Moores Creek Bacteria Implementation Plan 2012 Update

Rivanna River Basin Commission
September 6, 2012

Rivanna River Basin Commission
Protecting The Rivanna through a Confluence of Interests

This project received funding from U.S. Environmental Protection Agency's Section 319 Nonpoint Source Implementation Grant Program at the Virginia Department of Conservation and Recreation (DCR), via grant number 319-2011-P07-PT. It has not been formally reviewed by EPA. The views expressed are solely those of DCR and the Rivanna River Basin Commission. EPA does not endorse any products or commercial services mentioned.

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United States Environmental Protection Agency

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Rivanna River Basin Commission
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Editor's Note: "Moores Creek" is also referred as the possessive "Moore's Creek." For this IP update, we will consistently use the non-possessive "Moores Creek" unless it is the title of a published report.

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List of Acronyms

ACSA	Albemarle County Service Authority
ASA	Agricultural Stewardship Act
BMP	Best Management Practices
CBWI	Chesapeake Bay Watershed Initiative
CFU	Colony Forming Unit
CIP	Capital Improvement Plan
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
DCR	Virginia Department of Conservation and Recreation
DEQ	Virginia Department of Environmental Quality
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FSA	Farm Service Agency
GIS	Geographic Information Systems
HSPF	Hydrological Simulation Program-Fortran
IP	Implementation Plan
MGD	Million Gallons per Day
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NFWF	National Fish and Wildlife Foundation
NPS	Nonpoint source
NRCS	Natural Resource Conservation Service
PEC	Piedmont Environmental Council
PDC	Planning District Commission
RRBC	Rivanna River Basin Commission
RCS	Rivanna Conservation Society
RRSEP	Rivanna Regional Stormwater Educational Partnership
RWSA	Rivanna Water and Sewer Authority
SE/R-CAP	Southeast Rural Community Assistance Project
SPCA	Society for the Prevention of Cruelty to Animals
SWCB	State Water Control Board
SWCD	Soil and Water Conservation District
TDN	Total Digestible Nutrients
TJPDC	Thomas Jefferson Planning District Commission
TJSWCD	Thomas Jefferson Soil and Water Conservation District
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
UAA	Use Attainability Analysis
USDA	United States Department of Agriculture
UVA	University of Virginia
DEQ	Virginia Department of Environmental Quality
VBMP	Virginia Base Mapping Program

VCE	Virginia Cooperative Extension
VDACS	Virginia Department of Agriculture and Consumer Services
VDH	Virginia Department of Health
VNRCF	Virginia Natural Resources Commitment Fund
VPDES	Virginia Pollutant Discharge Elimination System
WHIP	Wildlife Habitat Incentive Program
WQIF	Water Quality Improvement Fund
WQMIRA	Water Quality Monitoring, Information and Restoration Act
WQS	Water Quality Standard
WRP	Wetland Reserve Program
WSMB	Wetland and Stream Mitigation Banking
WWTP	Waste Water Treatment Plant

Overview of the Moores Creek Bacteria Implementation Plan Update

This *Moores Creek Bacteria Implementation Plan 2012 Update* (2012 IP update) updates the *Moore's Creek Fecal Coliform TMDL Implementation Plan* that was prepared by the Thomas Jefferson Planning District Commission (TJPDC) for Virginia Department of Conservation and Recreation (DCR) and Virginia Department of Environmental Quality (DEQ) on February 28, 2005. The *Moore's Creek Fecal Coliform TMDL Implementation Plan* was prepared by University of Virginia Department of Civil Engineering and TJPDC for DCR and DEQ in response to the *Total Maximum Daily Load (TMDL) for Fecal Coliform Bacteria in Moore's Creek, Albemarle County, Virginia* (DCR and DEQ, 2002).

In 2011, the U.S. Environmental Protection Agency Region III made Section 319 funding available through DCR for implementing best management practices (BMP) to help meet the goal of reducing bacteria pollution in the Moores Creek watershed. However, the availability of these funds to help with landowners and homeowner cost-share for BMPs was made contingent upon an EPA-approved, updated implementation plan that addressed and modeled changes in the watershed since 2005, including the TMDL modifications for wasteload allocations in the bacteria TMDL for Moores Creek drainage basin in Albemarle County (July 2011). In addition, the implementation plan needed to include all the elements of an implementation plan as described by *Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003* (EPA, 2003).

This document includes, by reference, the *Moore's Creek Fecal Coliform TMDL Implementation Plan* (DCR and DEQ, 2005) and provides an update to that plan, thus meeting the EPA requirements for 319 funding of implementation practices. The 2012 IP update is funded by DCR Nonpoint Source Pollution Implementation Grant 319-2011-P07-PT.

1. Introduction

Section 1 reviews the federal Clean Water Act (CWA) of 1972 and applicable Virginia water quality standards as they relate to developing a Total Maximum Daily Load (TMDL) for state waters.

1.1 Background

The CWA requires that all U.S. streams, rivers, and lakes meet their state's water quality standards. The CWA also requires that states conduct monitoring to identify polluted waters or those that do not meet standards. Through this required program, the Commonwealth of Virginia has determined that many streams do not meet state water quality standards for protection of six beneficial uses: 1) aquatic life, 2) fish consumption, 3) public water supply, 4) shellfishing, 5) wildlife, and 6) recreation.

When streams fail to meet standards, Section 303(d) of the CWA and the U.S. Environmental Protection Agency's (EPA) Water Quality Management and Planning Regulation both require that states develop a Total Maximum Daily Load (TMDL) for each pollutant causing the impairment. A TMDL can be considered a "pollution budget" for a stream. That is, it establishes limits on the amount of pollution that a stream can accept and still maintain water quality standards. In order to develop a TMDL, background concentrations, point source loadings, and non-point source loadings are considered. A TMDL accounts for seasonal variations and must include a margin of safety. Through the TMDL process, states establish water-quality based controls to reduce pollution and meet water quality standards.

Once a TMDL is developed, measures must be taken to reduce pollution levels in the stream. Virginia's 1997 Water Quality Monitoring, Information and Restoration Act (WQMIRA) states that the State Water Control Board (SWCB) "shall develop and implement a plan to achieve fully supporting status for impaired waters." A TMDL Implementation Plan (IP) describes control measures, which can include the use of better treatment technology and the installation of best management practices (BMP) to be implemented in order to meet the water quality goals established by the TMDL.

1.2 Applicable Water Quality Standards

Water quality standards are designed to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.).

Virginia Water Quality Standard 9 VAC 25-260-10 (Designation of uses) states:

A. *All state waters, including wetlands, 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.*

♦

D. *At a minimum, uses are deemed attainable if they can be achieved by the imposition of effluent limits required under §§301(b) and 306 of the Clean Water Act and cost-effective and reasonable best management practices for nonpoint source control.*

♦

G. *The [State Water Quality Control] board may remove a designated use which is not an existing use, or establish subcategories of a use, if the board can demonstrate that attaining the designated use is not feasible because:*
   1. *Naturally occurring pollutant concentrations prevent the attainment of the use;*
   2. *Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met;*

♦

6. *Controls more stringent than those required by §§301(b) and 306 of the Clean Water Act would result in substantial and widespread economic and social impact.*

When Moores Creek was listed as impaired in 1998, the state's water quality criterion for bacteria was based on fecal coliform. For a non-shellfish supporting water body to be in compliance with Virginia fecal coliform standard for contact recreational use, Virginia Department of Environmental Quality (DEQ) specified the following criteria (Virginia Water Quality Standard 9 VAC 25-260-170):

A. *General requirements. In all surface waters, except shellfish waters and certain waters addressed in subsection B of this section, the fecal coliform bacteria shall not exceed a geometric mean of 200 fecal coliform bacteria per 100 ml of water for two or more samples over a 30-day period, or a fecal coliform bacteria level of 1,000 per 100 ml at any time.*

If the waterbody exceeded either criterion more than 10 percent of the time, the waterbody was classified as impaired and a TMDL was developed and implemented to bring the waterbody into compliance with the water quality criterion. Based on the sampling frequency, only one criterion was applied to a particular datum or data set (Virginia Water Quality Standard 9 VAC 25-260-170). If the sampling frequency was one sample or less per 30 days, the instantaneous criterion was applied; for a higher sampling frequency, the geometric criterion was applied. The instantaneous fecal coliform water quality standard was modified in 2003 to a level of 400 colony forming units (cfu) per 100 milliliters (ml).

Sufficient fecal coliform bacteria standard violations were recorded at DEQ water quality monitoring stations on Moores Creek to indicate that the recreational use designation was not being supported (DEQ, 1998). Most of the DEQ's ambient water quality monitoring is done on a monthly or quarterly basis. This sampling frequency does not provide the two or more samples within 30 days needed for use of the geometric mean part of the standard. Therefore, DEQ used the 1,000 cfu/100 mL standard in the 1996, 1998, and 2002 303(d) assessments for the fecal coliform bacteria monitoring data. The bacteria TMDL for Moores Creek was developed in 2002 and designed to meet the fecal coliform standard. The modified 400 cfu/100 ml standard was used in the 2004 Section 303(d) assessments for the fecal coliform bacteria monitoring data.

EPA revised bacteria water quality standards in response to the determination of a stronger correlation between the concentration of these organisms (*Esherichia coli* and *enterococci*) and the incidence of gastrointestinal illness than with fecal coliform. *Esherichia coli (E. coli*) and *enterococci* are both bacteriological organisms that can be found in the intestinal tract of warm-blooded animals. Like fecal coliform bacteria, these organisms indicate the presence of fecal contamination.

In response to EPA's recommendation that all states adopt an *E. coli* or *enterococci* standard for fresh water and enterococci criteria for marine waters by 2003, DEQ specified the following revised criteria for *E. coli* as of January 15, 2003, for a non-shellfish supporting waterbody to be in compliance with for contact recreational use:

E. coli bacteria concentrations for freshwater shall not exceed a geometric mean of 126 counts per 100 mL for two or more samples taken during any calendar month and shall not exceed an instantaneous single sample maximum of 235 cfu/100 mL.

1.3 Water Quality Standard Changes

Two regulatory actions related to the bacteria water quality standard in Virginia have been implemented. The first rulemaking action was to change the indicator species used to measure bacteria pollution from fecal coliform to *E. coli*. The second rulemaking action was to include an evaluation of the designated uses as part of the state's triennial review of its water quality standards. All waters in the Commonwealth have been designated as "primary contact" for the swimming use regardless of size, depth, location, water quality or actual use. The fecal coliform bacteria standard described in Section 1.2 of this report is to be met during all stream flow levels and was established to protect bathers from ingestion of potentially harmful bacteria. However, many headwater streams are small and shallow during base flow conditions when surface runoff has minimal influence on stream flow. Even in sections of the stream that have pooled, full body immersion is not possible during periods of base flow. In larger streams, lack of public access often precludes the swimming use.

Recognizing that all waters in the Commonwealth are not used extensively for swimming, Virginia has approved a process for re-designation of the swimming use for secondary contact in cases of: 1) natural contamination by wildlife, 2) small stream size, and 3) lack of accessibility to children, as well as due to widespread socio-economic impacts resulting from the cost of improving a stream to a "swimmable" status.

The re-designation of the current swimming use in a stream requires the completion of a Use Attainability Analysis (UAA). A UAA is a structured scientific assessment of the factors affecting the attainment of the use, which may include physical, chemical, biological, and economic factors as described in the Federal Regulations. The stakeholders in the watershed, Virginia, and EPA have an opportunity to comment on these special studies.

In some streams for which TMDLs have been developed, water quality modeling indicates that even after removal of all of the sources of *E. coli* (other than wildlife), the stream will not attain standards. TMDL allocation reductions of this magnitude are not realistic and do not meet EPA's guidance for reasonable assurance. Based on water quality modeling, many of these streams will not be able to attain standards without some reduction in wildlife. Virginia and EPA are not proposing to implement the reduction of wildlife to allow for the attainment of water quality standards. This is obviously an impractical action. While managing over-populations of wildlife remains as an option to local stakeholders, the reduction of wildlife or changing a natural background condition is not the intended goal of a TMDL. In such a case, after demonstrating that the source of *E. coli* contamination is natural and uncontrollable by effluent limitations and BMPs, the state may decide to re-designate the stream's use for secondary contact recreation or to adopt site specific criteria based on natural background levels of *E. coli*. The state must demonstrate that the source of *E. coli* contamination is natural and uncontrollable by effluent limitations and BMPs through a UAA as described above. All site-specific criteria or designated use changes must be adopted as amendments to the water quality standards regulations. Watershed stakeholders and EPA are able to provide comment during this process.

2. State and Federal Requirements for Implementation Plans

There are a number of state and federal requirements and recommendations for TMDL IPs. Section 2 defines these and states whether the "elements" are a required component of an IP that is eligible to receive Section 319 funds or are merely a recommended topic that should be covered in an IP. This section has three parts: 1) the requirements outlined by the WQMIRA that must be met in order to produce an IP that is approvable by the Commonwealth, 2) the EPA recommended elements of IPs, and 3) the required components of an IP in accordance with Section 319 guidance.

2.1 State Requirements

The TMDL IP is a requirement of Virginia's 1997 Water Quality Monitoring, Information, and Restoration Act (§62.1-44.19:4 through 19:8 of the Code of Virginia), or WQMIRA. WQMIRA directs the SWCB to "develop and implement a plan to achieve fully supporting status for impaired waters." In order for an IP to be approved by the Commonwealth of Virginia, it must meet the requirements as outlined by WQMIRA. WQMIRA requires that the IP include the following:

- Date of expected achievement of water quality objectives,
- Measurable goals,
- Necessary corrective actions, and
- Associated costs, benefits, and environmental impact of addressing the impairment.

2.2 Federal Recommendations

Section 303(d) of the CWA and current EPA regulations do not require the development of implementation strategies. EPA does, however, outline the minimum elements of an approvable IP in its *Draft Guidance for Water Quality-based Decisions: The TMDL Process (Second Edition)* (EPA, 1999). The listed elements include:

- Description of the implementation actions and management measures,
- Time line for implementing these measures,
- Legal or regulatory controls,
- Time required to attain water quality standards, and
- Monitoring plan and milestones for attaining water quality standards.

It is strongly suggested that EPA recommendations be addressed in the IP, in addition to the required components as described by WQMIRA.

2.3 Requirements for Section 319 Fund Eligibility

EPA develops guidelines that describe the process and criteria used to award CWA Section 319 nonpoint source grants to states. The guidance is subject to revision, and the most recent version should be considered for IP development. *Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003* (EPA, 2003) is the most recent revision at the time of writing of this IP update and identifies the 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 to achieve water quality standards;
3. Describe the non-point source (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 if progress is being made towards attaining water quality standards; if not, identify 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 effort.

3. Review of TMDL Development

Section 3 provides an overview of the 2002 TMDL developed for Moores Creek, the 2011 TMDL update, the implementation plan developed for the 2002 TMDL, and a description of how this 2012 IP update fits into the context of the previous plans.

3.1 Background

Moores Creek (waterbody ID VAV-H28R; HUC-12 020802040402) is listed as impaired due to violations of the State's water quality standard for fecal coliform on Virginia's *1998 303(d) Total Maximum Daily Load Priority List and Report* (DEQ, 1998). Water quality sampling on Moores Creek between August 1991 and January 2002 found that 14.5 percent of the water samples violated the instantaneous fecal coliform standard of 1000 cfu/100 ml and that the 30-day geometric mean standard of 200 cfu/100 ml was violated 59 percent of the time (DCR and DEQ, 2002). The 6.37 mile segment of Moores Creek impaired by fecal coliform bacteria extends from the intersection of U.S. Route 29 and County Route 1106 (Teel Lane) to the confluence of the Rivanna River.

Moores Creek watershed drains 31.49 square miles of Albemarle County and 3.49 square miles of the City of Charlottesville, for a total drainage area of 34.92 square miles. Moores Creek flows approximately 11 miles from its source in the Ragged Mountains to its confluence with the Rivanna River in Charlottesville. The watershed is predominantly forested, with residential areas, grasslands, and urban areas being the other major land uses. Section 4 provides a detailed description of land use change between 2002 and 2009.

