Water Quality Improvement Plan for the North Fork Rivanna River Watershed and Tributaries Located in Albemarle, Greene, and Orange Counties

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Acronyms

AllForX	All-Forest Load Multiplier
BMP	Best Management Practice
CADDIS	Causal Analysis Diagnosis Decision Information System
CBP	Chesapeake Bay Program
CEM	Community Engagement Meeting
CREP	Conservation Reserve Enhancement Program
CWA	Clean Water Act
FSA	Farm Service Agency
GWLF	Generalized Watershed Loading Function
IP	Implementation Plan
JMU	James Madison University
LA	Load Allocation
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristics Consortium
MS4	Municipal Separate Storm Sewer Systems
NHD	National Hydrography Dataset
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
POC	Pollutant(s) of Concern
SWCB	State Water Control Board
SWCD	Soil and Water Conservation District
TAC	Technical Advisory Committee
TDN	Total Digestible Nutrients
TMDL	Total Maximum Daily Load
TSS	Total Suspended Sediment
TP	Total Phosphorus
UAA	Use Attainability Analysis
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VACS	Virginia Agricultural BMP Cost-Share Program
VADCR	Virginia Department of Conservation and Recreation
VADEQ	Virginia Department of Environmental Quality
VCAP	Virginia Conservation Assistance Program
VDACS	Virginia Department of Agriculture and Consumer Services
VDH	Virginia Department of Health
VDOT	Virginia Department of Transportation
VGIN	Virginia Geographic Information Network
VLCD	Virginia Land Cover Dataset
VPDES	Virginia Pollutant Discharge Elimination System

VSCI	Virginia Stream Condition Index
WLA	Wasteload Allocation
WQIF	Water Quality Improvement Fund
WQMIRA	Water Quality Monitoring, Information and Restoration Act

1.0 INTRODUCTION

1.1. Background

The Clean Water Act (CWA) that became law in 1972 requires that all US streams, rivers, and lakes meet certain water quality standards. It also requires that states conduct monitoring to identify polluted waters or those that do not meet water quality standards. Through this required program, the Commonwealth of Virginia has found that many stream segments do not meet state water quality standards for protection of the six beneficial uses: fish consumption, swimming, shellfishing, aquatic life, public water supply, and wildlife.

When streams fail to meet standards, Section 303(d) of the CWA and the USEPA's Water Quality Management and Planning Regulation (40 CFR Part 130) require states to develop a TMDL for each pollutant. A TMDL is a "pollution budget" for a stream. That is, it sets limits on the amount of a pollutant a stream can tolerate and still maintain water quality standards. When a TMDL is developed, background pollutant concentrations, point source loadings, and nonpoint source loadings are considered. A TMDL also accounts for seasonal variations as well as a margin of safety. Through the TMDL process, states establish water-quality-based controls to reduce pollution and meet water quality standards.

Once a TMDL is developed, Virginia's 1997 Water Quality Monitoring, Information and Restoration Act (WQMIRA) requires development of a plan, commonly known as an 'Implementation Plan', that provides expeditious implementation of TMDLs in order to achieve fully supporting status for impaired waters. An Implementation Plan (IP) describes the pollutant control measures, which can include the use of better treatment technology and the installation of best management practices (BMPs), which need to be implemented in order to meet the water quality goals established in the TMDL. The types and number of BMPs, how they will be funded, and the details of implementation are described in a TMDL Implementation Plan (IP).

1.2. Designated Uses and Applicable Water Quality Standards

Virginia's Water Quality Standards (9VAC25-260) consist of designated uses established for water bodies in the Commonwealth, and water quality criteria set to protect those uses. Virginia's Water Quality Standards protect the public and environmental health of the Commonwealth and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.). Virginia Water Quality Standard 9VAC25-260-10 (Designation of uses) states:

> "A. All state waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a

balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish" (SWCB, 2010).

1.2.1. Aquatic Life Designated Use and General Standard (9VAC25-260-20)

Virginia's narrative general Standard 9VAC25-260-20 (General criteria), also known as the Aquatic Life Use standard, states:

> "A. State waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life.
>
> Specific substances to be controlled include, but are not limited to: floating debris, oil scum, and other floating materials; toxic substances (including those which bioaccumulate); substances that produce color, tastes, turbidity, odors, or settle to form sludge deposits; and substances which nourish undesirable or nuisance aquatic plant life. Effluents which tend to raise the temperature of the receiving water will also be controlled" (SWCB, 2010).

VADEQ's biological monitoring program is used to evaluate compliance with the above standard. This program monitors the assemblage of benthic (bottom-dwelling) macro (large enough to see) invertebrates (insects, mollusks, crustaceans, and annelid worms) in streams to determine the biological health of the stream. Benthic macroinvertebrates are sensitive to water quality conditions, important links in aquatic food chains, major contributors to energy and nutrient cycling in aquatic habitats, relatively immobile, and easy to collect. These characteristics make them excellent indicators of aquatic health. Changes in water quality are reflected in changes in the structure and diversity of the benthic macroinvertebrate community. Currently, VADEQ assesses the health of the benthic macroinvertebrate community using the Virginia Stream Condition Index (VSCI). This index was first developed by Tetra Tech (2003) and later validated by VADEQ (2006b). The VSCI is a multimetric index based on 8 biomonitoring metrics. The index provides a score from 0-100, and scores from individual streams are compared to a statistically derived cutoff value based on the scores of regional reference sites.

Ten (10) stream segments within the North Fork Rivanna River watershed currently do not support the aquatic life designated use based on biological monitoring of the benthic macroinvertebrate community (**Table 1-1**) and are being addressed in this Implementation Plan.

Table 1-1. Benthic impairments included in this Implementation Plan.

TMDL Watershed	305(b) Segment ID	Cause Group Code 303(d) Impairment ID
Blue Run	VAV-H27R_BLU01A04 (8.72 mi)	H27R-06-BEN
Marsh Run	VAV-H27R_MAR01A10 (3.65 mi)	H27R-05-BEN
Preddy Creek	VAV-H27R_PRD01A00 (7.48 mi)	H27R-08-BEN
Preddy Creek North Branch	VAV-H27R_PRD02A06 (6.24 mi)	H27R-03-BEN
Quarter Creek	VAV-H27R_QTR01A16 (1.58 mi)	H27R-10-BEN
North Fork Rivanna River	VAV-H27R_RRN02A00 (3.82 mi) VAV-H27R_RRN03A10 (3.51 mi)	H27R-09-BEN
Stanardsville Run	VAV-H27R_SDV01A14 (5.71 mi)	H27R-07-BEN
Swift Run	VAV-H27R_SFR01A00 (1.91 mi)	H27R-02-BEN
X-Trib to Flat Branch	VAV-H27R_FTB01A08 (2.03 mi)	H27R-01-BEN

In 2019, a benthic stressor analysis study was conducted to determine the pollutant(s) of concern contributing to the benthic impairments in the North Fork Rivanna River watershed (VADEQ, 2019). The stressor analysis study used a formal causal analysis approach developed by USEPA, known as CADDIS (Causal Analysis Diagnosis Decision Information System). The CADDIS approach evaluates 14 lines of evidence that support or refute each candidate stressor as the cause of impairment. In each stream, each candidate stressor was scored from -3 to +3 based on each line of evidence. Total scores across all lines of evidence were then summed to produce a stressor score that reflects the likelihood of that stressor being responsible for the impairment. The study found that sediment (measured as total suspended solids or TSS) was a probable stressor in all of the impaired tributaries. In two of the tributaries, Blue Run and Stanardsville Run, an additional probable stressor of total phosphorus (TP) was identified.

1.2.2. Bacteria Water Quality Criteria (9VAC 25-260-170)

In order to protect human health during primary contact recreation (e.g., swimming), the Commonwealth of Virginia has set limits on the amount of specific fecal bacteria in all state waters. The bacteria criterion for freshwater in place when the North Fork Rivanna River and Preddy Creek were listed as impaired in 2006 was based on *Escherichia coli (E. coli)*.

At the time of the bacteria TMDL development (VADEQ, 2008), the bacteria criteria for freshwater were that *E. coli* bacteria shall not exceed a geometric mean of 126 colony forming units (cfu)/100 mL, and a single sample value shall not exceed 235 cfu/100mL more than 10% of the time. The 2008 TMDL was required to meet both the geometric mean and instantaneous *E. coli* water quality standard.

One segment of North Fork Rivanna River (VAV-H27R-RRN01A00) 10.38 miles long was listed as impaired on Virginia's 2006 305(b)/303(d) Water Quality Assessment Integrated Report due to water quality exceedances of the then-current *E. coli* bacteria water quality standard (VADEQ, 2006a). Preddy Creek and Tributaries (VAV-H27R-PRD01A00, 25.96 miles) was similarly listed as impaired.

Since the 2008 TMDL was developed, the Preddy Creek and Tributaries assessment unit has been reclassified as two assessment units: Preddy Creek VAV-H27R_PRD01A00 (7.48 miles) and Preddy Creek North Branch VAV-H27R_PRD02A06 (6.24 miles). Additionally, Swift Run (VAV-H27R_SFR01A00, 1.91 miles) was listed as impaired on the 2010 Integrated Report (VADEQ, 2010) due to exceedances of the *E. coli* bacteria standard at the time. Four (4) stream segments within the North Fork Rivanna River watershed currently do not support the bacteria criteria for recreational use (**Table 1-2**) and are being addressed in this Implementation Plan.

Table 1-2. Bacteria impairments included in this Implementation Plan.

TMDL Watershed	305(b) Segment ID	Cause Group Code 303(d) Impairment ID
Preddy Creek	VAV-H27R_PRD01A00 (7.48 mi)	H27R-03-BAC
Preddy Creek North Branch	VAV-H27R_PRD02A06 (6.24 mi)	H27R-03-BAC
North Fork Rivanna River	VAV-H27R_RRN01B10 (3.98 mi)	H27R-04-BAC
Swift Run	VAV-H27R_SFR01A00 (1.91 mi)	H27R-02-BAC

In 2019, during the time between the TMDL report (VADEQ, 2008) and development of this Implementation Plan, the Virginia State Water Control Board adopted USEPA's new nationally recommended bacteria criteria. For *E. coli*, the criteria include a geometric mean value never to exceed 126 bacteria colony counts per 100 milliliters (counts/100mL) and no more than 10% of samples allowed to exceed a statistical threshold value of 410 counts/100mL within a 90-day period.

The 2008 bacteria TMDL developed reduction scenarios targeting a 0% exceedance rate of the 235 cfu/100mL *E. coli* standard. As such, final reductions needed to meet the TMDL will also meet the new standard.

1.3. Watershed Location and Description

The North Fork Rivanna River watershed is approximately 103,000 acres and includes portions of Albemarle and Greene Counties, and a very small portion of Orange County (**Figure 1-1**). The watershed includes portions of the Towns of Stanardsville, Ruckersville, and Earlysville. The study watershed includes VAHU6 watersheds JR09, JR10, JR11, and JR12. The North Fork Rivanna River and its tributaries are part of the James River basin, which ultimately drains to the Chesapeake Bay.

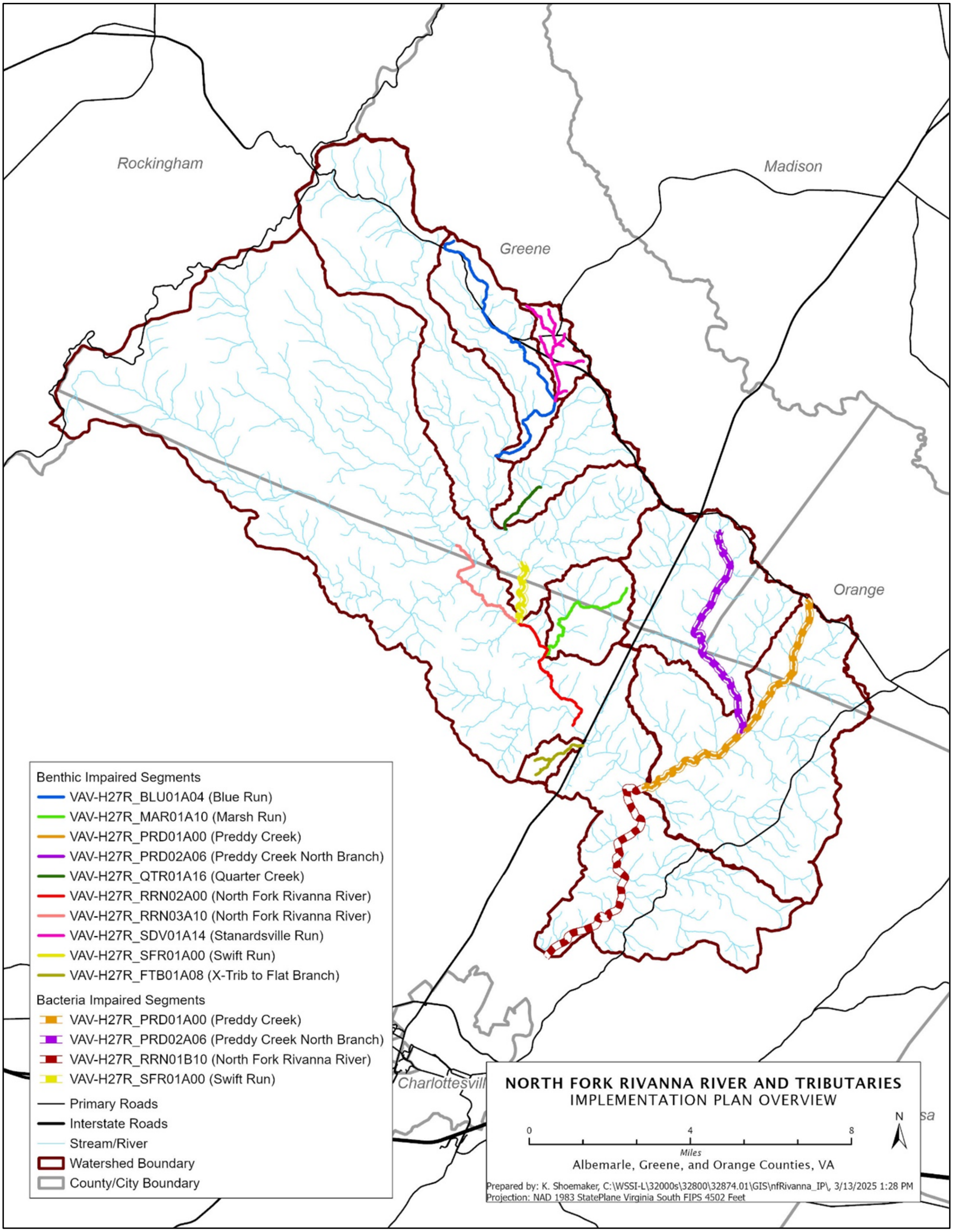

Figure 1-1. Watersheds and impairments included in this Implementation Plan.

1.3.1. Attainability of Designated Uses

Although the benthic TMDLs for the North Fork Rivanna River and Tributaries were developed for sediment and in some cases phosphorus, attainment of a healthy benthic community will ultimately be based on biological monitoring of the benthic macroinvertebrate community, in accordance with established DEQ protocols. If a future review should find that the reductions called for in these TMDLs based on current modeling are found to be insufficiently protective of local water quality and attainment of the aquatic life designated use, then revision(s) will be made as necessary to provide reasonable assurance that water quality goals will be achieved.

All waters in the Commonwealth have been designated as "primary contact" for the swimming use regardless of size, depth, location, water quality or actual use. The 2019 bacteria standard described in **Section 1.2.2** above is to be met during all stream flow levels and was established to protect swimmers from ingestion of potentially harmful bacteria. However, many headwater streams are small and shallow during base flow conditions when surface runoff has minimal influence on stream flow. Even in pools, these shallow streams do not allow full body immersion during periods of base flow. In larger streams, lack of public access often precludes the swimming use.

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

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

In some streams for which TMDLs have been developed, water quality modeling indicates that even after removal of all of the sources of E. coli (other than wildlife), the stream will not attain the applicable water quality standards. In such cases, after demonstrating that the source of E. coli contamination is natural and uncontrollable by reasonable control measures, Virginia may decide to re-designate the stream’s use for secondary contact recreation or to adopt site specific criteria based on natural background levels of E. coli. All site-specific criteria or designated use changes must be adopted as amendments to the water quality standards regulations. Watershed stakeholders and EPA will be able to provide comment during this process.

2.0 REQUIREMENTS FOR IMPLEMENTATION PLANS

There are a number of requirements and recommendations for TMDL IPs. The goal of this chapter is to clearly define what they are and explicitly state if the "elements" are a required component of an approvable IP or are merely a recommended topic that should be covered in a thorough IP. This chapter discusses a) the requirements outlined by WQMIRA that must be met in order to produce an IP that is approvable by the Commonwealth, b) IP elements recommended by the USEPA, and c) components of an IP required in Section 319 of the CWA.

2.1. State Requirements

The TMDL IP is a requirement under Virginia's 1997 WQMIRA when the TMDL is not expected to be fully implemented through existing mechanisms. WQMIRA directs VADEQ to provide "the expeditious development and implementation of total maximum daily loads." For IPs to be approved by the Commonwealth, they must meet the requirements outlined by WQMIRA (VADEQ, 2017) which include:

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

2.2. Federal Recommendations

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

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

It is strongly suggested that IPs address EPA recommendations in addition to the required components described by WQMIRA.

2.3. Requirements for Section 319 Fund Eligibility

EPA develops guidelines that describe the process and criteria used to award CWA Section 319 nonpoint source grants to States. The guidance is subject to revision, and the most recent version should be considered for IP development. The *Nonpoint Source Program and Grant Guidelines* *for States and Territories* (USEPA, 2024) identifies the following nine elements that must be included in the IP in order to qualify for CWA Section 319(h) funds:

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

While IPs that include EPA's nine elements are not guaranteed CWA Section 319(h) funds, incorporating these elements opens the door to the possibility of receiving CWA Section 319(h) funds which are awarded annually to the State.

3.0 REVIEW OF TMDL DEVELOPMENT

3.1. Overall Background

The North Fork Rivanna River and Tributaries watershed is located in Albemarle, Greene, and Orange Counties, Virginia, and drains a predominantly rural watershed with some isolated developed areas. The North Fork Rivanna River flows south into the Rivanna River, which is part of the James River basin that ultimately flows into the Chesapeake Bay.

The North Fork Rivanna River and several of its tributaries are listed as impaired on Virginia's Section 305(b)/303(d) Water Quality Assessment Integrated Report due to water quality violations of the general aquatic life (benthic) and recreational use (bacteria) standard. The impaired segments addressed in this document are shown in Table 3-1 and **Figure 1-1**.

Nine benthic impairments were addressed in the 2019 Benthic TMDL Development for the North Fork Rivanna River Watershed and Tributaries Located in Albemarle, Greene, and Orange Counties" report (VADEQ, 2019). A review of the 2019 benthic TMDL study is presented in **Section 3.2**.

Two of the bacteria impairments addressed in this Implementation Plan were included in the 2008 "Bacteria TMDL Development for the Rivanna River Mainstem, North Fork Rivanna River, Preddy Creek and Tributaries, Meadow Creek, Mechums River, and Beaver Creek Watersheds" report (VADEQ, 2008). Since the 2008 TMDL was developed, the Preddy Creek and Tributaries assessment unit has been reclassified as two assessment units: Preddy Creek VAV-H27R_PRD01A00 (7.48 miles) and Preddy Creek North Branch VAV-H27R_PRD02A06 (6.24 miles). Additionally, Swift Run (VAV-H27R_SFR01A00, 1.91 miles) was listed as impaired on the 2010 Integrated Report (VADEQ, 2010) due to exceedances of the *E. coli* bacteria standard at the time. A review of the 2008 bacteria TMDL study is presented in **Section 3.3**.

Table 3-1. Impaired segments addressed in the 2019 Benthic TMDL study, 2008 Bacteria TMDL study, and 2010 nested bacteria segments included in this Implementation Plan.

Waterbody Name	HUC12 (VAHU6)	DEQ 305(b) AU/ATTAINS ID	DEQ 303(d) Cause Group	TMDL Pollutant of Concern	Year Initially Listed	Description
Blue Run	020802040302 (JR10)	VAV-H27R_BLU01A04 (8.72 mi)	H27R-06-BEN	TSS, TP	2012	Blue Run from the headwaters downstream to its confluence with Swift Run
Marsh Run	020802040303 (JR11)	VAV-H27R_MAR01A10 (3.65 mi)	H27R-05-BEN	TSS	2010	Marsh Run from the headwaters downstream to its confluence with the North Fork Rivanna River
North Fork Rivanna River	020802040305 (JR13)	VAV-H27R_RRN01A00 (6.56 mi)	H27R-04-BAC	bacteria	2006	North Fork Rivanna River from its confluence with Preddy Creek downstream to its confluence with the Rivanna River
	020802040303 (JR11)	VAV-H27R_RRN01B10 (3.98 mi)				North Fork Rivanna River from the RWSA NF Rivanna River Public Water Intake downstream to its confluence with Preddy Creek
	020802040303 (JR11)	VAV-H27R_RRN02A00 (3.82 mi)	H27R-09-BEN	TSS	2016	North Fork Rivanna River from its confluence with Swift Run downstream to the RWSA-NF Rivanna River Public Water Intake
	020802040301 (JR09)	VAV-H27R_RRN03A10 (3.51 mi)				North Fork Rivanna River from its confluence with the Lynch River downstream to its confluence with Swift Run

Waterbody Name	HUC12 (VAHU6)	DEQ 305(b) AU/ATTAINS ID	DEQ 303(d) Cause Group	TMDL Pollutant of Concern	Year Initially Listed	Description
Preddy Creek	020802040304 (JR12)	VAV-H27R_PRD01A00 (7.48 mi)	H27R-08-BEN	TSS	2016	Preddy Creek from the headwaters downstream to its confluence with the North Fork Rivanna River
			H27R-03-BAC	bacteria	2006	
Preddy Creek North Branch	020802040304	VAV-H27R_PRD02A06 (6.24 mi)	H27R-03-BAC	bacteria	2010	North Branch of Preddy Creek from the headwaters downstream to its confluence with Preddy Creek
			H27R-03-BEN	TSS	2010	
Quarter Creek	020802040302 (JR10)	VAV-H27R_QTR01A16 (1.58 mi)	H27R-10-BEN	TSS	2016	Quarter Creek from the dam outfall at Jonquil Road to its confluence with Swift Run
Stanardsville Run	020802040302 JR10	VAV-H27R_SDV01A14 (5.71 mi)	H27R-07-BEN	TSS, TP	2014	Stanardsville Run and tributaries from the headwaters downstream to its confluence with Blue Run
Swift Run	020802040302 (JR10)	VAV-H27R_SFR01A00 (1.91 mi)	H27R-02-BAC	bacteria	2010	Swift Run from its confluence with Welsh Run downstream to its confluence with the North Fork Rivanna River
			H27R-02-BEN	TSS	2012	
X-Trib to Flat Branch	020802040303 (JR11)	VAV-H27R_FTB01A08 (2.03 mi)	H27R-01-BEN	TSS	2010	X-trib to Flat Branch from the headwaters (including tributaries) downstream to its confluence with Flat Branch

3.2. Sediment and Phosphorus TMDL

3.2.1. Background

Ten (10) impaired segments of the North Fork Rivanna River and Tributaries were included in the 2019 benthic TMDL development (VADEQ, 2019). The included impairments are listed in **Table 3-2** and shown in **Figure 3-1**.

A benthic stressor analysis study was conducted in January 2019 to identify pollutant(s) of concern for TMDLs to be developed for each of the impairments. The study found that the main cause of the impairments was too much sediment. In two of the tributaries, Blue Run and Stanardsville Run, the cause of the impairment was too much sediment as well as too much phosphorus.

For the impairment on the North Fork Rivanna River itself, the stressor identification analysis identified two probable stressors or reasons for the impairment: sediment and the presence of the Advance Mills Dam just 50 m upstream from the monitoring station (2-RRN012.89). In addition, other contributing factors, such as historic dams and sediment loads to the river may also be continuing to impact benthic life in the North Fork Rivanna River. Based on the combined factors of the highly localized nature of the impairment, VSCI scores periodically reported above 60, model results that showed no need for mainstem sediment reductions, and additional sediment reductions that will come from implementation of upstream TMDLs, VADEQ decided not to assign specific reductions to the mainstem North Fork Rivanna River in the 2019 TMDL. Implementation of upstream reduction scenarios related to the other impairments in the watershed will only improve the water quality in the North Fork Rivanna River. In addition, VADEQ began biological monitoring at a new station farther away from the potential influence of the dam in fall of 2018. Monitoring will continue at the new station to help determine if the impairment at the current station may in fact have been due to a combination of contributing factors, including the localized impact of the dam.

Table 3-2. Impaired segments addressed in the 2019 TMDL study (Table 1-1 in 2019 benthic TMDL study (VADEQ, 2019)).

TMDL Watershed	305(b) Segment ID	Cause Group Code 303(d) Impairment ID	Year Initially Listed
Blue Run	VAV-H27R_BLU01A04 (8.72 mi)	H27R-06-BEN	2012
Marsh Run	VAV-H27R_MAR01A10 (3.65 mi)	H27R-05-BEN	2010
Preddy Creek	VAV-H27R_PRD01A00 (7.48 mi)	H27R-08-BEN	2016
Preddy Creek North Branch	VAV-H27R_PRD02A06 (6.24 mi)	H27R-03-BEN	2010
Quarter Creek	VAV-H27R_QTR01A16 (1.58 mi)	H27R-10-BEN	2016
North Fork Rivanna River	VAV-H27R_RRN02A00 (3.82 mi) VAV-H27R_RRN03A10 (3.51 mi)	H27R-09-BEN	2016
Stanardsville Run	VAV-H27R_SDV01A14 (5.71 mi)	H27R-07-BEN	2014
Swift Run	VAV-H27R_SFR01A00 (1.91 mi)	H27R-02-BEN	2012
X-Trib to Flat Branch	VAV-H27R_FTB01A08 (2.03 mi)	H27R-01-BEN	2010

3.2.2. Watershed Characteristics

The North Fork Rivanna River watershed incorporated in the 2019 TMDL study is approximately 103,000 acres and includes portions of Albemarle, Greene, and Orange Counties, including portions of the Towns of Stanardsville, Ruckersville, and Earlysville. The study watershed includes VAHU6 watersheds JR09, JR10, JR11, and JR12. The North Fork Rivanna River and its tributaries are part of the James River basin, which ultimately drains to the Chesapeake Bay.

The TMDL used the 2016 VGIN VLCD land cover dataset to determine the land cover distribution throughout the watershed, with minor changes (**Figure 3-2**, **Table 3-3**).

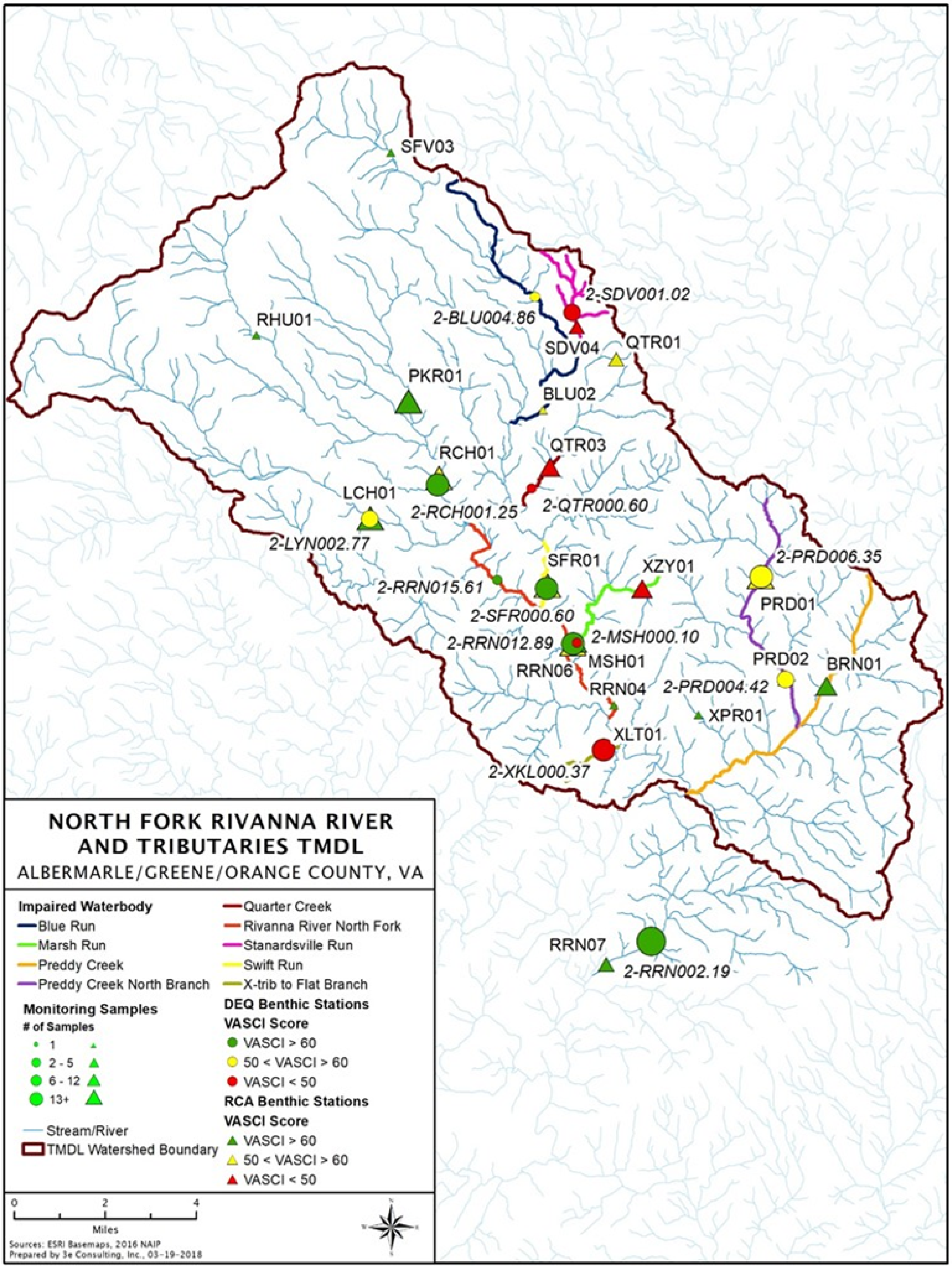

Figure 3-1. Stream health score summaries in the North Fork Rivanna River watershed (Figure 1-2 in TMDL report (VADEQ, 2019))

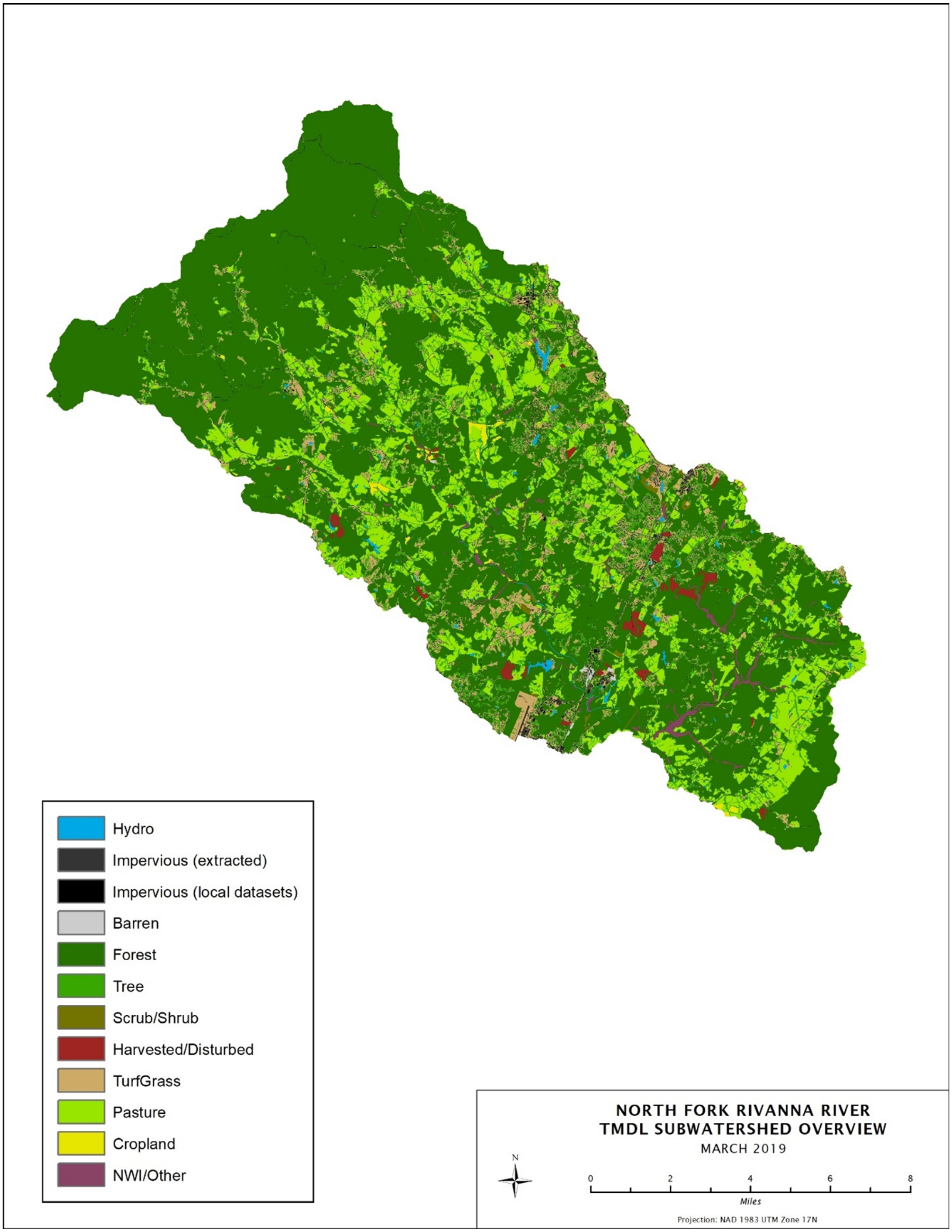

Figure 3-2. Land cover distribution used in the 2019 North Fork Rivanna River and Tributaries TMDL study (VADEQ, 2019).

Table 3-3. Land cover distribution in the 2019 benthic TMDL (VADEQ 2019)

Land Cover Category	Watershed Acreage								
	Blue Run	**Marsh Run**	**Preddy Creek**	**Preddy Creek North Branch**	**Quarter Creek**	**North Fork Rivanna River**	**Stanardsville Run**	**Swift Run**	**X-Trib to Flat Branch**
Cropland	12	0	60	11	0	276	0	128	0
Hay	548	257	1,552	288	214	4,618	87	2,118	3
Pasture	731	422	3192	592	285	6,546	116	2,821	5
Forest	3,088	1,449	14,255	4,445	1,580	45,345	405	16,502	291
Trees	834	381	2,833	1,453	701	6,538	268	3,067	73
Shrub	6	0	97	90	9	74	0	31	0
Harvested/ Disturbed	0	0	394	250	5	137	0	28	0
Water	65	6	121	46	30	269	14	131	4
Wetland	22	32	529	150	13	289	3	99	0
Barren	0	0	1	1	0	17	0	0	0
Turfgrass	454	198	1,488	1,012	476	3,732	214	1,527	122
Developed, pervious	38	6	106	81	37	190	18	114	25
Developed, impervious	228	76	668	447	181	1,340	103	688	93
Total	*6,025*	*2,828*	*25,295*	*8,863*	*3,531*	*69,371*	*1,230*	*27,253*	*616*

3.2.3. Water Quality Monitoring Data

Biological, physical, and chemical data from 38 monitoring stations within the NF Rivanna watershed were used to list these streams with a benthic impairment and in developing the benthic stressor analysis and TMDL study. This includes 13 benthic and 12 water quality monitoring stations operated by VADEQ within the watershed (6 of which are co-located benthic and water quality stations) as well as 19 benthic monitoring stations within the watershed operated by the RCA. RCA is a nonprofit watershed stewardship organization operating throughout the Rivanna River watershed. RCA’s benthic monitoring program is certified by VADEQ at Level III, meaning that their volunteer monitoring data can be used by VADEQ as if the samples had been collected by state and other government officials. The benthic stations are summarized in **Table 3-4** and the various monitoring stations are shown in **Figure 3-3**.

3.2.4. Model Selection and Description

The model selected for development of the sediment and phosphorus TMDLs in the North Fork Rivanna River and tributary watersheds was the Generalized Watershed Loading Functions (GWLF) model, developed by Haith et al. (1992), with modifications by Evans et al. (2001), Yagow et al. (2002), and Yagow and Hession (2007). GWLF is a continuous simulation model that operates on a daily timestep for water balance calculations and outputs a monthly sediment and nutrient yield for the lumped watershed. The model allows for multiple different land cover categories to be incorporated, but spatially it is lumped, in the fact that it does not account for the spatial distribution of sources and has no method of spatially routing sources within the watershed. Observed daily precipitation and temperature data is input, along with land cover distribution and a range of land cover parameters, soil data, and slope, which the model uses to estimate runoff and sediment loads in addition to dissolved and attached nitrogen and phosphorus loads. GWLF incorporates a delivery ratio into the overall sediment supply, and sediment transport takes into consideration the transport capacity of the runoff. To clearly identify sources of sediment, many of the watersheds were divided up into smaller subwatersheds. The sources and their respective sediment contributions were identified for each smaller subwatershed based on land use and climate data. The GWLF model was then used to simulate the transport of these pollutant loads to the streams.

