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Upper Goose Creek, Cromwells Run, and Little River TMDL Implementation Plan

Prepared by

Virginia Department of Environmental Quality (DEQ)

in cooperation with

Local stakeholders
Interstate Commission on the Potomac River Basin
Rappahannock Rapidan Regional Commission

June 2017

Cover Photo
Photo taken in the Goose Creek watershed (June 2016).

Table of Contents

List of Tables

List of Figures

Abbreviations

ACS	American Community Survey
AVMA	American Veterinary Medical Association
AWG	Agricultural Working Group
BMP	Best Management Practice
CCU	Confined Canine Unit
CDBG	Community Development Block Grant
CFNOVA	Community Development Fund of Northern Virginia
CFR	Code of Federal Regulations
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CWA	Clean Water Act
DCR	Virginia Department of Conservation and Recreation
DEQ	Virginia Department of Environmental Quality
DOE	Virginia Department of Education
DOF	Virginia Department of Forestry
DU	Ducks Unlimited
E. coli	Escherichia coli
EDF	Environmental Defense Fund
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FSA	Farm Service Agency
FWS	U.S. Fish and Wildlife
GCA	Goose Creek Association
GWG	Government Working Group
HH	Households
ICPRB	Interstate Commission on the Potomac River Basin
IP	Implementation Plan
IRT	Inter-Agency Review Team
JMSWCD	John Marshall Soil and Water Conservation District
LSWCD	Loudoun County Soil and Water Conservation District
LEF	Livestock Exclusion Fencing
MRLC	Multi-Resolution Land Characteristics
N/A	Not Applicable
NFWF	National Fish and Wildlife Foundation
NLCD	National Land Cover Dataset
NPS	Nonpoint Source
NRCS	Natural Resources and Conservation Service
PEC	Piedmont Environmental Council
PM	Pasture Management
RCPP	Regional Conservation Partnership Program
RRRC	Rappahannock-Rapidan Regional Commission
RWG	Residential Working Group
SC	Steering Committee
SER-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
TBD	To Be Determined
TMDL	Total Maximum Daily Load

TU	Trout Unlimited
UGC	Upper Goose Creek
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UT	Unnamed Tributary
VCAP	Virginia Conservation Assistance Program
VCE	Virginia Cooperative Extension
VCWRLF	Virginia Clean Water Revolving Loan Funds
VDH	Virginia Department of Health
VPDES	Virginia Pollutant Discharge Elimination System
WHIP	Wildlife Habitat Incentive Program
WLA	Wasteload Allocation
WQ	Water Quality
WQMIRA	Water Quality Monitoring, Information, and Restoration Act
WQMP	Water Quality Management Plan
WQS	Water Quality Standard

Units of Measurement

ft	foot
sq ft	square foot

Executive Summary

The plan contained in this report provides a detailed, multi-year framework to restore water quality in the Upper Goose Creek planning area to healthy conditions. It describes current water quality status, identifies the bacteria reductions needed to meet water quality standards, and summarizes a suite of management actions to restore water quality to attain those standards. The plan also summarizes the many programs, partners, and funding resources that can contribute to putting this plan into action.

Goose Creek and its tributaries are part of the Potomac River basin, within a watershed that covers 386 square miles in Loudoun and Fauquier Counties on the western edge of the Washington D.C. metropolitan area. The watershed is primarily rural in character, with forest and agricultural land uses predominant, and is well known for its scenic horse farms. More dense development is present in the northeastern portion of the watershed, where most population growth in the watershed is occurring.

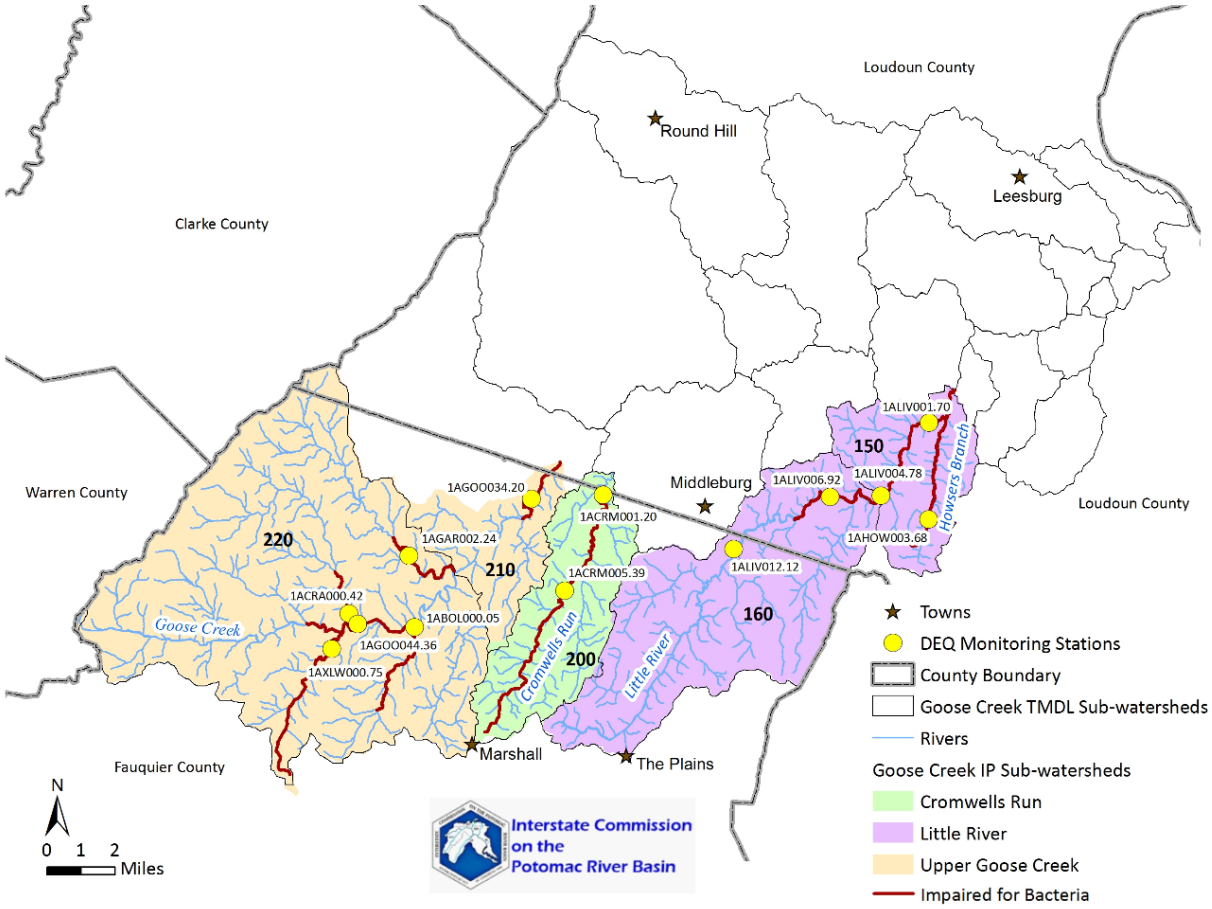
Goose Creek has been designated as a scenic river under Virginia's Scenic River Act, yet it also has degraded water quality that required management action. The mainstem of Goose Creek and six of its tributaries were listed as impaired on Virginia's 1998 and draft 2002 303(d) Total Maximum Daily Load (TMDL) Priority List and Report due to exceedances of the state's water quality standard for fecal coliform bacteria. The impaired stream segments do not meet designated uses for primary contact recreation (e.g. swimming); in other words, coming in direct contact with the Goose Creek's water could cause illnesses such as intestinal disorders.

The Virginia Department of Environmental Quality (DEQ) completed a TMDL study in 2003 for the entire Goose Creek watershed and set limits on the amount of bacteria each individual waterbody can receive and still support its designated recreational use standard. This TMDL Implementation Plan (IP) explains and quantifies the control measures, in the form of best management practices (BMPs), recommended over the next 15 years to reduce bacteria levels within the Upper Goose Creek (UGC) watershed area (Upper Goose Creek, Cromwells Run and Little River (**Figure ES-1**) and be removed from the impaired waters list. **Figure ES-2** shows the plan area within the Goose Creek watershed.

Figure ES-1. A section of Little River.

The vast majority of bacteria reaching Goose Creek watershed streams come from nonpoint sources, primarily agricultural activities. Within the sub- watersheds covered by this plan, only one point source is subject to a Virginia Pollutant Discharge Elimination System (VPDES) permit, and just 3 additional general permits address small businesses/residences.

Figure ES-2. Location of the Upper Goose Creek TMDL IP area within the Goose Creek watershed (Data Source: DEQ).



Review of the TMDL: The 2003 bacteria TMDLs called for elimination (100% reduction) of bacteria from failing septic systems and direct deposition from cattle into area streams. In addition, the TMDLs identified a need to reduce the bacteria loads from pastures by 98-99%. Given the passage of more than a decade of time since the TMDLs were prepared, planning for implementation actions required a comprehensive update of land uses within the upper watershed, as well as human, pet and livestock populations.

The TMDL model calculations were also revisited to estimate instream delivered loads rather than the originally reported edge-of-field loads to match current DEQ practice. At the bottom-line, the water quality modeling confirmed the overall scope and distribution of reductions called for in the 2003 TMDL report, with a modest decrease in the need for bacteria reductions from pasture lands.

It is encouraging that many water quality management actions have been put into place since the TMDL was developed, and it was important that the IP consider their impact before determining the additional actions needed. An estimated 100 miles of livestock exclusion fencing has been installed along streams in the UGC watershed since 2002, and both Loudoun and Fauquier Counties have active septic system programs that have repaired approximately 130 septic systems in the 2002-2016 timeframe.

DEQ analyzed the most current water quality monitoring data to identify current conditions in the plan area. DEQ's 2014 Integrated Report (DEQ 2014) documented water quality improvements across the area, using *E. coli* data collected in 2007 and 2012, but most sites continue to exceed bacteria Water Quality Standards (WQS), and

thus remain impaired for recreational uses. Current conditions call for significant additional action to restore water quality and enable the WQS for bacteria to be achieved.

Finally, the original bacteria pollutant reduction scenarios contained in the 2003 TMDL report were reviewed and an alternative scenario (to the one used in the 2003 TMDLs) was selected by DEQ. The pollutant reduction scenario that is the foundation for this plan spreads load reductions more broadly by also addressing cropland, equine sources, stormwater, and pet waste. This provides an opportunity to more broadly engage the local community in watershed protection and restoration. As a result, bacteria reductions needed from pasture have been reduced from the 98-99% levels called for in the TMDL to 75% in this plan.

Public Participation: Local stakeholders were broadly informed of the need for an implementation plan in a June 21, 2016 public meeting, and agricultural, residential and government workgroups were convened to seek input on how best to address bacteria contamination in UGC. Workgroup participants provided essential local knowledge throughout the process.

A Steering Committee comprised of selected workgroup members from local government agencies, local non-governmental organizations, and the John Marshall Soil and Water Conservation District provided valuable feedback on this draft plan during its May 25, 2017 meeting. DEQ will host a Final Public Meeting to present the draft plan on June 21, 2017. A 30-day public comment period will follow this meeting to seek additional public input that will enable DEQ to further clarify and refine the plan before submitting it for final approvals.

Recommended Management Measures: A broad suite of agricultural, residential, and education and outreach actions are recommended to reduce the sources of bacteria and restore safe recreational uses of the planning area's waters. In summary, these actions include:

- 169 additional miles of livestock exclusion fencing, with riparian buffers, at an estimated cost of $5.8 million.
- 9,917 acres of pasture and cropland improvements, and sediment retention structures addressing drainage for nearly 3,800 acres, at an estimated cost of $7.3 million.
- 3,600 acres of targeted conversion of pasture/cropland to forest or permanent vegetative cover, for steep slope land and critical stream habitat areas (these costs are included in pasture/cropland).
- Three community and over 300 individual equine manure composting systems, and over 100 barnyard runoff control systems for horse farms, at an estimated cost of $3.7 million.
- Extensive residential septic system improvements, including some 6,500 septic pump-outs, 400 repairs, 80 system replacements, and 20 public sewer system hookups, costing $4.8 million.
- Demonstration projects to improve stormwater management, at an estimated cost of $83 thousand, and pet waste management actions estimated to cost between $51 and 121 thousand.
- A comprehensive 15-year education, outreach and technical assistance program, costing approximately $778 thousand.

Benefits: The direct benefit of the actions called for in this plan will be restoration of water quality to enable safe recreational uses of the area's streams. The recommended actions are designed to allow delisting the current bacteria impairments of waters in the Upper Goose Creek watershed. These water quality benefits also contribute to improving the quality of downstream waters of Goose Creek, the Potomac River, and the Chesapeake Bay, while broadly enhancing the natural resource values of the watershed. This plan's actions will provide additional benefits of enhanced agricultural productivity, livestock health, and aquatic habitat within the watershed. Residential septic improvements will reduce the incidence of higher cost system failures and improved stormwater and pet waste management can reduce local flooding and improve community aesthetics.

The plan's recommended actions are proposed to be put into place over a 15-year timeframe. Strong local leadership, and support from both state and federal government agencies and a multitude of local stakeholders will be critical for success. An approved implementation plan will increase opportunities for Fauquier and Loudoun County local agencies and watershed residents to obtain funding to support their installation of the recommended best management practices . Sustained actions consistent with the recommendations of this plan are projected to allow for delisting of the impaired waters of the IP area by 2031.

1. Introduction

The Virginia Total Maximum Daily Load (TMDL) program is designed to improve water quality and restore impaired waters in Virginia. A TMDL identifies the maximum amount of a pollutant that a water body can receive without surpassing the state water quality standards. These standards are established to protect six beneficial uses: drinking water, recreational (i.e., primary contact/ swimming), fishing, shellfishing, aquatic life, and wildlife. If the water body exceeds the water quality criteria used to measure the standard during an assessment period, Section 303(d) of the Clean Water Act (CWA) and the United States Environmental Protection Agency's (EPA) Water Quality Management and Planning Regulation (40 CFR Part 130) both require states to develop a TMDL for each pollutant contributing to its impairment.

Figure 1-1. Beef farm in the Goose Creek watershed.

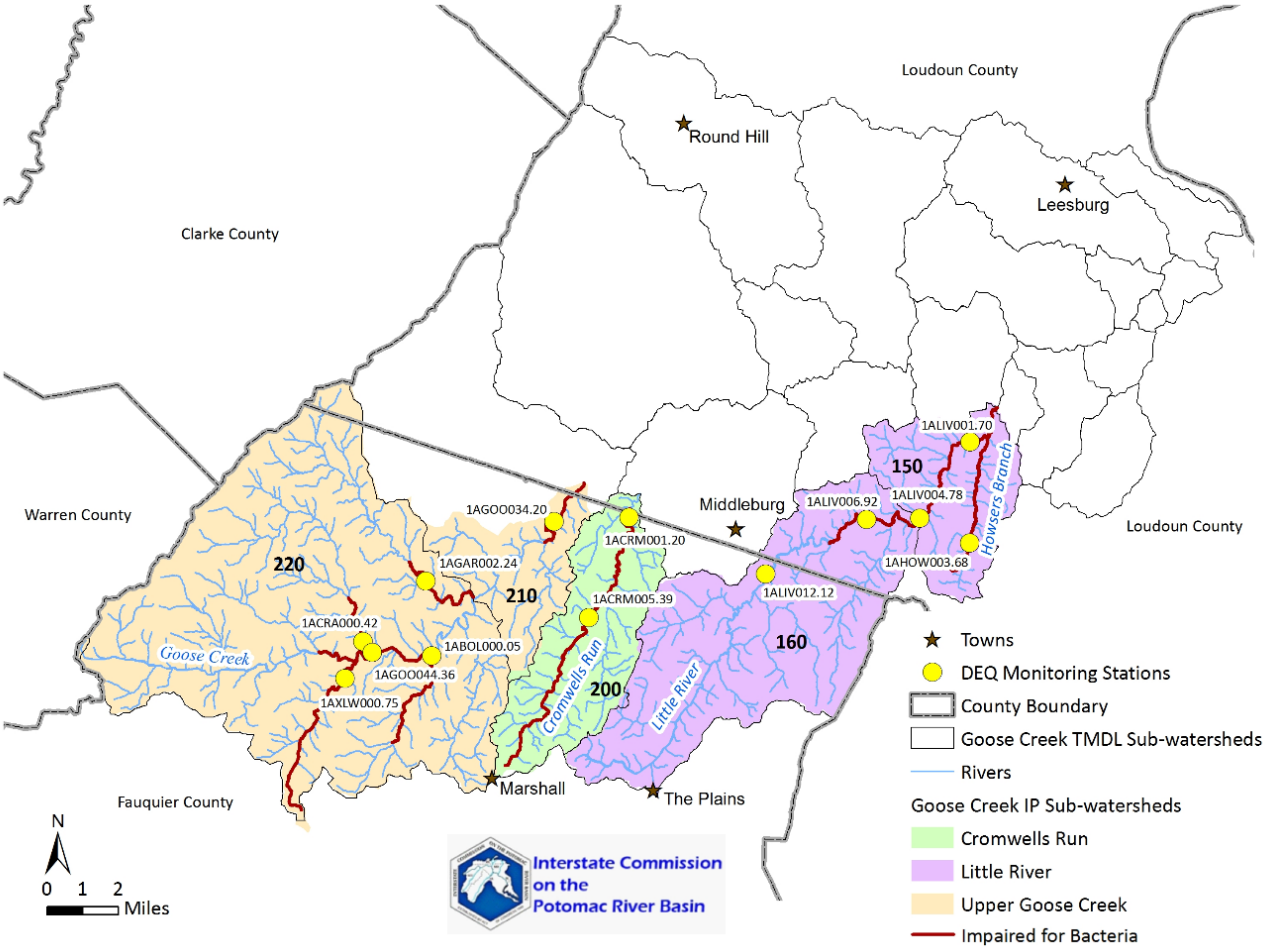
Goose Creek and its tributaries are part of the Potomac River basin. The Goose Creek watershed covers 386 square miles in Loudoun and Fauquier counties on the western edge of the Washington D.C. metropolitan area, as shown in **Figure 1-2**. The watershed is primarily rural in character (**Figure 1-1**), with forest and agricultural land uses predominant, though more dense development is present in the northeastern portion of the watershed. Goose Creek has been designated as a scenic river under Virginia's Scenic River Act.

Figure 1-2. Location of Goose Creek watershed, in Northern Virginia.

The mainstem of Goose Creek and six of its tributaries were listed as impaired on Virginia's 1998 and 2002 303(d) Total Maximum Daily Load Priority List and Report (DEQ 1998 and 2002) due to exceedances of the State's water quality standard for fecal coliform bacteria. The impaired stream segments did not meet designated uses for primary contact recreation (e.g. swimming). In addition, a five-mile segment of the mainstem of Goose Creek, below its impoundment to the inlet to the Potomac River, and Little River were also listed for benthic impairments in 1998, due to violation of the Commonwealth's General Standard.

