1) The urban loads (non-MS4) include the load allocation (NPS loads) from high, medium, low intensity, open space developed, bare land and unconsolidated shore land use categories. It does not include bacteria load associated with MS4 areas.

(2) There are no individual VPDES municipal point source dischargers; the WLA includes 1 percent of the TMDL to account for Future Growth.

The TMDL for Potomac Run is presented in **Table 4-39.**

Table 4-39: Potomac Run TMDL (cfu/year) for *E. coli*				
Watershed	**WLA[1]**	**LA**	**MOS**	**TMDL**
Potomac Run	**1.77E+11**	**5.33E+12**	**IMPLICIT**	**5.51E+12**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

As mentioned in Section 4-3, the long-term average *E. coli* loads and coefficient of variations were determined to implement the final allocation scenarios and to express the TMDL on a daily basis. Assuming a log-normal distribution of data and a probability of occurrence of 95%, the maximum daily loads were determined using the approach outlined in the *USEPA OWOW 2007 Options for Expressing Daily Loads in TMDLs*. In reference to the daily expression equation presented in Section 4.2, the coefficient of variation in Potomac Run watershed is 2.30.

A summary of the daily TMDL allocation plan loads for Potomac Run is presented in **Table 4-40**.

Table 4-40: Potomac Run TMDL (cfu/day) for *E. coli*				
Watershed	**WLA[1]**	**LA**	**MOS**	**TMDL**
Potomac Run	**1.92E+09**	**5.41E+10**	**IMPLICIT**	**5.60E+10**

[1]The wasteload allocation includes allocated load for future growth of point sources (VPDES and/or VSMP authorized discharges) equivalent to 1% of the TMDL.

The resulting geometric mean and instantaneous *E. coli* concentrations under the TMDL allocation plan are presented in **Figures 4-17** and **Figure 4-18**. **Figure 4-17** shows the calendar month geometric mean *E. coli* concentrations after applying the allocations of Scenario 13, as well as geometric mean loading under existing conditions. **Figure 4-18** shows the instantaneous *E. coli* concentrations also under the allocations of Scenario 13 as well as the loading under existing conditions. For Potomac Run, allocation Scenario 13 results in bacteria concentrations that are consistently below both the geometric mean and maximum assessment criterion for *E. coli*.

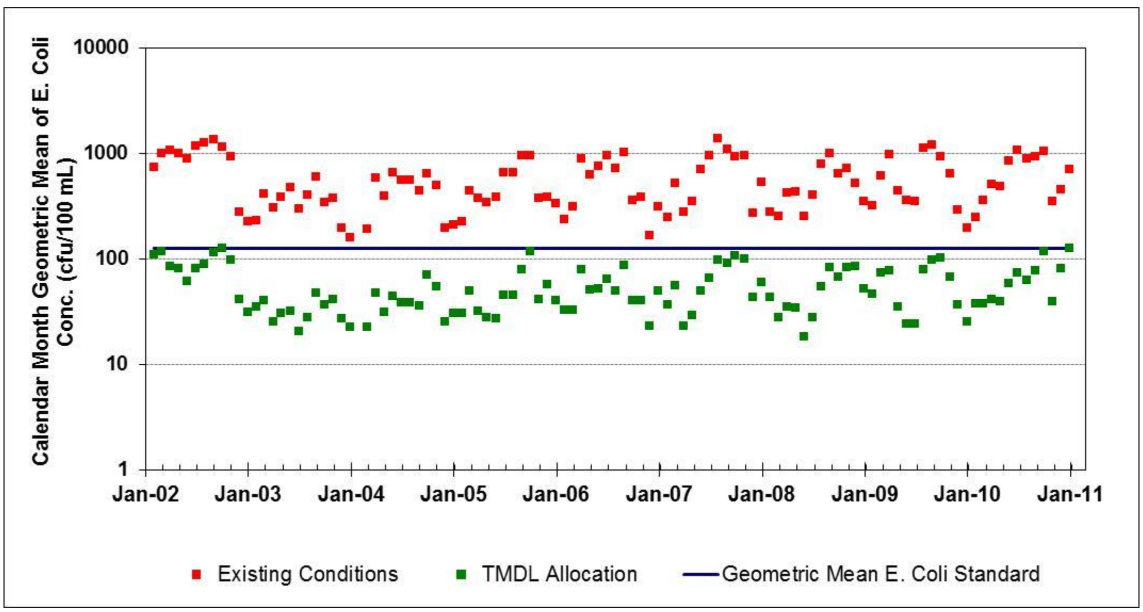


Figure 4-17: Potomac Run Geometric Mean *E. coli* Concentrations under Existing Conditions and Allocation Scenario 13

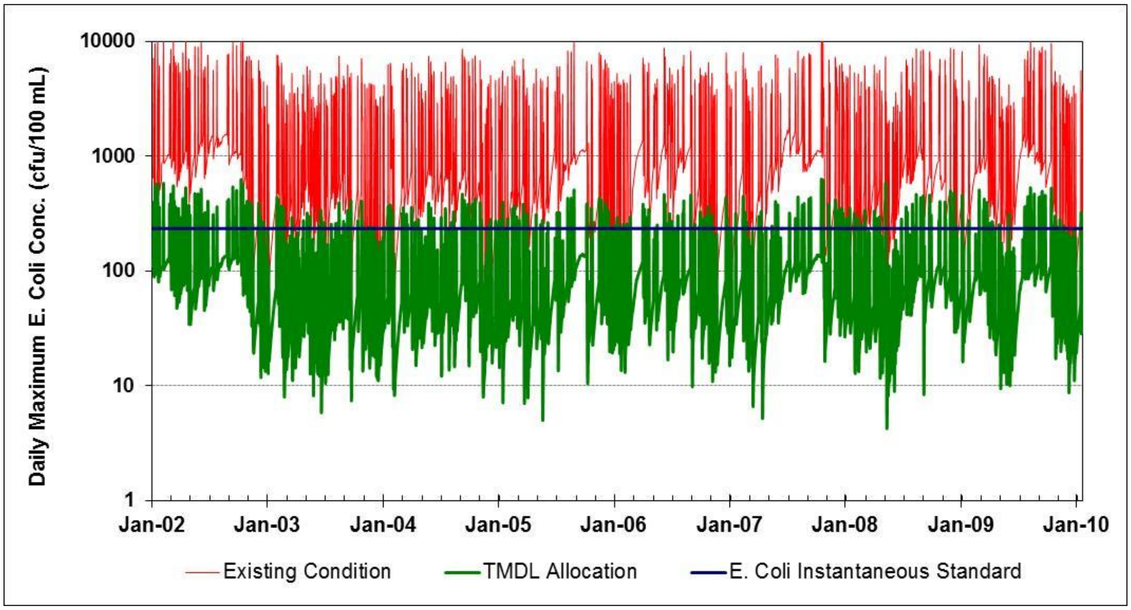


Figure 4-18: Potomac Run Instantaneous *E. coli* Concentrations under Allocation Scenario 13

5.0 TMDL Implementation and Reasonable Assurance

Once a TMDL has been approved by EPA, measures must be taken to reduce pollution levels from both point and non-point sources. The TMDL process involves three important steps: (1) TMDL Development, (2) Implementation Plan (IP) Development, which is geared towards addressing nonpoint sources of the pollutant, and (3) implementation of the measures outlined in the TMDL, and the monitoring of stream water quality to assess progress and determine if water quality standards are attained. The following sections outline the framework used in Virginia to provide reasonable assurance that the required pollutant reductions can be achieved.

5.1 Continuing Planning Process and Water Quality Management Planning

As part of the Continuing Planning Process, DEQ staff will present both EPA-approved TMDLs and TMDL implementation plans to the State Water Control Board (SWCB) for inclusion in the appropriate Water Quality Management Plan (WQMP), in accordance with the Clean Water Act's Section 303(e) and Virginia's Public Participation Guidelines for Water Quality Management Planning.

DEQ staff will also request that the SWCB adopt TMDL WLAs as part of the Water Quality Management Planning Regulation (9VAC 25-720), except in those cases when permit limitations are equivalent to numeric criteria contained in the Virginia Water Quality Standards, such as in the case for bacteria. This regulatory action is in accordance with §2.2-4006A.4.c and §2.2-4006B of the Code of Virginia. SWCB actions relating to water quality management planning are described in the public participation guidelines referenced above and can be found on DEQ's web site under http://www.deq.state.va.us/tmdl/pdf/ppp.pdf

5.2 Stage Implementation

In general, Virginia intends for the required control actions, including Best Management Practices (BMPs), to be implemented in an iterative process that first addresses those sources with the largest impact on water quality. The iterative implementation of pollution control actions in the watershed has several benefits:

1. It enables tracking of water quality improvements following BMP implementation through follow-up stream monitoring;
2. It provides a measure of quality control, given the uncertainties inherent in computer simulation modeling;
3. It provides a mechanism for developing public support through periodic updates on BMP implementation and water quality improvements;
4. It helps ensure that the most cost effective practices are implemented first; and
5. It allows for the evaluation of the adequacy of the TMDL in achieving water quality standards.

5.3 Implementation of Waste Load Allocations

Federal regulations require that all new or revised National Pollutant Discharge Elimination System (NPDES) permits must be consistent with the assumptions and requirements of any applicable TMDL WLA (40 CFR §122.44 (d)(1)(vii)(B)).

For the implementation of the WLA component of the TMDL, the Commonwealth utilizes the Virginia NPDES program (VPDES) and the Virginia Stormwater Management Program (VSMP). Requirements of the permit process should not be duplicated in the TMDL process; depending on the type and nature of a point source discharge, it may be addressed through the development of TMDL implementation plans, or it may be addressed solely through the discharge permit. However, it is recognized that implementation plan development may help to coordinate efforts of permitted sources through the collaborative process involved in development of the plan. The WLA requirements of the TMDL will be implemented through the referenced permit programs whether or not a TMDL implementation plan is developed.

5.3.1 Municipal (non-stormwater) Permits

This TMDL does not require reductions from municipal treatment plants with individual permits (there are three in the watersheds addressed by this TMDL: Aquia Wastewater Treatment Plant, Permit Number VA0060968; Abrahms Ct STP (planned), Permit Number VA0092479; and Randall STP, VA0089630) or general permits that discharge the contaminant of concern (only two in this TMDL, located in the Accokeek Creek and Unnamed Tributary to Potomac River watersheds). These facilities are required to meet the bacteria criterion of the Virginia WQS at the point of discharge as stipulated in their VPDES permit.

5.3.2 Stormwater Permits

There are separate state permitting programs that regulate the management of pollutants carried by stormwater runoff. Stormwater discharges associated with industrial activities are governed through the VPDES program, while stormwater discharges from construction sites and from municipal separate storm sewer systems (MS4s) are governed through the VSMP program. As with non-stormwater permits, all new or revised stormwater permits must be consistent with the assumptions and requirements of any applicable TMDL WLA. If a WLA is based on conditions specified in existing permits, and the permit conditions are being met, no additional actions may be needed. If a WLA is based on reduced pollutant loads, additional pollutant control actions will need to be implemented.

For MS4s/VSMP individual and general permits, the Commonwealth expects the permittee to specifically address the TMDL wasteload allocations (WLA) for stormwater through the iterative implementation of BMPs that may include both structural and nonstructural controls. Plans to comply with applicable WLAs are implemented through the MS4 permit. Additionally, permittees will be encouraged to participate in the development of TMDL implementation plans (IP) as recommendations from the IP process need to be incorporated into the MS4 stormwater management program in order to be consistent with the TMDL.

It should be noted that the implementation of the WLAs for MS4 permits will focus on achieving the percent reductions required by the TMDL, rather than the individual numeric WLAs. The MS4 WLAs are aggregated by geographic boundary. It is not intended that individual numeric WLAs will be applied towards each permit. Rather, the MS4 permittees are expected to implement programmatic controls aimed at achieving the pollutant reductions identified in this TMDL. Additionally, it is anticipated that the implementation of MS4 WLAs will focus on reducing anthropogenic sources of the pollutant of concern.

Additional information on Virginia's Stormwater program and a downloadable menu of Best Management Practices and Measurable Goals Guidance can be found at http://www.dcr.virginia.gov/sw/vsmp.htm.

5.3.3 TMDL Modifications for New or Expanding Dischargers

Permits issued for facilities with wasteload allocations developed as part of a TMDL must be consistent with the assumptions and requirements of these WLAs. In cases where a proposed permit modification is affected by a TMDL WLA, permit and TMDL staff must coordinate to ensure that new or expanding discharges meet this requirement. In 2005, DEQ issued guidance memorandum 05-2011 describing the available options and the process that should be followed under those circumstances, including public participation, EPA approval, State Water Control Board actions, and coordination between permit and TMDL staff. The guidance memorandum is available on DEQ's web site at http://www.deq.virginia.gov/waterguidance/

5.4 Implementation of Load Allocations

The TMDL program does not impart new implementation authorities. Therefore, the Commonwealth intends to use existing programs to the fullest extent in order to attain its water quality goals. The measures for non point source reductions, which can include the use of better treatment technology and the installation of BMPs, are implemented in an iterative process that is described along with specific BMPs in the TMDL implementation plan.

5.4.1 Implementation Plan Development

A TMDL implementation plan will be developed that addresses, at a minimum, the requirements specified in the Code of Virginia, Section 62.1-44.19.7. State law directs the State Water Control Board to "develop and implement a plan to achieve fully supporting status for impaired waters". The implementation plan "shall include the date of expected achievement of water quality objectives, measurable goals, corrective actions necessary and the associated costs, benefits and environmental impacts of addressing the impairments." EPA outlines the minimum elements of an approvable implementation plan in its 1999 "Guidance for Water Quality-Based Decisions: The TMDL Process." The listed elements include implementation actions/management measures, timelines, legal or regulatory controls, time required to attain water quality standards, monitoring plans and milestones for attaining water quality standards.

In order to qualify for other funding sources, such as EPA's Section 319 grants, additional plan requirements may need to be met. The detailed process for developing an implementation plan has been described in the "TMDL Implementation Plan Guidance Manual", published in July 2003 and available upon request from the DEQ and DCR TMDL project staff or at http://www.deq.virginia.gov/tmdl/implans/ipguide.pdf

Watershed stakeholders will have opportunities to provide input and to participate in the development of the TMDL implementation plan. Regional and local offices of DEQ, DCR, and other cooperating agencies are technical resources to assist in this endeavor.

With successful completion of implementation plans, local stakeholders will have a blueprint to restore impaired waters and enhance the value of their land and water resources. Additionally, development of an approved implementation plan may enhance opportunities for obtaining financial and technical assistance during implementation.

5.4.2 Staged Implementation Scenarios

The purpose of the staged implementation scenarios is to identify one or more combinations of implementation actions that result in the reduction of controllable sources to the maximum extent practicable using cost-effective, reasonable BMPs for nonpoint source control. Some examples of effective bacterial BMPs for both urban and rural watersheds are the stream side fencing for cattle farms (rural areas), pet waste clean-up programs (urban and rural areas) and government grant programs available to homeowners with failing septic systems and installation of treatment systems for homeowners currently using straight pipes (predominantly rural areas). An aggressive pet waste management campaign within the Prince William Forest Park may be one such BMP activity that can be pursued during implementation.

VADEQ expects that implementation of the bacteria TMDLs will occur in stages, and that full implementation of the TMDLs is a long-term goal. Implementation efforts will focus on controlling anthropogenic sources. Actions identified during TMDL implementation plan development that go beyond what can be considered cost-effective and reasonable will only be included as implementation actions if there are reasonable grounds for assuming that these actions will in fact be implemented.

If water quality standards are not met upon implementation of all cost-effective and reasonable BMPs, a Use Attainability Analysis (UAA) may need to be initiated since Virginia's water quality standards allow for changes to use designations if existing water quality standards cannot be attained by implementing effluent limits required under §301b and §306 of Clean Water Act, and cost effective and reasonable BMPs for nonpoint source control. Additional information on UAAs is presented in Section 5.6, Addressing Wildlife Contributions and the Attainability of Designated Uses.

5.4.3 Link to Ongoing Restoration Efforts

Implementation of this TMDL will contribute to on-going water quality improvement efforts aimed at restoring water quality in the Powells Creek, Quantico Creek/South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac

River, Austin Run, Accokeek Creek and Potomac Creek/Potomac Run watershed. Currently, there are various organizations dedicated to protection and restoration of the watersheds, including the Prince William Conservation Alliance, Friends of Stafford Creeks, and Friends of Quantico Bay. Organizations such as these have proved to be invaluable in the effort to restore water quality in impaired watersheds.

5.4.4 Implementation Funding Sources

The implementation of pollutant reductions from non-regulated nonpoint sources relies heavily on incentive-based programs, while the funding sources for regulated discharges can be varied depending on the type of discharge. Therefore, the identification of funding sources for non-regulated implementation activities is a key to success. Cooperating agencies, organizations and stakeholders must identify potential funding sources available for implementation during the development of the implementation plan in accordance with the "Virginia Guidance Manual for Total Maximum Daily Load Implementation Plans". The TMDL Implementation Plan Guidance Manual contains information on a variety of funding sources and government agencies that might support implementation efforts, as well as suggestions for integrating TMDL implementation with other watershed planning efforts.

Some of the major potential sources of funding for non-regulated implementation actions may include EPA Section 319 funds, Virginia State Revolving Loan Program (also available for permitted activities), Virginia Agricultural Best Management Practices Cost-Share Programs, Virginia Water Quality Improvement Fund (available for both point and nonpoint source pollution), tax credits and landowner contributions. With additional appropriations for the Water Quality Improvement Fund during recent legislative sessions, the Fund has become a significant funding stream for WWTPs. Additionally, funding is being made available to address urban and residential water quality problems. Information on WQIF projects and allocations can be found at http://www.deq.virginia.gov/bay/wqif.html

and at http://www.dcr.virginia.gov/sw/wqia.htm.

5.5 Follow-Up Monitoring

Following the development of the TMDL, DEQ will make every effort to continue to monitor the impaired stream in accordance with its ambient monitoring program. DEQ's Ambient Watershed Monitoring Plan for conventional pollutants calls for watershed monitoring to take place on a monthly basis for one year, with flexibility for watershed rotation yearly. In accordance with DEQ Guidance Memo No. 03-2004, during periods of reduced resources, monitoring can temporarily discontinue until the TMDL staff determines that implementation measures to address the source(s) of impairments are being installed. Monitoring can resume at the start of the following fiscal year, next scheduled monitoring station rotation, or where deemed necessary by the regional office or TMDL staff, as a new special study. The purpose, location, parameters, frequency, and duration of the monitoring will be determined by DEQ staff, in cooperation with the Implementation Plan Steering Committee and local stakeholders. Whenever possible, the location of the follow-up monitoring station(s) will be the same as the listing station. At a minimum, the monitoring station must be representative of the original impaired segment. The details of the follow-up monitoring will be outlined in the Annual Water Monitoring Plan prepared by each DEQ Regional Office. Other agency personnel, watershed stakeholders, etc. may provide input on the Annual Water Monitoring Plan. These recommendations must be made to the DEQ regional TMDL coordinator by September 30 of each year. **Table 5-1** provides a summary of the water quality monitoring stations in the Tributaries to the Potomac River: Prince William and Stafford County bacteria impaired watersheds.

