Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch Watersheds

TMDL Implementation Plan;

Albemarle County and the City of Charlottesville, Virginia

Submitted to:

The Stakeholders of the Moores Creek, Lodge Creek, Meadow Creek and Schenks Branch Watersheds

Prepared by:

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In Cooperation With:

Virginia Department of Environmental Quality

and

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Final Draft: September 6, 2012

VT-BSE Document No. 2012-0005

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List of Abbreviations

The following abbreviations are used throughout this document. To better aid the reader in comprehension of the document each abbreviation is defined here.

BMP – Best Management Practice
BSE – Biological Systems Engineering Department (Virginia Tech)
CWA – Clean Water Act, authorizes Total Maximum Daily Load Program
E&S – erosion and sediment
EPA – United States Environmental Protection Agency
EPT – three classes of sensitive stream organisms, *Ephemeroptera*, *Plecoptera*, and *Tricoptera*
HUC5 – Virginia's fifth-order hydrologic unit watershed codes
IP – Implementation Plan
LA – Load Allocation, the load allocated to nonpoint and background sources
LID – low impact development, a general class of urban infiltration management practices
MFBI – Modified Family Biotic Index, one of the biological metrics
MOS – Margin of Safety, a load reflecting uncertainty in the modeling process
MS4 – Municipal Separate Storm Sewer Systems, Phase II Stormwater Management Program
NPS – nonpoint source, referring to diffuse sources of pollution, such as from runoff
NRCS – Natural Resources Conservation Service
RTF – Rivanna Trails Fooundation
SCI – Stream Condition Index, an index developed for use in assessing stream health in Virginia
SSO – sanitary sewer overflow
SWCB – State Water Control Board
SWCD –Soil and Water Conservation District
SWM – storm water management
TAA – Technical Assistance and Administration
TBD – to be determined
TMDL – Total Maximum Daily Load (Study)
UVA – University of Virginia
VAC – Virginia Administrative Code
VCE – Virginia Cooperative Extension
VADCR – Virginia Department of Conservation and Recreation
VADEQ – Virginia Department of Environmental Quality
VDOF – Virginia Department of Forestry
VDOT – Virginia Department of Transportation
VPDES – Virginia Pollutant Detection and Elimination System
VT – Virginia Tech
WIP1-VA – Virginia's Phase 1 Bay TMDL Watershed Implementation Plan
WLA – Waste Load Allocation, the load allocated to point sources
WQIF – Water Quality Improvement Fund

WQMIRA – Water Quality Monitoring, Information and Restoration Act
WWTP – Waste Water Treatment Plant

EXECUTIVE SUMMARY

1.0 INTRODUCTION

A Total Maximum Daily Load (TMDL) study for Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch was prepared and submitted to DEQ in March 2012. Submission of the TMDLs in these watersheds for EPA approval will be timed to coincide with the completion of this Implementation Plan (IP). The final TMDL allocation scenario will be revised to incorporate the input from the Local Steering Committee so that reductions reflect the acceptable suite and extent of BMPs as determined through the implementation planning process. These TMDLs specify maximum sediment loads that are presumed to be protective of the benthic macroinvertebrate community in order for these stream segments to once again meet the Virginia's Aquatic Life Use water quality standard. This document serves as the TMDL IP for Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch located in Albemarle County and the City of Charlottesville, Virginia.

The following TMDLs and IPs have also been previously developed which affect one or more of the four benthic-impaired stream segments that are the subject of this report. A bacteria TMDL on Moores Creek was completed in 2002 (VADEQ, 2002b), followed by an implementation plan in 2005 (VADEQ, 2005), currently under revision (RRBC, 2012). The Rivanna River watershed, which encompasses the four watersheds that are the subject of this IP, was the subject of a 2008 sediment TMDL (VADEQ, 2008) and a 2009 bacteria TMDL. Findings from these studies, and actions planned impact the sediment reductions called for in the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch TMDLs.

1.1. *Regulatory Background of the TMDL Study*

In 1972, the US Congress enacted the Federal Water Pollution Control Act known as the "Clean Water Act" (CWA). The objective of that legislation was well defined in its opening paragraph,

> *"to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."*

The CWA covers a range of water quality efforts aimed at reaching this objective. Immediately relevant to this project are the requirements that states develop and promulgate water quality standards for waters within their jurisdictions. In §303(d) of the Act, the federal government requires states to identify those water bodies not meeting the published water quality standards for any given pollutant. This list is often called the "303(d) list" or the "impaired waters list." Virginia's first impaired waters list was published and reported to EPA in 1994. Recently, the 303(d) list has been combined with the 305(b) water quality assessment report which describes the overall quality of a state's waters. This combined report, known as the "305(b)/303(d) Integrated Report", is published and submitted to EPA every two years.

An additional §303(d) condition requires that, if a particular water body is listed as "impaired," the state must develop a "total maximum daily load" (TMDL) for the offending pollutant. The TMDL can be thought of as a "water pollution budget." A TMDL study estimates the amount of pollutant each source in the watershed can contribute to the water body while still allowing the water body to comply with applicable water quality standards.

The "Designation of Uses" of all waters in Virginia are defined in the Code of Virginia (9 VAC 25-260-10) as follows:

> 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 reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish). (SWCB, 2003)

The water quality standard supported through biological monitoring is Virginia's narrative General Standard (9 VAC 25-260-20, also known as the Aquatic Life Use standard) which states in part:

> All state waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are … harmful to human, animal, plant, or aquatic life.

> Specific substances to be controlled include, but are not limited to: floating debris, oil scum, and other floating materials; toxic substances (including those which bioaccumulate); substances that produce color, tastes, turbidity, odors, or settle to form sludge deposits; and substances which nourish undesirable or nuisance aquatic plant life. Effluents which tend to raise the temperature of the receiving water will also be controlled. (SWCB, 2003)

The biological monitoring program in Virginia used to evaluate compliance with the above standard is conducted by the Virginia Department of Environmental Quality (VADEQ). Evaluations of monitoring data from this program focus on the benthic (bottom-dwelling) macro (large enough to see) invertebrates (insects, mollusks, crustaceans, and annelid worms) and are used to determine whether or not a stream segment has a benthic impairment. Changes in water quality generally result in alterations to the quantity and diversity of the benthic organisms that live in streams and other water bodies. In addition to being the major intermediate constituent of the aquatic food chain, benthic macroinvertebrates are "living recorders" of past and present water quality conditions. This is due to their relative immobility and their variable resistance to the diverse contaminants that are introduced into streams. The community structure of these organisms provides the basis for the biological evaluation of water quality.

2.0 STATE AND FEDERAL REQUIREMENTS FOR TMDL IMPLEMENTATION PLANS

2.1. *Background*

Once a water body is listed as impaired and a subsequent TMDL study has been conducted, the watershed stakeholders must develop and implement a strategy that will reduce pollutant loadings to those levels specified in the TMDL study. Such a strategy, also known as an Implementation Plan (IP), must contain actions that will work to reduce pollutant loadings and bring the water body into compliance with the standard. Although IPs are alluded to in the CWA, they are not a requirement of that act. Such Implementation Plans are, however, a required by Virginia statute.

2.2. *State Requirements*

Developing a TMDL IP is required under Virginia's 1997 Water Quality Monitoring, Information, and Restoration Act or WQMIRA (§62.1-44.19:4 through 19:8 of the Code of Virginia). WQMIRA directs the Virginia Department of Environmental Quality (VADEQ) to "develop and implement a plan to achieve fully supporting status for impaired waters." For an IP to be approved by the State Water Control Board, the IP **must** include the following components, as outlined in the WQMIRA:

- necessary corrective actions;
- measurable goals;
- date of expected achievement of water quality objectives; and
- associated costs, benefits, and environmental impacts, of addressing the impairment.

2.3. *Federal Recommendations*

Section 303(d) of the CWA and current EPA regulations do not require the development of implementation strategies, though their guidance clearly describes pollution control measure implementation as the next step leading to the attainment of water quality objectives. In the 1999 "Guidance for Water Quality-Based Decisions: The

TMDL Process" (EPA 841-D-99-001), EPA recommends the following minimum elements be included in an IP:

- a description of the implementation actions and management measures,
- a time line for implementing these actions and measures,
- legal or regulatory controls,
- a monitoring plan to determine the effectiveness of actions and measures; and
- an estimate of the time required to attain water quality standards.

These recommendations closely track the State's WQMIRA requirements.

2.4. *Requirements for Section 319 Fund Eligibility*

Beyond the regulatory requirements listed above, the CWA was amended in 1987 to establish the Nonpoint Source Management Program in §319 of that act. Through that program, States, Territories, and Native American Tribes can receive grant monies for a variety of activities, including the restoration of impaired stream segments. Although there are various alternative sources of money to assist with the TMDL implementation process, §319 funds are most relevant to TMDL implementation. Therefore, the requirements to obtain these funds are discussed here. The Virginia Department of Conservation and Recreation (the state agency responsible for nonpoint source pollution management) strongly suggests that the requirements for §319 funds be addressed in the IP (in addition to the required components as described by the WQMIRA).

The EPA has developed guidelines that describe the process and criteria to be used to award CWA §319 nonpoint source grants to States. This guidance is subject to revision and the most recent version should be considered when developing an IP. The "Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003" identifies the following nine elements that must be included in the IP to meet the 319 requirements:

1. Identify the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan;
2. Estimate the load reductions expected from NPS management measures;
3. Describe the NPS management measures that will need to be implemented to achieve the identified load reductions;

4. Estimate the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan;
5. Provide an information/education component that will be used to enhance public understanding of the project and encourage the public's participation in selecting, designing, and implementing NPS management measures;
6. Provide a schedule for implementing the NPS management measures identified in the watershed-based plan;
7. Describe interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented;
8. Identify a set of criteria for determining if loading reductions are being achieved and progress is being made towards attaining water quality standards, and if not, the criteria for determining if the watershed-based plan needs to be revised; and
9. Establish a monitoring component to evaluate the effectiveness of the implementation efforts.

2.5. *Staged Implementation*

In general, the Commonwealth of Virginia intends for nonpoint source pollutant TMDL reductions to be implemented in stages. Staged implementation is an iterative process that incrementally implements management measures, initially targeting those sources and/or practices with the largest impact on water quality, coupled with a monitoring plan to continuously assess progress toward full attainment of designated uses.

There are many benefits of staged implementation, including:

1. Through stream monitoring, water quality improvements are recorded as they are accomplished;
2. Quality control is achieved to offset the uncertainties that exist in any watershed simulation model;
3. A mechanism for developing public support is developed;
4. The most cost effective practices are implemented initially; and
5. The adequacy of the TMDL to achieve the water quality standard is ensured.

With successful development and implementation of IPs, Virginia will be well on the way to restoring impaired waters and enhancing the value of the Commonwealth's aquatic resources. Additionally, development of an approved IP will increase the opportunities for a locality to obtain monetary assistance during implementation.

3.0 REVIEW OF THE MOORES CREEK, LODGE CREEK, MEADOW CREEK, AND SCHENKS BRANCH TMDL STUDY

The following summary of the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch TMDLs was excerpted from the final report submitted to the Virginia Department of Environmental Quality in March 2012 entitled "Benthic TMDL Development Report for the Sediment Stressor: Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch; Albemarle County and Charlottesville City, Virginia" as prepared by a team from the Virginia Tech Biological Systems Engineering Department.

3.1. *Impairment Listing*

The four impaired segments in these TMDLs are located within the Rivanna River Basin and straddle the boundary between the City of Charlottesville and Albemarle County in the Commonwealth of Virginia (Figure 3-1).

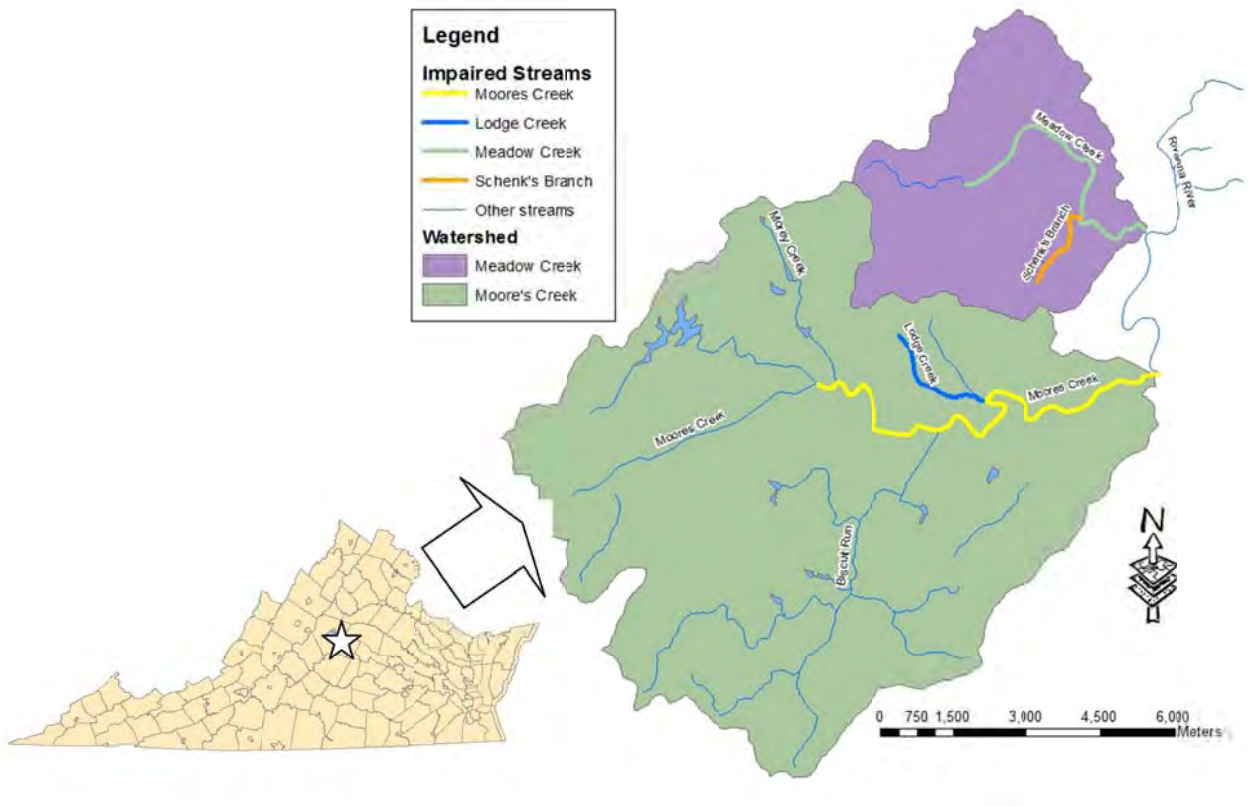

Figure 3-1. Location of Impaired Segments and Watersheds

Moores Creek and its tributary, Lodge Creek, were originally listed as impaired on Virginia's 2008 and 2006 305(b)/303(d) Water Quality Assessment Integrated Reports, respectively, due to water quality violations of the general aquatic life (benthic) standard. Meadow Creek and its tributary, Schenks Branch, were originally listed as impaired in the same reports in 2006 and 2008, respectively, also due to water quality violations of the general aquatic life (benthic) standard.

The Virginia Department of Environmental Quality (DEQ) has delineated the benthic impairment as 6.37 miles on Moores Creek, extending from its confluence with the Ragged Mountain Reservoir receiving stream, downstream to its confluence with the Rivanna River. The DEQ 2010 Fact Sheets for Category 5 Waters (VADEQ, 2010) state that Moores Creek was impaired based on assessments at DEQ biological station 2-MSC000.60 and citizen monitoring station, 2-MSC-MSC04-SW. The sources of impairment were listed as "Municipal (Urbanized High Density Area)" and "Non-Point Source".

DEQ delineated a benthic impairment on an unnamed tributary to Moores Creek, listed as 1.57 miles. The "unnamed tributary" is known locally as Lodge Creek, but also contains a portion of Rock Creek. The impaired segment extends 1.37 miles from the headwaters of Lodge Creek to its confluence with Rock Creek and along a 0.20 mile segment of Rock Creek down to its confluence with Moores Creek. This impaired segment will be referred to as Lodge Creek for the remainder of this report. The Lodge Creek watershed is a sub-watershed of the Moores Creek watershed. The DEQ 2010 Fact Sheets for Category 5 Waters (VADEQ, 2010) state that this segment was impaired based on assessments at DEQ biological station 2-XRC001.15 and citizen monitoring station, 2-XRC-XRC01-SW, with the impairment attributed to "Non-Point Source" pollution.

The benthic impairment on Meadow Creek was delineated as 4.0 miles, extending from its headwaters to its confluence with the Rivanna River. The DEQ 2010 Fact Sheets for Category 5 Waters (VADEQ, 2010) cite Meadow Creek as being impaired based on assessments at DEQ biological station 2-MWC000.60 and at citizen monitoring stations 2-MWC-MWC01-SW and 2-MWC-MWC03-SW. The source of impairment in Meadow Creek was stated as "Non-Point Source."

The benthic impairment on Schenks Branch extends 1.13 miles from its headwaters downstream to its confluence with Meadow Creek. Schenks Branch watershed is a sub-watershed of the Meadow Creek watershed. The DEQ 2010 Fact Sheets for Category 5 Waters (VADEQ, 2010) state that Schenks Branch was impaired based on assessments at DEQ biological stations 2-SNK000.88, 2-XSN000.08 and 2-XSN000.18, and citizen monitoring stations 2-SNK-SHK02-SW and 2-SNK-SHV01-SW. The sources of impairment in Schenks Branch were considered to be "Municipal (Urbanized High Density Area)" and "Non-Point Source" pollution.

3.2. *Watershed Characteristics*

The Moores Creek watershed (22,331.9 acres) comprises the 12-digit hydrologic unit JR15 and includes the Lodge Creek sub-watershed (471.4 acres), while the Meadow Creek watershed (5,818.7 acres) is in the headwater portion of hydrologic unit JR14 and includes the Schenks Branch sub-watershed (1,408.1 acres). All four watersheds are components of the HUC5 watershed, H28. These watersheds include portions of the City of Charlottesville and Albemarle County, and are part of the Rivanna River basin. The combined watersheds are 28,150.6 acres (11,392.4 ha) in size. Lodge Creek is tributary to Moores Creek, and Schenks Branch is tributary to Meadow Creek, and both Moores Creek and Meadow Creek are tributaries to the Rivanna River, eventually flowing into the James River and the Chesapeake Bay. The locations of the study watersheds are shown in Figure 3-2.

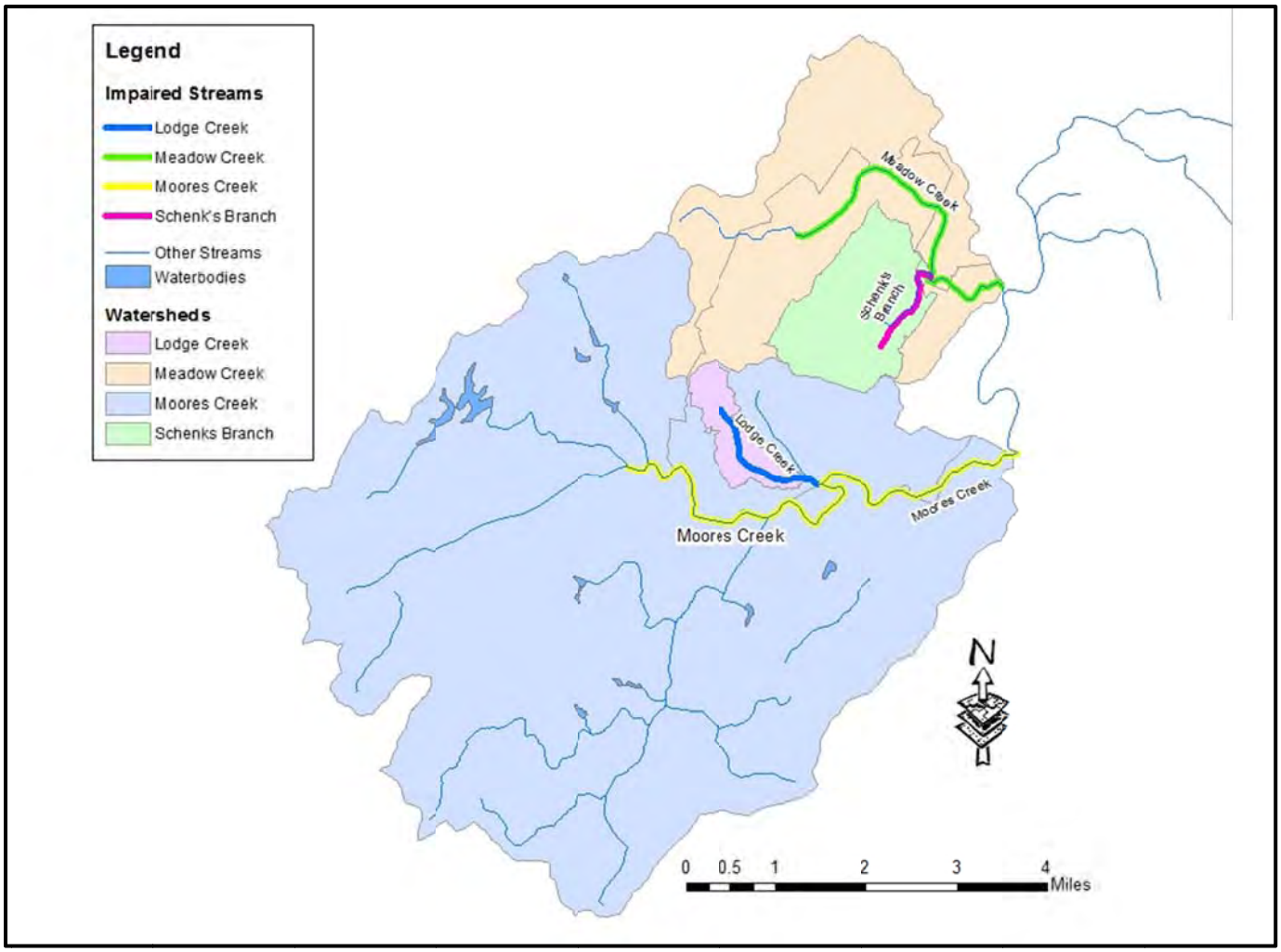

Figure 3-2. Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch Watersheds

The Moores Creek, Lodge Creek, Meadow Creek and Schenks Branch watersheds are located entirely within the Piedmont Upland sub-division of the Northern Piedmont ecoregion. The Northern Piedmont is a transitional region of low rounded hills, irregular plains, and open valleys in contrast to the low mountains of ecoregions to the north and west and the flat coastal plains of the ecoregion to the east (USEPA, 2002a).