After these listings, in 2003, the Virginia Department of Environmental Quality (DEQ) completed a TMDL study for the Goose Creek watershed that identified bacteria sources in each sub-watershed and set limits on the amount of bacteria these waterbodies can receive and still support their designated recreational use standard. (A separate TMDL report for the benthic impairments was completed in 2004, but that is not the focus of this implementation plan.) As part of the 2003 TMDL study, additional sections of the Little River and Cromwells Run and sections of Howsers Branch, Goose Creek, Gap Run, Bolling Branch, Crooked Run and an Unnamed Tributary of Goose Creek were also listed as impaired for bacteria. All identified impairments in the Upper Goose Creek (UGC) watershed are addressed by this plan. **Figure 1-3** shows the portion of the entire watershed that comprises the upper watershed area addressed here, which includes the Upper Goose Creek, Cromwells Run, and Little River subwatersheds.

Figure 1-3. Location of the Upper Goose Creek TMDL IP area within the Goose Creek watershed (Data Source: DEQ).



The TMDL Implementation Plan (IP) described in this report explains and quantifies actions needed to reduce bacteria levels to meet water quality standards (WQS) and allow a delisting of the impaired waters from the Section 303(d) List. The TMDL IP describes control measures, commonly called best management practices (BMPs), to be implemented in a staged process over the next 15 years. Local support and successful implementation of the plan will result in the restoration of Upper Goose Creek and enhancement of the natural resource values of the watershed more broadly. An approved IP will increase opportunities for Fauquier and Loudoun Counties, other local organizations and watershed residents to obtain funding to support installation of the recommended BMPs.

This public document is an abbreviated version of a more detailed technical document, which can be obtained at: http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLImplementation/TMDLImplementationPlans.aspx, accessed 5/15/2017.

2. Federal and State Requirements

Both state and federal requirements and recommendations were followed in developing this plan. 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 (DEQ 1997). WQMIRA directs the State Water Control Board (SWCB) to "develop and implement a plan to achieve fully supporting status for impaired waters."

In order for IPs to be approved by the Commonwealth, they must meet the following requirements of WQMIRA:

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

EPA regulations (40 CFR 130.33(b)(10)) require the inclusion of an implementation plan as an element of TMDL submittal. The EPA minimum elements of an approvable IP are described in EPA's 1999 *Guidance for Water Quality-Based Decisions: The TMDL Process*, and include:

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

The TMDL IP for Upper Goose Creek fully addresses both the EPA and Virginia requirements and recommendations for TMDL implementation plans.

2.1 Requirements for Section 319 Funding Eligibility

The EPA has developed guidelines that describe the process and criteria used to award CWA Section 319 nonpoint source grants to States. The "*Nonpoint Source Program and Grants Guidelines for State and Territories*" (April, 2013) continues long-standing emphasis on the following nine elements for meeting Section 319 program 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 nonpoint 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 implementation efforts.

Once complete, DEQ presents TMDL IPs to the State Water Control Board (SWCB) for approval to guide efforts to implement pollutant allocations and reductions contained in the TMDL. DEQ also requests inclusion of new IPs in the appropriate Water Quality Management Plan (WQMP), in accordance with CWA Sec. 303(e) and Virginia's Public Participation Guidelines for Water Quality Management Planning.

3. Review of the 2003 TMDL and Updated Analysis

A TMDL study was completed by DEQ and approved by EPA for the lower mainstem of Goose Creek and portions of six tributaries in 2003. The study identified sources and quantified the amount of bacteria that streams within the watershed could receive without exceeding WQS. The TMDLs for each of seven streams were designed to meet Virginia's WQS for recreational uses, using the criteria established for fecal coliform bacteria, and *E. coli.*

The vast majority of bacteria reaching Goose Creek watershed streams come from nonpoint sources, primarily agricultural activities. There are a total of 31 point source discharge permits in the Goose Creek watershed. Within the sub-watersheds covered by this IP, only one point source is subject to a VPDES permit, and just three additional general permits address small businesses/residences.

The TMDL provided wasteload allocations (WLAs) for point sources based on their VDPES permit limits. The WLAs were adjusted slightly upward in a 2006 TMDL Modification to allow for future population growth in the service areas of the wastewater treatment facilities.

Nonpoint source bacteria loads were estimated in the 2003 TMDL from land use data, since forest, cropland, pasture, and developed lands have different levels of bacteria runoff. Given the passage of more than a decade of time since the TMDLs were prepared, planning for TMDL implementation actions required a comprehensive update of land uses within the watershed.

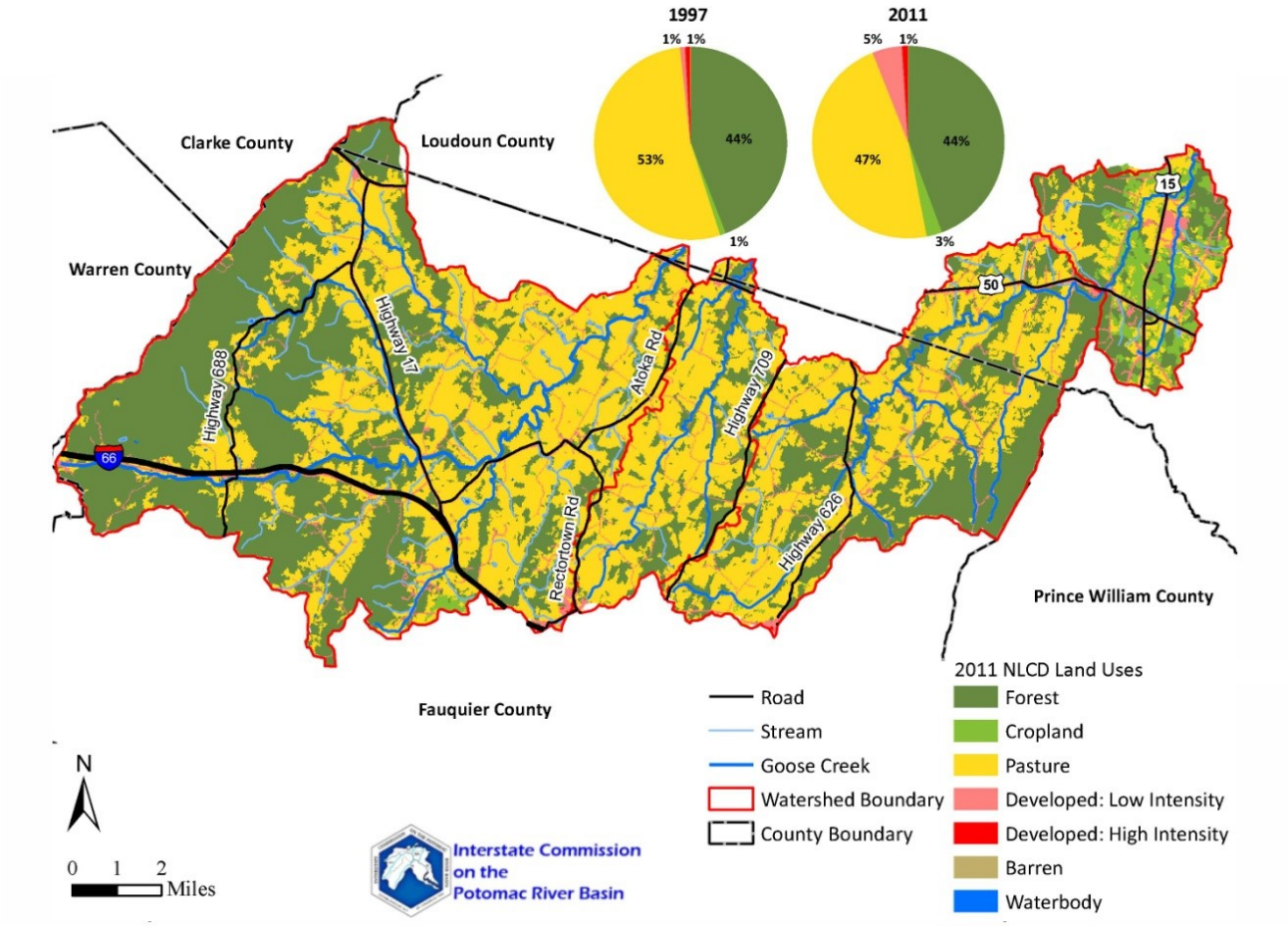
Land use updates were completed using the 2011 National Land Cover Dataset (NLCD) (Homer et al. 2015). Results showed minor changes to forest and pasture land uses for the upper watershed as a whole and very substantial increase in cropland and developed lands. **Table 3-1** and **Figure 3-1** summarize this information. Much of the increase in cropland is believed to be transitory, associated with a temporary rotation from pasture. The greatest increase in impervious developed lands occurred in the northeastern portion of the upper watershed, along Rt. 15 in the Little River sub-watershed. Updated land use values documented that overall, the IP area

remains predominantly rural in character, with forest and pasture land uses accounting for more than 90% of the land area. **Attachment A** includes land use analysis for the Upper Goose Creek (**Table A-6**), Cromwells Run (**Table A-7**), and Little River (**Table A-8**) sub-watersheds.

Table 3-1. Goose Creek IP area land use comparison.

Land Use Type		1997 (Acres)	2011 (Acres)	Change (Acres)	% Change
Pervious	Forest	46,516	46,796	280	1
	Cropland	1,031	2,746	1,715	166
	Pasture	56,053	49,570	-6,483	-12
	Developed Pervious	921	5,264	4,343	472
Impervious	Developed Impervious	816	1,070	254	31
	Barren	110	1	-109	-99

Figure 3-1. Goose Creek IP area land use comparison. The map displays the 2011 National Land Cover Dataset (NLCD) data. The pie charts compare 1997 Multi-Resolution Land Characteristics (MRLC) land use percentages with 2011 NLCD land use percentages using colors that also correspond to the map legend.



Population and household data were also updated using the 2014 American Community Survey (ACS) (USCB 2015). This analysis identified current populations served by the area's wastewater treatment facilities, as well as those utilizing septic systems. Overall, the watershed population grew by 12% since 2003, with most growth

occurring within the Little River sub-watershed. **Attachment A** provides additional detail on population changes (**Table A-1**) and septic system and public sewer system connections (**Table A-2**, **Table A-3**, **Table A-4**, and **Table A-5**).

The updated land use and population data were used to improve pet population estimates as well. Using residential population growth and the 2012 American Veterinary Medical Association (AVMA) information, the pet population is estimated to have grown by approximately 20% since 2003. Details of this analysis are included in **Attachment A** (**Table A-9**). Livestock population estimates were updated by comparing 2002 and 2012 U.S. Department of Agriculture (USDA) census of agriculture data for Loudoun and Fauquier counties, and allocating the data pro rata to the portions of each county falling within the project area (USDA 2014; USDA 2004). The results of this analysis are an increase of 8% to the beef cattle population, and increase of 3% to the horse population, and a decrease of 35% to the daily cow population included in the 2003 TMDL. Details of this analysis are also shown in **Attachment A** (**Table A-11**).

As part of the TMDL update, the original model was re-run for the upper watershed segments (Upper Goose Creek, Cromwells Run, and Little River) addressed in the IP to estimate instream delivered loads rather than the originally reported edge-of-field loads, per current DEQ practice. At the bottom-line, updated water quality modeling confirmed the overall scope and distribution of reductions called for in the 2003 TMDL report, with a modest decrease in the need for pasture load reductions. Changes in watershed conditions reflected in the updated source assessment were then credited towards accomplishing the load reductions called for in the TMDL. This analysis is shown for each sub-watershed in **Attachment A** (**Table A-12**, **Table A-13**, and **Table A-14**).

3.1 Water Quality Update

In addition to watershed land use and population changes, many water quality improvement actions have been completed since the TMDL was developed. Most significantly, according to the Virginia Department of Conservation and Recreation (DCR) database of agricultural practices (DCR 2016), an estimated 100 miles of livestock exclusion fencing have been installed along streams in the project area since 2002. In addition, both Loudoun and Fauquier Counties have active septic system maintenance programs that have resulted in approximately 130 septic system repairs between 2002 and 2016.

DEQ's 2014 Integrated Report documented water quality (WQ) improvement across the area, using *E. coli* data collected in 2007 and 2012, but most sites continue to exceed bacteria WQS, and remain impaired for recreational use. A detailed presentation of the impaired stream segments within the IP area is shown in **Attachment A** (**Table A-17**). The most recent water quality monitoring information for 2013-2016 is shown below in **Table 3-2**. While water quality improvements are evident, water quality standard violations remain of concern. Violation rates dropped for Station 1AGAR002.24 on Upper Goose Creek from 60 to 44%, for Station 1ACRM001.20 on Cromwells Run from 40 to 20%, and for Station 1ALIV004.78 on Little River from 54 to 25%. One segment of Little River, from the confluence with Hungry Run (near Aldie) downstream to confluence with Goose Creek, was delisted in the 2010 DEQ Impaired Waters/Integrated Report (DEQ 2010). But some WQ monitoring stations in the IP area showed increased violation rates. Overall, the most current water quality monitoring information shows that additional management actions, as recommended in this plan, are needed to achieve compliance with Virginia's WQS for bacteria.

Table 3-2. Comparison of bacteria water quality standard violations pre-TMDLs (before 2003) and present (2013-2016).

Station ID	Sub-watershed	Pre-TMDL (Before 2003)		Present (2013-2016)	
		No. of Samples	No. of Samples in Violation	No. of Samples	No. of Samples In Violation
1ACRM001.20	Cromwells Run	42**	17	15*	3
1AGAR002.24	Upper Goose Creek	5**	3	9*	4
1AGOO036.61	Upper Goose Creek	2**	0	12*	2
1AGOO039.63	Upper Goose Creek	-	-	1*	0
1AGOO044.36	Upper Goose Creek	136**	43	19*	3
1ALIV004.78	Little River	46+	25	12*	3
1ALIV004.79	Little River	-	-	1*	1
1ALIV012.12	Little River	1**	0	12*	5

Note: Raw data provided in **E. coli*, ***fecal coliform, or +both. Cells with "-" denote no samples were taken, "0" denotes no samples were in violation of water quality standards.

In addition to DEQ's water quality monitoring, the Goose Creek Association (GCA) has led a strong local voluntary monitoring program for the watershed for more than a decade. The specific locations of GCA's monitoring are described in **Attachment A** (**Table A-17**). Because not all of EPA/DEQ's rigorous requirements for use voluntary monitoring data are satisfied, the GCA data is noted to have detected "Observable Effects" for bacteria, but DEQ does not make water quality impairment determinations from this data.

4. 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 these plans are implemented primarily by watershed stakeholders on a voluntary basis (often with financial incentives), local input and support are the primary factors that will determine success in carrying out the IP's recommended actions.

A public meeting to formally begin development of the implementation plan was held on the evening of June 21, 2016 at the Wakefield school in The Plains, Virginia (**Table 4-1**). The public meeting was publicized through email announcements, fliers, and signs posted throughout the watershed; in total 27 people attended, including private citizens, government agency representatives, local businessmen, and representatives from several area non-profit organizations. This meeting served as an opportunity for local residents to learn more about the condition of local streams, and to work together to identify ideas to protect and restore water quality in their community. The meeting began with a brief presentation on existing water quality conditions in the streams, updates to the 2003 Goose Creek watershed TMDL, and the types of actions and information that could be included in an implementation plan to improve water quality. The public participation process that DEQ uses in developing these plans was also described to attendees.

A local farmer shared his experience with using a variety of BMPs on farmland he leased near the meeting location, which gave participants a better understanding of water quality management measures for agricultural lands. Following the presentation, attendees split into two working groups: a residential group and an agricultural group.

The working groups discussed how residential and agricultural land use practices are affecting the quality of local streams, and reviewed different management practices that could be included in the implementation plan. These discussions were facilitated by staff from DEQ, the Rappahannock-Rapidan Regional Commission (RRRC), and the Interstate Commission on the Potomac River Basin (ICPRB).

The final public meeting was held on June 21, 2017 in The Plains, VA. The primary purpose of this meeting was to present the final TMDL IP. A presentation was given describing the implementation plan and its major components. Maps with land use, topographic features, and analysis of best management practices recommended for each watershed were displayed and discussed during the presentation. (Complete following June 21, 2017 Final Public Meeting.)

Table 4-1. Meetings held during the TMDL IP development process.

Date	Meeting Type	Location	Attendance
06/21/16	Public Meeting	The Wakefield School	27
06/21/16	Agricultural & Residential Working Group #1	The Wakefield School	17
09/08/16	Governmental Working Group	Tri County Feeds	19
09/22/16	Agricultural & Residential Working Group #2	The Wakefield School	15
05/25/17	Steering Committee	Tri County Feeds	11
06/21/17	Final Public Meeting		

4.1 Agricultural Working Group

The role of the Agricultural Working Group (AWG) is to review potential conservation practices and outreach strategies from a local agricultural perspective, identify any obstacles (and solutions) related to BMP implementation, and provide input on the type, number, and costs of BMPs. During the first agricultural working group meeting on June 21, 2016, the group began to consider stream fencing opportunities within the watershed. The group discussed the need to ground-truth potential fencing areas identified through data analysis the John Marshal Soil and Water Conservation District (JMSWCD) had begun for the plan area. The group also discussed the challenge of enhancing conservation measures for leased properties.

The AWG thought it would be valuable to include groups like the Goose Creek Association in outreach efforts. Farm tours could provide information about the multiple benefits of BMPs, including water quality and wildlife habitat improvements and improved livestock health and agricultural productivity. They discussed portable watering systems as a promising way to enhance participation in rotational grazing. There is a substantial number of existing conservation easements in the area and the workgroup discussed potential easement program changes to require stream fencing in future easement agreements. Hobby farms, in particular those with horses, may need to be offered composting opportunities at the regional scale, given the cost to install individual small-farm composting.

A second AWG meeting was held on September 22, 2016. This meeting included a presentation about the Gilberts Corner Farm Project, which addressed bacterial sources comprehensively using Soil and Water Conservation District (SWCD) cost-share programs to create multiple benefits. At a total cost of $125,000, more than two miles of stream fencing, two hardened stream crossings, and water piping for six watering tank vaults were installed. Benefits of improved agricultural production, enhanced wildlife habitat, and water quality were discussed. Participants of the second agricultural working group meeting completed a BMP scoring sheet to determine which conservation measures would be the most applicable and popular with area farmers. In order of popularity with AWG members, the results were as follows:

1. Streamside livestock exclusion fencing,
2. Rotational grazing/Grazing land management, tied with
3. Forested streamside buffers,
4. Grassed streamside buffers,
5. Manure composting/storage facilities (equine),
6. Continuous no-till/Conservation tillage,

7. Forestation of crop, pasture or hayland.

Meeting participants then identified, in priority order, the following obstacles that will need to be addressed to achieve the desired level of stream exclusion:

1. Cost of installing fencing and creating off-stream water supplies,
2. Concern (economic) of giving up production of 35 linear feet for a stream buffer zone,
3. Grazing land is often rented with short-term leases,
4. Fence maintenance is costly and time-consuming.

Some participants also observed that low levels of government trust impede participation in cost-share programs.

4.2 Residential Working Group

The primary role of the Residential Working Group (RWG) was to discuss methods needed to reduce human and pet sources of bacteria entering the creeks, recommend methods to identify and correct or replace failing septic systems and straight pipes, and provide input on the residential BMPs to include in the plan. The June 21, 2016 meeting participants discussed recent Fauquier and Loudoun County data on septic systems repairs in each county. Recent septic system improvements have informed estimates of the need for additional septic system repairs and replacements in the implementation plan.