Table 3-4. Benthic scores in the North Fork Rivanna River watershed (Table 1-2 from Stressor Identification Analysis report within 2019 benthic TMDL study (VADEQ, 2019))

Stream	Station	Years Sampled	Samples Collected	SCI Average	Pooled SCI Since 2009	Agreement with Listing
Roach River	2-RCH001.25	2008-2017	6	66.3	61.4	Y
	RCH01	2005-2018	33	57.5		
	RHU01	2009	1	85.4	85.4	Y
Lynch River	2-LYN002.77	2008-2015	5	57.1	62.6	Y
	LCH01	2003-2018	39	65.3		
Stanardsville Run	2-SDV001.02	2012	3	38.9	38.9	Y
	SDV04	2016-2018	4	33.4	33.4	Y
Blue Run	2-BLU004.86	2018	1	57.4	57.4	Y
	BLU02	2009	1	50.2	50.2	Y
Quarter Creek	QTR01	2010-2012	5	55.8	55.8	N
	QTR03	2013-2018	12	48.2	48.2	Y
	2-QTR000.60	2018	1	41.1	41.1	Y
Swift Run	SFV03	2009	1	81.3	81.3	Y
	2-SFR000.60	2003-2015	9	66.7	56.9	Y
	SFR01	2002-2018	41	56.6		
Marsh Run X-Trib	XZY01	2007-2009	7	44.0	46.8	Y
Marsh Run	MSH01	2009-2018	12	65.5	61.6	N
	2-MSH000.10	2018	2	40.2		
Preddy Creek	2-PRD004.42	2006-2007	4	59.2	59.2	Y
	PRD02	2006-2007	4	59.2		
	2-PRD006.35	2008-2018	6	51.9	51.3	Y
	PRD01	2005-2018	31	52.5		
Burnley Branch	BRN01	2012-2018	12	60.6	60.6	N
Preddy Creek X-Trib	XPR01	2009	1	77.5	77.5	Y
X-Trib to Flat Branch	2-XKL000.37	2007-2018	7	30.7	31.9	Y
	XLT01	2003-2007	5	28.5		
NF Rivanna River	2-RRN015.61	2018	1	75.5	75.5	N
	2-RRN012.89	2007-2018	10	60.3	57.3	Y
	RRN06	2003-2017	34	55.0		
	RRN04	2009	1	61.2	61.2	N
	2-RRN002.19	2005-2015	14	68.2	64.7	Y
	RRN07	2016-2018	4	61.8		

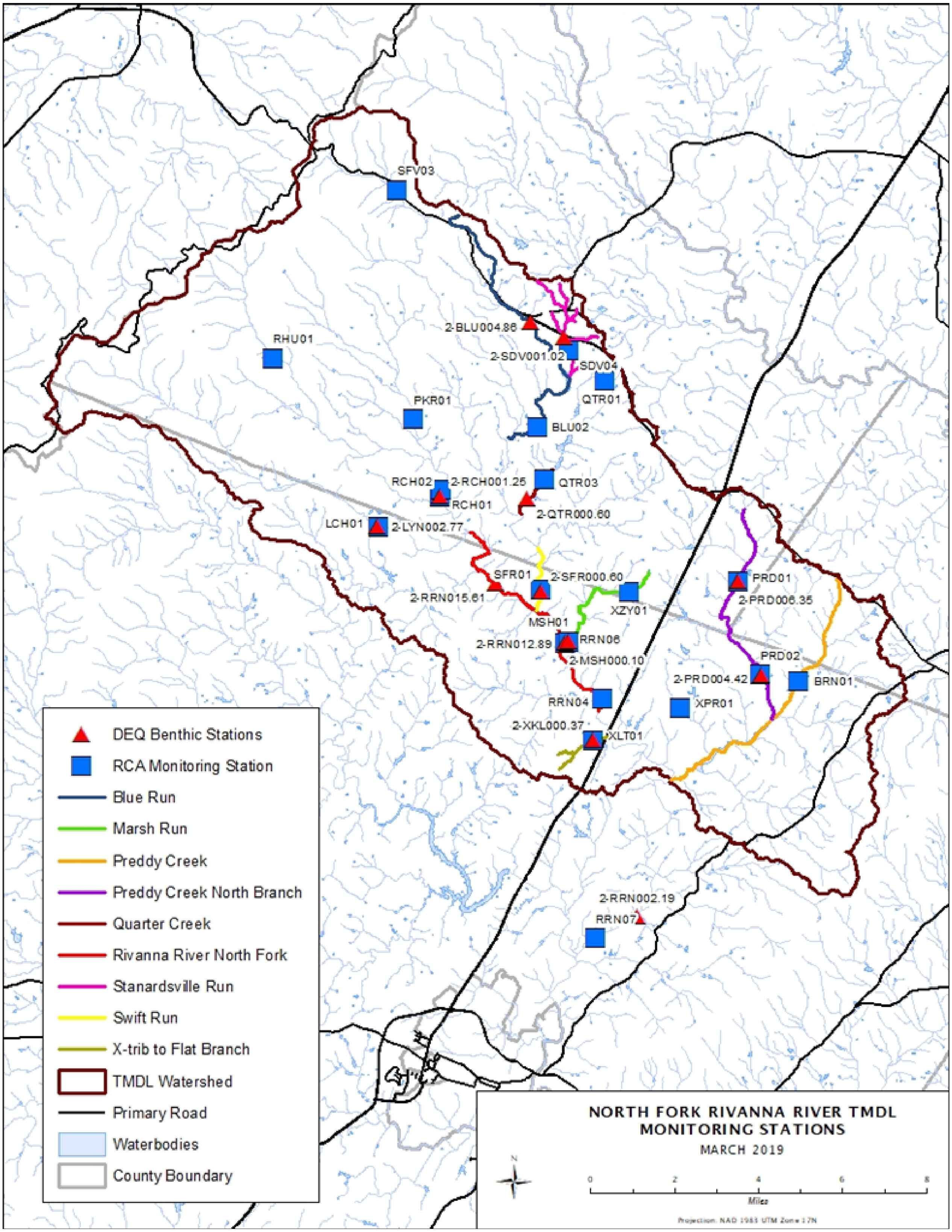

Figure 3-3. Locations of VADEQ and RCA monitoring stations in the North Fork Rivanna River watershed (Figure 3-4 in the 2019 benthic TMDL study (VADEQ, 2019)).

3.2.5. Source Assessment

Sediment and phosphorus can be delivered to streams by either point or non-point sources. Point sources include permitted sources such as water treatment facilities. Non-point sources encompass all of the other sources in the watersheds. Non-point sediment and phosphorus is primarily from surface runoff (anywhere not captured and converted to point sources) and erosion happening within and on the banks of streams. Phosphorus in particular can be either bound to and transported with eroded sediment or dissolved in water directly.

3.2.5.1. Nonpoint Sources

3.2.5.1.1. Surface Runoff

Sediment and attached phosphorus can be transported from both pervious and impervious surfaces during runoff events. Between rainfall events, sediment accumulates on impervious surfaces and can then be washed off of these impervious surfaces during runoff events. On pervious surfaces, soil particles are detached by rainfall impact and shear stress from overland flow and then transported with the runoff water to nearby streams. Various factors including rainfall intensity, storm duration, surface cover, topography, tillage practices, soil erosivity, soil permeability, and other factors all impact these processes. Surface applications of manure and other fertilizers are also subject to being suspended and transported in runoff water. In addition to the phosphorus attached to mobilized particles, phosphorus can also be dissolved in water. Surface runoff can ‘pick up’ soluble phosphorus and then contribute directly to dissolved phosphorus in streams.

VGIN 2016 VLCD land cover data was used to determine the distribution of different land cover types in the watersheds. Values for various parameters affecting sediment and phosphorus loads were gleaned from literature guidance (CBP, 1998; Haith et al., 1992; Hession et al., 1997) and adjusted during the modeling process where appropriate.

3.2.5.1.2. Streambank Erosion

Sediment is transported in stream systems as part of their natural processes. However, changes to the landscape can alter these processes, in turn changing the balance of sediment mobilization and deposition within the stream system. Phosphorus in the soil binds tightly with sediment and is transported in the stream along with the associated sediment, altering the loading and transportation of TP within the watershed.

Increases in impervious areas can increase the amount and rate of flow in streams following rainfall events, which provides more erosive power to the streams and increases the channel erosion potential. This is often the cause of the entrenchment of urban streams. The higher flows mobilize more sediment, both as total suspended sediment (TSS) in the water column and bedload (the movement of larger particles along the bottom of the channel). Erosion of entrenched streams continues as steep banks are more susceptible to erosion and eventually mass wasting as chunks of undercut banks are dislodged into the stream. Sediment deposition between storm events and the highly mobile bed material during erosive storm flows negatively impact aquatic life.

Additionally, impacts to riparian (streambank) vegetation from livestock access and other management practices weaken the stability of the streambanks themselves as root system matrices break down. Weakened streambanks are more easily eroded by storm flows and can lead to excessive channel migration and eventual channel over-widening. Increasing channel width decreases stream depth which can lead to increased sediment deposition and increased water temperatures, which both negatively impact aquatic life.

Stream bank and channel erosion is calculated in GWLF using an algorithm by Evans et al. (2003) as incorporated in the AVGWLF version (Evans et al., 2001) of the GWLF model and corrected for a flow accumulation coding error (VADEQ, 2005). This algorithm estimates average annual streambank erosion as a function of cumulative stream flow, fraction of developed land (i.e. impervious cover) in the watershed, and livestock density in the watershed with the area-weighted curve number and soil erodibility factors and the mean slope of the watershed.

3.2.5.1.3. Groundwater

Shallow surface groundwater interacts with phosphorus both dissolved in percolating runoff and also attached to the soil particles it moves around. The higher the concentration of soil-phosphorus and dissolved phosphorus in runoff water, the higher the levels of phosphorus in shallow groundwater. Groundwater can contribute directly to streamflow through upwelling, taking its dissolved phosphorus with it and adding to the overall total phosphorus (TP) load in the streams.

3.2.5.1.4. Residential Septic Systems

Residential septic systems are designed so that their drainfields dissipate the effluent over an area to be adsorbed to soil particles and used by plant roots and microorganisms. When systems are failing, they can discharge nutrient-rich waste to the surface where it is easily transported to surface waters during runoff events, or directly to surface waters if they are located nearby. Distribution of septic systems in the watersheds was estimated with input from localities and use of GIS data regarding sewer lines and parcel boundaries.

3.2.5.2. Point Sources

Various point sources of sediment and phosphorus exist within the North Fork Rivanna River and tributary watersheds. These point sources are permitted under the Virginia Pollutant Discharge Elimination System (VPDES) program and include the following categories of permits: individual permits, potable water treatment plant general permits, municipal separate storm sewer system (MS4) permits, mixed concrete general permits, industrial stormwater general permits, and domestic sewage general permits. These point sources of sediment and/or phosphorus in the watersheds are summarized in **Table 3-5** and **Table 3-6** along with their wasteload allocations (WLA) in the TMDLs.

Table 3-5 Permitted sediment point sources in the North Fork Rivanna River and tributary watersheds TMDL study (VADEQ, 2019).

Permit Type	Permit No.	Facility Name	Watershed	WLA (lb/yr TSS)
VPDES Individual Permit	VA0029556	Blue Ridge School STP	Chesley Creek (trib to North Fork Rivanna River)	3,201
Potable Water Treatment Plant Permit	VAG640065	North Fork Rivanna Water Treatment Plant	North Fork Rivanna River	6,401
Mixed Concrete General Permit	VAG110184	Wilson Redi-Mix Inc LLC	Flat Branch Unnamed Tributary (trib to North Fork Rivanna River, outside of X-Trib to Flat Branch impaired watershed)	1,653
Industrial Stormwater Permits	VAR050503	Charlottesville-Albemarle Airport	X-Trib to Flat Branch	1,936
	VAR050960	M & M Service & Salvage Yard Inc.	Welsh Run Unnamed Tributary (trib to Swift Run)	9,900
Domestic Sewage General Permit	VAG408459	N/A	Jacobs Run Unnamed Tributary (trib to North Fork Rivanna River)	91.44
Municipal Separate Storm Sewer System (MS4) Permits	VAR040074	Albemarle County	X-Trib to Flat Branch	16,210
	VA0092975	Virginia Department of Transportation (VDOT)		
Construction Stormwater General Permits	N/A	N/A	X-Trib to Flat Branch	7,980
			Preddy Creek	17,290
			Preddy Creek North Branch	29,780
			Swift Run	7,564
			Quarter Creek	2,878
			Blue Run	8,275
			Stanardsville Run	2,854

Table 3-6 Permitted phosphorus point sources in the North Fork Rivanna River and tributary watersheds TMDL study (VADEQ, 2019).

Permit Type	Permit No.	Facility Name	Watershed	WLA (lb/yr TP)
Construction Stormwater General Permits	N/A	N/A	Blue Run	4.5
			Stanardsville Run	1.1

3.2.6. TMDL Allocation Scenarios

3.2.6.1. Setting Target Sediment Loads

The 2019 benthic TMDL includes sediment and phosphorus reduction scenarios needed to meet the aquatic life use standard. Since neither sediment nor phosphorus have a numeric criterion, the "all-forest load multiplier" (AllForX) approach was used to establish endpoints in the North Fork Rivanna and Tributaries TMDLs. AllForX is the ratio of the simulated pollutant load under existing conditions to the pollutant load from an all-forest simulated condition for the same watershed. In other words, AllForX is an indication of how much higher current sediment loads are above an undeveloped condition. These multipliers were calculated for the watersheds represented by 22 monitoring stations in the North Fork Rivanna River system, representing both impaired and unimpaired reaches and each of the TMDL study reaches. A linear regression was then developed between the average Virginia Stream Condition Index (VSCI) scores at the monitoring stations and the corresponding AllForX ratio calculated for the watershed contributing to that monitoring station. The allowable pollutant TMDL load was then calculated by applying the AllForX threshold ratio where VSCI = 60 from the regression equation to the all-forest simulated pollutant load of the TMDL study watershed. This represents the allowable pollutant load under which the watersheds are anticipated to achieve a VSCI score of 60, the threshold for benthic water quality assessments.

3.2.6.2. Sediment and Phosphorus TMDL Equations

Total maximum daily loads are determined as the maximum allowable load of a pollutant among the various sources. Part of developing a TMDL is allocating this load among the various sources of the pollutant of concern (POC). Each TMDL is comprised of three components, as summed up in this equation:

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

where ΣWLA is the sum of the wasteload allocations (permitted sources),
ΣLA is the sum of the load allocations (non-point sources), and
MOS is a margin of safety.

To account for uncertainties inherent in model outputs, a margin of safety (MOS) is incorporated into the TMDL development process. The MOS can be implicit, explicit, or a combination of the two. The benthic TMDL includes both implicit MOSs and an explicit MOS of 10% of the total load. A wasteload allocation of 2% of the total load is specifically set aside for future growth of permitted loads within this TMDL.

Total loads to downstream subwatersheds were summed from the loads of each contributing upstream subwatershed after adjusting for pollutant losses caused by in-stream processes (i.e. sediment deposition, nutrient uptake, etc.) through the development of an attenuation factor. This attenuation factor was applied to the pollutant loads and point sources of upstream subwatersheds as their load was conveyed through downstream subwatersheds. Permitted loads listed in the WLAs account for the appropriate attenuation factors based on their position in the watershed.

The final sediment and phosphorus average annual loads allocated in the 2019 benthic TMDL are presented in **Table 3-7** through **Table 3-16**.

Table 3-7. Annual average sediment TMDL components for X-Trib to Flat Branch.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Sediment Load (lb/yr)					
X-Trib to Flat Branch - TSS (VAV-H27R_FTB01A08)	**27,890**	**51,710**	**8,847**	**88,400**	147,000	40.0%
Construction Permits	*7,980*					
Industrial Stormwater Permits	*1,936*					
MS4 Permits	*16,210*					
Future Growth (2% of TMDL)	*1,769*					

Table 3-8. Annual average sediment TMDL components for Marsh Run.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Sediment Load (lb/yr)					
Marsh Run - TSS (VAV-H27R_MAR01A01)	**5,210**	**229,200**	**26,050**	**260,000**	575,000	54.7%
Future Growth (2% of TMDL)	*5,210*					

Table 3-9. Annual average sediment TMDL components for Preddy Creek.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Sediment Load (lb/yr)					
Preddy Creek - TSS (VAV-H27R_PRD01A00)	**105,600**	**3,865,000**	**441,500**	**4,410,000**	4,890,000	9.8%
Construction Permits	*17,290*					
Future Growth (2% of TMDL)	*88,300*					

Table 3-10. Annual average sediment TMDL components for Preddy Creek North Branch.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Sediment Load (lb/yr)					
Preddy Creek North Branch - TSS (VAV-H27R_PRD02A06)	**47,940**	**769,300**	**90,810**	**908,000**	1,500,000	39.3%
Construction Permits	*29,780*					
Future Growth (2% of TMDL)	*18,160*					

Table 3-11. Annual average sediment TMDL components for Swift Run.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Sediment Load (lb/yr)					
Swift Run - TSS (VAV-H27R_SFR01A00)	**89,130**	**3,134,000**	**358,300**	**3,580,000**	4,120,000	13.1%
Construction Permits	*7,564*					
Industrial Stormwater Permits	*9,900*					
Future Growth (2% of TMDL)	*71,670*					

Table 3-12. Annual average sediment TMDL components for Quarter Creek.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Sediment Load (lb/yr)					
Quarter Creek - TSS (VAV-H27R_QTR01A16)	**11,020**	**355,400**	**40,730**	**407,000**	777,000	47.6%
Construction Permits	*2,878*					
Future Growth (2% of TMDL)	*8,145*					

Table 3-13. Annual average sediment TMDL components for Blue Run.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Sediment Load (lb/yr)					
Blue Run - TSS (VAV-H27R_BLU01A04)	**20,750**	**540,100**	**62,340**	**623,000**	1,370,000	54.4%
Construction Permits	*8,275*					
Future Growth (2% of TMDL)	*12,470*					

Table 3-14. Annual average sediment TMDL components for Stanardsville Run.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Sediment Load (lb/yr)					
Stanardsville Run - TSS (VAV-H27R_STV01A14)	**6,105**	**140,100**	**16,250**	**163,000**	358,000	54.5%
Construction Permits	*2,854*					
Future Growth (2% of TMDL)	*3,251*					

Table 3-15. Annual average phosphorus TMDL components for Blue Run.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Phosphorus Load (lb/yr)					
Blue Run – TP (VAV-H27R_BLU01A04)	**21.8**	**758**	**86.7**	**867**	1,260	31.1%
Construction Permits	*4.5*					
Future Growth (2% of TMDL)	*17.3*					

Table 3-16. Annual average phosphorus TMDL components for Stanardsville Run.

Impairment	WLA	LA	MOS	TMDL	Existing Load	Percent Reduction
	Phosphorus Load (lb/yr)					
Stanardsville Run – TP (VAV-H27R_SDV01A14)	**4.6**	**156**	**17.8**	**178**	353	49.6%
Construction Permits	*1.1*					
Future Growth (2% of TMDL)	*3.6*					

3.2.6.3. Sediment and Phosphorus Allocation Scenarios

Various scenarios were evaluated by a Technical Advisory Committee (TAC) to identify a fair and equitable approach to implementation that meets sediment and phosphorus endpoints. The total pollutant load allowable was distributed between point and non-point sources and reductions were identified based on existing and allocated loads. The TAC evaluated these reductions and selected a preferred scenario for each watershed. In watersheds where agricultural sources were the largest contributor to existing loads, stakeholders selected allocation scenarios that targeted higher reductions from these agricultural sources. In watersheds where urban sources were the largest contributor to existing loads, stakeholders selected allocation scenarios that spread reductions evenly over source categories. This methodology is reasonable because agricultural practices for reducing sediment and phosphorus are typically more cost efficient than urban practices. The selected sediment allocation scenarios are presented in **Table 3-17** through **Table 3-24,** and the selected phosphorus allocation scenarios are presented in **Table 3-25** and **Table 3-26**

In several larger watersheds (such as Swift Run and Preddy Creek), more severe impairments were in upstream portions of the watershed. For example, more stringent sediment reductions are needed to restore Blue Run and Stanardsville Run than the larger downstream Swift Run watershed. In these cases, fully meeting upstream TMDL targets would completely satisfy downstream reductions. Based on the nature of these nested impairments being most severe in the farthest upstream subwatersheds and progressively becoming less impaired moving downstream, it was decided to set the allocations from bottom-to-top of the nested watersheds, rather than allocating the upstream impairments first and carrying those reductions downstream. The most downstream impairments were addressed first, and the reductions determined for that overall watershed are presented as an interim scenario in the allocation of each upstream impairment. This method serves two key purposes. It ensures that assistance can be made available to landowners in the larger downstream subwatersheds by recommending a certain amount of reduction to the entire watershed, while also providing an interim target scenario for the more severely impaired upstream subwatersheds. The interim allocation scenarios in upstream watersheds do not meet the TMDL, but they can be a useful tool in phased implementation targeted at progressively meeting the TMDL reductions. Based on feedback received from the TAC during TMDL development, this approach provides additional reasonable assurance that TMDL reductions can be achieved and asks for a similar level of buy-in and participation from landowners throughout the project area.

Table 3-17. Allocation scenario for X-Trib to Flat Branch sediment loads.

X-Trib to Flat Branch Sediment		Allocation Scenario	
Source	Existing *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*
Hay	206	50.1	103
Pasture	5,641	50.1	2,815
Forest	7,238	-	7,238
Trees	17,260	-	17,260
Barren	159	50.1	79
Turfgrass	6,980	50.1	3,483
Developed Pervious	1,588	50.1	792
Developed Impervious	38,070	50.1	19,000
Streambank Erosion	1,869	50.1	933
MS4 Permits*	32,480	50.1	16,210
Construction Permits	21,280	-	7,979
ISW Permits	4,012	-	1,936
MOS (10%)	8,847		8,847
Future Growth (2%)	1,769		1,769
Total	*147,000* *0% red.*		*88,400* *40.0% red.*

* Both VDOT and Albemarle County MS4 permits are included in the 2008 “Benthic TMDL Development for the Rivanna River Watershed” with a recommended 59.3% reduction to sediment within their permitted areas in the overall Rivanna River watershed downstream to ‘just after the RWSA-Glenmore STP’ – the downstream extent of the 2008 study.

Table 3-18. Allocation scenario for Marsh Run sediment loads.

Marsh Run Sediment		Allocation Scenario	
Source	Existing *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*
Hay	12,660	70.0	3,797
Pasture	406,700	70.0	122,000
Forest	22,730	-	22,730
Trees	47,670	-	47,670
Wetland	2,076	-	2,076
Turfgrass	8,127	37.5	5,080
Developed Pervious	656	37.5	410
Developed Impervious	38,610	37.5	24,130
Streambank Erosion	4,431	70.0	1,329
MOS (10%)	26,050		26,050
Future Growth (2%)	5,210		5,210
Total	*575,000* *0% red.*		*260,000* *54.7% red.*

Table 3-19. Allocation scenario for Preddy Creek sediment loads. Calculated attenuation factors are applied to permitted loads individually based on their location in the watershed prior to aggregation into the loading values presented.

Preddy Creek Sediment		Allocation Scenario	
Source	Existing *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*
Cropland	27,240	13.2	23,640
Hay	74,330	13.2	64,520
Pasture	2,476,000	13.2	2,149,000
Forest	265,400	-	265,400
Trees	323,700	-	323,700
Shrub	5,661	-	5,661
Harvested	86,330	13.2	74,940
Wetland	21,530	-	21,530
Barren	3,205	13.2	2,782
Turfgrass	42,750	5.0	40,610
Developed Pervious	8,613	5.0	8,182
Developed Impervious	398,400	5.0	378,500
Streambank Erosion	583,500	13.2	506,500
Construction Permits	46,100	-	17,290
MOS (10%)	441,500		441,500
Future Growth (2%)	88,300		88,300
Total	*4,890,000* *0% red.*		*4,410,000* *9.8% red.*

Table 3-20. Allocation scenario for Preddy Creek North Branch sediment loads. Interim scenario presented reflects reductions recommended in the overall Preddy Creek watershed.

Preddy Creek North Branch Sediment		Interim Scenario		Allocation Scenario	
Source	Existing *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*
Cropland	4,995	13.2	4,335	57.3	2,133
Hay	15,300	13.2	13,280	57.3	6,532
Pasture	530,900	13.2	460,800	57.3	226,700
Forest	76,720	-	76,720	-	76,720
Trees	182,300	-	182,300	-	182,300
Shrub	6,871	-	6,871	-	6,871
Harvested	59,240	13.2	51,420	57.3	25,300
Wetland	5,477	-	5,477	-	5,477
Barren	4,382	13.2	3,804	57.3	1,871
Turfgrass	35,100	5.0	33,350	40.0	21,060
Developed Pervious	7,120	5.0	6,764	40.0	4,272
Developed Impervious	277,400	5.0	263,600	40.0	166,500
Streambank Erosion	102,200	13.2	88,680	57.3	43,630
Construction Permits	79,400	-	29,780	-	29,780
MOS (10%)	90,810		90,810		90,810
Future Growth (2%)	18,160		18,160		18,160
Total	*1,500,000* *0% red.*		*1,340,000* *10.7% red.*		*908,000* *39.3% red.*

Table 3-21. Allocation scenario for Swift Run sediment loads. Calculated attenuation factors are applied to permitted loads individually based on their location in the watershed prior to aggregation into the loading values presented.

Swift Run Sediment		Allocation Scenario	
Source	Existing *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*
Cropland	50,220	18.7	40,830
Hay	69,480	18.7	56,480
Pasture	1,888,000	18.7	1,535,000
Forest	246,900	-	246,900
Trees	293,900	-	293,900
Shrub	1,348	-	1,348
Harvested	4,305	18.7	3,500
Wetland	3,088	-	3,088
Turfgrass	40,160	5.0	38,160
Developed Pervious	9,779	5.0	9,290
Developed Impervious	412,300	5.0	391,700
Streambank Erosion	631,500	18.7	513,400
Construction Permits	20,170	-	7,564
ISW Permits	20,520	-	9,900
MOS (10%)	358,300		358,300
Future Growth (2%)	71,670		71,670
Total	*4,120,000*		*3,580,000*
	0% red.		*13.1% red.*

Table 3-22. Allocation scenario for Quarter Creek sediment loads. Interim scenario presented reflects reductions recommended in the overall Swift Run watershed.

Quarter Creek Sediment		Interim Scenario		Allocation Scenario	
Source	Existing *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*
Hay	13,830	18.7	11,240	70.7	4,051
Pasture	378,100	18.7	307,400	70.7	110,800
Forest	33,280	-	33,280	-	33,280
Trees	126,600	-	126,600	-	126,600
Shrub	172	-	172	-	172
Harvested	2,878	18.7	2,340	70.7	843
Wetland	804	-	804	-	804
Turfgrass	23,860	5.0	22,670	50.0	11,930
Developed Pervious	5,963	5.0	5,665	50.0	2,981
Developed Impervious	117,100	5.0	111,200	50.0	58,530
Streambank Erosion	18,090	18.7	14,710	70.7	5,301
Construction Permits	7,676	-	2,878	-	2,878
MOS (10%)	40,730		40,730		40,730
Future Growth (2%)	8,145		8,145		8,145
Total	*777,000* *0% red.*		*688,000* *11.5% red.*		*407,000* *47.6% red.*

Table 3-23. Allocation scenario for Blue Run sediment loads. Interim scenario presented reflects recommended reductions in the overall Swift Run watershed. Calculated attenuation factors are applied to permitted loads individually based on their location in the watershed prior to aggregation into the loading values presented.

Blue Run Sediment		Interim Scenario		Allocation Scenario	
Source	Existing *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*
Cropland	10,490	18.7	8,525	71.5	2,989
Hay	30,090	18.7	24,460	71.5	8,574
Pasture	830,600	18.7	675,300	71.5	236,700
Forest	52,840	-	52,840	-	52,840
Trees	134,400	-	134,400	-	134,400
Shrub	668	-	668	-	668
Wetland	521	-	521	-	521
Turfgrass	19,550	5.0	18,570	45.0	10,750
Developed Pervious	4,711	5.0	4,475	45.0	2,591
Developed Impervious	138,000	5.0	131,100	45.0	75,900
Streambank Erosion	49,720	18.7	40,420	71.5	14,170
Construction Permits	22,070	-	8,275	-	8,275
MOS (10%)	62,340		62,340		62,340
Future Growth (2%)	12,470		12,470		12,470
Total	*1,370,000* *0% red.*		*1,170,000* *14.2% red.*		*623,000* *54.4% red.*

Table 3-24. Allocation scenario for Stanardsville Run sediment loads. Interim scenarios 1 and 2 reflect recommended reductions in the overall Swift Run and Blue Run watersheds, respectively.

Stanardsville Run Sediment		Interim Scenario 1		Interim Scenario 2		Allocation Scenario	
Source	Existing *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*	Red. *%*	Allocation *TSS (lb/yr)*
Cropland	301	18.7	245	71.5	86	76.8	70
Hay	6,313	18.7	5,132	71.5	1,799	76.8	1,465
Pasture	177,800	18.7	144,600	71.5	50,670	76.8	41,250
Forest	10,420	-	10,420	-	10,420	-	10,420
Trees	55,250	-	55,250	-	55,250	-	55,250
Wetland	104	-	104	-	104	-	104
Turfgrass	11,570	5.0	10,990	45.0	6,361	60.0	4,626
Developed Pervious	2,760	5.0	2,622	45.0	1,518	60.0	1,104
Developed Impervious	63,060	5.0	59,910	45.0	34,680	60.0	25,220
Streambank Erosion	2,833	18.7	2,303	71.5	807	76.8	657
Construction Permits	7,610	-	2,854	-	2,854	-	2,854
MOS (10%)	16,250		16,250		16,250		16,250
Future Growth (2%)	3,251		3,251		3,251		3,251
Total	*358,000* *0% red.*		*314,000* *12.2% red.*		*184,000* *48.5% red.*		*163,000* *54.5% red.*

Table 3-25. Allocation scenario for Blue Run phosphorus loads. Calculated attenuation factors are applied to permitted loads individually based on their location in the watershed prior to aggregation into the loading values presented.

Blue Run Phosphorus		Allocation Scenario	
Source	Existing *TP (lb/yr)*	Red. *%*	Allocation *TP (lb/yr)*
Cropland	2.3	50.0	1.1
Hay	86.0	50.0	43.0
Pasture	384.2	50.0	192.1
Forest	9.7	-	9.7
Trees	21.0	-	21.0
Shrub	0.1	-	0.1
Wetland	0.1	-	0.1
Turfgrass	39.4	42.5	22.7
Developed Pervious	2.7	42.5	1.5
Developed Impervious	303.6	42.5	175
Streambank Erosion	17.4	50.0	8.7
Septic	43.0	-	43.0
Groundwater	240.9	-	240.9
Construction Permits	4.5	-	4.5
MOS (10%)	86.7		86.7
Future Growth (2%)	17.3		17.3
Total	*1,260* *0% red.*		*867* *31.1% red.*

Table 3-26. Allocation scenario for Stanardsville Run phosphorus loads. Interim scenario presented reflects recommended reductions in the overall Blue Run watershed.

Stanardsville Run Phosphorus		Interim Scenario		Allocation Scenario	
Source	Existing *TP (lb/yr)*	Red. *%*	Allocation *TP (lb/yr)*	Red. *%*	Allocation *TP (lb/yr)*
Cropland	0.1	50.0	0.0	67.8	0.0
Hay	14.5	50.0	7.3	67.8	4.7
Pasture	80.8	50.0	40.4	67.8	26.0
Forest	2.7	-	2.7	-	2.7
Trees	12.8	-	12.8	-	12.8
Wetland	0.0	-	0.0	-	0.0
Turfgrass	21.5	42.5	12.3	67.8	6.9
Developed Pervious	1.6	42.5	0.9	67.8	0.5
Developed Impervious	138.7	42.5	79.8	67.8	44.7
Streambank Erosion	1.0	50.0	0.5	67.8	0.3
Septic	10.1	-	10.1	-	10.1
Groundwater	46.9	-	46.9	-	46.9
Construction Permits	1.1	-	1.1	-	1.1
MOS (10%)	17.8		17.8		17.8
Future Growth (2%)	3.6		3.6		3.6
Total	*353* *0% red.*		*236* *33.1% red.*		*178* *49.6% red.*

3.3. Bacteria TMDL

3.3.1. Background

Six (6) impaired segments of the Rivanna River and Tributaries were included in the 2008 benthic TMDL development (VADEQ, 2008). The included impairments are listed in **Table 3-27** and shown in **Figure 3-4**. Only two of the impaired segments included in the 2008 bacteria TMDL, North Fork Rivanna River and Preddy Creek and tributaries, are addressed in this Implementation Plan (**Table 3-1**).

At the time of the bacteria TMDL development, the bacteria criteria for freshwater were that *E. coli* bacteria shall not exceed a geometric mean of 126 colony forming units (cfu)/100 mL, and a single sample value shall not exceed 235 cfu/100mL more than 10% of the time. The 2008 TMDL was required to meet both the geometric mean and instantaneous *E. coli* water quality standard.

Table 3-27. Impaired segments addressed in the 2008 TMDL study (VADEQ, 2008).

TMDL Watershed	305(b) Segment ID	Cause Group Code 303(d) Impairment ID	Year Initially Listed
Rivanna River	VAV-H28R-RVN01A00 (5.28 mi)	H28R-06-BAC	2006
Beaver Creek	VAV-H23R-BVR02A04 (4.8 mi)	H23R-02-BAC	2004
Meadow Creek	VAV-H28R-MWC01A00 (4.01 mi)	H28R-03-BAC	2002
Mechums River	VAV-H23R-MCM01A00 (10.44 mi)	H23R-03-BAC	2006
North Fork Rivanna River	VAV-H27R-RRN01A00 (10.38 mi)	H27R-04-BAC	2006
Preddy Creek and Tributaries	VAV-H27R-PRD01A00 (25.96 mi)	H27R-03-BAC	2006

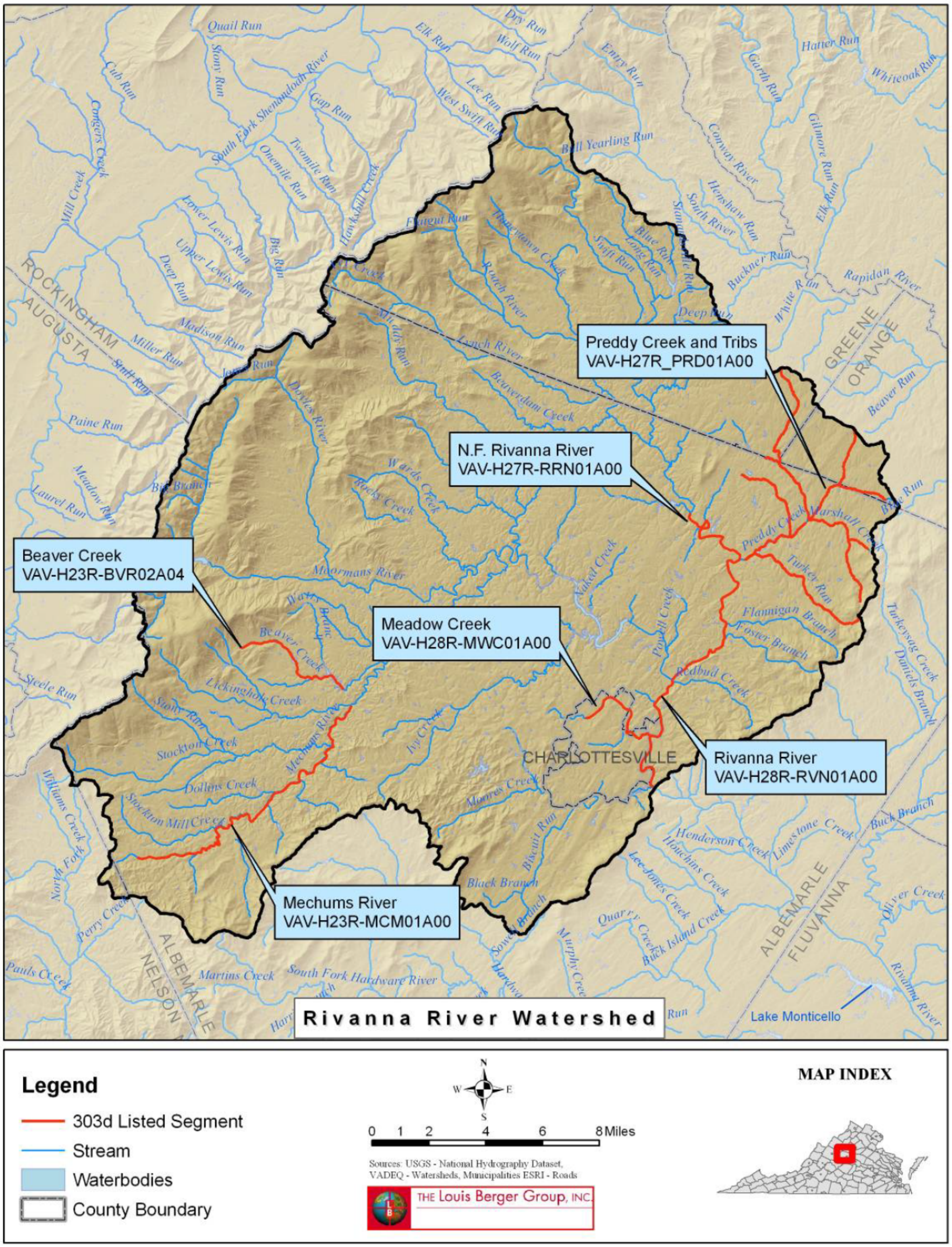

Figure 3-4. Location of Bacteria Impaired Segments of the Rivanna River and Tributaries addressed in bacteria TMDL (Figure 1-1 in TMDL report (VADEQ, 2008))

3.3.2. Watershed Characteristics

The bacteria impaired Rivanna River watershed is located within the borders of Albemarle, Greene, Nelson, and Orange counties. The city of Charlottesville is also within the watershed's boundaries. All impaired streams are located in the Rivanna River watershed (USGS Cataloging Unit 02080204). The entire Rivanna River bacteria impaired watershed addressed in the 2008 bacteria TMDL is approximately 321,877 acres.