The soils found in Moores Creek, Lodge Creek, Meadow Creek and Schenks Branch watersheds are primarily in the Chester, Cullen, Culpeper, Elioak, Hayesville, Hazel and Rabun series. These series form various complexes, many with rock outcrops (USDA-NRCS, 2010).

Land uses for the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch watersheds were derived from the 2009 Rivanna River Basin Commission's Rivanna Watershed and Vicinity Land Use/Land Cover Map geodatabase (RRBC, 2009) and the 2009 National Agricultural Statistics Service cropland data layer (NASS, 2009). In general, the RRBC land use data were used as the primary source. In the Albemarle County portions of each watershed, the NASS cropland categories were considered refinements of the RRBC "Open Land" category, and the four NASS urban development categories were used to interpret forest cover in those areas as pervious urban areas. The distribution of land uses in the four watersheds are shown in Table 3-1. In general, the vast majority (> 83%) of Lodge Creek, Meadow Creek, and Schenks Branch watersheds are in residential/developed uses with the remainder primarily in forest. The land uses in Moores Creek watershed include 61% in forest, 34% in residential/developed, and 5% in agricultural uses.

Table 3-1. Land Use Distribution in the Watersheds

Land Use Group	Lodge Creek	Moores Creek*	Schenks Branch	Meadow Creek*
	Area in acres			
Conventional Tillage - no manure	0.0	60.6	0.0	0.0
All Other Row Crops	0.0	10.3	0.0	7.3
Hay	0.0	781.5	0.0	31.6
Pasture	0.0	207.5	0.0	13.0
Low Density Residential - pervious	244.7	5,311.0	713.4	1,915.6
Low Density Residential - impervious	100.4	1,265.5	262.7	747.3
High Density Residential - pervious	29.6	358.2	154.2	406.2
High Density Residential - impervious	46.3	389.5	222.3	609.1
Forest	50.4	13,223.3	53.7	661.6
Harvested Forest	0.0	20.7	0.0	0.0
Water	0.0	232.4	1.9	19.0
Total	471.4	21,860.5	1,408.1	4,410.6

* Moores Creek excludes Lodge Creek; Meadow Creek excludes Schenks Branch.

3.3. *Biological Monitoring*

Biological monitoring consisted of sampling the benthic macro-invertebrate community along with corresponding habitat assessments. The data for the bioassessments in Moores Creek, Lodge Creek, Meadow Creek and Schenks Branch were based on DEQ biological monitoring at the six DEQ monitoring sites and various citizen monitoring data from the Save Our Streams and StreamWatch organizations in the watershed. One primary biological monitoring station was located in each of the four watersheds, supplemented with additional sampling at two points on an unnamed tributary to Schenks Branch. The primary biological stations were variably monitored between 2 and 5 times each during the period 2002 – 2009. The locations of the DEQ biological and ambient monitoring stations in these watersheds are shown in Figure 3-3, together with the major tributary sub-watersheds.

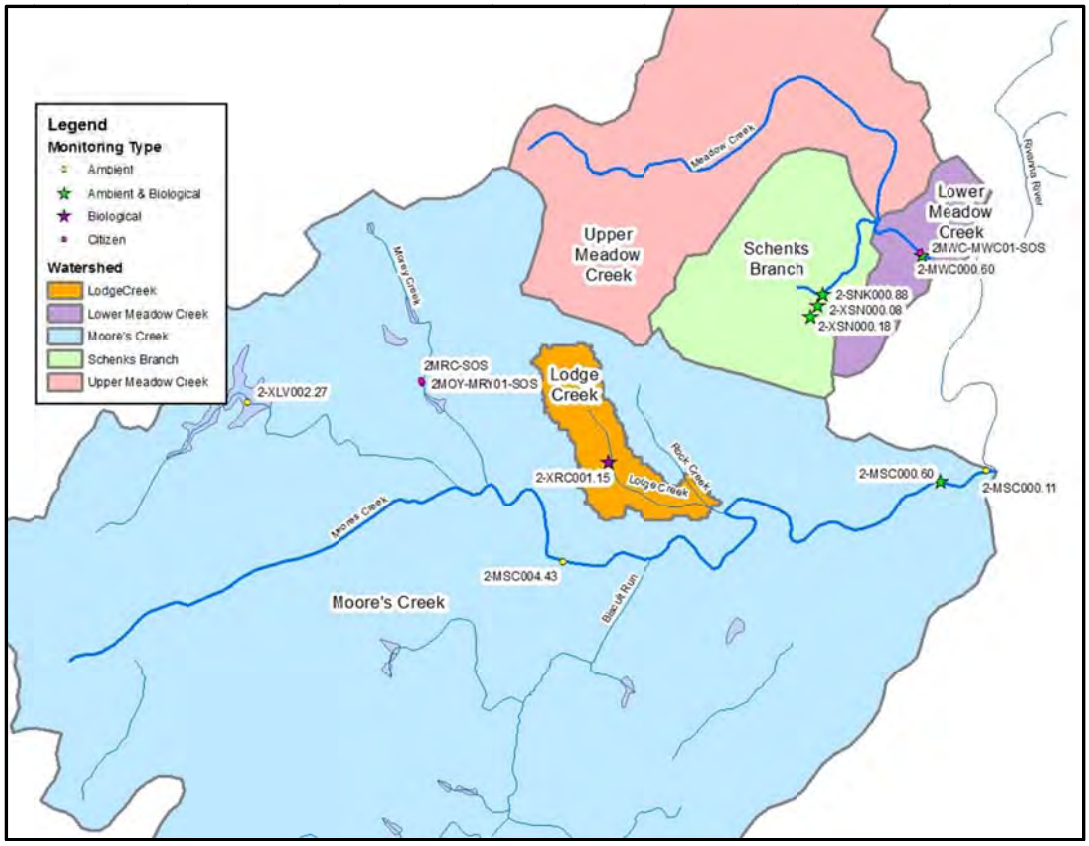

Figure 3-3. Monitoring Stations in the Watersheds

DEQ's biological assessment method is based on the Virginia Stream Condition Index (VSCI) for Virginia's non-coastal areas (Tetra Tech, 2003). This multi-metric index is based on 8 biomonitoring metrics that are based on the diversity, pollution tolerance, and abundance of organisms identified during a taxa inventory of each sample. VSCI has a scoring range of 0-100, where a maximum score of 100 represents the best benthic community sites. The current threshold criteria defines "non-impaired" sites as those with a VSCI of 60 or above, and "impaired" sites as those with a score below 60 (VADEQ, 2006). The VSCI scores for Moores Creek and Meadow Creek are shown in Figure 3-4. The VSCI scores for all six monitoring sites clearly fall within the "impaired" category.

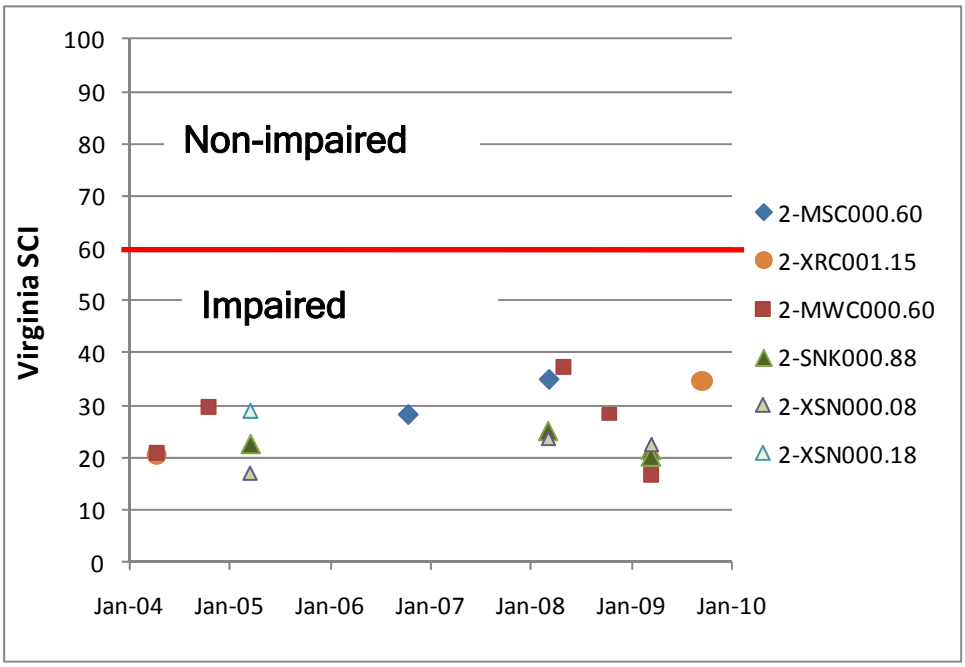

Figure 3-4. VSCI Scores for Moores Creek (MSC), Lodge Creek (XRC), Meadow Creek (MWC), Schenks Branch (SNK), and Schenks Branch Unnamed Tributary (XSN)

A qualitative analysis of various habitat parameters was conducted in conjunction with each biological sampling event. Habitat data collected as part of the biological monitoring were obtained from DEQ through the EDAS database. Each of the 10 parameters included in the habitat assessment was rated on a scale of 0-20, with a maximum score of 20 indicating the most desirable condition, and a score of 0 indicating the poorest habitat conditions. The best possible overall score for a single evaluation is

200. Many of the "poor" to "marginal" habitat scores shown in these two tables relate fairly closely with the sediment stressor. The habitat assessment data are shown for Moores Creek and Lodge Creek in Table 3-2, and for Meadow Creek and Schenks Branch in Table 3-3.

Table 3-2. Habitat Evaluation Scores for Moores Creek (MSC) and Lodge Creek (XRC)

StationID	2-MSC000.60		2-XRC001.15			
Collection Date	10/26/06	03/20/08	04/29/02	10/16/02	04/21/04	09/30/09
Channel Alteration	13	18	10	9	17	13
Bank Stability	8	17	14	14	11	6
Vegetative Protection	18	17	9	12	20	14
Embeddedness	11	14	13	13	13	13
Channel Flow Status	18	18	10	20	9	8
Frequency of riffles (or bends)	11	17	18	17	19	18
Riparian Vegetative Zone Width	4	12	2	4	2	4
Sediment Deposition	16	14	11	13	18	18
Epifaunal Substrate / Available Cover	13	16	19	11	18	16
Velocity / Depth Regime	16	17	9	13	8	12
10-metric Total Habitat Score	**128**	**160**	**115**	**126**	**135**	**122**
Average Station Score	**144**		**124.5**			

- Marginal or Poor habitat metric rating.

Table 3-3. Habitat Evaluation Scores for Meadow Creek (MWC), Schenks Branch (SNK), and the Unnamed Tributary to Schenks Branch (XSN)

StationID	2-MWC000.60					2-SNK000.88			2-XSN000.08			2-XSN000.18
Collection Date	04/21/04	10/27/04	05/12/08	10/27/08	03/30/09	03/30/05	03/20/08	03/30/09	03/30/05	03/20/08	03/30/09	03/30/05
Channel Alteration	19	18	18	18	19	6	10	2	6	12	7	2
Bank Stability	8	2	9	4	6	14	17	12	6	14	10	5
Vegetative Protection	20	18	16	18	18	17	11	12	18	12	14	14
Embeddedness	8	5	12	5	12	2	13	11	5	12	8	6
Channel Flow Status	8	15	18	10	8	16	17	15	15	16	10	15
Frequency of riffles (or bends)	18	18	17	17	17	16	18	18	16	18	16	17
Riparian Vegetative Zone Width	20	18	18	18	18	3	9	6	4	7	7	2
Sediment Deposition	6	3	10	10	9	7	13	14	4	11	15	13
Epifaunal Substrate / Available Cover	13	15	16	16	17	11	16	18	10	15	15	14
Velocity / Depth Regime	13	16	17	13	16	13	10	13	13	11	13	13
10-metric Total Habitat Score	**133**	**128**	**151**	**129**	**140**	**105**	**134**	**121**	**97**	**128**	**115**	**101**
Average Station Score	**136.2**					**120**			**113.3**			**101**

- Marginal or Poor habitat metric rating.

3.4. *Ambient and Stream Sediment Monitoring*

DEQ monitored chemical and bacterial water quality at six different stations with various periods of record between 1968 and the present, as shown in Table 2 8. The Moores Creek (MSC) impaired segment was monitored at the 2-MSC000.60 biological station in 2006 and 2008, with ambient sample collection at the same station from 1991 through 2007. Additional ambient sampling occurred downstream at station 2-MSC000.11 from 1968-79, and again in 2003 and 2010; and upstream at station 2-MSC004.43 between 2005 and 2006. No ambient data are available for Lodge Creek (XRC) at station 2-XRC001.15, except for physical parameters collected on the date of biological sampling. The Meadow Creek (MWC) impaired segment has been monitored at the 2-MWC000.60 biological station since 2004, with ambient sample collection at the same station since 1991. The Schenks Branch (SNK) impaired segment was monitored at the 2-SNK000.88 biological station between 2005 and 2009, and at two locations on an unnamed tributary. Ambient samples have been collected at the biological station and at one of the unnamed tributary (XSN) sites (2-XSN000.08) since 2008.

Table 3-4. Summary of Ambient Monitoring Data through October 2010

Station	Stream Name	Period	No. of Samples
2-MSC000.11	Moores Creek	1968 - 1979	87
2-MSC000.60		1991 - 2007	55
2-MSC004.43		2005 - 2006	9
2-MWC000.60	Meadow Creek	1991 - 2010	59
2-SNK000.88	Schenks Branch	2008 - 2010	2
2-XSN000.08	Schenks Branch UT	2008 - 2010	2

Chemical parameters included various forms of nitrogen and phosphorus – ammonia, total Kjeldahl nitrogen (TKN), nitrite plus nitrate-N, total N, and total P; dissolved oxygen (DO); various forms of solids – total solids, volatile solids, and suspended solids; chemical oxygen demand (COD); alkalinity; chlorides; sulfates; and total dissolved solids (TDS). Field physical parameters included temperature, pH, DO, and conductivity. The relevant water quality standards for these watersheds are listed under Class III Non-tidal Waters Coastal and Piedmont Zones (SWCB, 2010). Relevant

results from the ambient monitoring are discussed under the stressor analysis in the next section.

Stream sediment and water column samples have been collected and analyzed prior to 2009 for a standard suite of metals and toxic substances periodically in each of the watersheds, except for Lodge Creek. The majority of the toxics and metals testin in the analyses were found to be below their respective minimum analytical detection limits, and none of the substances found in channel bottom sediments exceeded any of the known probable effect concentrations (PECs; MacDonald et al., 2000), or any of the minimum threshold effects concentrations (TECs); and none of the tested substances in the water column exceeded known freshwater aquatic life, public water supply (PWS), or human health criteria (SWCB, 2010).

Additionally, beginning in March 2009, a series of sediment samples were taken and analyzed for toxic organic compounds at various sites along the Rivanna River, Moores Creek, Meadow Creek, Schenks Branch, and at two sites along an unnamed tributary to Schenks Branch.

Many samples at some of the Schenks Branch sites exceeded the probable effects concentration (PEC) for a variety of polycyclic aromatic hydrocarbon (PAH) congeners, but are not believed to be impacting the aquatic life. Neff et al. (2005) and McDonald et al. (2000) describe several indices to determine both the dominant PAH source type and the relative potential for toxicity from the cumulative concentrations of various congeners. While two of the indices give slightly different results, the major PAH sources appear to be fairly consistently pyrogenic in nature.

3.5. *Other Assessment Data*

Diurnal dissolved oxygen (DO) tests: No violations of either the minimum dissolved oxygen standard of 4.0 mg/L, or the daily average standard of 5.0 mg/L for Class III waters were observed on Schenks Branch or Meadow Creek, Figure 3-5.

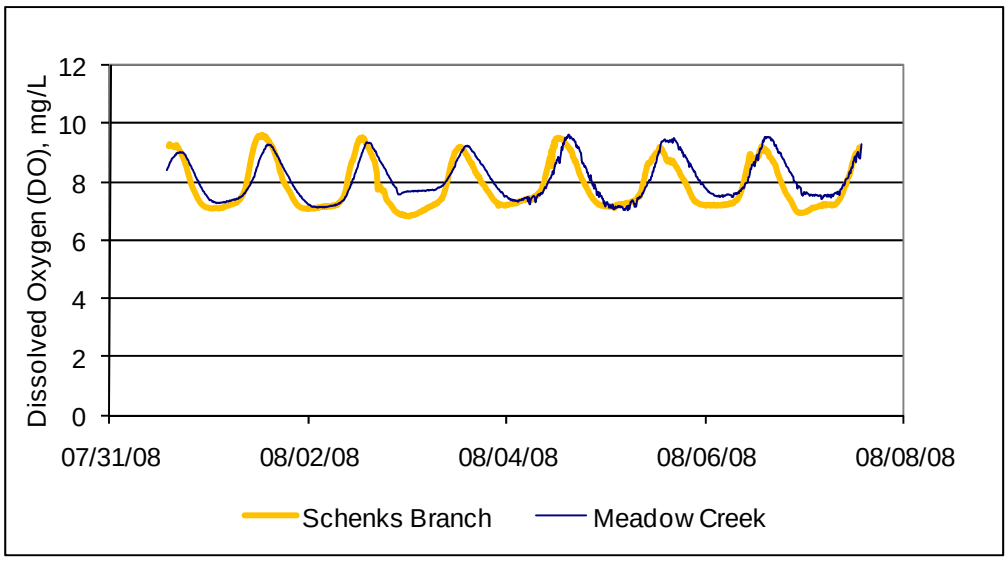

Figure 3-5. 4-Day Diurnal DO Results on Meadow Creek and Schenks Branch

Relative Bed Stability (RBS) Analysis: The RBS analysis showed that both Meadow Creek and Schenks Branch had a high percentage of fine sediment in the streams that directly contribute to embeddedness – the filling of the interstitial spaces in the channel bottom, Table 3-5. This percentage is very similar to that found in the Rivanna River (RVN), where sediment was determined to be one of the most probable stressors for its benthic impairment.

Table 3-5. RBS Analysis Results for Meadow Creek and Schenks Branch

Station	Sample Date	Mean Substrate Size (mm)	LRBS	Mean Embeddedness (channel + margin) (%)	% fines
2-SNK000.88	08/11/08	1.626	-0.029	42.6	22.9
2-MWC000.60	08/11/08	1.200	-0.248	54.2	22.9
2-RVN033.65	07/12/07				23.8

Pollutant Response Program (PReP) Reports: The majority of reported incidences in all of these watersheds related to sewage overflows during storm events. These overflows were included in the TMDLs for these streams. Two incidents were of note, however, as shown in Table 3-6, since they were both petroleum-related, and the high PAH samples in the Meadow Creek watershed were collected 9 months later in March 2009.

Table 3-6. Selected PReP Incidences

Incident Date	Site Name	Quantity Released	Unit	Material Released	Receiving Water	Incident Summary
06/25/08	Near English Inn	-1	Gallons	Unknown Petroleum	Meadow Creek	Caller reported a petroleum sheen and odor on Meadow Creek.
06/23/08	Tar Truck Fuel Release	15	Gallons	diesel fuel	Schenks Branch	A tar truck had a ruptured diesel fuel line that released 15 gallons of fuel onto roadway and into storm drain that leads to a stream called schenks branch.

Reported petroleum releases: The distribution of petroleum releases throughout the watersheds is illustrated in Figure 3-6. Those releases reported as "2006" in the figure are comprised of an unknown number of years of data that were first entered in the database in 2006.

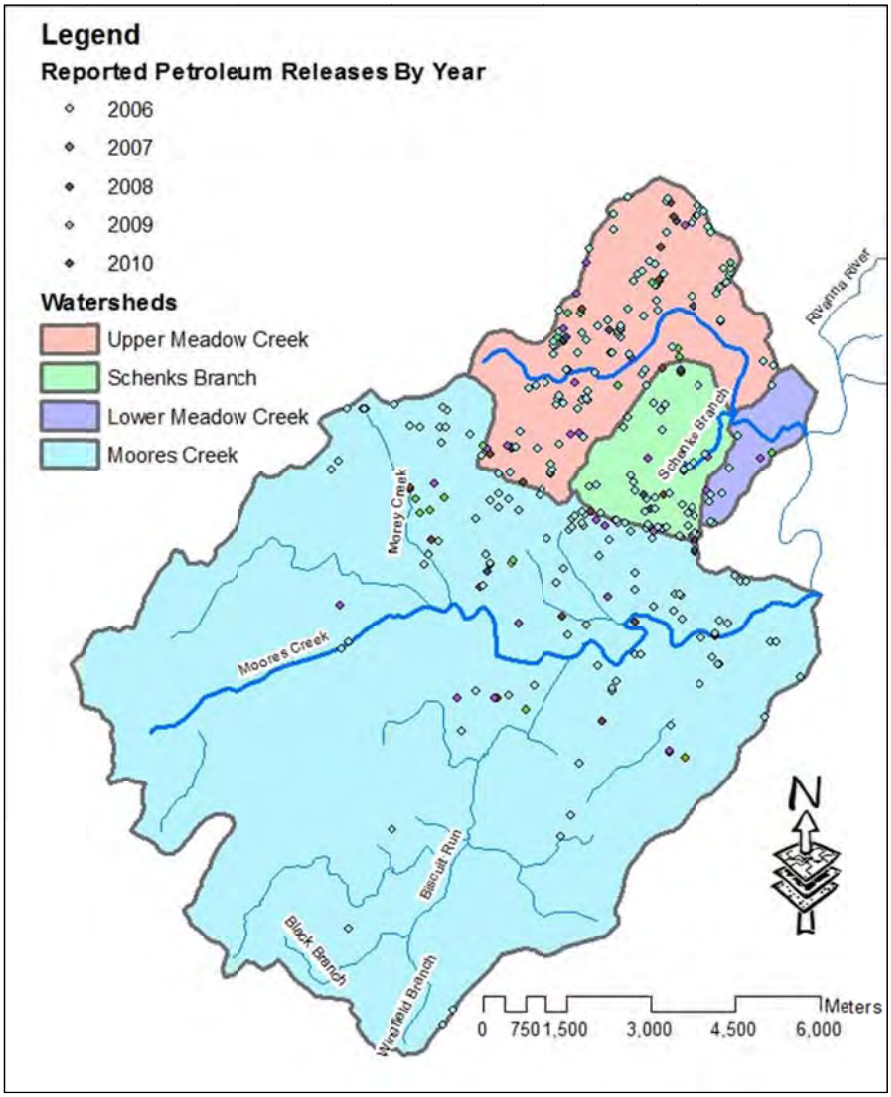

Figure 3-6. Reported Petroleum Releases By Year

Permitted Sources: There are no general discharge permits for single-family homes in any of the watersheds. Currently, there are 2 active VPDES permits in the watersheds, and an additional 2 permits were active as late as 2005. The largest of the current discharge permits is for the Moores Creek wastewater treatment plant, which sits just upstream of the Moores Creek outlet. As of fall 2010, there were seven active Virginia industrial stormwater permits in the impaired watersheds, with none listed in Lodge Creek. Additional state permits issued under the Virginia Stormwater Management Program (VSMP) include those related to temporary construction, as well as permits under the Municipal Separate Storm Sewer System (MS4) Program issued to Albemarle County, the City of Charlottesville, the University of Virginia, the Virginia Department of Transportation, and Piedmont Virginia Community College. The VSMP construction permits are for control of erosion and sediment on construction sites. The location of these disturbed areas will change from year to year as some construction is completed and other begun. The current total disturbed areas covered by these permits includes 89.80 acres in Moores Creek (excluding Lodge Creek), 6.8 acres in Lodge Creek, 58.56 acres in Meadow Creek (excluding Schenks Branch), and 15.61 acres in Schenks Branch.