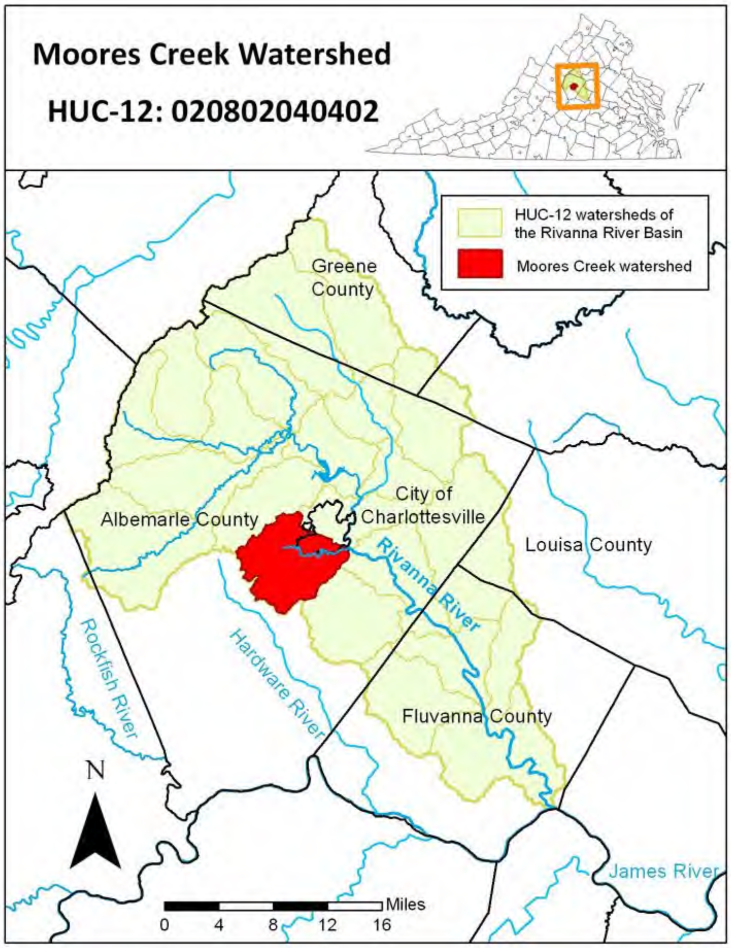

Figure 3.1 Location of the Moores Creek watershed.

3.2 Development of the 2002 Bacteria TMDL

The University of Virginia's (UVA) Department of Civil Engineering, located in Charlottesville VA, was contracted by DEQ through TJPDC to develop the TMDL for bacteria impairment on Moores Creek in 2002 after a proposal was submitted in 2000 and funded in 2001. The final TMDL was approved by EPA in May 2002. Appendix A provides the EPA decision rationale for Moores Creek fecal coliform TMDL.

3.2.1 Modification of the 2002 Bacteria TMDL

In 2005, DEQ produced Guidance Memo 05-2011, *TMDL Modifications in Response to New or Expanding Discharges* (DEQ, 2011a). The purpose of the memo is to inform TMDL staff of the following:

> *Permits issued for facilities with wasteload allocations developed as part of a Total Maximum Daily Load (TMDL) must be consistent with these wasteload allocations*

(WLA), as per EPA regulations. In cases where a proposed permit modification is affected by a TMDL WLA, permit and TMDL staff must coordinate to ensure that new or expanding discharges meet this requirement.

During the 2011 renewal of Virginia Pollutant Discharge Elimination System (VPDES) Permit Number VA0025518 for Moores Creek Waste Water Treatment Plant (WWTP), it was determined that a flow of 12 million gallons per day (MGD) was used to calculate the original wasteload allocation, although the design capacity was 15 MGD. This required a TMDL modification to the bacteria TMDL.

DEQ, with modeling support from UVA, recommended four specific modifications to the 2002 TMDL, which were submitted to EPA by DEQ and approved on July 11, 2011 (see Appendix B). These modifications include:

1. The approved TMDL was expressed only in annual loading rates and updated to include daily loading rates.
2. Adjustment to accommodate future growth for expansion of existing and new facilities to better account for where the associated change in loading is occurring in Moores Creek.
3. Waste load allocation (WLA) for Moores Creek WWTP increased from 3.32E+13 to 4.14E+13 cfu/year of fecal coliform to correct the design treatment capacity to 15 MGD.
4. Update the TMDL to reflect the *E. coli* Water Quality Standard (WQS).

None of the proposed modifications resulted in a change in the TMDL value or the margin of safety (MOS) because the future growth load allocation was modified to account for these changes. Table 3.1 provides a summary of the average annual and daily TMDL load allocations for both fecal coliform and *E. coli* (DEQ, 2011b). Southwood Mobile Home Park waste treatment plant was taken off-line in 2005.

Table 3.1 Average Annual and Daily TMDL Load Allocations for both Fecal Coliform and *E. coli* (DEQ, 2011b).

Description	Southwood Mobile Home Park Plant WLA*	Moores Creek WWTP WLA	Future Growth Allocation	Sum of Load Allocation	Margin of Safety (5% of the TMDL)	TMDL
Modified Daily (fecal cfu/day)	2.73E+08	1.14E+11	4.64E+10	1.61E+12	9.34E+10	1.87E+12
Modified Annual (fecal cfu/year)	1.00E+11	4.14E+13	1.69E+13	5.89E+14	3.41E+13	6.81E+14
Modified Daily (*E. coli* cfu/day)	1.86E+08	7.15E+10	2.92E+10	1.02E+12	5.89E+10	1.18E+12
Modified Annual (*E. coli* cfu/year)	6.79E+10	2.61E+13	1.07E+13	3.71E+14	2.15E+13	4.20E+14

*Taken off-line in 2005.

3.3 Description of Water Quality Monitoring

DEQ currently uses a six-year rotation as the basis for its state-wide ambient water quality monitoring network, which includes such parameters as temperature, dissolved oxygen, specific conductance, pH, bacteria, and nutrients. As part of this system, a station is monitored for two years of every six-year period (two years on, four years off). Once the TMDL IP update is complete, DEQ shifts these monitoring stations out of the rotational schedule and conducts continuous monitoring every other month.

Data previously collected by DEQ and Rivanna Water and Sewer Authority (RWSA) at station 2-MSC000.60, located immediately upstream of the discharge point for the Moores Creek Advanced Wastewater Treatment Plant (WWTP) (DCR and DEQ, 2002), were used to list Moores Creek as impaired by fecal bacteria.

DEQ has seen an overall decrease in *E. coli* and an increase in water quality from 2005 to 2012 (see Figure 3.2) at RWSA station 2-MSC000.60.

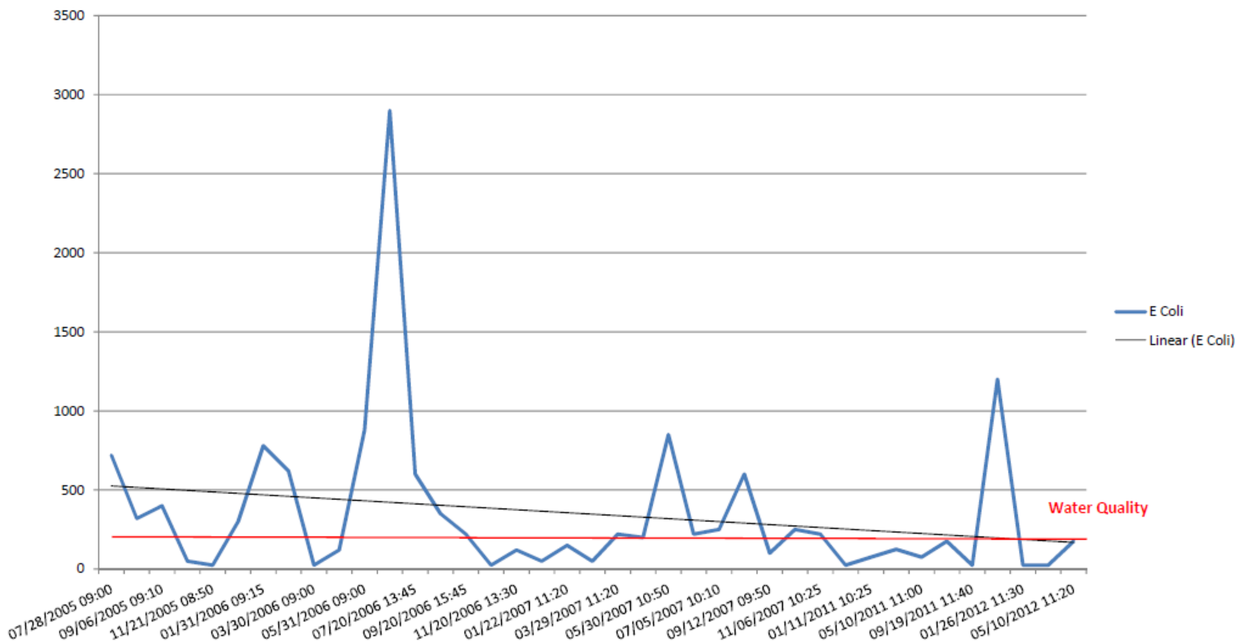

Figure 3.2 DEQ Monitoring Data for Moores Creek (2-MSC000.60) for *E. Coli* (Sieber, 2012). Note: The X-axis is *E. coli* (cfu/100 ml) and the red line is the *E. Coli* water quality standard.

Figure 3.3 shows the locations of the stations where DEQ will continue bacterial monitoring following completion of this TMDL implementation plan update, and Table 3.2 provides corresponding descriptions of the monitoring conducted at the stations located on impaired stream segments as of 2012.

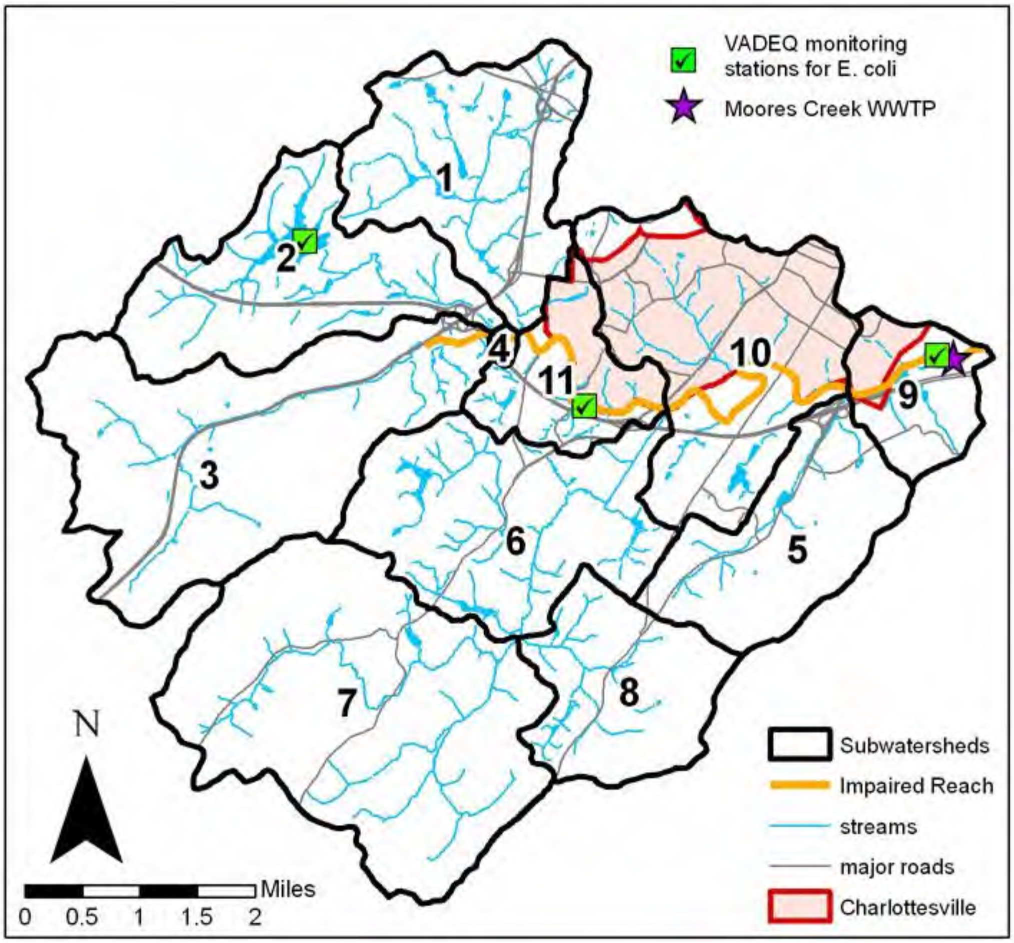

Figure 3.3 Monitoring stations in the Moores Creek watershed (DEQ, 2012).

Table 3.2 *E. coli* water quality monitoring within the Moores Creek watershed (DEQ, 2012).

DEQ Station ID	Stream Name	DEQ Station Location Description	# of Samples Collected	Violation Rate
2-MSC000.60	Moores Creek	RWSA WWTP Bridge	29	48.3%
2-MSC004.43	Moores Creek	100 yards downstream of Route 780 Bridge at Azalea Park	9	33.3%
2-XLV002.27	Ragged Mountain Reservoir	Above dam – Ragged Mountain Reservoir	6	0%

3.4 Description of Water Quality Modeling

Water quality for the 2002 TMDL was modeled using the BASINS Nonpoint Source Model (NPSM) and the Hydrologic Simulation Program-FORTRAN (HSPF) to simulate flow and the fate and transport of fecal coliform bacteria in the Moores Creek watershed. These models incorporate temporal and spatial variability within the watershed. Due to a minimal amount of flow observations from Moores Creek, an equivalent watershed approach and synthetic flow generation were used to calibrate the hydrological component of the models. The Buck Mountain Run watershed within the Rivanna drainage system was selected as an equivalent watershed. The HSPF/NPSM model was calibrated to the Buck Mountain Run watershed, which is similar but somewhat less developed than the Moore's Creek watershed, for the five-year period between October 1992 and September 1997. A synthetic flow generator that combined an artificial neural network and the maintenance of variance approach was developed and demonstrated on the Buck Mountain Run watershed. The synthetic flow generator was then applied to the Moores Creek system to create flow predictions for the period over which significant water quality and flow observations exist (October 1996 through August 2001).

The synthetic flow predictions not only accurately reproduced the observed flows on Moores Creek, but also provided a continuous calibration target for the HSPF/NPSM model on Moores Creek. HSPF/NPSM parameters for the Buck Mountain Run watershed were adjusted to accurately reproduce the synthetic flows for the 5-year period. The water quality model was then calibrated to the observed fecal coliform concentrations over the same 5-year period. The fecal coliform loads that were applied directly to the stream and to the land surface were calculated on a monthly basis to account for seasonal variability in wildlife populations and the varying time that cattle spend in the stream. (DCR and DEQ, 2002)

The development of the *Moore's Creek Fecal Coliform TMDL Implementation Plan* (DCR and DEQ, 2005) was based on the 2002 TMDL model, described above. Furthermore, no changes to the 2002 model were made to develop the 2011 TMDL modifications. Section 4 provides an overview of the changes made to the 2002 model to update this IP.

Figure 3.4 shows the subwatersheds used in the development of the TMDL and the impaired stream segment of Moores Creek.

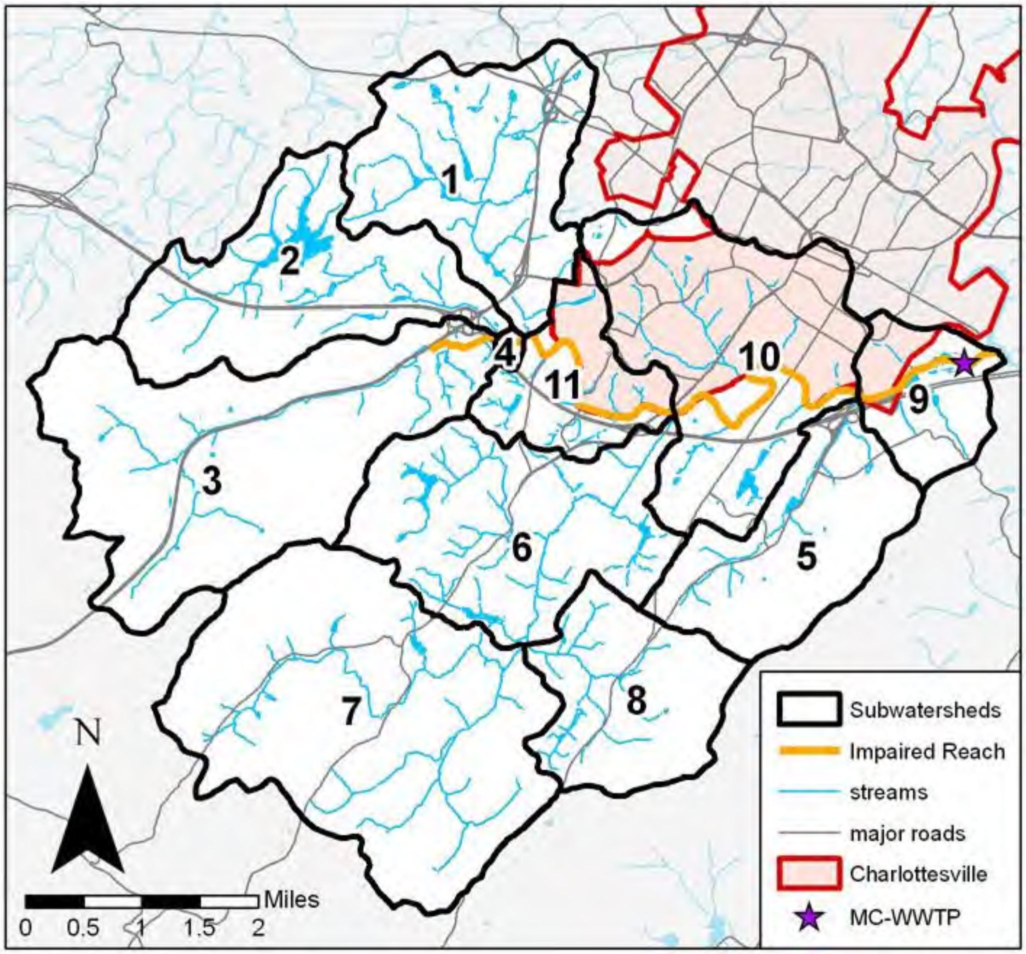

Figure 3.4 Subwatersheds used for TMDL development and the Moores Creek impaired stream segment.