The land use characterization for the 2008 bacteria TMDL was based on land cover data from MRLC NLCD using 2001 updated by incorporating a 2005 land cover dataset developed by the Virginia Department of Forestry. The distribution of land uses in the watershed, by land area and percentage, is presented in **Table 3-28** and shown in **Figure 3-5**. Specific acreages for the watersheds of interest for this Implementation Plan (Preddy Creek and Tributaries and North Fork Rivanna River) are presented in **Table 3-29** and **Table 3-30**).

Table 3-28. Land cover used in 2008 bacteria TMDL (Table 3-7 in TMDL (VADEQ, 2008)).

Land Cover Type	Hybrid NLCD/VOF Acreage	Percent of Watershed
Water/Wetlands	2,463	0.8%
Urban	46,132	14.5%
Agriculture	65,946	20.7%
Forest	203,413	64.0%
Barren	8	0.0%
Total	317,962	100%

Table 3-29. Preddy Creek and Tributaries land use reclassification (Table 4-4 in TMDL (VADEQ, 2008)).

Land Use Category	Acres	Percent of Watershed's Land Area
High Density Residential	2,750	2%
Low Density Residential	9,631	8%
Cropland	798	1%
Pasture	25,679	22%
Forest	76,570	66%
Wetland	135	<1%
Water	591	1%
Total	**116,155**	**100%**

Table 3-30. North Fork Rivanna River land use reclassification (Table 4-3 in TMDL (VADEQ, 2008)).

Land Use Category	Acres	Percent of Watershed's Land Area
High Density Residential	2,750	2%
Low Density Residential	9,631	8%
Cropland	798	1%
Pasture	25,679	22%
Forest	76,570	66%
Wetland	135	<1%
Water	591	1%
Total	**116,155**	**100%**

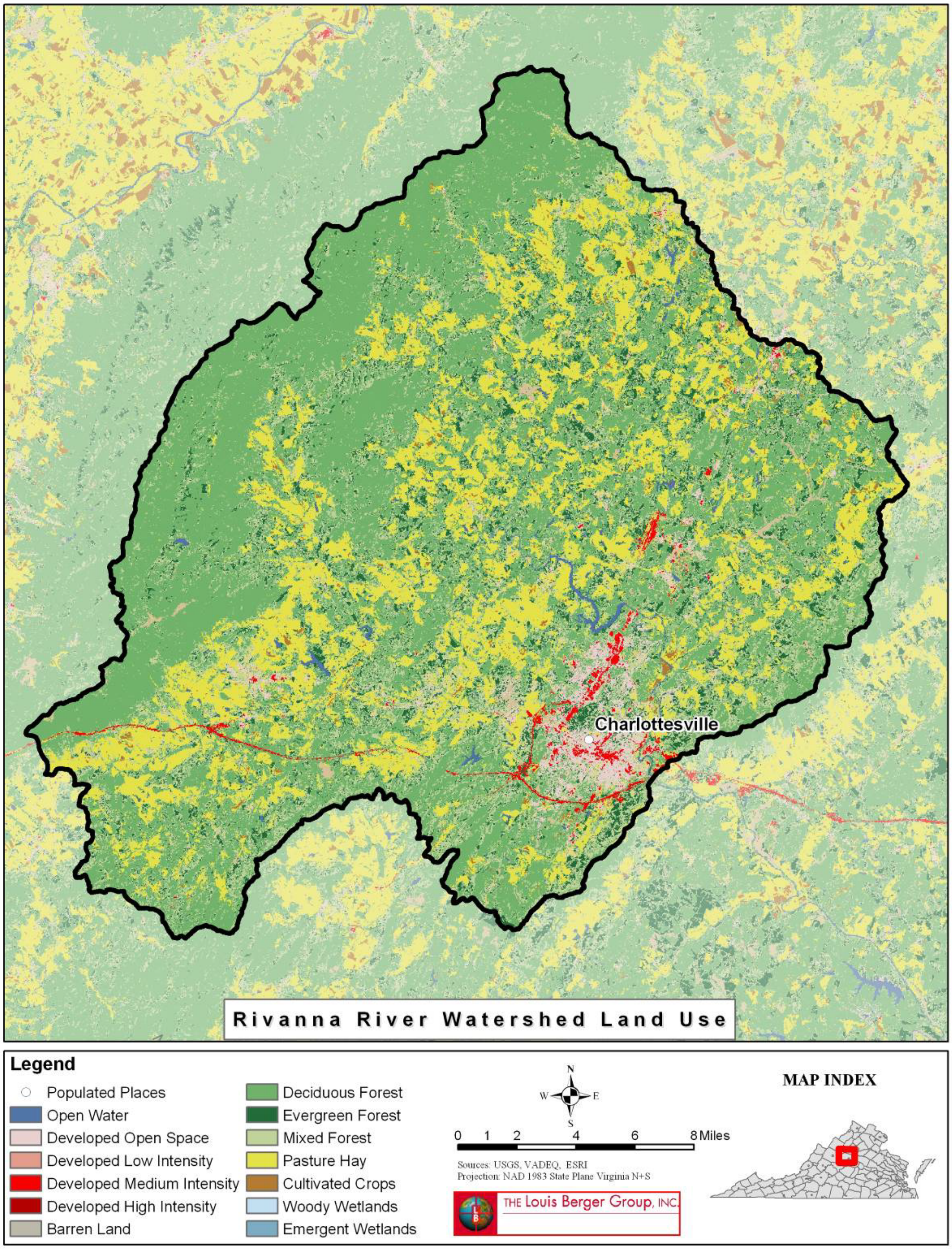

Figure 3-5. Land Use in the Rivanna River Watershed (Figure 3-2 in TMDL study (VADEQ, 2008).

3.3.3. Water Quality Monitoring Data

Water quality data used in the 2008 bacteria TMDL were obtained from DEQ, which conducted sampling at 55 monitoring stations located within the watershed (**Figure 3-6**). **Table 3-31** and **Table 3-32** the water quality sampling period of record and the number and percentage of samples violating the water quality standards collected between 1990 and 2006, as used in the bacteria TMDL study. Stations formatted in bold are located on the bacteria impaired segments.

Table 3-31. Fecal Coliform Data Collected within the Rivanna River Watershed (Table 3-10 in TMDL study (VADEQ, 2008)).

Station ID	# Samples	Date Sampled		Values (no/100mL)			Instant. Exceed[1]	
		First	Last	Min	Max	Average	Sum	Percent
2-BKM002.01	48	8/18/1993	6/16/2003	100	3000	292	5	10%
2-BLU000.78	14	8/7/2001	5/5/2003	100	1000	186	1	7%
2-BVR005.70	**18**	**11/29/1994**	**5/16/2001**	**100**	**4000**	**400**	**2**	**11%**
2-DYL000.63	12	7/10/2001	6/16/2003	100	500	150	1	8%
2-IVC000.02	4	3/17/1994	9/23/1996	100	100	100	0	0%
2-IVC005.19	7	8/5/1991	6/22/1993	100	400	186	0	0%
2-IVC008.09	12	7/10/2001	6/12/2003	100	200	125	0	0%
2-IVC010.20	15	7/29/1997	5/16/2001	100	2100	413	2	13%
2-JCB000.80	1	9/8/1992	9/8/1992	100	100	100	0	0%
2-LKN003.70	28	8/5/1991	3/4/1999	100	1200	250	3	11%
2-LKN005.47	14	4/19/1999	5/16/2001	100	400	171	0	0%
2-LYN002.77	12	8/7/2001	5/5/2003	100	100	100	0	0%
2-MCM005.12	156	1/3/1990	10/3/2006	25	8000	363	27	17%
2-MCM010.84	**10**	**7/10/2001**	**6/12/2003**	**100**	**600**	**280**	**2**	**20%**
2-MCM018.92	**28**	**9/1/1994**	**6/12/2003**	**100**	**1600**	**186**	**1**	**4%**
2-MNR000.39	37	12/5/1991	6/16/2003	100	1700	186	1	3%
2-MNR014.50	5	4/25/2001	9/18/2001	100	100	100	0	0%
2-MSC000.60	68	8/5/1991	9/20/2006	25	5400	586	23	34%
2-MWC000.60	**42**	**8/5/1991**	**6/26/2001**	**100**	**8000**	**1119**	**15**	**36%**
2-PRD004.42	**1**	**4/5/2006**	**4/5/2006**	**25**	**25**	**25**	**0**	**0%**
2-RCH001.25	12	8/7/2001	5/5/2003	100	500	142	1	8%
2-RRN002.19	**82**	**1/3/1990**	**7/17/2006**	**25**	**8000**	**386**	**13**	**16%**
2-RRN010.92	49	6/29/1998	6/16/2003	100	5700	292	3	6%
2-RRN015.61	13	8/7/2001	5/5/2003	100	300	123	0	0%
2-RRS003.12	123	1/3/1990	6/16/2003	100	5500	393	18	15%
2-RRS005.35	33	8/18/1993	5/16/2001	100	8000	361	2	6%
2-RRS010.30	1	10/1/2001	10/1/2001	300	300	300	0	0%
2-RVN033.65	129	1/3/1990	7/6/2006	25	4800	322	17	13%
2-RVN037.54	**35**	**8/18/1993**	**6/26/2001**	**100**	**5600**	**423**	**8**	**23%**
2-SFR000.60	39	8/1/1991	5/5/2003	100	2500	244	3	8%
2-SFR007.13	12	8/7/2001	5/5/2003	100	600	150	1	8%
2-SIN000.44	6	4/18/2001	10/23/2001	100	100	100	0	0%
2-WDC002.90	2	4/26/2004	5/10/2005	25	750	388	1	50%
2-WEL000.46	12	8/7/2001	5/5/2003	100	700	167	1	8%

1 Instantaneous maximum fecal coliform bacteria concentration of 400 cfu/100 ml.

Note: Rows in **bold** indicate stations located on the bacteria impairment segments.

Table 3-32. E. coli Data Collected within the Rivanna River Watershed (Table 3-11 in TMDL study (VADEQ, 2008)

Station ID	Number of Samples	Date Sampled		Values (no/100mL)			Instantaneous Exceedances[1]	
		First	Last	Min	Max	Average	Sum	Percent
2-BVR002.19	**7**	**4/13/2004**	**9/7/2005**	**25**	**280**	**61**	**1**	**14%**
2-JCB000.80	7	4/24/2006	10/3/2006	25	50	29	0	0%
2-MCM005.12	40	8/8/2002	10/3/2006	10	2000	169	5	13%
2-MNR011.69	7	7/12/2005	7/17/2006	25	25	25	0	0%
2-MSC000.60	15	7/28/2005	9/20/2006	25	1200	441	10	67%
2-MSC004.43	7	7/12/2005	7/17/2006	25	380	196	3	43%
2-MWC000.60	**12**	**7/7/2003**	**5/2/2005**	**25**	**2000**	**434**	**4**	**33%**
2-PRD000.21	**12**	**7/7/2003**	**5/2/2005**	**25**	**700**	**157**	**3**	**25%**
2-PRD004.42	**13**	**7/7/2003**	**4/5/2006**	**25**	**250**	**98**	**1**	**8%**
2-RRN002.19	**19**	**7/7/2003**	**7/17/2006**	**25**	**1200**	**167**	**5**	**26%**
2-RRS003.12	12	7/7/2003	5/2/2005	25	150	48	0	0%
2-RRS003.59	7	4/10/2003	10/7/2003	1	550	116	1	14%
2-RRS005.62	7	4/10/2003	10/7/2003	8	400	86	1	14%
2-RVN037.54	**12**	**7/7/2003**	**5/2/2005**	**25**	**1500**	**205**	**2**	**17%**
2-WDC002.90	2	4/26/2004	5/10/2005	10	680	345	1	50%
2-XLV002.27	7	4/18/2005	10/11/2005	25	25	25	0	0%

1 Instantaneous maximum *E. coli* bacteria concentration of 235/100 ml

Note: Rows in bold indicate stations located on the bacteria impairment segments.

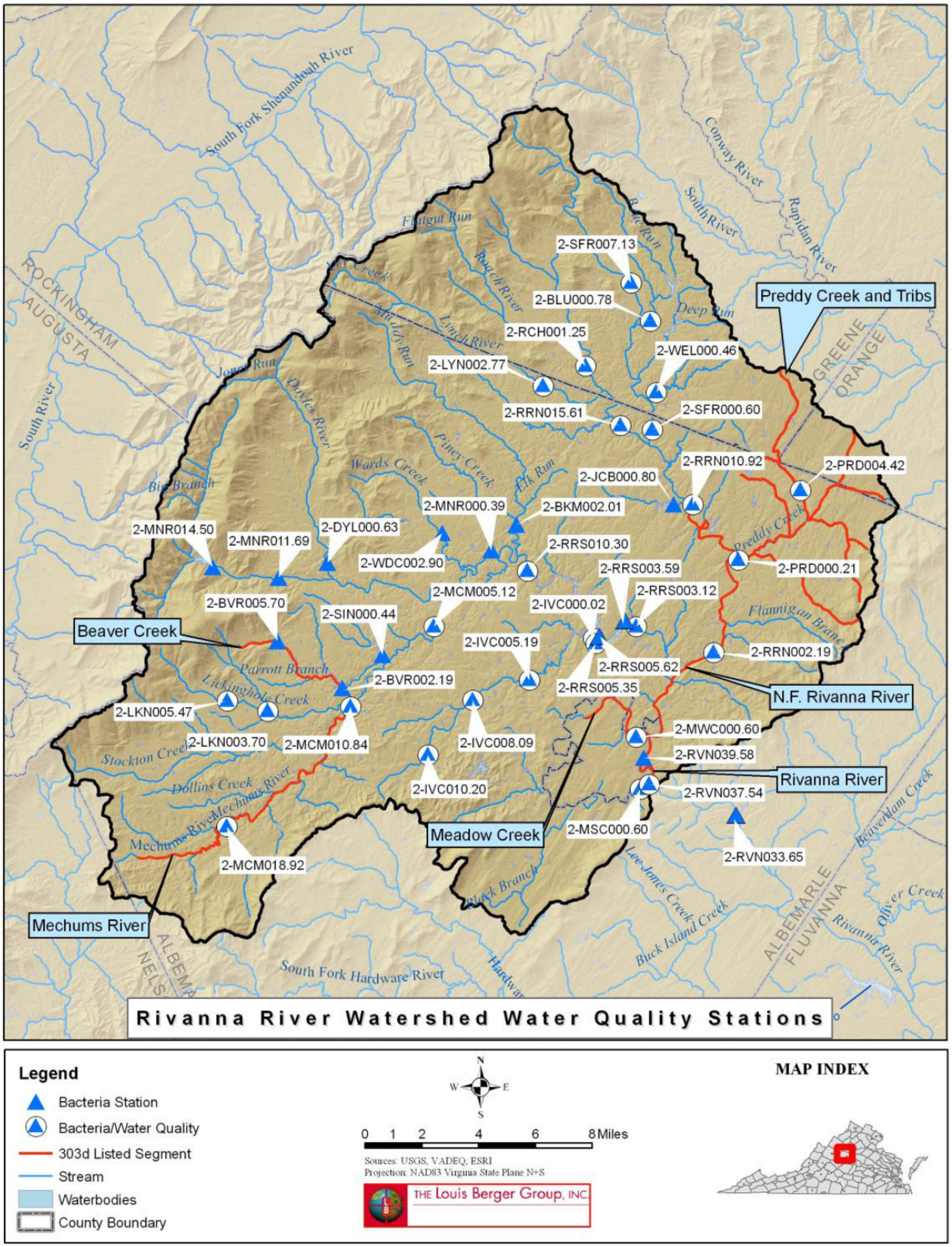

Figure 3-6. Rivanna River Watershed DEQ Water Quality Monitoring Stations (Figure 3-4 in TMDL study (VADEQ, 2008)).

3.3.4. Model Selection and Description

Bacteria load reduction estimates for the Rivanna River watershed were calculated using the USGS Hydrologic Simulation Program – Fortran (HSPF). The HSPF water quality model was used to model fecal coliform transport and fate in the watersheds. The HSPF watershed model simulates pollutant accumulation, die-off, and wash off according to the distribution of land uses, soils, and geographic features in a watershed. HSPF then simulates the routing of water and pollutants through the stream channel network, considering instream processes such as die-off. For the Rivanna River watershed bacteria TMDL, a source assessment of bacteria was performed for the watershed. Fecal coliform was then simulated as a dissolved pollutant using the HSPF model, and concentrations were translated to *E. coli* concentrations using DEQ's translator equation.

3.3.5. Bacteria Source Assessment

3.3.5.1. Nonpoint Sources

Nonpoint source pollution originates from sources across the landscape (e.g., agriculture and residential land uses) and is delivered to waterbodies by rainfall and snowmelt. In some cases, a precipitation event is not required to deliver nonpoint source pollution to a stream (e.g., pollution from straight pipes or livestock directly defecating in a stream). Nonpoint sources of bacteria in the watershed include failing septic systems, straight pipes, land application of manures, livestock, wildlife, and domestic pets. During TMDL development, bacteria sources and production rates were estimated based on information from GIS parcel data, U. S. Census Bureau, Virginia Department of Health (VDH), USDA National Agricultural Statistics Service, Virginia Department of Conservation and Recreation (VADCR), NRCS, Virginia Agricultural Statistics Service, the 2001 Virginia Equine Report, Soil and Water Conservation Districts (SWCD), Virginia Department of Game and Inland Fisheries (now Department of Wildlife Resources), American Veterinary Medical Association, stakeholder input, additional published information, field studies, and best professional judgement.

3.3.5.2. Point Sources

Various point sources of bacteria exist within the study watersheds. These point sources are permitted under the Virginia Pollutant Discharge Elimination System (VPDES) program as either individual permits, domestic sewage general permits, or municipal separate storm sewer system (MS4) permits. Several other types of general permits are present in the watershed, but are not considered sources of bacteria loading. The point sources of bacteria loads in the watersheds are summarized in **Table 3-33**, **Table 3-34**, and **Table 3-35**. The wasteload allocations of permits are included in the allocation tables in the following section**.**

Table 3-33. Individual Permitted Facilities within the Bacteria Impaired Rivanna River Watershed (Table 3-12 in TMDL study (VADEQ, 2008)).

Permit #	Facility Name	Receiving Stream	River Mile	Status	Size	Category	Design Flow (MGD)
VA0025488	Camelot STP	NF Rivanna River	9.72	Active	Minor	Municipal	0.365
VA0025518	Moores Creek Regional STP	Moores Creek	0.19	Active	Major	Municipal	15
VA0027065	Cooper Industries	S. F. Rivanna River, U.	1.25	Active	Minor	Industrial	0.04
VA0028398	Avionics Specialties Inc	Naked Creek, U.T.	0.68	Active	Minor	Municipal	0.005
VA0029556	Blue Ridge School STP	Chesley Creek	0.6	Active	Minor	Municipal	0.035
VA0055000	Crozet WTP	Beaver Creek Reservoir,	0.2	Active	Minor	Industrial	0.186
VA0080781	Ehart Subdivision STP	Preddy Creek, UT	1.3	Active	Minor	Municipal	0.07
VA0087351	Virginia Oil - Charlottesville	Schenks Branch, U.T.	0.12	Active	Minor	Industrial	Rainfall Dep.
VA0091120	North Rivanna WTP	North Fork Rivanna River	10.28	Active	Minor	Industrial	0.065

Table 3-34. General Permitted Facilities within the Rivanna River Watershed (

Permit #	Facility Name	Stream	Type
VPG260193	VRO	-------	Poultry*
VAG401839	Twin Lakes Subdivision Residence - Lot 020	Lake Skyline	Domestic Sewage
VAG401840	Twin Lakes Subdivision Residence - Lot B26	Lake Shenandoah, UT	Domestic Sewage

*The poultry permit allows land application of poultry manure, but is a no discharge permit.

Table 3-35. MS4 Permits within the Rivanna River Watershed

Number	MS4 Permit Holder	Permit Acreage	MS4 Locality	Locality Acreage
AR040051	City of Charlottesville	6,237	City of Charlottesville	6,513
VAR040033	VDOT Charlottesville Major Roads	60		

VAR040073	University of Virginia (Charlottesville)	216		
	University of Virginia (Albemarle)	916	Albemarle County	21,371
VAR040074	Albemarle County Urban Area	19,825		
VAR040033	VDOT Albemarle Urban Area	535		
Application	Piedmont Community College	95		
Total				**27,884**

3.3.6. TMDL Allocation Scenarios

Total maximum daily loads are determined as the maximum allowable load of a pollutant among the various sources. Part of developing a TMDL is allocating this load among the various sources of the pollutant of concern (POC). Each TMDL is comprised of three components, as summed up in this equation:

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

where ΣWLA is the sum of the wasteload allocations (permitted sources),
ΣLA is the sum of the load allocations (non-point sources), and
MOS is a margin of safety.

The MOS in the bacteria TMDL (VADEQ, 2008) was implicitly incorporated into the TMDL using conservative model assumptions. Additionally, the TMDL reduction scenarios targeted a 0% exceedance rate of the 235 cfu/100mL *E. coli* standard, more conservatively than the standard at the time which allowed a 10% exceedance of the 235 cfu/100mL value. Per the bacteria standard at the time, the reduction scenarios also targeted a 0% exceedance of the calculated monthly geometric mean of 126 cfu/100mL *E. coli*. Allocation scenarios were modeled using the calibrated HSPF model to adjust the existing bacteria loading conditions until the water quality target was attained.

3.3.6.1. North Fork Rivanna River Bacteria TMDL and Allocation Scenarios

There are five permitted facilities currently discharging bacteria load to the North Fork Rivanna River, including three municipal facilities and two domestic sewage facilities. These facilities do not have permit limits for bacteria. For this TMDL, the waste load allocation for such facilities is calculated using design flow discharge limits and bacteria concentrations of 126 cfu/100mL *E. coli*. **Table 3-36** shows the loading from the permitted point source discharger in the North Fork Rivanna River watershed. To account for future permitted growth in the TMDL, the WLA was multiplied 2 times the original allocation.

Table 3-36. North Fork Rivanna River Waste load Allocation for E. coli (Table 5-7 in TMDL study (VADEQ, 2008)).

Permit Number	Facility Type	Design Flow (MGD)	Effluent Limit (cfu/100ml)	Wasteload Allocation (cfu/day)	Wasteload Allocation (cfu/year)
VA0025488	Municipal	0.365	126	1.74E+09	6.35E+11
VA0029556	Municipal	0.035	126	1.67E+08	6.10E+10
VA0080781	Municipal	0.07	126	3.33E+08	1.22E+11
VAG401839	Domestic Sewage Discharge	0.001	126	4.76E+06	1.74E+09
VAG401840	Domestic Sewage Discharge	0.001	126	4.76E+06	1.74E+09
Existing WLA		0.472	126	2.25E+09	8.21E+11
Future Growth Scenario: 2 x Existing WLA*		0.944	126	4.50E+09	1.64E+12
Future Growth Scenario: 5 x Existing WLA		2.360	126	1.12E+10	4.09E+12

*Future growth scenario used in the TMDL

The scenarios considered for the North Fork Rivanna River load allocation are presented in **Table 3-37**. Scenario 8 was chosen as the final TMDL load allocation scenario for the North Fork Rivanna River. Under this scenario, complete elimination of the human sources (failed septic systems and straight pipes) and livestock direct deposition, 95 percent reduction of agricultural and urban non-point sources, and a 92 percent reduction of direct loading by wildlife are required.

Table 3-37. North Fork Rivanna River Load Reductions Under 30-Day Geometric Mean and Instantaneous Standards for E. coli (Table 5-8 in TMDL study (VADEQ, 2008)).

Scenario	Failed Septic & Pipes	Direct Livestock	NPS (Ag.)	NPS (Urban)	Direct Wildlife	*E. coli* % violation of GM standard 126 #/100ml	*E. coli* % violation of Inst. standard 235 #/100ml
0	0%	0%	0%	0%	0%	16.5	41.7
1	100%	0%	0%	0%	0%	16.4	41.7
2	100%	100%	0%	0%	0%	12.7	22.6
3	100%	100%	50%	0%	0%	11.8	21.4
4	100%	100%	50%	50%	0%	11.0	21.4
5	100%	100%	95%	50%	0%	8.8	21.4

6	100%	100%	95%	95%	0%	8.4	17.8
7	100%	100%	95%	95%	50%	3.5	4.7
8	100%	100%	95%	95%	92%	0.0	0.0

For the North Fork Rivanna River, as shown in **Table 3-37**, Scenario 8 will meet the 30-day *E. coli* geometric mean of 126 cfu/100 ml and the instantaneous threshold of 235 cfu/100ml. **Table 3-38** shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source. The annual bacteria TMDL equation for the North Fork Rivanna River is presented in **Table 3-39**.

Table 3-38 North Fork Rivanna River Distribution of Annual Average E. coli Load under Existing Conditions and TMDL Allocation (Table 5-9 in TMDL study (VADEQ, 2008)).

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Allocation (cfu/day)	Percent Reduction (%)
	Existing	Allocation		
Forest	2.47E+12	2.47E+12	2.61E+10	0%
Cropland	1.03E+13	5.15E+11	5.43E+09	95%
Pasture	1.83E+14	9.15E+12	9.65E+10	95%
Urban Residential	3.00E+13	1.50E+12	1.58E+10	95%
Water/Wetland	2.23E+07	2.23E+07	2.35E+05	0%
Cattle - direct deposition	1.41E+13	0.00E+00	0.00E+00	100%
Wildlife - direct deposition	2.17E+13	1.74E+12	1.83E+10	92%
Failed Septic - direct deposition	8.22E+10	0.00E+00	0.00E+00	100%
Point Source	8.21E+11	1.64E+12	4.50E+09	0%
MS4s	1.02E+13	5.10E+11	5.38E+09	95%
Total loads /Overall reduction	**2.73E+14**	**1.75E+13**	**1.72E+11**	**94%**

Table 3-39 North Fork Rivanna River Bacteria TMDL (cfu/year) for E. coli (Table 5-11 in TMDL study (VADEQ, 2008)).

WLA (Point Sources)	LA (Non-point sources)	MOS (Margin of safety)	TMDL
2.15E+12	**1.54E+13**	**Implicit**	**1.75E+13**

3.3.6.2. Preddy Creek and Tributaries Bacteria TMDL and Allocation Scenarios

There is one permitted facility currently discharging bacteria load to Preddy Creek. This facility does not have a permit limit for bacteria. For this TMDL, the waste load allocation for the facility is calculated using design flow discharge limits and bacteria concentrations of 126 cfu/100mL *E. coli*. **Table 3-40** shows the loading from the permitted point source discharger in the Preddy Creek watershed. To account for future growth in the TMDL, the WLA was multiplied 2 times the original allocation.

Table 3-40 Preddy Creek Waste load Allocation for E. coli (Table 5-12 in TMDL study (VADEQ, 2008)).

Permit Number	Facility Type	Design Flow (MGD)	Effluent Limit (cfu/100ml)	Wasteload Allocation (cfu/day)	Wasteload Allocation (cfu/year)
VA0080781	Municipal	0.07	126	3.33E+08	1.22E+11
Existing WLA		0.07	126	3.33E+08	1.22E+11
Future Growth Scenario: 2 x Existing WLA*		0.14	126	6.67E+08	2.43E+11
Future Growth Scenario: 5 x Existing WLA		0.35	126	1.67E+09	6.10E+11

*Future growth scenario used in the TMDL

The scenarios considered for the Preddy Creek and Tributaries load allocation are presented in **Table 3-41**. Scenario 8 was chosen as the final TMDL load allocation scenario for Preddy Creek and Tributaries. Under this scenario, complete elimination of the human sources (failed septic systems and straight pipes) and livestock direct deposition, a 95 percent reduction of urban and agricultural non-point sources, and a 72 percent reduction of direct loading by wildlife are required.

Table 3-41 Preddy Creek and Tributaries Load Reductions Under 30-Day Geometric Mean and Instantaneous Standards for E. coli (Table 5-13 in TMDL study (VADEQ, 2008)).

Scenario	Failed Septic & Pipes	Direct Livestock	NPS (Ag.)	NPS (Urban)	Direct Wildlife	*E. coli* % violation of GM standard 126 #/100ml	*E. coli* % violation of Inst. standard 235 #/100ml
0	0%	0%	0%	0%	0%	21.9	54.7
1	100%	0%	0%	0%	0%	21.9	54.7
2	100%	100%	0%	0%	0%	12.7	44.0
3	100%	100%	50%	0%	0%	11.8	41.6
4	100%	100%	50%	50%	0%	10.3	36.9
5	100%	100%	95%	50%	0%	8.5	35.7
6	100%	100%	95%	95%	0%	8.5	35.7
7	100%	100%	95%	95%	50%	0.98	4.7
8	100%	100%	95%	95%	72%	0.0	0.0

For Preddy Creek and Tributaries, as shown in **Table 3-41**, Scenario 8 will meet the 30-day *E. coli* geometric mean of 126 cfu/100 ml and the instantaneous threshold of 235 cfu/100ml. **Table 3-42** shows the distribution of the annual average *E. coli* load under existing conditions and under the TMDL allocation, by land use and source. The annual bacteria TMDL equation for Preddy Creek and Tributaries is presented in **Table 3-43**.

Table 3-42 Preddy Creek Distribution of Annual Average E. coli Load under Existing Conditions and TMDL Allocation (Table 5-14 in TMDL study (VADEQ, 2008)).

Land Use/Source	Average *E. coli* Loads (cfu/yr)		Allocation (cfu/day)	Percent Reduction (%)
	Existing	Allocation		
Forest	4.77E+11	4.77E+11	5.04E+09	0%
Cropland	2.17E+12	1.08E+11	1.14E+09	95%
Pasture	3.75E+13	1.87E+12	1.98E+10	95%
Urban Residential	7.14E+12	3.57E+11	3.78E+09	95%
Water/Wetland	2.23E+08	2.23E+08	2.36E+06	0%
Cattle - direct deposition	2.37E+12	0.00E+00	0.00E+00	100%
Wildlife - direct deposition	9.91E+12	2.77E+12	2.93E+10	72%
Failed Septic - direct deposition	1.29E+10	0.00E+00	0.00E+00	100%
Point Source	1.22E+11	2.43E+11	6.67E+08	0%
MS4s	0.00E+00	0.00E+00	0.00E+00	0%
Total loads /Overall reduction	**5.97E+13**	**5.83E+12**	**5.97E+10**	**90%**

Table 3-43 Preddy Creek Bacteria TMDL (cfu/year) for E. coli (Table 5-16 in TMDL study (VADEQ, 2008)).

WLA (Point Sources)	LA (Non-point sources)	MOS (Margin of safety)	TMDL
2.43E+11	5.58E+12	Implicit	5.83E+12

3.4. Implications of the TMDL on the Implementation Plan

Based on the bacteria reductions developed for the TMDLs, it is clear that significant reductions will be needed to meet the water quality standard for bacteria, particularly with respect to direct deposition from livestock. In addition, all uncontrolled discharges, failing septic systems, leaking sewer lines, and overflows must be identified and corrected.

However, there are subtler implications as well. Implicit in the requirement for 100% correction of uncontrolled discharges is the need to maintain all functional septic systems. Wildlife bacteria loads will not be explicitly addressed by this implementation plan. All efforts will be directed at controlling anthropogenic sources.

Although the benthic TMDLs were developed for sediment and phosphorus, attainment of a healthy benthic community will ultimately be determined by biological monitoring of the benthic macroinvertebrate community, in accordance with established DEQ protocols. If a future review should find that the reductions called for in these sediment and phosphorus TMDLs based on current modeling are found to be insufficiently protective of local water quality, then revision(s) will be made as necessary to provide reasonable assurance that water quality goals will be achieved.

4.0 CHANGES AND PROGRESS SINCE THE TMDL STUDY

4.1. Bacteria Water Quality Standard

In 2019, the Virginia State Water Control Board adopted USEPA's nationally recommended bacteria criteria. For *E. coli*, the criteria include a geometric mean value never to exceed 126 bacteria colony counts per 100 milliliters (counts/100mL) and no more than 10% of samples allowed to exceed a statistical threshold value of 410 counts/100mL within a 90-day period (9VAC 25-260-170).

As noted in Section 1.2.2, at the time of the bacteria TMDL development (VADEQ, 2008), the bacteria criteria for freshwater were that *E. coli* bacteria shall not exceed a geometric mean of 126 colony forming units (cfu)/100 mL, and a single sample value shall not exceed 235 cfu/100mL more than 10% of the time (instantaneous threshold). The 2008 bacteria TMDL developed reduction scenarios targeting a 0% exceedance rate of the 235 cfu/100mL *E. coli* standard as part of inclusion of a margin of safety, rather than a final allocation scenario representing a 10% exceedance of the instantaneous threshold. As such, final reductions needed to meet the TMDL will also meet the new standard. However, those reductions incorporate reductions to direct wildlife loads. Wildlife bacteria loads will not be explicitly addressed by this implementation plan.

4.2. Additional Impairment/ Impairment Changes

Since the 2008 TMDL was developed, the Preddy Creek and Tributaries assessment unit has been reclassified as two assessment units: Preddy Creek VAV-H27R_PRD01A00 (7.48 miles) and Preddy Creek North Branch VAV-H27R_PRD02A06 (6.24 miles). Additionally, Swift Run (VAV-H27R_SFR01A00, 1.91 miles) was listed as impaired on the 2010 Integrated Report (VADEQ, 2010) due to exceedances of the *E. coli* bacteria standard at the time. These impairments will be included in this Implementation Plan, as outlined in **Table 1-2**. Preddy Creek North Branch and Swift Run will receive separate treatment in this Implementation Plan to reflect their distinct assessment units. Bacteria target goals will be based on their downstream impairment goals: North Fork Rivanna River for Swift Run and Preddy Creek for Preddy Creek North Branch.

4.3. Land Cover and Loading Updates

The land cover dataset used in the 2019 benthic TMDL for North Fork Rivanna did not originally include the downstream watershed area contributing to the most downstream bacteria impaired segment incorporated in this Implementation Plan. The land cover dataset was updated to include the downstream sections included in the bacteria TMDL. This increased the North Fork Rivanna River watershed overall from the approximately 103,000 acres modeled in the 2019 benthic TMDL to approximately 113,200 acres. The updated land cover table is presented in **Table 4-1**.

Table 4-1 Updated land cover distribution in the North Fork Rivanna River impairment watershed, excluding Preddy Creek watershed.

Land Cover Category	North Fork Rivanna River Watershed	
	Acres	*%*
Cropland	336	0.3%
Hay	7,403	6.5%
Pasture	11,760	10.4%
Forest	70,440	62.2%
Trees	11,016	9.7%
Shrub	581	0.5%
Harvested/Disturbed	677	0.6%
Water	550	0.5%
Wetland	880	0.8%
Barren	71	0.1%
Turfgrass	6,354	5.6%
Developed, pervious	464	0.4%
Developed, impervious	2,694	2.4%
Total	*113,224*	*100.0%*

Given the time that has passed between the 2008 bacteria TMDL and this Implementation Plan, the bacteria loads per land cover were adjusted to match the changes in land cover. The land cover dataset from the 2018 benthic TMDL was used to scale the change in land cover distribution. The two TMDLs used different sources of land cover data, so a cross-walk between the two sets of categories was developed and is shown in **Table 4-2**. The shifts in land cover for North Fork Rivanna and Preddy Creek from the 2008 bacteria TMDL to this Implementation Plan are shown in **Table 4-3** and **Table 4-4**. These shifts in land cover acreage were then used to scale the bacteria load in cfu/year based on the per-acre loading rate calculated in the 2008 bacteria TMDL to reflect more recent land cover distribution changes by applying the calculated per-acre loading rate to the updated acreage values, as shown in **Table 4-5** and **Table 4-6**.

Table 4-2 North Fork Rivanna and Tributaries land cover category crosswalk between 2008 bacteria TMDL (VADEQ, 2008) and 2019 benthic TMDL (VADEQ, 2019) datasets.