Both Loudoun and Fauquier counties have ordinances requiring that septic systems be pumped out every five years, and septic haulers report actual pump outs to the respective health departments. The group agreed that more education is needed for septic system owners, especially for owners of newer homes which frequently have alternative septic systems. RWG participants identified realtors as a group that could help with septic maintenance educational outreach during real estate transactions. There was also discussion of the recent upgrades completed for the Broad Run Wastewater Treatment Facility to accommodate increased septic waste volume at the plant (regularly 20+ trucks per day) since Loudoun County established its septic system pump-out requirements. Any changes to septic pump-out programs triggered by the TMDL IP will need to account for the ability of local wastewater treatment facilities to handle increased loadings.

Options for pet waste BMPs were discussed; including composters, bag stations, leash bag holders, and confined canine units for kennel and hunt club operations. Information was shared about diseases that can affect both humans and pets when pet waste is not collected and allowed to run off into area streams. The group discussed some popular dog walking areas and homeowner associations that may be viable locations for new pet waste bag stations. The Parks and Recreation departments in both counties could provide maintenance of those stations on public property.

There are some good examples of proper pet waste management in the area, such as the Fauquier Society for the Prevention of Cruelty to Animals (SPCA). Special septic systems are needed to treat dense dog wastes, and they are expensive; less expensive dry stack composting methods may be more likely to be installed. Fauquier County requires kennel operations to provide plans for pet waste management when they apply for a kennel license.
The RWG also discussed special consideration and practices relevant to horses. Educating the many area horse owners on barnyard and pasture management techniques is important. Educational materials could be provided at kiosks along horse trails in the area. The residential work group participants believe there would be interest among local horse owners in a regional manure composting facility, as an alternative to individual farm manure composting units.

A second residential working group meeting was held on September 22, 2016. The group continued and built-upon its previous discussions of septic system issues, pet waste, and equine topics. It was observed that while both counties have strong septic program requirements, Loudoun County has a stronger inspection program.

Nevertheless, most area residents don't understand septic and alternative septic system maintenance needs. RWG participants see value in a septic pump out program, with no exclusions for those at greater distances from streams, and also believed there will be opportunities for more public wastewater system connections in the future within Loudoun County. Turning to the pet waste issue, several promising locations for pet waste stations were identified and some saw potential for successful introduction of pet waste composters if an effective educational program is included. Finally, there was brief discussion of opportunities to address equine waste, perhaps most effectively in partnership with the Middleburg Agricultural Research and Extension (MARE) Center.

4.3 Government Work Group

The goals of the Government Working Group (GWG) were to identify water quality controls currently in place in the watersheds (e.g. livestock stream exclusion fencing and sewer line connections), to identify existing programs and technical resources that may enhance implementation efforts, and to propose additional programs that would support implementation. A single GWG meeting was held with local government and conservation agency representatives on September 8, 2016. The group discussed a number of issues and ideas, including:

- Potential that nutrient trading may increase interest in reforestation of crop/pasture lands.
- Fine-tuning the projected number of conservation practices for small acreage grazing, including equine operations, and the opportunities and challenges given their small economic scale relative to requirements of agricultural cost-share programs.
- Septic system work will be affected by changes underway in the manner that septic repair vs. upgrade are defined, and this may affect residential BMP participation.
- Alternative septic system maintenance needs seem to be poorly understood and should be addressed in the IP.
- It may be valuable to direct some Section 319 funding to conduct research on BMPs for confined canine units.

The final portion of the GWG meeting included a presentation by the U.S. Geological Survey (USGS) of holistic water budget modeling work they are performing for Fauquier County. The monitoring stations this initiative includes may present opportunities to contribute to water quality monitoring for the TMDL IP.

4.4 Steering Committee

The Steering Committee (SC) consisted of eleven representatives from the AWG, RWG, and GWG; GCA; Piedmont Environmental Council (PEC); JMSWCD; RRRC; DEQ; and ICPRB. Its members evaluated recommendations from working groups, reviewed BMP quantification and cost estimates, provided input to refine the draft implementation plan document, and evaluated materials and presentations for final public meeting.

The Loudoun County member of the Steering Committee provided additional input on the County's program for steam exclusion fencing for horse farms, their Water and Wastewater Community Assistance Program, and Loudoun County's conservation easement and riparian planting buffer programs. Steering Committee members also clarified goals of the Goose Creek Scenic River Advisory Committee and water quality monitoring work by the Goose Creek Association, Loudoun Wildlife Conservancy, and the John Marshall SWCD. The JMSWCD representative also stressed the importance of verifying estimated needs for livestock exclusion fencing and offered to oversee work to complete a field survey of true needs.

The Piedmont Environmental Council member updated the Committee on their conservation easement program work, which is approaching its goal that 50% of the land in the watershed be enrolled in a conservation easement program. The Loudoun Water representative clarified conventional and alternative septic systems inspection and maintenance requirements, and requested consultation on plans to increase septic system pump-outs so they can

plan for increased wastewater treatment needs. Finally, several members commented on the increased number of resident geese in the watershed, and suggested it would be valuable to include some measures – such as vegetated buffers around ponds – targeted to reducing the bacteria that geese add to local waters.

5. Implementation Actions

Implementation actions (aka BMPs or management measures) are the heart of the UGC Implementation Plan. Individual actions will incrementally improve water quality and, in sufficient quantities and combinations, will enable the streams in the plan area to be removed from the impaired waters list.

Drawing on the updated technical analysis and the extensive public input described in the previous sections, DEQ completed a comprehensive assessment and developed a customized suite of actions for the UGC watershed. This assessment identified and quantified bacteria reduction measures that can enable the impaired stream segments to be removed from the Virginia impaired waters list by the end of a 15-year implementation period. The proposed management measures are voluntary and are designed to be adaptable to respond to changes in water quality over the course of the IP's 15-year timeline.

The 2003 bacteria TMDLs called for elimination (100% reduction) of bacteria from failing septic systems (as well as any "straight pipe" sewage discharges), and direct deposition from cattle into area streams. In addition, the TMDLs identified a need to reduce by 98-99% the bacteria loads from pastures within the sub-watersheds of the plan area. The TMDL identified other sources of bacteria, such as wildlife and developed land, but their relative contributions are so small relative to total bacteria loads that no specific goals for their reduction are contained in the TMDLs.

It was decided that the IP should not place its entire bacteria source reductions on livestock exclusion, pasture, and failing septic system needs. Doing so would miss the opportunity to more broadly engage the local community in watershed protection and restoration, and could be perceived as inequitable by the agricultural sector.

Accordingly, DEQ has reviewed the original bacteria pollutant reduction scenarios contained in the 2003 TMDL report, and selected an alternative scenario (to the one used in the 2003 TMDLs). The alternative selected for this plan achieves the required reductions, but spreads load reductions more broadly to also include cropland, equine sources, stormwater, and pet waste. As a result, reductions required from pasture are reduced from the 98-99% levels called for in the TMDL to 75% as shown in **Table 5-1** below. Information on the methodology used to determine the reduction goals shown in **Table 5-1** is contained in the 2003 TMDL report (ICPRB 2003) and is also described in the Upper Goose Creek TMDL IP Technical Report (IP Technical Report).

Table 5-1. Major reductions required to meet delisting goals by bacteria source.

Load Reductions (%)	Bacteria Sources				
	Cropland	**Pasture**	**Developed Land (without failing septic systems)**	**Failing Septic Systems**	**Direct Deposition from Cattle**
Upper Goose, Cromwells Run, and Little River sub-watersheds	75	75	75	100	100

A wide range of management measures were considered to determine the desired suite of measures to include in the plan – they are presented in the **Attachment A (Table A-18).**

5.1 Agricultural Implementation Needs

Approximately 99% of the bacteria reductions needed to meet delisting requirements come from the agricultural sector (cropland, pasture, and direct deposition from cattle). Seventy-nine percent of the needed bacteria reductions come from pasture alone (see **Table A-12**, **Table A-13**, and **Table A-14** in **Attachment A**). The proposed management measures to achieve the required reductions include Livestock Exclusion Fencing (LEF) and Pasture Management (PM).

5.1.1 Livestock Exclusion Fencing

Removing livestock from riparian corridors and limiting their access to surface waterbodies is a priority management measure. The 2003 TMDLs set forth a 100% reduction goal for bacteria coming from livestock in the water. Complete elimination of livestock access to streams will provide about 20% of total bacteria reductions needed to achieve the bacteria WQS for the plan area. Studies show restricting livestock access to streams also increases livestock productivity and reduces incidence of disease through improved pasture and water quality.

There are 269 miles of streams in the IP area that could potentially be accessed by livestock. This estimate of stream exclusion needs was determined using DEQ's Guidance Manual for TMDL Implementation Plans (2003), by calculating the length of stream segments that intersect pasture lands within the IP area. As noted above, according to DCR records, the JMSWCD and LSWCD worked with landowners to install 100 miles of livestock exclusion fencing in the project area since 2002. To achieve the reduction target, it is currently estimated that 169 additional miles of livestock exclusion fencing is needed. **Table 5-2** provides a summary of the livestock exclusion opportunity analysis conducted and the amount of livestock exclusion fencing recommended in each sub-watershed in the IP area. **Figure 5-1** identifies the stream segments where livestock exclusion fencing is appropriate, but not yet in place. Full details of the recommended livestock exclusion measures are presented in **Table A-18** of **Attachment A**, and more information on how the specific suite of recommended BMP practices were selected is found in the IP Technical Report. As noted earlier, it is recommended that additional field survey work be undertaken to more precisely identify fencing needs.

Table 5-2. Summary of livestock exclusion opportunities by sub-watershed.

Description	Upper Goose Creek	Cromwells Run	Little River	Total
Length of total streambank fencing opportunities (feet)	807,449	233,513	377,634	1,418,596
Length of streambank fencing installed since 2002 (feet)	294,550	53,940	176,538	525,028
Length of remaining streambank fencing opportunities (feet)	512,899	179,573	201,096	893,568

The total cost of recommended livestock exclusion fencing for the IP area is approximately $5.8 million. The greatest share of these measures is proposed for Upper Goose Creek, at a cost of $3.4 million. The Cromwells Run and Little River sub-watersheds have similar fencing needs, each costing approximately $1.2 million. The specific types of exclusion systems proposed for each of the three sub-watersheds and the detailed cost information is shown in **Table 5-3**.

Figure 5-1. Location of livestock exclusion fencing opportunities.

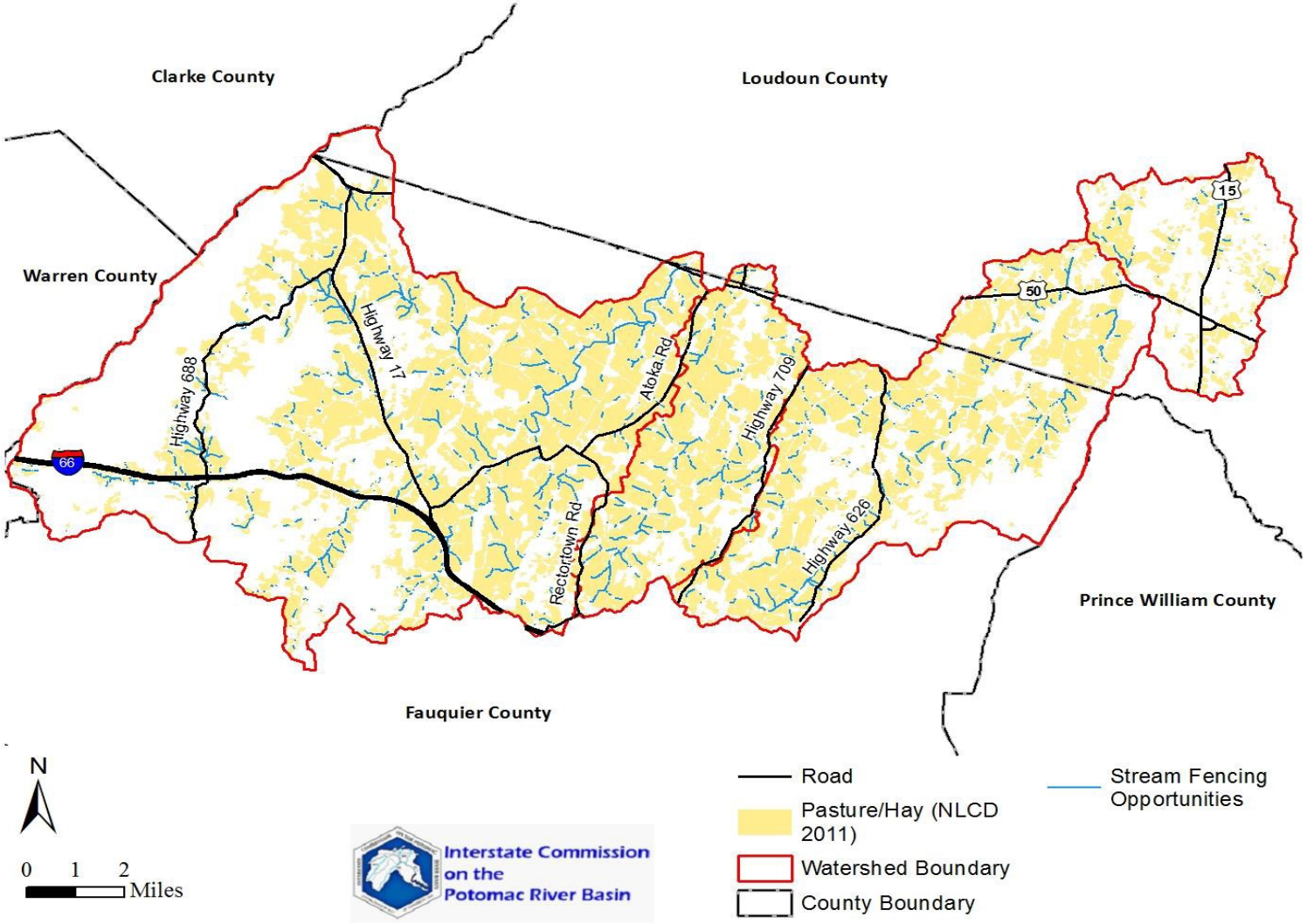
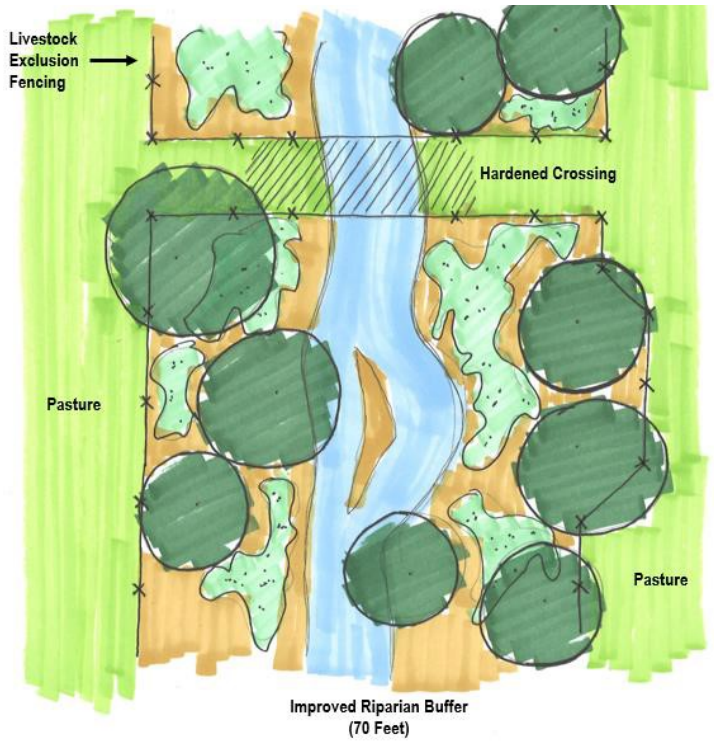


Table 5-3. Livestock exclusion management measures, average length (ft) per unit, average unit cost ($), and program division.

Livestock Exclusion System	Program Division (%)	Average Unit Cost ($)	Average Streamside Fencing (ft)	Upper Goose Creek		Cromwells Run		Little River		Total Estimated Cost ($)
				Units	Estimated Cost ($)	Units	Estimated Cost ($)	Units	Estimated Cost ($)	
Livestock Exclusion System (CREP, CRSL-6)	8	18,000	2,900	18	324,000	6	108,000	2	36,000	468,000
Livestock Exclusion System (EQIP)	11	15,000	4,080	18	270,000	4	75,000	2	30,000	360,000
Stream Exclusion with Grazing Land Management (SL-6)	20	36,000	3,680	28	1,008,000	10	360,000	11	396,000	1,764,000
Livestock Exclusion with Riparian Buffers (LE-1T)	30	36,000	3,680	42	1,512,000	15	540,000	16	576,000	2,628,000
Livestock Exclusion with Reduced Setback (LE-2 / LE-2T)	14	12,000	3,400	22	264,000	8	96,000	8	96,000	456,000
Stream Exclusion (CCI-SE-1)	14	1	N/A	47,268	47,268	23,634	23,634	55,146	55,146	126,048
Stream Protection (WP-2 / WP-2T)	2	2,500	2,691	3	7,500	1	2,500	2	5,000	15,000
Total Estimated Cost ($)	N/A	N/A	N/A	N/A	3,432,768	N/A	1,205,134	N/A	1,194,146	5,817,048

Multiple cost-share programs are available through DCR and DEQ to help off-set the capital costs of installing livestock exclusion fencing in the plan area. A typical livestock exclusion practice requires a 35-foot riparian buffer, and cost-share funding of 75-85% is available for stream fencing, cross fencing, and providing alternate water supplies for livestock. Approximately two-thirds of the recommended livestock exclusion measures are of this type. Hardened stream crossings may also be required as an effective way to allow livestock to cross the stream while minimizing negative water quality impacts and maintaining the benefits of installed buffers (**Figure 5-2**).

Figure 5-2. Livestock exclusion fencing with hardened stream crossing schematic.



For producers who are not able to dedicate 35 feet for a stream buffer, alternative livestock exclusion measures allow for a reduced setback (10 feet). Approximately one-third of the recommended stream exclusion fencing is of this type, which is supported with 60% cost-share funding; it is most appropriate for use along smaller tributaries or on smaller farm parcels.

Areas adjacent to G.R. Thompson State Wildlife Management Area and Sky Meadows State Park, along with the headwater streams of Cromwells Run and Little River, are high priorities for fencing. Many streams in these areas have full or partial livestock exclusion already installed and filling gaps or extending fencing systems further downstream will help maintain water quality conditions as flows move downstream from conservation areas and forested lands to agricultural working lands and developed areas.

An average 100-foot buffer along the main stem of Goose Creek is strongly encouraged, to the extent feasible, to help achieve state scenic river conservation goals. A 100-foot buffer will also provide bacteria reduction benefits from pasture as the larger riparian buffer can remove more bacteria and nutrients from runoff.