Local Sources: Several sources of local information were also considered in the stressor analysis, including stream corridor assessments (SCAs) that were conducted by Albemarle County in 2002, and by the City of Charlottesville in 2005, and a companion habitat assessment by the County. Another interesting source of local information was a series of YouTube videos produced by a local citizen titled "Charlottesville City of Trash" that highlighted problems in Lodge Creek, Rock Creek, and Moores Creek. The videos highlight sewer system overflows to Lodge Creek, leaching from the Avon sanitary landfill (closed in 1974), illegal dumping, and impacts on channel stability from urban runoff.

3.6. *Benthic Stressor Analysis Summary*

TMDLs must be developed for a specific pollutant. Since a benthic impairment is based on a biological inventory, rather than on a physical or chemical water quality

parameter, the pollutant is not identified in the assessment, as it is with physical and chemical parameters. The process outlined in EPA's Stressor Identification Guidance Document (EPA, 2000) was used to identify the critical stressor for each of the impaired watersheds in this study. Watershed and water quality data from these streams, permit data, local data, and field observations were used to help identify candidate causes.

The Moores Creek (VAV-H28R_MSC01A00) stream segment is severely impaired for its aquatic life use, with individual VSCI sample scores of 28.3 and 34.9, where a score of 60 or above represents a non-impaired condition (scale: 0 – 100). The Moores Creek watershed is impacted by a variety of agricultural and urban land uses. Sediment was determined to be the most probable stressor based on the repeated poor scores for sediment metrics in the habitat assessments and the observations of insufficient buffer, erosion, and bank instability at many locations in the watershed.

The Lodge Creek (VAV-H28R_XRC01A04) stream segment is severely impaired for its aquatic life use, with individual VSCI sample scores ranging from 20.6 to 37.8. The Lodge Creek watershed is impacted by urban land uses. Hydrologic modifications and sediment were determined to be the most probable stressors based on the high percent imperviousness, repeated poor scores for riparian vegetation, and observations of insufficient buffer, erosion, and bank instability at many locations along the stream.

The Meadow Creek (VAV-H28R_MWC01A00) stream segment is severely impaired for its aquatic life use, with individual VSCI sample scores ranging from 16.7 to 37.4. The Meadow Creek watershed is impacted by urban land uses. Hydrologic modifications and sediment were determined to be the most probable stressors based on the high percent of impervious area, repeated poor scores for sediment metrics in the habitat assessments, and the observations of insufficient buffer and active erosion sites at many locations in the watershed.

The Schenks Branch (VAV-H28R_SNK01A02) stream segment is severely impaired for its aquatic life use, with individual VSCI sample scores from both this segment and its unnamed tributary ranging from 16.8 to 29.0. The Schenks Branch watershed is impacted by urban land uses. Hydrologic modifications and sediment were determined to be the most probable stressors based on the high percent of impervious

area, repeated poor scores for sediment metrics in the habitat assessments, and the observations of insufficient buffer and active erosion sites in many riparian locations along the stream.

3.7. *Modeling for Sediment Impairment*

Virginia does not currently have numeric criteria for sediment; therefore, the disaggregate method (Yagow et al., 2012) was used to determine the sediment load that corresponds with acceptable water quality and habitat conditions necessary to support aquatic life. This approach is based on load calculations generated by the Chesapeake Bay Watershed Model (CBWM).

USEPA's Chesapeake Bay Program developed the CBWM to simulate the fate and transport of nutrients and sediment in the 64,000 mi^2 watershed that drains to the Chesapeake Bay. This model has evolved over time. The first version was developed in 1983; the latest version (phase 5.3.2) was released in June 2011. Data from 287 flow gauging stations and 164 water quality stations with varying periods of record were used to calibrate the CBWM (USEPA, 2010a). The CBWM simulates the Bay basin using 1,194 river segments. Most of the CBWM inputs are based on county-averaged data that is distributed on an area-weighted basis to portions of river segments that intersect each county.

For these TMDLs, sediment loads were initially calculated from a local inventory of land uses and 1985-2000 average annual unit-area loads (UALs) for corresponding land uses from the CBWM as available through the Virginia Assessment Scenario Tool (VAST; ICPRB, 2011). Baseline existing loads were calculated using UALs from the 2009 Progress scenario applied to 2010 land use acreages, while TMDL loads were calculated using UALs from the WIP1-VA scenario based on the December 2010 Chesapeake Bay TMDL and later revised for the Phase 5.3.2 simulation output reported on June 30, 2011, and further revised on November 7, 2011. During implementation planning for these watersheds, revised baseline existing loads were calculated based on the 2010 NoBMP scenario available through VAST, together with a local assessment of active BMPs through the end of 2011 and load reductions calculated using CBWM

BMP efficiencies, relevant land use changes and associated upland filtering effects for riparian buffers.

For the TMDL study, there was one CBWM river segment (JL4_6520_6710) which encompassed the four watersheds of interest, and two land-river segments (A51003JL4_6520_6710 and A51540JL4_6520_6710) defined by the Albemarle County/City of Charlottesville boundary line within the river segment. Data from these land-river segments were used to calculate distributions of land uses and their related UALs. The 23 CBWM land uses in these watersheds were then associated with the 10 land use categories in the locally-derived land use inventory compiled from the 2009 Rivanna River Basin Commission's Rivanna Watershed and Vicinity Land Use/Land Cover Map geodatabase (RRBC, 2009) and the 2009 National Agricultural Statistics Service cropland data layer (NASS, 2009) based on common land use groups. The acreages of the locally-derived land use groups were then redistributed to the CBWM land use categories based on the land-river segment distributions. Loads for each local watershed were then calculated by multiplying the distributed area times the related UAL and summed over all land uses. Permit-based and population-based source loads were calculated from population inventories and permit data.

This approach is based on the assumption that reduction of the sediment loads in the impaired watersheds, to proportional levels of loads called for in the Chesapeake Bay TMDL for a downstream tidal segment, will improve water and habitat quality and result in elimination of the local benthic impairment. Although sediment is used as a surrogate for benthic health in the development of these TMDLs, attainment of healthy benthic communities will ultimately be based on biological monitoring of the benthic macroinvertebrate community, in accordance with established DEQ protocols. If a future review should find that the reductions called for in these TMDLs based on current modeling are found to be insufficiently protective of local water quality, then revision(s) will be made as necessary to provide reasonable assurance that water quality goals will be achieved.

3.8. *Accounting for Critical Conditions and Seasonal Variations*

The modeling period for these TMDLs was the same as that used in modeling loads for the Chesapeake Bay TMDL, namely 1984 – 2005. This 22-year period captures the wide variability in annual and seasonal rainfall that result in sediment detachment and transport in these watersheds.

3.8.1. Critical Conditions

The CBWM is a continuous simulation model that uses an hourly time step. The period of rainfall selected for modeling was chosen as a multi-year period that was representative of typical weather conditions for the area, and included “dry”, “normal”, and “wet” years. The model, therefore, incorporated the variable inputs needed to represent critical conditions during low flow – generally associated with point source loads and in-stream disturbances – and critical conditions during high flow – generally associated with nonpoint source loads.

3.8.2. Seasonal Variability

The CBWM model, on which the UALs in this TMDL analysis are based, considered seasonal variation through a number of mechanisms. The use of hourly time steps, seasonally variable rainfall inputs, seasonal erodibility coefficients, and seasonal representation of agricultural tillage, harvesting, and management actions all contributed to the incorporation of seasonal variability as it manifested itself variably on different land uses represented in the model.

3.9. *Reassessment of the Moores Creek Impaired Stream Segment*

DEQ’s delineation procedures for stream segments corresponding to biological monitoring stations, defines the impaired segment as the entire stream segment from the nearest major upstream confluence to the nearest major downstream confluence. In the case of Moores Creek, the portion of the impaired stream segment downstream from the monitoring point receives discharge from the Moores Creek WWTP. Since this discharge is downstream from the biological monitoring point, it does not contribute to the identified upstream impairment. However, since it contributes discharge to the

overall impaired stream segment, its existing and permitted TSS loads traditionally would get factored into the overall existing and TMDL loads for the watershed. However, since the WWTP is discharging well below its permitted TSS load limit, incorporating the difference between its current average TSS load (87.7 tons/yr) and its permitted annual load (503.1 tons/yr) would require load reductions from other sources in the watershed, over and above those required at the identified point of impairment.

A discussion about the impairment delineation was held between representatives of DEQ's permit, assessment, and TMDL staff to explore a more reasonable approach to address this issue. The proposed solution was to base sediment load calculations only on those portions of the watershed upstream from the 2-MSC000.60 biological monitoring station, which was approved by EPA on August 30, 2012. A delineation of the new watershed boundary for Moores Creek reduces the watershed area used to calculate sediment loads by a very small amount (48.4 ha), and eliminates the additional load reductions that would be necessitated by including the WWTP permitted load. Since the WWTP already has a sediment WLA as part of the larger Rivanna River Benthic TMDL, it is not being excluded from the TMDL process, but is being represented more appropriately by being nested in a larger watershed where it is actually contributing to an impairment. This approach will exclude the WWTP from the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch TMDLs and IP. The remainder of the TMDL and IP analysis and calculations described in this report are based on this new watershed boundary.

3.10. *Sources of Sediment*

Sediment sources can be divided into point and nonpoint sources. The major sources of sediment are agricultural land and urban land. Agricultural lands, such as cropland and pasture/hay areas, can contribute excessive sediment loads through erosion and build-up/wash-off processes. Agricultural lands are particularly susceptible to erosion due to less vegetative coverage and to stream bank erosion in riparian pasture areas where livestock have unrestricted access to streams. Sediment in urban areas is contributed primarily through stormwater runoff, both permitted and non-permitted, with minor contributions from the three permitted point sources in the

watersheds, shown in Table 3-7. Permitted sources of stormwater runoff in these watersheds include seven facilities with industrial stormwater permits, a continuously varying number of construction sites, and five MS4 areas.

Table 3-7. Permitted point source facilities in the watersheds

Facility Name	Permit Number	Permit Type	Baseline Conditions			Permitted Conditions			Watershed
			Average Flow (MGD)	Average [TSS] (mg/L)	**TSS Load (lbs/day)**	Average Flow (MGD)	Average [TSS] (mg/L)	**TSS Load (lbs/day)**	
Virginia Oil	VA0087351	VPDES	0.0010	--	**--**	0.0073	--	**--**	Schenks Br.
Allied Concrete Company - Charlottesville	VAG110064	General				0.065	30	**16.3**	Schenks Br.
HT Ferron Company	VAG111032	General				0.052	30	**13.0**	Moores Cr.

3.11. *TMDL Allocations and Load Reductions*

The objective of the TMDL pollutant allocations is to distribute allowable loads among different pollutant sources so that the appropriate control actions can be taken to achieve water quality standards (EPA, 1994). The stressor analysis indicated that sediment was the “most probable (pollutant) stressor” in all four watersheds, although hydrologic modification was also cited as a non-pollutant stressor in three of the four watersheds, primarily related to the large amounts of impervious surfaces in those watersheds. Since TMDLs are typically only developed for “pollutant” stressors, sediment will serve as the basis for development of the TMDL in each watershed.

3.11.1. Sediment TMDLs

The sediment TMDL calculated for each of the four watersheds consisted of a permitted waste load allocation (WLA), a nonpoint source load allocation (LA), a margin of safety (MOS), and an allocation for future growth (FG), using the following equation:

$$TMDL = WLA + LA + MOS + FG$$

The TMDL load in each impaired watershed corresponds to the average annual sediment load, based on loads generated using the Virginia Watershed Implementation Plan scenario (WIP1-VA) and the CBWM. The WIP1-VA scenario incorporates BMP implementation percentages proposed by the state for achieving load reductions at the outlet of each downstream tidal segment, as identified in the Chesapeake Bay TMDL.

The waste load allocation (WLA) consisted of the aggregated loads for the various Municipal Separate Storm Sewer System (MS4) jurisdictions (including an aggregated WLA for construction permits), and the loads from permitted facilities. There are currently five MS4 permits in the study area (Albemarle County, City of Charlottesville, University of Virginia, Virginia Department of Transportation, and Piedmont Virginia Community College). In most cases, MS4 areas overlap or are intertwined and currently the boundaries of these systems are not geospatially defined, making disaggregation of the MS4 loads to individual jurisdictions difficult. EPA, DEQ, and DCR support the aggregation of MS4 WLAs for this reason. Additionally, aggregation encourages stakeholder cooperation and facilitates implementation of appropriate BMPs to address reductions required by the TMDL. The TMDL will be revisited in the future as new information warrants.

An implicit MOS was assumed in the sediment TMDL, as conservative parameter values and estimates of BMP efficiencies were used as inputs, and cumulative sediment loads resulting from the Bay-wide TMDL (reference) scenario met the applicable water clarity water quality standard in all segments of the Chesapeake Bay. Although the Chesapeake Bay estuarine model actually showed that no decrease was needed in sediment loads to achieve the light and turbidity standards, since phosphorus decreases were necessary, an explicit MOS of 19% was applied to sediment loads delivered to the tidal segments to represent the associated decreases in sediment from needed phosphorus reductions. However, since sediment is the focus of these TMDLs and the waters of concern are local and analogous to the CBWM edge-of-stream loads, the explicit MOS was not considered to be applicable. Furthermore, total watershed loads, calculated by the disaggregate method in this study, are based on the CBWM model, which was calibrated to in-stream loads, thereby producing loads that are more realistic in magnitude and less in need of an explicit MOS to ensure that simulated loads will provide an adequate basis for meeting water quality objectives.

After projecting future land use changes in each watershed, simulated changes in load showed slight variations, which on average, equaled approximately 1% of the TMDL load. The local Steering Committee recommended simplifying the load allocations for future growth (FG) to 1% of the TMDL load for each watershed.

The LA was calculated as the TMDL minus the sum of MOS, WLA, and FG. The TMDL load, components, and individual and aggregated WLAs are shown for each watershed in Table 3-8.

Table 3-8. Sediment TMDLs and Components (tons/yr) for Lodge Creek, Moores Creek, Schenks Branch, and Meadow Creek

Watershed	TMDL	WLA		LA	MOS	FG
Lodge Creek	154.1	147.0		5.6	Implicit	1.5
		VAR040051 City of Charlottesville VAR040074 Albemarle County VAR040073 University of Virginia VAR040115 Virginia DOT construction Aggregate WLA = 6.5 tons/yr	147.0			
Moores Creek*	2,630.8	1,010.5		1,594.0	Implicit	26.3
		VAR040051 City of Charlottesville (includes VAG111032) VAR040074 Albemarle County (includes VAR051960, VAR051387) VAR040073 University of Virginia VAR040115 Virginia DOT VAR040108 Piedmont Virginia Community College construction Aggregate WLA = 218.1 tons/yr	1,010.5			
Schenks Branch	505.2	499.3		0.8	Implicit	5.1
		VAR040051 City of Charlottesville (includes VAG110064) VAR040074 Albemarle County VAR040073 University of Virginia VAR040115 Virginia DOT construction Aggregate WLA = 15.6 tons/yr	499.3			
Meadow Creek*	1,360.1	1,309.5		37.0	Implicit	13.6
		VAR040051 City of Charlottesville (includes VAR050932) VAR040074 Albemarle County (includes VAR050876, VAR050974) VAR040073 University of Virginia (includes VAR051372) VAR040115 Virginia DOT construction Aggregate WLA = 72.9 tons/yr	1,309.5			

* Moores Creek excludes Lodge Creek; Meadow Creek excludes Schenks Branch.

3.11.2. Load Allocation Scenarios

The target load for the allocation scenario in each watershed is the TMDL minus the sum of MOS and FG. The MOS was determined to be implicit and the FG was represented as 1% of the TMDL load to account for future growth. The target loads, therefore, were equal to 99% of the TMDL. New baseline scenarios were developed during IP development based on the NoBMP scenario for the applicable CBWM land-river segments and BMPs were inventoried by the local jurisdictions to represent current conditions. The Final IP Scenarios, defined in the following tables, were the result of

load reduction calculations based on the types and distributions of BMPs decided on by the local stakeholders that would most reasonably achieve water quality goals in each watershed. Although new areas of harvested forest and construction will require BMPs to address these transient sources of sediment, it was assumed that these sources are fairly constant and are already being addressed through the state's E&S Program and the Department of Forestry's regulatory requirements in the existing condition.

The Allocation Scenario in the final TMDL report will be updated to correspond with the existing and planned BMP types and extents inventoried by the Local Steering Committee during IP development. Allocation scenarios are detailed in Table 3-9 through 3-12 for Lodge Creek, Moores Creek*, Schenks Branch, and Meadow Creek*, respectively.

Table 3-9. Lodge Creek: Sediment TMDL Allocation Scenario

CBWM Landuse/Source Category	Reference TMDL Scenario		New Baseline Scenario[1]		Final IP Scenario		
	Area (acres)	TSS (tons/yr)	Area (acres)	TSS (tons/yr)	Area (acres)	TSS (tons/yr)	% Load Reduction
forest	49.8	4.7	49.8	4.8	49.8	4.8	0.0%
harvested forest	0.5	0.2	0.5	0.2	0.5	0.2	
impervious developed	144.2	109.9	146.7	137.1	146.7	112.1	18.2%
pervious developed	274.7	32.8	272.0	36.2	272.0	29.0	20.0%
construction	2.2	6.5	2.3	6.6	2.3	6.6	0.0%
combined sewer overflows and SSOs		0.00		0.0002		0.00	100.0%
Average Annual Sediment Load		**154.1**		**184.8**		**152.6**	

Target Load (TMDL - FG) = 152.6 tons/yr

Overall Reduction = 17.4%

[1] 2010 landuse with RRBC pre2011 BMPs + E&S + Forest Harvesting BMPs

Table 3-10. Moores Creek* Sediment TMDL Allocation Scenario

CBWM Landuse/Source Category	Reference TMDL Scenario		New Baseline Scenario[1]		Final IP Scenario		
	Area (acres)	TSS (tons/yr)	Area (acres)	TSS (tons/yr)	Area (acres)	TSS (tons/yr)	% Load Reduction
conventional tillage - no manure	60.1	6.3	0.0	0.0	0.0	0.0	
high-till cropland	1.0	0.1	7.1	0.8	7.1	0.8	0.0%
low-till cropland	9.2	0.6	0.0	0.0	0.0	0.0	
hay	777.3	26.7	780.8	30.6	800.0	31.4	-2.6%
pasture, other	197.5	128.8	184.7	193.2	184.7	120.3	69.2%
pasture corridor	0.6	7.1	19.3	228.7	0.0	0.0	
animal feeding operations	4.4	8.4	4.4	14.0	4.4	14.0	
forest	13,138.9	437.3	13,206.8	439.6	13,206.8	439.6	0.0%
harvested forest	129.9	23.5	133.4	27.6	133.4	27.6	
impervious developed	1,629.3	1,164.8	1,654.6	1,390.0	1,654.2	1,261.1	9.3%
pervious developed	5,541.2	608.9	5,555.2	460.2	5,555.5	485.4	-3.7%
construction	90.2	218.1	92.8	224.2	92.8	224.2	
combined sewer overflows and SSOs		0.0		0.02		0.0	0.0%
Average Annual Sediment Load		**2,630.8**		**3,008.9**		**2,604.5**	

Target Load (TMDL - FG) = 2,604.5 tons/yr

Overall Reduction = 13.4%

* Moores Creek excludes Lodge Creek.