Table 5- 1: VA DEQ Water Quality Stations

Station ID	Stream
1APOW003.11	Powells Creek
1APOW006.11	Powells Creek
1APOW009.99	Powells Creek
1AQUA004.46	Quantico Creek
1ASOQ003.17	South Fork Quantico Creek
1ASOQ006.73	South Fork Quantico Creek
1AMIP000.40	Middle Branch Chopawamsic Creek
1ANOR009.87	North Branch Chopawamsic Creek

Table 5- 1: VA DEQ Water Quality Stations	
Station ID	**Stream**
1AXLF000.13	Unnamed Tributary to Potomac River
1AAUA001.39	Aquia Creek
1AAUA003.71	Aquia Creek
1AAUS000.49	Austin Run
1AAUA007.92	Aquia Creek
1AAUA012.15	Aquia Creek/Smith Lake
1AAUA012.55	Aquia Creek/Smith Lake
1AAUA014.51	Aquia Creek
1AAUA017.60	Aquia Creek
1AAUA019.99	Aquia Creek
1AAUA023.09	Aquia Creek
1ABED000.19	Beaverdam Run/Smith Lake
1ABED002.97	Beaverdam Run
1AACC006.13	Accokeek Creek
1APOM006.72	Potomac Creek
1APOM012.24	Potomac Creek
1APOM013.02	Potomac Creek
1APOM013.41	Potomac Creek
1ALOH002.20	Able Lake
1ALOH007.93	Long Branch
1AXLB001.49	Unnamed Tributary to Long Branch
1APOR000.40	Potomac Run

DEQ staff, in cooperation with the Implementation Plan Steering Committee and local stakeholders, will continue to use data from the ambient monitoring stations to evaluate reductions in pollutants (“water quality milestones” as established in the implementation plan), the effectiveness of the TMDL in attaining and maintaining water quality standards, and the success of implementation efforts. Recommendations may then be made, when necessary, to target implementation efforts in specific areas and continue or discontinue monitoring at follow-up stations.

In some cases, watersheds will require monitoring above and beyond what is included in DEQ’s standard monitoring plan. Ancillary monitoring by citizens’ or watershed groups, local government, or universities is an option that may be used in such cases. An effort should be made to ensure that ancillary monitoring follows established QA/QC guidelines in order to maximize compatibility with DEQ monitoring data. In instances where citizens' monitoring data is not available and additional monitoring is needed to assess the effectiveness of targeting efforts, TMDL staff may request of the monitoring managers in each regional office an increase in the number of stations or monitor existing stations at a higher frequency in the watershed. The additional monitoring beyond the original bimonthly single station monitoring will be contingent on staff resources and available laboratory budget. More information on citizen monitoring in Virginia and QA/QC guidelines is available at http://www.deq.virginia.gov/cmonitor/.

To demonstrate that the watershed is meeting water quality standards in watersheds where corrective actions have taken place (whether or not a TMDL or implementation plan has been completed), DEQ must meet the minimum data requirements from the original listing station or a station representative of the originally listed segment. The minimum data requirement for conventional pollutants (bacteria, dissolved oxygen, etc) is bimonthly monitoring for two consecutive years. For biological monitoring, the minimum requirement is two consecutive samples (one in the spring and one in the fall) in a one year period.

5.6 Assessing Wildlife Contributions and the Attainability of Designated Uses

In some streams for which TMDLs have been developed, water quality modeling indicates that even after removal of all bacteria sources (other than wildlife), the stream will not attain standards under all flow regimes at all times. Virginia and USEPA are not proposing the elimination of natural wildlife to allow for the attainment of water quality standards. It is also recognized that wildlife may significantly contribute to the total bacteria load on specific land uses (urban, MS4, cropland, etc), and that this may impact the ability of the land use/source to meet the allocated load. The elimination of wildlife is not proposed as a means to meet a wasteload allocation. Managing overpopulations of wildlife, however, remains an option available to local stakeholders. During the implementation plan development phase of a TMDL process, and in consultation with a local government or land owner(s), should the Department of Game and Inland Fisheries

(VDGIF) determine that a population of resident geese, deer or other wildlife is at "nuisance" levels, measures to reduce such populations may be deemed acceptable if undertaken under the supervision, or issued permit, of the VDGIF or the U.S. Fish and Wildlife Service as appropriate. Additional information on VDGIF's wildlife programs can be found at http://www.dgif.virginia.gov/hunting/va_game_wildlife/.

If water quality standards are not being met, a use attainability analysis (UAA) may be initiated to reflect the presence of naturally high bacteria levels due to uncontrollable sources. In some cases, the effort may never have to go to the UAA phase because the water quality standard exceedances attributed to wildlife in the model may have been very small and infrequent and within the margin of error.

In some streams for which TMDLs have been developed, factors may prevent the stream from attaining its designated use. In order for a stream to be assigned a new designated use, or a subcategory of a use, the current designated use must be removed. To remove a designated use, the state must demonstrate that the use is not an existing use, and that downstream uses are protected. Such uses will be attained by implementing effluent limits required under §301b and §306 of Clean Water Act and by implementing cost-effective and reasonable best management practices for nonpoint source control (9 VAC 25-260-10 paragraph I).

The state must also demonstrate that attaining the designated use is not feasible because of one or more of the following reasons:

1. Naturally occurring pollutant concentration prevents the attainment of the use.

2. Natural, ephemeral, intermittent or low flow conditions prevent the attainment of the use unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation.

3. Human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place.

4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate the modification in such a way that would result in the attainment of the use.

5. Physical conditions related to natural features of the water body, such as the lack of proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life use protection.

6. Controls more stringent than those required by §301b and §306 of the Clean Water Act would result in substantial and widespread economic and social impact.

This and other information is collected through a special study called a UAA. All site-specific criteria or designated use changes must be adopted by the SWCB as amendments to the water quality standards regulations. During the regulatory process, watershed stakeholders and other interested citizens, as well as the EPA, will be able to provide comment during this process. Additional information can be obtained at

http://www.deq.virginia.gov/wqs/pdf/WQS05A_1.pdf

The process to address potentially unattainable reductions based on the above is as follows:

As a first step, measures targeted at the controllable, anthropogenic sources identified in the TMDL's staged implementation scenarios will be implemented. In addition, measures should be taken to ensure that discharge permits are fully implementing provisions required in the TMDL. The expectation would be for the reductions of all controllable sources to the maximum extent practicable using the implementation approaches described above. DEQ will continue to monitor water quality in the streams during and subsequent to the implementation of these measures to determine if water quality standards are being attained. This effort will also help to evaluate if the modeling assumptions used in the TMDL were correct. In the best-case scenario, water quality goals will be met and the stream's uses fully restored using effluent controls and BMPs. If, however, water quality standards are not being met, and no additional effluent controls and BMPs can be identified, a UAA would then be initiated with the goal of re-designating the stream for a more appropriate use or subcategory of a use.

A 2006 amendment to the Code of Virginia under 62.1-44.19:7E. provides an opportunity for aggrieved parties in the TMDL process to present to the State Water Control Board reasonable grounds indicating that the attainment of the designated use for a water is not feasible. The Board may then allow the aggrieved party to conduct a use attainability analysis according to the criteria listed above and a schedule established by the Board. The amendment further states that "If applicable, the schedule shall also address whether TMDL development or implementation for the water shall be delayed."

6.0 Public Participation

The development of the Tributaries to the Potomac River: Prince William and Stafford County TMDLs would not have been possible without public participation. Three technical advisory committee (TAC) meetings and two public meetings were held for this project. The following is a summary of the meetings.

TAC Meeting No. 1: The first TAC meeting was held on March 1, 2011 at the DEQ Northern Regional Office in Woodbridge, Virginia. The purpose of this meeting was to provide information on the steps required in the TMDL process and to explain the types of data used in the development of bacteria TMDLs.

TAC Meeting No. 2: The second TAC meeting was held on September 19, 2011 at the Stafford County Administrative Building Center in Stafford, Virginia. The purpose of this meeting was to discuss the preliminary source assessment for the Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek and Potomac Run watersheds.

TAC Meeting No. 3: The third TAC meeting was held on January 4, 2012 at the Porter Library in Stafford, Virginia The purpose of this meeting was to provide information on the model calibration and validation results, as well as the preliminary TMDL bacteria allocation scenarios for Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek and Potomac Run.

Public Meeting No. 1: A set of meetings were held for the first public meeting. One meeting was held on April 19, 2011 at the Stafford Administration Building Center, Stafford, Virginia. Seven people attended this meeting. The second meeting was held on April 20, 2011 at the Ferlazzo Auditorium in Woodbridge, Virginia. Five people attended this meeting. The purpose of these meetings were to introduce the TMDL process to the public and explain the steps required in developing bacteria TMDLs for Powells Creek, Quantico Creek, North Branch Chopawamsic Creek, South Fork Quantico Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek and Potomac Run. Information regarding the potential bacteria sources in the watershed was also presented. Copies of the presentations were available for the public both at the meeting and on the DEQ website. This meeting was advertised in the *Virginia Register*.

Public Meeting No. 2: The second public meeting was held on February 1, 2012 at Ferlazzo Auditorium in Woodbridge, Virginia. The purpose of this meeting was to present the final TMDL results for Powells Creek, Quantico Creek, South Fork Quantico Creek, North Branch Chopawamsic Creek, Unnamed Tributary to Potomac River, Austin Run, Accokeek Creek, Potomac Creek and Potomac Run. Eleven people attended the meeting. Copies of the presentation and the draft report were available for the public both at the meeting and through the DEQ website. This meeting and the draft report were publically noticed in the *Virginia Registrar*. Five sets of written comments were received during the 30-day comment period, which extended from February 1, 2012 to March 2, 2012. DEQ provided written responses to these comments.

In response to DEQ staff evaluation of the 2012 draft report and in consideration of the comments received, the TMDL project was revisited. The water quality model was updated and updated TMDL results were provided. The revised draft TMDL report was publically noticed in the *Virginia Registrar* and was available for a 30 day public comment period, from July 1, 2013 to July 31, 2013. One set of comments was received on the revised draft report and DEQ provided written responses to the comments.

References

American Society of Agricultural Engineers, (ASAE) 1998. ASAE standards, 45th edition.

American Veterinary Medical Association Website (2007). Available at < https://www.avma.org/KB/Resources/Statistics/Pages/Market-research-statistics-US-pet-ownership.aspx#formulas >

Hagedorn, Charles, Virginia Tech. Identifying Sources of Fecal Pollution in Impaired Waters in Prince William County, Virginia: Comprehensive Seven Year Report prepared for the Prince William County Department of Public Works. 2011.

Horsley and Witten. 1996. Identification and evaluation of nutrient and bacterial loadings to Maquoit Bay, New Brunswick and Freeport, Maine.

Long Island Regional Planning Board (LIRPB). 1978. Long Island Comprehensive Waste Treatment Management Plan, Volumes I and II. Hauppauge, NY.

Lumb and Kittle, 1993. Users Manual for an Expert System (HSPEXP) for Calibration of the Hydrological Simulation Program-Fortran. U.S. Geological Survey, Virginia.

Metcalf and Eddy. 1991. Wastewater Engineering: Treatment, Disposal, Reuse. 3rd Ed. McGraw-Hill, Inc, New York.

National Climatic Data Center. 2011. First Order Summary of the Day and Hourly Precipitation Data. http://www.ncdc.noaa.gov/

NOAA (2006). *Coastal NLCD Classification Scheme.* National Oceanic and Atmospheric Administration. Available at: http://www.csc.noaa.gov/crs/lca/tech_cls.html

Prince William Soil and Water Conservation District. 2011. Personal Correspondence for Livestock Inventory Revisions.

Stafford County. 2011. Personal Correspondence for Livestock Inventory Revisions and Septic Information.

Swann, C. 1999. *A Survey of Residential Nutrient Behaviors in the Chesapeake Bay*. Widener Burrows, Inc. Chesapeake Research Consortium. Center for Watershed Protection. Ellicott City, MD

Tri-County/City Soil and Water Conservation District. 2011. Personal Correspondence for Livestock Inventory Revisions.

U.S. Census Bureau. 1990. 1990 U.S. Census Data for Virginia. Available at <http://www.census.gov/>

U.S. Census Bureau. 2000. 2000 State and County Quick Facts, Virginia. Available at <http://quickfacts.census.gov/qfd/states/51/51121.html>

U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS). 2010a. Soil Survey Geographic (SSURGO) Database for Virginia. Available at http://soildatamart.nrcs.usda.gov

U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS). 2010b. Geospatial Data Gateway. Available at: http://datagateway.nrcs.usda.gov/

U.S. Department of Agriculture. 2007 Agricultural Census. Available at <http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp>

U.S. Environmental Protection Agency (EPA). 1985. Rates, Constants, and Kinetics formulations in Surface Water Quality Modeling. Athens, GA.

U.S. Environmental Protection Agency (EPA). 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. Available at <http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/decisions_index.cfm>

U.S. Environmental Protection Agency (EPA). 2001a. Better Assessment Science Integrating Point and Nonpoint Sources (BASINS), Version 3 Washington, DC.

U.S. Environmental Protection Agency (EPA). 2001b. EPA 841-R-00-002. Protocols for developing Pathogen TMDLs. Available at <http://www.epa.gov/owow/tmdl/pathogen_all.pdf >

U.S. Environmental Protection Agency (EPA). 2005. “Overview or Current Total Maximum Daily Load (TMDL) Program and Regulations.” Available at <http://www.epa.gov/owow/tmdl/overviewfs.html > Website visited August, 2005.

U.S. Environmental Protection Agency (EPA). 2007. Options for Expressing Daily Loads in TMDLs. Available at <http://www.epa.gov/owow/tmdl/draft_daily_loads_tech.pdf>

U.S. Geological Survey. 2008. National Hydrography Dataset. Available at : http://nhd.usgs.gov/

U.S. Geological Survey. 2011. National Water Information System. Available at : http://waterdata.usgs.gov/nwis/inventory?search_criteria=search_site_no&submitted_form=introduction

Virginia. *State Water Control Board.* 2006. 9 VAC 25-260. Virginia Water Quality Standards. Available at <http://www.deq.virginia.gov/wqs.html >

Virginia Department of Conservation and Recreation. 2011a. Personal Correspondence for Livestock Inventory Revisions.

Virginia Department of Conservation and Recreation. 2011b. MS4 Permit Boundaries.

Virginia Department of Environmental Quality (DEQ). 2008. *Bacteria TMDL for the Difficult Run Watershed*. Available at <http://www.deq.state.va.us/export/sites/default/tmdl/apptmdls/potrvr/difficultec.pdf>

Virginia Department of Environmental Quality (DEQ). 2003. *Guidance Manual for Total Maximum Daily Load Implementation Plans.* Available at <http://www.deq.state.va.us/tmdl/implans/ipguide.pdf >

Virginia Department of Environmental Quality (DEQ). 2003. *Guidance Memo No. 03-2012 HSPF model Calibration and Verification for Bacteria TMDLs*.

Virginia Department of Environmental Quality (DEQ). 2004b. "Total Maximum Daily Loads, Background-Legal and Regulatory Framework." Available at <http://www.deq.state.va.us/tmdl/backgr.html>

Virginia Department of Environmental Quality (DEQ). 2005. "TMDL Modifications in Response to New or Expanding Discharges." Available at <http://www.deq.virginia.gov/waterguidance/pdf/052011.pdf>

Virginia Department of Environmental Quality (DEQ). 2005. "Total Maximum Daily Loads." Available at <http://www.deq.state.va.us/tmdl>

Virginia Department of Environmental Quality (DEQ). 2006. *Final 2006 305(b)/303(d) Water Quality Assessment Integrated Report.* Available at < http://www.deq.state.va.us/wqa/ir2006.html>

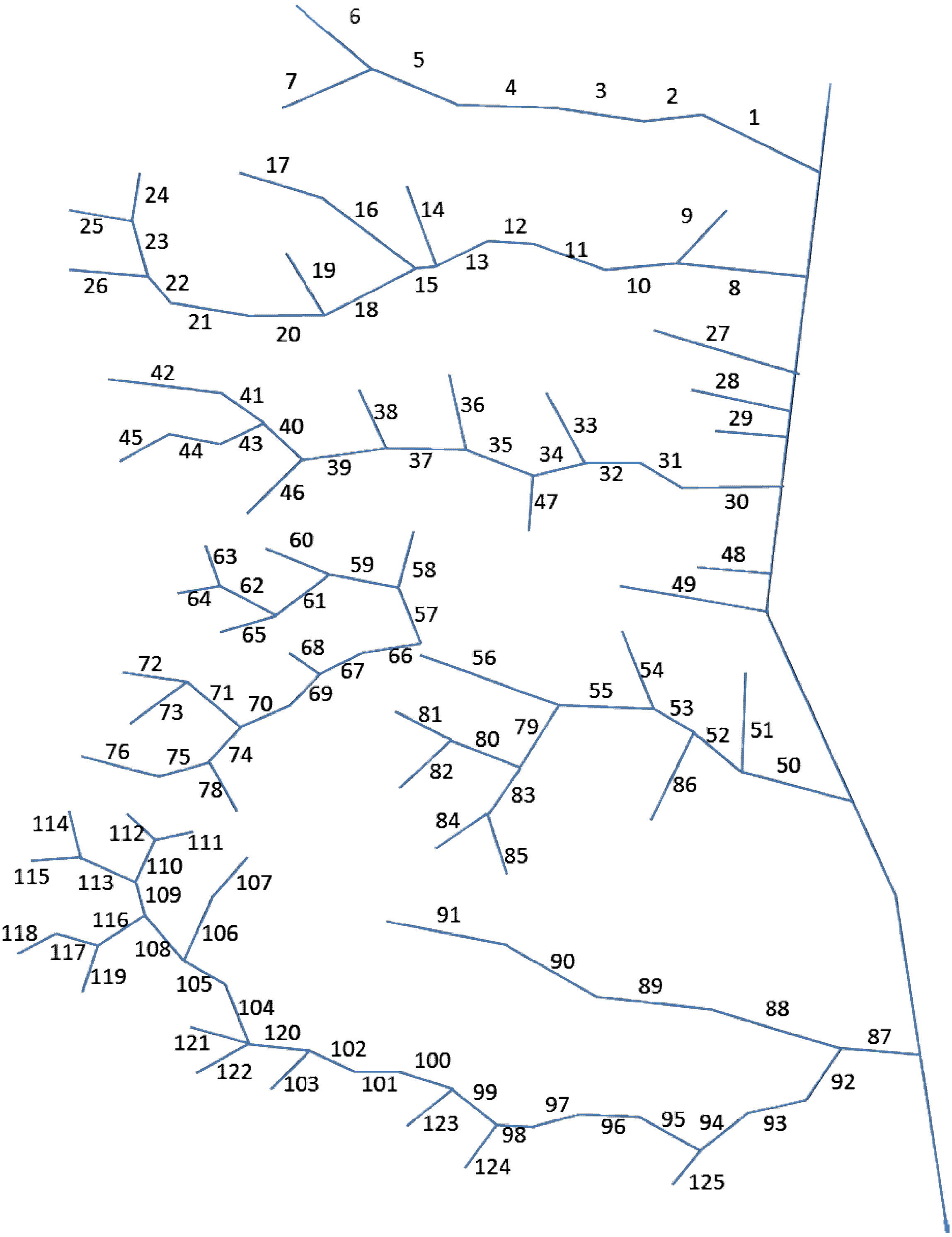
Virginia Department of Environmental Quality (DEQ). 2011. Final 2010 305(B)/303(D) Water Quality Assessment Integrated Report. Available at <http://www.deq.state.va.us/wqa/ir2010.html>

Virginia Department of Environmental Quality (DEQ). 2011b. Datasets relating to TMDL Development.

Virginia Department of Game and Inland Fisheries (DGIF). 2011. Personal Correspondence for Wildlife Inventory of Birds and Deer.