While not a requirement of livestock exclusion systems, improvements to riparian buffers are encouraged through planting of native plant species and tree plantings. An improved riparian buffer will increase bacteria and nutrient removal efficiencies providing additional water quality and habitat benefits. Landowners can partner with local watershed organizations, such as the Goose Creek Association, or schools to help improve the newly established riparian buffers. Loudon SWCD has a non-agricultural stream buffer planting project to support the creation of new riparian buffers.

5.1.2 Implementation Measures for Pasture and Cropland

Bacteria runoff from pasture and cropland accounts for about 79% of bacteria reductions required to achieve water quality goals in the IP area. In the Upper Goose Creek, Cromwells Run, and Little River sub-watersheds, bacteria load from pasture account for 74%, 88%, and 89% of the total baseline load, respectively (see **Table A-12**, **Table A-13**, and **Table A-14** in **Attachment A**).

The primary ways to reduce bacteria runoff from pasture or cropland include installing vegetative buffers, using improved pasture management or rotational grazing practices, reducing tillage, planting cover crops, and planting crops along field contours. Since 2002, these types of BMPs installed with funding from state cost-share programs have benefited 10,770 acres across the IP area. The majority of BMPs were installed in the Upper Goose Creek sub-watershed. While progress to reduce bacteria loads in the watershed has been steady since 2002, the bacteria reductions from pasture improvement measures completed between 2002 and 2016 only yielded approximately five percent of necessary reductions. Updated analysis shows that significant additional farm field improvements are required to achieve water quality goals. In total, the management measures included in the IP call for some 27,350 additional acres of pasture and cropland improvements.

Cropland contributes a small percentage (less than 1%) of overall bacteria to Upper Goose Creek, Cromwells Run, and Little River (see **Table A-12**, **Table A-13**, and **Table A-14** in **Attachment A**). Frequent crop rotation and conversion from cropland to pasture to hay are management measures that help reduce bacteria runoff from farm fields. Distributing water systems across pasture increases forage utilization and has been shown in some cases to allow farmers to increase animal density. Livestock exclusion fencing provides a benefit to pasture and therefore was also included in calculating total bacteria reductions from pasture lands. The efficiency of management measures to reduce bacteria runoff from pasture range from 50 to 99%, with most measures having bacteria reduction efficiencies of 50%.

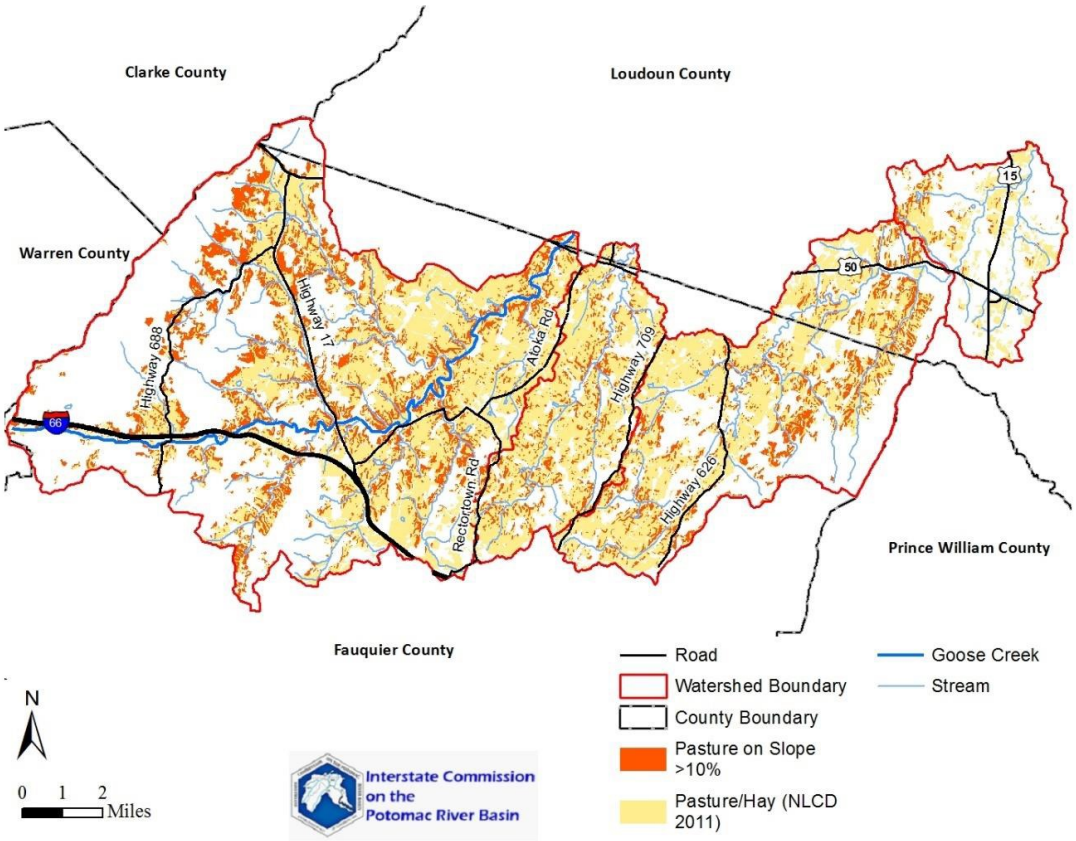
Table 5-4 provides a list of management measures to reduce bacteria runoff from pasture and cropland. Because the bacteria efficiency for each of these measures is 50 percent, the specific combination of management measures may be mixed and matched depending on the individual circumstances of each landowner and the resources available. Local SWCDs and stakeholders, working together, can find the optimal, site-specific combination of practices for each farm.

Table 5-4. Management measures to address bacteria runoff from pasture and cropland.

Pasture and Cropland Measures	Units for Tracking	Average Unit Cost ($)	Upper Goose Creek		Cromwells Run		Little River		Total Estimated Cost ($)
			Units	Estimated Cost ($)	Units	Estimated Cost ($)	Units	Estimated Cost ($)	
Reforestation of Erodible Cropland and Pastureland (FR-1)	Acres	450	2,600	1,170,000	--	--	400	180,000	1,350,000
Woodland Filter Buffer Area (FR-3)	Acres	1,500	10	15,000	--	--	--	--	15,000
Streambank Stabilization (WP-2A)	Linear Feet	150	33	4,950	33	4,950	33	4,950	14,850
Grazing Land Management (SL-9)	Acres	165	4,010	661,650	462	76,230	238	39,270	777,150
Pasture Management for TMDL Implementation (SL-10T / EQIP 528)	Acres	75	3,773	282,975	439	32,925	793	59,475	375,375
Permanent Vegetative Cover on Critical Areas (SL-11)	Acres	2,440	520	1,268,800	--	--	80	195,200	1,464,000
Conservation Tillage (SL-15A)	Acres	100	77	7,700	24	2,400	0	0	10,100
Cover Crops (SL-8B)	Acres	50	77	3,850	24	1,200	0	0	5,050
Grass Riparian Buffers (WQ-1)	Acres	165	5	825	5	825	0	0	1,650
Support for Extension of CREP Watering Systems (SL-7)	System	TBD	8	--	7	--	--	--	--
Sediment Retention, Erosion, or Water Control Structure (WP-1)	Drainage Area (acres)	870	3,750	3,262,500	--	--	36	31,320	3,293,820
Permanent Vegetative Cover on Cropland (SL-1)	Acres	175	10	1,750	10	1,750	10	1,750	5,250
Forage and Biomass Planting (EQIP - 512)	Acres	TBD	5	--	5	--	5	--	--
Total Estimated Cost ($)	N/A	N/A	N/A	6,680,000	N/A	120,280	N/A	511,965	7,312,245

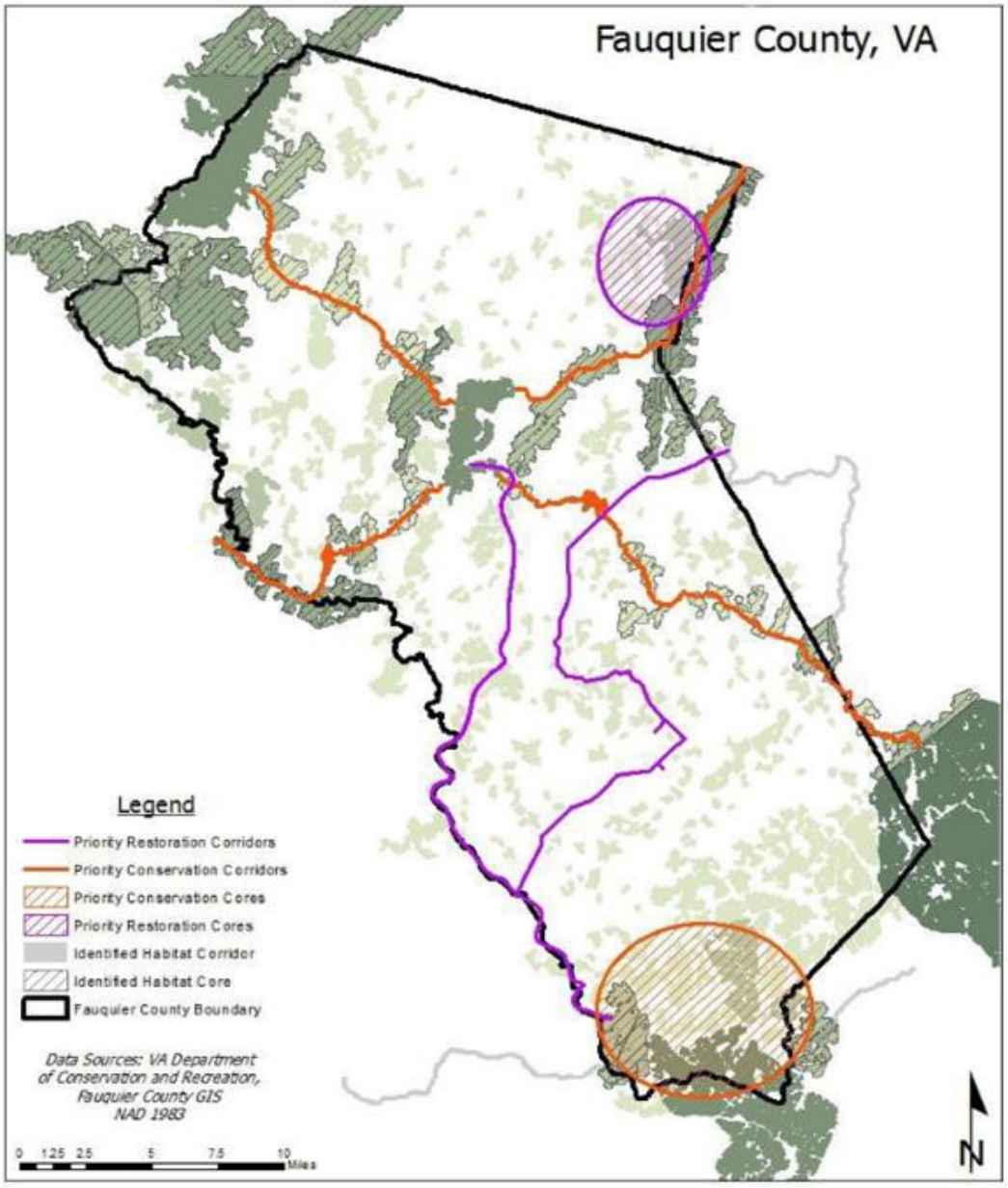
The total cost for the recommended pasture and cropland management measures is approximately $7.3 million, with the vast majority of these costs ($6.7 million) for Upper Goose Creek. Of these, nearly half ($3.3 million) is for Sediment Control, Erosion or Water Control structures due to the concentration of steep slope pasture there (**Figure 5-3**). These structures represent the highest cost BMP included in this IP, and are primarily included in Phase II, so that water quality improvements associated with the initial Phase I management measures can be assessed before final decisions are made for additional controls. The recommended pasture and cropland management measures for Cromwells Run and Little River are much less costly, at approximately $100 and $500 thousand, respectively. Taking out the Phase II Sediment Control, Erosion or Water Control structures, the overall cost of pasture and cropland measures for the entire IP area would drop from $7.3 to $4.0 million.

Figure 5-3. Location of pasture land on greater than ten percent slope.



A total of 3,600 acres of pasture land is on slopes greater than ten percent within the plan area Reforestation projects should be prioritized for these areas to stabilize slopes and reduce erosion and sedimentation of adjacent streams. In 2012 the University of Virginia conducted a green infrastructure study for Fauquier County which identified priorities for landscape restoration to maintain habitat cores and wildlife corridors. A wildlife corridor from G.R. Thompson State Wildlife Management Area crossing southeast across the IP area was identified (**Figure 5-4**), and restoration and conservation projects within these areas will contribute to achieving habitat and water quality goals. Reforestation projects in support of water quality improvement would provide additinal resource management benefits within this corridor area by also supporting county green infrastructure goals.

Figure 5-4. Priority restoration zones and wildlife corridors in Fauquier County (University of Virginia 2012).



Woodland filter buffers are strongly recommended where feasible to improve the bacteria reduction efficiency of livestock exclusion practices. Improving the stream buffer area along the main stem of Goose Creek is a priority to create a contiguous riparian corridor in the IP area. These management measures are considered land use conversion measures which achieve 99% reductions in bacteria coming from the acres to which they are applied. These buffers filter pasture runoff before it reaches the stream, producing additional water quality benefits. Stormwater management infrastructure can also be applied in agricultural settings to help manage runoff and prevent bacteria from entering local streams. Constructing stormwater infrastructure to manage runoff from pasture or fields can be cost prohibitive however, and should be considered only when other management measures are insufficient or contextually inappropriate.

5.1.3 Equine Management

Fauquier and Loudoun Counties are known for their bucolic horse farms nestled among historic sites along the foothills to the Blue Ridge Mountains. Since 2002, the area has seen a three percent growth in the horse population, and this trend is expected to continue. While the contribution to bacteria loads from equine activities in the Upper Goose Creek IP area is less than one percent, proactively working with owners and boarding operations to properly manage horse manure will help ensure bacteria is kept out of area streams. Proposed equine management measures were separated from the other agriculture BMPs to help identify opportunities for implementation and in obtaining funding assistance.

Figure 5-5. Horse manure composting micro-bins (McCormick Environmental, Inc n.d.).

Table 5-5 provides a list of management measures to address bacteria runoff specifically from horse farms that were identified at the agricultural working group meeting, in discussions with local stakeholders, and in consideration of potential funding opportunities. Composting in combination with improved pasture management is strongly encouraged. Composting facilities can vary in size and capital costs depending on the number of horses present at an individual farm. Small composting systems designed to handle manure from three to five horses cost about $1,200 to construct three micro-bins (**Figure 5-5**) while landowners with more than five horses will require larger systems. The Virginia Resource Conservation Service (NRCS) has developed a new(demonstration) manure composting management practice that is intended for application on horse farms.

Table 5-5. Management measures to address bacteria runoff from equestrian facilities.

Equine Measures	Average Unit Cost ($)	Upper Goose Creek		Cromwells Run		Little River		Total Estimated Cost ($)
		Units	Estimated Cost ($)	Units	Estimated Cost ($)	Units	Estimated Cost ($)	
Community Manure Composting Facility	$215,000	1	215,000	1	215,000	1	215,000	645,000
Equine Manure Storage / Composting	$1,200	152	182,400	49	58,800	122	146,400	387,600
Barnyard Runoff Controls	$20,000	50	1,000,000	16	320,000	40	800,000	2,120,000
Small Acreage Grazing Systems (SL-6AT)	$9,000	30	270,000	15	135,000	15	135,000	540,000
Total Estimated Cost ($)	N/A	N/A	1,667,400	N/A	728,800	N/A	1,296,400	3,692,600

Barnyard runoff controls are structures which collect and divert runoff from barnyard or associated buildings into areas of low environmental impact. These structures are similar to stormwater management practices applied in a barnyard setting; they store and filter nonpoint source pollution related to equine or other livestock.

During the first agricultural working group meeting, a community composting program was suggested as a way to provide options for smaller farms that lack room for on-site composting infrastructure. Such a program can reduce capital costs to individual farms while providing benefits to the environment and community. The Marshall Livestock Exchange and Mare Center were identified as potential sites for a pilot project. Under a proposed composting program, manure would be collected at a central composting facility and then sold or distributed to provide compost for gardening. **Figure 5-6** is an example of the scale of a proposed community composting facility. Further studies and discussion are required to determine the appropriate size of a facility and collection methods.

Figure 5-6. Community composting facility with stormwater BMP (O2Compost 2016).

Total costs for the recommended equine management measures are approximately $3.7 million. These are more evenly spread across the subwatersheds than the other agricultural BMPs discussed above. Upper Goose Creek has the greatest needs, at $1.7 million, with Little River close behind at $1.3 million and an additional $0.7 million needed for Cromwells Run.

5.2 Residential Implementation Needs

All non-agriculture sources of bacteria are referred to as residential and include sources from septic systems, pets, and stormwater. Bacteria contributions from residential sources are less than one percent of the total bacteria load in the plan area (see **Table A-12**, **Table A-13**, and **Table A-14** in **Attachment A**). Reducing these sources of bacteria will incrementally improve water quality and can also help address issues such as localized flooding through implementation of stormwater BMPs.

5.2.1 Septic Systems

Due to the rural nature of the region, the majority of the plan area is served by private septic systems. Proper design and maintenance of these systems is required to prevent bacteria from entering surface water and groundwater resources. Using updated population and household data, an estimated 2,158 septic systems existed in the IP area in 2014. According to the county health departments, the septic system failure rate is 1.6% (35 septic systems per year). There are no known straight pipes that convey raw sewage to plan area streams; however local representatives believe that greywater straight pipes may exist. Greywater comes from household or business sinks, showers, clothes or dish washing machines and other sources that have no fecal contamination.

Since 2002, Fauquier County has repaired or replaced 129 systems, and additional households were connected to existing or expanded municipal sewer treatment plants. If Fauquier and Loudoun counties continue repairing and replacing septic systems at their current rates, bacteria reduction targets from septic systems will be achieved.

Table 5-6 describes management measures to help support existing county programs. These measures were identified to achieve necessary load reductions at the working group meetings, in discussions with local stakeholders, and in consideration of potential funding opportunities. Municipal codes in Fauquier and Loudoun counties require homeowners to pump-out their septic systems once every five years to prevent bacteria from reaching local waterways (Fauquier County 2016; Loudoun County 2015). Distributing proper maintenance guidelines and pump-out reminders can inform homeowners of their obligations and prevent septic system failure.

Table 5-6. Management measures to address bacteria loads from septic systems.

On-Site Sewage Disposal System Measures	Program Division (%)	Average Unit Cost ($)	Upper Goose Creek		Cromwells Run		Little River		Total Estimated Cost ($)
			Units	Estimated Cost ($)	Units	Estimated Cost ($)	Units	Estimated Cost ($)	
Septic Tank Pump-out (RB-1)	100*	300	2,790	837,000	615	184,500	3,069	920,700	1,942,200
Septic Connection to Public Sewer System (RB-2)	4	12,500	--	--	--	--	21	262,500	262,500
Septic System Repair (RB-3)	76	3,500	188	658,000	9	31,500	208	728,000	1,417,500
Septic System Installation / Replacement (RB-4)	7	6,000	12	72,000	12	72,000	12	72,000	216,000
Septic System Installation / Replacement with Pump (RB-4P)	8	8,000	15	120,000	15	120,000	15	120,000	360,000
Alternative On-Site Systems (RB-5)	5	25,000	10	250,000	4	100,000	10	250,000	600,000
Total Estimated Cost ($)	N/A	N/A	N/A	1,937,000	N/A	508,000	N/A	2,353,200	4,798,200

*All septic systems are required by the counties to be pumped out at least every five years.