3.5 Description of Sources Considered

Potential sources of bacteria considered in the development of the TMDL included both point source and nonpoint source contributions.

3.5.1 Point Sources

The TMDL's waste load allocation accounts for the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Point sources of fecal coliform bacteria in the watershed include all municipal and industrial plants that treat human waste, as well as private residences that fall under general permits. As of 2009, these point sources are required to maintain an *E. coli* discharge concentration no greater than 126 cfu/100 mL. Permits issued prior to 2009 were based on the fecal coliform standard and were set at a limit of 200 cfu/100 mL. When the permits are reissued (every five years), they are changed over to the *E. coli* standard. Virginia issues VPDES permits for point sources. As of 2012, there is only one point source of bacteria in the watershed (Moores Creek WWTP, Permit No. VA0025518). The Southwood Mobile Home Park plant, included in the 2002 and 2011 TMDL, was taken off-line in 2005.

3.5.2 Nonpoint sources

Nonpoint source pollution originates from sources across the landscape (e.g., agricultural, residential and urban land uses) and is delivered to water bodies by runoff from rainfall and snowmelt that picks up and conveys pollutants off the land surfaces. In some cases, a precipitation event is not required to deliver nonpoint source pollution to a stream (e.g., pollution from leaking sewer lines or livestock directly defecating in a stream). Nonpoint sources of bacteria in the watershed include faulty residential sewage treatment systems, land application of waste, livestock, wildlife, and domestic pets.

Bacteria loads are represented either as land-based loads (where they are deposited on land and may be washed off land surfaces during a rainfall event) or as direct loads (where they are directly deposited into the stream). Land-based nonpoint sources are represented as an accumulation of bacteria on the land with some portion available for transport in runoff. The amount of accumulation and availability for transport varies with land use type and season. The HSPF/NPSM model allows a maximum accumulation of bacteria to be specified. The maximum accumulation was adjusted seasonally to account for changes in bacteria die-off rates, which are dependent on temperature and moisture conditions. Direct loads such as those from straight pipes are modeled similarly to point sources, since they do not require a runoff event for delivery to the stream.

3.6 TMDL Allocation Scenarios

The TMDL IP (DCR and DEQ, 2005) provided an overview of the TMDL allocation scenario based on 2001 conditions. The load reductions provided in the 2002 TMDL included 100 percent reductions in direct deposition from cattle from Subwatershed 3, the only subwatershed shown to have cattle present; a 100 percent reduction in septic, straight pipe, and sewer leakage; a 30 to 50 percent reduction in bacteria from low-density and medium-density residential and urban land; and a 30 percent reduction in grassland/pasture. (An 85 percent reduction was assigned to Subwatershed 9 due to the presence of an active stockyard.) These reductions met the 2002 TMDL that was based on the fecal coliform standard.

Since the TMDL was developed in 2002, the water quality standard has changed from fecal coliform to *E. coli,* which has increased the reductions required for each source necessary to achieve the TMDL goal. Adjustments have been made in the TMDL to reflect the increased load reductions needed to meet the revised standard. In this 2012 IP update, additional updates were made to fecal coliform production rates (see Section 4.3), land use data and associated pollutant loads, household and population estimates, existing septic/sewer system upgrades, and stormwater and agriculture BMPs (see Section 4.2).

Table 3.5 provides an overview of the reductions by land use needed to meet the revised *E. coli* TMDL based on existing conditions in the watershed in 2012 and conditions in the watershed when the TMDL was completed in 2002.

Table 3.5 Bacteria reduction scenario for Moores Creek TMDL (updated 2012).

Date	% Reductions by Land Use							
	Forest	Water	Pasture	Low Density Residential	Medium Density Residential	Urban	Direct Loads	Total Loads
2002 TMDL	2%	0%	67%	64%	78%	70%	87%	62%
2012 Revision	0%	0%	48%	59%	83%	81%	87%	56%

3.7 Implications of TMDLs on the Implementation Plan

Based on the bacteria reductions developed for the TMDL and updates made in support of the IP revision, it is clear that significant reductions from anthropogenic sources will be needed in order to meet the *E. coli* standard. This includes 100 percent correction of uncontrolled discharges from septic systems, exclusion of 100 percent of livestock from streams, and significant behavioral modifications from pet owners to address bacteria from pet waste. Reductions in wildlife sources are not explicitly addressed by this implementation plan. Section 4 provides an overview of the changes made to the 2002 model to update the IP, and Section 6 describes the final scenario selected for this IP update.

4. Description of the IP Revision Process

Section 4 provides detail on how the 2002 TMDL model was updated to reflect current (2012) conditions in order to determine the additional reductions needed to meet the TMDL water quality goal.

4.1 Background

RRBC contracted with Virginia Tech's Department of Biological Systems Engineering (VT-BSE) in May 2012 to run the HSPF/NPSM model to simulate flow and the fate and transport of *E. coli* bacteria in the Moores Creek watershed for this 2012 IP update. RRBC worked with its partners to obtain data necessary to create a baseline of current conditions in the Moores Creek watershed. Partners providing information, date, and input to this 2012 IP included DEQ, DCR, Virginia Department of Health (VDH), City of Charlottesville, Albemarle County, UVA, Albemarle County Service Authority (ACSA), TJPDC, Thomas Jefferson Soil and Water Conservation District (TJSWCD), and Rivanna Regional Stormwater Educational Partnership (RRSEP). In order to select a scenario that would meet the revised 2011 TMDL, partners reviewed several options provided by VT-BSE and compared these options with the updated model data (i.e., "baseline conditions"). RRBC and staff from the City of Charlottesville, Albemarle County, UVA, and ACSA worked together to provide input to the modeling effort to create the most feasible scenario for types and numbers of BMPs applied to residential land uses (pet waste management and stormwater BMPs on low-density, medium-density and urban residential land). RRBC, DCR, and TJSWCD collaborated to develop a feasible scenario for the grassland/pasture land use in the watershed. RRBC, ACSA, City of Charlottesville, TJPDC, and

VDH worked together to identify sewer upgrades since the 2002 TMDL, and to identify plans for future septic-to-sewer conversion planned in the future.

As a result, this IP update includes and defines a baseline of current conditions (land use; number and type of BMPs implemented since 2002; septic/sewer conversions since 2002). This update also models TMDL goal achievement based on the *E. coli* standard (as opposed to the fecal coliform standard used in 2002).

4.1.1 2002 Bacteria TMDL IP

In response to the 2002 TMDL, TJPDC completed the *Moore's Creek Fecal Coliform TMDL Implementation Plan* in 2003, which was approved by the State Water Control Board in 2005. Appendix C provides the executive summary of the *Moore's Creek Fecal Coliform TMDL Implementation Plan*.

The IP was submitted to EPA by DCR for formal review in 2011. Feedback from the EPA review of the IP was received on January 31, 2012 (see Appendix D). EPA noted that some of the components required in order to be eligible for Section 319 funding were missing or incomplete, and that it would be necessary to revise the IP in order for the plan to be eligible to receive Section 319 funding. In addition, EPA requested that the IP to include the revised (2011) TMDL and BMPs implemented since the 2002 TMDL was approved.

This document has been developed in order to meet EPA's requirements as stated in Appendix E so that 319 funds for implementing BMPs in the Moores Creek watershed may be released.

4.2 Overview of IP Updates

4.2.1 Land Use Update

The land use data used in the 2002 TMDL was developed by TJPDC in October 2001 and was based primarily on aerial photographs taken in March 2000 (DCR and DEQ, 2005), and was supplemented by a 1993 TJPDC land use study that utilized information dating back as far as 1987 (DCR and DEQ, 2002). Building on this older land use data, land uses were delineated visually and digitized manually from the aerial photographs. Automated classification methods were not employed. The result was 21 land use classes, many of which were based on zoning and other use data not observable directly from photographs. These were then condensed down to six major land uses according to similarities in hydrologic properties and fecal coliform bacteria loads (DCR and DEQ, 2002).

To update the land use for the 2012 IP update, RRBC visually inspected and compared 2002 and 2009 Virginia Base Mapping Program (VBMP) orthographic aerial imagery with the March 2000 land use data that was used in developing the 2002 TMDL and 2005 IP (Table 4.1). By doing so, RRBC was able to determine those areas consistent with the classification developed from March 2000 imagery and in which no visible changes between 2002 and 2009 were observed. Likewise, this same process was also used to identify those areas in the 2009 imagery either inconsistent with the March 2000 land use classification or that showed major and obvious changes in land cover or land use between 2002 and 2009.

Table 4.1 Land use comparison for Moores Creek watershed.

2000 vs. 2009 Land use comparison							
Date (units)	**Grassland**	**Forest**	**Low Density Residential**	**Medium Density Residential**	**Urban**	**Water**	**Total**
2000 (ac)	3,302	12,579	2,195	1,913	2,218	181	22,388
2009 (ac)	3,300	12,246	2,197	2,072	2,392	181	22,388
% Change	-0.01%	-1.49%	+0.01%	+0.71%	+0.78%	0%	0%

Though the percent change across the entire Moores Creek watershed was small, some subwatersheds showed more than a five percent changes in one or more land use. For this reason, the updated 2012 land use distributions per subwatershed were used as input for the revised 2012 HSPF/NPSM model runs rather than those from 2000.

The changes identified were primarily the result of new residential subdivision development in the Albemarle County urban ring around Charlottesville and, to a lesser extent, institution and commercial expansion. There was some redevelopment and in-fill development during the 2002 to 2009 interval between air photos in areas previously identified as developed area. However, this was not of such a degree that neighborhood housing density was greatly increased or the land use classification changed (except in cases where the redevelopment encroached upon areas previously classified as forest or grassland). Areas that showed land use change were digitized manually and assigned a new land use based on visual similarity to unchanged surrounding areas of housing density, structure and parking lot size, and tree cover. Table 4.1 provides an overview of land use acres in the Moores Creek watershed, and Figure 4.1 provides a map of the land use by subwatershed.

Table 4.2 2009 Land use acreages and percent total watershed acreage in the Moores Creek watershed (VBMP, 2008).

Land use acres (% total acreage)							
	Grassland	**Forest**	**Low Density Residential**	**Medium Density Residential**	**Urban**	**Water**	**Total**
Acres	3,300	12,246	2,197	2,072	2,392	181	22,388
% Total Acreage	(15%)	(55%)	(10%)	(9%)	(11%)	(<1%)	(100%)

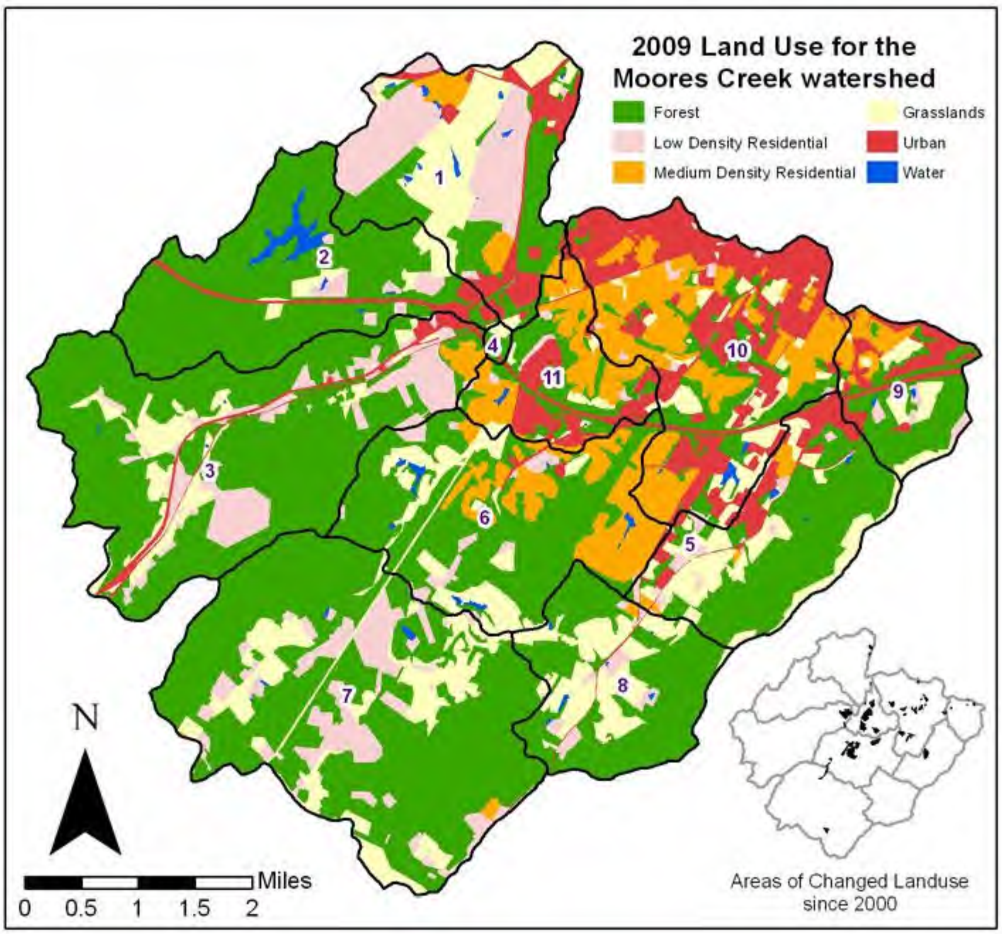

Figure 4.1 Land uses in the Moores Creek watershed.

4.2.2 Residential Information Update

<u>Number of Households</u>

The number of households in the Albemarle County portion of Moores Creek watershed including those on UVA-owned lands was estimated using April 2012 GIS data obtained from Albemarle County. These data included building footprints and detailed parcel-level data that included the number of "addressable" major structures and the number of dwelling units (by general type) in all the structures on each parcel. If a parcel straddled subwatersheds, dwellings in that parcel were assigned to a subwatershed based on the location of the building footprint and assumed location of possible septic drainage fields (if not served by public sewer).

The methodology for determining number of households in the City of Charlottesville was different because Charlottesville did not have similar dwelling unit data. The total number of city households was estimated using 2010 Census block data for Charlottesville's portion of the Moores Creek watershed. The total number of households was then apportioned to the subwatersheds in the same ratio as the Charlottesville April 2012 building footprint data layer. From this apportionment, the number of Charlottesville households per subwatershed was derived.

<u>Households on Septic and Sewer</u>
The number of households using septic systems and the number on public sewer (Table 4.1) was estimated using the following sources and types of information:

1. The number of households per local jurisdiction (Charlottesville, Albemarle County, UVA) per subwatershed;
2. Charlottesville households (address list) not connected to public sewer;
3. Charlottesville parcel zoning data (used to exclude commercial and other non-residential septic properties;
4. VDH cost-share septic repair permit database used to geolocate addresses associated with approved septic repair permits within Charlottesville;
5. UVA properties served by septic systems;
6. ACSA jurisdictional areas showing where connection to public water and sewer is possible;
7. GIS shapefiles of ACSA sewer lines and water meters (used to determine county parcels currently being served by public sewer); and
8. ACSA's current and future Capital Improvement Plan (CIP) project maps (used to identify expected sewer connection status at the time of completion of ACSA's 2012 CIP construction projects).

Table 4.3 Households and septic and sewage systems in the Moores Creek watershed

Date	2002	2012
Households	9,439	15,883
Households with Public Sewer	8,284	14,721
Households with Septic	1,155	1,172
% with Septic	12.2	7.4

The average household size for all 2010 Census blocks at least partially within the Moores Creek watershed was 2.27 people per household (excluding group housing). This is consistent with the 2010 Census that reported the average household size for all of Charlottesville at 2.3 people per household (owners and renters) and for all of Albemarle County (2.2 for owners, 2.4 for renters). As a result, the conversion factor of 2.3 was used to assign people living in group housing (dorms, prisons, shelters) to household-equivalent units for the purposes of modeling 2012 sewer and septic fecal loads.