APPENDIX A:

Model Representation of Stream Reach Networks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APPENDIX B:

Monthly Fecal Coliform Build-up Rates and Direct Deposition Loads

Table B- 1: Powells Creek Monthly Build-up Rates (January to June) cfu/ac/day

Land Use	Jan	Feb	Mar	April	May	Jun
Cropland	1.20E+08	1.70E+09	1.50E+09	3.10E+09	1.10E+09	2.70E+09
Forest	1.80E+08	1.80E+08	1.80E+08	1.35E+08	1.35E+08	1.35E+08
Residential	7.20E+09	7.20E+09	7.20E+09	6.90E+09	6.90E+09	6.90E+09
Pasture	2.80E+10	3.00E+10	3.00E+10	3.20E+10	2.90E+10	3.20E+10

Table B- 2: Powells Creek Monthly Build-up Rates (July to December) cfu/ac/day

Land Use	Jul	Aug	Sep	Oct	Nov	Dec
Cropland	1.10E+09	2.70E+09	1.50E+09	3.10E+09	1.70E+09	1.20E+08
Forest	1.35E+08	1.35E+08	1.35E+08	1.80E+08	1.80E+08	1.80E+08
Residential	6.90E+09	6.90E+09	6.90E+09	7.20E+09	7.20E+09	7.20E+09
Pasture	3.00E+10	3.20E+10	3.00E+10	3.30E+10	3.10E+10	2.80E+10

Table B- 3: Quantico Creek Monthly Build-up Rates (January to June) cfu/ac/day

Land Use	Jan	Feb	Mar	April	May	Jun
Cropland	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08
Forest	3.50E+07	3.50E+07	3.50E+07	2.60E+07	2.60E+07	2.60E+07
Residential	8.84E+09	8.84E+09	8.84E+09	8.58E+09	8.58E+09	8.58E+09
Pasture	4.94E+10	4.94E+10	4.94E+10	4.94E+10	4.81E+10	4.81E+10

Table B- 4: Quantico Creek Monthly Build-up Rates (July to December) cfu/ac/day

Land Use	Jul	Aug	Sep	Oct	Nov	Dec
Cropland	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08
Forest	2.60E+07	2.60E+07	2.60E+07	3.50E+07	3.50E+07	3.50E+07
Residential	8.58E+09	8.58E+09	8.58E+09	8.84E+09	8.84E+09	8.84E+09
Pasture	4.81E+10	4.81E+10	4.94E+10	4.94E+10	4.94E+10	4.94E+10

Table B- 5: South Fork Quantico Creek Monthly Build-up Rates (January to June) cfu/ac/day

Land Use	Jan	Feb	Mar	April	May	Jun
Cropland	1.20E+08	1.20E+08	1.20E+08	1.20E+08	1.20E+08	1.20E+08
Forest	2.72E+07	2.72E+07	2.72E+07	2.00E+07	2.00E+07	2.00E+07
Residential	6.90E+09	6.90E+09	6.90E+09	6.60E+09	6.60E+09	6.60E+09

Pasture	3.10E+10	3.10E+10	3.10E+10	3.00E+10	3.00E+10	3.00E+10

Table B- 6: South Fork Quantico Creek Monthly Build-up Rates (July to December) cfu/ac/day

Land Use	Jul	Aug	Sep	Oct	Nov	Dec
Cropland	1.20E+08	1.20E+08	1.20E+08	1.20E+08	1.20E+08	1.20E+08
Forest	2.00E+07	2.00E+07	2.00E+07	2.72E+07	2.72E+07	2.72E+07
Residential	6.60E+09	6.60E+09	6.60E+09	6.90E+09	6.90E+09	6.90E+09
Pasture	3.00E+10	3.00E+10	3.00E+10	3.10E+10	3.10E+10	3.10E+10

Table B- 7: North Branch Chopawamsic Creek Monthly Build-up Rates (January to June) cfu/ac/day

Land Use	Jan	Feb	Mar	April	May	Jun
Cropland	5.40E+09	7.70E+10	6.98E+10	1.41E+11	4.82E+10	1.20E+11
Forest	5.33E+07	5.33E+07	5.33E+07	3.99E+07	3.99E+07	3.99E+07
Residential	3.23E+11	3.23E+11	3.23E+11	3.11E+11	3.11E+11	3.11E+11
Pasture	1.30E+12	1.30E+12	1.30E+12	1.40E+12	1.30E+12	1.40E+12

Table B- 8: North Branch Chopawamsic Creek Monthly Build-up Rates (July to December) cfu/ac/day

Land Use	Jul	Aug	Sep	Oct	Nov	Dec
Cropland	4.82E+10	1.20E+11	6.98E+10	1.41E+11	7.61E+10	5.40E+09
Forest	3.99E+07	3.99E+07	3.99E+07	5.33E+07	5.33E+07	5.33E+07
Residential	3.11E+11	3.11E+11	3.11E+11	3.23E+11	3.23E+11	3.23E+11
Pasture	1.30E+12	1.40E+12	1.40E+12	1.50E+12	1.40E+12	1.30E+12

Table B- 9: Unnamed Tributary to Potomac River Monthly Build-up Rates (January to June) cfu/ac/day

Land Use	Jan	Feb	Mar	April	May	Jun
Cropland	5.90E+07	5.90E+07	6.10E+07	6.40E+07	6.30E+07	6.30E+07
Forest	7.00E+07	7.00E+07	7.00E+07	4.35E+07	4.35E+07	4.35E+07
Residential	3.30E+09	3.30E+09	3.30E+09	3.20E+09	3.20E+09	3.20E+09
Pasture	6.60E+09	6.60E+09	6.60E+09	6.30E+09	6.30E+09	6.30E+09

Table B- 10: Unnamed Tributary to Potomac River Monthly Build-up Rates (July to December) cfu/ac/day

Land Use	Jul	Aug	Sep	Oct	Nov	Dec
Cropland	6.30E+07	6.30E+07	6.40E+07	6.10E+07	5.90E+07	5.90E+07
Forest	4.35E+07	4.35E+07	4.35E+07	7.00E+07	7.00E+07	7.00E+07
Residential	3.20E+09	3.20E+09	3.20E+09	3.30E+09	3.30E+09	3.30E+09

Pasture	6.30E+09	6.30E+09	6.30E+09	6.60E+09	6.60E+09	6.60E+09

Table B- 11: Austin Run Monthly Build-up Rates (January to June) cfu/ac/day

Land Use	Jan	Feb	Mar	April	May	Jun
Cropland	6.80E+07	6.80E+07	7.31E+07	7.82E+07	7.65E+07	7.65E+07
Forest	2.30E+08	2.30E+08	2.30E+08	1.50E+08	1.50E+08	1.50E+08
Residential	1.12E+10	1.12E+10	1.12E+10	1.07E+10	1.07E+10	1.07E+10
Pasture	2.89E+10	2.89E+10	2.89E+10	2.89E+10	2.89E+10	2.89E+10

Table B- 12: Austin Run Monthly Build-up Rates (July to December) cfu/ac/day

Land Use	Jul	Aug	Sep	Oct	Nov	Dec
Cropland	7.65E+07	7.65E+07	7.82E+07	7.31E+07	6.80E+07	6.80E+07
Forest	1.50E+08	1.50E+08	1.50E+08	2.30E+08	2.30E+08	2.30E+08
Residential	1.07E+10	1.07E+10	1.07E+10	1.12E+10	1.12E+10	1.12E+10
Pasture	2.89E+10	2.89E+10	2.89E+10	2.89E+10	2.89E+10	2.89E+10

Table B- 13: Accokeek Creek Monthly Build-up Rates (January to June) cfu/ac/day

Land Use	Jan	Feb	Mar	April	May	Jun
Cropland	1.13E+08	1.13E+08	1.14E+08	1.14E+08	1.14E+08	1.14E+08
Forest	1.15E+08	1.15E+08	1.15E+08	7.50E+07	7.50E+07	7.50E+07
Residential	6.36E+09	6.36E+09	6.36E+09	6.12E+09	6.12E+09	6.12E+09
Pasture	5.64E+09	5.64E+09	5.64E+09	5.16E+09	5.16E+09	5.16E+09

Table B- 14: Accokeek Creek Monthly Build-up Rates (July to December) cfu/ac/day

Land Use	Jul	Aug	Sep	Oct	Nov	Dec
Cropland	1.14E+08	1.14E+08	1.14E+08	1.14E+08	1.13E+08	1.13E+08
Forest	7.50E+07	7.50E+07	7.50E+07	1.15E+08	1.15E+08	1.15E+08
Residential	6.12E+09	6.12E+09	6.12E+09	6.36E+09	6.36E+09	6.36E+09
Pasture	5.16E+09	5.16E+09	5.16E+09	5.64E+09	5.64E+09	5.64E+09

Table B- 15: Potomac Creek Monthly Build-up Rates (January to June) cfu/ac/day

Land Use	Jan	Feb	Mar	April	May	Jun

Cropland	2.03E+07	2.03E+07	2.03E+07	2.03E+07	2.03E+07	2.03E+07
Forest	9.20E+07	9.20E+07	9.20E+07	6.00E+07	6.00E+07	6.00E+07
Residential	1.15E+09	1.15E+09	1.15E+09	1.10E+09	1.10E+09	1.10E+09
Pasture	8.28E+08	8.28E+08	8.28E+08	7.44E+08	7.44E+08	7.44E+08

Table B- 16: Potomac Creek Monthly Build-up Rates (July to December) cfu/ac/day

Land Use	Jul	Aug	Sep	Oct	Nov	Dec
Cropland	2.03E+07	2.03E+07	2.03E+07	2.03E+07	2.03E+07	2.03E+07
Forest	6.00E+07	6.00E+07	6.00E+07	9.20E+07	9.20E+07	9.20E+07
Residential	1.10E+09	1.10E+09	1.10E+09	1.15E+09	1.15E+09	1.15E+09
Pasture	7.44E+08	7.44E+08	7.44E+08	8.28E+08	8.28E+08	8.28E+08

Table B- 17: Potomac Run Monthly Build-up Rates (January to June) cfu/ac/day

Land Use	Jan	Feb	Mar	April	May	Jun
Cropland	3.60E+08	3.60E+08	3.60E+08	3.60E+08	3.60E+08	3.60E+08
Forest	1.15E+08	1.15E+08	1.15E+08	7.50E+07	7.50E+07	7.50E+07
Residential	2.04E+10	2.04E+10	2.04E+10	1.95E+10	1.95E+10	1.95E+10
Pasture	1.47E+10	1.47E+10	1.47E+10	1.32E+10	1.32E+10	1.32E+10

Table B- 18: Potomac Run Monthly Build-up Rates (July to December) cfu/ac/day

Land Use	Jul	Aug	Sep	Oct	Nov	Dec
Cropland	3.60E+08	3.60E+08	3.60E+08	3.60E+08	3.60E+08	3.60E+08
Forest	7.50E+07	7.50E+07	7.50E+07	1.15E+08	1.15E+08	1.15E+08
Residential	1.95E+10	1.95E+10	1.95E+10	2.04E+10	2.04E+10	2.04E+10
Pasture	1.32E+10	1.32E+10	1.32E+10	1.47E+10	1.47E+10	1.47E+10

Table B- 19: Powells Creek Direct Deposition Rates (cfu/day)

Month	Direct Cattle	Direct Septic	Direct Wildlife
1	6.38E+08	2.34E+11	1.01E+10
2	6.38E+08	2.34E+11	1.01E+10
3	1.06E+09	2.34E+11	1.01E+10
4	1.49E+09	2.34E+11	9.09E+09
5	1.49E+09	2.34E+11	9.09E+09
6	1.91E+09	2.34E+11	9.09E+09
7	1.91E+09	2.34E+11	9.09E+09
8	1.91E+09	2.34E+11	9.09E+09
9	1.49E+09	2.34E+11	9.09E+09
10	1.06E+09	2.34E+11	1.01E+10
11	1.06E+09	2.34E+11	1.01E+10
12	6.38E+08	2.34E+11	1.01E+10

Table B- 20: Quantico Creek/South Fork Quantico Creek Monthly Direct Deposition Rates (cfu/day)			
Month	Direct Cattle	Direct Septic	Direct Wildlife
1	8.08E+07	8.85E+10	1.26E+10
2	8.08E+07	8.85E+10	1.26E+10
3	1.27E+08	8.85E+10	1.26E+10
4	1.74E+08	8.85E+10	1.14E+10
5	1.74E+08	8.85E+10	1.14E+10
6	2.20E+08	8.85E+10	1.14E+10
7	2.20E+08	8.85E+10	1.14E+10
8	2.20E+08	8.85E+10	1.14E+10
9	1.74E+08	8.85E+10	1.14E+10
10	1.27E+08	8.85E+10	1.26E+10
11	1.27E+08	8.85E+10	1.26E+10
12	8.08E+07	8.85E+10	1.26E+10

Table B- 21: North Branch Chopawamsic Creek Monthly Direct Deposition Rates (cfu/day)			
Month	Direct Cattle	Direct Septic	Direct Wildlife
1	0.00+00	7.01E+06	1.95E+09
2	0.00+00	7.01E+06	1.95E+09
3	0.00+00	7.01E+06	1.95E+09
4	0.00+00	7.01E+06	1.75E+09
5	0.00+00	7.01E+06	1.75E+09
6	0.00+00	7.01E+06	1.75E+09
7	0.00+00	7.01E+06	1.75E+09
8	0.00+00	7.01E+06	1.75E+09
9	0.00+00	7.01E+06	1.75E+09
10	0.00+00	7.01E+06	1.95E+09
11	0.00+00	7.01E+06	1.95E+09
12	0.00+00	7.01E+06	1.95E+09

Table B- 22: Unnamed Tributary to Potomac River Monthly Direct Deposition Rates (cfu/day)			
Month	Direct Cattle	Direct Septic	Direct Wildlife
1	6.47E+07	3.13E+08	2.64E+09
2	1.14E+10	3.13E+08	2.64E+09
3	1.81E+10	3.13E+08	2.64E+09
4	2.49E+10	3.13E+08	2.40E+09
5	2.49E+10	3.13E+08	2.40E+09
6	3.16E+10	3.13E+08	2.40E+09
7	3.18E+10	3.13E+08	2.40E+09
8	3.18E+10	3.13E+08	2.40E+09
9	2.50E+10	3.13E+08	2.40E+09
10	1.82E+10	3.13E+08	2.64E+09

11	1.82E+10	3.13E+08	2.64E+09
12	1.15E+10	3.13E+08	2.64E+09

Table B- 23: Austin Run Monthly Direct Deposition Rates (cfu/day)

Month	Direct Cattle	Direct Septic	Direct Wildlife
1	4.09E+08	7.88E+11	5.43E+09
2	4.09E+08	7.88E+11	5.43E+09
3	6.52E+08	7.88E+11	5.43E+09
4	8.96E+08	7.88E+11	4.51E+09
5	8.96E+08	7.88E+11	4.51E+09
6	1.14E+09	7.88E+11	4.51E+09
7	1.32E+09	7.88E+11	4.51E+09
8	1.32E+09	7.88E+11	4.51E+09
9	1.03E+09	7.88E+11	4.51E+09
10	7.54E+08	7.88E+11	5.43E+09
11	7.54E+08	7.88E+11	5.43E+09
12	4.73E+08	7.88E+11	5.43E+09

Table B- 204: Accokeek Creek Monthly Direct Deposition Rates (cfu/day)

Month	Direct Cattle	Direct Septic	Direct Wildlife
1	7.00E+08	2.65E+11	7.67E+09
2	7.00E+08	2.65E+11	7.67E+09
3	1.10E+09	2.65E+11	7.67E+09
4	1.51E+09	2.65E+11	6.82E+09
5	1.51E+09	2.65E+11	6.82E+09
6	1.91E+09	2.65E+11	6.82E+09
7	1.91E+09	2.65E+11	6.82E+09
8	1.91E+09	2.65E+11	6.82E+09
9	1.51E+09	2.65E+11	6.82E+09
10	1.10E+09	2.65E+11	7.67E+09
11	1.10E+09	2.65E+11	7.67E+09
12	7.00E+08	2.65E+11	7.67E+09

Table B- 21: Potomac Creek/Potomac Run Monthly Direct Deposition Rates (cfu/day)

Month	Direct Cattle	Direct Septic	Direct Wildlife
1	5.39E+09	3.28E+11	1.16E+10
2	5.39E+09	3.28E+11	1.16E+10
3	8.51E+09	3.28E+11	1.16E+10
4	1.16E+10	3.28E+11	1.06E+10
5	1.16E+10	3.28E+11	1.06E+10
6	1.48E+10	3.28E+11	1.06E+10
7	1.48E+10	3.28E+11	1.06E+10
8	1.48E+10	3.28E+11	1.06E+10
9	1.16E+10	3.28E+11	1.06E+10
10	8.51E+09	3.28E+11	1.16E+10

11	8.51E+09	3.28E+11	1.16E+10
12	5.39E+09	3.28E+11	1.16E+10

Appendix C

Abbreviations and Glossary

Abbreviations

AVMA: American Veterinary Medical Association
BMP: Best Management Practice
CWA: Clean Water Act
DEM: Digital Elevation Model
EPA: Environmental Protection Agency
HSPEXP: Expert System for Calibration of the Hydrological Simulation Program-FORTRAN
HSPF: Hydrologic Simulation Program-Fortran
HUC: Hydrologic Unit Code
LA: Load Allocation
MS4: Municipal separate storm sewer system
NCDC: National Climatic Data Center
NHD: National Hydrography Dataset
NLCD: National Land Coverage Database
NOAA: National Oceanic and Atmospheric Association
NRO: Northern Regional Office
NPDES: National Pollution Discharge Elimination System
NRCS: Natural Resources Conservation Service
MOS: Margin of Safety
SSURGO: Soil Survey Geographic
SWCB: State Water Control Board
SWCD: Soil and Water Conservation District
TAC: Technical Advisory Committee
TMDL: Total Maximum Daily Load
USGS: U.S. Geological Survey
VADCR: Virginia Department of Conservation and Recreation
VADEQ: Virginia Department of Environmental Quality
VADGIF: Virginia Department of Game and Inland Fisheries
VDH: Virginia Department of Health
VDMME: Virginia Department of Mines, Minerals, and Energy
VPDES: Virginia Pollutant Discharge Elimination System
VSMP: Virginia Stormwater Management Program
VT: Virginia Tech
UAA: Use Attainability Analysis
USDA: United States Department of Agriculture
WLA: Wasteload Allocation
WQIF: Water Quality Improvement Fund
WQMIRA: Water Quality Monitoring, Information, and Restoration Act

Glossary

303(d). A section of the Clean Water Act of 1972 requiring states to identify and list water bodies that do not meet the states' water quality standards.

Allocations. That portion of receiving water's loading capacity attributed to one of its existing or future pollution sources (non-point or point) or to natural background sources. (A wasteload allocation [WLA] is that portion of the loading capacity allocated to an existing or future point source, and a load allocation [LA] is that portion allocated to an existing or future non-point source or to natural background levels. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading.)

Ambient water quality. Natural concentration of water quality constituents prior to mixing of either point or non-point source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact on human health.

Anthropogenic. Pertains to the [environmental] influence of human activities.

Bacteria. Single-celled microorganisms. Bacteria of the coliform group are considered the primary indicators of fecal contamination and are often used to assess water quality.

Bacterial source tracking (BST). A collection of scientific methods used to track sources of fecal contamination.

Biosolids. Also known as Sewage sludge, is the name for the solid, semisolid, or liquid materials removed during the treatment of domestic sewage in a treatment facility. Biosolids include, but are not limited to, solids removed during primary, secondary, or advanced wastewater treatment, scum, domestic septage, portable toilet pumpings, Type III marine sanitation device pumpings, and sewage sludge products. When properly treated and processed, sewage sludge becomes "biosolids" which can be safely recycled and applied as fertilizer to improve and maintain productive soils and stimulate plant growth.