Households located in a municipal wastewater treatment service area should be encouraged to connect to the public sewer system. Over the course of the 15-year implementation timeline, there may be opportunities to connect residents to existing wastewater treatment facilities. The residential BMP cost-share program can partially offset the capital cost of connecting a residence to wastewater treatment facility sewer systems. This IP estimates the potential for 21 new connections based on the number of existing connections and total parcels within sewer service areas. To maximize additional public sewer system connections, increased low income household assistance through other grant or micro-loan programs should be made available when possible. To help meet this need, DEQ is proposing changes to its 2018 Residential Septic BMPs to provide a higher rate of cost-share for low income areas and individuals. For the lowest income residents in fiscally distressed areas, the cost-share is increased from the current uniform rate of 50% to 90%.

The total cost of recommended measures to address bacteria loads from residential septic systems is approximately $4.8 million. The majority of these costs are associated with pumping out nearly 6,500 septic systems, and repairing approximately 400 systems. The distribution of these costs links to existing population patterns within the plan area, with Little River having the greatest needs at $2.4 million, followed by Upper Goose Creek ($1.9 million) and Cromwells Run ($0.5 million).

5.2.2 Pet Waste

Waste from dogs, accounts for approximately 20% of bacteria entering local waterways from residential sources (for a description of the methodology used to calculate pet waste contributions, see the TMDL review and update in the IP Technical Report). During rain events, bacteria from dog waste can run off from lawns into local streams. Proper disposal of dog waste will eliminate associated bacteria from reaching local waterways, while also keeping public parks and gathering places cleaner.

Table 5-7 lists the management measures to address pet waste in the IP area. Mickie Gordon Memorial Park, along Main Street in The Plains, West Main Street and Community Center in Marshall are recommended locations to install pet waste stations. Installing waste stations and signage in Sky Meadows State Park and G.R. Thompson State Wildlife Management Area parking lots also help to remind pet owners to pick up after their dogs. Neighborhood homeowner associations are also encouraged to install pet waste stations.

Table 5-7. Management measures to address bacteria runoff from pet waste.

Pet Waste Measures	Average Unit Cost ($)	Upper Goose Creek		Cromwells Run		Little River		Total Estimated Cost ($)
		Units	Estimated Cost ($)	Units	Estimated Cost ($)	Units	Estimated Cost ($)	
Pet Waste Stations	500	2	1,000	2	1,000	6	3,000	5,000
Pet Waste Composters	50	9	400	8	400	8	400	1,200
Confined Canine Unit (CCU)	6,000-20,000	2	12,000-40,000	2	12,000-40,000	1	6,000-20,000	30,000-100,000
Pet Waste Education	5,000	1	5,000	1	5,000	1	5,000	15,000
Total Estimated Cost ($)	N/A	N/A	18,400-46,400	N/A	18,400-46,400	N/A	14,400-28,400	51,200-121,200

There are five kennel operations in the IP area. Kennels have a higher concentration of pet waste due to the nature of their business, and are important opportunities for water quality improvement. Several approaches to managing waste are available to kennel owners including dry stackers, septic systems, and

hauling waste directly to landfills. The cost of these measures varies depending on the selected approach (see CCU's in **Table 5-7**)

A robust education and outreach campaign is recommended to inform pet owners of the importance of picking up after their pet. Distributing dog waste bag leash holders is an inexpensive and popular way to improve public awareness and change pet owner behaviors. Events at the Upperville Showgrounds, Warrenton Horse Show, and local farmers markets are prime opportunities to distribute educational materials.

The cost for recommended pet waste management measures is a very small portion of total management measure needs for the plan area. These costs are quite evenly distributed among the three sub-watersheds, and are estimated at between $50 and $120 thousand, with the actions taken to address confined canine units (kennels) being the variable factor.

5.2.3 Stormwater

Stormwater BMPs can help achieve numerous water quality objectives by filtering and retaining pollutants during and after storm events. Stormwater runoff from developed land accounts for less than one percent of the total bacteria load (and the majority of this bacteria is linked to pet waste), so the measures described here are pilot projects to serve as community demonstrations of best practices. Their value is as much or more in strengthening public awareness of actions individuals can take to protect and restore water quality as in the actual bacterial source reduction achieved.

The proposed measures in **Table 5-8** are meant to serve as few highly visible BMPs to increase awareness of the benefits these systems provide for water quality, flood reduction, and streetscape enhancement (**Figure 5-7**). County government facilities such as schools may provide ideal locations for installation of demonstration stormwater BMPs especially when capital improvements are already planned. For example, permeable pavement can be installed when parking lots need resurfacing.

Figure 5-7. Bioswale to catch runoff from parking lot, Marshall, Virginia (September 2016).

Costs associated with the limited pilot projects recommended to demonstrate sound stormwater management practices are modest, at less than $100,000. In the long-term, reducing impervious surfaces in the plan area would most effectively reduce the transport of pollutants in stormwater. Impervious surfaces can be reduced through adoption of county policies, voluntary actions taken as a result of citizen education campaigns, and through public investment in alternative infrastructure (e.g. porous pavement and other low-impact development measures). Putting these practices in place during new or re-development can be very cost effective, while retrofitting existing development to reduce impervious surfaces can be quite costly.

Table 5-8. Management measures to address bacteria pollution from stormwater.

Stormwater Measures	Units for Tracking	Average Unit Cost ($)	Upper Goose Creek		Cromwells Run		Little River		Total Estimated Cost ($)
			Units	Estimated Cost ($)	Units	Estimated Cost ($)	Units	Estimated Cost ($)	
Vegetative Riparian Buffers (Residential)	Drainage Area (acres)	3,500	--	--	--	--	20.5	71,750	71,750
Rain Barrels	System	150	1	150	1	150	1	150	450
Redirecting Residential Downspouts	Roof Area (acres)	100	0.6	60	0.2	20	0.7	70	150
Porous Pavement	Area Treated (sq ft)	7.5	250	1,875	250	1,875	500	3,750	7,500
Rain Gardens	Area Treated (sq ft)	4	250	1,000	250	1,000	500	2,000	4,000
Infiltration Trench	Area Treated (acres)	11,300	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Total Estimated Cost ($)*	N/A	N/A	N/A	3,085	N/A	3,045	N/A	77,720	83,850

*These values do not include costs associated with infiltration trenches

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5.3 Other Potential Implementation Needs

5.3.1 Education and Outreach

As has been noted in individual sections above, education and outreach programs are important to the successful implementation of proposed management measures. Informing residents of the importance of protecting local water quality and increasing their awareness of the programs available to partially off-set capital costs to install management measures will support successful implementation of this plan. Ongoing education and outreach also provides an opportunity for residents and stakeholders to provide feedback to inform plan implementers of adjustments that may help meet reduction goals during implementation. **Table 5-9** provides a list of the proposed education and outreach programs, some which currently exist and could benefit from integration with other watershed protection efforts.

The programs that comprise the education and outreach component of the IP are:

- ***Septic System Education and Septic System Education for Area Realtors:*** Information about septic system maintenance and septic system owner obligations under municipal codes can be disseminated as mailers in utility bills, refrigerator magnets, or similar materials. Outreach to area realtors will enable them to inform prospective homeowners of their obligations when purchasing a home with a septic system. Information about cost-share programs should be broadly distributed, and also targeted to lower income households.
- ***Incorporate Water-Related Curriculum into Area Classrooms:*** The Virginia Department of Education (DOE) requires watershed-related curriculum as part of 3rd through 6th grade science education. Local watershed organizations like the Goose Creek Association can ensure students receive a "meaningful watershed experience," as called for by DOE. These programs can provide a "sense of place" for the children, engage parents in local water quality, and bring communities together to find solutions.
- ***Student Field Trips:*** In collaboration with the Goose Creek Association and other local watershed groups, organize student field trips to areas in the plan area where management measures have been installed to support the lessons taught in the classroom.
- ***Farm Days:*** Both Fauquier and Loudoun counties organize farm day events to provide residents a chance to meet local farmers and learn how their food is produced. These events also can highlight farms that have incorporated best management measures.
- ***Distribute Educational Materials at Farmers Market:*** Farmers markets provide a great venue to provide information to stakeholders on water quality improvement measures. A booth can be setup a few times a year to distribute materials to local stakeholders.
- ***Horse Pasture Management Education:*** Distributing education and outreach information to horse owners can inform this growing segment of the watershed of opportunities to meet multiple, complementary objectives. Many opportunities exist to engage residents, including the Marriot Ranch spring event, farm demonstration days, livestock auctions, organized community hunts, and through the Cattleman's Association.

Information should be distributed through a variety of communication mediums including social media, print media, newsletters, and radio advertisements. Working with local veterinarians to increase awareness of cost-share programs and benefits of improved pasture management and livestock exclusion provides another educational opportunity. The total estimated cost for all of these education and outreach activities is approximately $28,000.

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Table 5-9. Education and outreach programs.

Education and Outreach Measures	Units for Tracking	Average Unit Cost ($)	Upper Goose Creek		Cromwells Run		Little River		Total Estimated Cost ($)
			Units	Estimated Cost ($)	Units	Estimated Cost ($)	Units	Estimated Cost ($)	
Septic System Education	Program	2,500	1	2,500	1	2,500	1	2,500	7,500
Septic System Education for Area Realtors	Program	625	1	625	1	625	1	625	1,875
Incorporate Water-Related Curriculum into Area Classrooms	Program	1,000	1	1,000	1	1,000	1	1,000	3,000
Organize Student Field Trips to observe WQ BMPs	Program	1,000	1	1,000	1	1,000	1	1,000	3,000
Organize Farm Day Events	Program	1,000	1	1,000	1	1,000	1	1,000	3,000
Distribute Education Materials at the Farmers Market	Program	625	1	625	1	625	1	625	1,875
Horse Pasture Management Education	Program	2,500	1	2,500	1	2,500	1	2,500	7,500
Total Estimated Cost ($)	N/A	N/A	N/A	9,250	N/A	9,250	N/A	9,250	27,750

5.3.2 Assessment of Technical Assisstance Needs

Implementation of the actions called for in this plan are voluntary actions, and therefore will require local leadership and highly active community engagement. This will be accomplished through a full-time technical advisor funded by future grants. Technical assistance costs were estimated for Phase I (years 1-10) of the project assuming one full-time position, at a cost of $50,000/per year. The same level of technical assistance should continue for Phase II, bringing a total cost of $750,000 for the entire 15-year duration of the IP. (These figures are based on the existing staffing costs for Soil and Water Conservation Districts who are currently administering TMDL implementation projects in the Commonwealth).

6. Cost of Implementation

The total estimated costs for measures recommended as part of Phase I come to $12.3 million. The additional measures that constitute Phase II of this IP cost another $10.3 million, for a total IP cost estimate of $22.6 million. Total costs are summarized for agricultural and residential measures in **Table 6-1**. A detailed description of costs is provided in **Attachment A, Table A-20**.

Table 6-1. Estimated cost of recommended agricultural and residential management actions (in $thousands) by sub-watershed.

BMP Type	Upper Goose Creek	Cromwells Run	Little River	TOTAL
Agricultural	$11,780	$2,054	$ 3,002	$ 16,836
Residential	$1,995	$ 566	$ 2,468	$ 5,029
Total	$13,775	$ 2,620	$ 5,470	$ 22,615*

*Includes $750K in technical assistance which is not allocated across sub-watersheds.

7. Benefits of Management Measures

The primary objective for this plan is to meet the delisting requirements for bacteria in the plan area. Resolving the issues that cause the bacteria impairment, however, will improve more than just pollution from bacteria. Numerous direct and indirect improvements made through implementation of the management measures include economic benefits to local agricultural producers, improved ecosystem health and habitat creation, cleaner drinking water, enhanced recreation and tourism to benefit the local economy, and more engaged and proactive community support for watershed protection. Further, the measures implemented as a part of this plan also contribute to protecting the Chesapeake Bay and making progress towards meeting the Chesapeake Bay TMDL. Benefits of agricultural, residential, and education and outreach practices are discussed in more detail in the sections below.

7.1 Agricultural Practices

Agricultural management measures (e.g. livestock exclusion, pasture and cropland, and equine practices) have numerous potential benefits in addition to reducing instream bacteria. Keeping livestock out of the stream through installation of watering systems, stream fencing and crossings, riparian buffers, and other measures has the added benefit of preventing the spread of cattle diseases like salmonella, leptospirosis, and mastitis (Nordstrom 2016). Additional livestock benefits of increased access to clean water can include weight gain, increased milk production, and decreased foot rot (DEQ 2016). Benefits like these have been documented in the plan area where BMPs have already been installed (personal communication, first IP public meeting, 6/21/2016).

Stabilizing streambanks, installing sediment retention structures, creating vegetative buffers, and reforestation of erodible lands reduce pollutant transport to the stream, thereby improving aquatic habitat and preventing costly water quality treatment for downstream drinking water utilities. These measures also create and/or improve existing aquatic and terrestrial wildlife habitats, while directly addressing the additional water quality impairments caused by excess sediment releases in the Goose Creek watershed.

Pasture and cropland management measures can increase profitability for the producer by reducing the amount of purchased feed required (DEQ 2016).

7.2 Residential Practices

Although residential contributions to the bacteria impairment are modest in the plan area (contributing less than one percent of the total bacteria load), residential measures like repair and replacement of septic systems, implementation of pet waste controls, and stormwater management efforts have a number of additional benefits. For example, proper septic tank maintenance extends the life of the system, saving the homeowner money. In addition, stormwater measures can help address issues such as localized flooding. Rain gardens and rain barrels can decrease water bills by reducing the amount of potable water used for irrigation. Residential measures also encourage community involvement and education, discussed below.

7.3 Education and Outreach

Participation of a wide range of local stakeholders will be required to fully implement the plan and achieve water quality goals. This wide-reaching involvement necessitates education and outreach. By providing the local community with awareness of the problem, knowledge of the issues, and skill and knowledge of actions that need to be taken, the community is more likely to act on these and other problems now and in the future (Hungerford and Volk 1990).

8. Measurable Goals and Milestones for Attaining Water Quality Standards

Delisting the impaired waters in the plan area is the ultimate goal of this plan. As noted, the IP will be carried out in two phases. Phase I covers the first ten years of implementation (2017 to 2026). The measures selected for Phase I are considered those most important to achieving near term improvements in water quality. Phase II is the final five years (2027 to 2031), and will seek to improve water quality to meet standards for delisting. These measures should be reevaluated toward the end of Phase I, in light of water quality monitoring results, and may be altered or not implemented depending on the water quality improvements achieved as a result of Phase I BMPs.

Progress toward end goals will be assessed during the implementation process through tracking of BMP installations and through ongoing water quality monitoring. BMP installation milestones will track the percentage of implementation actions put into place over specified timeframes. Water quality monitoring activities will measure improvements in water quality over time as a result of BMP installation progress. These complementary approaches to assessing progress are inextricably linked because the proposed management measures are designed to reduce ambient bacteria levels in streams to achieve water quality standards for the Upper Goose Creek watershed plan area.

High priority practices for the first phase of implementation include improved pasture management and livestock exclusion from streams. These practices will provide the greatest extent of water quality benefits while also offering increased economic returns to agricultural producers. The Phase I goal is installation of approximately two-thirds (65%, or approximately 110 miles) of the total planned livestock exclusion fencing. While improved

pasture management and livestock exclusion are priority practices for Phase I, implementation efforts will be driven by what local landowners are interested to install on their property. When producers are interested, opportunities to transition pasture to permanent forest or other native vegetation as part of nutrient banking should also be pursued during Phase I. More aggressive implementation of reforestation and buffer measures is envisioned during Phase II after other management measures have been implemented (and will be informed by monitoring results and BMP implementation progress).

Measures to reduce equine bacterial loads should be implemented evenly across Phases I and II. The complexities and high capital costs of establishing a community composting program make it unlikely to complete the three planned composting facilities before the end of Phase II, with one regional composting facility coming online every five years beginning in 2021. Measures to improve barnyard runoff nonpoint source pollution should be implemented beginning in Phase I.

Fauquier and Loudoun Counties are effectively addressing failing septic systems across the IP area. The counties should continue to implement their current programs to repair or replace failing systems during Phases I and II. These programs can be supplemented by residential septic BMPs that would be a normal component of Sec. 31 grants that may be awarded to support implantation of the actions recommended in this plan.

The recommended stormwater BMP pilot projects should be installed within the first five years of Phase I if funding is available. Since these projects are meant to spur interest in implementing such measures throughout the plan area, they will have greatest value if installed in the early years of implementation. Management measures to address bacteria from pets should also be implemented during Phase I; however, extending implementation through Phase II for pet waste and stormwater management will not delay achieving the water quality of the Upper Goose Creek IP.

Finally, education and outreach programs and technical assistance will be on-going in Phases I and II. As noted, some education and outreach programs currently exist or have existed in the past. Work with local organizations and other partners can increase and improve citizen-led monitoring efforts during Phase I and II.

Details on the management measures called for during each phase of the plan, the number of units of each recommended measure, and the associated costs are included in **Attachment A** (see **Table A-19**, **Table A-20**, and **Table A-21**).

9. Water Quality Monitoring

The proposed monitoring program builds on ongoing efforts to facilitate evaluation of trends over time and assess progress towards achieving the bacteria water quality criteria. DEQ, in collaboration with local partners, will periodically evaluate the monitoring data to determine progress towards implementation goals. Proposed monitoring includes 1) continued DEQ monitoring, 2) citizen monitoring and, 3) additional monitoring. Each of these is discussed in more detail below.

9.1 DEQ Monitoring

DEQ regularly conducts monitoring in the IP area as part of its overall water quality monitoring program for the Commonwealth. Within the plan area, there is one DEQ monitoring program "Trend" station, at which WQ monitoring samples are taken bi-monthly every year, and two more Trend stations are located on Goose Creek below the IP area. In addition to these high frequency monitoring stations, on a five-year cycle DEQ samples other sites as a part of its probabilistic monitoring program, and other DEQ monitoring occurs periodically to meet specific program needs. These monitoring efforts will continue and be adapted as necessary to evaluate progress towards meeting the bacteria water quality criteria. DEQ's current network of monitoring stations within

the IP watersheds is shown in **Figure 1-3**. Data collected by DEQ are used in the water quality assessment, which determines whether waters are meeting water quality standards. Assessment results are submitted as an Integrated Report to the US EPA every two years, as required by the Clean Water Act.

9.2 Citizen Monitoring

Citizen water quality data can be greatly improve the understanding of water quality conditions over time. For almost 15 years, the Goose Creek Association (GCA) has conducted water quality monitoring at many locations throughout the entire Goose Creek watershed, including within the plan area. This monitoring has included both chemical and benthic community parameters, with sustained monitoring of benthic community health. Bacteria data collected by GCA have been designated as Level II data through the DEQ citizen water quality monitoring program. Level II data may be used to educate the community, assist Soil and Water Conservation Districts in prioritizing BMPs for implementation, and track performance of TMDL implementation.