4.2.3 Existing Stormwater BMPs Update

The City of Charlottesville, Albemarle County, and UVA provided structural stormwater BMP data for their respective jurisdictions in April 2012 in tabular and spatial formats (Table 4.4). Tabular data included description of the type of BMP, date of construction or design plan submission, number of acres treated by the BMP, and the percentage impervious to total area treated. Spatial data were provided as GIS shapefiles of point locations for each BMP and as polygons of the area treated by each BMP or collection of BMPs. Based on discussions between the project team, each BMP was categorized as BMP types used by the EPA-Chesapeake Bay Program (Devereux and Rigelman, 2012) for which sediment removal efficiencies were available (see Table 6.8). Based on DCR guidance, sediment removal efficiencies were used as proxies for fecal coliform removal efficiencies.

In addition, two of the BMP types were further subcategorized to clearly distinguish between various types of bioretention and types of underground or dry detention stormwater practices. This was necessary for a number of reasons: cost estimates for these practices varied widely; current levels of implementation varied; and site requirements for these BMPs differ from site to site in this region. Identifying these practices separately provided more detail to local staff when evaluating model results and planning for future implementation.

Table 4.4 Stormwater BMP acres treated from 2002 – present.

BMP	Acres Treated Since 2002 TMDL
Bioretention/raingardens	157
Bioswale	30
Dry Detention Ponds	169
Dry Extended Detention Ponds	112
Hydrodynamic Structures	14
Permeable Pavement	0.5
Urban Filtering Practices	4
Urban Infiltration	3
Wet Ponds and Wetlands	915
Total	**1,404.5**

Each BMP was assigned to a subwatershed using GIS. To determine the type(s) and acreage(s) of land use treated by each BMP, the area treated by each BMP was overlaid with 2009 land use data. In some cases, visual inspection of the surrounding landscape was used to identify and assign the TMDL land use type treated by the BMP to a land use consistent with those in the Chesapeake Bay model.

4.3 Fecal Coliform Production Rates Update

Fecal coliform production rates from beef cows, geese and deer were modified to be consistent with production rates cited in current literature and those commonly used in bacteria TMDLs in Virginia (DCR and DEQ, 2007; DEQ, 2008; and DEQ, 2007) (Tables 4.5-4.9). These fecal coliform production rates were considered during the 2002 TMDL study and listed as an alternative in that study. Upon revisiting the 2002 TMDL, it was determined that production rates used for wildlife were extremely high, while rates for livestock were much lower than commonly used values. After consulting with project partners, it was determined that these rates should be modified to more accurately reflect conditions in the watershed and associated load reductions needed to meet the water quality standard.

Table 4.5 Annual nonpoint source fecal coliform bacteria load in the Moores Creek watershed by land use category used in the 2012 IP update.

Source Category	Land-use type	Total fecal coliform bacteria load (cfu/yr)
Land-based sources	Urban	9.11E+14
	Low density residential	5.23E+14
	Medium density residential	2.20E+15
	Grassland	3.77E+15
	Forest	9.40E+14
Direct sources	Direct deposition (straight pipes, wildlife and livestock)	1.63E+13

Table 4.6 Fecal coliform production rates used in the 2002 TMDL model run and the 2012 IP update model run.

Animal	Daily Fecal Coliform Production (10^6 cfu/day)	
	Original (2002)	Revised (2012)
Beef cow	20,739	33,000
Deer	7,720	347
Goose	1,710	130

Table 4.7 Simulated annual fecal coliform loads used in the 2002 TMDL model run and the 2012 IP update model run.

Date	Total Land Load (cfu/yr)	Total Instream Load (cfu/yr)	Total Load (cfu/yr)
2002 TMDL	1.07E+16	1.81E+13	1.08E+16
2012 Revision	9.72E+15	1.63E+13	9.74E+15

Table 4.8 Comparison of fecal coliform simulations to observed statistics.
Note: Values for the original predictions and observed statistics are listed in Table 5.6 of the 2002 TMDL report.

Objective	Predictions		Observed*
	Original (2002)	Revised (2012)	
Percentage below 200 cfu/100ml	50.1%	47.1%	42.2%
Percentage above 1000 cfu/100ml	18.2%	17.1%	14.5%
Total Contribution of Wildlife	40.1%	16.9%	35% to 72%
Total Contribution of Livestock	34.1%	58.1%	12% to 30%
Total Contribution of Dogs	19.4%	20.3%	4% to 24%
Total Contribution of Humans	6.4%	4.8%	2% to 17%

*Observed data refers to the original October 1996 through August 2001 monitoring data against which the original model was calibrated.

Table 4.9 Comparison of the distribution of fecal coliform loads instream and by land use.

Date	Instream	Forest	Low Density Residential	Medium Density Residential	Urban	Pasture	Water
2002 TMDL	0.2%	23.5%	9.0%	18.9%	5.6%	42.7%	0.1%
2012 Revision	0.2%	9.8%	6.1%	17.5%	6.1%	60.2%	0.1%

5. Public Participation

Collecting input from the public on conservation and outreach strategies to include in the TMDL IP is a critical step in the planning process. Since the plan is implemented by watershed stakeholders primarily on a voluntary basis, local input and support are the primary factors that will determine the success of this plan. Public input was solicited during the development of the initial implementation plan (2002-2003) as well as during the revision process during 2012.

5.1 Public Participation during the Development of the 2005 TMDL IP

5.1.1 Public Meetings

The first public meeting for the development of the *Moore's Creek Fecal Coliform TMDL Implementation Plan* (DCR and DEQ, 2005) was held November 17, 2003, at the TJPDC offices in downtown Charlottesville. The following methods were used to advertise this public meeting:

- Public notice in the Virginia Register on November 3, 2003
- Notice on the TJPDC website
- Email to large distribution list that included elected and appointed officials and representatives of numerous environmental groups
- Listings in local events calendars
- Letters mailed to every landowner along Moores Creek or one of its major tributaries.

Presentations by Robert Brent of DEQ, Rochelle Garwood of TJPDC, and Michael Bowman of DCR covered background information on the TMDL, the parts of an implementation plan, and elements for a successful implementation plan. About 15 people attended, primarily members of the TMDL implementation plan technical committee (see Section 5.2). Copies of the presentation materials were made available at the meeting and were also posted on the TJPDC website. The public comment period ended on December 17, 2003. No written comments were received.

The second public meeting was held December 9, 2004, also at the TJPDC offices. This meeting was also advertised in the Virginia Register on November 15, 2004. The meeting was publicized using the same methods as above – with the addition of the following:

- Posting of signs throughout the watershed
- Radio public service announcements
- Listings in local newspapers calendars of events
- Special announcement at a well-attended presentation on Charlottesville's streams.

Despite these efforts, only members of the technical committee and staff members from TJPDC, DEQ and DCR attended this meeting. There was a formal presentation of the draft plan, followed by a discussion between state agency staff and members of the technical committee that included identifying options for funding for implementation of the plan.

5.1.2 Technical Committee

The technical committee assembled for the 2005 TMDL IP included representatives from:

- Albemarle County
- ACSA
- City of Charlottesville
- Albemarle Farm Bureau
- Virginia Farm Bureau

- The Nature Conservancy (TNC)
- RWSA
- Southern Environmental Law Center
- TJSWCD
- UVA
- VDH
- A local developer
- An interested citizen from the Belmont neighborhood (in the City of Charlottesville portion of the Moores Creek watershed)

The initial technical committee meeting was held on November 26, 2003. At this point, the committee was still not fully formed, and organizational discussion topics included recruiting additional membership and whether to form subcommittees. Members present at this meeting felt that the technical committee would never be sufficiently large to support breaking into smaller groups and that too many of the members had interests that crossed potential subcommittee boundaries. The convening of a citizens committee was considered as a possibility for later in the process when the draft implementation plan could be used as the basis for discussion. Committee members reviewed TMDL allocations by subwatershed, discussed sample IPs from other watersheds, and reviewed a table of allowable BMPs from the *Guidance Manual for Total Maximum Daily Load Implementation Plans* (DCR and DEQ, 2003). Members were encouraged to bring to the next meeting any plans that their agencies had already completed that overlapped or intersected with the implementation planning process for Moores Creek.

The technical committee met for the second time on January 7, 2004. The group discussed Albemarle County's recently completed stream assessment in which county staff walked approximately 100 miles of stream corridor, including Moore's Creek and many of its tributaries, and documented items that may contribute to stream degradation (such as streambank erosion and potential illicit discharge sites).

When the committee met again on February 20, 2004, the group reviewed potential BMPs for inclusion in the implementation plan. Members also looked over maps showing the bacterial counts and the source tracking from the bacterial source tracking study (Wiggins, 2001). They were surprised by the high percentage of bacteria attributed to goats. Based on their local knowledge, it was decided that the goats' contribution was an anomaly.

On April 15, 2004, the committee reviewed an expanded BMP table and discussed whether it was time to convene a citizen's committee. The consensus was that the BMP table was quite complete and that the most important input was whether citizens who were most directly affected by where the BMPs would be located would be receptive to these locations. The committee decided that the best course of action would be to address this directly with the stakeholders that would be affected.

The May 5, 2004, technical committee meeting was used for a final review of the BMP table and discussion of funding sources. The stream buffer and restoration projects proposed based on the Albemarle stream assessment appeared to have the most options for funding, and septic rehabilitation and sewer extension were identified as being the more difficult to achieve. Results of a field survey of livestock in the watershed revealed that there was considerably less livestock in Moores Creek watershed in 2004 than had been reported in the 2002 TMDL. A subcommittee was created to look more closely at the stream buffer and restoration projects and potential livestock BMPs to see how many could be co-located.

The final meeting of the technical committee was on October 19, 2004. The first draft of the IP was the major topic for discussion. Committee members provided initial comments and were encouraged to e-mail more detailed comments. Many committee members did so.

5.2 Public Participation during the Development of the TMDL IP Update

When the 2012 update to the implementation plan for Moores Creek bacterial TMDL commenced, there was not adequate time or funding to conduct an extensive public participation process. However, based on EPA's review of the *Moore's Creek Fecal Coliform TMDL Implementation Plan* (DCR and DEQ, 2005), and with guidance from the state agencies, it was determined that working closely with stakeholders and representative organizations that could guide implementation would be the most effective strategy to update the plan based on sound local input. Thus, public participation was focused on recruiting a well-rounded technical committee that represented all sectors.

In addition, considerable efforts were made to incorporate input received through a number of related, ongoing initiatives in the watershed including the development of the benthic (sediment) "Charlottesville streams TMDL" (Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch). The team assembled by RRBC to implement the DCR Nonpoint Source Pollution Implementation Grant 319-2011-P07-PT has been instrumental in providing opportunities to educate and inform the public about the different water quality issues in these watersheds and to encourage public participation in the planning and implementation phases of both projects.

Additional outreach was conducted to the residents of the Moores Creek watershed in support of ongoing implementation efforts. While the primary objective to this outreach was to make landowners aware of cost share opportunities for BMPs that were currently available or would be available following completion of the 2012 IP update, information about water quality in Moores Creek and the IP revision process was also shared with the local community. Following the award of the grant to RRBC and its partners, the project has been the subject of several press releases, public announcements, and TV, radio, and print stories. These are enumerated in Appendix D. TJSWCD, which is responsible for implementing the agricultural, septic and pet waste cost share components of the grant, issued a notice to the community about the availability of funds. StreamWatch, a community partner and sub-awardee that is undertaking supplemental bacteria monitoring in Moores Creek, also has launched a Rivanna watershed-wide bacteria monitoring program, which has included significant outreach through the StreamWatch network of volunteers and water quality stakeholders.

The following organizations participated on the technical committee convened to help update the 2012 TMDL IP and to ensure that the plan reflected current conditions and planned activities in the watershed:

- Albemarle County
- ACSA
- City of Charlottesville
- TJSWCD
- RRSEP[1], staffed by TJSWCD
- RWSA
- UVA
- DCR
- DEQ
- VT-BSE

Urban/Residential Technical Committee

An urban/residential technical committee was formed by the partners listed above in order to review urban/residential BMP information including BMPs to address stormwater and pet waste. This technical committee met two times at the RRBC office and met twice during meetings for the Charlottesville streams (benthic) TMDL. The technical committee communicated extensively via email and conference calls during the development of the implementation scenarios for this IP update. The final implementation scenario selected for Moores Creek underwent three reviews by the committee, which provided extensive input on BMPs included in the scenario, the extent of implementation of each practice, average BMP costs, and a timeline for implementation in the watershed. For example, the committee discussed if dry extended detention ponds will continue to be used in same frequency in the upcoming years. It was decided that more innovative BMPs such as bioretention, bioswales, and urban filtering will increasingly be selected in lieu of dry extended detention ponds. The committee also discussed the practicality and improved efficiency that would result from retrofitting existing dry detention ponds to act as dry extended detention ponds.

The first meeting of the technical committee was held June 22, 2012, and was used to review the initial stormwater BMP scenario provided by VT-BSE that would, in conjunction with reductions from residential and agricultural sectors, meet the bacteria load reductions required by the TMDL. This first scenario would have required up to 70 percent load reductions from agriculture and urban sectors as a result of the change from fecal coliform to *E. coli* as the basis for bacteria TMDLs in Virginia.

This initial scenario was based on the same fecal coliform loading rates from wildlife that were used in the 2002 TMDL and meant that urban stormwater BMPs would be required to reduce the loading from wildlife in addition to human sources. However, it was noted that the 2002 wildlife loading rates are much higher than those currently being used in Virginia for TMDL development. Concerns were expressed by local government representatives regarding the costs

[1] The Rivanna Regional Stormwater Educational Partnership was formed in 2004 to cooperatively implement the following minimum control measures: public education and outreach on stormwater impacts; public involvement and participation; illicit discharge detection and elimination; and pollution prevention/good housekeeping for municipal operations. RRSEP includes membership by Albemarle County, Albemarle County Public Schools, the City of Charlottesville, Piedmont Virginia Community College, RWSA, UVA, and the Virginia Department of Transportation.

and practicality of implementing a very high number of urban stormwater BMPs in order to address, in effect, the entire wildlife load.

Specific BMP costs also were discussed during this meeting and finalized during the second meeting of the technical committee. The committee evaluated the high cost of permeable pavement per the treated acreage and the unlikelihood that permeable pavement being utilized as a BMP at its present cost. The committee decided to reduce the amount of permeable pavement included in the IP and selected an appropriate cost to treat a square foot based on costs used on actual implemented projects in the local area.

The second meeting of the technical committee was held July 3, 2012. Based on guidance from DCR, the group agreed that using more current wildlife loading rates would be the best way to move forward and recommended that the scenario be revised using current wildlife fecal coliform rates (see Section 4.3). The technical committee also discussed several innovative ways to reduce bacteria loading in the watershed (see Table 7.3).

The technical committee was emailed the second scenario for review on July 5, 2012. VT-BSE incorporated comments provided by the technical committee, updated the fecal coliform rates, and re-ran the scenario. Specific changes recommended were to: 1) decrease the number of acres treated using permeable pavers; 2) decrease the number of acres treated by dry extended detention ponds; and 3) increase the number of acres treated using the following other BMPs:

- Bioretention/raingarden
- Bioswale
- Urban filtering practices
- Urban infiltration
- Vegetated open channels

The third scenario was emailed to the technical committee on July 11, 2012, for review. Based on feedback from the committee, the third scenario is incorporated into this IP update.

<u>Agricultural Technical Committee</u>
To develop and review the suite of agricultural BMPs necessary to meet the load reductions defined by the TMDL, RRBC conferred with staff from TJSWCD and DCR. DCR staff collected additional information on BMPs to address horse farms and associated pollutant loading from several Soil and Water Conservation Districts in the northern Shenandoah Valley. TJSWCD staff was consulted regarding livestock estimates, fencing estimates, and land use estimates. In addition, TJSWCD staff and other members of the RRSEP were consulted regarding the residential (pet waste) components of this 2012 IP update.

<u>Charlottesville Streams TMDL Technical Committee</u>
Most of the members of the Moores Creek bacteria TMDL technical team also were serving on the implementation advisory team for the Charlottesville streams TMDL. There was considerable discussion of how implementation strategies for both TMDLs could be coordinated. Meetings held for the Charlottesville streams TMDL were convened by DEQ on June 14, 2012, and July 10, 2012. Discussions relevant to both TMDLs included how to establish the costs of stormwater

BMPs and how best to craft the timeline for milestone implementation for both TMDLs, since the two plans have considerable overlap with respect to BMP implementation and education and outreach. The final milestone schedule for this 2012 IP update is included in Section 6.

Moores Creek TMDL Implementation Grant Partnership

The DCR Nonpoint Source Pollution Implementation Grant 319-2011-P07-PT was awarded to RRBC and its grant partners, TJSWCD and RRSEP, StreamWatch, and TJPDC. The "grant partnership" includes many other organizations, which come together on a quarterly basis to discuss and coordinate projects in the Moores Creek watershed. Other groups and agencies participating on the partnership team are:

- ACSA
- Albemarle County
- City of Charlottesville
- DCR
- DEQ
- James River Association
- Piedmont Environmental Council
- Rivanna Conservation Society
- Rivanna Water and Sewer Authority
- TJPDC
- TJSWCD
- UVA
- VDH

The Rivanna Conservation Society, Piedmont Environmental Council, and James River Association are citizen-based environmental groups in the region. StreamWatch is the Rivanna-based citizen-monitoring program. Through these four organizations, considerable publicity about the update to the Moores Creek IP and implementation of its first phase through the DCR Nonpoint Source Pollution Implementation Grant 319-2011-P07-PT has been generated.