[1] 2010 landuse with RRBC pre2011 BMPs + E&S + Forest Harvesting BMPs

Table 3-11. Schenks Branch Sediment TMDL Allocation Scenario

CBWM Landuse/Source Category	Reference TMDL Scenario		New Baseline Scenario[1]		Final IP Scenario		
	Area (acres)	TSS (tons/yr)	Area (acres)	TSS (tons/yr)	Area (acres)	TSS (tons/yr)	% Load Reduction
forest	52.9	5.5	53.1	5.5	53.1	5.5	0.0%
harvested forest	0.5	0.2	0.5	0.4	0.5	0.4	
impervious developed	474.6	376.4	485.0	467.9	485.0	421.8	8.7%
pervious developed	873.7	107.5	863.0	129.9	863.0	56.7	56.0%
construction	4.5	15.6	4.6	15.8	4.6	15.8	0.0%
combined sewer overflows and SSOs		0.00		0.00001		0.00	100.0%
Average Annual Sediment Load		**505.2**		**619.6**		**500.2**	

Target Load (TMDL - FG) = 500.2

Overall Reduction = 19.3%

[1] 2010 landuse with RRBC pre2011 BMPs + E&S + Forest Harvesting BMPs

Table 3-12. Meadow Creek* Sediment TMDL Allocation Scenario

CBWM Landuse/Source Category	Reference TMDL Scenario		New Baseline Scenario[1]		Final IP Scenario		
	Area (acres)	TSS (tons/yr)	Area (acres)	TSS (tons/yr)	Area (acres)	TSS (tons/yr)	% Load Reduction
forest	658.3	38.2	654.2	38.1	654.2	38.1	0.0%
harvested forest	6.6	1.5	6.6	2.7	6.6	2.7	
high-till with manure nutrient manageme	0.7	0.1	7.3	0.9	7.3	0.9	0.0%
low-till with manure nutrient managemer	6.6	0.4	0.0	0.0	0.0	0.0	
hay	31.6	1.1	31.5	1.2	31.5	1.2	0.0%
pasture	12.3	8.4	12.5	19.9	12.5	19.9	0.0%
animal feeding operation	0.5	1.0	0.5	1.6	0.5	1.6	
impervious developed	1,339.9	972.1	1,356.6	939.2	1,356.6	939.2	0.0%
pervious developed	2,306.8	264.5	2,292.9	186.4	2,292.9	186.4	0.0%
construction	28.3	72.9	28.9	74.3	28.9	74.3	0.0%
combined sewer overflows and SSOs		0.0		0.00002		0.0	100.0%
Average Annual Sediment Load		**1,360.1**		**1,264.3**		**1,264.3**	

Target Load (TMDL - FG) = 1,346.5 tons/yr

Overall Reduction = -6.5%

* Meadow Creek excludes Schenks Branch.

[1] 2010 landuse with RRBC pre2011 BMPs + E&S + Forest Harvesting BMPs

Table 3-12 shows that the existing levels of BMPs in Meadow Creek* are sufficient to meet and exceed the target TMDL sediment load. The reduced loads in the New Baseline Scenario were the result of the local inventorying of existing and ongoing BMP implementation, which included a recent extensive stream restoration effort that will be ongoing through 2014.

4.0 PUBLIC PARTICIPATION

4.1. *Introduction*

An essential step in crafting a TMDL implementation plan and then implementing that plan is input from, and engagement of, a broad range of stakeholders (individuals, agencies, organizations, and businesses) who have an interest in improving water quality and a familiarity with local conditions. Public participation involves a dialogue between local stakeholders and government agencies and a discussion of available resources that can be devoted to TMDL implementation, such as funding and technical support.

The stakeholders involved in developing the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch TMDL IP included a Steering Committee, Working Groups, and the general public. The Steering Committee and two Working Groups (one focused on rural issues and another on urban issues) were comprised of representatives from VADEQ, VADCR, VDH, VDOT, the Thomas Jefferson Soil and Water Conservation District (SWCD), the Thomas Jefferson Planning District Commission (TJPDC), Natural Resources Conservation Service (NRCS), Virginia Cooperative Extension, Albemarle County, the City of Charlottesville, the University of Virginia, the Rivanna River Basin Commission, and local watershed stakeholders. Public participation occurred via a series of Steering Committee and Working Group meetings, Table 4-1. These meetings are briefly described in this section, with details of the Working Group Meetings included in Appendix D.

Table 4-1. Summary of TMDL Implementation Planning Meetings

March 15, 2012	Final TMDL Public Meeting and IP Informational Kick-off Meeting, CitySpace, Charlottesville, VA
April 18, 2012	First Set of Rural and Urban Working Group Meetings
May 29, 2012	Second Set of Rural and Urban Working Group Meetings
July 10, 2012	First Steering Committee Meeting
August 6, 2012	Second Steering Committee Meeting
September 20, 2012	Final IP Public Meeting

The first of two public-noticed public meetings for implementation planning occurred on March 15, 2012 at CitySpace in downtown Charlottesville, Virginia. This public meeting served as both the final TMDL meeting and the kick-off meeting for implementation planning and had an attendance of 19. The goals of the public meeting were:

- to present the benthic TMDLs for Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch;
- to provide a basic introduction to the process of implementing TMDLs;
- to engage the community through the Steering Committee and Working Groups; and,
- to explain the roles and responsibilities of each Working Group and the commitment needed for a successful process.

The first set of Working Group Meetings was held at CitySpace in downtown Charlottesville on April 18, 2012, with the Rural Working Group meeting from 10:00am until noon, and the Urban Working Group Meeting from 1:00 – 3:00pm. The Rural Working Group meeting was attended by 10 stakeholders and included a review of preliminary sediment load reduction estimates for agricultural land uses. The Urban Working Group was attended by 14 stakeholders and also reviewed sediment load reduction estimates for urban land uses and discussed how to quantify urban BMPs.

The second set of Working Group Meetings was held on May 29, 2012 at the Albemarle County Office Building on Old Lynchburg Road in Charlottesville, with the Urban Working Group meeting from noon to 2:00pm, and the Rural Working Group meeting from 2:00-4:00pm. The Urban Working Group had 18 stakeholders in attendance and the Rural Working Group included 14 stakeholders.

The first Steering Committee meeting was held on July 10, 2012 at the Albemarle County Office Building in Charlottesville, Virginia, and was attended by 20 people. At this meeting DEQ's contractor reviewed the summary of BMPs provided by the localities and those anticipated being installed through the Moores Creek Bacteria IP.

The second Steering Committee meeting was held on August 6, 2012 from noon to 2:00 pm in the Albemarle County Office Building in Charlottesville and was attended by 11 stakeholders. An update on the Moores Creek Bacteria IP was given by Jessica Lassetter and a discussion was held on the latest draft of the sediment IP for Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch.

The second and final public meeting for Implementation Plan development will be held at 6:00 pm on September 20, 2012 at the downtown Albemarle County Office Building (xx stakeholders attended the meeting). The goals of the meeting were:

- to review the TMDL implementation planning process and the implementation chronology laid out in the TMDL IP;
- to review the analysis and techniques used to determine the final suite of corrective measures included in the TMDL IP; and
- to solicit stakeholder feedback (a formal 30-day public comment period following the final public meeting).

5.0 IMPLEMENTATION ACTIONS

An important element of the TMDL IP is to encourage voluntary implementation of pollution control measures by local, state, and federal government agencies, business owners, and private citizens. In order to accomplish this, those engaged in developing the IP must be aware of types of control measures that can achieve the needed pollutant reduction goals specified in the TMDL as practically and cost-effectively as possible.

5.1. *TMDL Reduction Goals*

The Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch TMDLs identified sediment as the major pollutant responsible for the benthic impairment in their respective watersheds. Table 5-1 summarizes the pollutant sources and reductions called for in the TMDLs.

Table 5-1. Summary of Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch TMDL Sediment Load Reductions

	Lodge Creek	Moores Creek*	Meadow Creek*	Schenks Branch
Landuse Category	% Category Reduction			
Urban Impervious	22.6%	18.6%	17.5%	8.7%
Urban Pervious	24.7%	32.4%	74.6%	56.0%
Cropland	--	0.0%	0.0%	--
Hay	--	-2.6%	0.0%	--
Pasture	--	66.2%	0.0%	--
Forest	0.0%	0.0%	0.0%	0.0%
SSOs	100.0%	0.0%	100.0%	100.0%

* Moores Creek excludes Lodge Creek; Meadow Creek excludes Schenks Branch.

5.2. *Selection of Appropriate Control Measures*

Potential control measures, their costs, and pollutant removal effectiveness estimates were identified through a review of the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch TMDLs, through input from the IP Working Groups, from literature review, and from modeling various BMP implementation scenarios. Because

the majority of the agricultural area is contained within the Moores Creek watershed, exclusive of the Lodge Creek drainage, agricultural BMPs were targeted solely in this watershed, in coordination with livestock exclusion and pasture management BMPs required through the recently revised Moores Creek bacteria IP (RRBC, 2012). A variety of implementation actions will be used to address the required sediment pollutant reductions. Control measures were selected, based on their ability to control sediment from specific sources, the required pollutant load reductions, the potential for cost-sharing of the control measure, the likelihood of implementation by landowners, and the input of watershed stakeholders. A list of potential control measures and their sediment removal efficiency values are listed in Table 5-2.

Table 5-2. Potential control measure efficiencies for sediment

BMPs	Reduction Type	Units	Sediment Removal Efficiency
Agricultural BMPs			
Pasture Fencing[2]	Landuse change + efficiency	percent	56
Precision Grazing/Pasture Mgmt.	Efficiency	percent	30
Urban/Residential BMPs			
Bioretention	Efficiency	percent	80
Raingardens	Efficiency	percent	80
Bioswale	Efficiency	percent	80
Dry Extended Detention Ponds	Efficiency	percent	60
Permeable Pavement	Efficiency	percent	70
Urban Filtering Practices	Efficiency	percent	80
Urban Infiltration	Efficiency	percent	95
Wet Ponds and Wetlands	Efficiency	percent	60
Vegetated Open Channels	Efficiency	percent	70
Street Sweeping 25x/yr	Efficiency	percent	9
Urban Forest Buffers	Efficiency	percent	50
Impervious Surface Reduction[1]	Landuse change	NA	NA
Urban Stream Restoration[2]	Load reduction	lbs/lin.ft./yr	62.4

Livestock exclusion includes additional reductions from filtering of runoff loads from 2x upland pasture area for sediment. Urban forest buffers include additional reductions from 2x upland pervious and impervious urban areas for sediment.

Urban stream restoration unit-length reduction was estimated as the sum of the old CBWM credited reduction (2.25 lbs/lin.ft./yr) and the interim estimate (310 lbs/lin.ft./yr) divided by 5.

Appendix A provides a glossary of BMP and other control measure definitions, and Appendix B contains a list of BMP codes and practice names.

5.3. *Quantification of Control Measures by Pollutant Source*

The extent of existing control measures previously implemented in the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch watersheds were quantified using the Virginia DCR Agricultural BMP Tracking Program database and inventories compiled by Albemarle County, the City of Charlottesville, and the University of Virginia. The list of control measures in this IP consists of those practices already planned and/or funded in each of the jurisdictions and those slated for installation through the revised Moores Creek Bacteria Implementation Plan (RRBC, 2012) and currently planned and funded Capital Improvement Plan (CIP) projects. Additional extents of these same control measures were included as necessary to meet the TMDL sediment load targets. The extents of measures needed to meet the sediment reduction targets were quantified using spreadsheet analyses and approximations of CBWM procedures to calculate load reductions and efficiencies or load reductions from each control measure as applied to each source category. This section provides a summary of the final set of control measures and extents needed to achieve the sediment load reductions specified in each TMDL watershed. Summaries of control measures are given in Tables 5-3 through 5-6 for Lodge Creek, Moores Creek, Meadow Creek and Schenks Branch, respectively. Previously applied control measures still within their practice life were identified and their extents are quantified in these tables as well.

Load reductions were based on changes in land use, filtering effects of applicable buffer-type control measures, unit-length load reductions, and the application of reduction efficiency estimates for the appropriate BMPs. All of the BMPs have a useable practice life of at least 10 years (longer with appropriate maintenance), with the exception of Street Sweeping, which is an annual practice. Details on the load reduction calculations for each control measure are provided in Appendix C.

Table 5-3. Lodge Creek: Existing and Needed Control Measures

BMPs	Lodge Creek					
	Total BMPs Needed to Achieve TMDL	BMPs in Place	New BMPs Needed	Additional BMPs included in MC Bacteria IP	% of Bacteria IP BMPs Needed to Achieve Sediment TMDL	**Additional BMPs Needed**
	Area in Acres Treated, unless otherwise noted					
Bioretention	5.5	0.0	5.5	17.2	25.0%	**0**
Raingardens	1.8		1.8	5.8	24.9%	**0**
Bioswale	20.8	15.0	5.8	18.2	25.0%	**0**
Dry Extended Detention Ponds	20.2	18.8	1.4	6.0	18.8%	**0**
Permeable Pavement	0.2	0.0	0.2	0.6	21.9%	**0**
Urban Filtering Practices	3.5	0.0	3.5	11.2	25.0%	**0**
Urban Infiltration	1.9	0.0	1.9	5.1	29.7%	**0**
Wet Ponds and Wetlands	5.6	0.0	5.6	23.5	18.8%	**0**
Vegetated Open Channels	5.2		5.2	14.7	27.7%	**0**
Street Sweeping 25x/yr	10.7	10.7	0.0			
Urban Forest Buffers	1.7	0.0	1.7	8.4	15.6%	**0**
Dry Detention Ponds	75.7	75.7	0.0			

New BMPs Needed = Total BMPs Needed - BMPs in Place

Table 5-4. Moores Creek**: Existing and Needed Control Measures

BMPs	Moores Creek**							
	Total BMPs Needed to Achieve TMDL	BMPs in Place	New BMPs Needed	BMPs in §319 Grant or CIPs~	Remaining BMPs Needed	Additional BMPs included in MC Bacteria IP	% of Bacteria IP BMPs Needed to Achieve Sediment TMDL	**Additional BMPs Needed**
	Area in Acres Treated, unless otherwise noted							
Agricultural BMPs								
Pasture Fencing[2]	27,766	0	27,766	27,766	0	0		**0**
Precision Grazing/Pasture Mgmt.	184.7	0.0	184.7	0.0	184.7	184.7	100.0%	**0**
Urban/Residential BMPs								
Bioretention	449.2	432.8	16.3	1.8	14.6	52.4	5.9%	**0**
Raingardens	149.7	144.3	5.4	0.6	4.8	17.5	2.0%	**0**
Bioswale	43.1	29.3	13.8	0.0	13.8	55.3	5.6%	**0**
Dry Extended Detention Ponds	48.3	44.9	3.4	0.0	3.4	18.1	1.4%	**0**
Permeable Pavement	6.8	6.4	0.4	0.0	0.4	1.9	0.2%	**0**
Urban Filtering Practices	16.9	8.4	8.5	0.0	8.5	34.1	3.4%	**0**
Urban Infiltration	9.9	5.4	4.5	0.0	4.5	15.4	1.8%	**0**
Wet Ponds and Wetlands	1,160.9	1,102.9	58.0	44.6	13.4	71.7	5.4%	**0**
Vegetated Open Channels	46.0		46.0	0.0	46.0	44.8	18.6%	**0**
Street Sweeping 25x/yr	59.8	59.8	0.0		0.0			
Urban Forest Buffers	67.9	63.9	4.0	0.0	4.0	25.5	1.6%	**0**
Impervious Surface Reduction[1]	6.0	5.5	0.5	0.4	0.1	0.0		**0**
Urban Stream Restoration[2]	1,200.0	1,200.0	0.0	0.0	0.0	0.0		**0**
Dry Detention Ponds	341.9	340.9	1.0		1.0			

New BMPs Needed = Total BMPs Needed - BMPs in Place

[1] Includes Rainwater Harvesting

[2] Units are in linear feet.

~ Local jurisdiction Capital Improvement Plan (CIP) projects

Remaining BMPs Needed = New BMPs Needed - BMPs in §319 Grant or CIPs

** Moores Creek excludes Lodge Creek.

Table 5-5. Schenks Branch: Existing and Needed Control Measures

BMPs	Schenks Branch				
	Total BMPs Needed to Achieve TMDL	BMPs in Place	New BMPs Needed	BMPs in CIPs~	**Additional BMPs Needed**
	Area in Acres Treated, unless otherwise noted				
Bioretention	65.1	11.8	53.4	0.0	**53.3**
Raingardens	21.7	3.9	17.8	0.0	**17.8**
Bioswale	56.3	0.0	56.3	0.0	**56.3**
Dry Extended Detention Ponds	24.6	0.0	24.6	0.0	**24.6**
Permeable Pavement	0.3	0.3	0.0	0.0	**0.0**
Urban Filtering Practices	37.9	3.2	34.7	0.0	**34.7**
Urban Infiltration	15.8	2.6	13.2	0.0	**13.2**
Wet Ponds and Wetlands	97.2	0.0	97.2	0.0	**97.2**
Vegetated Open Channels	52.1	0.0	52.1	0.0	**52.1**
Street Sweeping 25x/yr	60.5	60.5	0.0		
Urban Forest Buffers	41.5	0.0	41.5	0.0	**41.5**
Impervious Surface Reduction[1]	0.8	0.5	0.3		**0.3**
Dry Detention Ponds	31.4	31.4	0.0		

New BMPs Needed = Total BMPs Needed - BMPs in Place

[1] Includes Rainwater Harvesting

~ Local jurisdiction Capital Improvement Plan (CIP) projects

Table 5-6. Meadow Creek**: Existing and Needed Control Measures

BMPs	Meadow Creek**				
	Total BMPs Needed to Achieve TMDL	BMPs in Place	New BMPs Needed	BMPs in CIPs~	**Additional BMPs Needed**
	Area in Acres Treated, unless otherwise noted				
Bioretention	75.7	75.7	0.0	0.0	**0**
Raingardens	25.2	25.2	0.0	0.0	**0**
Bioswale	16.4	16.4	0.0	0.0	**0**
Dry Extended Detention Ponds	52.5	52.5	0.0	0.0	**0**
Permeable Pavement	5.1	5.1	0.0	0.0	**0**
Urban Filtering Practices	13.3	13.3	0.0	0.0	**0**
Urban Infiltration	6.1	6.1	0.0	0.0	**0**
Wet Ponds and Wetlands	1,601.1	1,601.1	0.0	178.0	**0**
Vegetated Open Channels		0.0	0.0	0.0	**0**
Street Sweeping 25x/yr	47.5	47.5	0.0	0.0	**0**
Urban Forest Buffers	0.0	0.0	0.0	0.0	**0**
Impervious Surface Reduction[1]	0.1	0.1	0.0	0.0	**0**
Urban Stream Restoration[2]	1,874.0	1,874.0	0.0	9,000.0	**0**
Dry Detention Ponds	1,057.2	1,057.2	0.0	0.0	**0**

New BMPs Needed = Total BMPs Needed - BMPs in Place

[1] Includes Rainwater Harvesting

~ Local jurisdiction Capital Improvement Plan (CIP) project

[2] Units are in linear feet.

**Meadow Creek excludes Schenks Branch.

As can be seen from the Table 5-3 and Table 5-4, the target TMDL sediment loads in both Lodge Creek and Moores Creek can be achieved through a combination of existing BMPs, BMPs funded through the 319 Grant for the Moores Creek Bacteria IP, and a portion of the other sediment-related BMPs called for in the Moores Creek Bacteria IP that are not currently funded. Assuming that all of the BMPs in that IP are implemented adds to the reasonable assurance that the sediment TMDL goals will be met, since more sediment-related BMPs are called for in the Moores Creek Bacteria IP to reduce bacteria sources, than would be needed to reduce sediment alone.

Table 5-5 shows that Schenks Branch requires additional BMP implementation efforts in order to achieve its target TMDL sediment load goal, while Table 5-6 illustrates that recent and ongoing stream restoration efforts in Meadow Creek are sufficient to meet its target TMDL sediment load goal. The additional planned and funded stream and wetlands restoration projects included in local jurisdictional CIPs further adds to the reasonable assurance that water quality goals will be achieved in this watershed.

5.3.1. Degraded Riparian Pasture

Unrestricted livestock access to streams allows for direct deposition of manure and associated nutrients into streams, and promotes degradation of stream banks and riparian vegetation through livestock hoof action. A GIS analysis was performed to delineate stream lengths adjacent to, or included in, pasture areas in the Moores Creek watershed. The 2007 Virginia Base Mapping Program (VBMP) Orthophotography was used to identify riparian pasture areas and to assess whether the pasture areas had livestock access from only one side or from both sides of the stream. The 2011 National Hydrography Dataset (NHD) streams layer was used to estimate the adjacent stream lengths requiring fencing, which amounted to a length of 27,766 feet in Moores Creek. The total stream length requiring fencing was then multiplied by the appropriate buffer width, and converted to acres. These areas were then compared with the area in the CBWM “degraded riparian pasture” land use category used for modeling in each watershed. Since the visual assessment of livestock locations and local assessment of livestock numbers were considered more representative than the CBWM county-based estimates, the area in “degraded riparian pasture” was adjusted to equal the calculated areas.

“Livestock exclusion fencing” is defined as fencing that meets VADCR or federal NRCS cost-share requirements with a minimum of a 10 ft. or 35 ft. buffer, depending on the practice. The cost-shared BMPs for livestock exclusion selected for use in these watersheds are 16,396 linear feet of the LE-1T (Livestock Exclusion with Riparian Buffers for TMDL Implementation) practice on 5 farms, 5,297 linear feet of the LE-2T (Livestock Exclusion with Reduced Setback for TMDL Implementation) practice on 4 farms, and 6,074 linear feet of the SL-6AT (Small Acreage Grazing System) practice on 3 farms. The LE-1T practice includes streamside fencing, cross fencing, alternative water system(s) and/or hardened stream crossing(s) when needed, and requires a 35-ft stream buffer. The LE-2T practice is similar to the LE-1T practice, except the stream exclusion fencing must be placed a minimum of 10 feet from the stream and the cost-share rate is less than for LE-1T. The SL-6AT practice is similar to the LE-1T practice, but is intended specifically for horse operations. This practice includes streamside fencing, establishment of grazing paddocks, development of heavy use, or sacrifice areas and establishment of walkways to facilitate herd movement.

The selected mix of the various livestock exclusion (LE) alternative practices was based on an inventory of livestock and an assessment of site-specific needs conducted by DCR. Tax parcel data was used to develop estimates of the number of systems needed in addition to the components and extent of each system.