These data are submitted to DEQ and may be used to identify waters for DEQ follow-up monitoring. While these data are a part of the water quality assessment, Level II data is not be used by DEQ to directly determine whether waters are meeting their water quality standards. Citizen monitoring data must be designated as Level III, and collected with protocols that are equivalent to those used by the DEQ water quality monitoring program, to be used for water quality assessment determinations. DEQ and GCA will collaborate on the location of monitoring sites to optimize coverage and avoid unnecessary duplication in future monitoring efforts to track performance under this TMDL implementation plan,

9.3 Additional Monitoring

Site specific monitoring efforts may assist in evaluation of management measure effectiveness and add flexibility within an adaptive implementation framework. To this end, collaboration with partners to design additional monitoring efforts will assist in the successful implementation of this plan. During the course of stakeholder discussions, several existing groups including USGS and Fauquier County's Emergency Management Planning mentioned an interest in contributing to the water quality monitoring efforts (personal communication, government working group meeting, 9/8/2016). USGS is conducting a five-year project with Fauquier County to assist in developing a holistic water budget for the county. Although this project is focused on water quantity – specifically how changes in precipitation affect the water budget – there may be opportunities for a collaborative effort to assist in obtaining water quality measurements. Fauquier County's Emergency Management Planning may be able to assist with basic water quality monitoring efforts if funding is identified. In addition, The John Marshall SWCD has technical capability and interest to conduct supplement water quality monitoring grant projects.

10. Stakeholder Roles and Responsibilities

10.1 Agricultural and Residential Landowners

Since nonpoint sources of runoff to streams is the dominant cause of the bacteria impairment of the Upper Goose Creek watershed, action by the many local landowners within the watershed is essential to achieving the water quality restoration goals of this plan. While actions are required by many, and the cost of these actions can be significant, government agencies are able to provide both technical and financial assistance to landowners to support their efforts to carry out the actions called for. Local governments, and local SWCD and NRCS staff are uniquely positioned to serve as a liaison between individual landowners and the government agencies and programs that can assist them in addressing the sources of bacteria pollution. Their personal knowledge of the local communities, local economy, and natural resources positions them well to foster the collective actions required to achieve this plan's goals.

10.2 John Marshall Soil and Water Conservation District and Loudoun Soil and Water Conservation District

The JMSWCD and LSWCD have considerable technical assistance capabilities to offer to landowners within the watershed. Together with NRCS, the local SWCDs continually reach out to farmers within their watersheds to provide conservation practice technical expertise. In the absence of this plan, these Districts would not have the ability to dedicate staff focused solely on the Upper Goose Creek watershed and this would limit the ability to achieve the ambitious BMP implementation measures called for. With dedicated staffing for the local watersheds, local SWCDs can provide agricultural BMP design and layout assistance to individual producers. Their staff will more broadly communicate with landowners in the watersheds to help advance environmental education and encourage participation in conservation programs, both agricultural and residential programs that focus on septic systems, pet waste and stormwater management. This IP meets the requirements for funding eligibility under EPA's Section 319 program, for which JMSWCD and LSWCD may apply for grant assistance to enable them to target their expertise to landowners.

10.3 Fauquier and Loudoun Counties

Decisions made by local government staff and elected officials regarding land use and zoning will play an important role in the implementation of this plan. This makes Fauquier and Loudoun County government key partners in long term implementation efforts. Approximately 84% of the upper watershed area falls within Fauquier County, so it will have a relatively greater role in the plan's implementation. Both Fauquier and Loudoun Counties administer conservation programs which have helped to encourage land conservation across the counties. Since 1979 when both counties created their Agricultural and Forestal District Programs, Fauquier County has established 13 districts covering over 78,000 acres, and Loudoun County has established 22 districts with over 43,000 acres located throughout the county (Fauquier County 2016b; Loudoun County 2017).

Based on feedback from the public meeting and working group discussions, residential land development is a significant issue in the eastern portion (Little River) of the watershed, with the number of working farms in the area declining in recent years. Local government support of land conservation will become increasingly important as greater numbers of conservation measures are implemented across the watersheds.

As has been noted earlier, both counties have very active and effective residential septic system programs, as well as limited plans to expand wastewater treatment facility capacity and connections. Also, both counties will serve as key partners in residential stormwater BMP outreach and implementation and may assist with the promotion of pet waste BMPs including composters and pet waste stations.

10.4 Virginia Department of Environmental Quality

The Virginia Department of Environmental Quality has a lead role in the development of TMDL implementation plans. DEQ also provides available grant funding and technical support for TMDL implementation, and will work closely with project partners to track implementation progress. In addition, DEQ will work with interested partners on grant proposals to provide grant funds for projects included in the implementation plan.

DEQ is also responsible for monitoring state waters to determine compliance with water quality standards. DEQ will continue monitoring water quality in Upper Goose Creek, Cromwells Run, and Little River and their tributaries in order to assess water quality and determine when restoration has been achieved and the streams can be removed from Virginia's list of impaired waters.

10.5 Virginia Department of Conservation and Recreation

The Virginia Department of Conservation and Recreation (DCR) administers the Virginia Agricultural Cost Share Program, working closely with Soil and Water Conservation Districts to provide cost share and operating grants needed to deliver this program at the local level and track implementation. In addition, DCR administers the state's Nutrient Management Program, which provides technical assistance to producers in appropriate manure storage and manure and commercial fertilizer.

10.6 Virginia Department of Forestry

The Virginia Department of Forestry (DOF) has prepared a manual to inform and educate forest landowners and the professional forest community on proper BMPs and technical specifications for installation of these practices in forested areas (http://dof.virginia.gov/infopubs/BMP-Technical-Guide_pub.pdf, accessed 5/15/2017). Forestry BMPs are primarily directed to control erosion. For example, streamside forest buffers provide nutrient uptake and soil stabilization, which can benefit water quality by reducing the amounts of nutrients and sediments that enter local streams. Although the DOF's BMP program is intended to be voluntary, it becomes mandatory for any silvicultural operation occurring within state waters (VA Silvicultural Water Quality Law 10.1-1181.2). *For more information:* visit Chapter 10 in the aforementioned manual.

10.7 Virginia Department of Health

The Virginia Department of Health (VDH) is responsible for adopting and implementing regulations for onsite wastewater treatment and disposal. The Sewage Handling and Disposal Regulations require homeowners to secure permits for handling and disposal of sewage (e.g. repairing a failing septic system or installing a new treatment system). VDH staff provide technical assistance to homeowners with septic system maintenance and installation, and respond to complaints regarding failing septic systems and straight pipes.

10.8 Other Potential Local Partners

There are numerous additional opportunities for future partnerships in the implementation of this plan. Additional potential partners in implementation include:

10.8.1 Virginia Cooperative Extension

Both Fauquier and Loudoun Counties have local offices of Virginia Cooperative Extension (VCE). These offices in Warrenton (Fauquier) and Leesburg (Loudoun) connect residents to Virginia's land-grant universities, Virginia Tech and Virginia State University. Through educational programs based on research and developed with input from local stakeholders, VCE offices help improve local communities with programs in Agriculture and Natural Resources, Family and Consumer Sciences, 4-H Youth Development, and Community Viability. *For more information:* http://ext.vt.edu/, accessed 5/15/2017.

10.8.2 Piedmont Environmental Council

The Piedmont Environmental Council (PEC) was formed in 1972 and works with the citizens of its nine-county region to conserve land, create high-quality communities, strengthen rural economies, celebrate historic resources, protect air and water quality, build smart transportation networks, promote sustainable energy choices, restore wildlife habitat, and improve people's access to nature. PEC works to empower citizens to protect what makes the Piedmont a wonderful place and encourage them to pursue a positive vision for the region's future. PEC has a long history of working with land owners to conserve their land through easements. Forty percent of the entire Goose Creek watershed is under conservation easement currently, and many properties in the UGC planning area

have been protected. PEC is now working to strengthen older easements to improve their water quality protections and increase the percentage of eased land in the watershed to fifty percent in the near-term, with a long-term target of seventy to eighty percent under easement in the watershed. *For more information:* http://www.pecva.org/, accessed 5/15/2017.

10.8.3 Goose Creek Association

The GCA was founded in 1970 to fight the discharge of sewage effluent into Goose Creek. Today the association addresses a broad array of issues, with an active board charged with monitoring stream water quality, proposed developments, legislation, zoning changes and other actions. Maintaining and improving the quality of the Goose Creek watershed is the overarching goal of the Association's efforts. GCA works together with many other conservation and preservation efforts to provide a unified voice for conservation/preservation–minded citizens in the area. *For more information:* http://www.goosecreek.org/, accessed 5/15/2017.

11. Integration with Other Planning Initiatives

11.1 Fauquier County Groundwater Study

In January 2016, USGS and the Virginia Water Science Center presented a Groundwater Resource Assessment and Monitoring Proposal to the Fauquier County Board of Supervisors. This proposal would focus on achieving the following objectives: (1) develop a county-wide water budget model to characterize hydrologic conditions affecting county aquifers; (2) couple groundwater and surface water monitoring to enable an assessment of the relationship of groundwater withdrawals and base stream flows; and (3) begin to collect data and develop tools to estimate the impacts of the county's population growth on its water resources. Fauquier County has initiated the five year USGS project and completed the water balance model.

11.2 Fauquier County Natural Resources Plan

In May 2016, the Fauquier County BOS adopted Chapter 2, Section A "Natural Resources" policy. Among its objectives are the following:

- Develop and implement a broad-based and robust water management program,
- encourage the establishment of stream buffers for water quality protection,
- seek to reduce pollution to our natural waters and stormwater systems, and
- identify fully functioning and healthy surface waters and explore means to sustain and maintain these baseline conditions.

11.3 Loudoun County Comprehensive Watershed Management Plan

In 2006-08, Loudoun County pursued an ambitious overall plan for watershed management, with technical assistance (via EPA and NFWF grants) from the University of Virginia and CH2M Hill. The proposed comprehensive framework for county-wide watershed management was presented to the Board of Supervisors in March 2009, with recommendations for implementation. In 2014 a detailed watershed plan for Upper Broad Run was completed under this framework. Additional watersheds, including parts of the Goose Creek watershed, may be the focus of future detailed plans.

11.4 Goose Creek Scenic River Advisory Committee

This Committee, which is formally sanctioned by the Commonwealth of Virginia, actively reviews proposed land use changes and development activities in the Goose Creek watershed. The Committee works to promote environmental enhancements in development proposals, including increased use of riparian buffers. Ideally planted in trees and bushes, these buffers help to retain scenic views, reduce stream bank erosion, reduce flooding, and enhance habitat values and water quality.

12. Funding for Implementation

A list of potential funding sources available for implementation is listed and discussed below. Detailed descriptions can be obtained from the parent agencies and the websites shown. While funding is currently being provided to the JMSWCD for agricultural BMPs and technical assistance for farmers, additional funding commitments are needed to fully implement the agricultural, residential and urban practices included in the plan.

12.1 Loudoun County Non-Qualifying Livestock Exclusion (Horse Fencing) Cost Share Program

For the past three years, Loudoun County Government has dedicated approximately $50,000 annually to provide funding for fencing and water systems for small farms, primarily horse farms, that do not qualify for the State's stream exclusion fencing cost-share program. The funds provide a 75% cost share, and in the most recent year, supported 14 projects totaling 6,037 feet of new stream fencing, and the maintenance of additional previously installed fencing in need of repair.

12.2 Loudoun County Water and Wastewater Community Assistance Program (Program)

This program was created to respond to the ongoing problem of failing septic systems in Loudoun County. The Program is designed to help prevent and solve community water and wastewater issues by administering a comprehensive program that addresses multiple types of water and wastewater issues, and provides funds to ensure that citizens have a safe, adequate, and proper means of sewage disposal. Potential at-risk communities are described in the *Loudoun County Water and Wastewater Needs Assessment, 2011*. *For more information:* https://www.loudoun.gov/DocumentCenter/View/113279, accessed 6/9/2017. *For additional information* on the Program, including opportunities for financial assistance: https://www.loudoun.gov/index.aspx?NID=3650, accessed 6/9/2017.

12.3 Loudoun Non-Agricultural Stream Buffer Planting Project

The Loudoun Soil and Water Conservation District (LSWCD) and Loudoun County jointly administer a program to reimburse riparian land owners (individuals, commercial/residential businesses, and home owner associations) who plan riparian areas of a minimum of 35 feet in width. This voluntary program is currently funded at $35,000 annually and reimburses property owners for the cost of purchasing and planting native deciduous trees, with options for evergreen trees and shrubs. *For more information:* www.lswcd.org, accessed 6/9/2017.

12.4 Virginia Agricultural Best Management Practices Tax Credit Program

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

the cost of repairs to streamside fencing. *For more information:* http://lfswcd.org/best-management-practices, accessed 5/15/2017.

12.5 Virginia Agricultural Best Management Practices Loan Program

Loan requests are accepted through DEQ. The interest rate is three 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 with no maximum limit. Eligible BMPs include structural practices such as animal waste control facilities, and grazing land protection systems. Loans are administered through participating lending institutions. *For more information:* http://www.deq.virginia.gov/programs/water/cleanwaterfinancingassistance/agriculturalbmp.aspx, accessed 5/15/2017.

12.6 Virginia Conservation Assistance Program

The Virginia Conservation Assistance Program (VCAP) is a relatively new program that can provide reimbursements to landowners who install stormwater BMPs. The program is administered by Soil and Water Conservation Districts, who accept and review BMP plans submitted by landowners, verify project eligibility, and issue and track reimbursements for completed projects. All non-agricultural property owners in eligible districts may apply. This includes businesses, public and private lands. A manual has been developed for the program, which includes standards and specifications for BMPs eligible for reimbursement. The JMSWCD and LSWCD may have staff members available to apply for funds through this program in order to work with interested property owners on residential/urban stormwater BMPs. *For more information:* http://vaswcd.org/vcap, accessed 5/15/2017.

12.7 Virginia Small Business Environmental Assistance Fund Loan Program

The Fund, administered through DEQ, is used to make or guarantee loans to small businesses for the purchase and installation of environmental pollution control equipment, or equipment and structures to implement agricultural BMPs. Loans are available up to $50,000 and will carry an interest rate of three percent, with repayment terms based on the borrower's ability to repay and the life of the equipment or BMP. 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. *For more information:*
http://www.deq.virginia.gov/portals/0/deq/air/smallbusinessassistance/autobody/appendix13.pdf, accessed 5/15/2017.

12.8 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 and nonpoint sources are administered through DEQ. *For more information:*
http://www.deq.virginia.gov/Programs/Water/CleanWaterFinancingAssistance/WaterQualityImprovementFund.aspx, accessed 5/15/2017.

12.9 Virginia Forest Stewardship Program

The program is administered by the DOF to protect soil, water, and wildlife and to provide sustainable forest products and recreation. *For more information:* http://dof.virginia.gov/manage/stewardship/index.htm, accessed 5/15/2017.

12.10 USDA Conservation Reserve Program

Through the USDA Conservation Reserve Program (CRP), cost-share assistance is available to establish trees or herbaceous vegetation covers on cropland. 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. The payment to the participant is up to 50% of the cost for establishing ground cover. *For more information:* http://www.nrcs.usda.gov/wps/portal/nrcs/main/va/programs/, accessed 5/15/2017.

12.11 USDA Conservation Reserve Enhancement Program

The USDA Conservation Reserve Enhancement Program (CREP) is an "enhancement" of the existing Farm Service Agency (FSA) CRP Continuous Signup. It has been "enhanced" by increasing the rental rates, and offering incentive payments to place the enrolled area under a 10-15-year contract. The average cost share payment in this program is 75%; however, additional incentives are available to raise this rate if a landowner is willing to install additional control measures. Buffers consisting of native, warm-season grasses on cropland, and mixed hardwood trees on pasture, must be established in widths ranging from the minimum of 30% of the floodplain or 35 feet, whichever is greater, to a maximum average of 300 feet. Federal cost-sharing (50%) 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. The State of Virginia will make an additional payment to landowners who elect to place a perpetual easement on the enrolled area. *For more information:* https://www.fsa.usda.gov/Internet/FSA_File/va_crep_infosheet.pdf, accessed 5/15/2017.

12.12 USDA Environmental Quality Incentives Program

Approximately 65% of the USDA Environmental Quality Incentives Program (EQIP) funding for the state of Virginia is directed toward "Priority Areas." These areas are selected from proposals submitted by a locally led conservation work group. The remaining 35% of the funds are directed toward statewide priority concerns of environmental needs. EQIP offers up to 10-year contracts to landowners and farmers to provide financial assistance, 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 agricultural production. *For more information:* http://www.nrcs.usda.gov/wps/portal/nrcs/main/va/programs/financial/eqip/, accessed 5/15/2017.

12.13 EPA Section 319 Grant Project Funds

Through Section 319 of the Federal Clean Water Act, Virginia is awarded grant funds to implement NPS programs. DEQ 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 (noted in **Section 2.1**). *For more information:* http://www.deq.virginia.gov/Programs/Water/CleanWaterFinancingAssistance/NonpointSourceFunding.aspx, accessed 5/15/2017.

12.14 USDA Regional Conservation Partnership Program

The USDA Regional Conservation Partnership Program (RCPP) is a five-year program that promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS provides assistance to producers through partnership agreements and through program contracts or easement agreements. The RCPP competitively awards funds to conservation projects designed by local partners specifically for their region. Partners such as SWCDs and nonprofit organizations can then work with interested landowners to utilize these funds for BMP implementation. The Chesapeake Bay watershed is one of eight "Critical Conservation Areas" identified in this program. *For more information:* http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/farmbill/rcpp/?cid=stelprdb1254053, accessed 5/15/2017.

12.15 USDA Wildlife Habitat Incentive Program

The USDA Wildlife Habitat Incentive Program (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 ten-year contract provides cost-share and technical assistance to carry out the plan. Cost-share assistance of up to 75% of the total cost of installation (not to exceed $10,000 per applicant) is available for establishing habitat. Types of practices include: prescribed burning, converting fescue to warm season grasses, and creating habitat for waterfowl. *For more information:* http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/whip/, accessed 5/15/2017.

12.16 Southeast Rural Community Assistance Project

The mission of the Southeast Rural Community Assistance Project (SER-CAP) 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. They can provide (at no cost): on-site technical assistance and consultation, operation and maintenance/management assistance, training, education, facilitation, volunteers, and financial assistance. Financial assistance includes $1,500 toward repair/replacement/ installation of a septic system and $2,000 toward repair/replacement/installation of an alternative waste treatment system. Funding is only available for families making less than 125% of the federal poverty level. *For more information:* http://www.sercap.org/se_loan_fund.htm, accessed 5/15/2017.

12.17 National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation (NFWF) administers the Chesapeake Bay Stewardship Fund, which is dedicated to the protection and restoration of the Chesapeake Bay. The Stewardship Fun is supported through partnerships with government agencies and private corporations, and typically awards $8 million to $12 million per year through two competitive grant programs (Innovative Nutrient and Sediment Reduction Grants and Small Watershed Grants) and a technical assistance program. A request for proposals is typically issued in the spring and awards are made in the fall. *For more information:* http://www.nfwf.org/chesapeake/Pages/home.aspx, accessed 5/15/2017.