This implementation plan has been reviewed by the technical committees and grant partnership team members. The RRBC, a public body created by Virginia statute, also has made this document available for review and comment by its commissioners, elected officials and appointed citizens from the Rivanna watershed. RRBC is served by its own technical advisory committee that includes staff members from the four Rivanna localities (including the City of Charlottesville, Albemarle County, and UVA) as well as technical experts in hydrology, stream ecology, and stormwater management. Comments from members of this technical advisory committee have also been solicited.

6. Implementation Actions

An important part of the IP is the identification of specific BMPs and associated technical assistance needed to improve water quality in the watershed. Since this plan is designed to be implemented by landowners on a voluntary basis, it is necessary to identify management practices that are both financially and technically realistic and suitable for this particular community. As part of this process, the costs and benefits of these practices must be examined and weighed. Once the best practices have been identified for implementation, an estimate of the number of each practice that would be needed in order to meet the TMDL water quality goals is made and used as the basis for confirming achievement of water quality goals by modeling the results.

6.1 Identification of Best Management Practices

Stormwater BMPs implemented since the development of the 2002 TMDL were assessed and credited towards implementation goals (see Table 4.4). One agriculture BMP installed since the development of the 2002 TMDL also was credited. Additional BMPs required to achieve the updated *E. coli* TMDL based on revised fecal coliform loading rates were discussed by the technical committee (see Section 5.2). Some of the BMPs, such as livestock exclusion, were included by necessity in order to meet the water quality goals established in the 2002 TMDL. Others were selected through a process of technical committee review. These measures are discussed in sections 6.1.1 and 6.1.2, respectively.

6.1.1 Control Measures Implied by the TMDL

The reductions in bacteria identified by the 2002 TMDL study dictated some of the control measures that must be employed during implementation in order to meet the pollutant reductions specified in the TMDL.

<u>Livestock Exclusion</u>
In order to meet the necessary bacteria reductions in direct deposition from livestock, some form of stream exclusion is necessary. Fencing is the most obvious choice; however, choices exist for the type of fencing, distance from the stream bank, and most appropriate management strategy for the fenced pasture. While it is recognized that farmers will want to minimize the cost of fencing and the amount of pasture lost with this BMP, the inclusion of a streamside buffer strip helps reduce bacteria, sediment and nutrient loads in runoff. The incorporation of effective buffers (35-foot minimum width) could reduce the need for more costly control measures.

From an environmental perspective, the best management scenario would be to exclude livestock from the stream bank 100 percent of the time and to establish permanent vegetation in the buffer area. This prevents livestock from eroding the stream bank, provides a buffer for capturing the pollutants in runoff from the pasture, and promotes the growth of streamside vegetation, one of the foundations for healthy aquatic life.

From a livestock-production perspective, the best management scenario is one that provides the greatest profit to the farmer. Obviously, taking even a small amount of land out of production can be contrary to that goal. However, a clean water source has been shown to improve milk production and weight gain. Clean water will also improve the health of cattle and horses by decreasing the incidence of waterborne illnesses and exposure to swampy areas near streams. State and federal conservation agencies including DCR and the Natural Resources Conservation Service (NRCS) have recently added several livestock exclusion practices to their agricultural cost share programs that offer farmers greater flexibility in fencing options. It is expected that this increased flexibility will encourage participation by farmers who were previously limited by practical and economic factors such as the cost of replacing washed out fencing or giving up too much pasture for a buffer. These reduced setback fencing practices were included in agricultural BMP implementation scenarios in this plan.

Septic Systems and Straight Pipes

The 100 percent reduction in loads from straight pipes and failing septic systems is a pre-existing legal requirement. This IP update, like the 2005 IP, includes the following corrective actions for straight pipes and failing septic systems: repair of an existing septic system, installation of a septic system where one previously does not exist (straight pipes), and installation of an alternative waste treatment system. It is anticipated that any straight pipes located in the Moores Creek watershed are likely to be located in areas that do not have adequate sites for septic drain fields. In these cases, the landowner will have to consider an alternative waste treatment system.

6.1.2 Control Measures Selected through Stakeholder Review

In addition to the control measures that were directly prescribed by the TMDL, a number of measures were identified by the technical committee to control bacteria from land-based sources in order to meet the TMDL goal. Various scenarios were developed and presented to the technical committee. All scenarios began with the BMPs prescribed by the TMDL, such as excluding livestock and eliminating straight pipes. Next, the BMPs included in DCR Nonpoint Source Pollution Implementation Grant 319-2011-P07-PT and CIP projects provided by Albemarle County and the City of Charlottesville were included. A series of currently utilized BMPs were then evaluated by the technical committee with respect to costs to construct and maintained effectiveness for improving water quality. The majority of agricultural practices considered are included in state and federal agricultural cost share programs that promote conservation. Currently, there is no dedicated source of cost share funding for the urban and residential practices recommended in this plan (see Table 6.12). In order to provide cost share to local landowners and localities that are interested in implementing these practices, additional grant funds will need to be obtained by interested organizations. The allocations of BMPs across sectors are proportional to the amount of bacteria loading calculated by land use.

The final set of BMPs identified for the IP update and their efficiencies are listed in Table 6.1.

Table 6.1 Best management practices and associated pollutant reductions.

BMP Type	Description	Bacteria Reduction	Reference Note
Pet Waste BMPs	Pet waste-to-energy digester	50%	1
	Pet waste composters	100%	1
	Pet waste pick up program	100%	1
	Neighborhood pet waste station	100%	1
	Pet waste education program	75%	3
Septic/Sewer BMPs	Septic tank pumpout	5%	2
	Septic system repair	100%	1
	Septic system replacement	100%	1
	Alternative waste treatment system	100%	1
	Connection to public sewer	100%	1
Stormwater BMPs	Bioretention/raingardens	80%	4
	Bioswale	80%	4
	Dry Extended Detention Ponds	60%	4
	Permeable Pavement	70%	4
	Urban Filtering Practices	80%	4
	Urban Infiltration	95%	4
	Wet Ponds and Wetlands	60%	4
	Vegetated Open Channels	70%	4
	Urban Forest Buffers	50%	1
Agriculture BMPs	Forested Buffer	56%	1
	Livestock Exclusion w/Riparian Buffers (LE-1T)	50(100)%*****	1,2
	Livestock Exclusion w/Reduced Setback (LE-2T)	50(100)%*****	1,2
	Small Acreage Grazing System (SL-6AT)	50(100)%*****	1,2
	Improved pasture management	50%	2

*Direct load reduction efficiency in parentheses

Reference Notes:

1. Removal efficiency is defined by the practice.
2. DCR, 2003
3. Swann, 1999
4. Devereux and Rigelman, 2012

6.2 Quantification of Control Measures

The quantity and subwatershed location of control measures recommended for implementation was determined by conducting spatial analyses, modeling alternative implementation scenarios, and using input from the technical committee. Data on land use, stream networks, and aerial photography were used in conjunction with spatial analyses to develop estimates of the number of control measures recommended in the Moores Creek watershed. Spatial data regarding agricultural and urban/residential best management practices installed in Moores Creek watershed since the TMDL was completed in 2002 was obtained from the DCR Agricultural BMP Database and from UVA, Albemarle County, and the City of Charlottesville. The locations of existing BMPs were used to help determine where additional BMPs might be needed or adopted. In addition, data from Albemarle County, the City of Charlottesville, UVA, VDH, and ACSA and the 2010 Census were used to quantify the number of septic system repairs, replacements, and connections to public sewer required to meet the reductions specified in the TMDL study. These sources along with aerial photos were used to develop estimates of residential on-site waste treatment systems, streamside fencing, and full livestock exclusion systems. The quantities of additional control measures were determined through modeling alternative scenarios and applying the related pollutant reduction efficiencies to their associated bacteria loads.

Implicit in the TMDL is the need to avoid increased delivery of pollutants from sources that may develop over time and from sources that have not been identified as needing a reduction. One potential for additional sources of the pollutants identified is future residential and urban development. Care should be taken to monitor residential development and its impacts on water quality. Where residential development occurs, there is potential for additional pollutant loads from pet waste, failing septic systems, sewer line overflows and leaks.

6.2.1 Agricultural Control Measures

Livestock Exclusion BMPs

In order to meet the bacteria TMDL for Moores Creek, all livestock will need to be excluded from the creek. To estimate fencing needs, the stream network was overlaid with land use and aerial imagery data layers using GIS mapping computer software (ArcView v.8.3). Stream segments that flowed through or were adjacent to land use areas that had a potential for supporting cattle or horses (e.g., pasture) were identified. Aerial imagery was then used to verify land use classifications. If the stream segment flowed through the land-use area, it was assumed that fencing was needed on both sides of the stream. If a stream segment flowed adjacent to the land-use area, it was assumed that fencing was required on only one side of the stream. Not every land-use area identified as pasture has livestock on it at any given point in time. However, it is assumed that all pasture areas have the potential for livestock access. The identified areas of potential access were compared with updated livestock population estimates for each subwatershed to ensure accuracy. Based on information from field surveys conducted in 2005 for the development of the TMDL IP, a 2009 StreamWatch survey of livestock (Murphy, 2011), and input from TJSWCD, it was determined that several subwatersheds no longer had a livestock population. No exclusion fencing was specified for these subwatersheds. Table 6.2 shows the extent of fencing needed in each subwatershed.

Table 6.2 Stream fencing needs summary

Sub-watershed	Total fencing needed (ft)	Total fencing needed (miles)
1	0	0
2	3,224	0.61
3	4,471	0.85
4	0	0
5	6,944	1.32
6	1,575	0.30
7	4,890	0.93
8	4,499	0.85
9	2,163	0.41
10	0	0
11	0	0
Total	**27,766**	**5.26**

Due to the small number of livestock exclusion systems needed in the Moores Creek watershed, it was possible to use county tax parcel boundaries and aerial imagery to define the length of fencing needed and the type of livestock to be excluded (horses or cattle).

In January 2009, a new livestock exclusion practice was introduced as part of the VA Agricultural Cost Share Program. This new practice, Livestock Exclusion with Riparian Buffers (LE-1T), offers 85 percent cost share for stream exclusion and grazing distribution fencing for cattle, for stream crossings, and for the development of alternative water supplies. This practice is only available in targeted TMDL watersheds with implementation plans. Consequently, it was assumed for this 2012 IP update that the majority of cattle exclusion (75 percent) would be accomplished using this practice. It was also assumed that the remaining 25 percent of exclusion systems would be installed using the Livestock Exclusion with Reduced Setback (LE-2T) practice. Like the new LE-1T practice, this practice was also introduced into the state cost share program in 2009 for targeted TMDL areas with implementation plans. This practice requires a 10-ft setback for stream fencing. Cost share at a reduced rate of 50 percent is provided for stream fencing, crossing fencing, and the development of alternative water supplies. It was determined that stream exclusion fencing for horses would be installed through the Small Acreage Grazing System (SL-6AT) practice included in the VA Agricultural Cost Share Program. This practice is only available in targeted TMDL watersheds with implementation plans. Cost share is authorized at a rate of 50 percent for streamside exclusion fencing; establishment of grazing paddocks and walkways to facilitate herd movement from the barn to heavy use areas and grazing paddocks; and the development of alternative water supplies.

The breakdown of number of exclusion systems that are expected to be LE-1T, LE-2T, and SL-6AT systems is shown in Table 6.3. Fencing that was already in place in the watershed was subtracted from the total fencing needs. It was estimated that 10 percent of all fencing installed would need to be replaced during the length of the 11-year implementation project timeline.

Table 6.3 Estimate of streamside exclusion fencing systems needed.

Sub-watershed	LE-1T fencing		LE-2T fencing		SL-6AT fencing	
	Linear feet	Systems	Linear feet	Systems	Linear feet	Systems
1	0	0	0	0	0	0
2	3,224	1	0	0	0	0
3	0	0	4,471	3	0	0
4	0	0	0	0	0	0
5	6,944	1	0	0	0	0
6	0	0	0	0	1,575	1
7	4,064	2	826	1	0	0
8	0	0	0	0	4,499	2
9	2,163	1	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
Total	**16,395**	**5**	**5,297**	**4**	**6,074**	**3**

<u>Land Based Agricultural BMPs</u>
In order to meet the bacteria reductions outlined in the TMDL, reductions of land-based sources by BMPs must also be included in implementation efforts. For modeling purposes, it was assumed that a typical vegetative buffer would be able to receive and treat runoff in the form of sheetflow from an area up to two times its width. For example, a buffer that is 35 feet wide and 1,000 feet long will treat runoff from an area that is 70 feet wide and 1,000 feet long. But, if the area being treated by the buffer is greater than two times the buffer width, it is assumed that runoff is in the form of channelized flow, which vegetated buffers cannot effectively trap. Table 6.4 provides a summary of the land-based agricultural BMPs by watershed needed to achieve water quality goals as modeled in this IP update.

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.

Table 6.4 Land based agricultural BMPs needed to meet bacteria TMDL goal.

BMP	Land use	Acres	Acres Treated
Riparian buffer: 35 ft	Pasture/grassland	18.05	36.10
Riparian buffer: 10 ft	Pasture/grassland	1.22	2.44
Improved pasture management	Pasture/grassland	2,968	2,968

6.2.2 Septic System Control Measures

All straight pipes (pipes directly discharging untreated sewage into the stream) and failing septic systems must be identified and corrected during implementation based on pre-existing legal requirements. The number of failing septic systems was estimated by subwatershed using methodology developed by Raymond Reneau, Jr. from the Crop and Soil Environmental Sciences Department at Virginia Tech:

- Systems installed prior to 1964 = 40% failure rate
- Systems installed between 1964 and 1984 = 20% failure rate
- Systems installed after 1984 = 5% failure rate

These failure rates were applied based on the age of the dwelling to all septic systems for dwellings in the Moores Creek watershed not being served by public sewer. The number of septic systems was calculated from USGS 7.5-min topographic maps that were developed from aerial photos taken from 1963 to 1965 (with photo-revisions in 1972, 1974, 1979 and 1984). This is the same methodology used to calculate failure rates in the 2002 TMDL.

These initial estimates of the number of failing septic systems were then reduced by the number of septic repairs that have occurred in each subwatershed since 2002 as documented by the VDH (Table 6.6) to arrive at the final estimates (Table 6.5).

The number of straight pipes in the watershed was calculated based on the assumption that 1.0% of the oldest (pre-1965) homes were on septic and 0.5 percent of the other homes not on septic have straight pipes.

Table 6.5 Failing septic systems and straight pipes by subwatershed.

Sub-watershed	Estimated Failing Septic Systems	Estimated Straight Pipes
1	37	2
2	7	0
3	37	2
4	0	0
5	7	0
6	21	2
7	33	1
8	15	0
9	3	0
10	0	0
11	0	0
Total	**160**	**7**

Based on input from the VDH and the technical committee, it was estimated that 50 percent of failing septic systems could be repaired and the remaining 50 percent would need to be replaced. Of the 50 percent needing to be replaced 25 percent would be replaced using a conventional septic system and 25 percent would be replaced using an alternative waste treatment system (due to site geology or a lack of space necessary for a conventional drainfield). Using information from local government staff, ACSA and VDH, opportunities for connection to public sewer were also estimated throughout the watershed (Table 6.6). Table 6.6 also shows a breakdown of the septic system and straight pipe replacements needed in the Moores Creek watershed and corrections to failing systems that have been made since the 2002 TMDL was completed (Craun 2012).

Table 6.6 Estimates of corrections to failing septic systems and straight pipes needed within Moores Creek watershed.

	Connection to public sewer (RB-2)*		**Septic system repair (RB-3)**		**Conventional septic system (RB-4)**		**Alternative waste treatment system (RB-5)**	
SW	Complete since TMDL	Still needed	Complete since TMDL	Still needed	Complete since TMDL	Still needed	Complete since TMDL	Still needed
1	1	39	8	0	17	0	1	0
2	0	0	0	3	2	2	0	2
3	0	0	0	19	3	10	0	10
4	0	0	0	0	0	0	0	0
5	0	0	1	4	0	2	0	1
6	59	2	0	11	7	5	0	5
7	0	0	2	17	5	9	0	8
8	0	0	0	7	2	4	0	4
9	0	0	0	1	1	1	0	1
10	0	0	0	0	0	0	0	0
11	0	0	0	0	1	0	0	0
Total	**60**	**41**	**11**	**62**	**38**	**33**	**1**	**31**

*Includes those reported and verified through VDH permits and ACSA CIP projects. ACSA reported 59 sewer-to-septic conversions in Oak Hill Phase I. One additional sewer-to-septic conversion located was located in Subwatershed 1 (switched from residential to UVA Foundation office use).