Best management practices (BMPs). Methods, measures, or practices determined to be reasonable and cost-effective means for a landowner to meet certain, generally non-point source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures.

Clean Water Act (CWA). The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The Clean Water Act (CWA) contains a number of provisions to restore and maintain the quality of the nation's water resources. One of these provisions is section 303(d), which establishes the TMDL program.

Concentration. Amount of a substance or material in a given unit volume of solution; usually measured in milligrams per liter (mg/L) or parts per million (ppm).

Contamination. The act of polluting or making impure; any indication of chemical, sediment, or biological impurities.

Cost-share program. A program that allocates project funds to pay a percentage of the cost of constructing or implementing a best management practice. The remainder of the costs is paid by the producer(s).

Critical condition. The critical condition can be thought of as the "worst case" scenario of environmental conditions in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence.

Designated uses. Those uses specified in water quality standards for each waterbody or segment whether or not they are being attained.

Domestic wastewater. Also called sanitary wastewater, consists of wastewater discharged from residences and from commercial, institutional, and similar facilities.

Drainage basin. A part of a land area enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into a receiving water. Also referred to as a watershed, river basin, or hydrologic unit.

Existing use. Use actually attained in the waterbody on or after November 28, 1975, whether or not it is included in the water quality standards (40 CFR 131.3).

Fecal Coliform. Indicator organisms (organisms indicating presence of pathogens) associated with the digestive tract.

Geometric mean. A measure of the central tendency of a data set that minimizes the effects of extreme values.

GIS. Geographic Information System. A system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth. (Dueker and Kjerne, 1989)

Infiltration capacity. The capacity of a soil to allow water to infiltrate into or through it during a storm.

Interflow. Runoff that travels just below the surface of the soil.

Loading, Load, Loading rate. The total amount of material (pollutants) entering the system from one or multiple sources; measured as a rate in weight per unit time.

Load allocation (LA). The portion of a receiving waters loading capacity attributed either to one of its existing or future non-point sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and non-point source loads should be distinguished (40 CFR 130.2(g)).

Loading capacity (LC). The greatest amount of loading a water body can receive without violating water quality standards.

Margin of safety (MOS). A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body (CWA section 303(d)(1)©). The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by EPA either individually or in state/EPA agreements. If the MOS needs to be larger than that which is allowed through the conservative assumptions, additional MOS can be added as a separate component of the TMDL (in this case, quantitatively, a TMDL = LC = WLA + LA + MOS).

Mean. The sum of the values in a data set divided by the number of values in the data set.

Monitoring. Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

Narrative criteria. Non-quantitative guidelines that describe the desired water quality goals.

Non-point source. Pollution that originates from multiple sources over a relatively large area. Non-point sources can be divided into source activities related to either land or water use including failing septic tanks, improper animal-keeping practices, forest practices, and urban and rural runoff.

Numeric targets. A measurable value determined for the pollutant of concern, which, if achieved, is expected to result in the attainment of water quality standards in the listed waterbody.

Point source. Pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving water waterbody or river.

Pollutant. Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. (CWA section 502(6)).

Pollution. Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, chemical, and radiological integrity of water.

Poultry Litter. A material used as bedding in poultry operations. Common litter materials are woodshavings, sawdust, peanut hulls, shredded sugar cane, straw, and other dry, absorbent, low-cost organicmaterials. After use, the litter consists primarily of poultry manure, but also contains the original littermaterial, feathers, and spilled feed.

Privately owned treatment works. Any device or system that is (a) used to treat wastes from any facility whose operator is not the operator of the treatment works and (b) not a publicly owned treatment works.

Public comment period. The time allowed for the public to express its views and concerns regarding action by EPA or states (e.g., a Federal Register notice of a proposed rule-making, a public notice of a draft permit, or a Notice of Intent to Deny).

Publicly owned treatment works (POTW). Any device or system used in the treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature that is owned by a state or municipality. This definition includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment.
Raw sewage. Untreated municipal sewage.

Receiving waters. Creeks, streams, rivers, lakes, estuaries, ground-water formations, or other bodies of water into which surface water and/or treated or untreated waste are discharged, either naturally or in man-made systems.

Riparian areas. Areas bordering streams, lakes, rivers, and other watercourses. These areas have high water tables and support plants that require saturated soils during all or part of the year. Riparian areas include both wetland and upland zones.

Riparian zone. The border or banks of a stream. Although this term is sometimes used interchangeably with floodplain, the riparian zone is generally regarded as relatively narrow compared to a floodplain. The duration of flooding is generally much shorter, and the timing less predictable, in a riparian zone than in a river floodplain.

Runoff. That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

Septic system. An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a drain field or subsurface absorption system consisting of a series of percolation lines for the disposal of the liquid effluent. Solids (sludge) that remain after decomposition by bacteria in the tank must be pumped out periodically.

Sewer. A channel or conduit that carries wastewater and storm water runoff from the source to a treatment plant or receiving stream. Sanitary sewers carry household, industrial, and commercial waste. Storm sewers carry runoff from rain or snow. Combined sewers handle both.

Slope. The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating one unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04), degrees (2 degrees 18 minutes), or percent (4 percent).

Stakeholder. Any person with a vested interest in the TMDL development.

Surface area. The area of the surface of a waterbody; best measured by planimetry or the use of a geographic information system.

Surface runoff. Precipitation, snowmelt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of non-point source pollutants.

Surface water. All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors directly influenced by surface water.

Topography. The physical features of a geographic surface area including relative elevations and the positions of natural and man-made features.

Total Maximum Daily Load (TMDL). The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for non-point sources and natural background, plus a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state’s water quality standard.

VADEQ. Virginia Department of Environmental Quality.

VDH. Virginia Department of Health.

Virginia Pollutant Discharge Elimination System (NPDES). The national program for issuing, modifying, revoking and re-issuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

Wasteload allocation (WLA). The portion of a receiving waters' loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)).

Wastewater. Usually refers to effluent from a sewage treatment plant. See also **Domestic wastewater**.

Wastewater treatment. Chemical, biological, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water to remove, reduce, or neutralize contaminants.

Water quality. The biological, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial uses.

Water quality criteria. Levels of water quality expected to render a body of water suitable for its designated use, composed of numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or states for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

Water quality standard. Law or regulation that consists of the beneficial designated use or uses of a waterbody, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular waterbody, and an antidegradation statement.

Watershed. A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

WQIA. Water Quality Improvement Act.

APPENDIX D:

NLCD 2006 Landuse Distribution in Modeling Segments

NLCD 2006 Landuse Distribution in Modeling Segments

Model Segment	Bare Land	Cultivated Crops	Deciduous Forest	Developed, High Intensity	Developed, Low Intensity	Developed, Medium Intensity	Developed, Open Space	Estuarine Emergent Wetland	Evergreen Forest	Grassland/ Herbaceous	Mixed Forest	Open Water	Palustrine Emergent Wetland	Palustrine Forested Wetland	Palustrine Scrub/Shrub Wetland	Pasture/ Hay	Scrub/ Shrub	Unconsolidated Shore	Grand Total
2	192	6	45	11	62	81	14			2	0		0	51	2	2	2		473
3	255	3	734	40	257	123	110		10	7	31			75	1	13	39	0	1,696
4	12	38	688	29	741	169	321	5	33	19	54	86	5	48	4	10	37	1	2,301
5	9	206	1,052	41	246	58	134		43	21	44		3	156	16	53	97		2,182
6	0	60	772	6	79	20	127	0	35	12	51	1	2	73	8	9	53		1,307
7	178	38	748	45	60	43	95		65	20	34		0	84	8	3	72		1,493
12	5	2	88	45	110	78	56	0	0	3	2		1	10	0		2	0	403
13	13	1	269	9	158	71	76		6	4	14			38	0	1	8		668
14	46	15	679	8	127	39	48		29	3	52		0	6	0		21	1	1,074
15		4	20		3	0	5		0	2	4			10	2		1		50
16	0	2	2,129	6	28	10	18		137	1	172	1	0	77	1		23		2,608
17	0	6	1,368	52	36	14	32		94	3	94		1	102	4	2	23		1,831
18		2	1,757	0	18	3	36		114	1	455			50	0		28		2,466
19			291						128		424			10	1		4		859
20		5	457		2	0	11		237	4	757	5	0	69	0	2	19		1,567
21		0	649			0			184	2	212			69	1	0	28		1,146
22			71						26	7	10		0	32	0		2		149
23		0	1,010	1	2	5	1		194	24	169		2	177	14	0	18		1,616
24		30	468	4	29	13	55		60	19	43	0	0	59	4	8	47		842
25		13	994	0	1	1	2		66	11	74		1	51	15		58		1,288
26			378		1	0	0		133	53	77		7	40	5		7		700
41			76		1		0		85	0	179			18	1		6		366
42		46	1,821		3	2	1		483	58	693		1	352	46	9	117		3,633
49	21	39	1,873	0	115	10	128	2	80	18	107	11	1	139	12	24	102	3	2,687
79	54	78	332	16	264	80	148	5	12	36	18	12	31	77	8	18	39	0	1,228
80	1		103	23	123	58	31		0	3	5		0	20	8		12		388
81	0		239	111	547	233	209		8	10	13		0	14	2	4	46		1,438
82	71	26	450	9	484	113	292		72	24	32		0	48	1	9	71		1,700
83	14	7	41		21	5	7			1	1		0	24	3		6		130
84	99	41	743	1	45	10	39		56	15	46		0	21	8	31	36	1	1,193
85	74	33	458	20	131	53	48		28	5	22	0		29	2	6	16		925
89	1	71	1,297	2	19	4	105	0	30	21	67	10	1	247	4	50	63		1,994
90	85	237	2,152	52	197	77	159	0	170	66	154	0	0	325	14	13	198	3	3,904
91	35	297	2,569	9	375	75	452		304	111	178	10	4	262	12	220	266		5,180
95		77	764		1		3	30	12	7	40	8	3	261	13	20	45		1,283

NLCD 2006 Landuse Distribution in Modeling Segments

Model Segment	Bare Land	Cultivated Crops	Deciduous Forest	Developed, High Intensity	Developed, Low Intensity	Developed, Medium Intensity	Developed, Open Space	Estuarine Emergent Wetland	Evergreen Forest	Grassland/ Herbaceous	Mixed Forest	Open Water	Palustrine Emergent Wetland	Palustrine Forested Wetland	Palustrine Scrub/Shrub Wetland	Pasture/ Hay	Scrub/ Shrub	Unconsolidated Shore	Grand Total
96	1	132	632		2	0	37		35	8	33	0	101	172	25	27	34		1,238
97	7	87	479	0	7	6	25		35	11	35	1	4	104	6	13	44	0	864
98		65	476		10	0	47	0	39	11	29	2	1	85	5	12	50	7	841
99	7	66	439	2	5	2	11		30	8	38	1	2	243	23	16	94	0	988
100	366	236	1,646	190	182	149	267	0	101	47	94	8	2	449	36	36	263	1	4,072
101		48	240	5	8	8	20		54	5	22			24	2	17	33		484
102	0	11	333		5	8	8		77	6	33	2	0	17		11	50		561
103	2	41	533		11		22		65	19	35	18	2	13	0	61	78	0	902
104	0	50	851	0	2	2	54		163	8	79	106	9	46	1	30	99	1	1,501
105	0	313	1,150	1	6	1	66		163	71	73	9	2	45	3	220	182	1	2,308
106		30	411		2	0	11		18	34	10			7	1	58	29		611
107	64	36	197	2	12	2	18		59	7	15			9	2	48	26		498
108		26	596		23	0	3		44	1	27			13		13	42		790
109		23	20				0			0	1			4		14	3		65
110		61	78		11		0		0	1	2			8	0	109	9		281
111	48	134	433	2	34	5	42		83	23	24	12	2	18	2	64	74	1	1,002
112	1	131	364		3		7		52	17	21	0	0	20	10	77	68		772
113		37	215		1	0	15		27	9	14	0	0	70	1	133	26		549
114	1	277	393				10		65	8	20	1	1	50	5	235	38		1,102
115	2	423	1,161		2	1	25		165	47	58	1	1	70	19	715	162		2,851
116	0	46	578		36	1	11		35	15	15	1	0	33	0	74	30		874
117		3	231		0				17	9	20	10	1	36	5	79	14		426
118	1	67	485		3	2	190		70	14	24	66	3	22	2	76	42	1	1,068
119		215	735		3	2	18		95	34	35		0	50	3	87	31		1,309
120		32	375				0		12		15	8	1	6			34	0	484
121		96	572		4		13		6	11	7		0	8	1	77	76		869
122		107	391		17	0	7		7	7	10	0	0	2		121	77		748
123	0	147	626	1	51	10	60		17	15	25	5	0	56	5	60	64		1,141
124	39	64	649	1	77	7	83	0	47	16	43	0	1	81	12	35	49		1,205
Total`	**1,706**	**4,390**	**42,874**	**748**	**4,804**	**1,657**	**3,838**	**44**	**4,516**	**1,055**	**5,185**	**397**	**201**	**4,887**	**391**	**3,027**	**3,433**	**23**	**83,175**
% Total	**2.05%**	**5.28%**	**51.55%**	**0.90%**	**5.78%**	**1.99%**	**4.61%**	**0.05%**	**5.43%**	**1.27%**	**6.23%**	**0.48%**	**0.24%**	**5.88%**	**0.47%**	**3.64%**	**4.13%**	**0.03%**	**100.00%**

APPENDIX B – DRAFT LOCAL TMDL MS4 GUIDANCE (DEQ)

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER DIVISION

Subject: Guidance Memo No. XXX,

To:

From: Melanie D. Davenport, Director

Date: April XX, 2015

Copies:

Summary: This guidance document provides staff and permittees with background information and procedures for developing and implementing local TMDL Action Plans as required in the Special Condition of the 2013-2018 General Permit for Discharges of Stormwater from Small (Phase II) MS4s, the reissued Phase I MS4 permits, and any Individual Phase II permits that are issued.

Contact Information:

Disclaimer:
This document is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, it does not mandate any particular method nor does it prohibit any particular method for the analysis of data, establishment of a wasteload allocation, or establishment of a permit limit. If alternative proposals are made, such proposals should be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.

DEFINTIONS – For the purposes of this guidance document, the following definitions shall apply:

Best Management Practices ("BMPs") – Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices, including both structural and nonstructural practices to prevent or reduce the pollution of surface waters and groundwater systems.

Load Allocation ("LA") - The portion of the loading capacity attributed to (1) the existing nonpoint sources of pollution and (2) natural background sources.

Newly Designated MS4 permittees – MS4 permittees receiving initial permit coverage under the July 1, 2013 General Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems.

Pollutant(s) of Concern ("POC") – The pollutant(s) impairing a water body for which one or more TMDL(s) has been developed.

TMDL Implementation Plan – A document guided by an approved TMDL(s) that at a minimum provides details of the corrective actions to address the load allocation of one or more TMDLs. The plan includes measureable goals needed to achieve pollutant(s) source load reductions; outlines a schedule to attain water quality standards along with costs, benefits, and environmental impacts to reduce pollutant(s) and remediate impaired waterbodies.

Total Maximum Daily Load ("TMDL") – The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, natural background loading and a margin of safety.

Wasteload Allocation ("WLA") - The portion of a receiving waters' pollutant loading capacity that is allocated to existing or future point sources of pollution, such as an MS4.

***For terms not defined above, please refer to the 9VAC25-890-1, 9VAC25-870-10, or 9VAC25-31-10 of the Virginia Administrative Code*.**

BACKGROUND

Since 1998 DEQ has developed Total Maximum Daily Loads ("TMDL"), with public input, to restore and maintain the water quality of impaired waterbodies. Section 303(d) of the Clean Water Act requires that wasteload allocations be implemented through the National Pollutant Discharge Elimination System (NPDES) permit program. As point sources, MS4s are assigned individual or aggregate WLAs in TMDLs for receiving streams or watersheds to which the MS4 discharges. Municipalities may also be assigned an LA for those areas outside of the regulated MS4 Service Area that are sources of the POC. TMDLs may quantify both LA and WLA loads from the Census designated urbanized area. Permittees are not required to incorporate approaches for addressing those LAs into their Action Plans. Load allocations are often addressed through TMDL Implementation Plans (IPs) which characterize the suite of corrective actions needed to reduce nonpoint source pollutant loads. This guidance document only addresses the requirements to address WLAs to meet the special conditions for approved total maximum daily loads (TMDL) other than the Chesapeake Bay TMDL" ("Special Condition for Local TMDLs").

The Special Condition for Local TMDLs in the 2013 General VPDES Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems (VAR04) ("GP") and the eleven Phase I Individual MS4 permits, as they are reissued, require permittees to develop Action Plans that address all POC(s) for which the permittee has been assigned a WLA under an approved TMDL. The Local TMDL Action Plans should identify BMPs and other management strategies that the permittee will implement to meet the TMDL WLA and achieve compliance with the Special Condition. Local TMDL Action Plans can be implemented in multiple stages over multiple permit cycles using an adaptive iterative approach provided the permittee demonstrates adequate progress toward achieving reductions necessary to meet the WLA(s). Implementation of the TMDL Action Plans is tracked via the permittee's Annual Reports.

PERMIT REQUIREMENTS

With the exception of newly designated permittees, the Phase II Small MS4 GP requires that:

1. Action Plans for local TMDLs approved before July 1, 2008 must be completed by July 1, 2015 and submitted with the Annual Report due October 1, 2015.

2. Action Plans for local TMDLs approved between July 1, 2008 and June 30, 2013 must be completed by July 1, 2016 and submitted with the annual report due October 1, 2016.

Newly designated MS4 permittees should have included a schedule for developing local TMDL Action Plans as part of the MS4 Program Plan and registration statement submitted to obtain initial coverage under the 2013 GP and should follow that approved schedule. Likewise, Phase I permittees must follow the schedule in their individual permit. In accordance with Section I.B.7 of the GP, permittees must include an estimated date by which they will achieve the assigned WLAs as part of the reapplication package.

The Phase II Small MS4 local TMDL Action Plans and updates become effective and enforceable 90 days after the date received by the Department unless specifically denied in writing. DEQ may request additional information in the review process, as needed. In the Action Plan permittees are responsible for establishing schedules and milestones to meet the assigned WLA(s). The approved Action Plan schedule will supersede any implied or explicit completion date or schedule provided in the local TMDL or Implementation Plan. Permittees are strongly encouraged to work closely with the DEQ regional TMDL and MS4 staff throughout the development of the Action Plan(s).

APPLICABLE WLAs

Prior to Action Plan development, permittees will need to determine the local TMDLs in which the MS4 has been assigned a WLA. Permittees may search for approved local TMDLs by city and/or county on the TMDL Reports page of DEQ's website. Permittees may verify whether they are subject to a local TMDL by using the Virginia Environmental Geographic Information System (VEGIS) to determine the waterbodies to which the MS4 discharges. This information should be refined and/or corrected as the permittee completes the mapping efforts required under GP Section II.B.3. General instructions for using VEGIS are located on the Department's VEGIS website.

Detailed information regarding the portion of each watershed that drains to an MS4 system may not be available during local TMDL development and WLA assignment, so a conservative, land-use based approach is often used. It is important to note that the actual areas within a local TMDL watershed that are subject to a MS4 WLA are those areas that are specifically regulated under the MS4 permit. TMDL studies do not attempt or intend to define the MS4 regulatory area. Rather, the areas used to develop loadings associated with the MS4 permits in local TMDLs (e.g. impervious developed or Census designated urbanized areas) are only surrogates for establishing WLAs and estimating a reasonable pollutant loading that is expected to be contributed by these permitted sources.