5.3.2. Pasture

Runoff from pasture is also a source of sediment loads. While part of the sediment load from pasture areas will be filtered by buffers created through fencing the riparian zone, additional reductions in pollutants from pasture areas can be achieved through improved pasture management and rotational grazing. Improved pasture management includes a system of pasture management techniques that improve the quantity, quality and utilization of forage for grazing animals and that reduce the risk of surface and groundwater contamination from nonpoint source pollution from pastures by maintaining an adequate stand of forage to absorb runoff and reduce pollutants. This practice includes the following: application of nutrients and lime according to nutrient management planning and soil tests; maintenance of adequate and uniform plant cover (greater than or equivalent to 60 percent); utilization of a rotational grazing system;

locating feeding and watering infrastructure to facilitate grazing land management and minimize water quality impacts; and chain harrowing of pastures to break-up manure piles after livestock are removed from a field at least twice a year. Improved pasture management and rotational grazing are recommended for all grazed pasture areas.

5.3.3. Urban

The primary pollutant control measures included in this IP for urban areas relate to stormwater management for control of sediment runoff and to urban stream restoration for reduction of stream channel contributions of sediment through erosion and mass wasting of unstable stream banks. The urban stormwater management control measures consist of a suite of BMPs that reduce available sources of sediment or reduce the transport of sediment through filtration, entrapment, or infiltration of sediment transporting flows.

Sediment loads from construction areas in the watersheds arise primarily from stormwater runoff from disturbed land. Some of these areas may have transient erosion and sediment (E&S) permits, may have been disturbed prior to the issuance of a permit, or may represent smaller disturbed areas that do not require permitting. Areas with E&S permits are already required to control sediment runoff, but may require increased setback distances, faster vegetation establishment, or increased plantings in setback areas, as determined by state inspectors.

The minor sanitary sewer overflows identified in the TMDL are being addressed by replacement of leaking sewer pipes and through upgrading of the sewer pipe capacities.

The control measures identified for control of sediment from urban areas are also beneficial to control of another possible contaminant in Schenks Branch, that of polycyclic aromatic hydrocarbons (PAHs). Although monitoring showed detectable levels of various PAHs in this watershed, this pollutant was not deemed the most probable stressor, but remains a pollutant of concern. PAHs come from vehicle exhaust emissions, vehicle tires, asphalt pavement, and coal tar-based sealants, which are deposited on impervious surfaces and washed off during wet weather events. BMPs that treat “first-flush” volumes are particularly beneficial in filtering PAHs and preventing their

entry into the stream. Particular emphasis in MS4 programs should focus on installing roofing over areas that are potential sources of chronic or acute releases of PAH, such as oil and petrochemical storage facilities, vehicle maintenance areas, and areas used to store fuel. Street sweeping helps to control the build-up of PAHs, as does proper recycling of used motor oils which contain high concentrations of PAHs and heavy metals. Both wet and dry stormwater detention systems can assist with treatment of PAHs, especially when planted with plants that have the ability to phytoremediate and degrade PAHs (Prabhukumar and Pagilla, 2010). One native species to the Piedmont area of Virginia capable of phytoremediation is switchgrass (Macek et al., 2000; VADCR, 2011). Bioretention, vegetated swales and control measures that promote infiltration are also extremely effective. Information will also be added to the Rivanna Regional Stormwater Education Partnership (RRSEP) web site that promotes knowledgeable use and maintenance of pavement surface sealers to minimize contributions from this identified source (Crane et al., 2000).

5.3.4. Forest Harvesting BMPs

The main source of sediment on forested lands comes from commercial forest harvesting operations. In Virginia, loggers are required to protect water quality, and the Virginia Department of Forestry (VDOF) has developed BMP guidelines for proper timber harvesting. To ensure voluntary compliance with these guidelines, the VDOF began conducting BMP Field Audits in 1993. Conducted four times a year, the field audits are used to gauge the status of forestry-related water quality protection efforts. If loggers do not follow BMPs on harvest sites, sediment deposition may occur, and they can be subject to civil penalties under the Silvicultural Water Quality Law. Forest harvesting BMPs are a suite of integrated conservation practices designed to prevent off-site sediment impact, protect stream crossings, and neutralize stormwater runoff.

5.4. *Technical Assistance Needs*

Technical assistance is needed for design and installation of selected control measures, as well as for educational outreach. Technical assistance needs for all of the agricultural BMPs and the urban BMPs outlined in Stages 1-5 have already been included in the bacteria IP for Moores Creek or are included in currently funded CIP

projects. However, for implementation in Schenks Branch, an additional half-time urban technical full-time-equivalent (0.5 FTE) employee will be required in order to assist in implementing the additional BMPs in Stages 2-5 (8 years). This time/effort estimate was based on similar projects and experience and knowledge of the Steering Committee. Educational outreach will include strategies identified by stakeholders for facilitating installation and execution of implementation actions.

5.5. *Education and Outreach*

Personnel from the Thomas Jefferson SWCD (TJSWCD) and NRCS have already been in contact with farmers in the target watersheds, and are providing outreach, technical and financial assistance to encourage the installation of agricultural BMPs. The availability of §319 Grant monies will also provide additional incentives to the remaining small group of farmers, primarily in the Moores Creek watershed.

In addition, the various MS4 permit holders in these watersheds (Albemarle County, the City of Charlottesville, the University of Virginia, Piedmont Virginia Community College, and the Virginia Department of Transportation) are coordinating their public education and outreach efforts through RRSEP. The TJSWCD serves as the partnership coordinating body. The partnership website is http://www.rivanna-stormwater.org/.

RRSEP meets at least six times per year to discuss and organize initiatives and share information pertaining to meeting stormwater permit requirements. This past reporting year, the partnership met seven times. Specific activities of the partnership (July 2010 – May 2011) include:

- A cigarette-litter collection event on Charlottesville's historic downtown pedestrian mall on two consecutive days (July 2010)
- Three stormwater PSA slides on ten movie screens (4 in the City of Charlottesville and 6 in Albemarle County) for two months prior to every movie shown (July – August 2010)
- City and County public schools conducted Meaningful Watershed Education Experiences (MWEEs) for 4th graders at Camp Albemarle with Enviroscape

watershed model and biological stream monitoring stations (September – October 2010)

- Fall BMPs ad placed in one edition of weekly newspaper: The Hook (October 2010)
- Fall BMPs poster placed on 27 Charlottesville Area Transit buses (October 2010)
- Stormwater education display at Charlottesville Streams TMDL public outreach meeting (January 6, 2011)
- Spring BMPs ad placed twice in weekly newspaper: C-ville Weekly (March 2011)
- Stormwater Survey ad placed in weekly newspaper: C-ville Weekly (March 26, 2011)
- 70 information packets mailed to small businesses that might engage in outdoor vehicle washing with cover letter, flyer, and brochure describing pollution issues and BMPs for washing vehicles near storm drains (March 31, 2011)
- Anti-cigarette litter and stormwater education display at Charlottesville Earth Week Eco-Fair; magnets handed out (April 23, 2011)
- Stormwater Survey placed online via surveymonkey.com; gift certificates from local shopping center awarded in random drawing to 4 respondents (April – June 2011)
- Spring BMPs poster placed on 27 Charlottesville Area Transit buses (April 2011)
- Spring BMPs ad translated into Spanish and placed on 27 Charlottesville Area Transit buses (April 2011)
- Ten Spring BMPs posters laminated and posted in park kiosks (April 2011)
- City and County public schools conduct MWEEs for 4th graders at Camp Albemarle with Enviroscape watershed model and biological stream monitoring stations (April – May 2011)

5.6. *Costs of Implementation*

The costs of implementation were calculated both for a portion of the sediment-related BMPs included in the Moores Creek Bacteria IP (RRBC, 2012) that are not currently funded and for the additional BMPs needed to be installed in Schenks Branch in order to meet the target load reductions of sediment. The costs were estimated considering the extent of BMPs needed, their related unit costs, and estimates of needed technical assistance. BMP unit costs were estimated from the DCR state agricultural cost-share database for Albemarle County, from the 2011 USDA-NRCS cost list for Virginia, from literature values, and from discussions with the Rivanna River Basin Commission and local technical personnel.

Technical assistance needs in Schenks Branch were calculated based on an estimate of the additional personnel required for installation of the urban pollutant control measures. For planning purposes, one urban full-time employee (FTE) was budgeted as $75,000/yr, including benefits, training, and related costs, based on estimates by the Steering Committee. Technical assistance for installation of urban BMPs was estimated as 0.5 FTE over the 8 years of implementation in Stages 2-5, amounting to $300,000.

TMDL target sediment loads in Moores Creek and Lodge Creek will be achieved through the implementation of BMPs currently included in local jurisdiction CIP projects and a portion of those slated for implementation through the Moores Creek Bacteria IP (RRBC, 2012). This accounting is not meant to duplicate efforts in the Moores Creek Bacteria IP, but is included since funding has not yet been secured for installation of these BMPs. The target sediment load in Meadow Creek has already been achieved through currently funded CIP projects, so no further implementation costs are included for this watershed. The responsibility for securing funding for costs included in Table 5-7 will be coordinated with the Rivanna River Basin Commission who is guiding the Moores Creek Bacteria IP implementation effort. The costs for sediment reduction in Lodge Creek and Moores Creek included in that IP amount to $7.54 million.

Table 5-7. Lodge Creek and Moores Creek Control Measures Costs

BMPs	Cost/Unit	Units	Lodge Creek		Moores Creek	
			Acres Treated	Cost	Acres Treated	Cost
Bioretention	$20,000	acres	17.2	$344,266	52.4	$1,048,175
Raingardens	$20,000	acres	5.8	$115,182	17.5	$350,690
Bioswale	$15,000	acres	18.2	$272,597	55.3	$829,967
Dry Extended Detention Ponds	$15,000	acres	6.0	$89,266	18.1	$271,785
Permeable Pavement	$326,700	acres	0.6	$209,055	1.9	$636,503
Urban Filtering Practices	$20,000	acres	11.2	$223,965	34.1	$681,898
Urban Infiltration	$20,000	acres	5.1	$101,104	15.4	$307,828
Wet Ponds and Wetlands	$10,000	acres	23.5	$235,483	71.7	$716,967
Vegetated Open Channels	$9,000	acres	14.7	$132,459	44.8	$403,294
Urban Forest Buffers	$3,500	acres	8.4	$29,339	25.5	$89,329
Technical Assistance*	$75,000	FTE	2.0	$150,000	4.0	$300,000
Total Costs**				**$1,902,718**		**$5,641,201**

* Lodge Creek: 8 years @ 0.25 FTE/yr; Moores Creek: 4 years @ 1.0 FTE/yr.

** Costs already included in the Moores Creek Bacteria IP.

The extent of additional sediment control measures was quantified earlier in this chapter for meeting TMDL pollutant reductions in Schenks Branch. These additional BMP extents, together with their unit costs, and total implementation costs are summarized in Table 5-8 for Schenks Branch. The estimated additional cost for full implementation of sediment control measures in the Schenks Branch watershed, including technical assistance, is $5.52 million.

Table 5-8. Schenks Branch Control Measures Costs

BMPs	Cost/Unit	Units	Schenks Branch	
			Acres Treated	Cost
Bioretention	$20,000	acres	53.3	$1,066,131
Raingardens	$20,000	acres	17.8	$356,698
Bioswale	$15,000	acres	56.3	$844,185
Dry Extended Detention Ponds	$15,000	acres	24.6	$368,588
Permeable Pavement	$326,700	acres	0.0	$0
Urban Filtering Practices	$20,000	acres	34.7	$693,580
Urban Infiltration	$20,000	acres	13.2	$263,665
Wet Ponds and Wetlands	$10,000	acres	97.2	$972,332
Vegetated Open Channels	$9,000	acres	52.1	$468,803
Urban Forest Buffers	$3,500	acres	41.5	$145,374
Technical Assistance*	$75,000	FTE	4.0	$300,000
Total Costs**				**$5,516,856**

* Schenks Branch: 8 years @ 0.5 FTE/yr.

** New Costs for Implementation not covered by existing funding.

The cost effectiveness analysis shown in Table 5-9 does not represent a comprehensive benefit analysis, but is confined to costs/ton of sediment over the design life of each practice. The cost-effectiveness is calculated as practice cost ($) divided by the product of practice life (yrs) and load reduction/yr.

Table 5-9. Relative cost-effectiveness of control measures for sediment removal

Control Measure (BMP) Name	Cost/Unit	Practice Life (yrs)	Effectiveness ($/ton)
Bioretention	$20,000	10	$4,086
Raingardens	$9,000	10	$1,839
Bioswales	$15,000	10	$3,064
Dry Extended Detention Ponds	$15,000	10	$2,298
Urban Stream Restoration	$645	20	$1,034
Urban Filtering Practices	$20,000	10	$4,086
Urban Infiltration	$20,000	10	$4,852
Rainwater harvest	$150,000	20	$20,841
Wet Ponds and Wetlands	$10,000	10	$1,532
Vegetated Open Channels	$12,000	15	$1,430
Urban Forest Buffers	$3,500	10	$447

5.7. *Benefits of Implementation*

The primary benefit of implementation is improved water quality. During implementation planning, it is important to recognize that healthy waters improve economic opportunities for Virginians and a healthy economic base provides the resources and funding necessary to pursue restoration and enhancement activities. The agricultural and residential practices recommended in this document will provide economic benefits to the community, as well as the expected environmental benefits.

Specifically, alternative (clean) water sources, exclusion of cattle from streams, and improved pasture management, will each provide economic benefits to land owners. Control measures implemented for stormwater management and urban stream restoration will improve the aesthetic value and recreational opportunities for all stakeholders and residents.

A clean water source has been shown to improve weight gain and milk production in cattle. A clean water source can prevent many water-borne diseases and

the associated veterinary bills required for treatment. In addition to reducing the likelihood of animals contracting waterborne illnesses by providing a clean water supply, streamside fencing excludes livestock from wet, swampy environments as are often found next to streams where cattle have regular access. Keeping cattle in clean, dry areas has been shown to reduce the occurrence of mastitis and foot rot. While the spread of mastitis through a dairy herd can be reduced through proper sanitation of milking equipment, mastitis-causing bacteria can be harbored and spread in the environment where cattle have access to wet and dirty areas. Installation of streamside fencing and well managed loafing areas will reduce the amount of time that cattle have access to these areas.

Taking the opportunity to implement an improved pasture management system in conjunction with installing clean water supplies will also provide economic benefits for the producer. Improved pasture management can allow a producer to feed less hay in winter months, thus improving the profitability of the operation. In addition to reducing costs to producers, intensive pasture management keeps cattle in closer proximity to each other, allowing for quicker examination and handling. In general, many of the agricultural BMPs recommended in this document will provide economic benefits to the farmer, as well as environmental benefits to all stakeholders.

In urban areas, the benefits are proportional to the scale and degree of implementation of storm water management BMPs. Many of these urban BMPs focus on reducing and/or delaying stormwater runoff through infiltration and detention. The benefits to “nearby” downstream areas in the watershed include the reduced frequency, extent, and impact of flooding; reduced pollution treatment costs; reduced erosion and sedimentation; improved water quality; and improved in-stream biological integrity and aesthetics, with these effects most noticeable in the stream corridors and riparian zones (Braden and Johnston, 2004). In addition to allowing the aquatic communities to thrive, the sediment control measures will also reduce delivery of other pollutants to the stream from upland locations. Many of the BMPs intended to reduce soil losses also increase infiltration, which will decrease peak flows downstream.

In addition to the benefits to individual landowners, the economy of the local community will be stimulated through expenditures made during implementation, and

the infusion of dollars from funding sources outside the impaired areas. Private consultants and contractors who deal with stream exclusion fence installation, urban stormwater control, stream restoration, and other BMP components can expect to see an increase in business during implementation. A portion of the funding for implementation can be expected to come from state and federal sources. This portion of funding represents money that is new to the area. In general, implementation will provide not only environmental benefits to the community, but economic benefits as well.

6.0 MEASURABLE GOALS AND MILESTONES

6.1. *Implementation Goals*

The goals of TMDL implementation are to restore the water quality in the impaired stream segments in the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch watersheds so that they comply with water quality standards and to de-list these segments from the Commonwealth of Virginia's 303(d) List of Impaired Waters. Progress towards these goals will be assessed based on Virginia Stream Condition Index (VSCI) scores. The VSCI is based on biological metrics calculated from an inventory of the benthic macro-invertebrate community in each stream. The inventory is performed in the spring and the fall each year at biological monitoring stations on each impaired stream segment. As this IP addresses benthic impairments in all four watersheds, the ultimate water quality goal is the restoration of healthy benthic macro-invertebrate communities, denoted by two consecutive VSCI scores in the non-impaired range (≥ 60) in each watershed. Annual assessments of progress will monitor improvements not only in the VSCI scores, but also in two of the habitat metrics most related to sediment impacts – "sediment deposition" and "embeddedness". Because the relationship between sediment "loads" and benthic community health is not fully quantifiable, the additional monitoring of the benthic community under this staged implementation approach is being used in lieu of interim water quality goals.

6.2. *Implementation Milestones*

Implementation milestones establish the portion of total implementation actions to be completed within certain timeframes, and these implementation actions are tracked as the number and type of control measures that are installed and programs or policies developed and executed. The milestones described herein are intended to achieve 100% implementation in Moores Creek, Lodge Creek, and Schenks Branch within 10 years (by 2023). Implementation of BMPs in these watersheds is being conducted in coordination with the Moores Creek Bacteria IP and the CIP projects of Albemarle

County, the City of Charlottesville, and the University of Virginia. Since street sweeping is an annual practice that requires annual expenditures, it is shown in each implementation stage, since these expenditures are currently funded and expected to be maintained at the same level throughout the implementation period by the City of Charlottesville and the University of Virginia. Gradual water quality improvement is expected throughout the stages of implementation in each watershed, with attainment of water quality goals expected within five years after full implementation. Because sufficient implementation has already recently occurred in the Meadow Creek watershed related to ongoing stream restoration efforts in that watershed, no further implementation is required in that watershed to meet its target TMDL sediment load and water quality conditions are expected to improve sooner than in the other watersheds.

The Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch TMDL IP Steering Committee is already engaged in the coordination and support of the many ongoing implementation activities in these watersheds. Many of the livestock exclusion and pasture management control measures being implemented under the Moores Creek Bacteria IP also reduce sediment and are complimentary to the efforts required under this sediment IP. Urban BMPs being planned and installed under Albemarle County's and the City of Charlottesville's CIP projects and under the University of Virginia's facility improvement plan are also integral to achieving target sediment loads.

The implementation of control measures will be accomplished in stages. The first five stages of this implementation plan are consistent with the Moores Creek Bacteria IP, and BMPs and associated technical assistance costs for these stages are quantified in that IP (RRBC, 2012). In general, the Commonwealth intends that control measures be implemented in a progressive process to address the pollutant sources with the largest impact on water quality first. This staged approach is based on meeting water quality goals over a thirteen-year period in Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch, consistent with milestones in the Moores Creek Bacteria IP and the Chesapeake Bay TMDL. After installation of all control measures, and full maturation of the control measures, full attainment of water quality goals and de-listing from the Section 303(d) list are expected by 2025. The list and extent of control measures by implementation stage are shown for Lodge Creek, Moores Creek, and Schenks Branch

watersheds in Table 6-1, Table 6-2, and Table 6-3, respectively. No further reductions are required in Meadow Creek, which is the subject of an ongoing stream restoration project along a long portion of its length.

Table 6-1. Lodge Creek: Staged Implementation Goals

BMPs	Lodge Creek					
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5*	Stage 6
	2012-2014	2015-2017	2018-2019	2020-2021	2022-2023	2024-2025
	Acres Treated					
Bioretention		2.18	4.36	6.54	4.14	
Raingardens		0.73	1.46	2.19	1.39	
Bioswale		2.30	4.60	6.90	4.37	
Dry Extended Detention Ponds		0.75	1.51	2.26	1.43	
Permeable Pavement		0.08	0.16	0.24	0.15	
Urban Filtering Practices		1.42	2.84	4.25	2.69	
Urban Infiltration		0.64	1.28	1.92	1.22	
Wet Ponds and Wetlands		2.98	5.96	8.94	5.66	
Vegetated Open Channels		1.86	3.73	5.59	3.54	
Street Sweeping 25x/yr	10.70	10.70	10.70	10.70	10.70	10.70
Urban Forest Buffers		1.06	2.12	3.18	2.02	
Cumulative Sediment % Reduction	**3%**	**16%**	**40%**	**77%**	**100%**	

* Only 79% of the applicable BMPs from the Moores Creek Bacteria IP are needed to achieve the sediment TMDL in Lodge Creek.

Table 6-2. Moores Creek: Staged Implementation Goals

BMPs	Moores Creek					
	Stage 1	Stage 2	Stage 3*	Stage 4*	Stage 5*	Stage 6
	2012-2014	2015-2017	2018-2019	2020-2021	2022-2023	2024-2025
	Acres Treated					
Agricultural BMPs						
Pasture Fencing[2]	27,766					
Precision Grazing/Pasture Mgmt.		18.47	36.93	55.40	73.86	
Urban/Residential BMPs						
Bioretention	1.8	24.72	27.69			
Raingardens	0.6	8.27	9.26			
Bioswale		28.10	27.23			
Dry Extended Detention Ponds		8.55	9.57			
Permeable Pavement		0.92	1.03			
Urban Filtering Practices		16.08	18.01			
Urban Infiltration		7.26	8.13			
Wet Ponds and Wetlands	44.6	33.82	37.88			
Vegetated Open Channels		21.14	23.67			
Street Sweeping 25x/yr	59.76	59.76	59.76	59.76	59.76	59.76
Urban Forest Buffers		12.04	13.48			
Impervious Surface Reduction[1]	0.35					
Cumulative Sediment % Reduction	65%	75%	91%	95%	100%	

[1] Includes Rainwater Harvesting

[2] Units are in linear feet.

* Only 21.2% of the applicable BMPs from the Moores Creek Bacteria IP are needed to achieve the sediment TMDL in Moores Creek, in addition to pasture management on 100% of pasture area.