The ACSA provided a list of CIP projects that for which funding is being sought in the Moores Creek watershed over the next 10 years (Table 6.7). It is estimated that the CIP projects in Subwatershed 1 will result in 305 new sewer connections out of 315 households currently on septic systems and will be effective in capturing all 39 estimated failing septic systems and straight pipes in that subwatershed. It also is estimated that the CIP projects in Subwatershed 6 will result in 21 new sewer connections (of the 310 households currently on septic systems) and will capture 7 percent of the estimated failing septic systems in the subwatershed (2 out of 23 failing systems and straight pipes). The result is that of the 167 estimated failing septic systems and straight pipes in the Moores Creek watershed (Table 6.5), 41 are expected to be corrected by septic-to-sewer conversions as a result of CIP sewer expansion.

Table 6.7 Estimated potential connections to public sewer by neighborhood (Zimmerman, 2012).

Neighborhood	Sub watershed	Estimated # of Connections	Status	Estimated Cost
Oak Hill Phase II	6	21	Planned for 2015	$605,000
Bellair Liberty Hill	1	105	Planned for 2018-2020	$1,969,200
Ednam Forest	1	140	Planned for 2020-2022	$3,774,800
Buckingham Circle	1	60	Planned for 2018	$730,000

6.2.3 Pet Waste Control Measures

In order to address bacteria from domestic pets entering the stream, either through runoff or direct deposition into the stream, one or more methods of pet waste management will be necessary.

An important component of the DCR Nonpoint Source Pollution Implementation Grant 319-2011-P07-PT is the pet waste reduction program, which is being implemented by the RRSEP, a collaborative effort among the local entities that hold stormwater permits under the National Pollutant Discharge Elimination System (NPDES) program. Prior to receipt of this grant, RRSEP was developing a pet waste education campaign for Albemarle County and the City of Charlottesville (where all Municipal Separate Storm Sewer System (MS4) permits in this area are located). Grant funding is being applied specifically to outreach and education in the Moores Creek watershed. In addition, the grant provides cost share funding for pet waste composters for private homeowners.

Pet waste composters, also known as pet waste digesters, come in several different styles. One style is a compact unit that is installed in hole dug in the homeowner's yard. Pet waste is collected and added to the digester along with water and an enzyme that aids in the breakdown of bacteria found in the waste. After sufficient time has been allowed for the breakdown of the material, it can then be applied to flower gardens and trees as a fertilizer. There are some limitations of pet waste composters, including the fact that they do not operate below freezing temperatures. Other pet waste management systems for homeowners are more conventional similar to barrel-type food waste composters.

Pet waste composters may be impractical or undesirable for homeowners who own several acres where their pets are free to roam. However, in areas of more compact residential development in the Moores Creek watershed including the City of Charlottesville and urbanized portions of Albemarle County, they could play an important role in assisting homeowners to implement proper pet waste management and disposal strategies.

During the technical committee meetings, RRSEP discussed the merits of the pet waste composters based on the difficulty in some Virginia localities of recruiting homeowners to purchase and use even discounted composters. A pet waste removal national franchise company, DoodyCalls© that provides homeowners with professional pet waste removal is expanding from northern Virginia into the Charlottesville. This and similar services will likely be an attractive alternative to homeowner management of pet waste.

In addition, the installation of neighborhood pet waste stations was discussed as a method to capture pet waste in subdivisions with homeowners associations that would be willing to assist in financing and maintaining the stations (possibly with support from localities). These stations would be effective in housing developments with larger lots sizes where composters would not be appealing, and in neighborhoods with apartment buildings and very small lots with little grass. It is expected that these and other emerging techniques will be increasingly popular as public consciousness increases about the public health and water quality problems associated with pet waste.

The DCR Nonpoint Source Pollution Implementation grant also includes funding for a pet waste education program and a pet waste-to-energy digester that will be built with the assistance of college and Vocational-Technical Center students. The pet waste-to-energy digester will be located at a public park in the Moores Creek watershed that has a dog run area and is popular with dog-walkers. This large digester will demonstrate how other community groups and localities can implement similar units. Educational materials and signage for proper pet waste management will be developed for use at community events and workshops at pet supply stores and on public and neighborhood bulletin boards. Significant publicity through radio and TV public service announcements (PSA), interviews, newspaper and online features will be used to generate curiosity about and understanding and acceptance of the need to protect our waterways, and Moores Creek in particular, from bacterial contamination from pet waste.

6.2.4 Stormwater Control Measures on Low-Density Residential, Medium-Density Residential, and Urban Land Uses

Land Based Residential and Urban Stormwater BMPs

In order to meet pollutant reductions goals established in the TMDL study, additional controls of nonpoint source pollution from residential and urban land will be required. The technical committee reviewed several scenarios and provided feedback to VT-BSE (see Section 5.2 for details) for the final scenario run (Table 6.8).

Due to the high cost of design and construction of stormwater BMPs, preference should be given to the proactive management strategies to address pet waste discussed in Section 6.2.3. However, Moores Creek also has a benthic impairment in which the primary stressor has been identified as sediment. A TMDL and implementation plan are currently under development to address this impairment, and it is expected that similar levels of stormwater BMP implementation will be necessary to reduce the sediment load sufficiently as would be required for the Moores Creek bacteria TMDL. Consequently, the technical committee determined that it would be wise to develop conservative estimates of pet waste BMPs such as composters, and include a greater number of stormwater BMPs that would work to address both bacteria and sediment. Should project partners find that citizen interest in using pet waste composters, neighborhood pet waste stations, and pet waste collection services is higher than originally anticipated during the first several years of implementation, it is expected that implementation goals will be shifted towards these more cost effective strategies.

Table 6.8 Land based urban and residential stormwater BMPs required to reach TMDL goal.

BMP	Units	Extent Needed
Bioretention/raingardens	ac treated	359
Bioswale	ac treated	284
Dry Extended Detention Ponds	ac treated	93
Permeable Pavement	ac treated	10
Urban Filtering Practices	ac treated	175
Urban Infiltration	ac treated	79
Wet Ponds and Wetlands	ac treated	368
Vegetated Open Channels	ac treated	230
Urban Forest Buffers	ac treated	131

6.3 Technical Assistance and Education

In order to involve landowners in implementation, it will be necessary to continue education and outreach strategies already underway in the Moores Creek and Rivanna watersheds and to provide technical assistance with the design and installation of various best management practices. There must be a proactive approach to contact farmers and residents to articulate exactly what the TMDL means to them and what practices will help meet the goal of improved water quality. The implementation grant specifies a number of outreach and education strategies and techniques that will be utilized during implementation. The following tasks associated with outreach programs were identified and will be undertaken during Phase 1 of the implementation plan, which coincides with the period of the grant:

<u>Agriculture Programs</u>

- Hold informational meetings for farmers to promote cost share availability and BMPs
- Develop and distribute outreach materials for mailings
- Make contact with landowners in the watersheds to make them aware of implementation goals, cost-share assistance, and voluntary options that are available to agricultural producers interested in conservation
- Provide technical assistance for agricultural programs (e.g., survey, design, layout, and approval of installation).
- Organize educational programs (e.g., County Fair, presentations at joint VCE events or club events)

<u>Programs Addressing Septic and Pet Waste Issues</u>

- Develop and distribute septic system education and outreach materials through direct mailings to households
- Identify landowners in older homes in order to identify potential straight-pipes and failing septic systems

- Contact septic pump-out businesses to help disseminate education and outreach materials especially about availability of cost-share programs
- Organize educational programs (e.g., demonstration septic pump-outs and on-site sewage disposal systems, nutrient management, pet waste control, rain barrel workshops)
- Distribute educational materials on bacteria pollution, TMDLs, BMPs, and cost share availability
- Promote programs and cost-share availability through newspaper ads, public service announcements, communication with septic contractors, and posters displayed throughout the watershed
- Design, construct, and install a pet waste-to-energy digester in a public park and develop contest for decoration, naming or adopting the digester
- Work with neighborhood associations to promote pet waste management and install pet waste stations where possible
- Explore opportunities to promote pet waste collection services such as DoodyCalls
- Distribute pet waste composters at workshops and recruit households and individuals to participate
- Use workshops to promote the septic maintenance program

Residential and Urban Stormwater Programs

- Develop educational materials and programs
- Develop and implement a robust maintenance program for stormwater BMPs and infrastructure (storm drains and pipes)
- Provide technical assistance in designing and installing urban stormwater BMPs on private property and public facilities
- Identify funding opportunities for pilot BMP projects

The staffing level needed to implement the agricultural, residential and urban components of the plan were estimated based on discussions with stakeholders and the staffing levels used in similar projects. Staffing needs were quantified using full time equivalents (FTE), with one FTE being equal to one full-time staff member. It was determined that one FTE would be needed to provide the technical assistance (engineering support, inspection services, outreach, program management) needed for agricultural and residential implementation. Based on existing staffing levels for urban BMP maintenance and implementation needs, it was estimated that a minimum of one FTE would be needed to reach urban implementation goals described in this plan.

6.4 Cost Analysis

6.4.1 Agricultural BMPs

The costs of agricultural best management practices included in this IP update were estimated based on data from the DCR Agricultural BMP Database and considerable input from staff of the TJSWCD.

The total cost of livestock exclusion systems includes costs associated with fence installation, repair, and maintenance, plus costs of developing alternative water sources. The cost of fence maintenance was identified as a deterrent to participation. Limited financial assistance is available for maintaining fences include an annual 25 percent tax credit for fence maintenance and an upfront incentive payment on $0.50/linear foot to maintain stream fencing (the WP-2T practice). Typically, the average cost of fence maintenance is significantly higher.

In developing the cost estimates for fence maintenance for Moores Creek, a figure of $3.50/linear foot of fence was used for cattle fencing and $4.00/linear foot for horse fencing. It was estimated that approximately 10 percent of fencing would need to be replaced over the 11-year implementation timeline. Table 6.9 provides a breakdown of fencing system costs for each type of system included in the plan, while Table 6.10 provides a summary of total costs by system type.

Table 6.9 Breakdown of fencing system components and costs

System component		Units	Cost/unit
Stream fencing	5-strand high tensile fence	Feet	$3.50
	Coated high tensile fence (horse farms)	Feet	$4.00
	Electric fence charger	Count	$300
Cross fencing	3-strand high tensile fence	Feet	$2.25
Alternative water source	Well	Count	$6,400
	Pumping plant	Count	$2,400
	Pipeline: 1.25" P.E. (average 1,000 feet/system)	Feet	$3.25
	4-hole frost proof trough (average 2/system)	Count	$1,000
	Frost proof hydrant	Count	$175
Stream crossing	Crossing	Count	$4,500

Table 6.10 Average fencing system costs

System type	Description	Cost share rate	Average system cost	Average extent of fencing/system (feet)
LE-1T	Livestock exclusion with 35-foot buffers	85%	$36,410	3,280
LE-2T	Livestock exclusion with reduced setback (10 foot minimum)	50%	$23,570	1,325
SL-6AT	Small acreage grazing system	50%	$30,873	2,025

Table 6.11 Agricultural BMP implementation costs by practice.

Practice	Cost Share Code	Total
Livestock Exclusion w/Riparian Buffers	LE-1T	$264,877
Livestock Exclusion w/Reduced Setback	LE-2T	$136,786
Small Acreage Grazing System	SL-6AT	$95,855
Fencing maintenance (10% replacement)	N/A	$10,022
Improved pasture management	EQIP 528	$296,800
	Total	**$804,340**

6.4.2 Septic/Sewer and Pet Waste BMPs

Septic system BMP costs were developed based on input from local government staff, ACSA, and local health department staff. These costs are shown in Table 6.12. Unit costs for septic tank pump outs, repairs, replacements, alternative waste treatment systems, and connections to public sewer are based on cost estimates from DCR staff. Pet waste cost estimates, except where otherwise noted, were also provided by DCR and were based on grant-funded projects sponsored by the agency over the past 5 to10 years.

Table 6.12 Residential BMP implementation costs.

Practice	Units	Unit Cost	Implementation Goal	Total Cost
Septic tank pump out	pump out	$250	40	$10,000
Connection to public sewer	connection	$6,000	41	$246,000
Septic system repair	repair	$4,250	62	$263,500
Septic system replacement	system	$8,000	30	$240,000
Septic system replacement with pump	system	$9,000	3	$27,000
Alternative waste treatment system	system	$20,000	31	$620,000
Pet waste digester	system	$8,000	1	$8,000
Pet waste composters	system	$100	60	$7,500
Pet waste pick up program*	program	$750	12	$99,000
Neighborhood pet waste station	system	$320	3	$960
Pet waste education program	program	$5,000	1	$5,000
			Total	$1,526,960

*Cost estimate based on current rates in Alexandria, VA, as of July 31, 2012 (Alexander and Ignaszewski, 2012). Cost is based on pet waste removal services of one dog over the length of the implementation plan (11-years) with an annual pre-pay discount of 10 percent applied.

6.4.2 Stormwater BMPs

Cost estimates for stormwater BMPs were developed based on input from local government staff and information from private contractors and manufacturers (Table 6.12). Cost information was also obtained from the University of Maryland Center for Environmental Science report, *Costs of Stormwater Management Practices In Maryland Counties Draft Final Report* (King and Hagan, 2010).

Table 6.13 Stormwater BMP implementation costs.

BMP	Units	Unit Cost	Implementation Goal	Total Cost
Bioretention	ac treated	$20,000	269	$5,380,000
Raingardens	ac treated	$9,000	90	$810,000
Bioswale	ac treated	$15,000	284	$4,260,000
Dry Extended Detention Ponds	ac treated	$15,000	93	$1,116,000
Permeable Pavement	ac treated	$261,360	10	$2,613,600
Urban Filtering Practices	ac treated	$20,000	175	$3,500,000
Urban Infiltration	ac treated	$20,000	79	$1,580,000
Wet Ponds and Wetlands	ac treated	$10,000	368	$3,680,000
Vegetated Open Channels	ac treated	$9,000	230	$2,070,000
Urban Forest Buffers	ac treated	$3,500	131	$458,500
			Total	$25,468,100

6.4.3 BMP Summary

A summary of the total amount of BMP costs by BMP type is included as Table 6.13. This cost estimate does not include on-going infrastructure maintenance required to prevent future sewer line leakage nor does it include technical assistance required for implementation.

Table 6.13 Total BMP implementation costs.

BMP Type	Total Cost
Agriculture BMPs	$804,340
Septic and Pet Waste BMPs	$1,526,960
Stormwater BMPs	$25,468,100
Total	**$27,799,400**

6.4.4 Technical Assistance

Technical assistance costs were estimated for one full time position (see Section 6.3) using an estimated cost of $50,000 per FTE focusing on agriculture and residential implementation and $75,000 per FTE focusing on urban implementation goals. These figures are based on the existing staffing costs included in the Virginia Department of Conservation and Recreation's grant agreements with soil and water conservation districts across the state provide technical assistance to landowners in TMDL implementation watersheds as well as input from local government staff. Based on an 11-year timeline, this would make the total cost of technical assistance approximately $1,375,000. When factored into the cost estimate for BMP implementation shown in Table 6.13, this would make the total cost of implementation approximately $29M.

7. Measurable Goals and Milestones

Given the scope of work involved with implementing this TMDL, full implementation and de-listing from the Virginia Section 305(b)/303(d) list could be expected within 11 years provided that full funding for technical assistance (two FTEs) and BMP cost share are made available and all urban, residential, and agricultural BMPs are implemented. This section provides a timeline for implementation, water quality and implementation goals and milestones, and strategies for targeting best management practices.

7.1 Milestones Identification

The end goals of implementation are restored water quality of the impaired waters and subsequent de-listing of the waters from the Commonwealth of Virginia's Section 305(b)/303(d) list within 11 years. Progress toward end goals will be assessed during implementation by ongoing water quality monitoring.

Expected progress in implementation is established with two types of milestones: implementation milestones and water quality milestones. Implementation milestones establish the amount of control measures installed within certain timeframes, while water quality milestones establish the corresponding improvements in water quality that can be expected as the implementation milestones are met. The milestones described here are intended to achieve full implementation within 11 years.

This implementation plan update uses a phased implementation approach in which resources and finances will be concentrated first on the most cost-efficient control measures and areas of highest interest. For instance, concentrating on implementing livestock exclusion fencing within the first several years may provide the highest return on water quality improvement with least cost to landowners.

Implementation has been divided up into five different phases where each phase is from 1.5 to 2.5 years long (Table 7.1). The purposes of staging implementation in this way is to: 1) match the DCR Nonpoint Source Pollution Implementation Grant 319-2011-P07-PT grant cycle; 2) coordinate with the Chesapeake Bay TMDL 2017 and 2025 milestones; and 3) match implementation schedule of the Moores Creek, Lodge Creek, Meadow Creek, and Schenks Branch sediment TMDL IP that projects completion in 2025.