The Department encourages permittees to participate in both the local TMDL and Implementation Plan development processes, which may provide insight into BMP applicability and strategies to meet water quality standards. If an Implementation Plan has been developed for a TMDL, permittees may examine the Implementation Plan for appropriate non-point source BMPs for the POC and other strategies for reducing pollutants. While an Implementation Plan may provide strategies for permittees to consider, permittees are not required to follow the strategies listed in an Implementation Plan to address their WLA(s).

Aggregate WLAs

In some circumstances multiple permittees may be assigned one WLA, or an aggregate WLA, for their discharges to the impaired waterbody. Aggregate WLAs are intended to address a watershed wide pollutant without discrete MS4 boundaries. Aggregated WLAs may be developed when permittees are closely interconnected, there is not sufficient information or detail to disaggregate the WLA, or the scale of the TMDL is too great to delineate individual WLAs. MS4 permittees are encouraged to work together to create a collaborative watershed strategy to meet these WLAs.

Forthcoming WLAs for Existing TMDLs

Newly designated Phase II and existing Phase II MS4 permittees with expanded urbanized areas as the result of the 2010 Census may drain to impaired waters for which a local TMDL has been developed. These permittees may not currently have a WLA assigned to them under these TMDLs.

Existing Permittees with Expanded Area

Existing permittees who were previously assigned a WLA and whose urbanized area expanded as a result of the 2010 Census are required to meet the WLA(s) assigned prior to the identification of an expanded urbanized area. As WLAs are revised and/or finalized by DEQ to incorporate the expanded urbanized area, permittees will be required to address those POC reductions in future permit cycles.

New permittees

New permittees that discharge to impaired waterbodies with one or more approved local TMDL(s) may not have been assigned WLA(s) yet. The Department recommends permittees begin planning for future WLAs by considering land use based reductions as discussed above.

ACTION PLAN CONTENT

The proposed strategies and the end date by which permittees will demonstrate compliance with their assigned WLA(s) will be determined by the permittee; however, the Action Plan should also include justification for these choices. Permittees should address the following in their Action Plan(s):

1. The name(s) of the Final TMDL report(s);
2. The pollutant(s) causing the impairment(s);
3. The WLA(s) assigned to the MS4 as aggregate or individual WLAs;
4. Significant sources of POC(s) from facilities of concern owned or operated by the MS4 operator that are not covered under a separate VPDES permit. A significant source of pollutant(s) from a facility of concern means a discharge where the expected pollutant loading is greater than the average pollutant loading for the land use identified in the TMDL;
5. Existing or new management practices, control techniques, and system design and engineering methods , that have been or will be implemented as part of the MS4 Program Plan that are applicable to reducing the pollutant identified in the WLA;
6. Legal authorities such as ordinances, state and other permits, orders, specific contract language, and interjurisdictional agreements applicable to reducing the POCs identified in each respective TMDL;
7. Enhancements to public education, outreach, and employee training programs to also promote methods to eliminate and reduce discharges of the POC(s) for which a WLA has been assigned;
8. A schedule of interim milestones and implementation of the items in 5, 6, and 7;
9. Methods to assess TMDL Action Plans for their effectiveness in reducing the pollutants identified in the WLAs; and
10. Measurable goals and the metrics that the permittee and Department will use to track those goals (and the milestones required by the permit). Evaluation metrics other than monitoring may be used to determine compliance with the TMDL(s).

Approaches to meeting WLAs

Action Plans should be developed in accordance with information and data in the TMDL. However, it is not necessary for a permittee to employ the same models and tools used to develop the TMDL in development and evaluation of the Action Plan. For example, watershed-based TMDLs often use Hydrological Simulation Program-Fortran (HSPF) to model the hydrology and pollutant fate and transport. The permittee may use other tools and models that may be better suited to their specific circumstance to develop a control strategy and evaluate alternatives. Permittees should consult with DEQ regional TMDL staff if they have questions regarding the methodology and data used in development of the MS4 TMDL WLAs.

Permittees may employ both structural and non-structural BMPs to address WLAs. There are a number of other resources permittees may reference to identify BMPs that may be implemented to address local WLAs. Reports are available through the Center for Watershed Protection and the Water Environment Research Foundation (WERF) that provide information on BMPs that can be used to address non-nutrient TMDLs. Existing Implementation Plans may also be valuable resources for permittees for information concerning relevant BMPs, BMP reduction efficiencies, cost and benefits, and strategies to address POC reductions necessary to meet the WLAs. Demonstration of adequate progress may be achieved through tracking, monitoring, and/or reporting of BMP implementation, and/or other strategies as approved by DEQ as part of the TMDL Action Plan.

Nutrient and Sediment TMDLs
Permittees may refer to the Chesapeake Bay TMDL Action Plan Guidance (GM14-2012) for strategies and information on how to calculate reductions from BMPs in watersheds with local nutrient and sediment TMDLs. It should be noted that the Action Plans for local TMDLs **do not** need to follow the requirements for the Chesapeake Bay TMDL Action Plan.

Pathogenic Pollutant TMDLs
For pathogenic pollutants (i.e. Enterococci, fecal coliform, and E. coli), any illicit discharges must be addressed by the permittee regardless of the assignment of a WLA. Existing programmatic practices, ordinances, and outreach currently in place under the MS4 program may be sufficient to address anthropogenic sources of bacteria. For these TMDLs, permittees are encouraged to consider practices such as public outreach and education to influence behaviors. This may include signage and supplies to encourage the collection and removal of pet waste at areas of high concentration, such as dog parks; residential outreach through fliers or pamphlets included with utility bills; and other education programs. Permittees may wish to reference the Environmental and Water Resource Institute's 2014 Pathogens in Urban Stormwater Report for techniques that can be used to address these TMDLs.

Polychlorinated Biphenyl (PCB) TMDLs
The recommended method to address these contaminants is through a pollutant minimization approach. Permittees may consider tracing back through the system and identifying past and current high risk land uses, followed by confirmation monitoring of soil and/or stormwater runoff when appropriate to address PCB sources. Upon discovery of a source of PCBs, a collaborative effort with DEQ may be necessary to address the site.

COMPLIANCE

To demonstrate compliance with the Special Condition for Local TMDLs, permittees must submit TMDL Action Plans that include all of the items listed in Section I.B in accordance with the schedule described in the permit. Permittees are responsible for meeting the schedule and milestones set in the approved Action Plan. If a permittee determines that elements of the approved Action Plan are insufficient to meet the WLA, a modification request should be submitted to DEQ as soon as the permittee determines that the plan needs to be updated. Modifications to the approved Action Plan may be made in accordance with GP Section II.F.1. The Department may also request that the Action Plan be modified to include additional and/or alternative strategies to address the POC. The Department encourages permittees subject to aggregate WLA(s) to take a collaborative approach to addressing those WLAs.

The permittee must make adequate progress in meeting the WLA in accordance with the approved Action Plan(s). Permittees are encouraged to discuss any concerns regarding demonstration of adequate progress with DEQ's MS4 permitting staff.

MODIFICATIONS

Permittees may make modifications to the approved TMDL Action Plan(s) as new opportunities become available or proposed projects/strategies are deemed infeasible or ineffective. TMDL Action Plan modification may be requested by the permittee at any time during the implementation of the Action Plan(s) by contacting the DEQ regional MS4 staff.

PRIORITIZATION

MS4 permittees may be assigned multiple TMDL WLAs. Permittees may prioritize TMDL Action Plan implementation using best professional judgment, including knowledge of the local watersheds, the local infrastructure, and insight into local water quality planning efforts to determine the number and types of BMPs that will be necessary to meet the requirements of the local TMDLs. The permittee should include as part of the Action Plan a section that establishes the justification for the prioritization and the proposed implementation schedule. If appropriate, permittees may address multiple TMDLs within a single Action Plan, although all applicable TMDL WLA's must be addressed in accordance with the schedule described above.

APPENDIX C – TOWN OF DUMFRIES MS4 SERVICE AREA MAP

Draper Aden Associates

Engineering • Surveying • Environmental Services

Town of Dumfries MS4 Service Area

November, 2015

REVISIONS

DESIGNED BY: CEP

DRAWN BY: CEP

CHECKED BY: CAH

SCALE: 1" = 400'

DATE: NOVEMBER 13, 2015

PROJECT NUMBER: **B15147B-01**

1 of 1

APPENDIX D – PUBLIC EDUCATION AND OUTREACH PROGRAM

Public Education Outreach Program

A component of the

Virginia Municipal

Separate Storm Sewer System Management Program

Town of Dumfries, Virginia

Public Works Department

17755 Main Street

Dumfries, VA 22026

Adopted 12-1-15

Table of Contents

1.0 Introduction

The purpose of the Public Education Outreach Program (PEOP) is to identify the community involvement approach the Town of Dumfries will use to promote methods to reduce the discharge of pollutants in stormwater runoff. The Town of Dumfries' Public Works Department is responsible for coordinating the PEOP for the town's municipal storm sewer system (MS4) management program.

1.1 Goals

The Virginia General Permit for Discharges of Stormwater from Small MS4s (General Permit), published at 9 VAC-25-890-40 et al, has specific requirements for public education and outreach efforts. The Town of Dumfries obtained coverage under the 2013 General Permit as General Permit Number VAR040117.

As required in Section II, Part B. 1.b of the General Permit, this plan was designed with the consideration of the following goals:

- Increasing target audience knowledge about the steps that can be taken to reduce stormwater pollution, placing priority on reducing impacts to impaired waters and other local water pollution concerns
- Increasing target audience knowledge of hazards associated with illegal discharges and improper disposal of waste, including pertinent legal implications; and
- Implementing a diverse program with strategies that are targeted toward audiences most likely to have significant stormwater impacts

1.2 Objectives

The PEOP outlines a plan for communicating with the people living and working within the Town of Dumfries that will support the Town's objective of achieving improved water quality through reduced pollutant loads entering water bodies through the Town's small MS4. Implementation of the actions described under this program will help the Town achieve the objective of improving water quality in the Town of Dumfries.

The PEOP complies with the General Permit requirements to:

- Identify, at a minimum, three high-priority water quality issues, that contribute to the discharge of stormwater and provide a rationale for the selection of these issues;
- Identify and estimate the population size of the target audience(s) associated with each high-priority water quality issue;
- Develop relevant message(s) and associated educational materials for message distribution to target audiences while considering minorities, disadvantaged audiences, and minors;
- Provide for public participation during PEOP development
- Annually conduct outreach activities designed to reach 20% of the target audience for each high-priority water quality issue. Failing to reach that goal is not considered a compliance issue unless "insufficient effort" is made to reach that goal; and
- Provide for the adjustment of target audiences and messages, including educational materials and delivery mechanisms to reach target audiences, in order to address any observed weaknesses or shortcomings.

2.0 Municipal Separate Storm Sewer System Stormwater Management Program

The Town of Dumfries is an operator of a Small Municipal Separate Storm Sewer System (MS4). A municipal separate storm sewer is defined as "a conveyance or system of conveyances otherwise known as a municipal separate storm sewer system, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains

1. Owned or operated by a federal, state, Town, county, district, association, or other public body, created by or pursuant to state law, having jurisdiction or delegated authority for erosion and sediment control and stormwater management agency under § 208 of Clean Water Act that discharges to surface waters;
2. Designed or used for collecting or conveying stormwater;
3. That is not a combined sewer; and
4. That is not a part of a publicly owned treatment works"

The US Census in 2010 determined the Town's population to be 4,961, that the Town is within an Urbanized Area, and thus subject to the General VPDES Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems which became effective July 1, 2013 and will expire on June 30, 2018 when a new permit cycle is expected to become effective. Among the requirements of the permit, the Town of Dumfries must develop and implement a PEOP as one measure to prevent harmful pollutants from entering the Town's MS4. This document fulfills the requirement to develop a PEOP.

2.1 Background

Common stormwater pollutants that may be found in the Town of Dumfries MS4 area include bacteria from pet waste; chemicals contained in materials used on green spaces such as fertilizers; and chemicals contained in leaked, spilled or dumped materials such as oils, cleaners, paints, and pesticides.

2.2 Applicable Regulations

As a small MS4 operator, the Town of Dumfries is obligated to comply with the requirements set forth in the "General Permit for Discharges of Stormwater from Small Municipal Storm Sewer Systems", General Permit No. VAR040117, dated July 1, 2013. The permit establishes six "minimum control measures" (MCMs) to prevent stormwater pollution in the MS4:

1. Public education and outreach on stormwater impacts
2. Public involvement and participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction runoff control for development and redevelopment
6. Good housekeeping and pollution prevention for municipal operations

The Town's MS4 Program Plan (which is updated annually) outlines specific actions, known as best management practices (BMPs), that the Town will use to address the six MCMs. The General Permit issued on July 1, 2013, mandate the preparation of a plan which addresses public education and outreach. Under this plan, there are opportunities for communicating with the people living and working in the Town of Dumfries that will support the broad goals of improved water quality through reduced pollutant loads entering water bodies through the Town's MS4.

3.0 Community Conditions

The Town of Dumfries in an incorporated town located in Northern Virginia and is surrounded by Prince William County. The Town comprises approximately 1.6 square miles of urban mixed land use development located approximately 25 miles south of Washington, D.C.

3.1 High Priority Water Quality Issues

The Town of Dumfries must identify at least three high-priority water quality issues, and provide rationale for their selection in accordance with the General Permit. The Town has identified four high-priority issues for this permit cycle.

3.1.1 Bacteria Impacts to Water Quality from Pet Waste

The EPA recommends E. coli as the best indicator of health risk from water contact in recreational waters. In urban areas, such as the Town of Dumfries, sources of E. coli include human fecal matter (in the case of poorly functioning wastewater treatment plants or septic systems) or animal fecal matter (both domesticated animals and wildlife). The Town of Dumfries has selected bacteria from pet waste as one of its four high-priority water quality issues on which public education and outreach efforts will focus. Section 5.1 of this document will provide the rationale for this selection.

3.1.2 Illicit Discharges from Commercial Automobile Washes

According to the Virginia Stormwater Management Program (VSMP) Regulations (9VAC25-870-10), illicit discharge is defined as "any discharge to municipal separate storm sewer that is not composed entirely of stormwater, except discharges pursuant to a separate Virginia Pollutant Discharge Elimination System (VPDES) or state permit (other than the state permit for discharges from the municipal separate storm sewer), discharges resulting from firefighting activities, and discharges identified by and in compliance with 9VAC25-870-400." Illicit discharge detection and elimination (IDDE) is important because stormwater runoff from the Town of Dumfries' MS4 flows into streams and rivers without additional treatment. The Town of Dumfries has selected illicit discharges related to commercial automobile shops as the second high-priority water quality issue on which public education and outreach efforts will focus. Section 5.1 of this document will provide the rationale for this selection.

3.1.3 Illicit Discharges from Automobile Repair Shops

The Town of Dumfries has selected illicit discharges related to automobile repair shops as the third high-priority water quality issue on which public education and outreach efforts will focus. Section 5.1 of this document will provide the rationale for this selection.

3.1.4 Illicit Discharges from Restaurants

The Town of Dumfries has selected illicit discharges related to restaurants as the fourth high-priority water quality issue on which public education and outreach efforts will focus. Section 5.1 of this document will provide the rationale for this selection.

4.0 Current and Past Community Outreach Efforts

As noted in Section 2.2 of this document, the Town of Dumfries must meet the requirements in the Virginia General Permit for Discharges of Stormwater from Small MS4s. The Town has identified numerous BMPs to comply with the permit's MCMs to prevent stormwater pollution within the MS4. These actions are reviewed below.

4.1 Existing Program

The Town of Dumfries added a stormwater page to their website located at http://www.dumfriesva.gov/governmentpublic-worksmunicipal-separate-storm-sewer-system-ms4. The page is used to provide citizens with information about the stormwater program. Available on the page are annual progress reports, pollution reporting form, and other educational and environmental information. The Town is also a member of the Northern Virginia Clean Water Partners.

4.2 Existing Resources

The Town has conducted several community outreach activities in the past and has a variety of existing resources at their disposal including:

- Promotional material prepared by the Northern Virginia Clean Water Partners
- Outreach Handouts (About 100 of the following were distributed at the September 13, 2014 Fall Festival):
  - "Taking Care of Stormwater"
  - "Town of Dumfries, Virginia- How to Dispose of Leaves the Bay-friendly Way"

5.0 Public Education and Outreach Planning

Stormwater runoff is generated from various pervious and impervious surfaces such as roads, sidewalks, lawns, managed green spaces, driveways and roofs. Efforts to control stormwater pollution must take into account individual, household, business, and public behaviors and activities that can generate pollution coming from these surfaces. The purpose of outreach is to educate the public about the impact their actions can have on stormwater pollution, and to encourage changes in behavior to reduce future stormwater pollution. The goals of the PEO program are to educate the public by:

- Increasing target audience knowledge about the steps that can be taken to reduce stormwater pollution, placing priority on reducing impacts to impaired waters and other local water pollution concerns;
- Increasing target audience knowledge of hazards associated with illegal discharges and improper disposal of waste, including pertinent legal implications; and
- Implementing a diverse program with strategies that are targeted toward audiences most likely to have significant stormwater impacts.

The following sections present the rationale used to develop the PEO program and the process to be followed to implement the plan.

5.1 High-Priority Water Quality Issues

The Town of Dumfries will focus on the four high-priority water quality issues identified in Section 3.2. The high-priority water quality issues, along with the rationale as to why they were selected, are presented in **Table 1** below.

Table 1. High-Priority Water Quality Issues

High-Priority Water Quality Issue	Rationale
Bacteria-Pet Waste	Bacteria from pet waste (such as E. Coli), has been identified as a significant concern that is contributing to impairments in waters in Virginia and the Town of Dumfries. There is a significant target population with whom to work within the Town.
Illicit Discharges- Commercial Automobile Washes	Improper discharges from car washes can result in the release of oil and grease, detergents, phosphates, debris and other hazardous chemicals to waters of Virginia and the Town of Dumfries.
Illicit Discharges- Automobile Repair Shops	Wastewater at auto repair shops is often generated by rinsing of parts and washing engines or dirty tools. Improper discharges from auto repair shops can result in the release of oil and grease, antifreeze, paints, and other hazardous solvents to waters of Virginia and the Town of Dumfries.
Illicit Discharges- Restaurants	Restaurants can be a significant source of illicit discharges into stormwater systems. Improper discharges from restaurants can result in the release of fats, oils, grease, debris, and hazardous chemicals to waters of Virginia and the Town of Dumfries.

5.2 Target Audiences

Population characteristics of the Town of Dumfries MS4 were evaluated to identify the Town populations to be reached by the education and outreach effort. Target audiences were selected through an assessment of the Town's community profile. The target audiences for stormwater outreach are shown in **Table 2** below.

High-Priority Water Quality Issue	Topic of Concern	Target Audience	Size
Bacteria- Pet waste	Pet waste	Homeowners and residents with pets	575 dogs (36.5% of US households x 1573 households)
Illicit Discharges- Commercial Auto Washes	Proper disposal of wastewater and debris	Commercial auto washes within the Town of Dumfries MS4	2
Illicit Discharges- Auto Repair Shops	Proper disposal of wastewater and hazardous chemicals	Auto repair shops within the Town of Dumfries MS4	24

Illicit Discharges-Restaurants	Proper disposal of fats, oils, grease, and other hazardous chemicals	Restaurants within the Town of Dumfries MS4	15

Pet Waste- To reduce levels of bacteria, the focus will be on pet waste from dogs. The Town has approximately 575 registered dog owners in the MS4 permit area.

Commercial Auto Washes- Proper disposal of wastewater and chemicals from commercial auto washes will be the focus of illicit discharge control. There are approximately 2 auto wash companies in the MS4 permit area.