Table 6-3. Schenks Branch: Staged Implementation Goals

BMPs	Schenks Branch					
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
	2012-2014	2015-2017	2018-2019	2020-2021	2022-2023	2024-2025
	Acres Treated					
Bioretention		5.33	10.66	15.99	21.32	
Raingardens		1.78	3.57	5.35	7.13	
Bioswale		5.63	11.26	16.88	22.51	
Dry Extended Detention Ponds		2.46	4.91	7.37	9.83	
Permeable Pavement		0.00	0.00	0.00	0.00	
Urban Filtering Practices		3.47	6.94	10.40	13.87	
Urban Infiltration		1.32	2.64	3.95	5.27	
Wet Ponds and Wetlands		9.72	19.45	29.17	38.89	
Vegetated Open Channels		5.21	10.42	15.63	20.84	
Street Sweeping 25x/yr	47.45	47.45	47.45	47.45	47.45	47.45
Urban Forest Buffers		4.15	8.31	12.46	16.61	
Impervious Surface Reduction[1]		0.03	0.05	0.08	0.10	
Cumulative Sediment % Reduction	3%	13%	32%	62%	100%	

[1] Includes Rainwater Harvesting

Monitoring will continue throughout the implementation stages to document progress towards sediment reduction goals and to provide a mechanism for evaluating the effectiveness of the implementation actions. The benefits of staged implementation are 1) as stream monitoring continues, 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 which exist in any implementation plan; 3) it provides a mechanism for developing public support; 4) it helps to ensure that the most cost-effective practices are implemented initially; and 5) it allows for the evaluation of the adequacy of the TMDL in achieving the water quality standard.

6.3. *Reasonable Assurance*

Public participation is an integral part of the IP development and is critical in gaining support for both the voluntary and regulated implementation activities that are being planned. During the public participation process, stakeholders in the watershed and local conservation agency personnel were involved in Working Groups and public meetings, and provided additional information through email and phone conversations. This participation by the major watershed stakeholders provides a reasonable assurance that the public was contributing to the TMDL process and had input into the selection of management and implementation practices recommended by this IP.

A Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch TMDL IP Steering Committee, formed following development of the implementation plan, will continue to provide oversight for implementation as needed, with guidance provided by DCR, DEQ, the RRBC, and the Thomas Jefferson SWCD, ensuring continuity of leadership and vision. Funding for a portion of the implementation measures needed to improve water quality in Moores Creek and Lodge Creek is currently available through a §319 Grant and state (DCR) and federal (NRCS) agricultural cost-share programs. Additional funding is available in all four watersheds through CIP projects in Albemarle County and the City of Charlottesville. Funding for BMPs on the campus of UVA will be included in facility improvement projects, as funding is secured.

Potential BMPs identified by UVA as water quality improvement opportunities, are shown in Table 6-4. Additional related opportunities at the university include:

- a comprehensive condition assessment of all perennial stream on UVA Grounds,
- an update Stormwater Master Plans for Moores Creek and Meadow Creek,
- a campus-wide plan to tap non-potable sources of water for irrigation and additional sources like cisterns to capture rain water from roof drains,
- an inventory of all buildings for potential roof top disconnects,
- an assessment as part of an impervious surface reduction program to convert parking lots and pedestrian areas to permeable surfaces,
- an upgrade of existing cisterns with pumps and inventory monitoring to increase efficiency of use, and
- a determination of appropriate areas for additional green roof retrofits.

These opportunities are not included in the quantified BMPs detailed previously, but provide an additional measure of assurance that appropriate BMPs for sediment reduction will occur in these watersheds.

Table 6-4. University of Virginia Potential BMP Opportunities

BMP	Watershed	Albemarle	Charlottesville	Units	Status	Notes
Direct roof drains to a water quality swale	Meadow Creek		0.9	acres	1	JPJ Arena
Daylight Meadow Creek and reconstruct stream channel	Meadow Creek		295	lin. ft.	1	between Emmet Street and Carr's Hill Field
Daylight Meadow Creek	Meadow Creek		1000	lin. ft.	1	Nameless Field
Permeable pavement retrofits	Moores Creek		0.07	acres	1	(1) Olsson Hall/Thornton area
	Meadow Creek		0.13	acres	1	(2) Ruffner Hall (upper lot)
	Moores Creek		2.75	acres	1	(3) E-school parking
Green roof retrofits	Meadow Creek		0.41	acres	1	(1) Clemons Library
	Meadow Creek		0.12	acres	1	(2) Campbell Hall
Rain garden/bioretention installation	Meadow Creek		0.10	acres	1	(1) between Lambeth parking lot at Meadow Creek
	Meadow Creek		0.06	acres	1	(2) between Ruffner parking lot and side walk
Stabilize eroding hillsides	Meadow Creek 3	0.15		acres	1	NRAO between upper and lower lots
Stabilize drainage area	Meadow Creek 3	0.43		acres	2	between Miller Center, Baseball field, and Old Ivy Road
Improvements to/conversion of older SWM BMPs:	Moores Creek		15	acres	1	Detention Basin at corner of Stadium and Alderman roads (MO3C-6462-01)
	Meadow Creek		314	acres	1	Detention Basin behind the JAG school (ME11-6458-01)
	Meadow Creek		0.8	acres	1	Detention Basin at the Child Development Center (ME10-0800-01)
	Meadow Creek		53	acres	1	FM Detention Basin (ME2-6433-01)
	Meadow Creek		1.4	acres	1	Pratt Dr Detention Basin (ME2-6431-01)
	Meadow Creek		15.6	acres	1	Detention Basin at the Park (ME11-6459-01)
	Meadow Creek 3	28		acres	1	Darden extended detention basin #1 (ME11-6457-01)
	Meadow Creek 3	10		acres	1	Darden detention basin #2 (ME11-6456-01)
	Moores Creek		36	acres	1	Gilmer Detention Basin (MO3A-6464-01)
	Meadow Creek		5	acres	1	Detention Basin at corner of Arlington Blvd/Massie Rd (ME12-6460-01))
	Moores Creek		1.5	acres	1	Detention Basin at ECC/Police (MO7-0624-01)
	Moores Creek		45.79	acres	1	Health System Wet Pond (MO6A-6901-01)
	Moores Creek		39	acres	1	Hereford College ext detention basin (MO1A-6463-01)

1 - Planned, but not funded.

2 - Partially completed in 2011

In addition to the BMPs identified and scheduled for implementation to meet their target TMDL sediment goals, additional sediment-related BMPs will be installed in the Lodge Creek and Moores Creek watersheds under the Moores Creek Bacteria IP over and above those necessary to address the sediment stressor alone, amounting to 21% and 78.8% of the urban sediment-related BMPs listed in Table 6-1 and Table 6-2, respectively. In addition to the current level of BMP implementation in the Meadow Creek watershed, which is already sufficient to meet its target TMDL sediment load, 9,000 linear feet of stream restoration and treatment of 178 acres with wetlands are funded under local jurisdictional CIPs and scheduled for implementation in the next several years.

Implementation to address the sediment-related biological impairments on Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch will be carried out primarily through the use of voluntary best management practices and educational programs. Available agricultural cost-share programs and the §319 Grant will be utilized to the extent possible to provide incentives to targeted watershed stakeholders. The MS4 programs of the five permit holders will be utilized for public education and outreach, and to encourage residential homeowners to adopt needed urban practices. Grant funding will be sought to provide additional incentives, which we expect will increase participation from specific targeted stakeholders that would otherwise be reticent to participate.

Taken together, all of these planning components comprise a reasonable assurance that implementation will progress as planned and will lead to the restoration of water quality in Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch.

6.4. *Implementation Tracking*

Tracking of agricultural practices will be performed by the TJSWCD through the existing Agricultural BMP Cost-Share database maintained by VADCR, supplemented by NRCS-reported practices installed and funded using only federal funds, and coordinated by the Rivanna River Basin Commission, who will be administering the §319 Grant for installation of BMPs to address the bacteria impairment in Moores Creek. Tracking of urban BMPs will continue to be performed by Albemarle County, the City of

Charlottesville, and the University of Virginia in the same manner as was performed to inventory existing and planned BMPs as part of this implementation plan. Tracking information will include the type of control measure, the area treated, the percent imperviousness, the year installed, and location by both jurisdiction and watershed. Strategies to facilitate implementation, such as educational programs and other outreach activities will also be tracked in the respective annual MS4 reports of Albemarle County, the City of Charlottesville, the University of Virginia, Piedmont Virginia Community College, and the Virginia Department of Transportation, and reported on the Rivanna Regional Stormwater Education Partnership's web site (http://www.rivanna-stormwater.org/). The IP Steering Committee will continue to provide oversight and direction as needed during implementation.

6.5. *Water Quality Monitoring*

Virginia's 1997 Water Quality Monitoring, Information and Restoration Act requires that TMDL IPs include measurable goals and milestones for attaining water quality standards. Implicit in those milestones is a method to measure progress. Water quality improvement will be evaluated through water quality monitoring conducted by DEQ. DEQ will continue to perform both ambient and biological monitoring for implementation progress in each watershed at the locations listed in Table 6-5 and shown in Figure 6-1.

Table 6-5. DEQ Water Quality Monitoring Stations

Station ID	*Stream Name*	*Station Type*	*Location*
2-MSC000.60	Moores Creek	Ambient/biological	RWSA STP bridge
2-XRC001.15	Lodge Creek	Biological	Cherry Avenue
2-MWC000.60	Meadow Creek	Ambient/biological	Holmes Avenue bridge
2-SNK000.88	Schenks Branch	Ambient/biological	Along McIntire Rd. culvert
2-XSN000.08	Schenks Branch UT	Ambient/biological	Alongside Allied Concrete

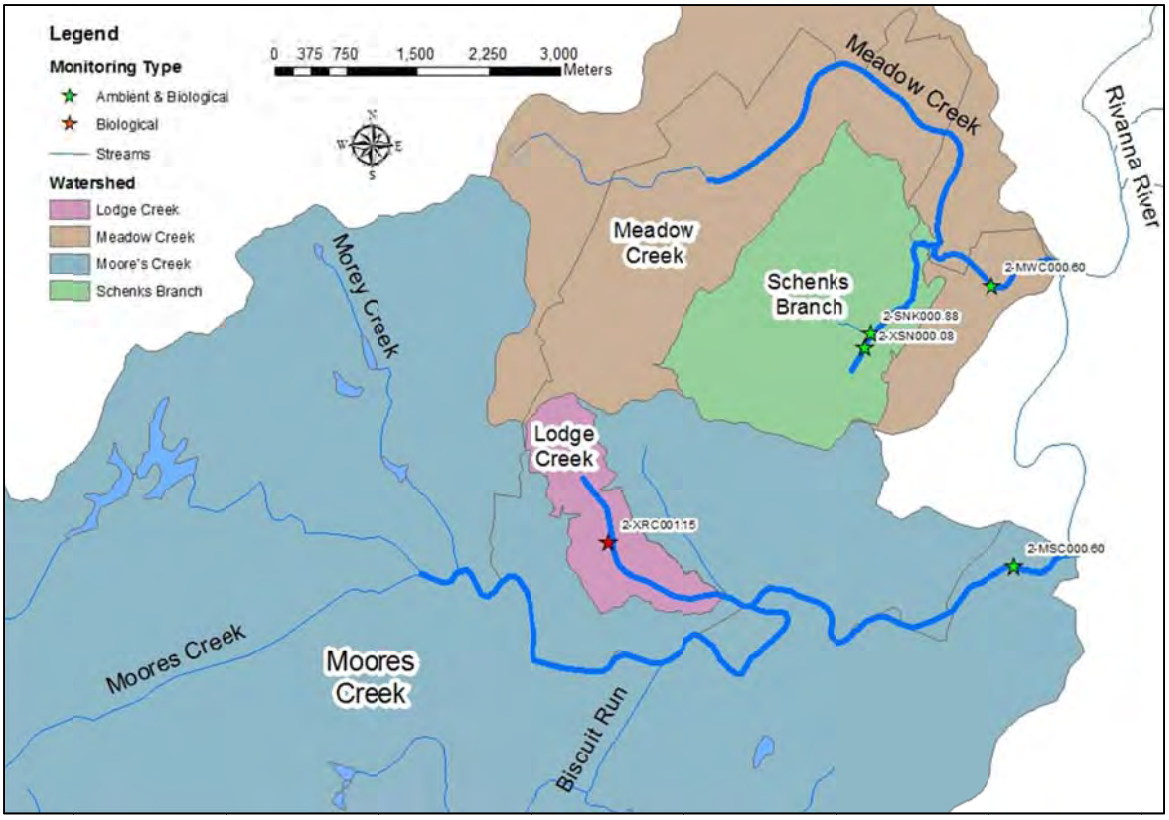

Figure 6-1. DEQ Monitoring Station Locations

DEQ will conduct monthly or bi-monthly sampling at each of the existing ambient monitoring sites, while sampling at the DEQ biological stations will be performed twice a year, in spring and fall. Metrics will be calculated for these samples for evaluation of the VSCI index.

6.6. *Evaluation of Progress*

An annual evaluation of implementation progress and water quality in Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch will be made by the Steering Committee with data provided by DEQ. During each annual evaluation, a reassessment of implementation priorities will be made by the Steering Committee to readjust and fine-tune targeting of resources in concert with the staged implementation approach. Periodic re-evaluation is especially critical during these times of economic uncertainty, where increasing energy prices and fluctuating market prices are bound to affect stakeholders in the agricultural sector and their willingness to commit resources for

conservation, especially if they are struggling to maintain their viability as a farming enterprise.

If reasonable progress toward implementing the management practices is not demonstrated, the Steering Committee will consider additional/alternative implementation actions. If it is demonstrated that reasonable and feasible management measures have been implemented for a sufficient period of time and TMDL targets are still not being met, the TMDL will be reevaluated and revised accordingly. If after five years the Steering Committee determines that load reductions are being achieved as management measures are implemented, then the recommended appropriate course of action would be to continue management measure implementation and compliance oversight. If it is determined that all proposed control measures have been implemented, yet the TMDLs have not been achieved, further investigations will be made to determine whether: 1) the control measures are not effective; 2) sediment loads are due to sources not previously addressed; or 3) one or more of the TMDLs is unattainable.

7.0 STAKEHOLDERS' ROLES AND RESPONSIBILITIES

Stakeholders are individuals who live or have land management responsibilities in the watershed, including government agencies, businesses, private individuals and special interest groups. Stakeholder participation and support is essential for achieving the goals of this TMDL effort (i.e. improving water quality and removing streams from the impaired waters list). The purpose of this chapter is to identify and define the roles of the stakeholders who will work together to put the IP into practice. The roles and responsibilities of some of the major stakeholders are described below.

7.1. *Federal Government*

U.S. Environmental Protection Agency (EPA) has the responsibility of overseeing the various programs necessary for the success of the Clean Water Act. However, administration and enforcement of such programs falls largely to the states. The NRCS is the federal agency that works hand-in-hand with US citizens to conserve natural resources on private lands. NRCS assists private landowners with conserving their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on the expertise of NRCS staff. NRCS is also a major funding stakeholder for impaired water bodies through the Conservation Reserve Enhancement Program (CREP) and the Environmental Quality Incentive Program (EQIP). For more information on NRCS, visit http://www.nrcs.usda.gov/.

7.2. *State Government*

In the Commonwealth of Virginia, water quality problems are dealt with through legislation, incentive programs, education, and legal actions. Currently, there are five state agencies responsible for regulating and/or overseeing statewide activities that impact water quality in the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch watersheds. These agencies are:

Virginia Department of Environmental Quality (VADEQ): The State Water Control Law authorizes the State Water Control Board to control and plan for the reduction of pollutants impacting the chemical and biological quality of the State's waters resulting in the degradation of the swimming, fishing, shell fishing, aquatic life, and drinking water uses. For many years the focus of VADEQ's pollution reduction efforts was the treated effluent discharged into Virginia's waters via the VPDES permit process. The TMDL process has expanded the focus of VADEQ's pollution reduction efforts from the effluent of wastewater treatment plants to the nonpoint source pollutants causing impairments of the streams, lakes, and estuaries. The reduction tools are being expanded beyond the permit process to include a variety of voluntary strategies and BMPs.

VADEQ is the lead agency in the TMDL process. The Code of Virginia directs VADEQ to develop a list of impaired waters, develop TMDLs for these waters, and develop IPs for the TMDLs. VADEQ administers the TMDL process, including the public participation component, and formally submits the TMDLs to EPA and the State Water Control Board for approval. VADEQ is also responsible for implementing point source WLAs, assessing water quality across the state, and conducting water quality standard related actions. VADEQ also provided funding for the continuous TMDL- implementation planning process for Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch.

Virginia Department of Conservation and Recreation (VADCR): VADCR is authorized to administer Virginia's NPS pollution reduction programs in accordance with §10.1-104.1 of the Code of Virginia and §319 of the Clean Water Act. EPA requires much of the §319 grant monies be used for the development of TMDLs. Because of the magnitude of the NPS component in the TMDL process, VADCR is a major participant in the TMDL process. VADCR has a lead role in the development of IPs to address correction of NPSs contributing to water quality impairments. VADCR also provides available funding and technical support for the implementation of NPS components of IPs. VADCR is also the lead agency for administering the Virginia Stormwater Management Program (VSMP) and Virginia's Erosion and Sediment Control Program (ESC), and as such is responsible for tracking and implementing Waste Load Allocations for permit holders under these programs. The staff resources in VADCR's

TMDL program focus primarily on providing technical assistance and funding to stakeholders to develop and carry out IPs, and support to VADEQ in TMDL development related to NPS impacts. VADCR staff will also be working with other state agencies, Soil and Water Conservation Districts, and watershed groups to gather support and to improve the implementation of TMDL plans through utilization of existing authorities and resources.

Virginia Department of Agriculture and Consumer Services (VDACS): The VDACS Commissioner of Agriculture has the authority to investigate claims that an agricultural producer is causing a water quality problem on a case-by-case basis (Pugh, 2001). If deemed a problem, the Commissioner can order the producer to submit an agricultural stewardship plan to the local soil and water conservation district. If a producer fails to implement the plan, corrective action can be taken, which may include civil penalties. The Commissioner of Agriculture can issue an emergency corrective action if runoff is likely to endanger public health, animals, fish and aquatic life, public water supply, etc. An emergency order can shut down all or part of an agricultural activity and require specific stewardship measures.

Virginia Department of Health (VDH): The VDH is responsible for maintaining safe drinking water measured by standards set by the EPA. Like VDACS, VDH is complaint driven. Complaints can range from a vent pipe odor that is not an actual sewage violation and takes very little time to investigate, to a large discharge violation that may take many weeks or longer to effect compliance. Their duties also include septic system regulation and regulation of biosolids land application. For TMDLs, VDH has the responsibility of enforcing actions to correct failed septic systems and/or eliminate straight pipes (Sewage Handling and Disposal Regulations, 12 VAC 5-610-10 et seq.).

Virginia Department of Forestry (VDOF): The VDOF has prepared a manual to inform and educate forest landowners and the professional foresters community on proper BMPs and technical specifications for installation of these practices in forested areas (www.dof.state.va.us/wq/wq-bmp-guide.htm). Forestry BMPs are directed primarily to control erosion. For example, streamside forest buffers provide nutrient

uptake and soil stabilization, which can benefit water quality by reducing the amount of nutrients and sediments that enter local streams. VDOF's BMP program is voluntary.

Another state entity with responsibilities for activities that impact water quality in the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch watersheds is:

Virginia Cooperative Extension (VCE): VCE provides educational outreach programs via Virginia's land grant universities (Virginia Tech and Virginia State University), and is part of USDA's National Institute for Agriculture. VCE is a product of cooperation among local, state, and federal governments in partnership with citizens. VCE offers educational programs and technical resources for topics such as crops, grains, livestock, poultry, dairy, natural resources, and environmental management. VCE has produced several publications that deal specifically with TMDLs and partners with DCR on the Nonpoint source pollution Education for Municipal Officials (NEMO) program. For more information on these publications and to find the location of county extension offices, visit http://www.ext.vt.edu.

7.3. *Regional and Local Government*

Regional and local government groups work closely with state and federal agencies throughout the TMDL process; these groups possess insights about their regional and local community that may help to ensure the success of TMDL implementation. These stakeholders have knowledge about a community's priorities, how decisions are made locally, and how the watershed's residents interact. Some local government groups and their roles in the TMDL process are listed below.

Thomas Jefferson SWCD: Soil and Water Conservation Districts (SWCDs) are local units of government responsible for the soil and water conservation work within their boundaries. The districts' role is to increase voluntary conservation practices among farmers, ranchers and other land users. District staff work closely with watershed residents and have valuable knowledge of local watershed practices.

Thomas Jefferson Planning District Commission: Planning District Commissions (PDCs) were organized to promote the efficient development of the environment by assisting and encouraging local governmental agencies to plan for the future. PDCs focus much of their efforts on water quality planning, which is complementary to the TMDL process.

Albemarle County: County government staff members work closely with PDCs and state agencies to develop and implement TMDLs in concert with their comprehensive plans. They may also help to promote education and outreach to citizens, businesses and developers to introduce the importance of the TMDL process.

City of Charlottesville: The City of Charlottesville takes its responsibility for stewardship of our environment and water resources seriously, and has been proactive in addressing water quality and stormwater management issues. The City has engaged in water quality and watershed planning, the administration of erosion and sediment control and post-construction stormwater management programs, and the incorporation of stormwater management facilities in municipal construction and redevelopment projects, as well as retrofits to existing City properties. Charlottesville owns and operates a small municipal separate storm sewer system (MS4) and has been operating under a General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems since 2003. The City also partners with local stakeholders to promote stormwater pollution prevention education and outreach to the local community, and has actively participated with state and local agencies to develop and implement TMDLs in the Rivanna River watershed.

University of Virginia: …

Rivanna River Basin Commission: The Rivanna River Basin Commission (RRBC) is the regional organization tasked with recommending programs for the enhancement of the water and natural resources of the Rivanna River and its watershed. The four jurisdictions participating in the RBBC are Albemarle, Fluvanna and Greene Counties and the City of Charlottesville. The purpose of the Rivanna River Basin Commission is to provide guidance for the stewardship and enhancement of the water and natural resources of the Rivanna River Basin.

7.4. *Businesses, Community Groups, and Citizens*

While successful implementation depends on stakeholders taking responsibility for their role in the process, the primary role falls on the local groups that are most affected; that is, businesses, community watershed groups, and citizens.