Table 7.1 Phases of Moores Creek IP

Phase	Year (% Implemented)	Dates (Years and Date Range)	
1	Year 0-2.5 (CIP and DCR Grant Funded Projects)	2012-2014	1/1/12-12/31/14
2	Year 2.5-4 (10% of Total)	2015-2017	1/1/15-12/31/17
3	Year 5-7 (20% of Total)	2018-2019	1/1/18-12/31/19
4	Year 8-9 (30% of Total)	2020-2021	1/1/20-12/31/21
5	Year 10-11 (40% of Total)	2022-2023	1/1/22-12/31/23

Though this IP update assumes 60 pet waste composters will be distributed (and used) during Phase 1 (Table 7.2). A limited number of neighborhood pet waste stations and pet waste collection service contracts were also included. Since all of these practices are relatively new with respect to pet waste management by private homeowners, the technical committee expects that it will be necessary to revisit these goals after the first several years of implementation in order to determine if some strategies are more appealing to pet owners than others. In addition, the technical committee expects that the extent of pet waste management BMPs may increase in successive milestone phases of implementation, but was reluctant to estimate total extents for each practice until more feedback is collected from participating pet owners. The technical committee will continue to purse different types of pet waste BMPs through RRSEP. The implementation team is focused on eliminating the pollutant at the source before more costly stormwater BMPs are relied upon for bacteria treatment and removal.

For TMDL development in Virginia, water quality modeling is conducted with fecal coliform inputs, and then a translator equation is used to convert the instream fecal coliform concentrations to *E. coli* concentrations to estimate violation rates of the *E. coli* water quality standard. The estimated decrease in violation rates resulting from BMP implementation at each phase are shown in Table 7.2. Table 7.3 lists the estimated nonpoint fecal coliform bacteria loads entering the stream at each phase of implementation.

Table 7.2 Phased implementation goals for Moores Creek.

BMP Type	BMP	Units	Phase				
			1	2	3	4	5
Pet Waste BMPs	Pet waste-to-energy digester	system	1	0	0	0	0
	Pet waste composter	system	60	0	0	0	0
	Pet waste pick up program	program	12*	0	0	0	0
	Neighborhood pet waste station	system	3*	0	0	0	0
	Pet waste education program	program	1*	0	0	0	0
Septic/Sewer BMPs	Septic tank pump out	Pump out	40	0	0	0	0
	Connection to public sewer	connection	1	4	8	12	16
	Septic system repair	repair	4	6	12	17	23
	Septic system replacement	system	2	3	5	9	11
	Septic system replacement with pump	system	1	1	1	0	0
	Alternative waste treatment system	system	1	3	6	9	12
Stormwater BMPs	Bioretention/raingardens	ac treated	2.39	36	71	108	114
	Bioswale	ac treated	2	28	57	85	114
	Dry Extended Detention Ponds	ac treated	0	9	19	28	37
	Permeable Pavement	ac treated	0	0	2	4	4
	Urban Filtering Practices	ac treated	0	18	35	53	69
	Urban Infiltration	ac treated	0	8	16	24	31
	Wet Ponds and Wetlands**	ac treated	40	33	36	99	131
	Vegetated Open Channels	ac treated	0	23	46	69	92
	Urban Forest Buffers	ac treated	0	13	27	39	52
Agriculture BMPs	Livestock Exclusion w/Riparian Buffers	system	5	0	0	0	0
	Livestock Exclusion w/Reduced Setback	system	4	0	0	0	0
	Stream Exclusion w/Grazing Land Management	system	3	0	0	0	0
	Improved Pasture Management on Pasture/ Grassland	acres	0	297	594	890	1,187
	Riparian Buffers	acres	19.27	0	0	0	0
Violations of the Geometric Mean Standard (%)			33	26	4	4	0
Violations of the Instantaneous Standard (%)			24	22	19	17	10
Estimated Cumulative Load Reduction of *E. coli* (%)			28	30	34	41	56

*Activities will be ongoing throughout the entire implementation plan.
** Wet ponds and wetlands' first milestone does not include a 4.6-acre forested wetland installed by Rivanna Water and Sewer Authority in Subwatershed 9 that provide mitigation for impacts to

wetlands resulting from the Ragged Mountain Dam expansion project. The plan is funded, permitted, and under contract and construction is expected to begin in September 2012.

Table 7.3 BMP implementation in Moores Creek: percent implemented and estimated nonpoint source fecal coliform load to the stream by phase.

Phase	Years	% Implemented	Fecal Coliform Load (E+15 cfu/yr)	% Reduction
Baseline*	-	0	8.38	-
1	1-2.5	N/A**	6.01	28%
2	2.5-5	10	5.90	30%
3	6-7	20	5.55	34%
4	8-9	30	4.95	41%
5	10-11	40	3.67	56%

* Based on existing conditions in the watershed in 2012.
** Percent implementation by phase is based on the total number of BMPs minus the CIP projects and DCR grant funded projects included in Phase 1. Once the 2.5-year grant is complete, percent implementation will increase with each phase as water quality monitoring is conducted.

7.2 Targeting

Implicit in the process of a phased implementation is targeting of best management practices. Targeting ensures optimum utilization of limited technical and financial resources.

7.2.1 Targeting Agricultural Implementation

Due to the small number of livestock exclusion systems needed to meet direct deposition reduction goals, targeting strategies for specific subwatersheds were not established for exclusion systems. However, based on the timeline of the DCR Nonpoint Source Pollution Implementation Grant and due to their cost effectiveness, it was determined that exclusion practices would be the focus of agricultural implementation efforts during Phase 1.

7.2.2 Targeting Pet Waste BMP Implementation

The technical committee agreed that outreach for the pet waste education program would be targeted to subwatersheds with the greatest residential population density (Subwatersheds 9 and 11, see Table 7.4), since homeowners with larger lots would less likely to pick up after their pets. However, subdivisions with large lot sizes could be targeted with neighborhood pet waste stations placed in high traffic walking areas.

7.2.3 Targeting Stormwater BMP Implementation

The technical committee recommended a targeted approach to implement stormwater BMPs. The committee identified retrofitting existing large regional detention basins as one of the most cost effective ways to reduce pollutant loading from urban areas. Staff from Albemarle County, Charlottesville, and UVA provided a list of high priority projects including potential retrofits for targeted implementation in several subwatersheds (Table 7.4, Figures 7.3-.5).

Projects from Albemarle County's current Capital Improvement Plan (CIP) and Charlottesville's list of capital projects were also identified. Albemarle County plans to install a bioretention filter at the County Office Building on 5th Street Extended that will treat approximately 2 acres. Charlottesville plans to install a constructed wetlands (40 acres treated) and bioretention (1.6 acres treated) at Azalea Park. Charlottesville also has plans for bioretention (0.44 acres treated) and rainwater harvesting (0.35 acres treated) at the Fontaine Fire Station.

Table 7.4 Targeted urban BMP project ideas by subwatershed (SW)

SW	Subwatershed Description	Targeted Project Description
6	Lower Biscuit Run	Enhancement project for wet pond at Mill Creek. Work with state to implement stream improvements, provide/maintain forested buffers, and install permeable pavement where possible in the to-be-developed Biscuit Run State Park.
7	Upper Biscuit Run Southwest	Work with state to implement stream improvements, provide/maintain forested buffers, and install permeable pavement where possible in the to-be-developed Biscuit Run State Park.
8	Upper Biscuit Run East	Runoff diversion project at Jordan Park.
9	Lowermost Moores Creek	Target the installation of pet waste stations based on housing density.
10	Lower Moores Creek	Projects identified for Tonsler Park through the *Stormwater Stewardship on Public Lands* study. Retrofit dry detention pond (20-acre drainage area) at Avon Street Maintenance Area. Target the installation of pet waste stations based on housing density.
11	Middle Moores Creek	Permeable pavement retrofits in the Olsson Hall/Thornton area and at Rice Hall. Improvements to/conversion of older stormwater management BMPs including: • Basin at corner of Stadium and Alderman Roads (1984) • Gilmer Pond (1996) • Basin at ECC/Police (1999) • Health System Pond (1999) • Hereford College basin (installed in 1993; modified in 2008) Target the installation of pet waste stations based on housing density.

In order to complete these projects, additional financial and technical assistance will be required. A list of potential funding sources is provided in Section 8 of this implementation plan. These projects should be given priority when grant funds are being pursued for urban BMP implementation.

8. Stakeholders and their Role in Implementation

Achieving the goals of this plan is dependent on stakeholder participation and strong leadership on the part of both community members and conservation organizations. RRBC has been working with project partners under DCR Nonpoint Source Pollution Implementation Grant 319-2011-P07-PT since January 2012. DCR staff is responsible for working with TJSWCD and other partners in tracking implementation efforts and evaluating progress. Additional partners will be necessary in order to address urban and residential implementation needs. The following sections in this chapter describe the responsibilities and expectations for the various components of implementation.

8.1 Partner Roles and Responsibilities

8.1.1 Watershed Landowners

Some of the practices recommended in this plan target watershed landowners and thus participation from local farmers is a key factor to the success of this plan. Consequently, it is important to consider characteristics of farms and farmers in the watersheds that will affect the decisions farmers make when it comes to implementing conservation practices on their farms. For example, the average size of farms is an important factor to consider, since it affects how much land a farmer can give up for a riparian buffer. Table 8.1 provides a summary of relevant characteristics of farmers and producers in Albemarle County from the 2009 Agricultural Census. Based on these data, it appears that farming in Albemarle County typically does not yield significant economic returns, though improving land use policy in the County to encourage specialty agricultural products and small-scale produce farming is a priority for the County. However, based on census data, the majority of farmers in the county rely on a secondary source of income. These characteristics will be considered when developing implementation and education and outreach strategies.

Table 8.1 Characteristics of farms and farmers in Albemarle County.

Characteristic	Value
Number of farms	895
Operators identifying farming as their primary occupation	372
Operators identifying something other than farming as their primary occupation	523
Average size of farm (acres)	177
Average net cash farm income of operation ($)	-7,001
Average farm production expenses ($)	39,265

8.1.2 Albemarle County, the City of Charlottesville, and UVA

In order to implement a number of the urban stormwater BMPs included in this plan, continued partnerships with the Albemarle County and the City of Charlottesville as well as UVA will be critical. Retrofitting existing stormwater facilities and installing new stormwater BMPs in the watersheds will need to be done with cooperation between these entities. Maintaining stormwater infrastructure is largely the responsibility university, of city and county staff. Representatives from the two localities and university expressed concerns about the staffing levels that will be needed in order to complete the urban stormwater BMPs prescribed in the plan and ensure enhanced maintenance of existing facilities. Concerns about the cost of contracting with engineers to design a number of these practices also were expressed. Additional funding for engineering support, inspection services, outreach, and program management will be needed to implement this IP. It is expected that partners will explore collaborative funding opportunities providing additional staff and implementation of the urban stormwater BMPs identified in this plan.

8.1.3 Thomas Jefferson Soil and Water Conservation District and the Natural Resources Conservation Service

During the implementation phases, TJSWCD and NRCS will continue to reach out to farmers in the Moores Creek watershed and provide them with technical and financial assistance with conservation practices. These agencies are responsible for promoting available funding and the benefits of BMPs and providing assistance in the survey, design, and layout of agricultural BMPs. TJSWCD and NRCS staff will conduct outreach activities, such as newsletters and flyers, in the watershed to encourage participation in conservation programs. The staff will work with other conservation organizations such as VA Cooperative Extension in these efforts. A residential education program about pet waste will be implemented by the RRSEP, which is coordinated through TJSWCD. RRSEP will distribute information on the importance of picking up after your pet and other activities identified in Section 6.3.

8.1.4 StreamWatch

Data collected during implementation of this 2012 implementation plan will be used to monitor water quality improvements (*E. coli*) and remove the stream from the impaired waters list. Coliscan Easygel® sampling activities provided by StreamWatch, a community based water quality monitoring program, over the next two and a half years will supplement standard DEQ's monitoring activities. Though StreamWatch's sampling method is not approved by DEQ to delist a stream (Level III), these data are qualified at DEQ's Level II and may be used to highlight areas of increased bacteria load that can be targeted for implementation.

8.2 Integration with Other Watershed Plans

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[1] 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

[1] Chapter 5.6 (§ 62.1-69.45 et seq.) of Title 62.1 of the Code of Virginia

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.

Meadow Creek Stormwater Retrofit Prioritization and Implementation

The 2002 Meadow Creek Stormwater Retrofit Prioritization and Implementation report provides an "Immediate Action Plan" that includes the evaluation of existing stormwater management information; design parameter development; and the establishment of a priority list for retrofits in the Meadow Creek watershed. The "Secondary Stormwater Management Plan" calls for the construction of retrofits. The report is a product of the Thomas Jefferson Planning District Commission, partnering with the University of Virginia, the County of Albemarle, and the City of Charlottesville. Funding was sought and received through the Clean Water Act Section 319 funding.

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.

<u>University of Virginia Moore's Creek Stormwater Management Master Plan</u>

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.

<u>Charlottesville Streams Sediment TMDL: Moores (and Lodge) Creek and Meadow Creek and Schenks Branch</u>

VADEQ and its local and state agency partners have been working together since 2010 to complete a concurrent TMDL and TMDL implementation plan to address benthic impairments in Lodge Creek, Moores Creek, Meadow Creek and Schenks Branch. Based on results from the stressor analysis conducted in support of this effort, the primary stressor of the benthic community has been identified as sediment. Efforts were made to coordinate the development of these two implementation plans (one to address sediment and another to address bacteria) throughout the planning process. Similar implementation timelines have been adopted, and BMPs were cross referenced within each project milestone. It is expected that the Charlottesville Stream TMDL implementation plan will becompleted late 2012-early 2013, making coordination of implementation efforts and monitoring implementation progress very achievable.

<u>Chesapeake Bay TMDL Phase II Watershed Implementation Plan</u>

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.

8.3 Monitoring Water Quality

Improvements in water quality and implementation progress will be determined through monitoring conducted through DEQ's ambient monitoring program. This program uses a variety of parameters to determine overall water quality status. Each stream will have a sampling site at a publicly accessible location that will be visited once a month by DEQ monitors.

Additionally, StreamWatch will be conducting Coliscan Easygel® testing at 6 sites on tributaries and upper reaches of Moores (DEQ already monitors two sites in the lower reaches of Moores Creek). Preliminary locations will be on Lodge Creek, Morey Creek, Moores Tributary near the Ragged Mountain Reservoir, Biscuit Run, Upper tributary to Biscuit Run, and Moores Creek along Route 29. StreamWatch will monitor these sites once a month for 12 months and then undertake an initial assessment, consulting with DEQ and the TMDL project partners. At that time, StreamWatch may relocate certain sites if there is a need for other data. The bacteria monitoring project is in conjunction with the Rivanna Conservation Society's "Can you swim here?" initiative, which will provide education and outreach to watershed residents about the presence of bacteria in popular recreational swimming spots.

8.4 Agricultural and Residential Education

Education and outreach is a significant component of any TMDL implementation project. The TJSWCD will be in charge of initiating contact with farmers to encourage the installation of BMPs. This one-on-one contact will facilitate communication of the water quality problems and the types of practices that could improve water quality. The district staff will conduct outreach activities in the watershed to encourage participation in conservation programs. Such activities include mailing out newsletters and organizing field days. Specific agricultural and residential outreach ideas are outlined in Section 6.3.

TJSWCD is a local government entity providing soil and water conservation assistance to farmers and residents of Albemarle County. During the implementation project, the TJSWCD will continue to provide outreach, technical and financial assistance to farmers and homeowners in the Moores Creek watershed through the Virginia Agricultural BMP Cost-Share and Tax Credit programs. Their responsibilities include promoting available funding and the benefits of BMPs and providing assistance in the survey, design, layout, and approval of agricultural BMPs. Education and outreach activities are also a portion of their responsibilities. A pet waste education program consisting of educational materials about pet waste and a pet waste digester program is currently being implemented through a partnership between the TJSWCD, RRSEP, and the Rivanna River Basin Commission.

8.5 Legal Authority

EPA has the responsibility of overseeing the various programs necessary for the success of the CWA. However, administration and enforcement of such programs falls largely to the states. In the Commonwealth of Virginia, water quality problems are dealt with through legislation, incentive programs, education, and legal actions. Currently, there are four state agencies responsible for regulating activities that impact water quality in Virginia. These agencies are DEQ, DCR, VDH, and Virginia Department of Agriculture and Consumer Services (VDACS).

DEQ has responsibility for monitoring waters to determine compliance with state standards, and for requiring permitted point dischargers to maintain loads within permit limits. It has the regulatory authority to levy fines and take legal action against those in violation of permits. Beginning in 1994, animal waste from confined animal facilities that hold in excess of 300 animal units (cattle and hogs) has been managed through a Virginia general pollution abatement permit. These operations are required to implement a number of practices to prevent surface and groundwater contamination. In response to increasing demand from the public to develop new regulations dealing with animal waste, the Virginia General Assembly passed legislation in 1999 requiring DEQ to develop regulations for the management of poultry waste in operations having more than 200 animal units of poultry (about 20,000 chickens) (ELI, 1999).