Auto Repair Shops- Proper disposal of wastewater and chemicals from auto repair shops will be another focus of illicit discharge control. There are approximately 24 auto repair shops within the MS4 permit area.

Restaurants- Proper disposal of fats, oils, grease, and wastewater from restaurants will also be a focus of illicit discharge control. There are approximately 15 restaurants located within the MS4 permit area.

5.3 Plan Implementation

A variety of actions will be conducted to educate the public in attempts to change behavior within the Town's permitted MS4 area. Actions will be focused on targeted audiences and high-priority water quality issues identified in this implementation plan. The framework for action was introduced in **Table 2**, details for implementation are provided below.

5.3.1 Actions and Messages

The messages developed for public education and outreach will be provided in both English and Spanish language versions. Attention will be given to developing informative, easily-understood materials.

Pet Waste

<u>Written Materials</u>- A trifold brochure that presents the impact animal waste can have on water quality will be developed.

<u>Active Engagement</u>- In-person presentations for selected targeted audiences will be provided.

The brochure will address pet waste as a major source of the bacteria found in waters within the Town that needs to be reduced. Topics that will be addressed: Why pet waste is a concern; how it can impact local water by affecting bacteria levels; and simple ways to keep pet waste out of water. Local contact information and sources for additional information will be included.

Commercial Automobile Washes

<u>Written Materials</u>- A set of take-home training handouts for recipients of the training.

<u>Active Engagement</u>- In-person training for auto wash companies within the Town of Dumfries.

The training information will address the basics of stormwater runoff and how improper water discharges to the storm sewers contribute to the degradation of water quality in nearby waters. Training materials will include: why car washes are a concern and how they can impact local water; how to manage and discharge wastewater; and ways to make car washes more environmentally friendly. Local contact information and other sources for additional information will be provided. **Automobile Repair Shops**

Written Materials- A set of take-home training handouts for recipients of the training.

Active Engagement- In-person training for auto repair shops that operate within the Town of Dumfries.

The training for auto repair shops will address the basics of stormwater runoff and how improper control of chemicals and discharge of wastewater can contribute to the degradation of water quality in nearby waters. The training materials will include the do's and don'ts for disposing of hazardous waste, discharging wastewater, and managing spills.

Restaurants

Written Materials- A set of take-home training handouts for recipients of the training.

Active Engagement- In-person training for restaurants that operate within the Town of Dumfries.

The training information for restaurants will address the basics of stormwater runoff and how improper disposal of waste from food preparation can contribute to the degradation of water quality in nearby waters. Training materials will include: how restaurants can be a source for illicit discharge, how to dispose of waste properly; and how to prevent accidental contamination. Local contact information and other sources for additional information will be provided.

5.3.2 Format and Distribution

Brochures will include visually appealing graphics and will provide information in easily understood terms. Use of existing themes developed under previous Town outreach efforts will be continued and where appropriate supplemented with new or additional color schemes, graphics, and slogans. These features will be used throughout the Town's stormwater education and outreach efforts. Repeating themes enhances the familiarity of the community with messages related to stormwater management and thus the same themes will be used to develop training materials for commercial automobile washes, automobile repair shops, and restaurants.

Brochures will be distributed to HOAs within the MS4 permit area along with a cover letter explaining the importance of the brochure and its intended use. Follow-up with communication with HOA points of contact will be critical to ensuring effectiveness.

5.4 Public Participation

The Town's MS4 permit also requires that the public be given the opportunity to participate in the development of the PEOP. Expanded education and outreach requirements must be implemented for the remaining years of the permit. Each year, there must be an evaluation of the strengths and weaknesses of the education and outreach effort improvements, if any, that will be implemented in the next permit year.

5.4.1 Involvement of the Community in Program Development

As noted in Section 1.2 of this plan, there are a number of required actions specified in the permit related to the public education and outreach. This plan provides for these actions as stated in the previous sections. Input from the community can help to increase the success of education efforts.

Citizens are invited to give input on ideas about how the Town can inform the public of best management practices related to stormwater. Opportunities for public input are advertised to improve citizen awareness.

5.5 Evaluation

The methodology for evaluating the effectiveness of the education and outreach program is provided in this section. Despite best efforts, there is usually room for improvement once the program has been implemented. Program success requires continued evaluation and modification where necessary.

A planned evaluation process is necessary to record strengths and weaknesses encountered during program implementation. Observations and evaluations will be made and feedback will be sought and documented at the following key points in the process:

1. Planning and Development- time during which activities and educational tools are identified, developed, and scheduled;
2. Execution of Actions- time during which planned activities and educational tools are conducted and introduced to community;
3. Target Audience Feedback- time during which members of the targeted audience provide feedback regarding their understanding of the need to change behavior;
4. Behavior Change and Evaluation Period- time during which the Town observes improved conditions within a targeted audience related to stormwater pollution.

Feedback during the planning and development period may indicate the need to add additional audiences or alter the way educational material is presented. Activities may need to be changed to better address the needs of the Town or of the targeted audience.

During the execution of actions stage, feedback regarding general difficulties encountered and responsiveness from targeted audiences will be recorded.

After the first year of conducting education and outreach activities on stormwater pollution reduction, feedback from targeted audiences will be formally sought. Short surveys seeking input should be developed and distributed. For the auto washes, auto repair shops, and restaurants, surveys can be distributed to the points of contact established for each business.

There will be an organized formal effort to determine the percentage of the target audience reached in any given year, along with how effective that communication was in changing behavior. Observed changes will be recorded and reported. The evaluation process will identify strengths and weaknesses associated with the POE program. Significant changes identified during this process will be made as soon as possible or at the end of each annual review cycle. Minor issues will be considered and addressed immediately when appropriate.

5.6 Additional Opportunities for Education and Outreach

The Town of Dumfries' Public Works Department is fully committed to maintaining compliance with its MS4 Permit requirements. The PEOP is designed to guide the Town through the required steps to increase target audience knowledge about stormwater pollution reduction. The PEOP was developed to address the MS4 Permit requirements for MCM 1, as noted in Section 2.2. Other education and outreach steps may be taken to supplement other aspects of permit compliance and to improve water quality in the Town. The Town will revise and adapt the PEOP throughout the permit term in order to address noted weaknesses or shortcomings.

APPENDIX E – TOWN OF DUMFRIES MS4 PROGRAM PLAN

Town of Dumfries, Virginia

MS4 Program Plan

Cycle: July 1, 2013 – June 30, 2018
Permit Number: VAR040117

In compliance with the Virginia Stormwater Management Program (VSMP) General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4)

Program Plan Prepared by: Town of Dumfries

Adopted 12-1-15

Town of Dumfries
MS4 Program Plan

Contents

1. Introduction

The Town of Dumfries is an incorporated town located in Northern Virginia and is surrounded by Prince William County. The Town comprises approximately 1.6 square miles of urban mixed use land development located approximately 25 miles south of Washington, D.C. The town is an operator of a Small Municipal Separate Storm Sewer System (MS4). A *municipal separate storm sewer* means "a conveyance or system of conveyances otherwise known as a municipal separate storm sewer system, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains:

1. Owned or operated by a federal, state, Town, town, county, district, association, or other public body, created by or pursuant to state law, having jurisdiction or delegated authority for erosion and sediment control and stormwater management, or a designated and approved management agency under § 208 of CWA that discharges to surface waters;
2. Designed or used for collecting or conveying stormwater;
3. That is not a combined sewer; and
4. That is not part of a publicly owned treatment works."

The US Census in 2010 determined the Town's population to be 4,961, that the Town is within an Urbanized Area, and thus subject to the General VPDES Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems, which became effective July 1, 2013 and will expire on June 30, 2018 when a new permit cycle is expected to become effective. As required by the MS4 permit, this report addresses items of the Town of Dumfries MS4 Program pertinent to the Virginia General Permit for Discharges from Small Municipal Storm Sewer Systems.

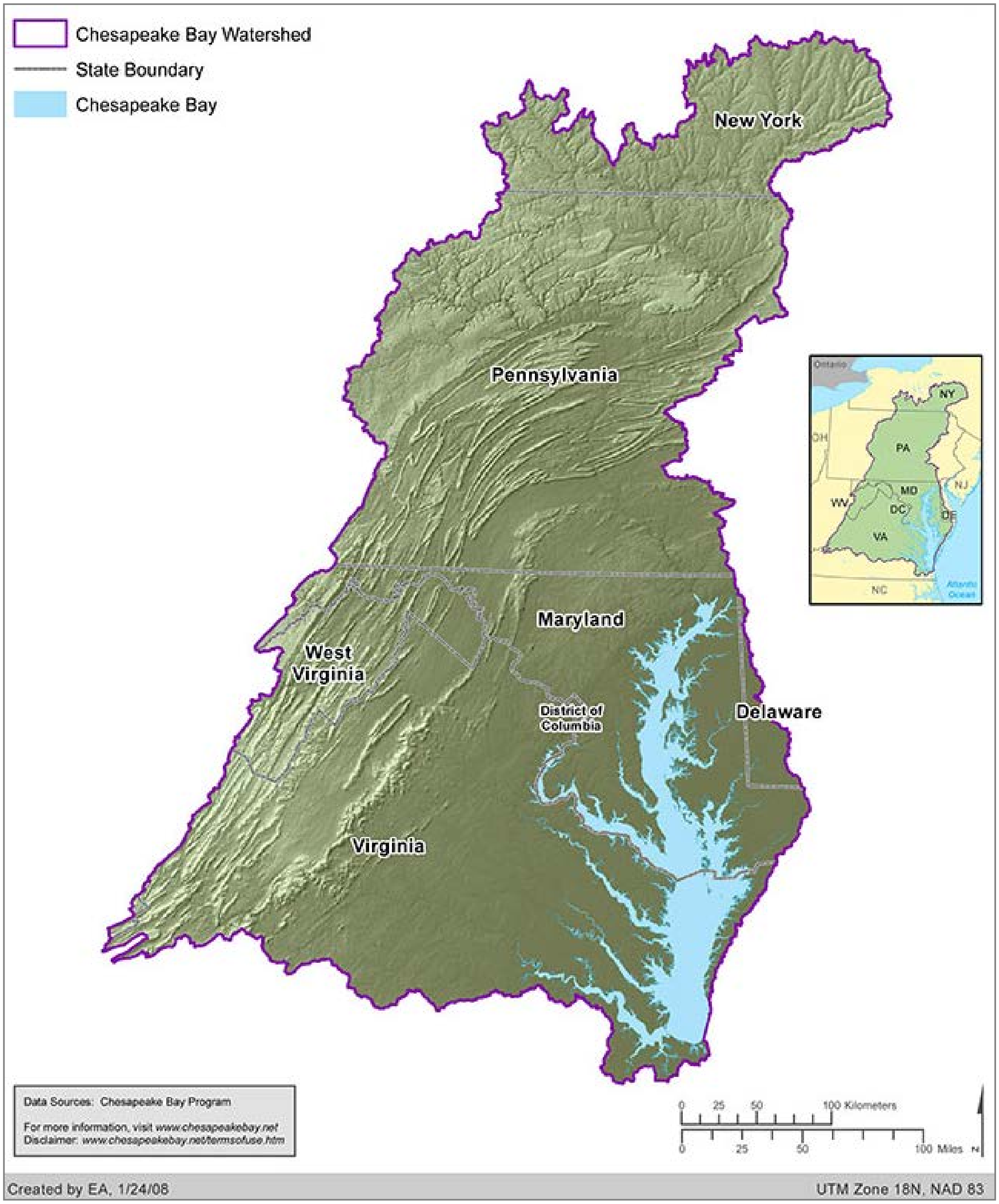
2. Watersheds

The Town of Dumfries's 1.6 square miles is highly urbanized and is encompassed by a sole watershed area, Quantico Creek, which discharges into the Potomac River. If appropriate measures are not taken to protect and prevent further degradation to Quantico Creek, water quality will decline beyond current existing conditions.

Subwatershed Name	Hydrologic Unit Code (HUC)	Approximate Length (miles) within Dumfries	Approximate Drainage Area (acres)	Impairments	TMDL WLA?
Quantico Creek	020700110104	1.45	4,877	▪ PCB in Fish Tissue ▪ Estuarine Bioassessments ▪ Sediment	No

Quantico Creek Watershed, Prince William County, VA

The Town of Dumfries also drains into the Chesapeake Bay Watershed. The Chesapeake Bay Watershed is 64,000 square miles and includes portions of New York, Pennsylvania, Delaware, Maryland, West Virginia, and Virginia. Altogether, more than 100,000 streams, creeks and rivers make up the Chesapeake Bay Watershed. As part of the Special Conditions for the Chesapeake Bay TMDL, the MS4 Permit requires the Town of Dumfries to address impairments for phosphorus, nitrogen, and sediment that enter the Chesapeake Bay.



Chesapeake Bay Watershed Map

3. Organizational Structure

The Town of Dumfries' Public Works Department coordinates the Town's municipal separate storm sewer system (MS4) program. The Public Works Department's Public Works Director is responsible for developing and updating the MS4 Program Plan and submitting Annual Reports. The Town Manager is responsible for providing the appropriate certification for documents. The Department of Community Services, Police Department, and other relevant town staff are the major contributors to Dumfries' MS4 Program although it is recognized that this is a town-wide and community-wide program.

The MS4 Program Plan that follows identifies which town department and title of the staff person(s) responsible for implementing specific best management practices.

4. Contact Information

Principal Executive Officer
Title: Town Manager Name: Daniel Taber Address: 17755 Main St. Dumfries, VA 22026 Phone: (703) 221-3400 Email: dtaber@dumfriesva.gov

Duly Authorized Representative
Title: Public Works Director Name: Richard West Address: 17755 Main St. Dumfries, VA 22026 Phone: (703) 221-3400 Email: rwest@dumfriesva.gov

5. MS4 Program Plan

The MS4 Program Plan details the Town of Dumfries' comprehensive program to manage the quality of stormwater runoff discharged from the MS4. This section of the MS4 Program plan is categorized into the following six minimum control measures and special conditions for TMDLs:

1. Public education and outreach on stormwater impacts
2. Public involvement and participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction runoff control for development and redevelopment
6. Good housekeeping and pollution prevention for municipal operations
7. Virginia TMDL Special Conditions
8. Chesapeake Bay TMDL Special Conditions

This MS4 Program Plan will be reviewed annually and updated as necessary. This MS4 Program Plan will remain on file in the Public Works Department and on Dumfries' stormwater webpages:

http://www.dumfriesva.gov/governmentpublic-worksmunicipal-separate-storm-sewer-system-ms4

Minimum Control Measure #1: Education & Outreach on Stormwater Impacts

The MS4 Permit requires the Town of Dumfries to design public education and outreach programs with consideration of the following goals:

1. Increasing target audience knowledge about the steps that can be taken to reduce stormwater pollution, placing priority on reducing impacts to impaired waters and other local water pollution concerns.

2. Increasing target audience knowledge of hazards associated with illegal discharges and improper disposal of waste, including pertinent legal implications.

3. Implementing a diverse program with strategies that are targeted towards audiences most likely to have significant stormwater impacts.

<table>
<tr><th>BMP 1.1 Develop and Implement Stormwater Public Education and Outreach Program</th></tr>
<tr><td>1.1.1 Description: The Town shall continue to implement an education and outreach program as included in the registration statement until the program is updated to meet the conditions of this permit.</td></tr>
<tr><td>1.1.2 Goals and Objectives: The MS4 Permit requires the Town of Dumfries to design public education and outreach programs with consideration of the following goals:

1. Increasing target audience knowledge about the steps that can be taken to reduce stormwater pollution, placing priority on reducing impacts to impaired waters and other local water pollution concerns.
2. Increasing target audience knowledge of hazards associated with illegal discharges and improper disposal of waste, including pertinent legal implications.
3. Implementing a diverse program with strategies that are targeted towards audiences most likely to have significant stormwater impacts.</td></tr>
<tr><td>1.1.3 Responsible Departments/Employees:

<u>Public Works Department</u>
Public Works Director
Assistant Public Works Director
Public Works and Zoning Program Administrator</td></tr>
<tr><td>1.1.4 Schedule of Implementation: High-priority issues for education and outreach are set forth in the Education and Outreach Program. These issues will be evaluated annually. Existing efforts will either be continued or activities for new issues will be developed. The Town will use citizen calls, complaints, site visits, and other methods of outreach to help inform our selection of priority issues each year.</td></tr>
</table>

1.1.5 Annual Reporting Requirements:

- A list of education and outreach activities conducted during the reporting period for each high- priority water quality issue, the estimated number of people reached, and the estimated percentage of the target audience or audiences that will be reached (See BMP 1.2).
- A list of education and outreach activities that will be conducted during the next reporting period for each high-priority water quality issue, the estimated number of people that will be reached, and the estimated percentage of the target audience or audiences that will be reached (See BMP 1.3).

Program Plan Requirements:

- The MS4 Program Plan shall describe how the conditions of the permit shall be updated.

Permit Cycle Requirement (*five years*):

- Evaluate the education and outreach program for:
  - Appropriateness of the high-priority stormwater issues;
  - Appropriateness of the selected target audiences for each high-priority stormwater issue;
  - Effectiveness of the messages or messages being delivered; and
  - Effectiveness of the mechanism or mechanisms of delivery employed in reaching target audiences.

1.*1.6 Describe how the Conditions of this Permit shall be attained.*

The Education and Outreach Plan will be referenced in the 2014-15 MS4 Annual Report. Education and outreach initiatives occurred in the 2014-15 reporting year, but they will not coincide with the Education and Outreach Plan until the 2015-2016 reporting year.

BMP 1.2 List of Education and Outreach Activities Conducted During Reporting Period

1.2.1 Description: The Town shall continue to document the annual activities for the reporting period.

1.2.2 Goals and Objectives: Accurately and consistently document, report, and announce all education and outreach activities conducted during the annual reporting cycle.

1.2.3 Responsible Departments/Employees:

Public Works Department
Public Works Director
Assistant Public Works Director
Public Works and Zoning Program Administrator

1.2.4 Schedule of Implementation: The Town will follow its Public Education and Outreach Program for its annual activity implementation. The program will be evaluated annually as set forth in BMP 1.1 and activities for the current reporting period submitted accordingly.

1.2.5 Annual Reporting Requirements:

- A list of education and outreach activities conducted during the reporting period for each high- priority water quality issue, the estimated number of people reached, and the estimated percentage of the target audience or audiences that will be reached.

BMP 1.3 List of Education and Outreach Activities To Be Conducted During Next Reporting Period

1.3.1 Description: The Town shall continue to announce and list the education and outreach activities planned for the next reporting period. Proposed education and outreach initiatives include:

- Handing out educational brochures at Town events on various topics such as impacts of pet waste on water quality, basic stormwater management practices, and proper disposal of leaves.
- In-person trainings for automobile washes, automobile repair shops, and restaurants to address the basics of stormwater runoff and how improper water discharges from these establishments can degrade water quality in local waters.

1.3.2 Goals and Objectives: Accurately and consistently promote, announce, document and report all upcoming education and outreach activities, including those planned for the next program year.

1.3.3 Responsible Departments/Employees:

<u>Public Works Department</u>
Public Works Director
Assistant Public Works Director
Public Works and Zoning Program Administrator

1.3.4 Schedule of Implementation: The Town will follow its Public Education and Outreach Program for its annual activity implementation, including that of each upcoming year. The program will be evaluated annually as set forth in BMP 1.1 and activities for the forthcoming reporting period submitted accordingly.

1.3.5 Annual Reporting Requirements:

- A list of education and outreach activities that will be conducted during the next reporting period for each high-priority water quality issue, the estimated number of people that will be reached, and the estimated percentage of the target audience or audiences that will be reached.