Land Cover Categories	
2008 TMDL Land Cover	**2019 TMDL Land Cover**
Forest	Forest
Cropland	Low till, High Till
Pasture	Hay, Pasture-Good, Pasture-Fair, Pasture-Poor

Urban (pets)	Tree, Turfgrass, Developed-Pervious, Developed-Impervious, Impervious
Water/Wetland	water, NWI/other
(no corresponding category)	Barren, Harvested/Disturbed, Shrub/scrub

Table 4-3. Preddy Creek and Tributaries land cover comparison.

Land Cover	Preddy Creek Acreage		% Change
	2008	2018	
Forest	15,825	14,255	-9.92
Cropland	151	60	-60.26
Pasture	4,879	4,744	-2.77
Urban (pets)	3189	5,095	59.77
Water/Wetland	175	650	271.4

Table 4-4. North Fork Rivanna River land cover comparison (exclusive of Preddy Creek watershed).

Land Cover	North Fork Rivanna Acreage		% Change
	2008	2018	
Forest	76,570	70440	-8.01
Cropland	798	336	-57.91
Pasture	25,679	19163	-25.38
Urban (pets)	12381	20527	65.80
Water/Wetland	726	1429	96.9

Table 4-5. Preddy Creek bacteria existing CFU/yr from TMDL (VADEQ, 2008) and calculated updated bacteria loading for use in this Implementation Plan.

Land Cover	TMDL CFU/yr	TMDL Acreage	CFU/ac/yr	IP Acreage	IP CFU/yr
Forest	4.77E+11	15,825	3.01E+07	14,255	4.30E+11
Cropland	2.17E+12	151	1.44E+10	60	8.62E+11
Pasture	3.75E+13	4,879	7.69E+09	4,744	3.65E+13
Urban (pets)	7.14E+12	3,189	2.24E+09	5,095	1.14E+13
Water/Wetland	2.23E+08	175	1.27E+06	650	8.28E+08

Table 4-6. North Fork Rivanna bacteria existing CFU/yr from TMDL (VADEQ, 2008) and calculated updated bacteria loading for use in this Implementation Plan.

Land Cover	TMDL CFU/yr	TMDL Acreag e	CFU/ac/yr	IP Acreage	IP CFU/yr

Forest	2.47E+12	76,570	3.23E+07	70,440	2.27E+12
Cropland	1.03E+13	798	1.29E+10	335	4.33E+12
Pasture	1.83E+14	25,679	7.13E+09	19,163	1.37E+14
Urban (pets)	3.00E+13	12,381	2.42E+09	20,527	4.97E+13
Water/Wetland	2.23E+07	726	3.07E+04	1,429	8.28E+08

The bacteria load reduction required for the watersheds was then calculated by subtracting the allocated loads (**Table 3-38** and **Table 3-42**) from the updated existing loads. BMP scenarios were then developed to account for the total cfu/year reduction estimates.

4.4. BMP Implementation Since TMDL Development

Progress made by implementation of BMPs in the watersheds since the development of each TMDL was accounted for in the Implementation Plan process. BMPs implemented since TMDL development are noted in **Table 4-7**.

Table 4-7. BMPs implemented since TMDL development.

Sub-watershed	Description (Cost-share codes in parentheses)	Units	Quantity
Blue Run	Septic System Replacement (RB-4)	Systems	2
Marsh Run	Stream exclusion with wide width buffer and grazing land management (SL-6W)	Linear Feet	6201
	Extension of Watering System (SL-7)	Acres Treated	26
Preddy Creek	Septic Tank Pumpout (RB-1)	Pump-out	3
	Grazing Land Management (SL-10)	Acres Treated	38.3
	Stream exclusion with wide width buffer and grazing land management (SL-6W)	Linear Feet	1832
	Extension of Watering System (SL-7)	Acres Treated	125
	Stream Protection Fencing with Wide Width Buffer (WP-2W)	Linear Feet	9285
Preddy Creek North Branch	Septic Tank Pumpout (RB-1)	Pump-out	6
	Septic Tank System Repair (RB-3)	Repair	1
	Septic Tank System Replacement (RB-4)	Systems	1
Quarter Creek	Cover Crop (SL-8B/8H)	Acres Treated	17.79
	Septic Tank Pumpout (RB-1)	Pump-out	3
	Septic Tank System Replacement (RB-4)	Systems	1

North Fork Rivanna	Stream exclusion with wide width buffer and grazing land management (SL-6W)	Linear Feet	6057
	Bioretention (BR-4)	Acres Treated	99.38
Swift Run	Stream exclusion with wide width buffer and grazing land management (SL-6W)	Linear Feet	36490
	Stream exclusion with narrow width buffer and grazing land management (SL-6N)		3724
	Grazing Land Management (SL-10)	Acres Treated	245.43
	Septic Tank Pumpout (RB-1)	Pump-out	2
	Septic Tank System Repair (RB-3)	Repair	1
	Septic Tank System Replacement (RB-4)	Systems	1
Stanardsville Run	Septic Tank Pumpout (RB-1)	Pump-out	1

5.0 PUBLIC PARTICIPATION

Public participation was elicited at every stage of the TMDL Implementation Plan development in order to receive input from stakeholders and to apprise the stakeholders of progress made. A series of two Community Engagement Meeting (CEM) meetings and two public meetings took place during the TMDL Implementation Plan development process. Since this plan is voluntarily implemented by watershed stakeholders, input and support from local sources is the one of the main factors determining the success of the plan.

5.1. Public Meetings

The first public meeting (14 attendees, September 20th, 2023) was held at the Piedmont Virginia Community College Eugene Giuseppe Center in Stanardsville, VA. This meeting introduced attendees to Virginia's water quality process, reviewed the benthic North Fork Rivanna River TMDL and the bacteria Rivanna River TMDL, and what an Implementation Plan is/is not and laid out the planned next steps and proposed timeline.

A final public meeting was held on XXX DATE at the Piedmont Virginia Community College Eugene Giuseppe Center in Stanardsville, VA to present the draft Implementation Plan document. The public meeting marked the beginning of the official public comment period and was attended by ## watershed residents and other stakeholders. The public comment period ended on XXX DATE. XXX comments were received/addressed. Summaries of these meetings are included in Appendix A of this document.

5.2. Community Engagement Meetings

The first Community Engagement Meeting (CEM) (13 attendees, December 13th, 2023) was held in Virginia Cooperative Extension Services – Greene Unit in Stanardsville, VA to get initial feedback on the status of the North Fork Rivanna River Watershed's bacteria, sediment, and phosphorus sources and ways to reduce these sources in the watershed with best management practices, outreach/education and partnerships; and discuss next steps.

The second Community Engagement Meeting (15 attendees, September 24th, 2024) was held at the Greene County Public Library in Stanardsville, VA. This meeting discussed implementation timeline for the North Fork Rivanna River Watershed's bacteria, sediment, and phosphorous impairments. The goal was to discuss the most reasonable timeline to stage the BMPs, the quantity of BMPs needed, outreach/education, and partnerships needed to address the impairment sources and discuss the next steps with the community.

For implementation planning, the stakeholders recommended that BMPs be implemented in four (4) stages of five (5) years each. BMPs targeted in Stages 1 and 2 prioritize the most cost-effective

BMPs, and reductions associated bring all of the watersheds to meeting the sediment and phosphorus TMDL goals. Further implementation in stages 3 and 4 are required to meet the bacteria TMDL goals. These stages, the associated timeline, and the adaptive approach used are explained in greater detail in **Section 8.0**.

An electronic copy of the draft plan was shared with participants in the community engagement meetings one month prior to the final public meeting to solicit feedback and revisions. Summaries of these meetings are included in Appendix A of this document.

6.0 IMPLEMENTATION ACTIONS

An important part of the implementation plan is the identification of specific best management practices and associated technical assistance needed to improve water quality in the watersheds. Since this plan is designed to be implemented by landowners on a voluntary basis, it is necessary to identify management practices that are both financially and technically realistic and suitable for this community. As part of this process, the costs and benefits of these practices must be examined and weighed. Once the best practices have been identified for implementation, we must also develop an estimate of the number of each practice that would be needed to meet the water quality goals established during the TMDL study.

Implicit in the TMDL is the need to avoid increased delivery of pollutants from sources that have not been identified as needing a reduction, and from sources that may develop over time. One potential for additional sources of the pollutants identified is future residential development. Care should be taken to monitor development and its impacts on water quality. Where residential development occurs, there is potential for additional pollutant loads from increased impervious surfaces and land disturbance associated with new development.

6.1. Identification of Best Management Practices

Potential BMPs, their costs and efficiencies, and potential funding sources were identified through the review of the TMDL, literature review, and input from the working group. BMPs that can be promoted through existing cost share programs, state and federal, were identified, as well as those not supported by current programs. Some BMPs had to be implemented to meet water quality goals, such as the replacement or repair of failing septic identified in the TMDL. Other BMPs were chosen through a process of review and analysis by stakeholders for their effectiveness in these watersheds. Various scenarios were developed and presented to the stakeholders, who considered both their economic costs and the water quality benefits that they produced. Most of these practices are included in state and federal agricultural cost share programs that promote conservation. The final set of best management practices (BMPs) identified, and the efficiencies used in this study to estimate needs are listed in **Table 6-1**.

6.1.1. Control Measures implied by the Pollution Source Assessment

The reductions in bacteria, sediment, and phosphorus identified in the pollutant source assessment dictated some of the control measures that must be employed during implementation to meet the pollutant reductions needed to address the water quality impairments.

Livestock Exclusion

To meet the bacteria reductions needed from direct deposition from cattle, some form of stream exclusion will be required. Fencing is the first and foremost choice, however, what type of fencing, setback from the stream, and management of the fenced pasture is less clear. It is important to note that farmers want to minimize the cost of implementing the fencing and reduce the amount of pasture lost. The inclusion of a streamside buffer strip helps to reduce bacteria, sediment, and nutrient loads in runoff. The minimum effective buffer width for nutrient removal benefits is 50 feet, and it could help reduce the need for more costly control measures. From an environmental perspective the best management scenario would be to keep livestock excluded 100% of the time and the establishment of permanent vegetation in the buffer zone. This keeps the livestock from eroding the stream bank, the established vegetated buffer captures pollutants in runoff from pasture and creates the foundation for healthy aquatic life.

While removing usable land from production can be seen as unfavorable for livestock production in the farmer's eyes, it has been shown that a clean water source has been shown to improve milk production and weight gain. Clean water will also reduce the incidence of waterborne illness in animals and reduce exposure to swampy areas. State and federal conservation agencies including VADCR and NRCS offer several options with respect to livestock exclusion in their agricultural cost share programs that offer farmers some flexibility.

Septic Systems and Straight Pipes

The 100% reduction in loads from straight pipes and failing septic systems is a pre-existing legal requirement. The options for correcting straight pipes and failing septic systems include: the repair of an existing septic system, the installation of a septic system (conventional or alternative), and the connection to a public sewer system. It is anticipated that a significant portion of straight pipes will be in areas where an adequate site for a septic drain field is not available. In these cases, the landowner will have to consider implementing an alternative waste treatment system.

Table 6-1 Best management practices and associated pollutant reductions.

BMP Type	Description (Cost-share codes in parentheses)	% Effectiveness			Reference	Units
		Sediment	Phosphorus	Bacteria		
Livestock Exclusion	Livestock exclusion from waterway (SL-6N, SL-6W, CRSL-6, WP-2W)	*Land Use Change + 48%	*Land Use Change + 36%	100.00%	1,2	linear feet
Pasture and Cropland	Streamside buffer (25-50 feet) (SL-6N, SL-6W, CRSL-6, WP-2W	Land Use Change + 48%	Land Use Change + 36%	Land Use Change +50%	1,2	Acres treated
	Long term vegetative cover on cropland (SL-1)	Land Use Change	Land Use Change	75%	1	Acre
	Cover Crop (SL-8B/8H)	20%	15%	20%	2	
	Afforestation of crop, hay, and pasture land (FR-1)	Land Use Change	Land Use Change	Land Use Change	2	Acres treated
	Woodland buffer filter area (FR-3)	Land Use Change + 48%	Land Use Change + 36%	Land Use Change +50%	2	
	Permanent vegetative cover on critical areas (SL-11)	Land Use Change	Land Use Change	75%	2	
	Improved pasture management (SL-10)	30%	24%	50%	2	
	Extensions of watering system (SL-7)	10%	8%	50%	2	
	Sediment retention, erosion, or water control structures (WP-1)	80%	60%	88%	2	
	Animal waste control facilities (WP-4)	70%	80%	70%	3	System
	Roof runoff management (WQ-12)	40%	0%	40%	3	
Harvested	Afforestation of Crop, Hay, and Pasture Land (FR-1)	Land Use Change	Land Use Change	Land Use Change	2	Acres treated
Barren	Farm Road or Heavy Animal Travel Lane Stabilization (SL-11B)	Land Use Change	Land Use Change	-	1	Acre

BMP Type	Description (Cost-share codes in parentheses)	% Effectiveness			Reference	Units
		Sediment	Phosphorus	Bacteria		
Residential/ Urban	Bioretention/Raingarden (BR-4, RG)	80%	75%	90%	2	Acres treated
	Permeable Pavement (PP)	70%	50%	-	4	
	Impervious Surface Removal (ISR)	Land Use Change	Land Use Change	Land Use Change	1	
	Grass Channels (VOC-1)	70%	45%	50%	2	
	Bioswale/dry swale (BR-6, BR-7)	80%	75%	80%	2	
	Conservation Landscaping (CL-1)	Land Use Change	Land Use Change	Land Use Change	1	Acre
	Rainwater Harvesting	75%	70%	-	4	Acres treated
	Pet waste management plan (PW-0)	-	-	55%	2	Program
	Pet waste disposal station (PW-1)	-	-	75%	2	System
Straight pipes and septic systems	Septic Tank Pumpout (RB-1)	-	100%	5%	2	Pump-out
	Connection to Public Sewer (RB-2)	-	100%	100%	1	System
	Septic Tank Repair (RB-3)	-	100%	100%	1	Repair
	Septic System Replacement (RB-4)	-	100%	100%	1	System
	Installation of Alternative Waste Treatment System (RB-5)	-	100%	100%	1	System

*Buffer must be implemented as part of livestock exclusion to generate sediment/phosphorus reductions.

1. Removal Efficiency defined by the practice
2. VDEQ. 2017 Guidance Manual for Total Maximum Daily Load Implementation Plans
3. Bacteria efficiency assumed to be equal to sediment efficiency - Chesapeake Assessment Scenario Tool - BMP effectiveness values by land use and pollutant
4. Schueler T. and C. Lane. 2015. Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects. Chesapeake Stormwater Network.

6.2. Quantification of Control Measures

The quantity of control measures recommended during the IP Development was determined through spatial analyses, calculations derived from TMDL allocation scenarios, and input from the working groups. Data on land use, stream networks, septic systems, and elevation were used in spatial analyses to develop estimates of the number of control measures recommended overall in the watershed, and within sub-watersheds. The quantities of additional control measures were determined through developing alternative scenarios and applying the related pollutant reduction efficiencies to their associated sediment loads.

6.2.1. Agricultural Control Measures

6.2.1.1. Livestock Exclusion BMPs

To reduce bacteria, sediment, and phosphorus in North Fork Rivanna River and its tributaries, all livestock must be excluded from the streams. To estimate fencing needs, the stream network was overlaid with land use using GIS mapping software. A 35 foot buffer was developed around NHD stream segments (perennial and intermittent) and the sections that intersected pasture were used to determine potential fencing length. The locations of known existing livestock exclusion BMPs were checked and verified that they were not captured in the automated GIS estimate to prevent double-counting opportunity. These areas were examined, and potential stream length was removed if the automated system flagged potential fencing opportunity that overlapped with an existing BMP. The fencing needs still required can be found in **Table 6-2**.

Table 6-2 Livestock fencing needs and current installation.

Sub-watershed	Approximate fencing installed to date (feet)	Fencing Still Needed			
		Stage 1	Stage 2	Stage 3	Stage 4
Blue Run	-	2938.5	2938.5	-	-
Marsh Run	6201.0	1043.5	1043.5	-	-
Preddy Creek	11117.0	8197.50	8197.50	-	-
Preddy Creek North Branch	-	2016.50	2016.50	-	-
Quarter Creek	-	1302.0	1302.0	-	-
North Fork Rivanna	6057.0	11637.0	11637.0	7132.0	7132.0
Swift Run	40214.0	4749.0	4749.0	-	-
Stanardsville Run	-	760.00	-	-	-

TMDL bacteria allocation scenarios called for 100% reduction of livestock direct deposition load. To calculate bacteria reductions from proposed livestock exclusion fencing measures, the total bacteria load was divided by the total livestock exclusion opportunity to get an average bacteria load per linear foot of stream. Reductions were calculated using number of units of each proposed measure installed multiplied by the average bacteria load per linear foot of stream.

Most of the livestock exclusion fencing will be accomplished through Virginia Agricultural BMP Cost-Share Program (VACS), DEQ Non-Point Source BMP Implementation Program, and federal Natural Resource Conservation Service (NRCS) cost-share program. The applicable BMPs from the cost share program are SL-6N (Stream Exclusion with Narrow Width Buffer and Grazing Land Management), SL-6W (Stream Exclusion with Wide Width Buffer and Grazing Land Management), and CREP (Conservation Reserve Enhancement Program) practice CRSL-6 (CREP Stream Exclusion with Grazing Land Management). Input was collected from the working group to determine what composition of Stream Exclusion BMPs to implement as well as to determine the most accurate cost. The quantity of livestock exclusion is shown in **Table 6-3** and **Table 6-4**.

Table 6-3. Extent of wide buffer practices proposed to achieve reduction of pollutant loads from livestock direct deposition. Assumes one exclusion system averages 1,500 linear feet of stream fencing.

Sub-watershed	SL-6W or CRSL-6 (50ft buffer)				
	Unit	Stage 1	Stage 2	Stage 3	Stage 4
Blue Run	System	1.86	1.86	-	-
Marsh Run		0.66	0.66	-	-
Preddy Creek		5.20	5.20	-	-
Preddy Creek North Branch		1.28	1.28	-	-
Quarter Creek		0.83	0.83	-	-
North Fork Rivanna		7.14	7.14	4.76	4.76
Swift Run		3.01	3.01	-	-
Stanardsville Run		0.48	-	-	-

Table 6-4. Extent of narrow buffer practices proposed to achieve reduction of pollutant loads from livestock direct deposition. Assumes one exclusion system averages 1,500 linear feet of stream fencing.

Sub-watershed	SL-6N (25ft Buffer)				
	Unit	Stage 1	Stage 2	Stage 3	Stage 4
Blue Run	System	0.10	0.10	-	-
Marsh Run		0.035	0.035	-	-
Preddy Creek		0.275	0.275	-	-
Preddy Creek North Branch		0.065	0.065	-	-
Quarter Creek		0.045	0.045	-	-
North Fork Rivanna		0.625	0.625	-	-
Swift Run		0.16	0.16	-	-
Stanardsville Run		0.03	-	-	-

Through the VACS program, Stream Exclusion with Wide Width Buffer and Grazing Land Management (SL-6N) offers a rate of 95% to 100% cost-share rate for off-stream watering, establishment of a rotational grazing system, stream crossings, and stream exclusion with a 50-foot setback and a lifespan of 10 to 15 years. Based on discussions with the working group, it was determined that SL-6W and CRSL-6 would be the most appealing to landowners in the watershed as most of the landowners were already implementing larger setbacks. Through the VACS program, Stream Exclusion with Narrow Width Buffer and Grazing Land Management (SL-6N) offers a rate of 70% to 75% cost-share rate for off stream watering, establishment of a rotational grazing system, stream crossings, and stream exclusion with a 25-foot setback and a lifespan of 10 to 15 years. It was determined that 5% of the total livestock exclusion should be implemented as SL-6N to have it as an option for landowners, as the working group expressed that more farmers in the area were opting for larger setbacks.

This suite of BMPs that has been chosen for this plan will satisfy the bacteria reductions needed to meet the water quality goals. The quantity and parameters of these BMPs are subject to change in the future to account for updates related to policies and programs, as well as cost share programs.

6.2.1.2. Land Based Agricultural BMPs

In order to meet the bacteria, sediment, and phosphorus outlined in the TMDLs, BMPs to treat land based sources of bacteria, sediment, and phosphorus must also be included in implementation plans. **Table 6-6** through **Table 6-14** provides the land-based BMPs for each of the impaired watersheds. It is expected that the Virginia Agricultural BMP Cost-share program (VACS), DEQ Non-Point Source BMP Implementation Program, and federal Natural Resource Conservation Service (NRCS) cost-share programs will provide funding assistance for most of the agricultural practices.

Long Term Vegetative Cover on Cropland (SL-1)
This practice aims to establish grass and/or legume vegetation on cropland with existing cover that is less than 60%, converting it to pasture or hay land to reduce soil erosion and enhance water quality. VACS offers a payment rate up to 75% of the estimated cost to implement or the eligible cost, whichever is less, and a one-time incentive bonus to implement.

Cover Crop (SL-8B/8H)
This practice establishes vegetative cover on cropland to provide protection from erosion and the reduction of nutrient losses to the groundwater. VACS offers an incentive based on the amount of acres utilized.

Afforestation of Erodible Crop and Pasture Land (FR-1)
This practice sets aside a portion of cropland or hayland to be converted into forest. The intent of this practice is to take pasture/cropland that is not as suited to agriculture and optimize the land

use to prevent runoff and soil loss from marginal agricultural land. VACS offers cost share funding up to 75% of the cost of implementation along with a flat rate payment per acre.

Woodland Buffer Filter Area (FR-3)
This practice creates a woodland buffer filter area to protect waterways and/or waterbodies by reducing erosion, sedimentation, and the pollution from agricultural non-point sources. VACS offers a cost share for tree establishment up to 95% along with a flat rate payment per acre.

Permanent Vegetative Cover on Critical Areas (SL-11)
This practice promotes land shaping and planting permanent vegetative cover on critically eroding areas. The purpose of the practice is to improve water quality by stabilizing soil, thus reducing the movement of sediment and nutrients from the site. VACS offers cost share funding up to 75% of the cost to implement the practice.

Improved Pasture Management (SL-10)
This practice supports grazing management systems that will provide and ensure adequate surface cover protection to minimize soil erosion. The system will reduce sediment, nutrients, and pathogen loads in runoff. This practice will improve the quantity, quality, and utilization of forage for livestock and reduce the risk of surface and groundwater contamination from non-point source pollution from pastures by assuring that an adequate stand of forage is available to absorb runoff and reduce pollutants. VACS cost share program offers a one-time incentive payment per acre improved. For practice purposes, pastures are represented by those lands that have been seeded, usually with introduced species (i.e, tall fescue, legumes) or in some cases native plants (e.g switchgrass or native warm season grasses), and which are managed using agronomic practices for livestock.

Extension of Watering System (SL-7)
This practice provides a management system to ensure adequate surface cover protection to minimize soil erosion. The system will reduce sediment, nutrients and pathogen loads in runoff. This practice will improve the quantity, quality, and utilization of forage for livestock and reduce the risk of surface and groundwater contamination from non-point source pollution from pastures by assuring that an adequate stand of forage is available to absorb runoff and reduce pollutants. The VACS cost share program offers funding based on the fencing setback and the lifespan of the project.

Sediment Retention, Erosion, or Water Control Structures (WP-1)
This practice promotes structures that will collect and store debris or control the grade of drainage ways. The purpose of this practice is to improve water quality by reducing the movement of sediment and materials from agricultural land to receiving streams. Cost share and tax credit is authorized for the following:

- For sediment detention or retention structures, such as erosion control dams (excluding water storage dams), desilting reservoirs, sediment basin, debris basins, or similar structures.
- For channel linings, chutes, drop spillways, and pipe drops that better manage excess water.
- For fencing or otherwise protecting a vegetative cover (including mulching needed to protect the structure) and for leveling and filling to permit the installation of the structure.
- For installing sediment retention structures on public roadsides only where these structures are essential to solve a farm-based pollution or conservation problem.
- Only if the measures will contribute significantly to maintain or improving soil or water quality.

The VACS cost share program offers up to 90% of the approved estimated cost or eligible actual cost, whichever is less.

Animal Waste Control Facilities (WP-4)
This practice creates a planned system designed to manage liquid and/or solid waste from existing feeding facilities, hardened pads, or other areas where livestock and poultry are concentrated and from which manure can be collected. This practice is designed to provide facilities for the storage and handling of livestock and poultry waste and the control of surface runoff to permit the recycling of animal waste onto the land in a way that will abate pollution that would otherwise result from existing livestock or poultry operations. Its purpose is to improve water quality by storing and spreading waste at the proper time, rate, location, and/or to control erosion and nutrient input caused by feeding operations located adjacent to riparian areas or other environmentally sensitive features. VACS cost share program offers 75% of the approved estimated cost or actual cost, whichever is less.

Roof Runoff Management (WQ-12)
This practice establishes a planned system designed to manage roof runoff from agricultural structures in areas where concentrated runoff creates a water quality concern through contact with animal waste such as barnyards and feeding areas. This practice is designed to collect, control and convey precipitation runoff from a roof to an appropriate discharge area in a way that will protect water quality. The purpose of this practice is to protect water quality by capturing roof runoff and routing it away from contaminated and/or sensitive areas to control bacteria and nutrient input. VACS cost share program offers 75% of the approved estimated cost or actual cost, whichever is less.

6.2.1.3. Harvested and Barren BMPs

Afforestation of Erodible Crop and Pasture Land (FR-1)
In this case, the FR-1 practice is being applied barren areas or to harvested timber to reforest the area, preventing transport of sediment and phosphorus. VACS offers cost share funding up to 75%

of the cost of implementation along with a flat rate payment per acre, but eligibility requires the land be in crop, hay, or pasture production two of the past five years. Replanting timbered areas are thus generally not eligible for VACS cost share funding, though the pollutant load reductions would be the same.

Farm Road or Heavy Animal Travel Lane Stabilization (SL-11B)
This practice promotes structural and/or management practices that will protect surface water and groundwater recharge areas from pollution from travel ways of farm equipment and livestock or from a winter-feeding area. The purpose of this practice is to protect or maintain water quality by stabilizing travel methods used by farm equipment and/or livestock or from winter feeding area. This project only offers tax-share credit for its implementation.

6.2.2. Urban/Residential Control Measures

6.2.2.1. Land Based Urban BMPs

Bioretention/Raingarden (BR-4/RG)
Bioretention/rain garden is a shallow landscaped depression that temporarily allows runoff to pond and then filter through an engineered soil media prior to being discharged to an underdrain or absorbing into the underlying soil. Bioretention provides both runoff reduction and pollutant removal. Bioretention is intended to treat runoff from single lots, multiple lots, and/or commercial rooftops. The practice should be in common areas or within drainage easements, to treat a combination of roadway and lot runoff. Rain gardens are intended to treat smaller areas such as individual rooftops, driveways and small parking areas. VCAP offers cost share funding up to 80% of the cost of implementation for a 10-year lifespan.

Permeable Pavement (PPP
Permeable pavement is an alternative surface that allows stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated. All permeable pavement systems have a similar structure, consisting of a permeable surface layer, bedding layer, reservoir layer, and under drain with geotextile fabric installed underneath if needed based on site characteristics. A variety of permeable pavement surfaces are available, including pervious grid pavers, porous asphalt/concrete, and permeable interlocking pavers. Permeable pavement should only be installed when it is either replacing impervious surfaces or when treating additional impervious surface that offsets the square footage of the practice footprint. VCAP offers cost share funding of $14 per sq ft of implemented area up to a maximum of $20,000.

Impervious Surface Removal (ISR)
Impervious surface removal is the demolition and disposal of impervious surfaces and includes remediation of the subsoil, adding topsoil, and vegetation establishment or other best management

practice. Impervious surfaces include hardscape and pavement materials such as asphalt, concrete, brick, and densely graded stone aggregate. This practice is not intended to provide cost share for structure removal (roof, buildings, pools, etc.). The practice can be implemented by removing the impervious surface and stabilizing with vegetation and landscaping, or it can be followed by the installation of permeable pavement. VCAP offers a cost share funding of $5 per sq. ft. up to a maximum of $20,000, all costs associated with ISR component costs of permeable pavement.

Grass Channels (VOC-1)
Grass channels can provide a modest amount of runoff filtering and volume attenuation within the stormwater conveyance system resulting in the delivery of less runoff and pollutants than a traditional system of curb and gutter, storm drain inlets, and pipes. The performance of grass channels will vary depending on the underlying soil permeability. Grass channels, however, are not capable of providing the same stormwater functions as dry swales as they lack the storage volume associated with the engineered soil media. Grass channels are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system, where development density, topography and soils permit. Grass channels can also be used to treat runoff from the managed turf areas of turf-intensive land uses, such as sports fields and golf courses, and drainage areas with combined impervious and turf cover (e.g., roads and yards).

Bioswale/Dry Swale (BR-6, BR-7)
Bioswale (wet swales) are shallow channels with check dams that create permanent pools that intercept groundwater and provide enhanced pollutant removal within the conveyance. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. On-line or off-line cells are formed within the channel to create saturated soil or shallow standing water conditions.

Dry swales are shallow channels with a series of check dams to provide temporary storage and to allow infiltration of the desired treatment volume (Tv). Dry swales use an engineered soil media as the channel bed unless existing soils are permeable enough to infiltrate runoff into underlying soils. In most cases, however, the runoff treated by the soil media flows into an underdrain, which conveys treated runoff to a conveyance system downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. Dry swales can be planted with turf grass or other suitable ground cover. VCAP offers cost share funding up to 80% of the actual implemented cost for a 10 year lifespan.

Conservation Landscaping (CL-1)
Conservation landscaping is the establishment of native plantings to provide ground cover and understory protection from rainfall and runoff. This practice uses exclusively native plants, as native plants are best adapted to local soil and climate conditions and therefore require the least amount of nutrient addition or cultivation to maintain the amount of ground cover best suited to

minimize runoff. Conservation Landscaping shall be eligible to receive cost-share only if it addresses a nutrient or sediment resource concern, such as poor vegetative cover or excess runoff. VCAP offers cost share funding up to 35% of the actual costs.

Rainwater Harvesting (RWH)
Rainwater harvesting systems intercept, store, and release rainfall for future use. For purposes of this specification, rainwater harvesting includes the collection and conveyance of roof runoff into an above- or below-ground storage tank where it can be reused or safely diverted to a receiving area for infiltration. Rainwater harvesting collects and treats runoff from roofs including homes, businesses, farm buildings, and accessory structures such as garages and sheds. The VCAP offers cost share funding for $1.50 per gallon of treatment volume or $4.00 per gallon of treated volume.

6.2.2.2. Pet Waste BMPs

Pet Waste Management Plan (PW-0)
Pet waste management plans, or education programs, are essential to informing pet owners of the impact their pets have upon their watersheds. A pet waste management plan should be implemented to encourage pet owners to pick up after their pets and facilitate the proper disposal of pet waste. A management plan such as this would include the distribution of educational materials and installation of disposal stations. A pet waste education program could be combined with septic waste education. This program could include newspaper articles, radio ads, postcard mailings and brochures to be distributed at local events and businesses.

Pet Waste Disposal Stations (PW-1)
Pet waste disposal stations entail the installation and regular maintenance of a pet waste disposal station in a dog walking/exercising area, so that dog waste can be removed and properly disposed of. The purpose of this is to improve water quality by removing from the land surface raw pet waste that can potentially impact surface water or groundwater during storm events or impact surface water through runoff conveyance into a storm sewer. This provides pet owners with easy access to plastic or bio-degradable bags for waste pick-up and a trash receptacle to clean up after their pets. It also improves the aesthetics of the area where the disposal station is located. Disposal station quantities were determined by locating residential areas, dog parks, trails, and commercial areas. Additionally pet groomers, kennels, and veterinary offices were located to determine other areas of implementation.

6.2.2.3. Septic and Sewer BMPs

Septic Tank Pumpout (RB-1)
This practice is the maintenance of a conventional or alternative onsite sewage system by having septic tanks pumped to remove solids and to inspect septic tank components. This is done to maintain the operation and performance of the system (conventional or alternative). It was

determined during the working group meetings that half of the total systems in each sub watershed should be pumped out, and other septic BMPs such as repairs and replacements should be increased as during the pumpout process other necessary repairs are often identified. The functional and ponded septic system counts for the watersheds can be found in **Table 6-5**. VADEQ's cost share program offers an amount equal to 50% to 90% of the total unit cost to implement based upon the participants income level.

Table 6-5. Estimated septic systems by watershed.

Watershed	Functioning Septic Systems	Ponded Septic Systems
Blue Run	409	14
Marsh Run	452	15
Preddy Creek	699	24
Preddy Creek North Branch	1,775	60
Quarter Creek	905	31
North Fork Rivanna	2,341	80
Swift Run	700	23
Stanardsville Run	118	4
X Trib to Flat Branch	20	1

Connection to Public Sewer (RB-2)

This practice connects a residence to an existing sewer line to eliminate a malfunctioning onsite sewage system, an identified non-complying discharging system (e.g., straight pipe), or a system not VDH-approved that can potentially impact water quality. A malfunctioning system could be contributing raw or partially treated sewage on the ground's surface or resulting in a direct source of sewage to adjacent ditches, waterways, or groundwater. A straight pipe can potentially deliver sewage directly to a stream, pond, lake, or river. Gray water may also be connected to public sewer via this BMP, but only if in addition to work that connects a residence to an existing sewer line as a replacement of a malfunctioning onsite sewage system or a straight pipe. This improves water quality by removing raw or partially treated sewage on the land surface that can enter groundwater during storm events or sewage that is a direct source of contamination to surface water or ground water. During the working group meeting it was noted that there were 2-3 large communities that could be connected to sewer. Parcel data was analyzed in GIS to identify groups of houses for potential connection to sewer based on existing nearby sewer lines and cost-effectiveness of bringing connections to clusters of houses. VADEQ's cost share program offers an amount equal to 50% to 90% of the total unit cost to implement based upon the participant's income level.

Septic Tank Repair (RB-3)

This practice provides improvements to a failing or failed conventional onsite sewage system to remove the presence of raw or partially treated sewage on the ground's surface to prevent sewage from entering adjacent ditches or waterways or from potentially impacting groundwater. A conventional onsite sewage system refers to treatment system consisting of one or more septic tanks with gravity, pumped, or siphoned conveyance to a gravity-distributed subsurface drainfield. The purpose is to improve water quality by removing raw or partially treated sewage on the land surface that can enter the surface water or groundwater during storm events or sewage that is a direct source of contamination. Additional repairs were included beyond the number of estimated failing systems to account for potential failing septic systems being discovered during septic pumpouts. VADEQ's cost share program offers an amount equal to 50% to 90% of the total unit cost to implement based upon the participants income level.

Septic System Replacement (RB-4)
This practice involves the installation of a conventional onsite sewage system to replace an identified non-complying discharging system (e.g., straight pipe) or installation to replace a failing or failed conventional sewage system. The purpose is to improve water quality by removing raw or partially treated sewage on the land surface that can enter surface water or groundwater during storm events or sewage that is a direct source of contamination to surface water or groundwater. Additional replacements were included beyond the number of failings that were expected to account for potential failing septic systems being discovered during septic pump outs. VADEQ's cost share program offers an amount equal to 50% to 90% of the total unit cost to implement based upon the participants income level.

Installation of Alternative Waste Treatment System (RB-5)
This practice involves the installation of an alternative onsite sewage system to correct a malfunctioning or failing conventional onsite sewage system, malfunctioning, or failing alternative onsite sewage system, or to replace an identified non-complying discharging system (e.g., straight pipe) in situations where installation or replacement of a conventional onsite sewage system cannot be permitted. An alternative onsite sewage system means a treatment work that is not a conventional onsite sewage system. The purpose is to improve water quality by removing raw or partially treated sewage on the land surface that can enter surface water or groundwater during storm events or sewage that is direct source of contamination to surface water or groundwater. With input collected from the working group, it was decided that the total number of alternative systems to implement would be 5% of the total repairs and replacements for a watershed. VADEQ's cost share program offers an amount equal to 50% to 90% of the total unit cost to implement based upon the participants income level.

6.2.3. Streambank Control Measures

Stream Bank Stabilization (WP-2A)
This practice promotes protection methods along streams that reduce erosion, sedimentation, and the pollution of water from agricultural non-point sources. The purpose of this practice is to improve water quality by changing land use, providing vegetative stabilization, and/or improving

management techniques to more effectively control soil erosion, sedimentation and nutrient loss from surface runoff. VACS offers a payment rate up to 90% of the estimated cost to implement or the eligible cost, whichever is less.

Stream Restoration

This practice is more involved than stream bank stabilization, often incorporating changes to the stream channel alignment, installation of in-stream structures such as cross-vanes, and will generally require a qualified engineer to design. Stream restoration goals include sediment and pollutant reduction, but also aim to improve localized habitat through modifying the flow regime, improving streamside vegetation, and implementing in-stream structures. Depending on the location of the project and the parties involved, funding opportunities could come from the Stormwater Local Assistance Fund (SLAF) grant system, National Fish and Wildlife Foundation (NFWF) grants, and other sources.

6.3. BMP Quantities by Watershed

The BMP quantities for each watershed are displayed in **Table 6-6** through **Table 6-14**. The BMPs are implemented across four stages, for more information see **Section 8.0** for details and the corresponding reductions. The livestock exclusion system assumes 1 system equals approximately 1,500 linear feet.