Community Watershed Groups: (StreamWatch, Rivanna Conservation Society, James River Association, Save Our Streams, etc.) Local watershed groups offer a meeting place for river groups to share ideas and coordinate preservation efforts and are also a showcase site for citizen action. Watershed groups also have a valuable knowledge of the local watershed and river habitat that is important to the implementation process.

Citizens and Businesses: The primary role of citizens and businesses is simply to get involved in the TMDL process. This may include participating in public meetings (Section 5.1), assisting with public outreach, providing input about the local watershed history, and/or implementing best management practices to help restore water quality.

Community Civic Groups: Community civic groups take on a wide range of community service including environmental projects. Such groups include the Ruritan, Farm Clubs, Homeowner Associations and youth organizations such as 4-H and Future Farmers of America. These groups offer a resource to assist in the public participation process, educational outreach, and assisting with implementation activities in local watersheds.

Animal Clubs/Associations: Clubs and associations for various animal groups (e.g., beef, equine, poultry, swine, and canine) provide a resource to assist and promote conservation practices among farmers and other land owners.

Secondary Schools: Long-term solutions to our water quality problems must include education of future generations regarding the need to make changes in our personal and social habits and traditions, in order to preserve and maintain our land and water resources. Towards this end, environmental education, especially that which includes hands-on interaction with natural resources through field trips and class projects, is highly recommended. Activities, such as those included in the Future Farmers of America, “The Meaningful Educational Experience”, “Trout in the

Classroom", and Envirothon programs help our youth understand how they can maintain and enhance these precious resources.

Riverkeeper Network: The Riverkeeper Network is committed to acting as an advocate to protect water quality. Although the program began in New York, the Riverkeeper program has expanded to 153 different programs across the US and beyond. A Riverkeeper is a full-time, on the water, advocate for your right to protect and defend the environment. The goal of this important core program is to maintain a constant vigil on the James River, monitoring its conditions, identifying problems and ensuring that solutions are executed properly. For more information, see www.jamesriverassociation.org/what-we-do/river-keepers .

8.0 INTEGRATION WITH OTHER WATERSHED PLANS

Each watershed within the state is under the jurisdiction of a multitude of individual yet related water quality programs and activities, many of which have specific geographical boundaries and goals. These include, but are not limited to, Total Maximum Daily Loads, water quality management plans (WQMPs), sediment and erosion control regulations, stormwater management (SWM), Source Water Assessment Program (SWAP), and local comprehensive plans.

8.1. *Continuing Planning Process*

According to Perciasepe (1997) the continuing planning process (CPP) established by Section 303(e) of the Clean Water Act provides a good framework for implementing TMDLs, especially the NPS load allocations. Under the Section 303(e) process, states develop and update statewide plans that include TMDL development and adequate implementation of new and revised water quality standards, among other components. The water quality management regulations at 40 CFR 130.6 require states to maintain WQMPs that are used to direct implementation of key elements of the continuing planning process, including TMDLs, effluent limitations, and NPS management controls. These state WQMPs are another way for states to describe how they will achieve TMDL load allocations for NPSs. The CPP in Virginia is implemented in various state programs, all aimed toward achieving and maintaining the state water quality standards. Virginia Code Sections 62.1-44.15(10) & (13), 62.1-44.17:3, and 62.1-44.19:7 give the Virginia State Water Control Board (Board) the duty and authority to conduct the CPP in Virginia. Under the authority of Virginia Code Section 10.1-1183, VADEQ serves as the administration arm of the Board. Virginia WQMPs consist of initial plans produced in accordance with Sections 208 and 303(e) of the CWA and approved updates to the plans. Currently, Virginia has a total of 18 WQMPs developed under Sections 208 and 303(e). Many of these plans are outdated, and efforts are underway to update them. The updated plans will serve as repositories for all TMDLs approved by EPA and adopted by the Board, as well as IPs approved by the Board.

8.2. *Statewide Watershed and Water Quality Management Planning Programs*

TMDLs – TMDLs define the amount of a specific pollutant that a water body can assimilate and still meet state water quality standards. TMDLs are developed for water bodies that are listed on a state's 303(d) list, known as the "Impaired Waters List." The TMDL develops a waste load allocation for point sources and a load allocation for NPSs and incorporates a "margin of safety" in defining the assimilation capacity of the water body. The TMDL IP outlines specific strategies and pollution control measures to meet the pollutant allocations.

These project watersheds are within the Chesapeake Bay Watershed. IPs that reduce nutrients and sediment from entering local waterways also benefit the downstream waters of the Chesapeake Bay. With overlapping BMP implementation goals, coordination between lead agencies and the documentation of work completed is important.

WQMPs – Water Quality Management Plans (WQMPs) are produced and updated by VADEQ in accordance with Sections 208 and 303(e) of the CWA as outlined in the CPP section above. These plans will be the repository for TMDLs and TMDL IPs.

Erosion and Sediment Control Regulations – VADCR implements the state Erosion and Sediment Control (ESC) Program according to the Virginia Erosion and Sediment Control Law, Regulations, and Certification Regulations (VESCL&R). The ESC Program goal is to control soil erosion, sedimentation, and nonagricultural runoff from regulated "land-disturbing activities" to prevent degradation of property and natural resources. The regulations specify "Minimum Standards," which include criteria, techniques and policies that must be followed on all regulated activities. These statutes delineate the rights and responsibilities of governments that administer a local ESC program and those of property owners who must comply. For more information, visit http://www.VADCR.state.va.us/sw/e&s.htm.

SWAP – Section 1453 of the 1986 Amendments of the Safe Drinking Water Act (SDWA) requires each state to develop a Surface Water Assessment Plan (SWAP) that will delineate the boundaries of the assessment areas from which public water systems receive drinking water using hydrogeologic information, water flow, recharge, and discharge and other reliable information. The VDH is the primary agency for drinking water and is therefore responsible for SWAP. In Virginia, all 187 surface water intakes serving 151 public waterworks have completed surface water assessments. All 4,584 ground water source assessments, serving nearly 4,000 public waterworks, were completed by the end of 2003.

VSMP – VADCR is responsible for the issuance, denial, revocation, termination and enforcement of individual and general Virginia Stormwater Management Programs (VSMP) permits for the control of stormwater discharges from MS4s and construction activities. VADCR administers these program through Virginia Stormwater Management Program (VSMP) Permit Regulations, authorized by the Virginia Stormwater Management Act. These statutes are specifically set forth regarding land development activities to prevent water pollution, stream channel erosion, depletion of ground water resources, and more frequent localized flooding to protect property values and natural resources. VADCR oversees regulated activities undertaken on state and federal property, while localities have the option to establish a local program to regulate these same activities on private property in their jurisdiction. Local SMP programs operated according to the law are designed to address these adverse impacts and comprehensively manage the quality and quantity of stormwater runoff on a watershed-wide basis. For more information, visit http://www.VADCR.state.va.us/sw/stormwat.htm.

8.3. *Local Watershed and Water Quality Management Planning Programs*

Each watershed in the state is under the jurisdiction of a multitude of individual yet related water quality programs and activities, many of which have specific geographic boundaries and goals. These include but are not limited to TMDLs, watershed roundtables, Water Quality Management Plans, erosion and sediment control regulations, stormwater management, Source Water Protection Programs, and local

comprehensive plans. Coordination of the implementation project with these existing programs could result in additional resources and increased participation.

Rivanna River Basin Watershed Action Plan: Since 2007, the RRBC, an entity of local government enabled by Virginia statute and charged with promoting the economic and ecologic health of the Rivanna watershed has been active in promoting and coordinating conservation, protection, and restoration activities in the watershed on behalf of its member local governments, which include the City of Charlottesville and Albemarle County. The RRBC has been instrumental in developing this update to the Moores Creek implementation plan, as well as providing coordination with other existing and emerging planning activities including the Bay TMDL local watershed implementation planning by local governments. In addition, RRBC will be undertaking a significant watershed management planning effort for the Rivanna in FY13-14, and it is anticipated that this watershed action plan will serve to integrate and coordinate a number of activities and plans and achieve the following goals:

- Provide a watershed context and coordination for 2012 WIP II local government submissions (2012 to DCR) and create a mechanism for relating WIP II to local TMDLs such as the Moores Creek Bacteria TMDL in the Rivanna watershed.
- Provide a tool to bring together existing plans already developed for the watershed, e.g., TMDL IPs, WIP II submissions, TNC's Rivanna Conservation Area Plan (2003/2011), StreamWatch's Land Use Effects Study (2011), four local comprehensive plans, and numerous reports that recommend specific watershed protection measures.

Moores Creek Watershed Study: This study was completed in 1996 by Dewberry & Davis for Albemarle County and the City of Charlottesville. It included hydrologic and hydraulic analyses, water quality data and analysis, an evaluation of various stormwater mitigation measures, and a watershed plan. The construction of regional stormwater management facilities was considered, but the only possible sites were located in the undeveloped parts of the watershed, which would offer limited benefits. Many of the immediate action items in the study have been completed, including the development of a stormwater management ordinance, a design and construction standards manual, and a watershed geographic information system (GIS), and stabilization of the banks of Moore's Creek at Azalea Park. A number of the other action items, such as culvert and bridge replacement and debris removal, were more related to flood control than to water

quality improvement. The immediate construction of 100' of channel stabilization for Monticello Avenue Creek was also recommended. The secondary stormwater management plan included many thousands of dollars of stream restoration projects, including $792,000 along Moores Creek, $65,000 along Monticello Avenue Creek, $250,000 along Rock Creek, $250,000 along a tributary to Rock Creek, $125,000 along Pollock's Branch, and $650,000 along Biscuit Run.

Albemarle County Comprehensive Plan: The Albemarle Comprehensive Plan covers water resources extensively in its Natural Resources chapter (adopted March 3, 1999, and revised in 2008, and being updated in FY13-14). Objectives include:

- Implement an ongoing educational and incentive program for the general public that emphasizes protection of surface and groundwaters and the property owner's responsibility and opportunity.
- Maintain a water resources committee to coordinate local water resources protection matters.
- Protect the County's surface water through a management program that recognizes the functional interrelationship of stormwater hydrology, stream buffers, flood plains, wetlands, and human management practices.
- Preserve designated stream valleys in their natural state in order to protect significant resources associated with stream valleys and to provide buffer areas.
- Protect floodplains from inappropriate uses and recognize their value for stormwater management and ecological functions.
- Protect wetlands from inappropriate uses and recognize their value for maintaining surface water quality and other benefits.
- Encourage BMPs to reduce nonpoint source pollution from agricultural and forestry uses.

Albemarle Water Protection Ordinance: Albemarle County adopted a Water Protection Ordinance in 1998, which consolidated and updated the Erosion and Sediment Control, Runoff Control, and Water Resources Protection Areas Ordinances, as well as the stormwater detention requirements of the Subdivision Ordinance. Stormwater management/BMP plans, which may include structural and/or nonstructural measures, are required for new development, and stream buffers along perennial streams and/or wetlands contiguous to those streams. Buffer widths vary from 25 feet for croplands to 100 feet in development areas to 200 feet within water supply protection

areas. Within the Moores Creek watershed, the land that drains to the Ragged Mountain Reservoir is a water supply protection area.

Before the Storm: Reducing the Damage from Polluted Stormwater Runoff, Recommendations for Albemarle County: In 2009, the Southern Environmental Law Center; Rivanna Conservation Society; and University of Virginia Law School's Environmental Law and Conservation Clinic, published this report which provides strategies and recommendations that support better stormwater protections in Albemarle County using several near-term programmatic and provisional changes.

The City of Charlottesville Comprehensive Plan: The City of Charlottesville's Comprehensive Plan (adopted 2007 and being updated in FY13-14). Chapter 8, "Environment," provides the goals and objectives of the city's water quality, stormwater and watershed management. Goals include:

- Goal A: Promote, protect and restore riparian (streamside) and stream ecosystems to protect habitat and water quality for people and animals.
- Goal B: Improve public and private stormwater infrastructure to protect natural systems from flooding due to extreme stormwater volumes and velocities and protect public health by reducing contaminants in stormwater runoff.
- Goal C: Reduce and prevent impacts from polluted stormwater runoff through voluntary and incentive programs for government agencies, businesses, developers and residents.

Charlottesville 2004 Water Protection Ordinance: The Water Protection Ordinance amended Chapter 34 of the City Code (Erosion and Sediment Control) and re-designated Chapter 10 as the City's Water Protection Ordinance. The ordinance, adopted in September of 2004, accomplished the following:

- Amended and updated the city's local erosion and sediment control program,
- Established a local storm water management program,
- Established 100-foot wide stream buffers across properties adjacent to the Rivanna River, Moores Creek, and Meadow Creek, and
- Prohibits illicit discharges and connections to the city's storm sewer system

Charlottesville 2005 Water Quality Management Study: This Study incorporated the results of stream corridor assessments, collated historic information regarding urban

waterways conditions, completed mapping of the streams, and includes recommendations for future strategies for the city to consider as it seeks to protect its waterways and community health.

Charlottesville Water Resources Protection Program: The city and a Citizens Advisory Committee have developed a comprehensive Water Resources Protection Program (WRPP) proposal. The program, funded mainly through the collection of a stormwater utility fee from all city property owners, include the following goals to address the city's water resource challenges including:

- Regulatory compliance;
- Drainage and flooding problems;
- Stormwater infrastructure rehabilitation;
- Environmental protection and restoration;
- Public education, outreach, and involvement.

As of July 2012, implementation of the stormwater utility is being re-considered by the Charlottesville City Council.

Reducing Runoff from New Development, Recommendations for the City of Charlottesville: In 2008, the Southern Environmental Law Center, Rivanna Conservation Society, and University of Virginia Law School's Environmental Law and Conservation Clinic published this report which provides strategies and recommendations that support better stormwater protections in Charlottesville using several near-term programmatic and provisional changes.

City of Charlottesville, Stormwater Stewardship on Public Lands: Charlottesville received a Small Watershed Grant from National Fish and Wildlife Foundation in 2006 to undertake a study (published in 2008) to:

- Systematically evaluate parks and school campuses;
- Identify potential retrofits, pollution prevention opportunities, and landscape improvements;
- Provide blueprint/catalogue for future city retrofit activity; and
- Provide stormwater education and outreach through retrofits.

University of Virginia Moore's Creek Stormwater Management Master Plan: In 2002, Judith Nitsch Engineering, Inc. published the "University of Virginia Moore's Creek Stormwater Management Master Plan" (JNEI Project #3534). The goals and objectives of this plan include:

- Understand the "baseline" conditions associated with the existing conditions within the watershed;
- Evaluate the hydrologic sensitivity of the watershed;
- Model the development conditions associated with the UVA's build-out plans for the Southern portion of Campus;
- Support the UVA's desire to be responsible to the environment and to its downstream neighbors;
- Ensure compatibility with previous stormwater management planning;
- Implement realistic hydrologic mitigation and water quality treatment measures in support of the plans for development within the watershed, thus creating a blueprint for development of the UVA grounds;
- Develop onsite and/or local-type management approaches to stormwater quantity and quality, and
- Develop a stormwater management plan in accordance with the Virginia Stormwater Management Regulations addressing hydrologic and water quality issues associated with the UVA's development within the watershed.

Chesapeake Bay TMDL Phase II Watershed Implementation Plan: Virginia's Phase II Watershed Implementation was submitted to EPA on March 30, 2012. Both local governments in the Moores Creek watershed (City of Charlottesville and Albemarle County) provided input to DCR regarding baseline conditions and planned strategies for addressing nutrient and sediment pollution. RRBC worked with Charlottesville, Albemarle County, and UVA to review strategies and assist in developing input to DCR. These strategies were considered in the development of this implementation plan, since the majority of BMPs and associated implementation strategies pursued to reduce nutrient and sediment loading produce similar benefits with respect to bacteria reductions. Progress in achieving Bay TMDL and Moores Creek TMDL goals will be tracked concurrently.

A Green Infrastructure Study for the Thomas Jefferson Planning District: The primary goal of this study, published in 2009, is to develop information on implementation measures that can be provided to all jurisdictions for consideration in their planning processes. Water quality protection, drinking water protection, water habitat protection, and recreation protection are included as main goals with the following included as sub-goals of the study:

- General water quality protection:
  - Set minimum stream buffers (with recommendations for larger buffers and forested buffers).
  - Enhance and protect forested areas around streams.
  - Protect healthy waters and contain and reverse stream impairment.
  - Recommend implementation of standards similar to those used in Chesapeake Bay Act localities for consideration by all jurisdictions in the planning district.
- Drinking water protection:
  - Ensure that future drinking water supply plans and development plans reflect each other.
- Water habitat protection:
  - Protect healthy habitats and special habitats through stream restoration and preservation.
  - Ensure adequate water is present in channels to support a diverse aquatic biota. This includes flow variability both over the course of a year and from one year to the next.
- Recreation protection:
  - Provide access to water that's swimmable and fishable.
  - Provide access to green space to improve quality of life.

9.0 POTENTIAL FUNDING SOURCES

A list of potential funding sources available for implementation has been developed. Detailed descriptions can be obtained from the Thomas Jefferson SWCD, VADCR, Natural Resources Conservation Service (NRCS), and Virginia Cooperative Extension (VCE). While some assistance is available for agricultural BMPs and technical assistance for farmers through pre-existing programs, an additional funding commitment is needed to implement the residential and urban practices included in the plan.

Chesapeake Bay Watershed Initiative

This initiative was authorized in the 2008 Farm Bill for 2009-2012. It provides technical and financial assistance to producers to implement practices that reduce sediment and nutrients to help protect and restore the Chesapeake Bay. Priority has been given to the Shenandoah and Potomac River Basins and selected watersheds that have impaired streams due to high levels of nutrients and sediment. Producers who live in an NRCS high priority Chesapeake Bay watershed receive additional consideration in the funding ranking process.

Clean Water State Revolving Fund

EPA awards grants to states to capitalize their Clean Water State Revolving Funds (CWSRFs). The states, through the CWSRF, make loans for high-priority water quality activities. As loan recipients make payments back into the fund, money is available for new loans to be issued to other recipients. Eligible projects include point source, nonpoint source and estuary protection projects. Point source projects typically include building wastewater treatment facilities, combined sewer overflow and sanitary sewer overflow correction, urban stormwater control, and water quality aspects of landfill projects. Nonpoint source projects include agricultural, silvicultural, rural, and some urban runoff control; on-site wastewater disposal systems (septic tanks); land conservation and riparian buffers; leaking underground storage tank remediation, etc.

Conservation Reserve Enhancement Program (CREP)

The Conservation Reserve Enhancement Program (CREP) is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. CREP is an offshoot of the country's largest private-lands environmental improvement program -- the Conservation Reserve Program (CRP). Like CRP, CREP is administered by USDA's Farm Service Agency (FSA). CREP addresses high-priority conservation issues of both local and national significance, such as impacts to water supplies, loss of critical habitat for threatened and endangered wildlife species, soil erosion, and reduced habitat for fish populations such as salmon. CREP is a community-based, results-oriented effort centered on local participation and leadership. CREP contracts require a 10- to 15-year commitment to keep lands out of agricultural production. A federal annual rental rate, including an FSA state committee-determined maintenance incentive payment, is offered, plus cost-share of up to 50 percent of the eligible costs to install the practice.

Environmental Quality Incentives Program (EQIP)

The USDA Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) was established to provide a voluntary conservation program for farmers and ranchers to address significant natural resource needs and objectives. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land. Approximately 65% of the EQIP funding for the state of Virginia is directed toward “Priority Areas.” These areas are selected from proposals submitted by a locally led conservation work group. The remaining 35% of the funds are directed toward statewide priority concerns of environmental needs. EQIP offers 5 to 10-year contracts to landowners and farmers to provide 75% cost-share assistance, 25% tax credit, and/or incentive payments to implement conservation practices and address the priority concerns statewide or in the priority area. Eligibility is limited to persons who are engaged in livestock or agricultural production.

EPA Section 319 Grant Project Funds

Through Section 319 of the Federal Clean Water Act, Virginia is awarded grant funds to implement NPS programs. The VADCR administers the money annually on a competitive grant basis to fund TMDL implementation projects, outreach and educational activities, water quality monitoring, and technical assistance for staff of local sponsor(s) coordinating implementation. In order to meet eligibility criteria established for 319 funding, all proposed project activities must be included in the TMDL implementation plan covering the project area. In addition, this plan must include the nine key elements of a watershed based plan identified by EPA (see Guidance Manual for Total Maximum Daily Load Implementation Plans, Virginia Department of Conservation and Recreation and Department of Environmental Quality, July 2003).

National Fish and Wildlife Foundation

Grant proposals for this funding are accepted throughout the year and processed during fixed sign up periods. There are two decision cycles per year. Each cycle consists of a pre-proposal evaluation, a full proposal evaluation, and a Board of Directors' decision. Grants generally range between $10,000 and $150,000. Grants are awarded for the purpose of conserving fish, wildlife, plants, and their habitats. Special grant programs are listed and described on the NFWF website (http://www.nfwf.org). If the project does not fall into the criteria of any special grant programs, a proposal may be submitted as a general grant if it falls under the following guidelines: 1) it promotes fish, wildlife and habitat conservation, 2) it involves other conservation and community interests, 3) it leverages available funding, and 4) project outcomes are evaluated.

Southeast Rural Community Assistance Project (SE/R-CAP)

The mission of this project is to promote, cultivate, and encourage the development of water and wastewater facilities to serve low-income residents at affordable costs and to support other development activities that will improve the quality of life in rural areas. Staff members of other community organizations complement the SE/R-CAP staff across the region. They can provide (at no cost): on-site technical assistance and consultation, operation and maintenance/management assistance, training, education, facilitation, volunteers, and financial assistance. Financial assistance includes $1,500

toward repair/replacement/ installation of a septic system and $2,000 toward repair/replacement/installation of an alternative waste treatment system. Funding is only available for families making less than 125% of the federal poverty level. For more information, visit http://www.southeastrcap.org.

Virginia Agricultural Best Management Practices Cost-Share Program

The Virginia Agricultural Best Management Practices (BMPs) Cost-Share Program provides funds to help install conservation practices that protect water and make farms more productive. Funding availability varies by SWCD. The state provides SWCDs with funds to target areas with known water quality needs. Areas with the greatest need receive the greatest funding. The cost-share program supports using various practices in conservation planning to treat animal waste, cropland, pastureland and forested land. Some are paid for at a straight per-acre rate. Others are cost-shared on a percentage basis up to 85 percent. In some cases, USDA also pays a percentage. In fact, the cost-share program's practices can often be funded by a combination of state and federal funds, reducing the landowner's expense to less than 30 percent of the total cost. Cost-share funds are also available for approved innovative BMP demonstration projects intended to improve water quality.