Minimum Control Measure #2: Public Involvement/Participation

BMP 2.1: Maintaining Updated MS4 Program Plan and Annual Reports
2.1.1 Description: The Town of Dumfries will review and, as needed, will update the MS4 Program Plan in conjunction with the Annual Report as required at a minimum of once a year. The Town shall post copies of the MS4 Program Plan on its website within 30 days of submittal of the Annual Report. The Town shall solicit public comment of the MS4 Program Plan prior to applying for coverage and address how comments were received on the MS4 Program Plan as part of the reapplication package.
2.1.2 Goals and Objectives: To solicit public participation and comment through availability of MS4 Program Plan.
2.1.3 Responsible Departments/Employees: Public Works Department *Public Works Director* *Public Works and Zoning Program Administrator*
2.1.4 Schedule of Implementation: • Promote availability of the MS4 Program Plan to citizens (posting online, etc.): Years 1-5 • Solicit and receive public comment on MS4 Program Plan prior to applying for coverage: Years 4-5 • Update MS4 Program Plan as needed: Years 1-5
2.1.5 Policies and Procedures: The Public Works Director is responsible for updating and making available the MS4 Program Plan. The Public Works Director will make the Town's MS4 Program Plan and Annual Reports available on the Town's website: www.dumfriesva.gov. This MS4 Program Plan will be reviewed annually and updated as necessary. The Town will receive and document public comments on the proposed MS4 Program Plan and address comments, as appropriate, in updates to the MS4 Program Plan. Prior to applying for coverage for the next permit cycle (2018-2023), the Town of Dumfries will notify the public and provide for receipt of comment of the proposed MS4 Program Plan that will be submitted with the registration statement.
2.1.6 Annual Reporting Requirements: • The Town shall post copies of the MS4 Program on the Town website within 30 days of submittal of the Annual Report (Due each October 1). • Post copies of the Annual Report to the Town website within 30 days of submittal to VDEQ and retain copies of Annual Reports online for the duration of this state permit.

BMP 2.2: Public Participation Events
2.2.1 Description: The Town of Dumfries will participate in at least four local activities annually. Participation can be through promotion, sponsorship, or other involvement. Information for these activities will be advertised, tracked, and stored in the Town's archives and online. The four activities planned for the five year permit cycle may vary. Below are examples of four proposed events: • Quantico Creek Clean Up • Storm Drain Marking • Elementary School Field Trips • Informational Table at Town Events
2.2.2 Goals and Objectives: To increase public participation to reduce stormwater pollutant loads; improve water quality; and support local restoration and clean-up projects, programs, groups, meetings or other opportunities for public involvement.
2.2.3 Responsible Departments/Employees: Public Works Department *Public Works Director* *Public Works Assistant Director* *Public Works and Zoning Program Administrator* Community Services Department *Community Services Director*
2.2.4 Schedule of Implementation: • Annually evaluate success of events completed in previous reporting year (Years 1-5) • Next reporting year, identify four (4) activities in which the Town will participate (Years 1-5)
2.2.5 Procedure for Implementation: The Public Works Director is responsible for ensuring that at least four (4) activities are identified, and that a responsible lead is identified for each activity.
2.2.6 Annual Reporting Requirements • Documentation of compliance with the public participation requirements of permit. **Program Plan Requirements** • The MS4 Program Plan shall include written procedures for implementing this program.

Minimum Control Measure #3: Illicit Discharge Detection and Elimination

BMP 3.1: Storm Drain System, Outfalls, and Information Map

3.1.1 Description: The Town of Dumfries will maintain an updated map of the Town's MS4 system.

3.1.2 Goals and Objectives: Maintenance and updates of the Storm Drain System Map.

3.1.3 Responsible Departments/Employees:

<u>Public Works Department</u>
Public Works Director
Assistant Public Works Director
Maintenance Crew

3.1.4 Policies and Procedures:

The storm sewer system map must show the following, at a minimum:

- The location of all MS4 outfalls. In cases where the outfall is located outside of the MS4 operator's legal responsibility, the operator may elect to map the known point of discharge location closest to the actual outfall. Each mapped outfall must be given a unique identifier, which must be noted on the map; and
- The name and location of all waters receiving discharges from the MS4 outfalls and the associated HUC.

The associated information table shall include for each outfall the following:

- The unique identifier;
- The estimated MS4 acreage served;
- The name of the receiving surface water and indication as to whether the receiving water is listed as impaired in the Virginia 2010 303(d)/305(b) Water Quality Assessment Integrated Report; and
- The name of any applicable TMDL or TMDLs.

3.1.5 Schedule of Implementation:

- Update Town's Storm Drain System Map: Years 1-5
- Have complete and updated storm sewer system map and information table: Year 3

3.1.6 Annual Reporting Requirements:

- None. Data available upon request.

BMP 3.2: Maintenance of BMP Tracking System
3.2.1 Description: The Town of Dumfries will maintain a BMP tracking system.
3.2.2 Goals and Objectives: Maintenance and update of the BMP tracking system
3.2.3 Responsible Departments/Employees: Public Works Department *Public Works Director* *Assistant Public Works Director* *Public Works and Zoning Program Administrator*
3.2.4 Policies and Procedures: The BMP Tracking System must contain: • All eligible developed/urban BMPs that have been implemented and documented since July 1, 1999; • General BMP information such as BMP type, location/address, property owner, installation date, and maintenance agreement information; • Utilize Quality Assurance/Quality Control Measures to ensure integrity of the data.
3.2.5 Schedule of Implementation: • Update BMP Tracking System: Year 2 • Have complete and updated BMP Tracking System: Year 3
3.2.6 Annual Reporting Requirements: • None. Data available upon request.

BMP 3.3: Bacteria Sampling and Testing
3.3.1 Description: The Town of Dumfries will maintain an updated map of the Town's MS4 system.
3.3.2 Goals and Objectives: Continue annual bacteria sampling and testing to report to DEQ.
3.3.3 Responsible Departments/Employees: Public Works Department *Public Works Director* *Assistant Public Works Director* *Public Works and Zoning Program Administrator* Prince William County Soil & Water Conservation District *Volunteers*

3.3.4 Policies and Procedures: The Prince William County Soil & Water Conservation District utilizes volunteers to take bacteria samples from four identified point sources and report the results to DEQ annually.
3.3.5 Schedule of Implementation: • Annual reporting of bacteria sampling and testing: Years 1-5
3.3.6 Annual Reporting Requirements: • Data is submitted to DEQ annually and posted on the State's website.

BMP 3.4 Notification of Regulated Downstream MS4
3.4.1 Description: The Town of Dumfries will notify, in writing, any downstream regulated MS4 to which the small regulated MS4 is physically interconnected.
3.4.2 Goals and Objectives: To notify downstream regulated MS4s and to be notified from upstream MS4s to assist in identifying the potential source of pollutants should an illicit discharge be found.
3.4.3 Responsible Departments/Employees: Public Works Department *Public Works Director* *Public Works Assistant Director* *Public Works and Zoning Program Administrator*
3.4.4 Implementation Schedule: • Send written notice to downstream MS4: Year 3 • Document received written notice from upstream MS4 (PWC, VDOT): Year 2
3.4.5 Annual Reporting Requirements: • A list of written notifications of physical interconnection given by the Town to other MS4s.

BMP 3.5: Illicit Discharges & Connections Ordinance
3.5.1 Description: The Town of Dumfries will effectively prohibit non-stormwater discharges into the storm sewer system by adopting an Illicit Discharges and Connections ordinance.
3.5.2 Goals and Objectives: To use an Illicit Discharge & Connections ordinance to operate an IDDE program effectively to eliminate non-stormwater discharges to storm sewer system.

3.5.3 Responsible Departments/Employees:

Public Works Department
Public Works Director
Public Works and Zoning Program Administrator

Town Attorney's Office
Town Attorney

3.5.4 Schedule of Implementation:

- Enact ordinance: Year 3
- Utilize ordinance to prohibit non-stormwater discharges to MS4: Years 3-5

3.5.5 Annual Reporting Requirements:

- None, unless ordinance is adopted or amended.

BMP 3.6: Written Procedures to Detect & Eliminate Illicit Discharges

3.6.1 Description: The Town of Dumfries shall implement and update written procedures to detect, identify, and address unauthorized non-stormwater discharges to the MS4.

3.6.2 Goals and Objectives: Written procedures utilized shall include:

- Dry weather field screening methodologies
- Schedule of field screening activities
- Minimum number of field screening activities completed annually
- Methodologies to collect general information
- Time frame upon which to conduct an investigation
- Methodologies to determine the source of illicit discharge
- Mechanisms to eliminate source of illicit discharges
- Methods for conducting a follow-up investigation
- Mechanism to track all investigations

3.6.3 Responsible Department/Employees:

Public Works Department
Public Works Director
Public Works Assistant Director
Public Works and Zoning Program Administrator

3.6.4 Schedule of Implementation:

- Utilize written procedures to effectively detect, identify, and address illicit discharges: Years 1-5
- Update written procedures as needed/required: Years 1-5

3.6.5 Written Procedures:

a. Dry Weather Field Screening Methodologies

- Dry screening of outfalls from Dumfries' MS4 will be done annually to include outfalls to be inspected, as required by the MS4 permit. The Town has less than 50 known outfalls.
- Dry screening inspections will be defined as inspections performed when precipitation is less than 0.5 inches within a 48 hour period, per the MS4 permit.
- Inspections of outfalls will be performed by trained Town staff.
- Number of outfalls inspected will be reported to DEQ annually with the MS4 Annual Report including
  - The screenings results, and
  - Detail of any follow-up actions necessitated by screening results.
- Outfalls are already identified; if any new outfalls are found they will be recorded into a Town database.
- Inspection instructions shall be as follows:
  1. Walking from downstream to upstream (in the stream so as to not disturb water or sediments which could alter assumptions of an outfall) inspect outfalls one at a time.
  2. Note the:
     a. Date
     b. Outfall Number
     c. Size of Outfall
     d. Time since last rain
     e. Quantity of the last rain
     f. Site descriptions, see regulations
     g. Estimated discharge,
     h. Visual observations: odor, color, clarity, floatables, deposits or stains, vegetation condition, structural condition, biology) – good/ bad
  3. In the event that an outfall is suspected to have an illicit discharge, document the outfall/illicit discharge and fill out the Town's standard illicit discharge reporting form. The suspected illicit discharge shall be handled with illicit discharge procedures set forth.

- Outfall inspection data will be maintained by the Public Works Department.

- Dry weather field screening to detect illicit discharges in specific areas may also be defined based on criteria such as infrastructure, land use, historical illegal discharges, dumping or cross connections..

b. Illicit Discharge Investigation Procedures

- The Town will follow its IDDE Investigation Process based on regulatory requirements and best management practices as enumerated and cited in its written procedures. The procedures shall be monitored and updated from time to time to adapt to changing best practices or evolving regulations (see Appendix A - IDDE Investigation Procedures).

3.6.6 Annual Reporting Requirements:

- The total number of outfalls screened during the reporting period, the screening results, and detail of any follow-up actions necessitated by the screening results.

• A summary of each investigation conducted by the operator of any suspected illicit discharge. The summary must include: (i) the date that the suspected discharge was observed, reported, or both; (ii) how the investigation was resolved, including any follow-up, and (iii) resolution of the investigation and the date the investigation was closed.

BMP 3.7: Promotion and Facilitation of Public Reporting of Illicit Discharges
3.7.1 Description: The Town of Dumfries shall operate and promote an online pollution reporting form for citizens to report illicit discharges. Citizens may also call the Town of Dumfries for reporting.
3.7.2 Goals and Objectives: To encourage citizen action in reporting pollution by phone, email, or online reporting form and Public Works phone number. Citizen involvement will assist Town in investigating and eliminating illicit discharges. www.dumfriesva.gov
3.7.3 Responsible Department/Employees: Public Works Department *Public Works Director* *Public Works Assistant Director* *Public Works and Zoning Program Administrator*
3.7.4 Schedule of Implementation: • Operate and promote online pollution reporting form: Years 1-5 • Continue fielding pollution reports: Years 1-5
3.7.5 Annual Reporting Requirements: • None. Data available upon request.

Minimum Control Measure #4: Construction Site Stormwater Runoff Control

BMP 4.1: Ordinance and other legal authorities to require Erosion & Sediment Controls
4.1.1 Description: The Town of Dumfries will implement its ordinance and legal authorities to require erosion and sediment controls on construction sites that disturb 10,000 square feet or greater, or land-disturbing activities in jurisdictions in Tidewater Virginia, as defined in § 62.1-44.15:68 of the Code of Virginia, that disturb 2,500 square feet or greater and are located in areas designated as Resource Protection Areas (RPA), Resource Management Areas (RMA) or Intensely Developed Acres (IDA), pursuant to the Chesapeake Bay Preservation Area Designation and Management Regulations adopted pursuant to the Chesapeake Bay Preservation Act. Legal authorities include: • Chapter 26, Article IV of the Town Code describes the Erosion and Sediment Control Ordinance. • Town's Subdivision (Chapter 54) and Zoning Ordinance (Chapter 70) • References from above ordinances and documents to the "Virginia Erosion and Sediment Control Regulations" and the Virginia Erosion & Sediment Control Handbook

Additional information about the Town's erosion and sediment control program can be found at: www.dumfriesva.gov (Note: The Town of Dumfries utilizes an agreement in lieu of a plan for the construction of single-family residences as provided in Code of Virginia §62.1-44.15:55.) The Town requires that land disturbance not begin until and erosion and sediment control plan or an agreement in lieu of a plan is approved by the Town.
4.1.2 Goals and Objectives: To prevent degradation of properties, stream channels, waters, and other natural resources.
4.1.3 Responsible Departments/Employees: <u>Public Works Department</u> *Public Works Director* *Public Works Assistant Director*
4.1.4 Schedule of Implementation: • Town Ordinance is in place (Chapter 26, Article IV) per Code of Virginia, § 10.1-560 et seq.; local erosion and sediment control programs, Code of Virginia, § 10.1-562

4.1.5 Written Plan Review Procedures and all associated documents utilized in plan review:
 	
• Procedures for Site Plan Review
• Site Plan Review Checklist:
• Design and Construction Standards Manual
• Town Code (E&S Control):
• Virginia Erosion and Sediment Control Law
• State Water Control Board; Erosion and Sediment Control Regulations; Chapter 840
• Town Code Sections:
  o Sec 26-102. Submission and approval of plans; contents of plans
  o Sec 26-103. Permits; fees; security for performance

4.1.6 Written Inspection Procedures and all associated documents utilized during inspection, including the inspection schedule: • Town Code Sec. 26-104. Monitoring, reports and inspections
4.1.7 Written Procedures for Compliance and Enforcement, including a progressive compliance and enforcement strategy, where appropriate: • Town Code Sec. 26-105. Penalties, injunctions, and other legal actions
4.1.8 Annual Reporting Requirements: • None. Data available upon request.

BMP 4.2: Inspections and Tracking of Land Disturbance Activities

4.2.1 Description:

Town Inspectors will inspect land-disturbing activities for compliance with an approved erosion and sediment control plan or agreement in lieu of a plan in accordance with minimum standards. Inspections shall take place (a) upon initial installation of erosion and sediment controls, (b) at least once during every two week period; (c) within 48 hours of any runoff producing storm event; and (d) upon completion of the project and prior to the release of any applicable performance bonds.

The Town shall also:

- Utilize legal authority to require compliance with an approved plan when an inspection finds that the approved plan is not being properly implemented.
- Utilize, as appropriate, legal authority to require changes to an approved plan when an inspection finds that the approved plan in inadequate to effectively control soil erosion, sediment deposition, and runoff to prevent the unreasonable degradation of properties, stream channels, waters, and other natural resources.

The Town shall ensure that inspections are conducted by personnel who hold a certificate of competence in accordance with 9VAC25-850-40.

The MS4 Annual Reports shall include:

(a) total number of land disturbing activities,
(b) total number of acres disturbed,
(c) total number of inspections conducted, and
(d) a summary of enforcement actions taken including total number and type of enforcement actions taken during reporting period.

4.2.2 Goals and Objectives: To prevent degradation of properties, stream channels, waters, and other natural resources.

4.2.3 Responsible Departments/Employees:

<u>Public Works Department</u>
Public Works Director
Public Works and Zoning Program Administrator

<u>Planning & Zoning Department</u>
Zoning Administrator

4.2.4 Schedule of Implementation:

- Conduct Inspections of Land Disturbing Activities: Years 1-5 (Town Inspectors)
- Track regulated land-disturbing activities: Years 1-5 (Public Works and Zoning Program Administrator)
- Maintain copies of inspection reports from construction inspections: Years 1-5 (Public Works and Zoning Program Administrator)
- Maintain documentation of certificates of competence of staff members who conduct erosion and sediment control inspections: Years 1-5 (Public Works and Zoning Program Administrator)

4.2.5 Annual Reporting Requirements:

- Total number of regulated land-disturbing activities
- Total number of acres disturbed
- Total number of inspections conducted
- Summary of enforcement actions taken, including the total number and type of enforcement actions taken during the reporting period

BMP 4.3: Require VSMP Permit for Land Disturbing Activities

4.3.1 Description: The Town of Dumfries requires all land disturbing activities encompassing areas of over 2,500 square feet to secure a VSMP storm water permit, through the Town's MS4 Permit Program, for the activity.

4.3.2 Goals and Objectives: To prevent degradation of properties, stream channels, waters, and other natural resources.

4.3.3 Responsible Departments/Employees:

Public Works Department
Public Works Director
Public Works Assistant Director
Public Works and Zoning Program Administrator

Planning & Zoning Department
Zoning Administrator

4.3.4 Schedule of Implementation:

- Require VSMP permit for all land disturbing activities over 2,500 SF: Years 1-5

4.3.5 Annual Reporting Requirements:

- None. Data available upon request.

BMP 4.4: Promote to the Public a Mechanism for Receipt of Complaints Regarding Regulated Land Disturbing Activities

4.4.1 Description: The Town of Dumfries promotes reporting of construction site issues through contact with the public at public outreach & education events described in MCM 1 and 2, and also promotes reporting through its website at www.dumfriesva.gov. Calls are received by the Departments of Public Works and Planning & Zoning.

4.4.2 Goals and Objectives: To prevent degradation of properties, stream channels, waters, and other natural resources.

4.4.3 Responsible Departments/Employees:

Public Works Department
Public Works Director

Public Works Assistant Director *Public Works and Zoning Program Administrator* Planning & Zoning Department *Zoning Administrator*
4.4.4 Schedule of Implementation: • Promote and respond to complaints received by the public regarding regulated land disturbing activities: Years 1-5
4.5.5 Annual Reporting Requirements: • None. Data available upon request.