DCR holds the responsibility for addressing nonpoint source pollution. Historically, most DCR programs have dealt with agricultural NPS pollution through education and voluntary incentive programs. These cost-share programs were originally developed to meet the needs of voluntary partial participation and not the level of participation required by TMDLs, which is usually close to 100%. To meet the needs of the TMDL program and achieve the goals set forth in the CWA, the incentive programs are continually reevaluated to account for this level of participation.

Through Virginia's Agricultural Stewardship Act (ASA), the 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 can include a civil penalty of up to $5,000 per day. 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. VDACS has only two staff members dedicated to enforcing the Agricultural Stewardship Act, and very little funding is available to support water quality sampling. The Agricultural Stewardship Act is entirely complaint-driven.

VDH is responsible for maintaining safe drinking water measured by standards set by the EPA. Their duties also include septic system regulation and, historically, regulation of biosolids land application on permitted farmland sites. Like VDACS, VDH’s actions are 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. In relation to these TMDLs, VDH has the responsibility of enforcing actions to correct or eliminate failed septic systems and straight pipes.

State government has the authority to establish state laws that control delivery of pollutants to local waters. Local governments, in conjunction with the state, can develop ordinances involving pollution prevention measures. In addition, citizens have the right to bring litigation against persons or groups of people shown to be causing some harm to the claimant. The judicial branch of government also plays a significant role in the regulation of activities that impact water quality through hearing the claims of citizens in civil court and the claims of government representatives in criminal court.

8.6 Legal Action

The Clean Water Act Section 303(d) calls for the identification of impaired waters. It also requires that the streams be ranked by the severity of the impairment and that TMDLs be calculated for streams to meet water quality standards. TMDL implementation plans are not required in the Federal Code; however, Virginia State Code does include the development of implementation plans for impaired streams. EPA largely ignored the nonpoint source section of the Clean Water Act until citizens began to realize that regulating only point sources was no longer maintaining water quality standards. Lawsuits from citizens and environmental groups citing EPA for not carrying out the statutes of the CWA began as far back as the 1970s and have continued until the present. In Virginia in 1998, the American Canoe Association and the

American Littoral Society filed a complaint against EPA for failure to comply with provisions of §303d. The suit was settled by Consent Decree, which contained a TMDL development schedule through 2010. It is becoming more common for concerned citizens and environmental groups to turn to the courts for the enforcement of water quality issues.

Successful implementation depends on stakeholders taking responsibility for their role in the process. The primary role, of course, falls on the landowner. However, local, state and federal agencies also have a stake in ensuring that Virginia's waters are clean and provide a healthy environment for its citizens. An important first step in correcting the existing water quality problem is recognizing that there is a problem and that the health of citizens is at stake. Virginia's approach to correcting NPS pollution problems has been, and continues to be, encouragement of participation through education and financial incentives.

9. Implementation Benefits

The primary benefit of implementing this plan will be cleaner water in Moores Creek. Specifically, *E. coli* contamination in the creek will be reduced to meet water quality standards. It is hard to gage the impact that reducing *E. coli* contamination will have on public health, as most cases of waterborne infection are not reported or are falsely attributed to other sources. However, because of the reductions required, the incidence of infection from *E. coli* sources through contact with surface waters should be reduced considerably.

An important objective of the implementation plan is to foster continued economic vitality. This objective is based on the recognition 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, improved pasture management, and private sewage system maintenance will each provide economic benefits to land owners. Additionally, money spent by landowners and state agencies in the process of implementing this plan will stimulate the local economy.

9.1 Agricultural Practices

Restricting livestock access to streams and providing them with clean water source has been shown to improve weight gain and milk production in cattle (Zeckoski, Benham, Lunsford, 2007). Studies have shown that increasing livestock consumption of clean water can lead to increased milk and butterfat production and increased weight gain (Landefeld and Bettinger, 2002). Table 9.1 shows an example of how this can translate into economic gains for producers. Fresh clean water is the primary nutrient for livestock with healthy cattle consuming, on a daily basis, close to 10% of their body weight during winter and 15% of their body weight in summer.

Many livestock illnesses can be spread through contaminated water supplies. For instance, coccidia can be delivered through feed, water and haircoat contamination with manure (VCE, 2000). In addition, horses drinking from marshy areas or areas where wildlife or cattle carrying

Leptospirosis have access tend to have an increased incidence of moonblindness associated with Leptospirosis infections (VCE, 1998b). A clean water source can prevent illnesses that reduce production and incur the added expense of avoidable veterinary bills.

Table 9.1 Example of increased revenue due to installing off-stream waterers (Surber, Williams, Manoukian, 2005).

Typical calf sale weight	Additional weight gain due to off-stream waterer	Price	Increased revenue due to off stream waterer
500 lbs/calf	5% or 25 lbs	$0.60 per lb	$15/calf

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 that 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. The VCE (1998a) reports that mastitis costs producers $100 per cow from reduced quantity and quality of milk produced. On a larger scale, mastitis costs the U.S. dairy industry about $1.7 billion to 2 billion annually or 11 percent of total U.S. milk production. 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 reduces 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 also provides economic benefits for the producer. Improved pasture management can allow a producer to feed less hay in winter months, increase stocking rates by 30 to 40 percent and, consequently, improve the profitability of the operation. Feed costs are typically responsible for 70 to 80 percent of the cost of growing or maintaining an animal, and pastures provide feed at a cost of 0.01 to 0.02 cents/lb of total digestible nutrients (TDN) compared to 0.04 to 0.06 cents/lb TDN for hay. Thus, increasing the amount of time that cattle are fed on pasture is clearly a financial benefit to producers (VCE, 1996). Standing forage utilized directly by the grazing animal is always less costly and of higher quality than the same forage harvested with equipment and fed to the animal. In addition to reducing costs to producers, intensive pasture management can boost profits by allowing higher stocking rates and increasing the amount of gain per acre. Another benefit is that cattle are closely confined allowing for quicker examination and handling. Many of the agricultural BMPs recommended in this document will provide both environmental benefits and economic benefits to the farmer.

9.2 Residential Practices

The residential programs identified in this plan play an important role in improving water quality, since human waste can carry with it human viruses in addition to the bacterial and protozoan pathogens that all fecal matter can potentially carry. In terms of economic benefits to homeowners, the homeowner that understand how on-site sewage treatment systems operate and how best to keep them functioning properly and maintained can extend the life of his system and reduce the overall cost of ownership. The average septic system will last 20 to 25 years if properly maintained. Proper maintenance includes knowing the location of the system components and protecting them (e.g., not driving or parking on top of them); not planting trees where roots could damage the system; keeping hazardous chemicals out of the system; and pumping out the septic tank every 3 to 5 years. The cost of proper maintenance as outlined here is relatively inexpensive ($225) in comparison to repairing or replacing an entire system ($6,000 to $22,500). Repair and replacement programs will benefit owners of private sewage (e.g., septic) systems, particularly low-income homeowners, by sharing the cost of required maintenance.

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. Building contractors and material suppliers who deal with private sewage system repair and installation, fencing, and other BMP components can expect to see an increase in business during implementation. Income from maintenance of these systems should continue long after implementation is complete. As is outlined in Section 10, 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 and will stimulate the local economy. In general, implementation provides economic as well as environmental benefits to the community, which in turn may result in more individual landowners being able to participate in implementation.

9.3 Urban Practices

The primary benefits of urban stormwater management practices to private property owners include flood mitigation and improved water quality. A 2004 study assessing the economic benefits of stormwater management showed that these services can be valued at 0-5 percent of the market value of a home (Braden and Johnston, 2004). In flood prone and waterfront communities like several neighborhoods along the South River in Waynesboro, these services can be assigned an even greater value by property owners (Thunberg and Shabman, 1991).

In addition, urban stormwater BMPs have a number of economic benefits to localities. Increased retention of stormwater on site can lower peak discharges, thereby reducing the drainage infrastructure needed to prevent flooding. This can result in cost savings to local governments through reduced engineering and land acquisition costs and reduced materials and installation costs for stormwater culverts and streambank armoring to prevent scour. Additional savings may be realized by local governments through reduced pollution treatment costs particularly in communities with combined sewers or systems that suffer from infiltration during wet weather events. By reducing storm sewer flows through increased infiltration of stormwater, localities can subsequently reduce stormwater treatment costs, overflow damages and storage costs (Braden and Johnston, 2004).

Last, and of great importance in the Rivanna and Moores Creek watersheds, stormwater BMPs greatly reduces soil erosion and sediment transport to our rivers, streams and lakes. A 1993 study of the economic cost of erosion-related pollution showed that national off-site damages from urban sediment sources cost between $192 million on $2.2 billion per year in 1990 dollar values (Paterson et al., 1993). This cost range would be far greater today if adjusted for inflation. By proactively implementing stormwater management practices to reduce the volume of stormwater runoff coming in to Moores Creek, and to filter out the sediment that this runoff carries with it, the economic and environmental costs of erosion can be greatly reduced.

10.Funding for Implementation

A list of potential funding sources available for implementation is provided here along with a brief description of the programs and their requirements. Detailed descriptions can be obtained from the TJSWCD, DCR, NRCS, and VCE.

<u>Virginia Agricultural Best Management Practices Cost-Share Program</u>
The cost-share program is funded with state and federal monies through local SWCDs. SWCDs administer the program to encourage farmers and landowners to use BMPs on their land to better control transportation of pollutants into our waters due to excessive surface flow, erosion, leaching, and inadequate animal waste management. Program participants are recruited by SWCDs based upon those factors, which have a great impact on water quality. Cost-share is typically 75 percent of the actual cost and does not exceed the local maximum.

<u>Virginia Agricultural Best Management Practices Tax Credit Program</u>
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 percent of the first $70,000 expended for agricultural best management practices by the individual. Any practice approved by the local SWCD Board must be completed within the taxable year in which the credit is claimed. The credit is only allowed for expenditures made by the taxpayer from funds of his/her own sources. 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. If the amount of the credit exceeds the taxpayer's liability for such taxable year, the excess may be carried over for credit against income taxes in the next five taxable years until the total amount of the tax credit has been taken. 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.

<u>Virginia Agricultural Best Management Practices Loan Program</u>
Loan requests are accepted through DEQ. The interest rate is 3 percent 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, and there is no maximum limit. Eligible BMPs include 23 structural practices such as animal waste control facilities, loafing lot management systems, and grazing land protection systems. The loans are administered through participating lending institutions.

<u>CWA Section 319 Grant Project Funds</u>
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 Departments of Conservation and Recreation and Department of Environmental Quality*, July 2003).

Virginia Small Business Environmental Assistance Fund Loan Program

The Fund, administered through DEQ, 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. Loans must be for equipment needed by the small business to comply with the federal Clean Air Act or be used by the small business to implement voluntary pollution prevention measures. Loans are available in amounts up to $50,000 and will carry an interest rate of 3 percent, 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. There is a $30 non-refundable application-processing fee. The Fund will not be used to make loans to small businesses for the purchase and installation of equipment needed to comply with an enforcement action. 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

This is a permanent, non-reverting fund established by the Commonwealth of Virginia in order to assist local stakeholders in reducing point and nonpoint nutrient loads to surface waters. Eligible recipients include local governments, SWCDs, and individuals. Grants for point sources are administered through VADEQ and grants for nonpoint sources are administered through VADCR. Most WQIF grants provide matching funds on a 50/50 cost-share basis.

Virginia Natural Resources Commitment Fund

The fund was established in the Virginia Code as a sub fund of the Water Quality Improvement Fund in 2008. Monies placed in the fund are to be used solely for the Virginia Agricultural BMP Cost Share Program as well as agricultural needs for targeted TMDL implementation areas. Watersheds addressed in the water quality improvement plan are eligible for these funds, which are appropriated by DCR to Headwaters SWCD.

Conservation Reserve Program (CRP)

Cost-share assistance is available to establish trees cover or herbaceous vegetation on cropland through the CRP program. Offers for the program are ranked, accepted and processed during fixed signup periods that are announced by FSA. If accepted, contracts are developed for a minimum of 10 and not more than 15 years. Payments are based on a per-acre soil rental rate. To be eligible for consideration, the following criteria must be met: 1) cropland was planted or considered planted in an agricultural commodity for two of the five most recent crop years, and 2) cropland is classified as "highly-erodible" by NRCS. Application evaluation points can be increased if certain tree species, spacing, and seeding mixtures that maximize wildlife habitats are selected. Land must have been owned or operated by the applicant for at least 12 months prior to the close of the signup period. The payment to the participant is up to 50 percent of the cost for establishing ground cover. Incentive payments for wetlands hydrology restoration equal 25 percent of the cost of restoration.

Conservation Reserve Enhancement Program (CREP)

This program is an "enhancement" of the existing USDA CRP Continuous Sign-up. It has been "enhanced" by increasing the cost-share rates from 50 percent to 75 percent and 100 percent, increasing the rental rates, and offering a flat rate incentive payment to place a permanent "riparian easement" on the enrolled area. Pasture and cropland (as defined by USDA) adjacent to streams, intermittent streams, seeps, springs, ponds and sinkholes are eligible for enrollment. Buffers types ranging from native, warm-season grasses on cropland to mixed hardwood trees on pasture must be established in widths ranging from the minimum of 30 percent of the floodplain or 35 feet, whichever is greater, to a maximum average of 300 feet. Cost-sharing (75 percent – 100 percent) is available to help pay for: fencing to exclude livestock from the riparian buffer; watering facilities; hardwood tree planting; filter strip establishment; and wetland restoration. In addition, a 40 percent incentive payment upon completion is offered along with an average rental rate of $70/acre on stream buffer area for 10-15 years. The State of Virginia will make an additional incentive payment to place a perpetual conservation easement on the enrolled area.

The landowner can obtain and complete CREP application forms at the FSA center. The forms are forwarded to local NRCS and SWCD offices. FSA determines land eligibility. If the land is deemed eligible, NRCS and the local SWCD determine and design appropriate conservation practices. A conservation plan is written, and fieldwork is begun, which completes the conservation practice design phase.

FSA then measures CREP acreage and prepares the conservation practice contract, and practices are then installed. The landowner submits bills for cost-share reimbursement to FSA. Once the landowner completes BMP installation, and the practice is approved, FSA and the SWCD make the cost-share payments. The SWCD also pays out the state's one-time, lump sum rental payment. FSA conducts random spot checks throughout the life of the contract, and the agency continues to pay annual rent throughout the contract period.

Environmental Quality Incentives Program (EQIP)

This program was established in the 1996 Farm Bill to provide a single voluntary conservation program for farmers and landowners to address significant natural resource needs and objectives. Approximately 65 percent 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. Proposals describe serious and critical environmental needs and concerns of an area or watershed, and the corrective actions they desire to take to address these needs and concerns. The remaining 35 percent 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 percent cost-share assistance, 25 percent 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. Eligible lands include cropland, pasture, and other agricultural land in priority areas, or land that has an environmental need that matches one of the statewide concerns.

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. In Virginia, these plans are prepared to address one or more of the following high priority habitat needs: early grassland habitats that are home to game species such as quail and rabbit and non-game species like meadowlark and sparrows; riparian zones along streams and rivers that provide benefits to aquatic life and terrestrial species; migration corridors which provide nesting and cover habitats for migrating songbirds, waterfowl and shorebird species; and decreasing natural habitat systems that are environmentally sensitive and have been impacted and reduced through human activities. Cost-share assistance of up to 75 percent 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. For cost-share assistance, USDA pays up to 75 percent of the cost of installing wildlife practices.

Wetland Reserve Program (WRP)
This program is a voluntary program to restore and protect wetlands on private property. The program benefits include providing fish and wildlife habitat, improving water quality, reducing flooding, recharging groundwater, protecting and improving biological diversity, and furnishing recreational and esthetic benefits. Sign-up is on a continuous basis. 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 retains ownership but voluntarily limits future use of the land. The program offers landowners three options: permanent easements, 30-year easements, and restoration cost-share agreements of a minimum of 10 years. Under the permanent easement option, landowners may receive the agricultural value of the land up to a maximum cap and 100 percent of the cost of restoring the land. For the 30-year option, a landowner will receive 75 percent of the easement value and 75 percent cost-share on the restoration. A 10-year agreement is also available that pays 75 percent of the restoration cost. 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. At any time, a landowner may request that additional activities be added as compatible uses. Easement participants must have owned the land for at least one year.

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 and management assistance; training; education; facilitation; volunteers; and financial assistance. Financial assistance may include $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 percent of the federal poverty level.

National Fish and Wildlife Foundation

Grant proposals for this funding are accepted throughout the year and processed during fixed signup periods and cycles. 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.

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 (CWSRF). 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.

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 that provides compensation for aquatic resources in financially and environmentally preferable ways. Not every site or property is suitable for mitigation banking. Mitigation banks are required to be protected in perpetuity and to provide financial assurances and long term stewardship. The mitigation banking process is overseen by an Inter-Agency Review Team made up of state and federal agencies and chaired by DEQ and Army Corps of Engineers.

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