Table 6-6. Blue Run BMP quantities, exclusive of upstream impairment counts.

BMP Type	Description	BMP Code	Units	Extent				
				Stage 1	Stage 2	Stage 3	Stage 4	Total
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	1.86	1.86	0	0	3.72
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		0.1	0.1	0	0	0.2
Cropland	Long Term Vegetative Cover on Cropland	SL-1	Acre	2	3	0	0	5
	Cover Crop	SL-8B/8H		3	4	0	0	7
	Sediment Retention, Erosion, or Water Control Structures	WP-1		2	3	0	0	5
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	9.5	9.5	6	6	31
	Woodland buffer filter area	FR-3		3.68	3.68	0	0	7.36
	Permanent vegetative cover on critical areas	SL-11		40	40	60	60	200
	Improved pasture management	SL-10		120	120	80	80	400
	Extensions of Watering System	SL-7		6	6	8	8	28
	Sediment Retention, Erosion, or Water Control Structures	WP-1		75	75	112.5	112.5	375
	Animal waste control facilities	WP-4	System	1	0	0	0	1
	Roof Runoff Management	WQ-12		1	0	0	0	1
Residential/ Septic	Bioretention/Raingarden	BR-4, RG	Acres Treated	14	14	21	21	70
	Permeable Pavement	PP		0.2	0	0	0	0.2
	Impervious Surface Removal	ISR		0.3	0	0	0	0.3
	Grass Channels	VOC-1		3.9	3.9	2.6	2.6	13
	Conservation Landscaping	CL-1	Acres	18	18	26	26	88
	Rainwater Harvesting	RWH	Acres Treated	2.8	2.9	4.2	4.2	14.1
	Pet Waste Disposal Station	PW-1	System	5	0	0	0	5

	Septic Tank Pumpout	RB-1	Pump-out	64	64	42	42	212
	Connection to Public Sewer	RB-2	Systems	33	32	0	0	65
	Septic Tank Repair	RB-3	Repair	4	3	1	1	9
	Septic System Replacement	RB-4		4	3	1	1	9
	Installation of Alternative Waste Treatment System	RB-5	Systems	1	0	0	0	1
Stream Bank	Stream Restoration	N/A	Feet	79	79	33	33	224
	Stream Bank Stabilization	WP-2A		183	183	78	78	522

Table 6-7 Marsh Run BMP quantities.

BMP Type	Description	BMP Code	Units	Extent				
				Stage 1	Stage 2	Stage 3	Stage 4	Total
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	Systems	0.66	0.66	0	0	1.32
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		0.035	0.035	0	0	0.07
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	5.5	5.5	7	7	25
	Woodland buffer filter area	FR-3		1.08	1.08	0	0	2.16
	Permanent vegetative cover on critical areas	SL-11		13	14	20	20	67
	Improved pasture management	SL-10		135	135	90	90	450
	Extension of Watering System	SL-7		10.5	10.5	7	7	35
	Sediment Retention, Erosion, or Water Control Structures	WP-1		80	80	120	120	400
	Animal waste control facilities	WP-4	Systems	1	0	0	0	1
	Roof Runoff Management	WQ-12		1	0	0	0	1
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	5	5	7	7	24
	Permeable Pavement	PP		0.4	0	0	0	0.4

	Impervious Surface Removal (ISR)	ISR		0.2	0	0	0	0.2
	Grass Channels	VOC-1		5.5	0	0	0	5.5
	Conservation Landscaping	CL-1	Acres	28.5	28.5	44	44	145
	Rainwater Harvesting	RWH	Acres Treated	3	0	0	0	3
	Pet Waste Disposal Station	PW-1	Systems	6	0	0	0	6
	Septic Tank Pumpout	RB-1	Pump-out	70	70	47	47	234
	Septic Tank Repair	RB-3	Repair	4	4	1	1	10
	Septic System Replacement	RB-4		3	4	1	1	9
	Installation of Alternative Waste Treatment System	RB-5	Systems	1	0	0	0	1
Stream Bank	Stream Restoration	N/A	Feet	21	0	0	0	21
	Stream Bank Stabilization	WP-2A		49	0	0	0	49

Table 6-8. Preddy Creek BMP quantities, exclusive of upstream impairment counts.

BMP Type	Description	BMP Code	Units	Extent				
				Stage 1	**Stage 2**	**Stage 3**	**Stage 4**	**Total**
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	system	5.2	5.2	0	0	10.4
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		0.275	0.275	0	0	0.55
Cropland	Long Term Vegetative Cover on Cropland	SL-1	Acre	4	4	5	5	18
	Cover Crop	SL-8B/8H		5	5	7.5	7.5	25
	Sediment Retention, Erosion, or Water Control Structures	WP-1		6.5	6.5	10	10	33
	Afforestation of erodible cropland	FR-1	Acres Treated	5.2	0	0	0	5.2
Pasture	Afforestation of erodible pasture	FR-1		115	115	172.5	172.5	575

	Woodland buffer filter area	FR-3	Acres Treated	6.92	6.92	0	0	13.84
	Permanent vegetative cover on critical areas	SL-11		83	83	124	124	414
	Improved pasture management	SL-10		810	810	540	540	2700
	Extension of Watering System	SL-7		5	5	0	0	10
	Sediment Retention, Erosion, or Water Control Structures	WP-1		346	346	519	519	1730
	Animal waste control facilities	WP-4	Systems	1	0	0	0	1
	Roof Runoff Management	WQ-12		1	0	0	0	1
Harvested	Afforestation of Crop, Hay, and Pasture Land	FR-1	Acre	3.6	3.6	5.3	5.3	17.8
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	Acre	0.01	0	0	0	0.01
Residential/ Septic	Bioretention	N/A	Acres Treated	40	40	60	60	200
	Permeable Pavement	N/A		0.6	0	0	0	0.6
	Impervious Surface Removal (ISR)	N/A		0.5	0	0	0	0.5
	Grass Channels	N/A		5	5	0	0	10
	Bioswale	N/A		5	5	0	0	10
	Conservation Landscaping	N/A	Acres	130	130	195	195	650
	Rainwater Harvesting	N/A	Acres Treated	1	1	0	0	2
	Pet Waste Management Plan*	N/A	Program	0	0	0	1	1
	Pet Waste Disposal Station	N/A	Systems	4	4	0	0	8
	Septic Tank Pumpout	RB-1	Pump-out	109	109	72	72	362
	Septic Tank Repair	RB-3	Repair	6	6	1	1	14
	Septic System Replacement	RB-4	Systems	6	6	1	1	14
	Installation of Alternative Waste Treatment System	RB-5		1	0	0	0	1

Stream Bank	Stream Restoration	N/A	Feet	127	127	85	85	424
	Stream Bank Stabilization	WP-2A		346	346	149	149	990

Table 6-9. Preddy Creek North Branch BMP quantities.

BMP Type	Description	BMP Code	Units	Extent				
				Stage 1	Stage 2	Stage 3	Stage 4	Total
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	1.28	1.28	0	0	2.56
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		0.065	0.065	0	0	0.13
Cropland	Long Term Vegetative Cover on Cropland	SL-1	acre	2	2	0	0	4
	Cover Crop	SL-8B/8H		2	2	0	0	4
	Sediment Retention, Erosion, or Water Control Structures	WP-1		3.5	0	0	0	3.5
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	55	55	92.5	92.5	295
	Woodland buffer filter area	FR-3		1.67	1.67	0	0	3.34
	Permanent vegetative cover on critical areas	SL-11		21	21	32	32	106
	Improved pasture management	SL-10		135	135	90	90	450
	Extension of Watering System	SL-7		5	0	0	0	5
	Sediment Retention, Erosion, or Water Control Structures	WP-1		70	70	105	105	350
	Animal waste control facilities	WP-4	System	1	0	0	0	1
	Roof Runoff Management	WQ-12		1	0	0	0	1
Harvested	Afforestation of Crop, Hay, and Pasture Land	FR-1	Acres treated	31	31	46	46	154
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	Acre	0.31	0	0	0	0.31
	Bioretention	BR-4, RG		60	60	90	90	300

Residential/ Septic	Permeable Pavement	PP	Acres Treated	0.4	0	0	0	0.4
	Impervious Surface Removal (ISR)	ISR		0.2	0	0	0	0.4
	Grass Channels	VOC-1		3.5	3.5	2	2	11
	Bioswale	BR-6, BR-7		5	5	0	0	10
	Conservation Landscaping	CL-1	Acre	150	150	225	225	750
	Rainwater Harvesting	RWH	Acres Treated	4.5	4.5	6	6	21
	Pet Waste Disposal Station	PW-1	System	6	6	0	0	12
	Septic Tank Pumpout	RB-1	Pump-out	275	275	184	184	918
	Connection to Public Sewer	RB-2	Systems	105	105	45	45	300
	Septic Tank Repair	RB-3	Repair	15	15	2	2	34
	Septic System Replacement	RB-4	System	15	15	2	2	34
	Installation of Alternative Waste Treatment System	RB-5		3	0	0	0	3
Stream Bank	Stream Restoration	N/A	Feet	137	137	58.5	58.5	391
	Stream Bank Stabilization	WP-2A		320	320	137	137	914

Table 6-10. Quarter Creek BMP quantities.

BMP Type	Description	BMP Code	Units	Extent				
				Stage 1	Stage 2	Stage 3	Stage 4	Total
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	system	0.825	0.825	0	0	1.65
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		0.045	0.045	0	0	0.09
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	7	7	10.5	10.5	35
	Woodland buffer filter area	FR-3		1.75	1.75	0	0	3.5
	Permanent vegetative cover on critical areas	SL-11		16	16	24	24	80

	Improved pasture management	SL-10		78	78	52	52	260
	Extension of Watering System	SL-7		6	6	0	0	12
	Sediment Retention, Erosion, or Water Control Structures	WP-1		50	50	75	75	250
	Animal waste control facilities	WP-4	Systems	1	0	0	0	1
	Roof Runoff Management	WQ-12		1	0	0	0	1
Harvested	Afforestation of Erodible pasture	FR-1	acre	3.5	0	0	0	3.5
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	18	18	27	27	90
	Permeable Pavement	PP		0.4	0	0	0	0.4
	Impervious Surface Removal (ISR)	ISR		0.2	0	0	0	0.2
	Grass Channels	VOC-1		6.2	6.2	4	4	20.4
	Conservation Landscaping	CL-1	Acre	40	40	60	60	200
	Rainwater Harvesting	RWH	Acres Treated	8	8	10	10	36
	Pet Waste Disposal Station	PW-1	Systems	6	0	0	0	6
	Septic Tank Pumpout	RB-1	Pump-out	140	140	94	94	468
	Connection to Public Sewer	RB-2	Systems	5	0	0	0	5
	Septic Tank Repair	RB-3	Repair	5	5	3	3	16
	Septic System Replacement	RB-4	Systems	5	4	3	3	15
	Installation of Alternative Waste Treatment System	RB-5		1	1	0	0	2
Stream Bank	Stream Restoration	N/A	feet	85	0	0	0	85
	Stream Bank Stabilization	WP-2A		200	0	0	0	200

Table 6-11. North Fork Rivanna BMP quantities, exclusive of upstream impairment counts.

BMP Type	Description	BMP Code	Units	Extent				
				Stage 1	Stage 2	Stage 3	Stage 4	Total
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	7.14	7.14	4.76	4.76	23.8
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		0.625	0.625	0	0	1.25
Cropland	Long Term Vegetative Cover on Cropland	SL-1	Acre	5	5	7.5	7.5	25
	Cover Crop	SL-8B/8H		20	20	30	30	100
	Sediment Retention, Erosion, or Water Control Structures	WP-1		20	20	30	30	100
	Afforestation of erodible pasture	FR-1	Acres Treated	3	3	4.5	4.5	15
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	102	102	154	154	512
	Woodland buffer filter area	FR-3		19.8	19.8	13.2	13.2	66
	Permanent vegetative cover on critical areas	SL-11		160	160	240	240	800
	Improved pasture management	SL-10		2091	2091	1394	1394	6970
	Extension of Watering System	SL-7		13.5	13.5	9	9	45
	Sediment Retention, Erosion, or Water Control Structures	WP-1		1060	1060	1590	1590	5300
	Animal waste control facilities	WP-4	System	4	0	0	0	4
	Roof Runoff Management	WQ-12		3	0	0	0	3
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	54	54	36	36	180
	Impervious Surface Removal (ISR)	ISR		0.6	0	0	0	0.6
	Grass Channels	VOC-1		6	6	4	4	20
	Conservation Landscaping	CL-1	Acre	160	160	240	240	800
	Pet Waste Management Plan	PW-0	Program	0	0	0	1	1
	Pet Waste Disposal Station	PW-1	Systems	5	5	6	6	22

	Septic Tank Pumpout	RB-1	Pump-out	363	364	242	242	1211
	Connection to Public Sewer	RB-2	Systems	60	61	0	0	121
	Septic Tank Repair	RB-3	Repair	20	20	1	1	42
	Septic System Replacement	RB-4	Systems	20	20	1	1	42
	Installation of Alternative Waste Treatment System	RB-5	System	1	1	1	1	4

Table 6-12. Swift Run BMP quantities, exclusive of upstream impairment counts.

BMP Type	Description	BMP Code	Units	Extent				
				Stage 1	Stage 2	Stage 3	Stage 4	Total
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	3.01	3.01	0	0	6.02
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		0.16	0.16	0	0	0.32
Cropland	Long Term Vegetative Cover on Cropland	SL-1	acre	7.5	7.5	0	0	15
	Cover Crop	SL-8B/8H		14.5	14.5	21	21	71
	Sediment Retention, Erosion, or Water Control Structures	WP-1		12.5	12.5	20	20	65
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	65	65	97.5	97.5	325
	Woodland buffer filter area	FR-3		6.65	6.65	0	0	13.3
	Permanent vegetative cover on critical areas	SL-11		78	78	117	117	390
	Improved pasture management	SL-10		450	450	300	300	1500
	Extension of Watering System	SL-7		6	6	0	0	12
	Sediment Retention, Erosion, or Water Control Structures	WP-1		220	220	330	330	1100
	Animal waste control facilities	WP-4	Systems	1	0	0	0	1
	Roof Runoff Management	WQ-12		1	0	0	0	1

Harvested	Afforestation of erodible pasture	FR-1	acres	1.94	0	0	0	1.94
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	27	27	41	41	136
	Permeable Pavement	PP		0.4	0	0	0	0.4
	Impervious Surface Removal (ISR)	ISR		0.4	0	0	0	0.4
	Grass Channels	VOC-1		1.7	0	0	0	1.7
	Conservation Landscaping	CL-1	Acres	70	70	105	105	350
	Rainwater Harvesting	RWH	Acres Treated	1.5	0	0	0	1.5
	Pet Waste Disposal Station	PW-1	Systems	5	6	0	0	11
	Septic Tank Pumpout	RB-1	Pump-out	109	109	72	72	362
	Septic Tank Repair	RB-3	Repair	6	6	1	1	14
	Septic System Replacement	RB-4	Systems	5	6	1	1	13
	Installation of Alternative Waste Treatment System	RB-5		1	0	0	0	1
Stream Bank	Stream Restoration	N/A	Feet	210	210	140.5	140.5	701
	Stream Bank Stabilization	WP-2A		491	491	327.5	327.5	1637

Table 6-13. Stanardsville Run BMP quantities.

BMP Type	Description	BMP Code	Units	Extent				
				Stage 1	Stage 2	Stage 3	Stage 4	Total
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	0.48	0	0	0	0.48
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		0.03	0	0	0	0.03
Cropland	Long Term Vegetative Cover on Cropland	SL-1	acre	0.15	0.15	0	0	0.3
	Cover Crop	SL-8B/8H		0.1	0	0	0	0.1
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	5	5	6	6	22
	Woodland buffer filter area	FR-3		0.53	0.53	0	0	1.06

	Permanent vegetative cover on critical areas	SL-11		8.5	8.5	13	13	43
	Improved pasture management	SL-10		33	33	22	22	110
	Extension of Watering System	SL-7		7	7	4.5	4.5	23
	Sediment Retention, Erosion, or Water Control Structures	WP-1		26	26	39	39	130
	Animal waste control facilities	WP-4	Systems	1	0	0	0	1
	Roof Runoff Management	WQ-12	Systems	1	0	0	0	1
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	14	14	22	22	72
	Permeable Pavement	PP	Acres Treated	0.4	0	0	0	0.4
	Impervious Surface Removal (ISR)	ISR	Acres Treated	0.4	0	0	0	0.4
	Grass Channels	VOC-1	Acres Treated	6	6	4	4	20
	Conservation Landscaping	CL-1	Acres	28.5	28.5	44	44	145
	Rainwater Harvesting	RWH	Acres Treated	4	4	5	5	18
	Pet Waste Disposal Station	PW-1	Systems	3	0	0	0	3
	Septic Tank Pumpout	RB-1	Pump-out	19	18	12	12	61
	Connection to Public Sewer	RB-2	Systems	11	11	8	8	38
	Septic Tank Repair	RB-3	Repair	1	1	1	1	4
	Septic System Replacement	RB-4	Systems	1	1	1	1	4
	Installation of Alternative Waste Treatment System	RB-5	Systems	1	0	0	0	1
Stream Bank	Stream Restoration	N/A	feet	15	0	0	0	15
	Stream Bank Stabilization	WP-2A	feet	34	0	0	0	34

Table 6-14. X-Trib to Flat Branch BMP quantities.

BMP Type	Description	BMP Code	Units	Extent				
				Stage 1	Stage 2	Stage 3	Stage 4	Total
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	0.2	0.2	0	0	0.4
	Permanent vegetative cover on critical areas	SL-11		0.65	0	0	0	0.65
	Improved pasture management	SL-10		1.7	0	0	0	1.7
	Extension of watering system	SL-7		0.7	0	0	0	0.7
	Animal waste control facilities	WP-4	Systems	1	0	0	0	1
	Roof Runoff Management	WQ-12	Systems	1	0	0	0	1
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	acres	0.01	0	0	0	0.01
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	6.2	6.2	9.3	9.3	31
	Permeable Pavement	PP		0.2	0	0	0	0.2
	Impervious Surface Removal (ISR)	ISR		0.3	0	0	0	0.3
	Grass Channels	VOC-1		6	6	0	0	12
	Conservation Landscaping	CL-1	Acres	12.5	12.5	19	19	63
	Rainwater Harvesting	RWH	Treated Acres	4.4	0	0	0	4.4
	Pet Waste Disposal Station	PW-1	Systems	3	0	0	0	3
	Septic Tank Pumpout	RB-1	Pump-out	5	4	1	1	11
	Septic Tank Repair	RB-3	Repair	1	0	0	0	1
	Installation of Alternative Waste Treatment System	RB-5	System	1	0	0	0	1
Stream Bank	Stream Restoration	N/A	Feet	6	0	0	0	6
	Stream Bank Stabilization	WP-2A		15	0	0	0	15

6.4. Technical Assistance and Education

To inform and get landowners involved in implementation, outreach, education, and technical assistance with the specifications and design of the BMPs will be necessary. A proactive approach must be taken to reach farmers and residents to determine what the TMDLs mean to them and what practices will both help them and improve the water quality. The following general tasks associated with agricultural and residential programs were identified.

Agricultural Programs

- Contact landowners/producers in the watershed and absentee landowners to make them aware of implementation goals and cost-share assistance programs.
- Assist with BMP surveys, designs, layout, and approvals of installations.
- Develop educational materials and programs based on local needs.
- Organize educational programs (e.g., pasture walks, presentations at field days, or grazing club events).
- Distribute educational materials (e.g., informational articles in Farm Service Agency (FSA) or Farm Bureau newsletters, local media).
- Assess and track progress toward BMP implementation goals.
- Follow up with landowners who have installed BMPs.
- Coordinate use of existing agricultural programs and suggest modifications where necessary.

Residential Programs

- Identify failing septic systems and straight pipes using stream walks, analysis of aerial photos, and/or monitoring and report to VDH.
- Track septic system repairs/replacements/installations.
- Develop pet waste educational program and materials
- Distribute educational materials (e.g., informational pamphlets on TMDLs and on-site sewage disposal systems).
- Assess progress toward implementation goals.
- Follow up with landowners who have participated in the program(s).

An important part in the successful implementation of this plan is knowledgeable staff that can be available to work with landowners in implementing BMPs. While a general list of practices have been provided in this plan that can be implemented, some property owners will have more unique circumstances such as financial barriers and design challenges. Consequently, receiving technical assistance from trained local professionals is key to implementing BMPs successfully. Such technical assistance includes helping landowners identify suitable BMPs for their property, designing BMPs and locating funding to finance implementation.

7.0 COST AND BENEFITS

7.1. BMP Cost Analysis

The cost of agricultural best management practices included in the implementation plan were estimated based on data for Albemarle, Greene, Orange Counties from the VADCR Agricultural database, the FY 2025 NRCS Virginia Practice Average Annual Costs (PAAC) data, and input from Culpepper SWCD and working group.

The total cost of livestock exclusion systems includes not only the costs associated with fence installation, repair, and maintenance, but also the cost of developing alternative water sources for SL-6N, SL-6W, and CRSL-6.

Many recommended agricultural practices in the IP are included in state and federal cost share programs. These programs offer financial assistance in implementing the practices and may also provide landowners with an incentive payment to encourage participation. The cost to both landowners, state, and federal programs must be considered when implementing BMPs.

The urban/residential best management practices included in the implementation plan were estimated based on VCAP data provided, and significant input from the Culpepper SWCD, Thomas Jefferson SWCD, and the working group. The estimated costs were determined based on VCAP data provided, input from the working group, and on other implementation plans in the area. Per the bacteria TMDL, 100% of the failing septic systems must be replaced or repaired. Their costs were determined through VADEQ's 2025 Nonpoint Source Implementation Best Management Practice Specifications.

In some watersheds, BMPs were required on harvested forest and barren land covers to meet sediment goals. The estimated costs were determined based on VADEQ's 2025 Nonpoint Source Implementation Best Management Practice Specifications and other implementation plans in the area.

Stream bank stabilization and restoration was incorporated to account for sediment impairments from stream banks. The estimated costs were determined based on technical expertise and input from the working group.

The costs per watershed, including their total cost per stage, are shown in **Table 7-1** through **Table 7-9**. The total estimated cost to meet the bacteria, sediment, and phosphorus delisting goals are shown in **Table 7-10** for the four stages of implementation.

Table 7-1. Blue Run BMP implementation costs, exclusive of upstream impairment counts.

BMP Type	Description	BMP Code	Units	Unit Cost	Extent					Total Cost
					Stage 1	Stage 2	Stage 3	Stage 4	Total	
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	$103,400	1.86	1.86	0	0	3.72	$384,648
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		$64,000	0.1	0.1	0	0	0.2	$12,800
Cropland	Long Term Vegetative Cover on Cropland	SL-1	Acre	$150	2	3	0	0	5	$750
	Cover Crop	SL-8B/8H		$80	3	4	0	0	7	$560
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	2	3	0	0	5	$750
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	$500	9.5	9.5	6	6	31	$15,500
	Woodland buffer filter area	FR-3		$3,470	3.68	3.68	0	0	7.36	$25,539.20
	Permanent vegetative cover on critical areas	SL-11		$1,800	40	40	60	60	200	$360,000
	Improved pasture management	SL-10		$75	120	120	80	80	400	$30,000
	Extensions of Watering System	SL-7		$20,000	6	6	8	8	28	$560,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	75	75	112.5	112.5	375	$56,250
	Animal waste control facilities	WP-4	System	$375,000	1	0	0	0	1	$375,000
	Roof Runoff Management	WQ-12		$1,450	1	0	0	0	1	$1,450
Residential/ Septic	Bioretention/Raingarden	N/A	Acres Treated	$10,000	14	14	21	21	70	$700,000
	Permeable Pavement	N/A		$1,165,500	0.2	0	0	0	0.2	$233,100
	Impervious Surface Removal	N/A		$291,800	0.3	0	0	0	0.3	$87,540

	Grass Channels	N/A		$18,150	3.9	3.9	2.6	2.6	13	$235,950
	Conservation Landscaping	N/A	Acres	$7,000	18	18	26	26	88	$616,000
	Rainwater Harvesting	N/A	Acres Treated	$100,000	2.8	2.9	4.2	4.2	14.1	$1,410,000
	Pet Waste Disposal Station	PW-1	System	$2,000	5	0	0	0	5	$10,000
	Septic Tank Pumpout	RB-1	Pump-out	$375	64	64	42	42	212	$79,500
	Connection to Public Sewer	RB-2	Systems	$12,500	33	32	0	0	65	$812,500
	Septic Tank Repair	RB-3	Repair	$7,500	4	3	1	1	9	$67,500
	Septic System Replacement	RB-4	Systems	$12,500	4	3	1	1	9	$112,500
	Installation of Alternative Waste Treatment System	RB-5	Systems	$31,500	1	0	0	0	1	$31,500
Stream Bank	Stream Restoration	N/A	Feet	$750	79	79	33	33	224	$168,000
Stream Bank	Stream Bank Stabilization	WP-2A	Feet	$250	183	183	78	78	522	$130,500
			Total Cost		$2,406,209	$1,645,499	$1,233,065	$1,233,065		$6,517,837

Table 7-2. Marsh Run BMP implementation costs.

BMP Type	Description	BMP Code	Units	Unit Cost	Extent					Total Cost
					Stage 1	Stage 2	Stage 3	Stage 4	Total	
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	Systems	$103,400	0.66	0.66	0	0	1.32	$136,488
Livestock Exclusion	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	Systems	$64,000	0.035	0.035	0	0	0.07	$4,480
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	$500	5.5	5.5	7	7	25	$12,500
Pasture	Woodland buffer filter area	FR-3	Acres Treated	$3,470	1.08	1.08	0	0	2.16	$7,495
Pasture	Permanent vegetative cover on critical areas	SL-11	Acres Treated	$1,800	13	14	20	20	67	$120,600
Pasture	Improved pasture management	SL-10	Acres Treated	$75	135	135	90	90	450	$33,750

	Extension of Watering System	SL-7		$20,000	10.5	10.5	7	7	35	$700,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	80	80	120	120	400	$60,000
	Animal waste control facilities	WP-4	Systems	$375,000	1	0	0	0	1	$375,000
	Roof Runoff Management	WQ-12		$1,450	1	0	0	0	1	$1,450
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	$10,000	5	5	7	7	24	$240,000
	Permeable Pavement	PP		$1,165,500	0.4	0	0	0	0.4	$466,200
	Impervious Surface Removal (ISR)	ISR		$291,800	0.2	0	0	0	0.2	$58,360
	Grass Channels	VOC-1		$18,150	5.5	0	0	0	5.5	$99,825
	Conservation Landscaping	CL-1	Acres	$7,000	28.5	28.5	44	44	145	$1,015,000
	Rainwater Harvesting	RWH	Acres Treated	$100,000	3	0	0	0	3	$300,000
	Pet Waste Disposal Station	PW-1	Systems	$2,000	6	0	0	0	6	$12,000
	Septic Tank Pumpout	RB-1	Pump-out	$375	70	70	47	47	234	$87,750
	Septic Tank Repair	RB-3	Repair	$7,500	4	4	1	1	10	$75,000
	Septic System Replacement	RB-4		$12,500	3	4	1	1	9	$112,500
	Installation of Alternative Waste Treatment System	RB-5	Systems	$31,500	1	0	0	0	1	$31,500
Stream Bank	Stream Restoration	N/A	Feet	$750	21	0	0	0	21	$15,750
	Stream Bank Stabilization	WP-2A		$250	49	0	0	0	49	$12,250
			Total Cost		$2,048,092	$690,057	$619,875	$619,875		$3,977,898

Table 7-3. Preddy Creek BMP implementation costs, exclusive of upstream impairment counts.

BMP Type	Description	BMP Code	Units	Unit Cost	Extent					Total Cost
					Stage 1	Stage 2	Stage 3	Stage 4	Total	
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	system	$103,400	5.2	5.2	0	0	10.4	$1,075,360
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		$64,000	0.275	0.275	0	0	0.55	$35,200
Cropland	Long Term Vegetative Cover on Cropland	SL-1	Acre	$150	4	4	5	5	18	$2,700
	Cover Crop	SL-8B/8H		$80	5	5	7.5	7.5	25	$2,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	6.5	6.5	10	10	33	$4,950
	Afforestation of erodible cropland	FR-1	Acres Treated	$500	5.2	0	0	0	5.2	$2,600
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	$500	115	115	172.5	172.5	575	$287,500
	Woodland buffer filter area	FR-3		$3,470	6.92	6.92	0	0	13.84	$48,024.80
	Permanent vegetative cover on critical areas	SL-11		$1,800	83	83	124	124	414	$745,200
	Improved pasture management	SL-10		$75	810	810	540	540	2700	$202,500
	Extension of Watering System	SL-7		$20,000	5	5	0	0	10	$200,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	346	346	519	519	1730	$259,500
	Animal waste control facilities	WP-4	Systems	$375,000	1	0	0	0	1	$375,000
	Roof Runoff Management	WQ-12		$1,450	1	0	0	0	1	$1,450
Harvested	Afforestation of Crop, Hay, and Pasture Land	FR-1	Acres treated	$500	3.6	3.6	5.3	5.3	17.8	$8,900

Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	Acre	$134,630	0.01	0	0	0	0.01	$1,346.30
Residential/ Septic	Bioretention	N/A	Acres Treated	$10,000	40	40	60	60	200	$2,000,000
	Permeable Pavement	N/A		$1,165,500	0.6	0	0	0	0.6	$699,300
	Impervious Surface Removal (ISR)	N/A		$291,800	0.5	0	0	0	0.5	$145,900
	Grass Channels	N/A		$18,150	5	5	0	0	10	$181,500
	Bioswale	N/A		$42,000	5	5	0	0	10	$420,000
	Conservation Landscaping	N/A	Acres	$7,000	130	130	195	195	650	$4,550,000
	Rainwater Harvesting	N/A	Acres Treated	$100,000	1	1	0	0	2	$200,000
	Pet Waste Management Plan*	N/A	Program	$16,000	0	0	0	1	1	$16,000
	Pet Waste Disposal Station	N/A	Systems	$2,000	4	4	0	0	8	$16,000
	Septic Tank Pumpout	RB-1	Pump-out	$375	109	109	72	72	362	$135,750
	Septic Tank Repair	RB-3	Repair	$7,500	6	6	1	1	14	$105,000
	Septic System Replacement	RB-4	Systems	$12,500	6	6	1	1	14	$175,000
	Installation of Alternative Waste Treatment System	RB-5		$31,500	1	0	0	0	1	$31,500
Stream Bank	Stream Restoration	N/A	Feet	$750	127	127	85	85	424	$318,000
	Stream Bank Stabilization	WP-2A		$250	346	346	149	149	990	$247,500
			Total Cost		$4,321,089	$3,063,992	$2,546,300	$2,562,300		$12,493,681

Table 7-4. Preddy Creek North Branch BMP implementation costs.

BMP Type	Description	BMP Code	Units	Unit Cost	Extent					Total Cost
					Stage 1	Stage 2	Stage 3	Stage 4	Total	
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	$103,400	1.28	1.28	0	0	2.56	$264,704
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		$64,000	0.065	0.065	0	0	0.13	$8,320
Cropland	Long Term Vegetative Cover on Cropland	SL-1	acre	$150	2	2	0	0	4	$600
	Cover Crop	SL-8B/8H		$80	2	2	0	0	4	$320
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	3.5	0	0	0	3.5	$525
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	$500	55	55	92.5	92.5	295	$147,500
	Woodland buffer filter area	FR-3		$3,470	1.67	1.67	0	0	3.34	$11,589.80
	Permanent vegetative cover on critical areas	SL-11		$1,800	21	21	32	32	106	$190,800
	Improved pasture management	SL-10		$75	135	135	90	90	450	$33,750
	Extension of Watering System	SL-7		$20,000	5	0	0	0	5	$100,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	70	70	105	105	350	$52,500
	Animal waste control facilities	WP-4	System	$375,000	1	0	0	0	1	$375,000
	Roof Runoff Management	WQ-12		$1,450	1	0	0	0	1	$1,450
Harvested	Afforestation of Crop, Hay, and Pasture Land	FR-1	Acres treated	$500	31	31	46	46	154	$77,000
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	Acre	$134,630	0.31	0	0	0	0.31	$41,735.30

Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	$10,000	60	60	90	90	300	$3,000,000
	Permeable Pavement	PP		$1,165,500	0.4	0	0	0	0.4	$466,200
	Impervious Surface Removal (ISR)	ISR		$291,800	0.4	0	0	0	0.4	$116,720
	Grass Channels	VOC-1		$18,150	3.5	3.5	2	2	11	$199,650
	Bioswale	BR-6, BR-7		$42,000	5	5	0	0	10	$420,000
	Conservation Landscaping	CL-1	Acre	$7,000	150	150	225	225	750	$5,250,000
	Rainwater Harvesting	RWH	Acres Treated	$100,000	4.5	4.5	6	6	21	$2,100,000
	Pet Waste Disposal Station	PW-1	System	$2,000	6	6	0	0	12	$24,000
	Septic Tank Pumpout	RB-1	Pump-out	$375	275	275	184	184	918	$344,250
	Connection to Public Sewer	RB-2	Systems	$12,500	105	105	45	45	300	$3,750,000
	Septic Tank Repair	RB-3	Repair	$7,500	15	15	2	2	34	$255,000
	Septic System Replacement	RB-4	System	$12,500	15	15	2	2	34	$425,000
	Installation of Alternative Waste Treatment System	RB-5		$31,500	3	0	0	0	3	$94,500
Stream Bank	Stream Restoration	N/A	Feet	$750	137	137	58.5	58.5	391	$293,250
	Stream Bank Stabilization	WP-2A		$250	320	320	137	137	914	$228,500
			Total Cost		$5,724,222	$4,528,092	$4,010,275	$4,010,275		$18,272,864

Table 7-5. Quarter Creek BMP implementation costs.

BMP Type	Description	BMP Code	Units	Unit Cost	Extent					Total Cost
					Stage 1	Stage 2	Stage 3	Stage 4	Total	
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	system	$103,400	0.825	0.825	0	0	1.65	$170,610
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		$64,000	0.045	0.045	0	0	0.09	$5,760

Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	$500	7	7	10.5	10.5	35	$17,500
	Woodland buffer filter area	FR-3		$3,470	1.75	1.75	0	0	3.5	$12,145
	Permanent vegetative cover on critical areas	SL-11		$1,800	16	16	24	24	80	$144,000
	Improved pasture management	SL-10		$75	78	78	52	52	260	$19,500
	Extension of Watering System	SL-7		$20,000	6	6	0	0	12	$240,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	50	50	75	75	250	$37,500
	Animal waste control facilities	WP-4	Systems	$375,000	1	0	0	0	1	$375,000
	Roof Runoff Management	WQ-12		$1,450	1	0	0	0	1	$1,450
Harvested	Afforestation of Erodible pasture	FR-1	acre	$500	3.5	0	0	0	3.5	$1,750
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	$10,000	18	18	27	27	90	$900,000
	Permeable Pavement	PP		$1,165,500	0.4	0	0	0	0.4	$466,200
	Impervious Surface Removal (ISR)	ISR		$291,800	0.2	0	0	0	0.2	$58,360
	Grass Channels	VOC-1		$18,150	6.2	6.2	4	4	20.4	$370,260
	Conservation Landscaping	CL-1	Acre	$7,000	40	40	60	60	200	$1,400,000
	Rainwater Harvesting	RWH	Acres Treated	$100,000	8	8	10	10	36	$3,600,000
	Pet Waste Disposal Station	PW-1	Systems	$2,000	6	0	0	0	6	$12,000
	Septic Tank Pumpout	RB-1	Pump-out	$375	140	140	94	94	468	$175,500
	Connection to Public Sewer	RB-2	Systems	$12,500	5	0	0	0	5	$62,500
	Septic Tank Repair	RB-3	Repair	$7,500	5	5	3	3	16	$120,000
	Septic System Replacement	RB-4	Systems	$12,500	5	4	3	3	15	$187,500
	Installation of Alternative Waste Treatment System	RB-5		$31,500	1	1	0	0	2	$63,000

Stream Bank	Stream Restoration	N/A	feet	$750	85	0	0	0	85	$63,750
	Stream Bank Stabilization	WP-2A		$250	200	0	0	0	200	$50,000
			Total Cost		$2,907,448	$1,803,938	$1,921,450	$1,921,450		$8,554,285

Table 7-6. NF Rivanna BMP implementation costs, exclusive of upstream impairment counts.