Minimum Control Measure #5: Post-Construction Stormwater Management in New Development & Redevelopment

BMP 5.1: Ordinance and other legal authorities to address Post-Construction Runoff
5.1.1 Description: The Town of Dumfries will implement its ordinance to address post-construction runoff from new development and redevelopment projects to ensure compliance with the Virginia Stormwater Management Act and attendant regulations. Legal authorities include: • Chapter 26, Article V of the Town Code describes the Stormwater Management Ordinance Additional information about the Town's stormwater management program can be found at: http://www.dumfriesva.gov/governmentpublic-worksmunicipal-separate-storm-sewer-system-ms4
5.1.2 Goals and Objectives: To ensure the general health, safety, and welfare of citizens and protect the quality and quantity of state waters from potential harm from unmanaged stormwater, including protection from a land disturbing activity causing unreasonable degradation of properties, water quality, stream channels, and other natural resources.
5.1.3 Responsible Departments/Employees: Public Works Department *Public Works Director* *Assistant Public Works Director*
5.1.4 Schedule of Implementation: • Ordinance is in place (Chapter 26, Article V) per Code of Virginia, § 15.2-2114, Local regulation of stormwater

5.1.5 Written policies and procedures utilized to ensure that stormwater management facilities are designed and installed in accordance with Section II B 5b:

The following documents outline procedures:

- Procedures for Site Plan Review: http://www.dumfriesva.gov/businesses/site-development
- Site Plan Process: http://www.dumfriesva.gov/government/planningandzoning/site-plan
- Design and Construction Standards Manual: The Town has adopted Prince William County's DCSM http://www.pwcgov.org/government/dept/development/ld/Pages/dcsm.aspx
- Chapter 26, Article V of the Town Code describes the Stormwater Management Ordinance
- Virginia Stormwater Management Act
- State Water Control Board; Virginia Stormwater Management Program (VSMP) Regulation; Chapter 870
- Virginia Stormwater Management Handbook
- Department of Environmental Quality Guidance Documents: http://www.deq.virginia.gov/Programs/Water/Laws,Regulations,Guidance/Guidance/StormwaterManagementGuidance.aspx
  Virginia Runoff Reduction Method (VRRM) Spreadsheets
  VSMP Technical Bulletins

For privately owned stormwater management facilities the following documents also apply:

- Design & Construction Standards Manual

5.1.6 Written policies and procedures utilized in conducting inspections:

See documents listed in 5.1.5.

5.1.7 Written procedures for inspection, compliance and enforcement to ensure maintenance is conducted on private stormwater facilities to ensure long-term operation in accordance with approved design:

See documents listed in 5.1.5.

5.1.8 Written procedures for inspection and maintenance of operator-owned stormwater management facilities:

The Town will establish a program for inspection and maintenance of stormwater management facilities owned by the Town in the form of a "Stormwater Post Construction Inspection Manual".

The manual will list all of the stormwater management facilities the Town is responsible for, by department, and include the following: type of stormwater management facility, the Town ID #, a periodic inspection checklist, and the annual inspection check list. The periodic inspection checklist is optional; however, departments will be encouraged to utilize them as stormwater management facilities are maintained. If deficiencies are found during maintenance, they are to be reported to the responsible party within the department, and repairs are to be scheduled.

The annual inspection checklist provided in the manual is to be used by the "Stormwater Inspection Staff" (led by the Public Works Director). These inspections will be conducted annually by Stormwater Inspectors and the results will be provided to the Public Works Director and the responsible person within the given department. If deficiencies are found during annual inspections, repairs will be budgeted and scheduled.

5.1.9 Annual Reporting Requirements:

- None, unless ordinance or procedures are amended.

BMP 5.2: Require long-term operation and maintenance of stormwater management facilities not owned by the Town

5.2.1 Description: The Town shall require adequate long-term operation and maintenance of stormwater management facilities by the owner by requiring the owner to develop a recorded inspection schedule and maintenance agreement.

The Town provides developers with a template maintenance agreement in the Design and Construction Standards Manual (Section 720.15). The maintenance agreement requires that the owner submit to the Town an annual inspection report, along with one certified by a professional engineer every 3 years, to assure safe and proper functioning of the facilities.

If maintenance is neglected by the owner, the maintenance agreement allows the Town, after proper notice is provided, to enter upon the property and take whatever steps necessary to correct deficiencies and charge the costs of such repairs to the owner.

5.2.2 Goals and Objectives: To ensure that stormwater management facilities and BMPs are properly functioning as they were designed to control stormwater quantity and quality.

5.2.3 Responsible Employees:

Public Works Department
Public Works Director
Assistant Public Works Director

5.2.4 Schedule of Implementation:

- Require owners to develop recorded inspection schedule and maintenance agreements: Year 1
- Implement a schedule to inspect all privately owned stormwater management facilities at least once every 5 years: Year 3

5.2.5 Annual Reporting Requirements:

- None, unless procedures amended.

BMP 5.3: Require long-term operation and maintenance of stormwater management facilities owned by the Town
5.3.1 Description: The Town shall require adequate long-term operation and maintenance of stormwater management facilities owned by the Town. Town Inspectors inspect stormwater management facilities annually, generally in the Fall, and inform Town departments responsible for the stormwater management facilities of any deficiencies found. Town departments are responsible for maintaining stormwater management facilities on properties they manage unless an alternative agreement has been established.
5.3.2 Goals and Objectives: To ensure that stormwater management facilities and BMPs are properly functioning as they were designed to control stormwater quantity and quality.
5.3.3 Responsible Departments/Employees: <u>Public Works Department</u> *Public Works Director* *Assistant Public Works Director*
5.3.4 Schedule of Implementation: • Maintain list of all known Town-owned facilities: Years 1-5 • Inspect Town-owned stormwater facilities: Years 1-5
5.3.5 Annual Reporting Requirements: • None, unless procedures amended.

BMP 5.4: Track stormwater management facilities
5.4.1 Description: The Town shall maintain an updated electronic database of all known operator-owned and privately-owned stormwater management facilities that discharge into the MS4. The database shall include: (a) The stormwater management facility type; (b) A general description of the facility's location, including the address or latitude or longitude; (c) The acres treated by the facility, including total acres, as well as the breakdown of pervious and impervious acres; (d) The date the facility was brought online (MM/YYYY).If the date is not known, the Town shall use June 30, 2005, as the date brought online for all previously existing stormwater management facilities; (e) The sixth order hydrologic unit code (HUC) in which the stormwater management facility is located; (f) The name of any impaired water segments within each HUC listed in the 2010 § 305 (b)/ 303 (d) Water Quality Assessment Integrated Report to which the stormwater management facility discharges; (g) Whether the stormwater management facility is operator-owned or privately owned; (h) Whether a maintenance agreement exists if the stormwater management facility is privately owned; and

(i) The date of the operator's most recent inspection of the stormwater management facility.

5.4.2 Goals and Objectives: To ensure that stormwater management facilities and BMPs are properly functioning as they were designed to control stormwater quantity and quality.

5.4.3 Responsible Departments/Employees:

Public Works Department
Public Works Director
Assistant Public Works Director
Public Works and Zoning Program Administrator

5.4.4 Schedule of Implementation:

- Track all new stormwater management facilities that require a maintenance agreement: Years 1-5
- Maintain list of all known Town-owned facilities: Years 1-5
- Inspect and verify details regarding Town-owned stormwater facilities: Years 1-3

5.4.5 Annual Reporting Requirements:

- Total number of inspections completed and, when applicable, the number of enforcement actions taken to ensure long-term maintenance.
- Submit an electronic database or spreadsheet of all stormwater management facilities brought online during each reporting year with the appropriate annual report.

Minimum Control Measure #6: Pollution Prevention/Good Housekeeping for Municipal Operations

BMP 6.1: Develop Written Procedures to Minimize or Prevent Discharges
6.1.1 Description: The Town of Dumfries shall develop and implement written procedures for daily operations designed to minimize or prevent discharges. Procedures shall be written for: daily street and parking lot maintenance, equipment maintenance, and pesticide, herbicide, and fertilizer application, storage and transport of materials.
6.1.2 Goals and Objectives: Written procedures for daily operations shall be designed to: • Prevent illicit discharges • Ensure the proper disposal of waste • Prevent the discharge of vehicle wash water • Require BMPs for discharging water pumped from construction and maintenance activities • Minimize pollutant runoff from bulk storage areas • Prevent pollutant discharges from municipal automobiles and equipment • Ensure application of fertilizers and pesticides is conducted under manufacturer's recommendations
6.1.3 Responsible Departments/Employees: <u>Public Works Department</u> *Public Works Director* *Assistant Public Works Director* Procedures will be developed by the Public Works Department in coordination with other department representatives.
6.1.4 Schedule of Implementation: • Develop and implement written procedures for daily operations: Year 3 • Update written procedures as needed or required: Years 3-5
6.1.5 Annual Reporting Requirements: • A summary report on the development and implementation of the daily operational procedures.

BMP 6.2: Identify All Municipal High-Priority Facilities and Municipal High-Priority Facilities With a High Potential For Pollutant Discharges

6.2.1 Description: The Town of Dumfries identified all municipal high-priority facilities. The Town shall continue to update this list as new facilities are created or as existing facilities are modified or updated.

6.2.2 Goals and Objectives: To identify municipal facilities that may create pollutant discharges to the MS4. This identification process shall allow the Town to develop and implement Stormwater Pollution Prevention Plans for these facilities, in order to effectively prevent and eliminate pollutant discharges from municipal facilities.

6.2.3 Responsible Departments/Employees:

Public Works Department
Public Works Director
Assistant Public Works Director

Facilities will be identified by the Public Works Department in coordination with other department representatives

6.2.4 Schedule of Implementation:

- Identify High Priority & High Potential Facilities: Year 3
- Update list of High Priority & High Potential Facilities as necessary: Years 3-5

6.2.5 Identification of High Priority & High Potential Facilities:

High priority facilities are defined as facilities that include any of the following:
(i) composting facilities, (ii) equipment storage and maintenance facilities, (iii) materials storage yards, (iv) pesticide storage facilities, (v) public works yards, (vi) recycling facilities, (vii) salt storage facilities, (viii) solid waste handling and transfer facilities, and (ix) vehicle storage and maintenance yards.

High priority facilities with a high potential for discharging pollutants are defined as including any of the following:

(a) Areas where residuals from using, storing or cleaning machinery or equipment remain and are exposed to stormwater;
(b) Materials or residuals on the ground or in stormwater inlets from spills or leaks;
(c) Material handling equipment (except adequately maintained vehicles);
(d) Materials or products that would be expected to be mobilized in stormwater runoff during loading/unloading or transporting activities (e.g., rock, salt, fill dirt);
(e) Materials or products stored outdoors (except final products intended for outside use where exposure to stormwater does not result in the discharge of pollutants);
(f) Materials or products that would be expected to be mobilized in stormwater runoff contained in open, deteriorated or leaking storage drums, barrels, tanks, and similar containers;
(g) Waste material except waste in covered, non-leaking containers (e.g., dumpsters);
(h) Application or disposal of process wastewater (unless otherwise permitted); or
(i) Particulate matter or visible deposits of residuals from roof stacks, vents or both not otherwise regulated (i.e., under an air quality control permit) and evident in the stormwater runoff.

The following are the municipal facilities identified as either High Priority or High Priority with a Potential For Discharging Pollutants by the Town of Dumfries:

High Priority Facilities:

1. Public Works Shop Facility

6.2.6 Annual Reporting Requirements:

- None. Data available upon request.

BMP 6.3: Develop and Implement Specific Stormwater Pollution Prevention Plans (SWPPPs) for High Priority Facilities With a High Potential for Discharging Pollutants

6.3.1 Description: The Town of Dumfries shall develop and implement site-specific Stormwater Pollution Prevention Plans for identified high priority facilities with a high potential for discharging pollutants. Any facilities covered under a separate VPDES permit shall be excluded from this requirement. Each SWPPP shall be evaluated and updated as necessary to reflect any discharge, release or spill from the facility. A copy of each SWPPP shall be kept and updated and utilized as part of staff training.

6.3.2 Goals and Objectives: To prevent and eliminate pollutant discharges from municipal facilities that are labeled as high priority with a high potential for discharging pollutants.

Each SWPPP developed shall include:

- A site description including a site map identifying outfalls, direction of flows, existing source controls, and receiving bodies of water.
- A discussion and checklist of potential pollutants and sources.
- A discussion of all potential non-stormwater discharges.
- Written procedures designed to reduce and prevent pollutant discharges.
- A description of the applicable training required.
- Annual site compliance evaluation procedures.
- Inspection and maintenance schedule for site specific source controls.
- The date of each inspection and associated findings.
- Date, material discharged, released or spilled, and quantity discharged for each event that occurs.

6.3.3 Responsible Departments/Employees:

Public Works Department

Public Works Director

Assistant Public Works Director

6.4.4 Annual Reporting Requirements:

- Summary report on the development and implementation of all required SWPPPs

6.4: BMP Implement Turf and Landscape Nutrient Management Plans
6.4.1 Description: The Town of Dumfries shall implement turf and landscape nutrient management plans developed by a certified nutrient management planner on all lands owned or operated by the Town where nutrients are applied to a contiguous area greater than one acre.
6.4.2 Goals and Objectives: To utilize turf and landscape nutrient management plans to responsibly apply nutrients to municipal properties. Facilities Requiring Nutrient Management Plans: 1. Ginn Memorial Park 2. Weems-Botts The Town shall not apply any deicing agent containing urea or other forms of nitrogen or phosphorous to any parking lots, roads, sidewalks, etc.
6.4.3 Responsible Departments/Employees: Public Works Department *Public Works Director* *Assistant Public Works Director* *Maintenance Crew*
6.4.4 Schedule of Implementation: • Identify all lands owned or operated by the Town where nutrients were applied to a contiguous area greater than one acre: Year 2 • Implement turf and landscape nutrient management plans for at least 30% of applicable lands: Year 3 • Implement turf and landscape nutrient management plans for at least 70% of all applicable lands: Year 4 • Implement turf and landscape nutrient management plans for all applicable lands: Year 5
6.4.5 Annual Reporting Requirements: • Summary of the turf and landscape management plan (total acreage, acreage of lands upon which turf and landscape nutrient management plans have been implemented; and updated list of properties with longitude/latitude).

BMP 6.5: Implement Employee Training On Written Procedures to Minimize or Prevent Discharges
6.5.1 Description: The Town of Dumfries shall conduct stormwater training for municipal employees. Training shall be designed specifically for different departments and their duties and daily operations and how it relates to stormwater management. The Town shall document training activities, employees in attendance, and other applicable information.
6.5.2 Goals and Objectives: To train municipal employees on stormwater management and various ways to minimize or prevent pollutant discharges. Training Shall Be Designed To Include: 1. Biennial training to field personnel in the recognition and reporting of illicit discharges 2. Biennial training to employees in good housekeeping and pollution prevention practices that are to be employed during road, street, and parking lot maintenance. 3. Biennial training to employees in good housekeeping and pollution prevention practices that are to be employed in and around maintenance and public works facilities. 4. Biennial training to employees in good housekeeping and pollution prevention practices that are to be employed in and around recreational facilities. 5. Ensure that employees and contractors who apply pesticides and herbicides are properly trained and certified in accordance with the Virginia Pesticide Control Act. 6. Ensure that plan reviewers, inspectors, program administrators, and construction site operators hold the proper certification as required under Virginia Erosion and Sediment Control Law. 7. Ensure that applicable employees obtain the proper certifications as required by Virginia Erosion and Sediment Control Law. 8. Emergency response employees shall have training in spill response. 9. Keep documentation on each training event including training date, number of employees attending, and the objective of the training event for a period of three years after each event.
6.5.3 Responsible Employees: <u>Public Works Department</u> *Public Works Director* *Assistant Public Works Director*
6.5.4 Schedule of Implementation: • Implement biennial training events: Years 2-5 • Ensure that pesticide and herbicide applicators hold proper certification: Years 3-5 • Ensure that plan reviewers, inspectors, program administrators, and construction site operators hold proper certification: Years 1-5 • Ensure that applicable employees obtain the proper certifications as required by Virginia Erosion and Sediment Control Law: Years 1-5 • Spill response training for emergency personnel: Years 2-5 • Keep documentation of training events: Years 2-5

6.5.5 Annual Reporting Requirements:

- Summary report on the required training, including a list of training events, the training date, the number of employees attending training and the objective of the training.

BMP 6.6: Require Municipal Contractors Use Appropriate Control Measures and Procedures for Stormwater Discharges to the MS4 System

6.6.1 Description: The Town of Dumfries shall require that municipal contractors use appropriate control measures and procedures for stormwater discharges to the MS4 system.

6.6.2 Goals and Objectives: To reduce or eliminate potential discharges from municipal contractors.

Oversight of municipal contractors will be the responsibility of Town inspectors or Town project manager(s). Include contract language in the Town's Terms & Conditions to ensure compliance. The document will be accessible on the Town webpage for download.

6.6.3 Responsible Departments/Employees:

Public Works Department
Public Works Director
Public Works Assistant Director
Public Works and Zoning Program Administrator

6.6.4 Schedule of Implementation:

- Develop new contract provisions requiring municipal contractors to use appropriate control measures and procedures for stormwater discharges to the MS4 system: Year 3
- Require municipal contractors use control measure and procedures for stormwater discharges: Years 3-5

6.6.5 Annual Reporting Requirements:

- Report on activities to develop procedures.

BMP 6.7: Street Sweeping

6.7.1 Description: The Town of Dumfries maintains a schedule to sweep every street at least monthly. Approximately half the streets are swept more than once per month, largely depending on the weather.

6.7.2 Goals and Objectives: To reduce or eliminate potential discharges from public rights-of-way.

6.7.3 Responsible Departments/Employees:

Public Works Department
Public Works Director
Assistant Public Works Director
Maintenance Crew

6.7.4 Schedule of Implementation:

- Sweep all streets at least once per month: Years 1-5

6.7.5 Annual Reporting Requirements

- Summary report on activities.

BMP 6.8: Litter Pickup

6.8.1 Description: The Town of Dumfries has a dedicated part-time position for litter pickup. The position is able to remove litter from public rights-of-way and other public properties at least three days per week.

6.8.2 Goals and Objectives: To reduce or eliminate potential discharges from public rights-of-way.

6.8.3 Responsible Departments/Employees:

Public Works Department
Public Works Director
Assistant Public Works Director
Maintenance Crew

6.8.4 Schedule of Implementation:

- Litter removal at least 3 days per week: Years 1-5

6.8.5 Annual Reporting Requirements:

- Summary report on activities

BMP 6.9: Snow and Ice Removal

6.9.1 Description: The Town of Dumfries shall require that any staff or contractors use appropriate control measures and procedures for stormwater discharges to the MS4 system.

6.9.2 Goals and Objectives: To reduce or eliminate potential discharges from public rights-of-way.

Oversight of any municipal contractors will be the responsibility of Town inspectors. Include contract language in the Town's Terms & Conditions to ensure compliance.

6.9.3 Responsible Departments/Employees: <u>Public Works Department</u> *Public Works Director* *Assistant Public Works Director*
6.9.4 Schedule of Implementation: • Use best available practices for snow and ice removal and the storage of the require materials: Years 1-5
6.10.5 Annual Reporting Requirements: • Summary report on activities

Virginia Total Maximum Daily Load (TMDL) Special Conditions

The Town will work on developing the TMDL Action Plan to address pollutants which the Town's MS4 has been assigned a waste load allocation. This Plan will also include the Potomac River TMDL's for bacteria and PCBs.

The TMDL Action Plan will identify the best management practices and interim milestone activities. The TMDL Action Plan will be submitted to the Virginia Department of Environmental Quality with the July 1, 2015 through June 30, 2016 Annual Report.

Chesapeake Bay Total Maximum Daily Load (TMDL) Special Conditions

In its Phase I and Phase II Chesapeake Bay TMDL Watershed Implementation Plans (WIP), the Commonwealth committed to a phased approach for MS4s to implement necessary pollutant reductions (phosphorus, nitrogen, and sediment). This permit (2013-2018) requires an implementation of 5% pollutant reductions as specified in the 2010 Phase I WIP.

The Town will work on developing the Chesapeake Bay TMDL Action Plan during the first three years of this permit cycle in accordance with the permit requirements. The Chesapeake Bay TMDL Action Plan will be submitted to the Virginia Department of Environmental Quality with the July 1, 2015 through June 30, 2016 Annual Report.

Prior to the start of the 2018-2023 permit cycle, as part of the Town's reapplication package, the Town shall document that sufficient control measures have been implemented to meet the compliance target identified in the MS4 permit and draft a second phase Chesapeake Bay TMDL Action Plan to reduce an additional 35% of pollutants from existing and new sources as described in the permit.