12.18 EPA/VA Clean Water State Revolving Fund

EPA awards grants to Virginia for its Clean Water Revolving Loan Funds (VCWRLF). The VCWRLF make loans for priority water quality activities throughout the Commonwealth. As recipients make payments, 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. *For more information:* http://www.deq.virginia.gov/programs/water/cleanwaterfinancingassistance.aspx, accessed 5/15/2017.

12.19 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 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. Mitigation banks are required to be protected in perpetuity, to provide financial assurances, and long term stewardship. The mitigation banking processes is overseen by the Inter-Agency Review Team (IRT) consisting of state and federal agencies and chaired by DEQ and the Army Corps of Engineers. *For more information:* http://www.deq.virginia.gov/Programs/Water/WetlandsStreams/Mitigation.aspx, accessed 5/15/2017.

12.20 Community Development Block Grant Program

"The Virginia Community Development Block Grant (CDBG) program provides funding to eligible units of local government for planning and implementing projects that address critical community development needs, including housing, infrastructure and economic development. The goal of the CDBG Program is to improve the economic and physical environment in Virginia's communities through activities which primarily benefit low- and moderate-income persons, prevent or eliminate slums and blighting conditions or meet urgent needs which threaten the welfare of citizens."
For more information: http://www.dhcd.virginia.gov/index.php/community-partnerships-dhcd/76-community-development-block-grant-cdbg-competitive-grants.html, accessed 5/15/2017.

12.21 Additional Sources of Funding

Participants in the IP Working Group meeting also identified the following programs as additional potential sources of founding:

- Virginia Outdoors Foundation (VOF). *For more information:* http://www.virginiaoutdoorsfoundation.org/, accessed 5/15/2017.
- Virginia Nutrient Mitigation Bank Program. *For more information:* http://www.deq.virginia.gov/Programs/Water/PermittingCompliance/PollutionDischargeElimination/NutrientTrading.aspx/, accessed 5/15/2017.
- Community Development Fund of Northern Virginia (CFNOVA). *For more information:* http://www.cfnova.org, accessed 5/15/2017.
- US Fish and Wildlife Service Conservation Grant Program. *For more information:* https://www.fws.gov/grants/, accessed 5/15/2017.
- USDA Agricultural Conservation Easement Program. *For more information:* https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/, accessed 5/15/2017.
- Trout Unlimited. *For more information:* http://www.tu.org/connect/groups/9va-virginia, accessed 5/15/2017.
- Environmental Defense Fund (EDF). *For more information:* https://www.edf.org/, accessed 5/15/2017.
- Ducks Unlimited. *For more information:* http://www.ducks.org/, accessed 5/15/2017.
- Potomac Conservancy. *For more information:* https://potomac.org/mission-programs/, accessed 5/15/2017

References

AVMA. 2002. Veterinary market statistics for dogs and cats. https://www.avma.org/KB/Resources/Statistics/Pages/Market-research-statistics-US-pet-ownership.aspx, accessed 4/28/16.

AVMA. 2012. Veterinary51 market statistics for dogs and cats. https://www.avma.org/KB/Resources/Statistics/Pages/Market-research-statistics-US-pet-ownership.aspx, accessed 4/28/16.

DCR. 2016. Management measure tracking database.

DEQ. 1997. Water quality monitoring, information and restoration act. https://vacode.org/62.1/3.1/4.01/, accessed 5/15/2017.

DEQ. 2003. Guidance manual for total maximum daily load implementation plans. Virginia Department of Environmental Quality. Richmond, VA. http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLImplementation/TMDLImplementationPlanGuidanceManual.aspx, accessed 5/15/2017.

DEQ. 2014. Final 2014 305(b)/303(d) Water Quality Assessment Integrated Report. Virginia Department of Environmental Quality. Richmond, VA. http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/2014305(b)303(d)IntegratedReport.aspx, accessed 5/15/2017.

DEQ. 2016. Crooked, Stephens, West Runs, and Willow Brook: A plan to reduce bacteria in the water. http://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/ImplementationPlans/Crooked_TMDL_IP_Public_Doc.pdf, accessed 4/12/2017.

EPA. 1999. Guidance for Water Quality-based Decisions: The TMDL Process. EPA 440/4-91-001. U.S. Environmental Protection Agency. Office of Water. Washington, DC.

EPA. 2002. Multi-Resolution Land Characteristics (MRLC) Consortium. https://www.mrlc.gov/, accessed 5/15/2016.

EPA. 2013. Nonpoint Source Program and Grants Guidelines for State and Territories. https://www.epa.gov/sites/production/files/2015-10/documents/319-guidelines-fy14.pdf, accessed 5/9/2017.

Fauquier County. 2016. County code of ordinances: Chapter 17 – Sewers and sewage disposal. https://www2.municode.com/library/va/fauquier_county/codes/code_of_ordinances?nodeId=COOR_CH17SESEDI_ARTIINGE, accessed 5/20/16.

Fauquier County. 2016b. Agricultural and Forestal District, Fauquier County, VA. http://www.fauquiercounty.gov/home/showdocument?id=7482, map accessed 5/9/2017.

Homer, C.G., J.A. Yang, S. Jin, P. Danielson, G. Xian, J Coulston, N.D. Herold, J.D. Wickham, K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States – Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing 81(5):345-354.

Hungerford, H.R. and T.L. Volk. 1990. Changing learner behavior through environmental education. Journal of Environmental Education 21(3):8-21.

ICPRB. 2003. Bacteria TMDLs for the Goose Creek watersheds. Prepared for DEQ.

Loudoun County. 2017. Agricultural and Forestal Districts, Fauquier County, VA. https://www.loudoun.gov/index.aspx?nid=2471, accessed 5/15/2017.

Loudoun County. 2015. Facilities standards manual. https://www.loudoun.gov/DocumentCenter/View/113092, accessed 5/20/16.

Nordstrom, S. 2016. Agriculture: We're half way there. Chesapeake Bay Foundation. Fact Sheet. May 2016. http://www.gettingmoreontheground.com/files/2016/06/Nordstrom-April-2016.pdf, accessed 4/12/2017.

USCB. 2002. 2000 United States census block data. http://www.census.gov/, accessed 4/22/16.

USCB. 2012. 2010 United States census block data. http://www.census.gov/, accessed 4/22/16.

USCB. 2015. American Community Survey 2014 population estimates. https://www.census.gov/programs-surveys/acs/, accessed 4/22/16.

USDA. 2004. USDA Census of Agriculture. http://agcensus.mannlib.cornell.edu/AgCensus/censusParts.do?year=2002, accessed 5/15/2017.

USDA. 2014. USDA Census of Agriculture. https://www.agcensus.usda.gov/Publications/2012/, accessed 5/9/2017.

Attachment A

Population by Sub-watershed

Table A-1. Population and households (HH) by sub-watershed for the years 2000 and 2014.

Sub-watershed	2000			2014 (Estimate)		
	Population	Avg HH Size	HH	Population	Avg HH Size	HH
Upper Goose Creek, Segment 210	272	2.36	115	238	2.48	96
Upper Goose Creek	2,349	2.48	947	2,495	2.45	1,003
Cromwells Run	805	2.40	335	657	2.47	266
Upper Little River	1,536	2.41	637	1,503	2.37	634
Little River	717	2.65	271	1,506	2.86	526
Total	5,679		2,305	6,363		2,525

Septic Systems by Sub-watershed

Table A-2. Number of households connected to sewer systems by sub-watershed for the year 2016.

Sub-watershed	Households on Sewer
Upper Goose Creek, Segment 210	0
Upper Goose Creek	169
Cromwells Run	61
Upper Little River	104
Little River	33
Total	367

Table A-3. Estimated number of septic systems by sub-watershed for the year 2002.

Sub-watershed	No. of Septic Systems	No. of Failing Systems	No. of Failing Systems < 50 feet from a Stream
Upper Goose Creek, Segment 210	117	6	1
Upper Goose Creek	947	47	5
Cromwells Run	335	17	2
Upper Little River	637	40	3
Little River	271	14	0
Total	2,307	124	11

Table A-4. Estimated number of septic systems by sub-watershed for the year 2014.

Sub-watershed	No. of Septic Systems	No. of Failing Systems
Upper Goose Creek Segment 2010	96	2
Upper Goose Creek	834	13
Cromwells Run	205	3
Upper Little River	530	8
Little River	493	8
Total	2,158	35

Table A-5. Septic system percent change between 2003 and 2014.

Sub-watershed	Septic Systems % Change	Failing Systems % Change
Upper Goose Creek, Segment 210	-18	-67
Upper Goose Creek	-11	-72
Cromwells Run	-39	-82
Upper Little River	-17	-70
Little River	82	-43
Total	-6	-72

Sub-Watershed Land Use Comparisons

Table A-6. Upper Goose Creek land use comparison.

Land Use Type		1997 (Acres)	2011 (Acres)	Change (Acres)	% Change
Pervious	Forest	28,370	29,237	867	3
	Cropland	535	285	-250	-47
	Pasture	28,190	25,591	-2,599	-9
	Developed Pervious	449	2,507	2,058	458
Impervious	Developed Impervious	518	534	16	3
	Barren	93	0	-93	-100

Table A-7. Cromwells Run land use comparison.

Land Use Type		1997 (Acres)	2011 (Acres)	Change (Acres)	% Change
Pervious	Forest	3,217	3,334	117	4
	Cropland	23	0	-23	-100
	Pasture	8,653	8,110	-543	-6
	Developed Pervious	115	532	417	362
Impervious	Developed Impervious	72	112	40	56
	Barren	8	0	-8	-100

Table A-8. Little River land use comparison.

Land Use Type		1997 (Acres)	2011 (Acres)	Change (Acres)	% Change
Pervious	Forest	14,929	14,224	-705	-5
	Cropland	473	2,461	1,988	420
	Pasture	19,210	15,868	-3,342	-17
	Developed Pervious	357	2,225	1,868	523
Impervious	Developed Impervious	226	424	198	87
	Barren	9	1	-8	-85

Estimated Dog Population by Sub-watershed

Table A-9. Estimated dog populations and percent change by sub-watershed in the Goose Creek IP area. Households were calculated using census data from the years 2000 and 2014 for the TMDL and IP, respectively (USCB 2015; USCB 2012; USCB 2002). Average number of dogs per household were calculated using AVMA data (AVMA 2012) from the years 2002 and 2012 for the TMDL and IP, respectively.

Sub-watershed	TMDL (2003)		IP (2017)		% Change
	Households	Dog (#)	Households	Dog (#)	
Upper Goose Creek, Segment 210	115	62	96	56	-9
Upper Goose Creek	947	506	1,003	586	16
Cromwells Run	335	179	266	155	-13
Upper Little River	637	340	634	370	9
Little River	271	144	526	307	113
Total	2,305	1,230	2,525	1,474	20

Livestock Population by Sub-Watershed

Table A-10. Livestock population comparison between 2002 and 2012.

Sub-watershed	Beef Cattle		Dairy Cattle		Sheep		Horses	
	2002	2012	2002	2012	2002	2012	2002	2012
Upper Goose Creek	6,042	6,345	17,808	12,267	2,862	1,974	1,431	1,269
Cromwells Run	1,862	2,025	5,488	3,915	882	630	441	405
Little River	2,790	3,164	3,162	1,017	2,511	2,825	744	1,017
Total	10,694	11,534	26,458	17,199	6,255	5,429	2,616	2,691

Table A-11. Livestock population percent change between 2002 and 2012.

Sub-watershed	Beef Cattle	Dairy Cattle	Sheep	Horses
Upper Goose Creek	5%	-31%	-31%	-11%
Cromwells Run	9%	-29%	-29%	-8%
Little River	13%	-68%	13%	37%
Total	8%	-35%	-13%	3%

Baseline and Allocated *E. coli* Loads by Sub-watershed

Table A-12. *E. coli* load allocation for Upper Goose Creek.

Source	Baseline Load (cfu/yr)	IP Allocated Load (cfu/yr)	IP Reduction
Forest	1.23E+12	1.23E+12	0%
Cropland	8.58E+10	2.15E+10	75%
Pasture	3.30E+14	8.25E+13	75%
Developed Land (without failing septic systems)	7.70E+10	1.93E+10	75%
Failing Septic Systems	1.16E+12	0	100%
Straight Pipes / Septic Systems within 50 ft of Surface Water	6.05E+04	0	100%
Direct Deposition from Cattle	1.11E+14	0	100%
Direct Deposition for Wildlife	9.56E+11	9.56E+11	0%
Total Load Allocation	4.44E+14	8.47E+13	81%

Table A-13. *E. coli* load allocation for Cromwells Run.

Source	Baseline Load (cfu/yr)	IP Allocated Load (cfu/yr)	IP Reduction
Forest	1.60E+12	1.60E+12	0%
Cropland	1.40E+10	3.50E+09	75%
Pasture	8.80E+13	2.20E+13	75%
Developed Land (without failing septic systems)	3.73E+10	9.33E+09	75%
Failing Septic Systems	5.38E+11	0	100%
Straight Pipes / Septic Systems within 50 ft of Surface Water	2.82E+05	0	100%
Direct Deposition from Cattle	9.28E+12	0	100%
Direct Deposition for Wildlife	4.98E+11	4.98E+11	0%
Total Load Allocation	9.99E+13	2.41E+13	76%

Table A-14. *E. coli* load allocation for Little River.

Source	Baseline Load (cfu/yr)	IP Allocated Load (cfu/yr)	IP Reduction
Forest	2.78E+12	2.78E+12	0%
Cropland	3.37E+11	8.43E+10	75%
Pasture	4.94E+14	1.24E+14	75%
Developed Land (without failing septic systems)	1.61E+11	4.03E+10	75%
Failing Septic Systems	2.39E+12	0	100%
Straight Pipes / Septic Systems within 50 ft of Surface Water	3.42E+05	0	100%
Direct Deposition from Cattle	5.51E+13	0	100%
Direct Deposition for Wildlife	1.33E+12	1.33E+12	0%
Total Load Allocation	5.56E+14	1.28E+14	77%

Updated Water Quality Monitoring Information

Table A-15. Comparison of bacteria water quality standard violations pre-TMDLs (before 2003) and present (2013-2016). Raw data provided in **E. coli*, **fecal coliform, or +both. Cells with "-" denote no samples were taken, "0" denotes no samples were in violation of water quality standards.

Station ID	Sub-watershed	Pre-TMDL (Before 2003)		Present (2013-2016)	
		No. of Samples	No. of Samples in Violation	No. of Samples	No. of Samples in Violation
1ACRM001.20	Cromwells Run	42**	17	15*	3
1AGAR002.24	Upper Goose Creek	5**	3	9*	4
1AGOO036.61	Upper Goose Creek	2**	0	12*	2
1AGOO039.63	Upper Goose Creek	-	-	1*	0
1AGOO044.36	Upper Goose Creek	136**	43	19*	3
1ALIV004.78	Little River	46+	25	12*	3
1ALIV004.79	Little River	-	-	1*	1
1ALIV012.12	Little River	1**	0	12*	5

Table A-16. Comparison of bacteria water quality standard violation rates pre-TMDLs (before 2003) and present (2013-2016). Cells with "-" denote no samples were collected, "0" denotes no samples were in violation of water quality standards.

Station ID	Sub-watershed	Pre-TMDL (Before 2003)	Present (2013-2016)
		Violation Rate	Violation Rate
1ACRM001.20	Cromwells Run	40%	20%
1AGAR002.24	Upper Goose Creek	60%	44%
1AGOO036.61	Upper Goose Creek	0%	17%
1AGOO039.63	Upper Goose Creek	-	0%
1AGOO044.36	Upper Goose Creek	32%	16%
1ALIV004.78	Little River	54%	25%
1ALIV004.79	Little River	-	100%
1ALIV012.12	Little River	0%	42%

Table A-17. DEQ water quality assessment (2014), DEQ and citizen monitoring stations.

IP Sub-watershed	HUC12 Name (Code)	Water Name	VAHU6	2014IR DEQ Assessment Unit ID	2014IR Impairment Length (miles)	2014IR Impairment Length Description	2014IR Citizen Monitoring Station (DEQ Station Name)	2014IR DEQ Listing Station	2014IR: Recreation Use
Little River	Little River (020700080701)	Bartons Creek		VAN-A08R_BAO01A06	4.81	headwaters downstream to confluence with Little River	16 (1aBAO-16-SOS)	---	Observed effect**
		Howsers Branch		VAN-A08R_HOW01A08‡	5.10	headwaters downstream to confluence with Little River	---	1aHOW003.68	Impaired
		Hungry Run		VAN-A08R_HUN01A06	6.23	headwaters downstream to confluence with Little River (rivermile 6.25)	17 (1AHUN-17a-SOS)	---	Observed effect**
		Little River	PL13	VAN-A08R_LIV02A06‡	2.48	confluence with UT* downstream to confluence with Hungry Run (~1.5 rivermiles upstream from Route 50 near Aldie)	---	1aLIV006.92	Impaired
				VAN-A08R_LIV01A00	6.41	confluence with Hungry Run (~1.5 rivermiles upstream from Route 50 near Aldie) downstream to confluence with Goose Creek	--	1aLIV001.70 1aLIV004.78 1aLIV004.79	Fully Supporting (delisted 2010)
				VAN-A08R_LIV02B10	4.36	confluence with Bartons Creek downstream to confluence with UT	--	1aLIV012.12	Fully Supporting
				VAN-A08R_LIV03A06	5.86	confluence with UT* to Little River (~0.6 rivermile upstream from the Route 705 crossing) downstream to confluence with Bartons Creek	12 (1aLIV-12-SOS)	---	Observed effect**
							23 (1aLIV-23-SOS)	---	Observed effect**
Cromwells Run	Cromwells Run (020700080504)	Cromwells Run, UT*		VAN-A05R_XMI01A12	4.11	headwaters downstream to confluence with Cromwells Run	14 (1aXMI-14-SOS)	---	Observed effect**
		Cromwells Run	PL09	VAN-A05R_CRM02A06‡	6.76	headwaters downstream to confluence with UT* XMI (at rivermile 4.61)	15 (1aCRM-15A-SOS)	1aCRM005.39	Impaired
				VAN-A05R_CRM01A00†	3.81	confluence with UT* to Cromwells Run (~0.78 rivermile downstream from Route 715) downstream to confluence with Rocky Creek (~0.4 rivermile downstream from Route 50)	---	1aCRM001.20	Impaired
Upper Goose Creek	Goose Creek-Mitchell Branch (020700080501)	Goose Creek, UT*		VAN-A04R_GOO01B00‡	4.31	confluence with Kettle Run downstream to confluence with Bolling Branch	5 (1aGOO-5-SOS)	1aGOO044.36	Impaired
				VAN-A04R_XLW01A14‡	5.91	headwaters downstream to the confluence with Goose Creek (at rivermile 45.10)	---	1aXLW000.75	Impaired
		Goose Creek	PL06	VAN-A04R_GOO02A04	8.11	headwaters downstream to confluence with Kettle Run	6 (1aGOO-6-SOS)	---	Observed effect**
							7 (1aGOO-7-SOS)	---	Observed effect**

IP Sub-watershed	HUC12 Name (Code)	Water Name	VAHU6	2014IR DEQ Assessment Unit ID	2014IR Impairment Length (miles)	2014IR Impairment Length Description	2014IR Citizen Monitoring Station (DEQ Station Name)	2014IR DEQ Listing Station	2014IR: Recreation Use
Upper Goose Creek	Goose Creek-Crooked Run- Gap Run (0207000805)	Gap Run	PL07	VAN-A04R_GAR01A04‡	3.21	confluence with a UT* to Gap Run (just downstream from Route 712) downstream to confluence with Goose Creek	8 (1aGAR-8-SOS)	1aGAR002.24	Impaired
		Bolling Branch		VAN-A04R_BOL01A04‡	3.64	confluence with UT* to Bolling Branch (just upstream from Route 723) downstream to confluence with Goose Creek	9 (1aBOL-9-SOS) 18 (1aBOL-18-SOS)	1aBOL000.05	Impaired
		Crooked Run		VAN-A04R_CRA01A04‡	1.85	confluence with a UT* to Crooked Run (just downstream from Route 724) downstream to confluence with Goose Creek	---	1aCRA000.42	Impaired
				VAN-A04R_CRA02A08	3.58	confluence UT* to Crooked Run (rivermile 5.23) downstream to confluence with another UT* to Crooked Run (just downstream from Route 724)	10 (1aCRA-10-SOS)	---	Observed effect**
		Goose Creek		VAN-A04R_GOO01A08	3.51	confluence with Bolling Branch downstream to confluence with Gap Run	4 (1aGOO-4-SOS)	---	Observed effect**
		Goose Creek	PL07	VAN-A05R_GOO02B06‡	2.68	confluence with UT* to Goose Creek (rivermile 35.28) downstream to confluence with Panther Skin Creek	2 (1aGOO-2-SOS)	1aGOO034.20	Impaired
				VAN-A05R_GOO02C04	3.27	confluence with Gap Run downstream to confluence with UT* to Goose Creek (rivermile 35.28)	3 (1aGOO-3-SOS)	1AGOO036.61	Observed effect**
				VAN-A05R_GOO02C04	3.27	confluence with Gap Run downstream to confluence with UT* to Goose Creek (rivermile 35.28)	11 (1aGOO-11-SOS)	1AGOO036.61	Observed effect**

†Assessment unit impaired at the time of TMDL development
‡Assessment unit impaired after TMDL development
*UT: unnamed tributary
**Insufficient information with an observed effect for bacteria

Summary of Management Measures

Table A-18. Summary of management measures, average unit cost, and bacteria reduction efficiency.