BMP Type	Description	BMP Code	Units	Unit Cost	Extent					Total Cost
					Stage 1	Stage 2	Stage 3	Stage 4	Total	
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	$103,400	7.14	7.14	4.76	4.76	23.8	$2,460,920
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		$64,000	0.625	0.625	0	0	1.25	$80,000
Cropland	Long Term Vegetative Cover on Cropland	SL-1	Acre	$150	5	5	7.5	7.5	25	$3,750
	Cover Crop	SL-8B/8H		$80	20	20	30	30	100	$8,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	20	20	30	30	100	$15,000
	Afforestation of erodible pasture	FR-1	Acres Treated	$500	3	3	4.5	4.5	15	$7,500
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	$500	102	102	154	154	512	$256,000
	Woodland buffer filter area	FR-3		$3,470	19.8	19.8	13.2	13.2	66	$229,020
	Permanent vegetative cover on critical areas	SL-11		$1,800	160	160	240	240	800	$1,440,000
	Improved pasture management	SL-10		$75	2091	2091	1394	1394	6970	$522,750
	Extension of Watering System	SL-7		$20,000	13.5	13.5	9	9	45	$900,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	1060	1060	1590	1590	5300	$795,000

	Animal waste control facilities	WP-4	System	$375,000	4	0	0	0	4	$1,500,000
	Roof Runoff Management	WQ-12		$1,450	3	0	0	0	3	$4,350
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	$10,000	54	54	36	36	180	$1,800,000
	Impervious Surface Removal (ISR)	ISR		$291,800	0.6	0	0	0	0.6	$175,080
	Grass Channels	VOC-1		$18,150	6	6	4	4	20	$363,000
	Conservation Landscaping	CL-1	Acre	$7,000	160	160	240	240	800	$5,600,000
	Pet Waste Management Plan	PW-0	Program	$16,000	0	0	0	1	1	$16,000
	Pet Waste Disposal Station	PW-1	Systems	$2,000	5	5	6	6	22	$44,000
	Septic Tank Pumpout	RB-1	Pump-out	$375	363	364	242	242	1211	$454,125
	Connection to Public Sewer	RB-2	Systems	$12,500	60	61	0	0	121	$1,512,500
	Septic Tank Repair	RB-3	Repair	$7,500	20	20	1	1	42	$315,000
	Septic System Replacement	RB-4	Systems	$12,500	20	20	1	1	42	$525,000
	Installation of Alternative Waste Treatment System	RB-5	System	$31,500	1	1	1	1	4	$126,000
				Total Cost	$6,554,612	$4,888,057	$3,847,163	$3,863,163		$19,152,995

Table 7-7. Swift Run BMP implementation costs, exclusive of upstream impairment counts.

BMP Type	Description	BMP Code	Units	Unit Cost	Extent					Total Cost
					Stage 1	Stage 2	Stage 3	Stage 4	Total	
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	$103,400	3.01	3.01	0	0	6.02	$622,468
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		$64,000	0.16	0.16	0	0	0.32	$20,480
Cropland	Long Term Vegetative Cover on Cropland	SL-1	acre	$150	7.5	7.5	0	0	15	$2,250
	Cover Crop	SL-8B/8H		$80	14.5	14.5	21	21	71	$5,680

	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	12.5	12.5	20	20	65	$9,750
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	$500	65	65	97.5	97.5	325	$162,500
	Woodland buffer filter area	FR-3		$3,470	6.65	6.65	0	0	13.3	$46,151
	Permanent vegetative cover on critical areas	SL-11		$1,800	78	78	117	117	390	$702,000
	Improved pasture management	SL-10		$75	450	450	300	300	1500	$112,500
	Extension of Watering System	SL-7		$20,000	6	6	0	0	12	$240,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	220	220	330	330	1100	$165,000
	Animal waste control facilities	WP-4	Systems	$375,000	1	0	0	0	1	$375,000
	Roof Runoff Management	WQ-12		$1,450	1	0	0	0	1	$1,450
Harvested	Afforestation of erodible pasture	FR-1	acres	$500	1.94	0	0	0	1.94	$970
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	$10,000	27	27	41	41	136	$1,360,000
	Permeable Pavement	PP		$1,165,500	0.4	0	0	0	0.4	$466,200
	Impervious Surface Removal (ISR)	ISR		$291,800	0.4	0	0	0	0.4	$116,720
	Grass Channels	VOC-1		$18,150	1.7	0	0	0	1.7	$30,855
	Conservation Landscaping	CL-1	Acres	$7,000	70	70	105	105	350	$2,450,000
	Rainwater Harvesting	RWH	Acres/ Systems	$100,000	1.5	0	0	0	1.5	$150,000
	Pet Waste Disposal Station	PW-1	Systems	$2,000	5	6	0	0	11	$22,000
	Septic Tank Pumpout	RB-1	Pump-out	$375	109	109	72	72	362	$135,750
	Septic Tank Repair	RB-3	Repair	$7,500	6	6	1	1	14	$105,000
	Septic System Replacement	RB-4	Systems	$12,500	5	6	1	1	13	$162,500

BMP Type	Description	BMP Code	Units	Unit Cost	Stage 1	Stage 2	Stage 3	Stage 4	Total	Total Cost
	Installation of Alternative Waste Treatment System	RB-5		$31,500	1	0	0	0	1	$31,500
Stream Bank	Stream Restoration	N/A	Feet	$750	210	210	140.5	140.5	701	$525,750
	Stream Bank Stabilization	WP-2A		$250	491	491	327.5	327.5	1637	$409,250
			Total Cost		$3,079,680	$1,921,485	$1,715,280	$1,715,280		$8,431,724

Table 7-8. Stanardsville Run BMP implementation costs.

BMP Type	Description	BMP Code	Units	Unit Cost	Extent					Total Cost
					Stage 1	Stage 2	Stage 3	Stage 4	Total	
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	System	$103,400	0.48	0	0	0	0.48	$49,632
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6		$64,000	0.03	0	0	0	0.03	$1,920
Cropland	Long Term Vegetative Cover on Cropland	SL-1	acre	$150	0.15	0.15	0	0	0.3	$45
	Cover Crop	SL-8B/8H		$80	0.1	0	0	0	0.1	$8
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	$500	5	5	6	6	22	$11,000
	Woodland buffer filter area	FR-3		$3,470	0.53	0.53	0	0	1.06	$3,678.20
	Permanent vegetative cover on critical areas	SL-11		$1,800	8.5	8.5	13	13	43	$77,400
	Improved pasture management	SL-10		$75	33	33	22	22	110	$8,250
	Extension of Watering System	SL-7		$20,000	7	7	4.5	4.5	23	$460,000
	Sediment Retention, Erosion, or Water Control Structures	WP-1		$150	26	26	39	39	130	$19,500
	Animal waste control facilities	WP-4	Systems	$375,000	1	0	0	0	1	$375,000
	Roof Runoff Management	WQ-12		$1,450	1	0	0	0	1	$1,450

Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	$10,000	14	14	22	22	72	$720,000
	Permeable Pavement	PP		$1,165,500	0.4	0	0	0	0.4	$466,200
	Impervious Surface Removal (ISR)	ISR		$291,800	0.4	0	0	0	0.4	$116,720
	Grass Channels	VOC-1		$18,150	6	6	4	4	20	$363,000
	Conservation Landscaping	CL-1	Acres	$7,000	28.5	28.5	44	44	145	$1,015,000
	Rainwater Harvesting	RWH	Acres Treated	$100,000	4	4	5	5	18	$1,800,000
	Pet Waste Disposal Station	PW-1	Systems	$2,000	3	0	0	0	3	$6,000
	Septic Tank Pumpout	RB-1	Pump-out	$375	19	18	12	12	61	$22,875
	Connection to Public Sewer	RB-2	Systems	$12,500	11	11	8	8	38	$475,000
	Septic Tank Repair	RB-3	Repair	$7,500	1	1	1	1	4	$30,000
	Septic System Replacement	RB-4	Systems	$12,500	1	1	1	1	4	$50,000
	Installation of Alternative Waste Treatment System	RB-5		$31,500	1	0	0	0	1	$31,500
Stream Bank	Stream Restoration	N/A	feet	$750	15	0	0	0	15	$11,250
	Stream Bank Stabilization	WP-2A		$250	34	0	0	0	34	$8,500
			Total Cost		$2,247,242	$1,178,687	$1,349,000	$1,349,000		$6,123,928

Table 7-9. X-Trib to Flat Branch BMP implementation costs.

BMP Type	Description	BMP Code	Units	Unit Cost	Extent					Total Cost
					Stage 1	Stage 2	Stage 3	Stage 4	Total	
Pasture	Afforestation of erodible pasture	FR-1	Acres Treated	$500	0.2	0.2	0	0	0.4	$200
	Permanent vegetative cover on critical areas	SL-11		$1,800	0.65	0	0	0	0.65	$1,170
	Improved pasture management	SL-10		$75	1.7	0	0	0	1.7	$127.50
	Extension of watering system	SL-7		$20,000	0.7	0	0	0	0.7	$14,000

	Animal waste control facilities	WP-4	Systems	$375,000	1	0	0	0	1	$375,000
	Roof Runoff Management	WQ-12	Systems	$1,450	1	0	0	0	1	$1,450
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	acres	$134,630	0.01	0	0	0	0.01	$1,346.30
Residential/ Septic	Bioretention	BR-4, RG	Acres Treated	$10,000	6.2	6.2	9.3	9.3	31	$310,000
	Permeable Pavement	PP		$1,165,500	0.2	0	0	0	0.2	$233,100
	Impervious Surface Removal (ISR)	ISR		$291,800	0.3	0	0	0	0.3	$87,540
	Grass Channels	VOC-1		$18,150	6	6	0	0	12	$217,800
	Conservation Landscaping	CL-1	Acres	$7,000	12.5	12.5	19	19	63	$441,000
	Rainwater Harvesting	RWH	Treated Acres	$100,000	4.4	0	0	0	4.4	$440,000
	Pet Waste Disposal Station	PW-1	Systems	$2,000	3	0	0	0	3	$6,000
	Septic Tank Pumpout	RB-1	Pump-out	$375	5	4	1	1	11	$4,125
	Septic Tank Repair	RB-3	Repair	$7,500	1	0	0	0	1	$7,500
	Installation of Alternative Waste Treatment System	RB-5	System	$31,500	1	0	0	0	1	$31,500
Stream Bank	Stream Restoration	N/A	Feet	$750	6	0	0	0	6	$4,500
	Stream Bank Stabilization	WP-2A		$250	15	0	0	0	15	$3,750
			Total Cost		$1,467,359	$260,000	$226,375	$226,375		$2,180,109

Table 7-10. Total BMP implementation costs.

BMP Application	Cost by Stage				Total
	Stage 1 (Years 1-5)	Stage 2 (Years 6-10)	Stage 3 (Years 11-15)	Stage 4 (16-20)	
Agricultural	$10,574,291	$5,673,640	$3,595,243	$3,595,243	$23,438,417
Residential	$20,181,660	$14,306,165	$13,873,540	$13,905,540	$62,266,905
Total Estimated Cost	$30,755,951	$19,979,805	$17,468,783	$17,500,783	$85,705,322

7.2. Technical Assistance

Technical assistance costs were estimated as six full-time positions using a cost of $60,000/position per year. This figure is based on the existing staffing costs included in the Virginia Department of Environmental Quality's grant agreements with the Soil and Water Conservation Districts across the state to provide technical assistance to landowners in TMDL implementation watersheds. Based on the 20-year timeline of this plan (described in the **Section 8.0**), this would make the total cost of technical assistance approximately $7,200,000. When factored into the cost estimate for BMP implementation shown in **Table 7-10**, this would make the total cost of implementation approximately $92.9M.

7.3. Benefit Analysis

The primary benefit of implementing this plan will be cleaner water in the North Fork Rivanna River Watershed. Specifically, *E. coli,* sediment, and phosphorus contamination in the watershed will be reduced to meet water quality standards at which the river is once again capable of supporting a healthy and diverse community of aquatic life. It is hard to gauge the impact that reducing *E. coli* contamination will have on public health, as most cases of waterborne infection are not reported or are falsely attributed to other sources. However, because of the reductions required, the incidence of infection from *E. coli* sources through contact with surface waters should be reduced considerably.

An important objective of the implementation plan is to foster continued economic vitality. This objective is based on the recognition that healthy waters improve economic opportunities for Virginians and a healthy economic base provides the resources and funding necessary to pursue restoration and enhancement activities. The agricultural and residential practices recommended in this document will provide economic benefits to the community, as well as the expected environmental benefits. Specifically, alternative (clean) water sources, exclusion of livestock from streams, improved pasture management, and private sewage system maintenance will provide economic benefits to landowners. Additionally, money spent by landowners and state agencies in the process of implementing this plan will stimulate the local economy.

7.3.1. Agricultural Practices

It is recognized that every farmer faces unique management challenges that may make implementation of some BMPs more cost effective than others. Consequently, the costs and benefits of the BMPs recommended in this plan must be weighed on an individual basis. The benefits highlighted in this section are based on general research findings.

Restricting livestock access to streams and providing them with clean water sources has been shown to improve weight gain and milk production in cattle (Zeckoski et al., 2007). Studies have shown that increasing livestock consumption of clean water can lead to increased milk and butterfat production and increased weight gain (Landefeld et al, 2002). **Table 7-11** shows an example of how this can translate into economic gains for producers. Fresh clean water is the primary nutrient for livestock with healthy cattle consuming, daily, close to 10% of their body weight during winter and 15% of their body weight in summer. Many livestock illnesses can be spread through contaminated water supplies. For instance, coccidia can be delivered through feed, water and haircoat contamination with manure (VCE, 2000). In addition, horses drinking from marshy areas or areas where wildlife or cattle carrying Leptospirosis have access tend to have an increased incidence of moon blindness associated with Leptospirosis infections (VCE, 1998b). A clean water source can prevent illnesses that reduce production and incur the added expense of avoidable veterinary bills.

Table 7-11 Example of increased revenue due to installing off stream waterers (Surber et al., 2005)

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

In addition to reducing the likelihood of animals contracting waterborne illnesses by providing a clean water supply, streamside fencing excludes livestock from wet, swampy environments as are often found next to streams where cattle have regular access. Keeping cattle in clean, dry areas has been shown to reduce the occurrence of mastitis and foot rot. The VCE (1998a) reports that mastitis costs producers $100 per cow in reduced quantity and quality of milk produced. On a larger scale, mastitis costs the U.S. dairy industry about $1.7 billion to 2 billion annually or 11% of total U.S. milk production. While the spread of mastitis through a dairy herd can be reduced through proper sanitation of milking equipment, mastitis-causing bacteria can be harbored and spread in the environment where cattle have access to wet and dirty areas. Installation of streamside fencing and well managed loafing areas will reduce the amount of time that cattle have access to these areas.

Taking the opportunity to implement a rotational grazing system in conjunction with installing clean water supplies will also provide economic benefits for the producer. Improved pasture management can allow a producer to feed less hay in winter months, increase stocking rates by 30 to 40% and, consequently, improve the profitability of the operation. With feed costs typically responsible for 70 to 80% of the cost of growing or maintaining an animal, and pastures providing feed at a cost of 0.01 to 0.02 cents/lb of total digestible nutrients (TDN) compared to 0.04 to 0.06 cents/lb TDN for hay, increasing the amount of time that cattle are fed on pasture is clearly a financial benefit to producers (VCE, 1996). Standing forage utilized directly by the grazing animal is always less costly and of higher quality than the same forage harvested with equipment and fed to the animal. In addition to reducing costs to producers, intensive pasture management can boost profits by allowing higher stocking rates and increasing the amount of gain per acre. Another benefit is that cattle are closely confined allowing for quicker examination and handling. In general, many of the agricultural BMPs recommended in this document will provide both environmental benefits and economic benefits to the farmer.

7.3.2. Residential Stormwater Practices

The primary benefits of stormwater management practices to private property owners include flood mitigation and improved water quality. A 2004 study assessing the economic benefits of stormwater management showed that these services can be valued at 0-5% of the market value of a home (Braden and Johnston, 2004). In terms of economic benefits to homeowners, an improved understanding of on-site sewage treatment systems, including knowledge of what steps can be taken to keep them functioning properly and the need for regular maintenance, will give homeowners the tools needed for extending the life of their systems and reducing the overall cost of ownership. The average septic system will last 20 to 25 years if properly maintained. Proper maintenance includes: knowing the location of the system components and protecting them (e.g., not driving or parking on top of them), not planting trees where roots could damage the system, keeping hazardous chemicals out of the system, and pumping out the septic tank every 3 to 5 years. The cost of proper maintenance, as outlined here, is relatively inexpensive ($450) in comparison to repairing or replacing an entire system ($4,875 to $31,500). Additionally, the repair/replacement and pump-out programs will benefit owners of private sewage (e.g., septic) systems, particularly low-income homeowners, by sharing the cost of required maintenance.

In addition, residential BMPs have several economic benefits to localities. Increased retention of stormwater on site can lower peak discharges, thereby reducing the drainage infrastructure needed to prevent flooding. This can result in cost savings to local governments through reduced engineering and land acquisition costs, and reduced materials and installation costs for stormwater culverts and streambank armoring to prevent scour. Lastly, implementation of residential BMPs greatly reduces soil erosion and sediment transport to our rivers, streams, and lakes. A 1993 study of the economic cost of erosion-related pollution showed that national off-site damages from urban sediment sources cost between $192 million and $2.2 billion per year in 1990-dollar values (Paterson et al, 1993). This cost range would be far greater today if adjusted for inflation.

7.3.3. Watershed Health and Associated Benefits

Focusing on reducing bacteria, sediment, and phosphorus in the watersheds will have associated watershed health benefits as well. Reductions in streambank erosion, excessive nutrient runoff, and water temperature are additional benefits associated with streamside buffer plantings. In turn, reduced nutrient loading and erosion and cooler water temperatures improves habitat for fisheries, which provides associated benefits to anglers and the local economy. Riparian buffers can also improve habitat for wildlife such as ground-nesting quail and other sensitive species. Data collected from Breeding Bird Surveys in Virginia indicate that the quail population declined 4.2% annually between 1966 and 2007. Habitat loss has been cited as the primary cause of this decline.

As a result, Virginia has experienced significant reductions in economic input to rural communities from quail hunting. The direct economic contribution of quail hunters to the Virginia economy was estimated at nearly $26 million in 1991, with the total economic impact approaching $50 million. Between 1991 and 2004, the total loss to the Virginia economy was more than $23 million from declining quail hunter expenditures (VDGIF, 2009). Funding is available to assist landowners in quail habitat restoration (see **Section 10.0**).

8.0 MEASURABLE GOALS AND MILESTONE FOR ATTAINING WATER QUALITY STANDARDS

Based upon the scope of work involved with implementing this TMDL, full implementation could be expected within 20 years provided that full funding for technical assistance and BMP cost-share are available. Delisting from the Virginia Section 305(b)/303(d) list can be expected after full implementation, when BMPs attain their maximum reduction efficiencies. A timeline for implementation, water quality and implementation goals and milestones, and strategies for targeting of best management practices are described in this section.

8.1. Milestone Identification

The end goals of implementation are restored water quality of the impaired waters and subsequent delisting of the waters from the Commonwealth of Virginia's Section 305(b)/303(d) list following implementation. Progress toward end goals will be assessed during implementation through tracking of best management practices through the Virginia Agricultural BMP Cost-Share Program and continued water quality monitoring.

Expected progress in implementation is established with two types of milestones: *implementation milestones* and *water quality milestones*. Implementation milestones establish the amount of control measures installed within certain timeframes, while water quality milestones establish the corresponding improvements in water quality that can be expected as the implementation milestones are met. The milestones described here are intended to achieve full implementation within 20 years.

Following the idea of a staged implementation approach, resources and finances will be concentrated on the most cost-efficient control measures and areas of highest interest first. Implementation has been divided into four stages: Stage 1 includes years 1 through 5, Stage 2 includes years 6 through 10, Stage 3 includes years 11 through 15 and Stage 4 includes years 16 through 20. **Table 8-1** through **Table 8-9** show implementation goals, the *E.coli* bacteria water quality improvement goals and estimated reductions from each type of BMP for each watershed in each implementation stage. **Table 8-10** through **Table 8-18** show the implementation goals for sediment water quality improvement goals and estimated reductions from each type of BMP for each watershed in each implementation stage. **Table 8-19** and **Table 8-20** show the implementation goals for phosphorus water quality improvement goals and estimated reductions from each type of BMP for each watershed in each implementation stage.

It is important to note that the sediment and phosphorus water quality goals are often being met in either the first or second stage due to the greater quantity of BMPs required to reduce the bacteria load. In the case of water quality goals for bacteria, they are reducing the NPS anthropogenic loads to their allocated amounts published in the TMDL, however, determining the percent exceedance past stage 4 isn't possible as we cannot include non-anthropogenic sources that the implemented BMPs can address.

To estimate the bacteria percentage exceedances achieved by the BMP scenarios presented in this report, a correlation between anthropogenic nonpoint source loads and percent exceedances presented in the TMDL needed to be developed. For each reduction scenario presented in the TMDL (shown in **Table 3-37** and **Table 3-41**), the corresponding estimated anthropogenic nonpoint source load was calculated by applying the scenario reductions to the presented existing loads in the TMDL for the watershed. Using these loading values and the corresponding scenario exceedances, linear interpolations could be developed between each data point, allowing the estimation of a percent exceedance value for remaining anthropogenic nonpoint source loads in any given BMP scenario developed for this Implementation Plan. The percent exceedances for Preddy Creek North Branch and Swift Run have been derived from Preddy Creek and North Fork Rivanna's exceedances due to Preddy Creek North Branch and Swift Run being contained within those larger impairments but not having allocation scenarios within the original bacteria TMDL.

This method was used to estimate the percent exceedance of the 235 cfu/100mL instantaneous standard used in TMDL development. The current bacteria standard is that a waterbody shall not have greater than a 10% excursion frequency of a statistical threshold value (STV) of 410 counts/100 ml. Mathematically, meeting a 10% exceedance of 235 cfu/100mL would more than meet a STV of 410 counts/100 ml. For both the North Fork Rivanna River and the Preddy Creek and Tributaries impairments, scenarios developed in the bacteria TMDL only meet the water quality criteria of less than 10% exceedance of the instantaneous value of 235 cfu/100mL when reductions are simulated to the wildlife load, following 100% reduction on direct septic and livestock contributions and 95% reduction of land-based nonpoint source agricultural and urban loads. Wildlife bacteria loads will not be explicitly addressed by this implementation plan.

8.1.1. Bacteria

Table 8-1. Blue Run bacteria reductions.

BMP Type	Description	BMP Code	Estimated Bacteria Reduction (cfu/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream Exclusion With Grazing Land Management	SL-6W, CRSL-6	-	3.64E+11	3.64E+11	-	-
	Stream Exclusion With Grazing Land Management	SL-6N, CRSL-6	-	1.74E+10	1.74E+10	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	1.94E+10	2.90E+10	-	-
	Cover Crop	SL-8B/8H	-	7.74E+09	1.03E+10	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	2.27E+10	3.41E+10	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	6.74E+10	6.74E+10	4.26E+10	4.26E+10
	Woodland buffer filter area	FR-3	-	5.23E+10	5.23E+10	-	-
	Permanent vegetative cover on critical areas	SL-11	-	2.14E+11	2.14E+11	3.21E+11	3.21E+11
	Improved pasture management	SL-10	-	4.28E+11	4.28E+11	2.85E+11	2.85E+11
	Extensions of Watering System	SL-7	-	2.14E+10	2.14E+10	2.85E+10	2.85E+10
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	4.70E+11	4.70E+11	7.06E+11	7.06E+11
	Animal waste control facilities	WP-4	-	4.99E+08	4.99E+08	-	-
	Roof Runoff Management	WQ-12	-	5.70E+08	5.70E+08	-	-
Residential/ Septic	Bioretention/Raingarden	N/A	-	3.05E+10	3.05E+10	4.58E+10	4.58E+10
	Permeable Pavement	N/A	-	-	-	-	-
	Impervious Surface Removal (ISR)	N/A	-	3.59E+08	-	-	-
	Grass Channels	N/A	-	4.72E+09	4.72E+09	3.15E+09	3.15E+09
	Conservation Landscaping	N/A	-	4.30E+10	4.30E+10	6.22E+10	6.22E+10
	Rainwater Harvesting	N/A	-	-	-	-	-
	Pet Waste Disposal Station	PW-1	-	9.09E+09	-	-	-

	Septic Tank Pumpout	RB-1	-	1.70E+09	1.70E+09	1.11E+09	1.11E+09
	Connection to Public Sewer	RB-2	-	1.75E+10	1.70E+10	-	-
	Septic Tank Repair	RB-3	-	2.12E+09	1.59E+09	5.30E+08	5.30E+08
	Septic System Replacement	RB-4	1.06E+09	2.12E+09	1.59E+09	5.30E+08	5.30E+08
	Installation of Alternative Waste Treatment System	RB-5	-	5.30E+08	-	-	-
Stream Bank	Stream Restoration	N/A	-	-	-	-	-
	Stream Bank Stabilization	WP-2A	-	-	-	-	-
Stanardsville Run			2.65E+07	6.15E+11	5.09E+11	6.15E+11	6.15E+11
Estimated Total Reduction from existing			1.09E+09	2.41E+12	2.32E+12	2.11E+12	2.11E+12

Table 8-2. Marsh Run bacteria reductions.

BMP Type	Description	BMP Code	Estimated Bacteria Reduction (cfu/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	1.06E+12	1.29E+11	1.29E+11	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	6.14E+09	6.14E+09	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	3.90E+10	3.90E+10	4.97E+10	4.97E+10
	Woodland buffer filter area	FR-3	-	1.54E+10	1.54E+10	-	-
	Permanent vegetative cover on critical areas	SL-11	-	7.22E+10	7.22E+10	1.07E+11	1.07E+11
	Improved pasture management	SL-10	-	4.81E+11	4.81E+11	3.21E+11	3.21E+11
	Extension of Watering System	SL-7	9.26E+10	3.74E+10	3.74E+10	2.49E+10	2.49E+10
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	5.02E+11	5.02E+11	7.53E+11	7.53E+11
	Animal waste control facilities	WP-4	-	4.99E+08	-	-	-
	Roof Runoff Management	WQ-12	-	5.70E+08	-	-	-
Residential / Septic	Bioretention	BR-4, RG	-	1.09E+10	1.09E+10	1.53E+10	1.53E+10

	Permeable Pavement	PP	-	-	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	2.39E+08	-	-	-
	Grass Channels	VOC-1	-	6.66E+09	-	-	-
	Conservation Landscaping	CL-1	-	6.81E+10	6.81E+10	1.05E+11	1.05E+11
	Rainwater Harvesting	RWH	-	-	-	-	-
	Pet Waste Disposal Station	PW-1	-	1.09E+10	-	-	-
	Septic Tank Pumpout	RB-1	-	1.86E+09	1.86E+09	1.25E+09	1.25E+09
	Septic Tank Repair	RB-3	-	2.12E+09	2.12E+09	5.30E+08	5.30E+08
	Septic System Replacement	RB-4	-	1.59E+09	2.12E+09	5.30E+08	5.30E+08
	Installation of Alternative Waste Treatment System	RB-5	-	530322580.6	-	-	-
Stream Bank	Stream Restoration	N/A	-	-	-	-	-
	Stream Bank Stabilization	WP-2A	-	-	-	-	-
	Estimated Total Reduction from existing		1.16E+12	1.39E+12	1.37E+12	1.38E+12	1.38E+12

Table 8-3. Preddy Creek bacteria reductions.

BMP Type	Description	BMP Code	Estimated Bacteria Reduction (cfu/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	5.28E+11	7.91E+11	7.91E+11	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	3.62E+10	3.62E+10	-	-
	Stream Protection Fencing with Wide Width Buffer	WP-2W	7.26E+11	-	-	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	4.31E+10	4.31E+10	5.39E+10	5.39E+10
	Cover Crop	SL-8B/8H	-	1.44E+10	1.44E+10	2.16E+10	2.16E+10
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	8.22E+10	8.22E+10	1.26E+11	1.26E+11
	Afforestation of erodible cropland	FR-1	-	7.46E+10	-	-	-

Pasture	Afforestation of erodible pasture	FR-1	-	8.80E+11	8.80E+11	1.32E+12	1.32E+12
	Woodland buffer filter area	FR-3	-	1.06E+11	1.06E+11	-	-
	Permanent vegetative cover on critical areas	SL-11	-	4.78E+11	4.78E+11	7.15E+11	7.15E+11
	Improved pasture management	SL-10	1.47E+11	3.11E+12	3.11E+12	2.08E+12	2.08E+12
	Extension of Watering System	SL-7	4.80E+11	1.92E+10	1.92E+10	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	2.34E+12	2.34E+12	3.51E+12	3.51E+12
	Animal waste control facilities	WP-4	-	5.38E+08	-	-	-
	Roof Runoff Management	WQ-12	-	6.15E+08	-	-	-
Harvested	Afforestation of Crop, Hay, and Pasture Land	FR-1	-	-	-	-	-
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	-	-	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	8.06E+10	8.06E+10	1.21E+11	1.21E+11
	Permeable Pavement	PP	-	-	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	5.52E+08	-	-	-
	Grass Channels	VOC-1	-	5.60E+09	5.60E+09	-	-
	Bioswale	BR-6, BR-7	-	8.96E+09	8.96E+09	-	-
	Conservation Landscaping	CL-1	-	2.87E+11	2.87E+11	4.31E+11	4.31E+11
	Rainwater Harvesting	RWH	-	-	-	-	-
	Pet Waste Management Plan*	PW-0	-	-	-	-	3.97E+12
	Pet Waste Disposal Station	PW-1	-	6.72E+09	6.72E+09	-	-
	Septic Tank Pumpout	RB-1	6.91E+07	2.51E+09	2.51E+09	1.66E+09	1.66E+09
	Septic Tank Repair	RB-3	-	2.76E+09	2.76E+09	4.61E+08	4.61E+08
	Septic System Replacement	RB-4	-	2.76E+09	2.76E+09	4.61E+08	4.61E+08
	Installation of Alternative Waste Treatment System	RB-5	-	4.61E+08	-	-	-
	Stream Restoration	N/A	-	-	-	-	-

Stream Bank	Stream Bank Stabilization	WP-2A	-	-	-	-	-
Preddy Creek North Branch			1.06E+09	2.40E+12	2.33E+12	2.66E+12	2.66E+12
Estimated Total Reduction from Existing			1.88E+12	1.08E+13	1.06E+13	1.10E+13	1.50E+13
Estimated % Reduction from Existing			3.68	21.09	20.80	21.59	29.35
Average Annual *E.Coli* load (TMDL Goal: 2.34E+12)			4.92E+13	3.85E+13	2.78E+13	1.68E+13	1.79E+12
E.Coli Inst. Standard Exceedance (235 cfu/100mL)			54.85%	42.92%	41.55%	36.45%	35.70%

*Pet waste management plan implementation to occur throughout all four implementation stages.

Table 8-4. Preddy Creek North Branch bacteria reductions.

BMP Type	**Description**	**BMP Code**	**Estimated Bacteria Reduction (cfu/yr)**				
			Installed to Date	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	-	1.939E+11	1.94E+11	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	8.90E+09	8.9E+09	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	2.156E+10	2.16E+10	-	-
	Cover Crop	SL-8B/8H	-	5.748E+09	5.75E+09	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	4.426E+10	-	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	4.211E+11	4.21E+11	7.08E+11	7.08E+11
	Woodland buffer filter area	FR-3	-	2.507E+10	2.51E+10	-	-
	Permanent vegetative cover on critical areas	SL-11	-	1.211E+11	1.21E+11	1.84E+11	1.84E+11
	Improved pasture management	SL-10	-	5.188E+11	5.19E+11	3.46E+11	3.46E+11
	Extension of Watering System	SL-7	-	1.922E+10	-	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	4.735E+11	4.73E+11	7.10E+11	7.10E+11
	Animal waste control facilities	WP-4	-	538020086	-	-	-
	Roof Runoff Management	WQ-12	-	768600123	-	-	-

Harvested	Afforestation of Crop, Hay, and Pastureland	FR-1	-	-	-	-	-
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	-	-	-	-	-
Residential / Septic	Bioretention	BR-4, RG	-	1.209E+11	1.21E+11	1.81E+11	1.81E+11
	Permeable Pavement	PP	-	-	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	441760840	-	-	-
	Grass Channels	VOC-1	-	3.918E+09	3.92E+09	2.24E+09	2.24E+09
	Bioswale	BR-6, BR-7	-	8.956E+09	8.96E+09	-	-
	Conservation Landscaping	CL-1	-	3.313E+11	3.31E+11	4.97E+11	4.97E+11
	Rainwater Harvesting	RWH	-	-	-	-	-
	Pet Waste Disposal Station	PW-1	-	1.008E+10	1.01E+10	-	-
	Septic Tank Pumpout	RB-1	1.38E+08	6.335E+09	6.33E+09	4.24E+09	4.24E+09
	Connection to Public Sewer	RB-2	-	4.838E+10	4.84E+10	2.07E+10	2.07E+10
	Septic Tank Repair	RB-3	4.61E+08	6.911E+09	6.91E+09	9.21E+08	9.21E+08
	Septic System Replacement	RB-4	4.61E+08	6.911E+09	6.91E+09	9.21E+08	9.21E+08
	Installation of Alternative Waste Treatment System	RB-5	-	1.382E+09	-	-	-
Stream Bank	Stream Restoration	N/A	-	-	-	-	-
	Stream Bank Stabilization	WP-2A	-	-	-	-	-
Estimated Total Reduction from existing			1.06E+09	2.4E+12	2.33E+12	2.66E+12	2.66E+12

Table 8-5. Quarter Creek bacteria reductions.

BMP Type	Description	BMP Code	Estimated Bacteria Reduction (cfu/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	-	1.61E+11	1.61E+11	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	7.68E+09	7.68E+09	-	-

Cropland	Cover Crop	SL-8B/8H	4.59E+10	-	-	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	4.97E+10	4.97E+10	7.45E+10	7.45E+10
	Woodland buffer filter area	FR-3	-	2.49E+10	2.49E+10	-	-
	Permanent vegetative cover on critical areas	SL-11	-	8.55E+10	8.55E+10	1.28E+11	1.28E+11
	Improved pasture management	SL-10	-	2.78E+11	2.78E+11	1.85E+11	1.85E+11
	Extension of Watering System	SL-7	-	2.14E+10	2.14E+10	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	3.14E+11	3.14E+11	4.70E+11	4.70E+11
	Animal waste control facilities	WP-4	-	4.99E+08	-	-	-
	Roof Runoff Management	WQ-12	-	5.70E+08	-	-	-
Harvested	Afforestation of erodible pasture	FR-1	-	-	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	3.93E+10	3.93E+10	5.89E+10	5.89E+10
	Permeable Pavement	PP	-	-	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	2.39E+08	-	-	-
	Grass Channels	VOC-1	-	7.51E+09	7.51E+09	4.85E+09	4.85E+09
	Conservation Landscaping	CL-1	-	9.56E+10	9.56E+10	1.43E+11	1.43E+11
	Rainwater Harvesting	RWH	-	-	-	-	-
	Pet Waste Disposal Station	PW-1	-	1.09E+10	-	-	-
	Septic Tank Pumpout	RB-1	1.59E+09	3.71E+09	3.71E+09	2.49E+09	2.49E+09
	Connection to Public Sewer	RB-2	-	2.65E+09	-	-	-
	Septic Tank Repair	RB-3	-	2.65E+09	2.65E+09	1.59E+09	1.59E+09
	Septic System Replacement	RB-4	5.30E+08	2.65E+09	2.65E+09	1.59E+09	1.59E+09
	Installation of Alternative Waste Treatment System	RB-5	-	5.30E+08	5.30E+08	-	-
Stream Bank	Stream Restoration	N/A	-	-	-	-	-
	Stream Bank Stabilization	WP-2A	-	-	-	-	-
	Estimated Total Reduction from existing		4.80E+10	1.11E+12	1.09E+12	1.07E+12	1.07E+12

Table 8-6. North Fork Rivanna bacteria reductions.

BMP Type	Description	BMP Code	Estimated Bacteria Reduction (cfu/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	1.11E+12	1.39E+12	1.39E+12	9.3E+11	9.3E+11
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	1.11E+11	1.11E+11	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	4.84E+10	4.84E+10	7.26E+10	7.26E+10
	Cover Crop	SL-8B/8H	-	5.16E+10	5.16E+10	7.74E+10	7.74E+10
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	2.27E+11	2.27E+11	3.41E+11	3.41E+11
	Afforestation of erodible pasture	FR-1	-	1.73E+10	1.73E+10	2.6E+10	2.6E+10
Pasture	Afforestation of erodible pasture	FR-1	-	7.24E+11	7.24E+11	1.09E+12	1.09E+12
	Woodland buffer filter area	FR-3	-	1.65E+11	1.65E+11	1.1E+11	1.1E+11
	Permanent vegetative cover on critical areas	SL-11	-	8.55E+11	8.55E+11	1.28E+12	1.28E+12
	Improved pasture management	SL-10	-	7.45E+12	7.45E+12	4.97E+12	4.97E+12
	Extension of Watering System	SL-7	-	4.81E+10	4.81E+10	3.21E+10	3.21E+10
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	6.65E+12	6.65E+12	9.97E+12	9.97E+12
	Animal waste control facilities	WP-4	-	2E+09	-	-	-
	Roof Runoff Management	WQ-12	-	1.71E+09	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	2.17E+11	1.18E+11	1.18E+11	6.98E+10	6.98E+10
	Impervious Surface Removal (ISR)	ISR	-	7.17E+08	-	-	-
	Grass Channels	VOC-1	-	7.27E+09	7.27E+09	4.85E+09	4.85E+09
	Conservation Landscaping	CL-1	-	3.83E+11	3.83E+11	5.74E+11	5.74E+11
	Pet Waste Management Plan*	PW-0	-	-	-	-	1.96E+13
	Pet Waste Disposal Station	PW-1	-	9.09E+09	9.09E+09	1.09E+10	1.09E+10
	Septic Tank Pumpout	RB-1	-	9.63E+09	9.63E+09	6.42E+09	6.42E+09

	Connection to Public Sewer	RB-2	-	3.23E+10	3.23E+10	-	-
	Septic Tank Repair	RB-3	-	1.06E+10	1.06E+10	5.3E+08	5.3E+08
	Septic System Replacement	RB-4	-	1.06E+10	1.06E+10	5.3E+08	5.3E+08
	Installation of Alternative Waste Treatment System	RB-5	-	5.3E+08	5.3E+08	5.3E+08	5.3E+08
Stanardsville Run			-	6.15E+11	5.09E+11	6.15E+11	6.15E+11
Blue Run			1.06E+09	1.80E+12	1.81E+12	1.50E+12	1.50E+12
Quarter creek			4.80E+10	1.11E+12	1.09E+12	1.07E+12	1.07E+12
Swift Run			7.52E+12	5.09E+12	5.09E+12	5.08E+12	5.08E+12
Marsh Run			1.16E+12	1.39E+12	1.37E+12	1.38E+12	1.38E+12
X Trib			-	7.19E+10	5.22E+10	6.57E+10	6.57E+10
North Preddy			1.06E+09	2.40E+12	2.33E+12	2.66E+12	2.66E+12
Preddy			1.88E+12	8.38E+12	8.30E+12	8.38E+12	1.23E+13
Estimated Total Reduction from existing			1.19E+13	3.92E+13	3.89E+13	4.03E+13	6.39E+13
Estimated % Reduction from existing			5.83	19.13	18.98	19.68	31.17
Average Annual *E.Coli* load (TMDL Goal: 1.23E+13)			1.93E+14	1.54E+14	1.15E+14	7.45E+13	1.07E+13
E.Coli % 235 Inst standard Exceedance			22.23	21.74	21.40	21.40	17.37

*Pet waste management plan implementation to occur throughout all four implementation stages.