Virginia Agricultural Best Management Practices Loan Program

The Virginia Agricultural Best Management Practices Loan Program provides a source of low interest financing which will encourage the use of specific best management practices which reduce or eliminate the impact of Agricultural Nonpoint Source (NPS) pollution to Virginia's waters. VADEQ's Virginia Ag BMP loan program is a subset of the parent Virginia Clean Water Revolving Loan Fund (VCWRLF) loan program and is intended to create a continuing source of low interest financing that will be available to Virginia's agricultural producers to assist them in their efforts to reduce agricultural non-point source pollution. Unlike other assistance programs, the Ag BMP loan program is not dependent on legislative appropriations for its fund availability. All repayments of principle and interest from previous Ag BMP loans are returned to the Fund and used to provide additional loans to other Virginia farmers. In addition to the revenue available from repayments, VADEQ will request that the State Water Control Board (SWCB)

consider making additional funding set-asides from the VCWRLF revenue as deemed necessary in order to meet Virginia's agricultural non-point source pollution reduction needs. Loan requests are accepted through VADEQ. The interest rate is 3% per year and the term of the loan coincides with the life span of the practice. To be eligible for the loan, the BMP must be included in a conservation plan approved by the local SWCD Board. The minimum loan amount is $5,000; there is no maximum limit. Eligible BMPs include 23 structural practices such as animal waste control facilities, and grazing land protection systems. The loans are administered through participating lending institutions.

Virginia Agricultural Best Management Practices Tax Credit Program

For all taxable years, any individual or corporation engaged in agricultural production for market, who has in place a soil conservation plan approved by the local SWCD, is allowed a credit against the tax imposed by Section 58.1-320 of an amount equaling 25% of the first $70,000 expended for agricultural best management practices by the individual. The amount of the credit cannot exceed $17,500 or the total amount of the tax imposed by this program (whichever is less) in the year the project was completed. This program can be used independently or in conjunction with other cost-share programs on the stakeholder's portion of BMP costs. It is also approved for use in supplementing the cost of repairs to streamside fencing.

Virginia Environmental Endowment

The Virginia Mini-Grant Program supports community-based efforts to strengthen environmental education and to promote stewardship of Virginia's waterways. Preference is given to modest local projects. Public and private schools (K-12) and nongovernmental, nonprofit community organizations in Virginia are eligible to apply for one-year Mini-Grant awards up to $5,000. Local, state, and federal government agencies and programs are not eligible.

Virginia Open-Space Lands Preservation Trust Fund

Farmland, forest land, and open space land are important to our heritage in Virginia. These lands are under increasing pressure from urban development in parts of the

Commonwealth. The 1997 Virginia General Assembly created a new fund (Va. Code Sections 10.1801-2) to assist landowners with the costs of conveying conservation easements and the purchase of all or part of the value of the easements. The fund is operated by the Virginia Outdoors Foundation. Conservation easements preserve farmland, forestland, and natural and recreational areas by restricting intensive uses, such as development and mining, which would alter the conservation values of the land. An easement is a voluntary legal agreement between a landowner and a public body or conservation group in which the parties agree to protect the open-space and natural resource values of the land. Each easement is tailored to reflect the conservation values of the property and is recorded in the local courthouse as a permanent part of the property records. Easements do not grant public access to a landowner's property. Costs that the fund may reimburse include legal costs, appraisal and other costs, and all or part of the easement's value. To be eligible, the easement must be perpetual in duration. Additional information is available at http://www.virginiaoutdoorsfoundation.org/VOF_land-ptf.php.

Virginia Small Business Environmental Assistance Fund Loan Program

The Fund, administered through VADEQ, is used to make loans or to guarantee loans to small businesses for the purchase and installation of environmental pollution control equipment, equipment to implement voluntary pollution prevention measures, or equipment and structures to implement agricultural BMPs. The loans are available in amounts up to $50,000 and will carry an interest rate of 3%, with favorable repayment terms based on the borrower’s ability to repay and the useful life of the equipment being purchased or the life of the BMP being implemented. To be eligible for assistance, a business must employ 100 or fewer people and be classified as a small business under the federal Small Business Act.

Virginia Water Quality Improvement Fund

The purpose of the Virginia Water Quality Improvement Act of 1997 (WQIA) is to restore and improve the quality of state waters and to protect them from impairment and destruction for the benefit of current and future citizens of the Commonwealth of Virginia (Section 10.1-2118 of the Code of Virginia). The purpose of the fund is to provide water

quality improvement grants to local governments, soil and water conservation districts and individuals for point and nonpoint source pollution prevention, reduction and control programs (Section 10.1-2128.B. of the Code of Virginia). Nonpoint source pollution is a significant cause of degradation of state waters. The Virginia Department of Environmental Quality (VADEQ) is responsible for administering point source grants and the Virginia Department of Conservation and Recreation (VADCR) administers nonpoint source grants. WQIF funds are provided, in accordance with the guidelines, to help stimulate nonpoint source pollution reduction through the Virginia Agricultural Best Management Practices Cost-share Program and water quality improvement projects. VADCR staff provides technical assistance, as well as financial assistance. During implementation in the RR watersheds, standards, specifications, cost-share, and tax credits for practices under the Virginia Agricultural BMP Cost-share Program will be followed for funding eligibility.

Wildlife Habitat Incentive Program (WHIP)

WHIP is a voluntary program for landowners who want to develop or improve wildlife habitat on private agricultural lands. Participants work with NRCS to prepare a wildlife habitat development plan. This plan describes the landowner's goals for improving wildlife habitat and includes a list of practices and a schedule for installation. A 10-year contract provides cost-share and technical assistance to carry out the plan. Cost-share assistance of up to 75% of the total cost of installation (not to exceed $10,000 per applicant) is available for establishing habitat. Types of practices include: disking, prescribed burning, mowing, planting habitat, converting fescue to warm season grasses, establishing riparian buffers, creating habitat for waterfowl, and installing filter strips, field borders and hedgerows.

Wetland and Stream Mitigation Banking

Mitigation banks are sites where aquatic resources such as wetlands, streams, and streamside buffers are restored, created, enhanced, or in exceptional circumstances, preserved expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources. Mitigation banking is a commercial venture which provides compensation for aquatic resources in financially and environmentally

preferable ways. Not every site or property is suitable for mitigation banking. Wetlands and streams are complex systems, and their restoration, creation, enhancement, or preservation often requires specialized ecological and engineering knowledge. Likewise, the mitigation banking process requires experience to efficiently navigate. Mitigation banks are required to be protected in perpetuity, to provide financial assurances, and long term stewardship. The mitigation banking processes is overseen by the Inter-Agency Review Team (IRT) consisting of several state and federal agencies and chaired by DEQ and Army Corps of Engineers. For more information, contact the Army Corps of Engineers or VADEQ's Virginia Water Protection Program.

Wetland Reserve Program (WRP)

This program is a voluntary program to restore and protect wetlands on private property. Landowners who choose to participate in WRP may receive payments for a conservation easement or cost-share assistance for a wetland restoration agreement. The landowner will retain ownership but voluntarily limits future use of the land. To be eligible for WRP, land must be suitable for restoration (formerly wetland and drained) or connect to adjacent wetlands. A landowner continues to control access to the land and may lease the land for hunting, fishing, or other undeveloped recreational activities.

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Appendix A. Glossary of BMP and other Control Measure Definitions

Adaptive fencing: This term refers to livestock exclusion fencing that is typically installed on a voluntary basis using less expensive poly-wire fencing, and is typically installed with a smaller buffer width, resulting in more available grazing acreage.

Alternative water system: A structural practice that will provide an alternative water source for livestock to discourage animal access to streams. Cost-sharing and/or tax credits may apply to construction or deepening of wells; development of springs or seeps, including fencing of the area where needed, to protect the development from pollution by livestock; construction or repair of dugouts, dams, pits, or ponds; and the installation of pipelines, storage facilities, cisterns, troughs and artificial watersheds.

Critical area stabilization: Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices. This practice is used in areas with existing or expected high rates of erosion or degraded sites that usually cannot be stabilized by ordinary conservation treatment.

Cover crops: A fall-seeded grass or legume crop planted after the harvest of corn or soybeans to maintain a vegetative cover over the winter.

Fencing: A constructed barrier to livestock, wildlife or people. Standard or conventional (barbed or smooth wire), suspension, woven wire, or electric fences shall consist of acceptable fencing designs to control the animal(s) or people of concern and meet the intended life of the practice.

Hardened crossing: A controlled stream crossing for livestock and/or farm machinery in order to prevent streambed erosion and reduce sediment.

Improved pasture management: This practice consists of a series of measures to improve vegetative cover on, and reduce bacteria loading from, pasture areas and may include soil testing, application of lime and fertilizer based on soil testing results, maintenance of a 3-inch minimum grass height through the growing season except for droughts, mowing to control woody vegetation, and chain-harrowing to break-up manure piles after livestock are moved from field.

Livestock exclusion: Excluding livestock from areas where grazing or trampling will cause erosion of stream banks and lowering of water quality by livestock activity in or adjacent to the water. Limitation is generally accomplished by permanent or temporary fencing. In addition, installation of an alternative water source away from the stream has been shown to reduce livestock access.

Livestock exclusion fencing: This practice consists of installing fencing, both temporary and stream exclusion (permanent), for grazing distribution and to restrict stream access in connection with newly developed watering facilities. State cost-sharing requires that the stream exclusion fence be placed a minimum of 35 feet away from the stream, except as designed in areas immediately adjacent to livestock crossings and controlled hardened accesses.

Livestock exclusion buffers: In the implementation plan, this term is used to differentiate the filtering benefits of the buffer, as opposed to the removal of livestock and their directly deposited

bacteria loads from the stream. Removal of the livestock has an immediate effect in removing bacteria loads, while the buffer mitigates loading from surface runoff during storm events.

Reforestation of erodible pastureland: This practice consists of planting trees (hardwoods and/or conifers) on land currently used as cropland or pastureland in order to make a permanent land use conversion to forest, so as to more effectively control the soil and nutrient loss from surface runoff, thus improving water quality. As part of the practice, a permanent vegetative cover is to be established on gullied or eroded areas and shall be maintained until trees provide a protective canopy.

Riparian forest buffer: A protection method used along streams to reduce erosion, sedimentation, and the pollution of water from agricultural nonpoint sources. An area of trees and shrubs 35 – 300 feet wide located up gradient, adjacent, and parallel to the edge of a water feature.

Riparian grass buffer: Grass filter strips are vegetative buffers that are located along the banks of water courses to filter runoff, anchor soil particles, and protect banks against scour and erosion. The strips also improve water quality by filtering out fertilizers, pesticides, and microorganisms that otherwise might reach waterways. In addition, grass filter strips along streams serve as environmental corridors.

Vegetated filter strip: A densely vegetated strip of land engineered to accept runoff from upstream development as overland sheet flow. It may adopt any naturally vegetated form, from grassy meadow to small forest. The purpose of a vegetated filter strip is to enhance the quality of stormwater runoff through filtration, sediment deposition, infiltration and absorption.

Appendix B. VADCR BMP Codes and Practice Names

CRFR-3: CREP riparian forest buffer
LE-1T: Livestock exclusion with riparian buffers
LE-2T: Livestock exclusion with reduced setback
SL-6: Stream exclusion with grazing land management
SL-6AT: Small acreage grazing systems
SL-9: Grazing land management
SL-10T: Pasture management
WP-2A: Stream bank stabilization
WP-2T: Stream protection systems
WQ-1: Grass filter strips

Appendix C. Documentation for Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch BMP Pollutant Load Reduction Modeling

Basis for BMP Extents

- For the TMDL scenario, the extent of BMPs in these watersheds were those represented in the Watershed Implementation Plan for the Albemarle County and the City of Charlottesville land segments and used in the Chesapeake Bay watershed model. For existing conditions, a new baseline was developed based on the NoBMP Scenario using 2010 land uses and BMPs inventoried by Albemarle County, the City of Charlottesville, and the University of Virginia through 2011. Separate BMPs were quantified for the revised Moores Creek Bacteria IP (RRBC, in press), and those that also provide sediment reductions were included as planned BMPs. BMP extents from the Moores Creek Bacteria IP were distributed between Lodge Creek and the remainder of Moores Creek watershed based on their relative amounts of impervious area, except for the two agricultural practices – livestock exclusion and pasture grazing management – which were not applicable to Lodge Creek.

- Livestock exclusion: Livestock locations, riparian pasture areas, and stream access lengths were delineated from 2007 VBMP orthophotography. The total stream length requiring fencing was then multiplied by either 35 feet or 10 feet, based on the assessed BMP needs, to calculate the riparian buffer area in acres. The area in the CBWM "degraded riparian pasture" land use category was then adjusted to equal this assessed area in the Moores Creek watershed. The remainder of the pasture area was treated with the pasture grazing management BMP, though fewer acres were inventoried in the Moores Creek sediment TMDL and IP than in the bacteria IP, as the Bacteria IP pasture category appeared to include other open space land use categories, not confirmed as pasture in our assessment.

- Additional BMPs were required in Schenks Branch after considering those BMPs in place, and those BMPs already planned and funded in various jurisdictional work plans (CIPs) that also provide sediment load reductions. The needed load reduction in Schenks Branch was obtained by applying proportionate extents of sediment-applicable BMPs (excluding the least cost-effective BMP – permeable pavement) as applied in the Moores Creek Bacteria IP until the target load was reached.

Basis for Pollutant Load Reduction Calculations

Sediment load reductions were generally calculated from unit-area loads (UALs) associated with individual land use categories from the TMDL modeling, the area treated by the BMP, and the estimated effectiveness of the individual control measures. Reductions from land use changes were simulated as the difference in the UALs between the two land uses, and practices associated with additional filtering benefits were simulated as affecting some multiple of the buffer area. The upland multiplier (UM) = 2 for sediment. The following calculations were for sediment control practices. Area is in units of acres, UAL in units of tons/acre, and efficiency is a percentage.

- Bioretention/raingardens, Bioswales, Dry Detention Ponds, Urban Infiltration, Urban Filtering Practices, Wet Ponds and Wetlands, Street Sweeping, and Permeable Pavement:
  $(area_{imp} \times UAL_{imp} + area_{per} \times UAL_{per}) * \text{BMP efficiency}$

The area quantified for street sweeping amounted to the total linear length swept/yr multiplied by a sweeper width of 8 feet, and divided by 25 times/yr.

- Impervious Surface Reduction: $area_{imp} \times (UAL_{imp} - UAL_{per})$

- Urban Stream Restoration: stream length (ft) * 62.4 lbs sediment/ft * 0.0005 tons/lb

- Livestock exclusion with CREP:
  (length of fencing x 35 ft)/43,560 sq.ft/ac x $[(UAL_{trp} – UAL_{for}) + UM \times UAL_{pas} \times \text{BMP efficiency}]$

- Livestock exclusion:
  (length of fencing x buffer width)/43,560 sq.ft/ac x $[(UAL_{trp} – UAL_{hyo}) + UM \times UAL_{pas} \times \text{BMP efficiency}]$

- Grazing land management: UAL_{pas} x area x BMP efficiency

Notes: The land use subscripts are defined as follows:

- for = forest, including forest buffers.
- hyo = hay without nutrients, the land use designation for grass buffers.
- imp = urban impervious areas.
- pas = pasture areas.
- per = urban pervious areas.
- trp = trampled riparian pasture, the land use designation for riparian pastures with livestock access.

Appendix D. Notes on the Working Group and Steering Committee Meetings

The first set of Working Group Meetings was held at CitySpace in downtown Charlottesville on April 18, 2012, with the Rural Working Group meeting from 10:00am until noon, and the Urban Working Group Meeting from 1:00 – 3:00pm. The Rural Working Group meeting was attended by 10 stakeholders and included a review of preliminary sediment load reduction estimates for agricultural land uses and a discussion about how to verify actual levels of BMPs on the ground, which includes only one recorded cost-shared agricultural BMP, versus the levels of BMPs incorporated in the Chesapeake Bay model. The Thomas Jefferson SWCD is part of a demonstration effort to identify voluntary BMPs in this area. Nesha McRae (DCR representative) volunteered to assess and calculate fencing needs for livestock exclusion in coordination with an EPA §319 Grant for a previously developed IP on Moores Creek for a bacteria impairment. The Urban Working Group was attended by 14 stakeholders and also reviewed sediment load reduction estimates for urban land uses and discussed how to quantify urban BMPs. The jurisdictions volunteered to individually assess their BMPs, extents, and year installed, and to make all GIS data and BMP shapefiles available to DEQ's contractor. Local sites with known erosion problems were discussed, including a site near a pedestrian bridge off Sunset Avenue and a site behind Jackson Via Elementary School. The group decided that invitations to join the steering committee should be made to representatives from the Albemarle County Trails, Rivanna Trails Foundation (RTF), and trail monitors. The contractor (BSE) agreed to investigate BMPs that might be appropriate to treat runoff from the approximately 700 acres draining to the underground portions of Schenks Branch.

The second set of Working Group Meetings was held on May 29, 2012 at the Albemarle County Office Building on Old Lynchburg Road in Charlottesville, with the Urban Working Group meeting from noon to 2:00pm, and the Rural Working Group meeting from 2:00-4:00pm. The Urban Working Group had 18 stakeholders in attendance and the Rural Working Group included 14 stakeholders. In the Urban Working Group Meeting, mention was made of differing methods of load calculation within the Chesapeake Bay model and in Virginia's Runoff Reduction Method, which will

be required for development and redevelopment stormwater management beginning in 2014. It was announced that the Avon Street landfill restoration plan was to be completed in early June and would include some bank stabilization and stream restoration. Tara Sieber (DEQ representative) volunteered to compile urban BMP cost estimates from localities, local consultants and engineering firms and to coordinate with the Rivanna River Basin Commission, who is heading up the Moores Creek Bacteria IP revision and 319 grant administration. Localities were asked if there were other BMPs that might quality for reduction credits but have not been accounted for in our current inventory, and if so, to report them to DEQ's contractor. The Rural Working Group discussed the agricultural BMPs outlined by Ms. McRae, including the SL-6AT practice for horse farms. Representatives from VDOF reported that since 2009, 12 timber harvests occurred in Moores Creek consisting of 520 acres. Each job ran from 6 months to 2 years. They reported that BMPs on the whole harvested tract are voluntary, but that BMPs are mandatory and enforced in the riparian buffer zone. They recommended offering incentives to the loggers to cover their costs, such as for graveling access roads, rather than to the landowners, as being more productive. They reminded us that silvicultural practices are aimed at minimizing sediment in the stream, not at controlling upland erosion. Conservation easements were discussed as one option for controlling land use change, and mention was made that tax exemptions had been talked about for acreage maintained in riparian buffers. The new Biscuit Run State Park will also serve to protect the rural nature of that portion of the County. Carrie Swanson, an Extension agent specializing in horses, described horse farms in the area as being comprised, on the average of 6-7 horses per farm, with a stocking density that ranged widely from 1-20 acres per horse. Other recommendations included educational programs to prospective new home builders about how to minimize their sediment footprint during construction – no resolution was reached on the best way to accomplish this, and creating an urban outreach plan as an action item in the IP, possibly funded through walk-up grants.

The first Steering Committee meeting was held on July 10, 2012 at the Albemarle County Office Building in Charlottesville, Virginia, and was attended by 20 people. At this meeting DEQ's contractor reviewed the summary of BMPs provided by the localities and those anticipated being installed through the Moores Creek Bacteria IP. The group

suggested that the planned bacteria IP urban BMPs be distributed between Lodge Creek and the remainder of Moores Creek based on their relative % imperviousness. The timeline was adjusted to match the first 5 stages in the Bacteria IP and to add a sixth stage that would align with the Chesapeake Bay TMDL's final milestone of 2025. The last stage would include all additional BMPs not already being planned by the jurisdictions or through the Moores Creek Bacteria IP. In Schenks Branch, BMPs should be identified which, in addition to sediment, could also be used to trap or treat possible PAH contamination. One of the Albemarle County planned BMPs is for an enhancement to an existing wet retention pond, and discussion followed about how load reduction credit could be estimated for such a BMP, not currently represented in the Bay model. UVA agreed to see if they could quantify any of their planned BMPs so as to include them in the IP planned load reductions. A suggestion was made that the state be responsible for stream restoration for a 2,000 foot section of Biscuit Run within the new State Park, as part of the IP. Educational programs described in each jurisdiction's MS4 annual reports will be included in the IP (see the rivanna-stormwater.org website for more educational resources currently available). Technical assistance needs for the agricultural practices will be covered by costs included in the Moores Creek Bacteria IP, but technical assistance in the urban areas will also be needed.

The second Steering Committee meeting was held on August 6, 2012 from noon to 2:00 pm in the Albemarle County Office Building in Charlottesville and was attended by 11 stakeholders. An update on the Moores Creek Bacteria IP was given by Jessica Lassetter and a discussion was held on the latest draft of the sediment IP for Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch. A decision was made to increase the annual cost for urban technical assistance to $75,000/FTE-yr. A request was made to include in the IP only those BMPs and associated costs that were needed, at a minimum, to achieve the reductions in the sediment TMDL in each watershed, rather than including additional BMPs that are included in the Moores Creek Bacteria IP and jurisdictional CIPs, that are over and above the required amounts. A discussion then followed on how to address PAHs in the IP. Caution was urged to include only native species in the list of possible grasses to be used for phytoremediation. A question was raised as to whether or not local jurisdictions had the authority to ban coal tar-

based asphalt sealants, and Kristel Riddervold said that she would check on local PAH ordinances in Virginia. UVA asked that their currently unfunded BMPs be listed as opportunities. The final public meeting was set for September 20th in the evening at a location to be determined. Committee members were asked to provide comments on the current draft IP to Gene Yagow by August 15th, so that he could revise, finalize the draft IP, and distribute it the following week for thorough review by all members well in advance of the final public meeting.