Control Measure	Unit	Average Unit Cost ($)	Reduction Efficiency (%)
Livestock Exclusion			
Livestock Exclusion System (CREP, CRSL-6)	System	18,000	50 (100)[1]
Livestock Exclusion System (EQIP)	System	15,000	50 (100)[1]
Stream Exclusion with Grazing Land Management (SL-6)	System	36,000	50 (100)[1]
Livestock Exclusion with Riparian Buffers (LE-1T)	System	36,000	50 (100)[1]
Livestock Exclusion with Reduced Setback (LE-2 / LE-2T)	System	12,000	50 (100)[1]
Stream Exclusion (CCI-SE-1)	Linear Feet	1	(100)[1]
Stream Protection (WP-2 / WP-2T)	System	2,500	50 (100)[1]
Pasture and Cropland			
Reforestation of Erodible Cropland and Pastureland (FR-1)	Acres	450	99
Woodland Filter Buffer Area (FR-3)	Acres	1,500	40
Streambank Stabilization (WP-2A)	Linear Feet	150	N/A
Grazing Land Management (SL-9)	Acres	165	50
Pasture Management for TMDL Implementation (SL-10T / EQIP 528)	Acres	75	50
Permanent Vegetative Cover on Critical Areas (SL-11)	Acres	2,440	99
Conservation Tillage (SL-15A)	Acres	100	61
Cover Crops (SL-8B)	Acres	50	20
Grass Riparian Buffers (WQ-1)	Acres	165	40
Support for Extension of CREP Watering Systems (SL-7)	System	TBD	50
Sediment Retention, Erosion, or Water Control Structure (WP-1)	Drainage Area (acres)	870	75
Permanent Vegetative Cover on Cropland (SL-1)	Acres	175	75
Forage and Biomass Planting (EQIP – 512)	Acres	TBD	75
Equine			
Community Manure Composting Facility	System	215,000	80
Equine Manure Storage / Composting	System	1,200	80
Barnyard Runoff Controls	System	20,000	100
Small Acreage Grazing Systems (SL-6AT)	System	9,000	100
On-Site Sewage Disposal Systems			
Septic Tank Pump-out (RB-1)	System	300	10
Septic Connection to Public Sewer System (RB-2)	System	12,500	100
Septic System Repair (RB-3)	System	3,500	100
Septic System Installation / Replacement (RB-4)	System	6,000	100
Septic System Installation / Replacement with Pump (RB-4P)	System	8,000	100
Alternative On-Site Systems (RB-5)	System	25,000	100
Pet Waste Management			
Pet Waste Stations	System	500	75
Pet Waste Composters	System	50	100

Control Measure	Unit	Average Unit Cost ($)	Reduction Efficiency (%)
Confined Canine Unit (CCU)	System	6,000 – 20,000	100
Pet Waste Education	Program	5,000	70
Stormwater Management			
Vegetative Riparian Buffers (Residential)	Drainage Area (acres)	3,500	40
Rain Barrels	System	150	90
Redirecting Residential Downspouts	Roof Area	100	70
Porous Pavement	Area Treated (sq ft)	7.5	50
Rain Gardens	Area Treated (sq ft)	4	70
Infiltration Trench	Area Treated (acres)	11,300	90
Education and Outreach			
Septic System Education	Program	2,500	N/A
Septic System Education for Area Realtors	Program	625	N/A
Work with Local School District to Incorporate Water-Related Curriculum into the Classroom	Program	1,000	N/A
Organize Field Trips to Demonstrate Water Quality BMPs for Students	Program	1,000	N/A
Organize a “Farm Day” Event with Local Landowners to Demonstrate Agricultural BMPs	Program	1,000	N/A
Distribute Education Materials at the Farmer’s Market	Program	625	N/A
Horse Pasture Management Education	Program	2,500	N/A
Technical Assistance			
Agricultural and Residential	Full time Equivalent	50,000 / yr	N/A

[1] Direct load reduction efficiency in parenthesis

Management Measures by Implementation Phase and Cost

Table A-19. Management measure by implementation phase.

Control Measure	Upper Goose Creek	Cromwells Run	Little River
Livestock Exclusion			
Livestock Exclusion System (CREP, CRSL-6)	I & II	I & II	I & II
Livestock Exclusion System (EQIP)	I & II	I & II	I & II
Stream Exclusion with Grazing Land Management (SL-6)	I & II	I & II	I & II
Livestock Exclusion with Riparian Buffers (LE-1T)	I & II	I & II	I & II
Livestock Exclusion with Reduced Setback (LE-2 / LE-2T)	I & II	I & II	I & II
Stream Exclusion (CCI-SE-1)	I & II	I & II	I & II
Stream Protection (WP-2 / WP-2T)	I	I	I
Pasture and Cropland			
Reforestation of Erodible Cropland and Pastureland (FR-1)	I & II	N/A	I & II
Woodland Filter Buffer Area (FR-3)	I	N/A	N/A
Streambank Stabilization (WP-2A)	I & II	I & II	I & II
Grazing Land Management (SL-9)	I & II	I & II	I & II
Pasture Management for TMDL Implementation (SL-10T / EQIP 528)	I & II	I & II	I & II
Permanent Vegetative Cover on Critical Areas (SL-11)	I & II	N/A	I & II
Conservation Tillage (SL-15A)	I	I	N/A
Cover Crops (SL-8B)	I	I	N/A
Grass Riparian Buffers (WQ-1)	I	I	N/A
Support for Extension of CREP/EQIP Watering Systems (SL-7)	I & II	I & II	N/A
Sediment Retention, Erosion, or Water Control Structure (WP-1)	I & II	I & II	I & II
Permanent Vegetative Cover on Cropland (SL-1)	I	I	I
Forage and Biomass Planting (EQIP – 512)	I	I	I
Equine			
Community Manure Composting Facility	I & II	I & II	I & II
Equine Manure Storage / Composting	I & II	I & II	I & II
Barnyard Runoff Controls	I & II	I & II	I & II
Small Acreage Grazing Systems (SL-6AT)	I & II	I & II	I & II
On-Site Sewage Disposal Systems			
Septic Tank Pump-out (RB-1)	I & II	I & II	I & II
Septic Connection to Public Sewer System (RB-2)	N/A	N/A	I & II
Septic System Repair (RB-3)	I & II	I & II	I & II
Septic System Installation / Replacement (RB-4)	I & II	I & II	I & II

Control Measure	Upper Goose Creek	Cromwells Run	Little River
Septic System Installation / Replacement with Pump (RB-4P)	I & II	I & II	I & II
Alternative On-Site Systems (RB-5)	I & II	I & II	I & II
Pet Waste Management			
Pet Waste Stations	I	I	I
Pet Waste Composters	I	I	I
Confined Canine Unit (CCU)	I	I	I
Pet Waste Education	I & II	I & II	I & II
Stormwater Management			
Vegetative Riparian Buffers (Residential)	I	I	I
Rain Barrels	I	I	I
Redirecting Residential Downspouts	I	I	I
Porous Pavement	I	I	I
Rain Gardens	I	I	I
Infiltration Trench	TBD	TBD	TBD
Education and Outreach			
Septic System Education	I & II	I & II	I & II
Septic System Education for Area Realtors	I & II	I & II	I & II
Work with Local School District to Incorporate Water-Related Curriculum into the Classroom	I & II	I & II	I & II
Organize Field Trips to Demonstrate Water Quality BMPs for Students	I & II	I & II	I & II
Organize a “Farm Day” Event with Local Landowners to Demonstrate Agricultural BMPs	I & II	I & II	I & II
Distribute Education Materials at the Farmer’s Market	I & II	I & II	I & II
Horse Pasture Management Education	I & II	I & II	I & II
Technical Assistance			
Agricultural and Residential	I & II	I & II	I & II

Table A-20. Cost breakdown by implementation phase.

Control Measure	Phase I Cost ($)	Phase II Cost ($)	Total ($)
Livestock Exclusion			
Livestock Exclusion System (CREP, CRSL-6)	288,000	180,000	468,000
Livestock Exclusion System (EQIP)	225,000	135,000	360,000
Stream Exclusion with Grazing Land Management (SL-6)	1,008,000	756,000	1,764,000
Livestock Exclusion with Riparian Buffers (LE-1T)	1,620,000	1,008,000	2,628,000
Livestock Exclusion with Reduced Setback (LE-2 / LE-2T)	276,000	180,000	456,000
Stream Exclusion (CCI-SE-1)	75,629	50,419	126,048
Stream Protection (WP-2 / WP-2T)	15,000	--	15,000
Total ($), Livestock Exclusion	**3,507,629**	**2,309,419**	**5,817,048**
Pasture and Cropland			
Reforestation of Erodible Cropland and Pastureland (FR-1)	405,000	945,000	1,350,000
Woodland Filter Buffer Area (FR-3)	15,000	--	15,000
Streambank Stabilization (WP-2A)	9,600	5,250	14,850
Grazing Land Management (SL-9)	441,540	335,610	777,150
Pasture Management for TMDL Implementation (SL-10T / EQIP 528)	236,550	138,825	375,375
Permanent Vegetative Cover on Critical Areas (SL-11)	439,200	1,024,800	1,464,000
Conservation Tillage (SL-15A)	10,100	--	10,100
Cover Crops (SL-8B)	5,050	--	5,050
Grass Riparian Buffers (WQ-1)	1,650	--	1,650
Support for Extension of CREP Watering Systems (SL-7)	TBD	TBD	TBD
Sediment Retention, Erosion, or Water Control Structure (WP-1)	823,890	2,469,930	3,293,820
Permanent Vegetative Cover on Cropland (SL-1)	5,250	--	5,250
Forage and Biomass Planting (EQIP – 512)	TBD	--	TBD
Total ($), Pasture and Cropland*	**2,392,830**	**4,919,415**	**7,312,245**
Equine			
Community Manure Composting Facility	430,000	215,000	645,000
Equine Manure Storage / Composting	255,600	132,000	387,600
Barnyard Runoff Controls	1,400,000	720,000	2,120,000
Small Acreage Grazing Systems (SL-6AT)	360,000	180,000	540,000
Total ($), Equine	2,445,600	1,247,000	3,692,600
On-Site Sewage Disposal Systems			
Septic Tank Pump-out (RB-1)	1,294,800	647,400	1,942,200
Septic Connection to Public Sewer System (RB-2)	212,500	50,000	262,500
Septic System Repair (RB-3)	934,500	483,000	1,417,500
Septic System Installation / Replacement (RB-4)	144,000	72,000	216,000
Septic System Installation / Replacement with Pump (RB-4P)	240,000	120,000	360,000
Alternative On-Site Systems (RB-5)	425,000	175,000	600,000
Total ($), On-Site Sewage Disposal Systems	**3,250,800**	**1,547,400**	**4,798,200**

Control Measure	Phase I Cost ($)	Phase II Cost ($)	Total ($)
Pet Waste Management			
Pet Waste Stations	5,000	--	5,000
Pet Waste Composters	1,200	--	1,200
Confined Canine Unit (CCU)	100,000	--	100,000
Pet Waste Education	10,000	5,000	15,000
Total ($), Pet Waste Management	**116,200**	**5,000**	**121,200**
Stormwater Management			
Vegetative Riparian Buffers (Residential)	71,750	--	71,750
Rain Barrels	450	--	450
Redirecting Residential Downspouts	150	--	150
Porous Pavement	7,500	--	7,500
Rain Gardens	4,000	--	4,000
Infiltration Trench	TBD	TBD	TBD
Total ($), Stormwater Management*	**83,850**	**0**	**83,850**
Education and Outreach			
Septic System Education	3,750	3,750	7,500
Septic System Education for Area Realtors	937.5	937.5	1,875
Work with Local School District to Incorporate Water-Related Curriculum into the Classroom	1,500	1,500	3,000
Organize Field Trips to Demonstrate Water Quality BMPs for Students	1,500	1,500	3,000
Organize a "Farm Day" Event with Local Landowners to Demonstrate Agricultural BMPs	1,500	1,500	3,000
Distribute Education Materials at the Farmer's Market	937.5	937.5	1,875
Horse Pasture Management Education	3,750	3,750	7,500
Total ($), Education and Outreach	**13,875**	**13,875**	**27,750**
Technical Assistance			
Agricultural and Residential	**500,000**	**250,000**	**750,000**
Total ($)	**12,310,784**	**10,292,109**	**22,602,893**

*These costs do not include estimates for TBD categories.

Table A-21. Number of management measure units per phase by sub-watershed.

Control Measure	Upper Goose Creek		Cromwells Run		Little River		Total	
	Phase I Units	Phase II Units	Phase I Units	Phase II Units	Phase I Units	Phase II Units	Phase I Units	Phase II Units
Livestock Exclusion								
Livestock Exclusion System (CREP, CRSL-6)	11	7	4	2	1	1	16	10
Livestock Exclusion System (EQIP)	11	7	3	1	1	1	15	9
Stream Exclusion with Grazing Land Management (SL-6)	16	12	6	4	6	5	28	21
Livestock Exclusion with Riparian Buffers (LE-1T)	26	16	9	6	10	6	45	28
Livestock Exclusion with Reduced Setback (LE-2 / LE-2T)	13	9	5	3	5	3	23	15
Stream Exclusion (CCI-SE-1)	28,361	18,907	14,180	9,454	33,088	22,058	75,629	50,419
Stream Protection (WP-2 / WP-2T)	3	--	1	--	2	--	6	--
Pasture and Cropland								
Reforestation of Erodible Cropland and Pastureland (FR-1)	780	1,820	--	--	120	280	900	2,100
Woodland Filter Buffer Area (FR-3)	10	--	--	--	--	--	10	--
Streambank Stabilization (WP-2A)	21	12	21	12	21	12	63	36
Grazing Land Management (SL-9)	2,284	1,726	259	203	133	105	2,676	2,034
Pasture Management for TMDL Implementation (SL-10T / EQIP 528)	2,377	1,396	277	162	500	293	3,154	1,851
Permanent Vegetative Cover on Critical Areas (SL-11)	156	364	--	--	24	56	180	420
Conservation Tillage (SL-15A)	77	--	24	--	--	--	101	--
Cover Crops (SL-8B)	77	--	24	--	--	--	101	--
Grass Riparian Buffers (WQ-1)	5	--	5	--	--	--	10	--
Support for Extension of CREP Watering Systems (SL-7)	5	3	4	3	--	--	9	6
Sediment Retention, Erosion, or Water Control Structure (WP-1)	938	2,812	--	--	9	27	947	2,839
Permanent Vegetative Cover on Cropland (SL-1)	10	--	10	--	10	--	30	--
Forage and Biomass Planting (EQIP - 512)	5	--	5	--	5	--	15	--

Control Measure	Upper Goose Creek		Cromwells Run		Little River		Total	
	Phase I Units	Phase II Units	Phase I Units	Phase II Units	Phase I Units	Phase II Units	Phase I Units	Phase II Units
Equine								
Community Manure Composting Facility	--	1	1	--	1	--	2	1
Equine Manure Storage / Composting	100	52	32	17	81	41	213	110
Barnyard Runoff Controls	33	17	11	5	26	14	70	36
Small Acreage Grazing Systems (SL-6AT)	20	10	10	5	10	5	40	20
On-Site Sewage Disposal Systems								
Septic Tank Pump-out (RB-1)	1,860	930	410	205	2,046	1,023	4,316	2,158
Septic Connection to Public Sewer System (RB-2)	--	--	--	--	17	4	17	4
Septic System Repair (RB-3)	124	64	6	3	137	71	267	138
Septic System Installation / Replacement (RB-4)	8	4	8	4	8	4	24	12
Septic System Installation / Replacement with Pump (RB-4P)	10	5	10	5	10	5	30	15
Alternative On-Site Systems (RB-5)	7	3	3	1	7	3	17	7
Pet Waste Management								
Pet Waste Stations	2	--	4	--	4	--	10	--
Pet Waste Composters	8	--	8	--	8	--	24	--
Confined Canine Unit (CCU)	1	--	2	--	2	--	5	--
Pet Waste Education	0.5	0.5	0.5	0.5	0.5	0.5	2	2
Stormwater Management								
Vegetative Riparian Buffers (Residential)	--	--	--	--	20.5	--	20.5	--
Rain Barrels	1	--	1	--	1	--	3	--
Redirecting Residential Downspouts	0.6	--	0.2	--	0.7	--	1.5	--
Porous Pavement	250	--	250	--	500	--	1,000	--
Rain Gardens	250	--	250	--	500	--	1,000	--
Infiltration Trench	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Note: Education and outreach and technical assistance categories are not included in this table as they are expected to proceed continuously throughout implementation.