Table 8-7 Swift Run Bacteria Reductions

BMP Type	Description	BMP Code	Estimated Bacteria Reduction (cfu/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	6.05E+12	5.88E+11	5.88E+11	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	5.90E+11	2.80E+10	2.80E+10	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	7.26E+10	7.26E+10	-	-
	Cover Crop	SL-8B/8H	-	3.74E+10	3.74E+10	5.42E+10	5.42E+10

	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	1.42E+11	1.42E+11	2.27E+11	2.27E+11
Pasture	Afforestation of erodible pasture	FR-1	-	4.61E+11	4.61E+11	6.92E+11	6.92E+11
	Woodland buffer filter area	FR-3	-	9.45E+10	9.45E+10	-	-
	Permanent vegetative cover on critical areas	SL-11	-	4.17E+11	4.17E+11	6.25E+11	6.25E+11
	Improved pasture management	SL-10	8.75E+11	1.60E+12	1.60E+12	1.07E+12	1.07E+12
	Extension of Watering System	SL-7	-	2.14E+10	2.14E+10	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	1.38E+12	1.38E+12	2.07E+12	2.07E+12
	Animal waste control facilities	WP-4	-	4.99E+08	-	-	-
	Roof Runoff Management	WQ-12	-	5.70E+08	-	-	-
Harvested	Afforestation of erodible pasture	FR-1	-	-	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	5.89E+10	5.89E+10	8.94E+10	8.94E+10
	Permeable Pavement	PP	-	-	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	4.78E+08	4.78E+08	-	-
	Grass Channels	VOC-1	-	2.06E+09	2.06E+09	-	-
	Conservation Landscaping	CL-1	-	1.67E+11	1.67E+11	2.51E+11	2.51E+11
	Rainwater Harvesting	RWH	-	-	-	-	-
	Pet Waste Disposal Station	PW-1	-	9.09E+09	1.09E+10	-	-
	Septic Tank Pumpout	RB-1	5.30E+07	2.89E+09	2.89E+09	1.91E+09	1.91E+09
	Septic Tank Repair	RB-3	5.30E+08	3.18E+09	3.18E+09	5.30E+08	5.30E+08
	Septic System Replacement	RB-4	5.30E+08	2.65E+09	2.65E+09	5.30E+08	5.30E+08
	Installation of Alternative Waste Treatment System	RB-5	-	5.30E+08	-	-	-
Stream Bank	Stream Restoration	N/A	-	-	-	-	-
	Stream Bank Stabilization	WP-2A	-	-	-	-	-
Stanardsville Run			2.65E+07	6.15E+11	5.09E+11	6.15E+11	6.15E+11
Blue Run			1.06E+09	1.80E+12	1.81E+12	1.50E+12	1.50E+12

Quarter Creek	4.80E+10	1.11E+12	1.09E+12	1.07E+12	1.07E+12
Estimated Total Reduction from existing	7.57E+12	8.61E+12	8.51E+12	8.26E+12	8.26E+12

Table 8-8. Stanardsville Run bacteria reductions.

BMP Type	Description	BMP Code	Estimated Bacteria Reduction (cfu/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	-	9.41E+10	-	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	4.49E+09	-	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	1.45E+09	1.45E+09	-	-
	Cover Crop	SL-8B/8H	-	2.58E+08	-	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	3.55E+10	3.55E+10	4.26E+10	4.26E+10
	Woodland buffer filter area	FR-3	-	7.54E+09	7.54E+09	-	-
	Permanent vegetative cover on critical areas	SL-11	-	4.54E+10	4.54E+10	6.95E+10	6.95E+10
	Improved pasture management	SL-10	-	1.18E+11	1.18E+11	7.84E+10	7.84E+10
	Extension of Watering System	SL-7	-	2.49E+10	2.49E+10	1.60E+10	1.60E+10
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	1.63E+11	1.63E+11	2.45E+11	2.45E+11
	Animal waste control facilities	WP-4	-	4.99E+08	-	-	-
	Roof Runoff Management	WQ-12	-	5.70E+08	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	3.05E+10	3.05E+10	4.80E+10	4.80E+10
	Permeable Pavement	PP	-	-	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	4.78E+08	4.78E+08	-	-
	Grass Channels	VOC-1	-	7.27E+09	7.27E+09	4.85E+09	4.85E+09
	Conservation Landscaping	CL-1	-	6.81E+10	6.81E+10	1.05E+11	1.05E+11
	Rainwater Harvesting	RWH	-	-	-	-	-
	Pet Waste Disposal Station	PW-1	-	5.45E+09	-	-	-

	Septic Tank Pumpout	RB-1	2.65E+07	5.04E+08	5.04E+08	3.18E+08	3.18E+08
	Connection to Public Sewer	RB-2	-	5.83E+09	5.83E+09	4.24E+09	4.24E+09
	Septic Tank Repair	RB-3	-	5.30E+08	5.30E+08	5.30E+08	5.30E+08
	Septic System Replacement	RB-4	-	5.30E+08	5.30E+08	5.30E+08	5.30E+08
	Installation of Alternative Waste Treatment System	RB-5	-	5.30E+08	-	-	-
Stream Bank	Stream Restoration	N/A	-	-	-	-	-
	Stream Bank Stabilization	WP-2A	-	-	-	-	-
Estimated Total Reduction from existing			-	6.15E+11	5.09E+11	6.15E+11	6.15E+11

Table 8-9. X-Trib to Flat Branch bacteria reductions.

BMP Type	Description	BMP Code	Estimated Bacteria Reduction (cfu/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Pasture	Afforestation of erodible pasture	FR-1	-	1.42E+09	1.42E+09	-	-
	Permanent vegetative cover on critical areas	SL-11	-	3.47E+09	0.00E+00	-	-
	Improved pasture management	SL-10	-	6.06E+09	0.00E+00	-	-
	Extension of watering system	SL-7	-	2.49E+09	0.00E+00	-	-
	Animal waste control facilities	WP-4	-	4.99E+08	0.00E+00	-	-
	Roof Runoff Management	WQ-12	-	2.85E+08	0.00E+00	-	-
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	-	-	-	-	-
Residential/ Septic	Bioretention	N/A	-	1.35E+10	1.35E+10	2.03E+10	2.03E+10
	Permeable Pavement	N/A	-	-	-	-	-
	Impervious Surface Removal (ISR)	N/A	-	3.59E+08	0.00E+00	-	-
	Grass Channels	N/A	-	7.27E+09	7.27E+09	-	-
	Conservation Landscaping	N/A	-	2.99E+10	2.99E+10	4.54E+10	4.54E+10

	Rainwater Harvesting	N/A	-	-	-	-	-
	Pet Waste Disposal Station	PW-1	-	5.45E+09	0.00E+00	-	-
	Septic Tank Pumpout	RB-1	-	1.33E+08	1.06E+08	2.65E+07	2.65E+07
	Septic Tank Repair	RB-3	-	5.30E+08	0.00E+00	-	-
	Installation of Alternative Waste Treatment System	RB-5	-	5.30E+08	0.00E+00	-	-
Stream Bank	Stream Restoration	N/A	-	-	-	-	-
	Stream Bank Stabilization	WP-2A	-	-	-	-	-
Estimated Total Reduction from existing			-	7.19E+10	5.22E+10	6.57E+10	6.57E+10

8.1.2. Sediment

Table 8-10. Blue Run sediment reductions.

BMP Type	Description	BMP Code	Estimated Sediment Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream Exclusion with Grazing Land Management	SL-6W, CRSL-6	-	9271.11	9271.11	-	-
	Stream Exclusion with Grazing Land Management	SL-6N, CRSL-6	-	244.11	244.11	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	1570.76	2356.14	-	-
	Cover Crop	SL-8B/8H	-	504.14	672.19	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	1680.47	2520.71	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	13951.26	13951.26	11136.24	11136.24
	Woodland buffer filter area	FR-3	-	332.32	332.32	-	-
	Permanent vegetative cover on critical areas	SL-11	-	69054.12	69054.12	103581.19	103581.19
	Improved pasture management	SL-10	-	32743.52	32743.52	21829.01	21829.01
	Extensions of Watering System	SL-7	-	682.16	682.16	909.54	909.54

	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	68215.67	68215.67	102323.50	102323.50
	Animal waste control facilities	WP-4	-	79.58	-	-	-
	Roof Runoff Management	WQ-12	-	90.95	-	-	-
Residential/ Septic	Bioretention/Raingarden	N/A	-	5805.36	5805.36	8708.04	8708.04
	Permeable Pavement	N/A	-	66.40	-	-	-
	Impervious Surface Removal (ISR)	N/A	-	98.97	-	-	-
	Grass Channels	N/A	-	1124.27	1124.27	749.52	749.52
	Conservation Landscaping	N/A	-	467.84	467.84	675.77	675.77
	Rainwater Harvesting	N/A	-	1914.98	1983.37	2872.47	2872.47
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	-	-	-	-	-
	Connection to Public Sewer	RB-2	-	-	-	-	-
	Septic Tank Repair	RB-3	-	-	-	-	-
	Septic System Replacement	RB-4	-	-	-	-	-
	Installation of Alternative Waste Treatment System	RB-5	-	-	-	-	-
Stream Bank	Stream Restoration	N/A	-	3545.52	3545.52	1481.04	1481.04
	Stream Bank Stabilization	WP-2A	-	8213.04	8213.04	3500.64	3500.64
Stanardsville Run			-	94325.32	88318.49	113110.22	113110.22
Estimated Total Reduction from existing			-	313981.90	309501.21	370877.17	370877.17
Estimated % Reduction from existing			-	24.69	24.34	29.17	29.17
Average Annual Sediment Load (lbs/yr) (TMDL Goal: 540,103)			-	957608.10	648106.89	277229.72	-93647.45

Table 8-11. Marsh Run sediment reductions.

BMP Type	Description	BMP Code	Estimated Sediment Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4

Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	33800.60	2790.35	2790.35	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	73.17	73.17	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	8337.82	8337.82	6637.20	6637.20
	Woodland buffer filter area	FR-3	-	87.62	87.62	-	-
	Permanent vegetative cover on critical areas	SL-11	-	27649.26	27649.26	40961.86	40961.86
	Improved pasture management	SL-10	-	31229.03	31229.03	20819.36	20819.36
	Extension of Watering System	SL-7	2506.03	1012.05	1012.05	674.70	674.70
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	61686.98	61686.98	92530.47	92530.47
	Animal waste control facilities	WP-4	-	67.47	-	-	-
	Roof Runoff Management	WQ-12	-	77.11	-	-	-
Residential / Septic	Bioretention	BR-4, RG	-	2029.06	2029.06	2840.68	2840.68
	Permeable Pavement	PP	-	124.65	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	65.76	-	-	-
	Grass Channels	VOC-1	-	1585.50	-	-	-
	Conservation Landscaping	CL-1	-	720.36	720.36	1112.14	1112.14
	Rainwater Harvesting	RWH	-	2051.62	-	-	-
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	-	-	-	-	-
	Septic Tank Repair	RB-3	-	-	-	-	-
	Septic System Replacement	RB-4	-	-	-	-	-
	Installation of Alternative Waste Treatment System	RB-5	-	-	-	-	-
Stream Bank	Stream Restoration	N/A	-	942.48	-	-	-
	Stream Bank Stabilization	WP-2A	-	2199.12	-	-	-
Estimated Total Reduction from existing (Existing LA: 543,660)			36306.63	142729.41	135615.70	165576.41	165576.41
Estimated % Reduction from existing			6.68	26.25	24.94	30.46	30.46

Cumulative Reduction (Sediment Reduction Target: 229,222)	645804.57	364623.96	229008.25	63431.84	-102144.57

Table 8-12. Preddy Creek sediment reductions.

BMP Type	Description	BMP Code	Estimated Sediment Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	25152.43	17584.19	17584.19	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	462.89	462.89	-	-
	Stream Protection Fencing with Wide Width Buffer	WP-2W	8333.31	-	-	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	1618.38	1618.38	2022.97	2022.97
	Cover Crop	SL-8B/8H	-	452.47	452.47	678.71	678.71
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	2352.86	2352.86	3619.78	3619.78
	Afforestation of erodible cropland	FR-1	-	2256.05	-	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	117044.27	117044.27	130596.51	130596.51
	Woodland buffer filter area	FR-3	-	520.47	520.47	-	-
	Permanent vegetative cover on critical areas	SL-11	-	120105.18	120105.18	179434.24	179434.24
	Improved pasture management	SL-10	8912.78	188494.79	188494.79	125663.20	125663.20
	Extension of Watering System	SL-7	9696.23	387.85	387.85	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	214713.41	214713.41	322070.12	322070.12
	Animal waste control facilities	WP-4	-	54.30	-	-	-
	Roof Runoff Management	WQ-12	-	62.06	-	-	-
Harvested	Afforestation of Crop, Hay, and Pasture Land	FR-1	-	721.24	721.24	1061.82	1061.82
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	-	59.79	-	-	-
	Bioretention	BR-4, RG	-	15892.57	15892.57	23838.85	23838.85

Residential/ Septic	Permeable Pavement	PP	-	196.99	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	184.08	-	-	-
	Grass Channels	VOC-1	-	1441.38	1441.38	-	-
	Bioswale	BR-6, BR-7	-	1986.57	1986.57	-	-
	Conservation Landscaping	CL-1	-	1314.22	1314.22	1971.33	1971.33
	Rainwater Harvesting	RWH	-	683.92	683.92	-	-
	Pet Waste Management Plan*	PW-0	-	-	-	-	-
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	-	-	-	-	-
	Septic Tank Repair	RB-3	-	-	-	-	-
	Septic System Replacement	RB-4	-	-	-	-	-
	Installation of Alternative Waste Treatment System	RB-5	-	-	-	-	-
Stream Bank	Stream Restoration	N/A	-	5699.76	5699.76	3814.80	3814.80
	Stream Bank Stabilization	WP-2A	-	15528.48	15528.48	6687.12	6687.12
Preddy Creek North Branch			0.00	245375.10	240621.89	300524.28	300524.28
Estimated Total Reduction from Existing			52094.76	955193.25	947626.77	1101983.73	1101983.73
Estimated % Reduction from Existing			1.21	22.13	21.95	25.53	25.53
Average Annual Sediment load (lbs/yr) (TMDL goal = 3,864,965)			4,264,564.24	3,309,370.99	2,361,744.22	1,259,760.48	157,776.75

Table 8-13. Preddy Creek North Branch sediment reductions.

BMP Type	Description	BMP Code	Estimated Sediment Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	-	5028.5881	5028.588	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	132.57306	132.5731	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	838.11654	838.1165	-	-

	Cover Crop	SL-8B/8H	-	188.95545	188.9555	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	1322.6882	-	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	51001.924	51001.92	81662.62286	81662.62
	Woodland buffer filter area	FR-3	-	145.40152	145.4015	-	-
	Permanent vegetative cover on critical areas	SL-11	-	36342.986	36342.99	55379.78818	55379.79
	Improved pasture management	SL-10	-	36456.31	36456.31	24304.2066	24304.21
	Extension of Watering System	SL-7	-	450.0779	-	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	50408.725	50408.72	75613.0872	75613.09
	Animal waste control facilities	WP-4	-	63.010906	-	-	-
	Roof Runoff Management	WQ-12	-	90.01558	-	-	-
Harvested	Afforestation of Crop, Hay, and Pasture Land	FR-1	-	6846.283	6846.283	10159.00059	10159
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	-	2546.8044	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	24011.414	24011.41	36017.12137	36017.12
	Permeable Pavement	PP	-	133.34606	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	147.26717	-	-	-
	Grass Channels	VOC-1	-	1008.9628	1008.963	576.550163	576.5502
	Bioswale	BR-6, BR-7	-	2000.9512	2000.951	-	-
	Conservation Landscaping	CL-1	-	2622.8989	2622.899	3934.348337	3934.348
	Rainwater Harvesting	RWH	-	3077.6362	3077.636	4103.514925	4103.515
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	-	-	-	-	-
	Connection to Public Sewer	RB-2	-	-	-	-	-
	Septic Tank Repair	RB-3	-	-	-	-	-
	Septic System Replacement	RB-4	-	-	-	-	-

	Installation of Alternative Waste Treatment System	RB-5	-	-	-	-	-
Stream Bank	Stream Restoration	N/A	-	6148.56	6148.56	2625.48	2625.48
	Stream Bank Stabilization	WP-2A	-	14361.6	14361.6	6148.56	6148.56
Estimated Total Reduction from existing			-	245375.10	240621.89	300524.28	300524.28
Estimated % Reduction from existing			-	18.76	18.40	22.98	22.98
Average Annual Sediment load (lbs/yr) (TMDL goal = 769,366)			-	1062629.90	822008.02	521483.74	220959.46

Table 8-14. Preddy Creek North Branch sediment reductions.

BMP Type	Description	BMP Code	Estimated Sediment Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	-	5028.5881	5028.588	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	132.57306	132.5731	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	838.11654	838.1165	-	-
	Cover Crop	SL-8B/8H	-	188.95545	188.9555	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	1322.6882	-	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	51001.924	51001.92	81662.62286	81662.62
	Woodland buffer filter area	FR-3	-	145.40152	145.4015	-	-
	Permanent vegetative cover on critical areas	SL-11	-	36342.986	36342.99	55379.78818	55379.79
	Improved pasture management	SL-10	-	36456.31	36456.31	24304.2066	24304.21
	Extension of Watering System	SL-7	-	450.0779	-	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	50408.725	50408.72	75613.0872	75613.09
	Animal waste control facilities	WP-4	-	63.010906	-	-	-
	Roof Runoff Management	WQ-12	-	90.01558	-	-	-
Harvested	Afforestation of Crop, Hay, and Pasture Land	FR-1	-	6846.283	6846.283	10159.00059	10159

Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	-	2546.8044	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	24011.414	24011.41	36017.12137	36017.12
	Permeable Pavement	PP	-	133.34606	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	147.26717	-	-	-
	Grass Channels	VOC-1	-	1008.9628	1008.963	576.550163	576.5502
	Bioswale	BR-6, BR-7	-	2000.9512	2000.951	-	-
	Conservation Landscaping	CL-1	-	2622.8989	2622.899	3934.348337	3934.348
	Rainwater Harvesting	RWH	-	3077.6362	3077.636	4103.514925	4103.515
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	-	-	-	-	-
	Connection to Public Sewer	RB-2	-	-	-	-	-
	Septic Tank Repair	RB-3	-	-	-	-	-
	Septic System Replacement	RB-4	-	-	-	-	-
	Installation of Alternative Waste Treatment System	RB-5	-	-	-	-	-
Stream Bank	Stream Restoration	N/A	-	6148.56	6148.56	2625.48	2625.48
	Stream Bank Stabilization	WP-2A	-	14361.6	14361.6	6148.56	6148.56
Estimated Total Reduction from existing			-	245375.10	240621.89	300524.28	300524.28
Estimated % Reduction from existing			-	18.76	18.40	22.98	22.98
Average Annual Sediment load (lbs/yr) (TMDL goal = 769,366)			-	1062629.90	822008.02	521483.74	220959.46

Table 8-15. Quarter Creek sediment reductions.

BMP Type	Description	BMP Code	Estimated Sediment Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	-	4798.185	4798.185	-	-

	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	126.0639	126.0639	-	-
Cropland	Cover Crop	SL-8B/8H	1398.661556	-	-	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	12567.98	12567.98	18851.96522	18851.97
	Woodland buffer filter area	FR-3	-	185.2329	185.2329	-	-
	Permanent vegetative cover on critical areas	SL-11	-	32191.88	32191.88	48287.81398	48287.81
	Improved pasture management	SL-10	-	24865.13	24865.13	16576.75467	16576.75
	Extension of Watering System	SL-7	-	796.9594	796.9594	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	53130.62	53130.62	79695.93589	79695.94
	Animal waste control facilities	WP-4	-	92.97859	-	-	-
	Roof Runoff Management	WQ-12	-	106.2612	-	-	-
Harvested	Afforestation of erodible pasture	FR-1	-	2046.53	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	7739.471	7739.471	11609.20688	11609.21
	Permeable Pavement	PP	-	136.9545	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	75.39487	-	-	-
	Grass Channels	VOC-1	-	1787.349	1787.349	1153.128466	1153.128
	Conservation Landscaping	CL-1	-	1161.945	1161.945	1742.917407	1742.917
	Rainwater Harvesting	RWH	-	5471.341	5471.341	6839.176213	6839.176
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	-	-	-	-	-
	Connection to Public Sewer	RB-2	-	-	-	-	-
	Septic Tank Repair	RB-3	-	-	-	-	-
	Septic System Replacement	RB-4	-	-	-	-	-
	Installation of Alternative Waste Treatment System	RB-5	-	-	-	-	-
Stream Bank	Stream Restoration	N/A	-	3814.80	-	-	-
	Stream Bank Stabilization	WP-2A	-	8976.00	-	-	-

Estimated Total Reduction from existing	1398.66	160071.08	144822.16	184756.90	184756.90
Estimated % Reduction from existing	0.19	22.21	20.10	25.64	25.64
Average Annual Sediment load (lbs/yr) (TMDL goal = 355,292)	719278.34	559207.26	414385.10	229628.21	44871.31

Table 8-16. Swift Run sediment reductions.

BMP Type	Description	BMP Code	Estimated Sediment Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	165853.08	8795.08	8795.08	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	13510.53	230.99	230.99	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	2702.24	2702.24	-	-
	Cover Crop	SL-8B/8H	-	1140.00	1140.00	1651.03	1651.03
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	4913.79	4913.79	7862.07	7862.07
Pasture	Afforestation of erodible pasture	FR-1	-	50113.68	50113.68	63788.50	63788.50
	Woodland buffer filter area	FR-3	-	327.94	327.94	-	-
	Permanent vegetative cover on critical areas	SL-11	-	79216.28	79216.28	118824.42	118824.42
	Improved pasture management	SL-10	49272.85	90342.58	90342.58	60228.39	60228.39
	Extension of Watering System	SL-7	-	401.52	401.52	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	117779.96	117779.96	176669.94	176669.94
	Animal waste control facilities	WP-4	-	46.84	-	-	-
	Roof Runoff Management	WQ-12	-	53.54	-	-	-
Harvested	Afforestation of erodible pasture	FR-1	-	267.35	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	10776.03	10776.03	16363.60	16363.60
	Permeable Pavement	PP	-	132.02	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	150.52	-	-	-

	Grass Channels	VOC-1	-	490.07	-	-	-
	Conservation Landscaping	CL-1	-	844.25	844.25	1266.37	1266.37
	Rainwater Harvesting	RWH	-	1025.88	-	-	-
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	-	-	-	-	-
	Septic Tank Repair	RB-3	-	-	-	-	-
	Septic System Replacement	RB-4	-	-	-	-	-
	Installation of Alternative Waste Treatment System	RB-5	-	-	-	-	-
Stream Bank	Stream Restoration	N/A	-	9424.80	9424.80	6305.64	6305.64
	Stream Bank Stabilization	WP-2A	-	22036.08	22036.08	14698.20	14698.20
Stanardsville Run			-	94325.32	88318.49	113110.22	113110.22
Blue Run			-	219656.57	221182.72	257766.95	257766.95
Quarter creek			1398.66	160071.08	144822.16	184756.90	184756.90
Estimated Total Reduction from existing			230035.12	875264.42	853368.59	1023292.22	1023292.22
Estimated % Reduction from existing			6.30	23.97	23.37	28.03	28.03
Average Annual Sediment load (lbs/yr) (TMDL goal = 3,133,596)			3420944.88	2545680.47	1692311.87	669019.65	-354272.57

Table 8-17. Stanardsville Run sediment reductions.

BMP Type	Description	BMP Code	Estimated Sediment Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	-	3232.31	-	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	85.06	-	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	92.45	92.45	-	-
	Cover Crop	SL-8B/8H	-	13.78	-	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	9019.10	9019.10	9046.99	9046.99

	Woodland buffer filter area	FR-3	-	61.72	61.72	-	-
	Permanent vegetative cover on critical areas	SL-11	-	19736.39	19736.39	30185.07	30185.07
	Improved pasture management	SL-10	-	15182.72	15182.72	10121.81	10121.81
	Extension of Watering System	SL-7	-	1073.53	1073.53	690.12	690.12
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	31899.05	31899.05	47848.57	47848.57
	Animal waste control facilities	WP-4	-	107.35	-	-	-
	Roof Runoff Management	WQ-12	-	122.69	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	5981.43	5981.43	9399.39	9399.39
	Permeable Pavement	PP	-	133.98	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	112.54	-	-	-
	Grass Channels	VOC-1	-	1729.65	1729.65	1153.10	1153.10
	Conservation Landscaping	CL-1	-	806.76	806.76	1245.52	1245.52
	Rainwater Harvesting	RWH	-	2735.71	2735.71	3419.63	3419.63
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	-	-	-	-	-
	Connection to Public Sewer	RB-2	-	-	-	-	-
	Septic Tank Repair	RB-3	-	-	-	-	-
	Septic System Replacement	RB-4	-	-	-	-	-
	Installation of Alternative Waste Treatment System	RB-5	-	-	-	-	-
Stream Bank	Stream Restoration	N/A	-	673.2	-	-	-
	Stream Bank Stabilization	WP-2A	-	1525.92	-	-	-
Estimated Total Reduction from existing			-	94325.32	88318.49	113110.22	113110.22
Estimated % Reduction from existing			-	28.55	26.73	34.23	34.23
Average Annual Sediment Load (lbs/yr) (TMDL Goal: 140,166)			-	236085.68	147767.18	34656.97	-78453.25

Table 8-18. X-Trib to Flat Branch sediment reductions.

BMP Type	Description	BMP Code	Estimated Sediment Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Pasture	Afforestation of erodible pasture	FR-1	-	384.11	384.11	-	-
	Permanent vegetative cover on critical areas	SL-11	-	1601.90	-	-	-
	Improved pasture management	SL-10	-	498.86	-	-	-
	Extension of watering system	SL-7	-	85.59	-	-	-
	Animal waste control facilities	WP-4	-	85.59	-	-	-
	Roof Runoff Management	WQ-12	-	48.91	-	-	-
Barren	Farm Road or Heavy Animal Travel Lane Stabilization	SL-11B	-	130.31	-	-	-
Residential/ Septic	Bioretention	N/A	-	2541.01	2541.01	3811.52	3811.52
	Permeable Pavement	N/A	-	70.50	-	-	-
	Impervious Surface Removal (ISR)	N/A	-	68.88	-	-	-
	Grass Channels	N/A	-	1729.69	1729.69	-	-
	Conservation Landscaping	N/A	-	822.40	822.40	1250.05	1250.05
	Rainwater Harvesting	N/A	-	3009.22	-	-	-
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	-	-	-	-	-
	Septic Tank Repair	RB-3	-	-	-	-	-
	Installation of Alternative Waste Treatment System	RB-5	-	-	-	-	-
Stream Bank	Stream Restoration	N/A	-	269.28	-	-	-
	Stream Bank Stabilization	WP-2A	-	673.20	-	-	-
Estimated Total Reduction from existing			-	12019.44	5477.22	5061.57	5061.57
Estimated % Reduction from existing			-	15.21	6.93	6.41	6.41
Average Annual Sediment load (lbs/yr) (TMDL goal: 51,703)			-	66991.56	61514.34	56452.78	51391.21

8.1.3. Phosphorus

Table 8-19. Blue Run phosphorus reductions.

BMP Type	Description	BMP Code	Estimated Phosphorus Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream Exclusion With Grazing Land Management	SL-6W, CRSL-6	-	3.70	3.70	-	-
	Stream Exclusion With Grazing Land Management	SL-6N, CRSL-6	-	0.07	0.07	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	0.05	0.08	-	-
	Cover Crop	SL-8B/8H	-	0.08	0.11	-	-
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	0.37	0.55	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	6.75	6.75	5.51	5.51
	Woodland buffer filter area	FR-3	-	0.98	0.98	-	-
	Permanent vegetative cover on critical areas	SL-11	-	33.65	33.65	50.48	50.48
	Improved pasture management	SL-10	-	18.93	18.93	12.62	12.62
	Extensions of Watering System	SL-7	-	0.25	0.25	0.34	0.34
	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	23.67	23.67	35.50	35.50
	Animal waste control facilities	WP-4	-	0.04	-	-	-
	Roof Runoff Management	WQ-12	-	-	-	-	-
Residential/ Septic	Bioretention/Raingarden	N/A	-	10.90	10.90	16.35	16.35
	Permeable Pavement	N/A	-	0.10	-	-	-
	Impervious Surface Removal (ISR)	N/A	-	0.26	-	-	-
	Grass Channels	N/A	-	1.59	1.59	1.06	1.06
	Conservation Landscaping	N/A	-	1.51	1.51	2.18	2.18
	Rainwater Harvesting	N/A	-	3.93	4.07	5.90	5.90
	Pet Waste Disposal Station	PW-1	-	-	-	-	-

	Septic Tank Pumpout	RB-1	-	499.89	499.89	328.05	328.05
	Connection to Public Sewer	RB-2	-	257.76	249.95	-	-
	Septic Tank Repair	RB-3	-	31.24	23.43	7.81	7.81
	Septic System Replacement	RB-4	15.62	31.24	23.43	7.81	7.81
	Installation of Alternative Waste Treatment System	RB-5	-	7.81	-	-	-
Stream Bank	Stream Restoration	N/A	-	5.37	5.37	2.24	2.24
	Stream Bank Stabilization	WP-2A	-	12.44	12.44	5.30	5.30
Stanardsville Run			7.81	315.21	294.37	240.58	240.58
Estimated Total Reduction from existing			23.43	1267.79	1215.69	721.74	721.74
Estimated % Reduction from existing			2.58	139.39	133.67	79.36	79.36
Average Annual Phosphorus Load (lbs/yr) (TMDL Goal: 518)			901.69	586.48	292.11	51.53	-189.04

Table 8-20. Stanardsville Run phosphorus reductions

BMP Type	Description	BMP Code	Estimated Phosphorus Reduction (lbs/yr)				
			Installed to Date	Stage 1	Stage 2	Stage 3	Stage 4
Livestock Exclusion	Stream exclusion with wide width buffer and grazing land management	SL-6W, CRSL-6	-	1.27	-	-	-
	Stream exclusion with narrow width buffer and grazing land management	SL-6N, CRSL-6	-	0.02	-	-	-
Cropland	Long Term Vegetative Cover on Cropland	SL-1	-	0.01	0.01	-	-
	Cover Crop	SL-8B/8H	-	0.00	-	-	-
Pasture	Afforestation of erodible pasture	FR-1	-	4.21	4.21	4.14	4.14
	Woodland buffer filter area	FR-3	-	0.15	0.15	-	-
	Permanent vegetative cover on critical areas	SL-11	-	9.35	9.35	14.29	14.29
	Improved pasture management	SL-10	-	5.52	5.52	3.68	3.68
	Extension of Watering System	SL-7	-	0.39	0.39	0.25	0.25

	Sediment Retention, Erosion, or Water Control Structures	WP-1	-	10.87	10.87	16.31	16.31
	Animal waste control facilities	WP-4	-	0.06	-	-	-
	Roof Runoff Management	WQ-12	-	-	-	-	-
Residential/ Septic	Bioretention	BR-4, RG	-	11.00	11.00	17.29	17.29
	Permeable Pavement	PP	-	0.21	-	-	-
	Impervious Surface Removal (ISR)	ISR	-	0.33	-	-	-
	Grass Channels	VOC-1	-	2.45	2.45	1.63	1.63
	Conservation Landscaping	CL-1	-	2.67	2.67	4.12	4.12
	Rainwater Harvesting	RWH	-	5.62	5.62	7.02	7.02
	Pet Waste Disposal Station	PW-1	-	-	-	-	-
	Septic Tank Pumpout	RB-1	7.81	148.41	140.59	93.73	93.73
	Connection to Public Sewer	RB-2	-	85.92	85.92	62.49	62.49
	Septic Tank Repair	RB-3	-	7.81	7.81	7.81	7.81
	Septic System Replacement	RB-4	-	7.81	7.81	7.81	7.81
	Installation of Alternative Waste Treatment System	RB-5	-	7.81	-	-	-
Stream Bank	Stream Restoration	N/A	-	1.02	-	-	-
	Stream Bank Stabilization	WP-2A	-	2.31	-	-	-
Estimated Total Reduction from Existing			7.81	315.21	294.37	240.58	240.58
Estimated % Reduction from existing			2.36	95.32	89.01	72.75	72.75
Average Annual Phosphorus Load (lbs/yr) (TMDL goal: 155.6 lbs)			322.89	7.68	-286.69	-527.27	-767.84

8.2. Water Quality Monitoring

Improvements in water quality will be evaluated through water quality monitoring conducted at monitoring stations located in the watersheds as shown in **Figure 8-1**. At these stations, implementation monitoring will begin no sooner than the second odd numbered calendar year following the initiation of implementation once the IP has been accepted by EPA and approved by the Virginia SWCB. While implementation is ongoing through the various state and federal agency programs, initiation of implementation is generally defined as beginning once obtaining a CWA Section 319(h) project through the annual RFA process. Beginning implementation monitoring after 2 to 3 years of implementation will help ensure that time has passed for remedial measures to have stabilized and BMPs to have become fully functional.

8.2.1. DEQ Monitoring

Improvements in water quality will be evaluated through biological monitoring conducted at DEQ monitoring stations located in the watersheds as shown below in **Figure 8-1**. Descriptions of these stations are provided in Error! Reference source not found.. The map shows stations that are part of DEQ's Biological Monitoring Program and are co-located with ambient monitoring stations as well. Biological monitoring is conducted in the spring and fall and takes place on a rotating basis within a six-year assessment cycle. Monitoring will begin no sooner than the second odd numbered calendar year following the initiation of implementation. Beginning monitoring after 2 to 3 years of BMP implementation will help ensure that time has passed for remedial measures to have stabilized and BMPs to have become functional. At a minimum, the frequency of sample collections will be every spring and fall for two years. After two years of bi-annual monitoring an assessment will be made to determine if the segments are no longer impaired. If full restoration, as defined in the current or most recent version of the DEQ Final Water Quality Assessment Guidance Manual, has been achieved, monitoring will be suspended. If the two listing stations shown on the map do not show signs of improvement within this two-year period, monitoring will be discontinued for two years. Bi-annual monitoring will be resumed for another two years on the odd numbered calendar year in the third two-year period of the six-year assessment window. After this, the most recent two years of data will be evaluated, and the same criteria as was used for the first two-year monitoring cycle will apply.

To assess progress in the bacteria load reductions, several stations are specifically part of DEQ's Ambient Monitoring Program, wherein bi-monthly watershed monitoring takes place on a rotating basis for two consecutive years of a six-year assessment cycle. At a minimum, the frequency of bacteria sample collections will be every other month for two years. After two years of bimonthly monitoring an evaluation will be made to determine if water quality is improving. If the water quality is improving and is close to meeting the water quality milestones presented earlier in **Section 8.0**, high frequency monitoring will then be conducted to assess the segments potential for delisting. If full restoration, as defined in the current or most recent version of the VADEQ Final Water Quality Assessment Guidance Manual, has been achieved, monitoring will be suspended. If an implementation monitoring station associated with this Implementation Plan is not trending to meet the bacteria standard within this two-year period, monitoring will be discontinued for two years. Bi-monthly monitoring will be resumed for another two years on the odd numbered calendar year in the third two-year period of the six-year assessment window. After this, the most recent two years of data will be evaluated, and the same criteria as was used for the first two-year monitoring cycle will apply. Monitoring station locations are evaluated annually in order to address program and watershed needs and are subject to change from the list shown in **Table 8-21**.

8.2.2. Citizen Monitoring

Citizen monitoring is another valuable tool for assessing water quality. Citizen monitoring can supplement DEQ monitoring, identify priority areas for implementation, and detect improvements in water quality following implementation. DEQ offers information on Citizen Water Quality Monitoring at https://www.deq.virginia.gov/our-programs/water/water-quality/monitoring/citizen-monitoring

A key source of citizen monitoring already present in the North Fork Rivanna watershed is the Rivanna Conservation Alliance (RCA). RCA is a nonprofit watershed stewardship organization operating throughout the Rivanna River watershed. RCA's benthic monitoring program is certified by VADEQ at Level III, meaning that their volunteer monitoring data can be used by VADEQ as if the samples had been collected by state and other government officials. RCA stations were used in evaluating the impairments in the benthic TMDL study and its benthic stressor analysis. Several of the monitoring stations in **Table 8-21** are RCA monitoring stations (noted by the 'RCA' in the monitoring station name).

Table 8-21. Water quality monitoring stations used to evaluate implementation in the North Fork Rivanna River and Tributaries.

TMDL Watershed	305(b) Segment ID	Cause Group Code 303(d) Impairment ID	Monitoring Station	Station Description
Blue Run	VAV-H27R_BLU01A04 (8.72 mi)	H27R-06-BEN	2-BLU004.86; 2-BLU-BLU02-RCA	South of Rt. 33, due west of Stanardsville High; upstream of Beazley Rd Bridge
Marsh Run	VAV-H27R_MAR01A10 (3.65 mi)	H27R-05-BEN	2BMSH000.10	Rt. 641
Preddy Creek	VAV-H27R_PRD01A00 (7.48 mi)	H27R-03-BAC	2-PRD000.21	Rt. 600 Bridge at Watts
		H27R-08-BEN	2-PRD-BRN01-RCA	Burnley Station Rd. Bridge
Preddy Creek North Branch	VAV-H27R_PRD02A06 (6.24 mi)	H27R-03-BAC	2-PRD004.42	Rt. 641 Bridge
		H27R-03-BEN		
Quarter Creek	VAV-H27R_QTR01A16 (1.58 mi)	H27R-10-BEN	2BQTR000.60	Upstream ford on farm road
North Fork Rivanna River	VAV-H27R_RRN01B10 (3.98 mi)	H27R-04-BAC	2-RRN002.19	Rt. 649 Bridge
	VAV-H27R_RRN02A00 (3.82 mi)	H27R-09-BEN	2-RRN012.89	downstream of Rt. 743 bridge at Advance Mills
	VAV-H27R_RRN03A10 (3.51 mi)		2-RRN015.61	Rt. 604 Bridge
Stanardsville Run	VAV-H27R_SDV01A14 (5.71 mi)	H27R-07-BEN	2-SDV001.02	Culvert downstream of Rt. 33
Swift Run	VAV-H27R_SFR01A00 (1.91 mi)	H27R-02-BAC	2-SFR000.60	Rt. 605 Bridge
		H27R-02-BEN		
X-Trib to Flat Branch	VAV-H27R_FTB01A08 (2.03 mi)	H27R-01-BEN	2-XKL000.37	Lewis and Clark Drive

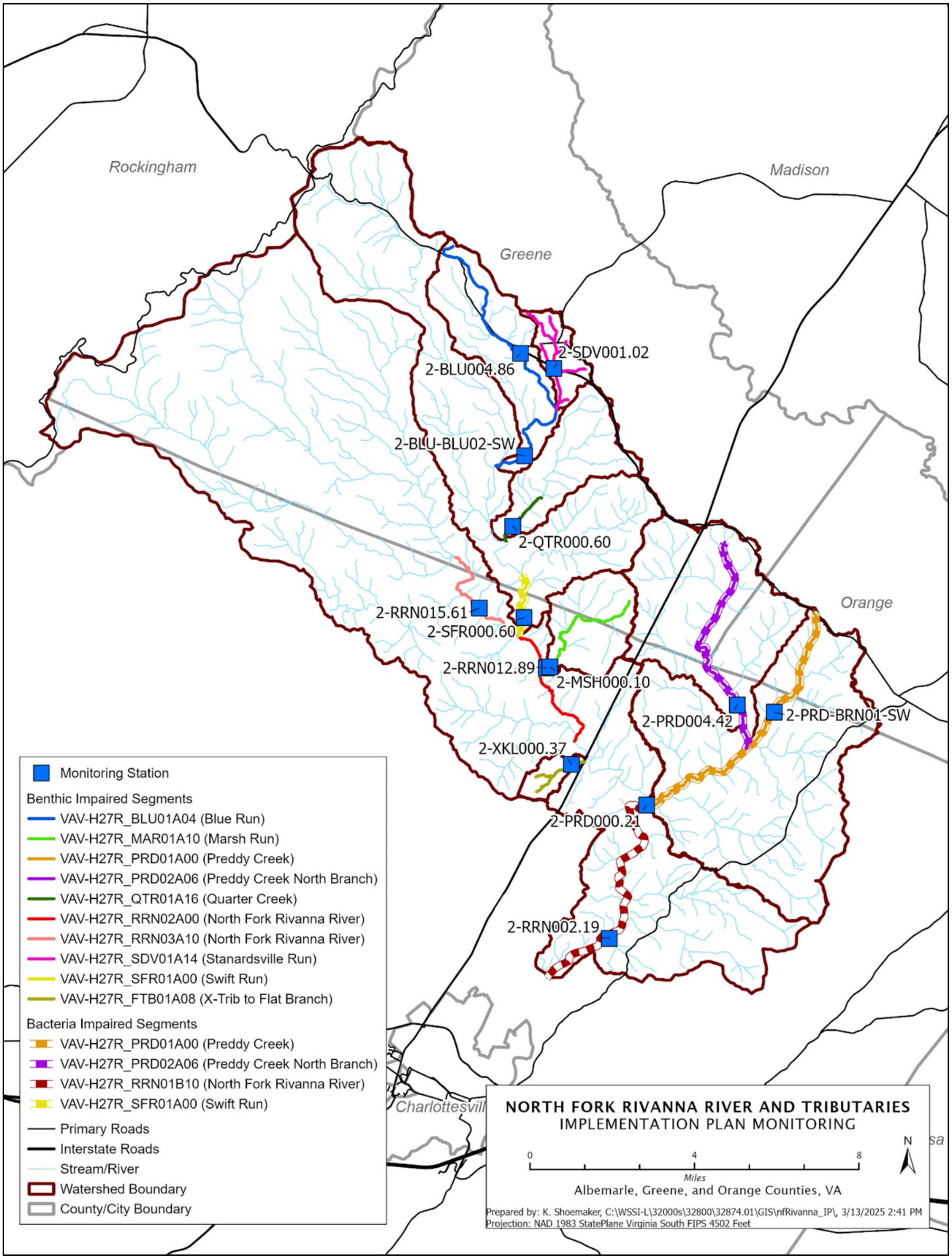

Figure 8-1. Water quality monitoring stations used to evaluate implementation in the North Fork Rivanna River and Tributaries.

8.3. Prioritizing Implementation Actions

Staged implementation implies the process of prioritizing BMPs to achieve the greatest bacteria and sediment reduction benefits early in the process. For example, practices that reduce bacteria from residential septic systems and straight pipes are considered 100% effective. Since malfunctioning septic systems contributing sewage to surface water or groundwater and straight pipes are illegal it will be essential to focus on these human sources. Thus, the majority of residential practices will be implemented in Stage 1 and 2. Prioritizing different BMPs across the stages optimizes the use of limited resources by focusing on the most cost-effective practices and those that present the least obstacles (acceptance by landowners, available cost-share, etc.)

Implementation actions were also prioritized spatially based on watershed inventory and optimum utilization of limited technical and financial resources. The watershed was divided into the subwatersheds represented in the 2019 benthic TMDL and prevalence of target features or land cover types by area within each subwatershed were used to develop prioritization by subwatershed for various BMP groups. **Figure 8-2** illustrates the subwatersheds with the highest density of stream running through pasture/hay land cover, which can be used to prioritize reaching out to landowners within watersheds in the Highest and High priority rankings early in the implementation efforts. Making headway in subwatersheds with a greater density of target features or land cover types can doubly benefit the process by having more landowners exposed to the implementation work and word of mouth regarding water quality progress. Similarly, **Figure 8-3** highlights subwatersheds with the greatest density of pasture, hay, and cropland cover types, which can be priorities for targeted implementation of land-based agricultural BMPs. **Figure 8-4** displays subwatershed prioritization rankings for residential and urban BMPs, ranking highest those subwatersheds with the greatest density of developed, impervious, and turfgrass cover types.

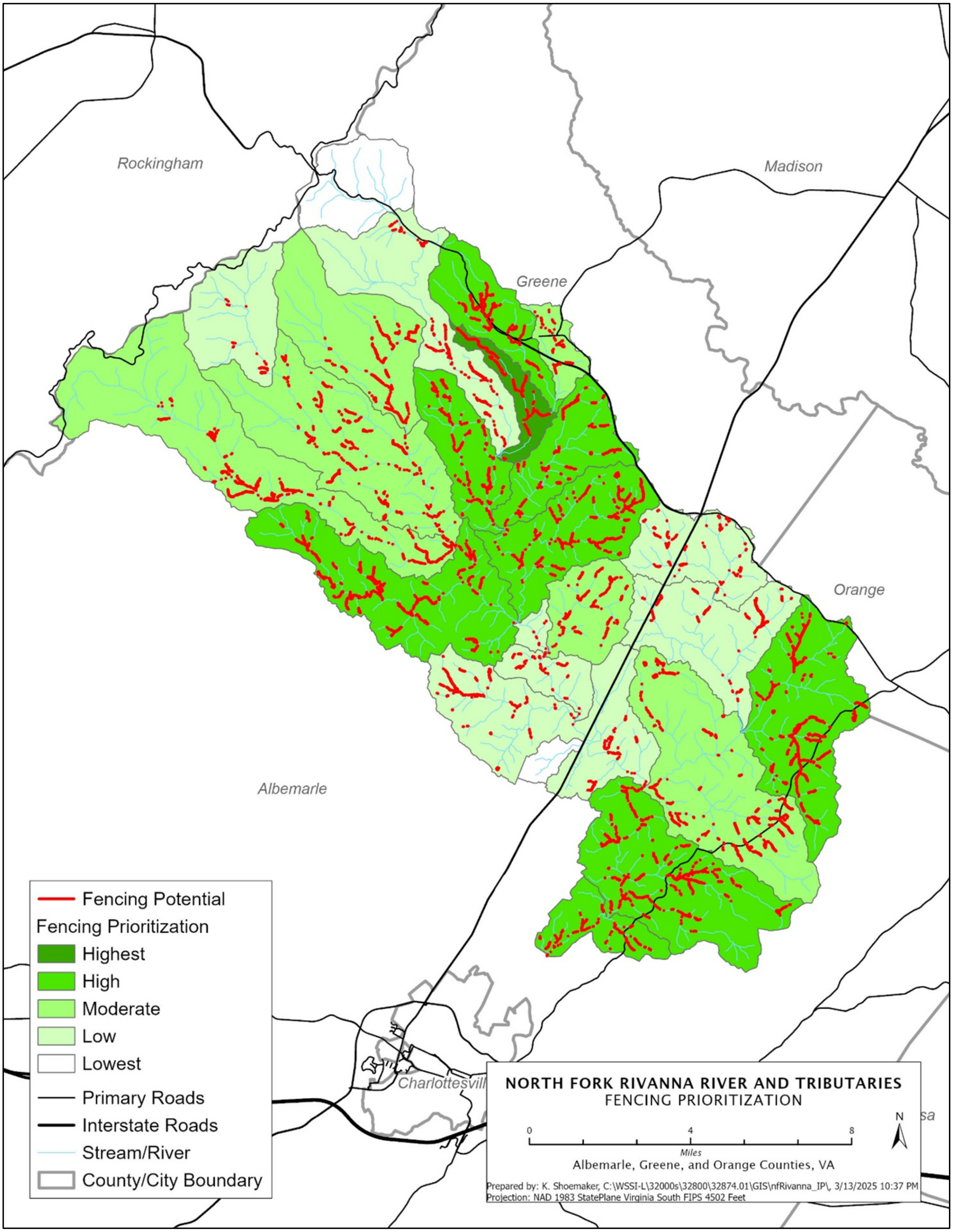

Figure 8-2. Streambank fencing prioritization by subwatershed for the North Fork Rivanna River and Tributaries.

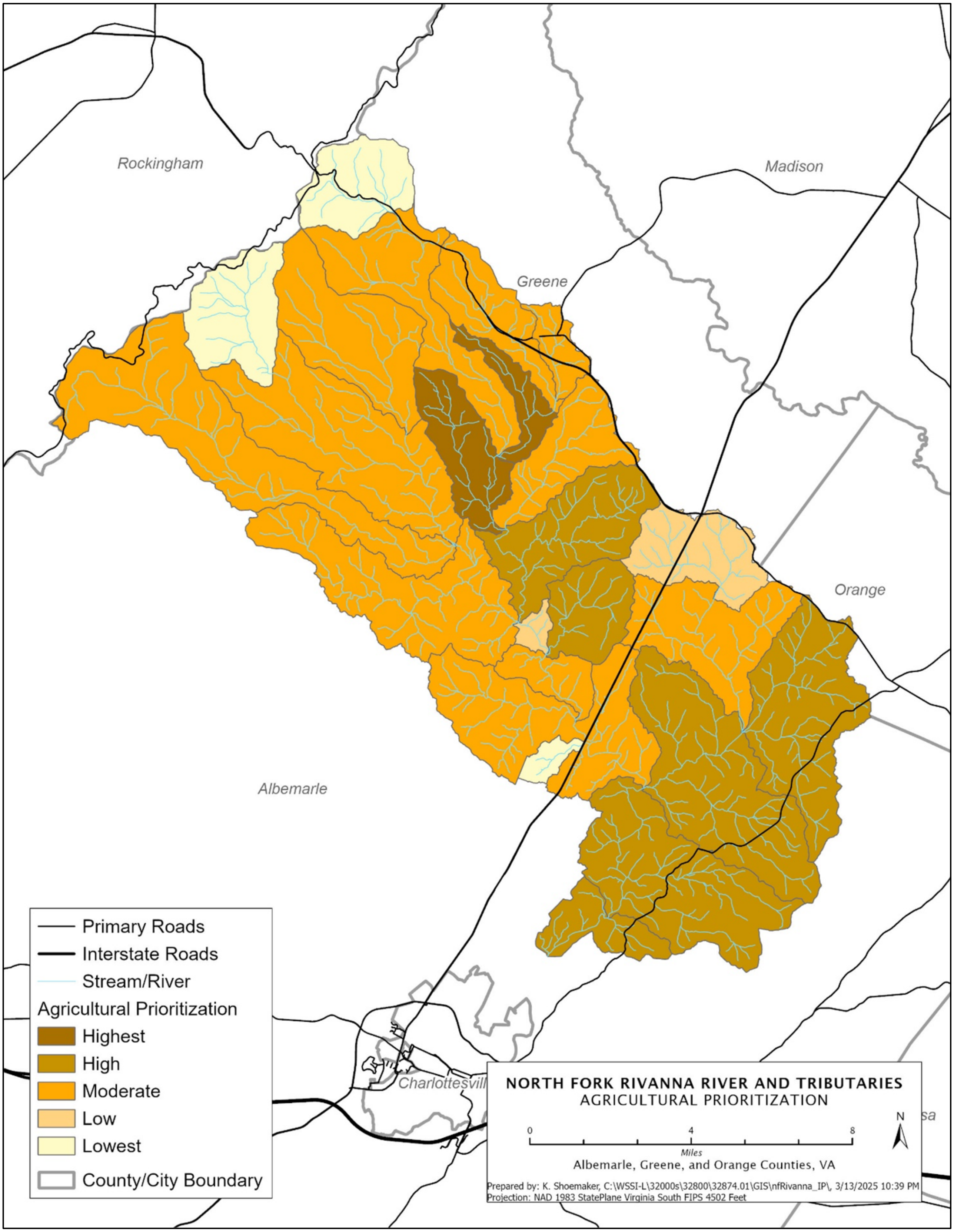

Figure 8-3. Agricultural land-based practices prioritization by subwatershed for the North Fork Rivanna River and Tributaries.

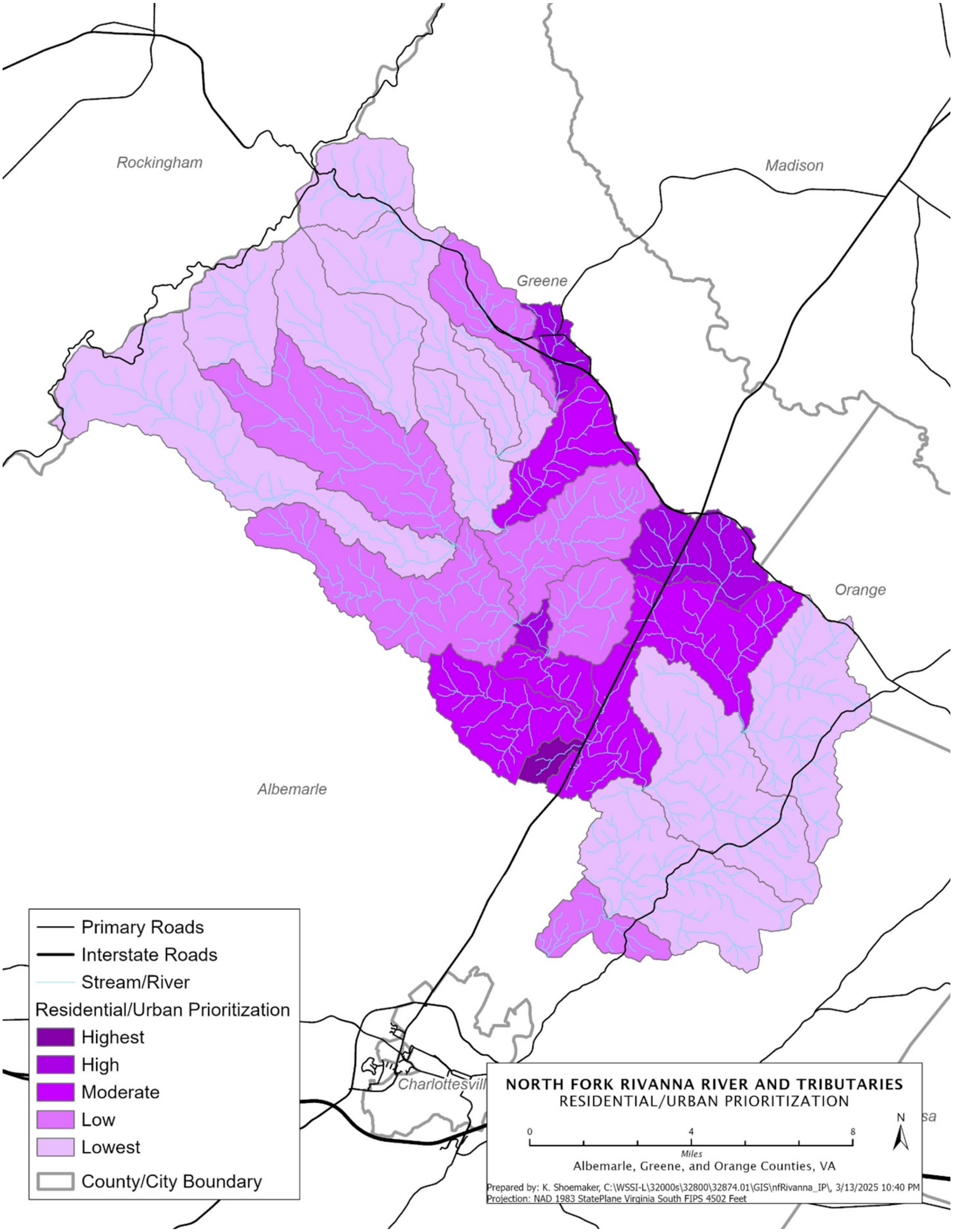

Figure 8-4. Residential/urban prioritization by subwatershed for the North Fork Rivanna River and Tributaries.

8.4. Adaptive Management Strategy

An adaptive management strategy will be utilized in the implementation of this plan to achieve water quality goals. Throughout the course of implementation, the management measures and water quality goals will be assessed, and adjustments of actions will be made as appropriate. The assessment of these measures and goals will be accomplished through monitoring of water quality, as discussed in **Section 8.2** of this report, and evaluation of BMP implementation. Both mechanisms are documented in DEQ's triennial Progress Reports. The Progress Report is developed at the watershed/IP level and includes a summary of the watershed, implementation highlights, and water quality monitoring results. Information in the Progress Report can be used to determine if adaptive management is necessary. For example, if assessments of Stage 1 water quality and implementation milestones show that progress toward achieving the sediment reduction goals is not as expected, the implementation strategy can be adjusted. Stakeholders, such the Culpeper and Thomas Jefferson SWCDs, NRCS, and DEQ will be responsible for making this determination. Stakeholders' roles are described in **Section 9.0**.

As new technologies and BMPs become available, these practices will be evaluated for implementation in the watersheds. In addition, as new funding opportunities become available, they will be reviewed and pursued if applicable in the North Fork Rivanna River watersheds.

9.0 STAKEHOLDERS' ROLES AND RESPONSIBILITIES

Achieving the goals of this plan is dependent on stakeholder participation and strong leadership on the part of both community members and conservation organizations. The Culpepper Soil and Water Conservation District and Thomas Jefferson Soil and Water Conservation District cover all the project area with respect to administration of the VA Agricultural BMP Cost Share Program. Additional partners will be necessary to address urban/residential implementation needs including Albemarle County, Greene County, and Orange County. The following sections in this chapter describe the responsibilities and expectations for the various components of implementation.

9.1. Partner Roles and Responsibilities

9.1.1. Watershed Landowners

Participation by homeowners and local farmers are equally important in the success of this implementation plan. Residential property owners will need to repair or replace any malfunctioning septic system and ensure that their septic systems continue to work properly by regularly pumping and having inspections every 3 to 5 years. SWCD and NRCS Conservationist staff will work with farmers to select the most applicable and cost-efficient practices for their farms. To assist with this selection, it is important to consider characteristics of farms in the watersheds that will affect the decisions farmers make when it comes to implementing conservation practices on their farms. For example, the average size of farms is an important factor to consider, since it affects how much land a farmer can give up for a riparian buffer. The average age of a farmer, which was 58 in Virginia in 2017, may also influence their decision to implement BMPs, particularly if they are close to retirement and will be relying on the sale of their land for income during retirement. In such cases, it may be less likely that a farmer would be willing to invest a portion of their income in BMPs.

In addition to local farmers and homeowners, participation from elected officials is critical to the success of this plan. Elected officials make important decisions with respect to land use and development that are likely to affect water quality. It is critical that the goals of this plan are considered as these decisions are evaluated.

9.1.2. Culpeper Soil and Water Conservation District (CSWCD), Thomas Jefferson Soil and Water Conservation District (TJSWCD) and Natural Resource Conservation Service

At the local level in Virginia, SWCDs work in partnership with the USDA NRCS staff to deliver agricultural conservation technical advice and services to area producers. The Culpeper SWCD serves Greene and Orange Counties, as well as Culpeper, Madison, and Rappahannock Counties and has the largest geographic jurisdictions and staff capacity within Virginia. Thomas Jefferson SWCD serves Albemarle County, as well as Fluvanna, Louisa, and Nelson Counties. SWCDs have considerable technical assistance capabilities to offer landowners within the IP watersheds. Together with NRCS, CSWCD and TJSWCD continually reach out to farmers within their watersheds to provide conservation practice technical expertise. With dedicated staffing capability for the IP watersheds, the SWCDs can better provide agricultural BMP design and layout assistance to individual producers. SWCD 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-focused. Once this IP meets the requirements for funding eligibility under EPA's CWA Section 319(h) program, the SWCDs may apply for grant assistance to enable them to target their expertise to the IP project area landowners. A residential septic system maintenance cost-share program and/or pet waste program could be administered by a number of different entities including the SWCDs or the or the Blue Ridge Health District of the VDH.

9.1.3. Natural Resource Conservation Service (NRCS)

NRCS is the federal agency that works hand-in-hand with the American people to conserve natural resources on private lands. NRCS assists private landowners with conserving their soil, water, and other natural resources. Local, state, and federal agencies and policymakers also rely on NRCS staff expertise. NRCS is also a major funding stakeholder for impaired waterbodies through the Environmental Quality Incentive Program (EQIP).

9.1.4. Albemarle, Greene, and Orange 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 the Counties a key partner in long term implementation efforts.

9.1.5. Virginia Department of Environmental Quality

The Virginia Department of Environmental Quality has a lead role in the development of IPs to address nonpoint source pollutants such as bacteria from straight pipes, failing septic systems, pet waste, agricultural operations, and stormwater that contribute to water quality impairments. DEQ provides available grant funding and technical support for the implementation of NPS (nonpoint source) components of IPs. DEQ will work closely with project partners including the Culpeper Soil and Water Conservation District and Thomas Jefferson Soil and Water Conservation District to track implementation progress for BMPs. In addition, DEQ will work with interested partners on grant proposals to generate funds for projects included in the Implementation Plan. When needed, DEQ will facilitate additional meetings of the stakeholder group to discuss implementation progress and make necessary adjustments to 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 the North Fork Rivanna River and tributaries in order to assess water quality and determine when restoration has been achieved, and the stream can be removed from Virginia's impaired waters list.

9.1.6. Virginia Department of Conservation and Recreation (DCR)

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

9.1.7. Virginia Department of Health (VDH)

The Virginia Department of Health 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.

9.1.8. Rappahannock-Rapidan Regional Commission (RRRC)

RRRC serves Orange County providing a variety of progressional planning and technical resources to local governments and community members. RRRC encourages and facilitates local government cooperation in addressing regional problems of greater than local significance. Among grant writing assistance, program management, land use planning, transportation planning and housing and homelessness planning, RRRC also has a dedicated program area toward agriculture and environmental planning. RRRC facilitates a land use and environment committee, supports Chesapeake Bay TMDL and local TMDL efforts, and protects land through the promotion of green infrastructure. The mission and involvement of RRRC in this implementation plan process will help carry forward the implementation goals.

9.1.9. Thomas Jefferson Planning District Commission (TJPDC)

TJDPC serves Albemarle and Green Counties providing a variety of progressional planning and technical resources to local governments and community members. Services provided to localities and the public include planning, technical assistance, data, and information gathering. TJPDC also has a dedicated program for solid waste planning, housing planning, economic development and hazard mitigation. They also support Chesapeake Bay TMDL and local TMDL efforts through grant opportunities, supporting education on BMPs, and assistance with writing water quality plans, programs and policies. The mission and involvement of TJPDC in this implementation plan process will help carry forward the implementation goals.

9.1.10. Other Potential Local Partners

There are numerous opportunities for future partnerships in the implementation of this plan and associated water quality monitoring. A list of additional organizations and entities with which partnership opportunities should be explored is provided below:

- Local Ruritan Clubs
- Home Owners Associations
- Chesapeake Bay Foundation
- Rivanna River Basin Commission
- Virginia Cooperative Extension
- Virginia Department of Housing and Community Development
- Virginia Department of Agriculture and Consumer Services
- Virginia Department of Forestry
- Virginia Department of Transportation

9.2. Integration with Other Watershed Plans

Each watershed in the state is under the jurisdiction of a multitude of individual yet related water quality programs and activities, many of which have specific geographic boundaries and goals. These include but are not limited to TMDLs, Roundtables, Water Quality Management Plans, erosion and sediment control regulations, stormwater management, Source Water Protection Programs, and comprehensive local plans. Coordination of the implementation project with these existing programs could result in additional resources and increased participation.

9.3. Legal Authority

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

DEQ has responsibility for monitoring waters to determine compliance with state standards, and for requiring permitted point dischargers to maintain loads within permit limits. It has regulatory authority to levy fines and take legal action against those in violation of permits. Beginning in 1994, animal waste from confined animal facilities that hold more than 300 animal units (cattle and hogs) has been managed through a Virginia general pollution abatement permit. These operations require several practices to prevent surface and groundwater contamination. In response to increasing demand from the public to develop new regulations dealing with animal waste, the Virginia General Assembly passed legislation in 1999 requiring DEQ to develop regulations for the management of poultry waste in operations having more than 200 animal units of poultry (about 20,000 chickens) (ELI, 1999). On January 1, 2008, DEQ assumed regulatory oversight of all land applications of treated sewage sludge, commonly referred to as biosolids as a directed by the Virginia General Assembly in 2007. DEQ's Office of Land Application Programs within the Water Quality Division manages the biosolids program. The biosolids program includes having and following nutrient management plans for all fields receiving biosolids, unannounced inspections of the land application site, certification of persons land applying biosolids, and payment of a $7.50 fee per dry ton of biosolids land applied. DEQ holds the responsibility for addressing nonpoint sources (NPS) of pollution as of July 1, 2013.

DCR is responsible for administering the Virginia Agricultural Cost Share and Nutrient Management Programs. Historically, most DCR programs have dealt with agricultural NPS pollution through education and voluntary incentives. These cost-share programs were originally developed to meet the needs of voluntary partial participation and not the level of participation required by TMDLs (near 100%). To meet the needs of the TMDL program and achieve the goals set forth in the CWA, the incentive programs are continually reevaluated to account for this level of participation.

Through Virginia's Agricultural Stewardship Act (ASA), the Commissioner of Agriculture has the authority to investigate claims that an agricultural producer is causing a water quality problem on a case-by-case basis (Pugh, 2001). If deemed a problem, the Commissioner can order the producer to submit an agricultural stewardship plan to the local soil and water conservation district. If a producer fails to implement the plan, corrective action can be taken which can include a civil penalty of up to $5,000 per day. The Commissioner of Agriculture can issue an emergency corrective action if runoff is likely to endanger public health, animals, fish and aquatic life, public water supply, etc. An emergency order can shut down all or part of an agricultural activity and require specific stewardship measures. VDACS has three staff members dedicated to enforcing the Agricultural Stewardship Act, and a small amount of funding is available to support water quality sampling. The Agricultural Stewardship Act is entirely complaint driven.

VDH is responsible for maintaining safe drinking water measured by standards set by the EPA. Their duties also include septic system regulation and, historically, regulation of biosolids land application on permitted farmland sites. Like VDACS, VDH's actions are complaint driven. Complaints can range from a vent pipe odor that is not an actual sewage violation and takes very little time to investigate, to a large discharge violation that may take many weeks or longer to effect compliance.

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

9.4. Legal Action

The Clean Water Act Section 303(d) calls for the identification of impaired waters. It also requires that the streams be ranked by the severity of the impairment and that TMDLs be calculated for streams to meet water quality standards. Implementation Plans are not required in the Federal Code; however, the Virginia State Code does include the development of Implementation Plans for impaired streams. EPA largely ignored the nonpoint source section of the Clean Water Act until citizens began to realize that regulating only point sources was no longer maintaining water quality standards. Lawsuits from citizens and environmental groups citing EPA for not carrying out the statutes of the CWA began as far back as the 1970s and have continued until the present. In Virginia in 1998, the American Canoe Association and the American Littoral Society filed a complaint against EPA for failure to comply with provisions of §303(d). The suit was settled by Consent Decree, which contained a TMDL development schedule through 2010. It is becoming more common for concerned citizens and environmental groups to turn to the courts for the enforcement of water quality issues.

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

10.0 POTENTIAL FUNDING SOURCES

A list of potential funding sources available for implementation has been developed. A brief description of the programs and their requirements is provided in this chapter. Detailed descriptions can be obtained from the SWCD, DEQ, VADCR, NRCS, and VCE.

10.1. Virginia Nonpoint Source Implementation Program

Virginia's nonpoint source (NPS) implementation best management practice cost-share program is administered by DEQ through local Soil & Water Conservation Districts (SWCD), local governments, nonprofits, planning district commissions, and local health departments to improve water quality in the Commonwealth's streams and rivers and in the Chesapeake Bay. DEQ, through its partners, provides cost-share assistance to landowners, homeowners, and agricultural operators as an incentive to voluntarily install nonpoint source BMPs in designated watersheds. The program uses funds from a variety of sources, including CWA Section 319(h) and the state-funded Water Quality Improvement Fund (WQIF) to install BMPs with the goal of ultimately meeting Virginia's NPS pollution water quality objectives. Although resource-based problems affecting water quality can occur on all land uses, this program addresses cost-share assistance on agricultural, residential, and urban lands. The geographic extent of eligible lands is identified in grant agreements and in watershed-based plans (WBPs), including IPs approved by DEQ and accepted by EPA.

10.2. Virginia Agricultural Best Management Practices Cost-Share Program (VACS)

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

10.3. Virginia Agricultural Best Management Practices Tax Credit Program

The program provides a tax credit for approved agricultural BMPs that are installed to improve water quality in accordance with a conservation plan approved by the local SWCD. The goal of this program is to encourage voluntary installation of BMPs that will address Virginia's NPS pollution water quality objectives. The amount of the credit cannot exceed $17,500 or the total amount of the tax imposed by this program (whichever is less) in the year the project was completed. If the amount of the credit exceeds the taxpayer's liability for such taxable year, the excess may be carried over for credit against income taxes in the next five taxable years until the total amount of the tax credit has been taken.

10.4. Virginia Conservation Assistance Program (VCAP)

The Virginia Conservation Assistance Program can provide financial incentives and technical and educational assistance to residential/urban landowners who install stormwater BMPs. The program is administered by SWCDs, 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 (including businesses and public and private lands) in eligible districts may apply for project funding to reduce erosion and address poor drainage and poor vegetation that contribute to water quality problems. A program manual includes standards and specifications for the urban BMPs that are eligible for reimbursement. The local SWCDs may have staff members available to apply for funds through this program to work with interested property owners on eligible BMPs.

10.5. Water Quality Improvement Fund (WQIF)

This is a permanent, non-reverting fund established by the Commonwealth of Virginia to assist local stakeholders in reducing point and nonpoint source loads to surface waters. Eligible recipients include local governments, SWCDs, and individuals. Grants are administered through DEQ and require matching funds on a 50/50 cost-share basis.

10.6. Conservation Reserve Program (CRP)

Through this program, cost-share assistance is available to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Applications for the program are ranked, accepted and processed during signup periods that are announced by the Farm Service Agency (FSA). If accepted, contracts are developed for a minimum of 10 and not more than 15 years. To be eligible for consideration, land and applicants must meet certain criteria set by FSA. Payments may include cost share for practice establishment, incentive payments, and rental payments on enrolled acres.

10.7. Conservation Reserve Enhancement Program (CREP)

This program is an "enhancement" of the existing USDA Conservation Reserve Program. It has been enhanced by combining federal funds with state funds in a partnership to address high priority conservation concerns. In exchange for removing environmentally sensitive land from production and establishing permanent resource conserving plant species, farmers are paid an annual rental rate along with state and federal incentives. Contracts are typically established for 10 or 15 years in support of CREP goals, which include reducing sediment, nutrients, nitrogen and other pollutants entering waterbodies, reducing soil erosion, wetland restoration, and enhancement of wildlife habitat.

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

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

10.8. Environmental Quality Incentives Program (EQIP)

This program was established in the 1996 Farm Bill to provide a single voluntary conservation program for farmers and landowners to address significant natural resource needs and objectives. EQIP is administered by NRCS and offers landowners and farmers cost-share assistance to implement a wide range of conservation practices on agricultural and forest land. Applications are ranked and priority is given to conservation practices that will result in greater environmental benefits.

10.9. EPA Water Infrastructure Finance and Innovation Act (WIFIA) Funds

The WIFIA program was established by the Water Infrastructure Finance and Innovation Act of 2014. WIFIA provides long-term, low-cost supplemental loans for regionally and nationally significant projects. The funds can be used for development and implementation activities for eligible projects including, but not limited to, wastewater conveyance and treatment, drinking water treatment and distribution, enhanced energy efficiency projects at drinking water and wastewater facilities, acquisition of property if it is integral to the project or will mitigate the environmental impact of a project, and combinations of eligible projects. Loans can be combined with other funding sources including state Revolving Fund loans.

10.10. National Fish and Wildlife Foundation (NFWF)

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

10.11. Clean Water State Revolving Fund

EPA awards grants to states to capitalize their Clean Water State Revolving Funds (CWSRFs). The states, through CWSRF, make loans for high-priority water quality activities. As loan recipients make payments back into the fund, money is available for new loans to be issued to other recipients. Eligible projects include point source, nonpoint source and estuary protection projects. Point source projects typically include building wastewater treatment facilities, combining 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.

10.12. Wetland and Stream Mitigation Banking

Mitigation banks are sites where aquatic resources such as wetlands, streams and streamside buffers are restored, created, enhanced, or in exceptional circumstances, preserved expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources. Mitigation banking is a commercial venture that provides compensation for aquatic resources in financially and environmentally preferable ways. Not every site or property is suitable for mitigation banking. Mitigation banks are required to be protected in perpetuity, to provide financial assurances and long-term stewardship. The mitigation banking process is overseen by an Inter-Agency Review Team made up of state and federal agencies and chaired by DEQ and the Army Corps of Engineers.

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Appendix A. Public and Community Engagement Meeting Summaries